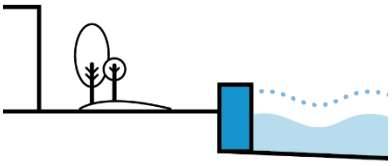
Measure Profile

Rip-Rap Revetment

Flood Adaptation Measure

PHYSICAL INFRASTRUCTURE



SHORELINE LOCATION:

Shoreline

Seawall of riprap on Panama Bay - Panama City, Panama
©Rob Crandall/Alamy Stock Photo

DESIGN LIFE	ADAPTABILITY	IMPACT ON THE WATERFRONT	CONSTRUCTION COST
50+ years	High	Major Intervention	TBD

COASTAL FLOOD HAZARDS MITIGATED:

Sea Level Rise

Storm Surge

Groundwater

Waves

Erosion

MEASURES COMPATIBILITY:

Flood	Seismic
Vegetated Terraces, Seawalls, Floodwalls, Tide Pools, Ecological Concrete Units	Nearshore Buttress, Landside Buttress, Liquefaction Mitigation

ECOSYSTEM SERVICES: Measure may affect these shoreline values

Aquatic Habitat	Terrestrial Habitat	Water Quality	Carbon Storage
—	—	—	—

DESCRIPTION:

Rip-rap revetments are the most commonly used structures for shore protection in San Francisco Bay. Typically, they consist of an armor layer of stone with additional stone underlayers and/or a geotechnical fabric to prevent the loss of soil material due to wave action. Revetments are typically built at a 2H:1V or shallower slopes and achieve stability through the weight of the armor stone as well as some interlocking between stones. Rip-rap revetments are generally less expensive than bulkheads or seawalls but with a larger footprint. Revetments also have an advantage that they are flexible and can sustain some damage or adjust to settlement and still retain their function.

Measure Profile

Rip-Rap Revetment

Flood Adaptation Measure

CONSIDERATIONS:

- Design must account for geotechnical stability and foundation settlement

ADVANTAGES:

- Effectively mitigates erosion
- Economical and low maintenance
- Can sustain damage or adjust to settlement without catastrophic failure
- Can provide habitat for rock-dwelling mollusks and aquatic vegetation

DISADVANTAGES:

- Can lead to loss of existing intertidal habitat due to the footprint of the structure
- On sandy shores, can accelerate erosion of adjacent unprotected shores
- Slope of revetment can limit maritime access to the shoreline
- Rip-rap can provide unwanted habitat to rodents or other pests and be a hazard to people climbing on the revetment
- Requires permitting of additional bay fill

CONSTRUCTION IMPACTS TO THE PUBLIC:

- Installation can be completed from the water or landside. Access to the shoreline will be restricted during construction.

SEA LEVEL RISE ADAPTATION OPPORTUNITIES:

- Flood walls can be added to the crest to reduce flooding due to rising sea levels without increasing the overall footprint of the revetment.

CASE STUDIES:

- Treasure Island, SF; Brooklyn Bridge Parks, NYC

DESIGN OPPORTUNITIES:

Ecological Enhancements

- Vegetation benches and aquatic habitats can be integrated into the design of revetments

Urban Design

- Pathways can be set on top of revetment structures

Form

- Revetment structures can have different slopes and create unique spaces along the waterfront

DESIGN CONSIDERATIONS:

- Armor layer must be sized to remain stable under extreme wave conditions as well as propeller wash from ship operations at the site.
- Underlayer size and grading should meet specific filter and stability criteria to prevent loss of soil material and underlayer material.
- Design must account for geotechnical stability and foundation settlement.
- Additional stone is normally placed at the toe to support the armor layer and to prevent scour of the toe.
- Design should consider potential for erosion behind the crest due to wave overtopping.

SITE-SPECIFIC CONSIDERATIONS:

- Water levels, waves, currents, propeller wash from ship activity should be well defined.
- Geotechnical investigations should be performed to determine potential for settlement and stability.

Measure Profile

Rip-Rap Revetment

Flood Adaptation Measure

ARCHITECTURAL CONSIDERATIONS:

- Randomly placed rip-rap on the armor layer may not be an aesthetically attractive at certain locations. Fitted stone could be considered as an alternative.

URBAN DESIGN CONSIDERATIONS:

- Rip-rap revetments can present a hazard if people walk on or climb down the revetment. Armor stone should be angular in shape or other measures should be employed to discourage people from climbing down to the water over the revetment.
- Rip-rap of revetments accessible to the public should be sized large enough to prevent removal of stones by people.

INSTALLATION AND CONSTRUCTABILITY CONSIDERATIONS:

- Installation can be performed from landside or waterside from a barge.
- Requires grading of existing soil prior to placing revetment material. Potential for suspension of sediment.

OPERATIONS AND MAINTENANCE CONSIDERATIONS:

- Once constructed, little to no maintenance should be required.
- Revetment should be inspected periodically following significant storm events and damage areas that could affect the stability of the structure repaired.