SEAWALLS

CE A676 Coastal Engineering

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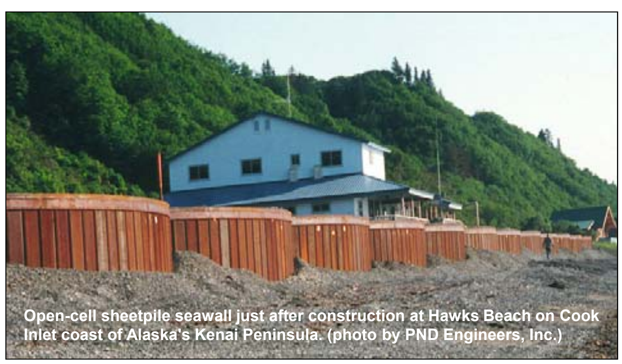
PURPOSES SEAWALLS

- Retaining walls for shoreline fill
- Armor against wave and current forces
- Port structures
  - Mooring berths
- Erosion control along navigation channels



Open-cell sheetpile seawall just after construction at Hawks Beach on Cook Inlet coast of Alaska's Kenai Peninsula. (photo by PND Engineers, Inc.)

PRO'S AND CON'S

- Advantages (if well built)
  - Very strong interlocked materials
  - Conventional construction
  - Small footprint
  - Stable ground behind
  - Face can be used for mooring ships, if water depth allows
- Disadvantages
  - Wave reflection-induced scour
  - Vertical face disrupts natural profile

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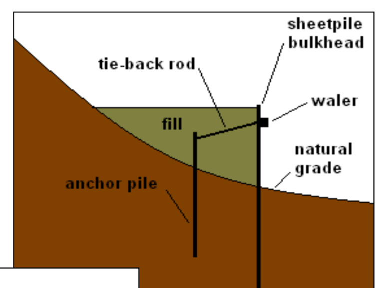
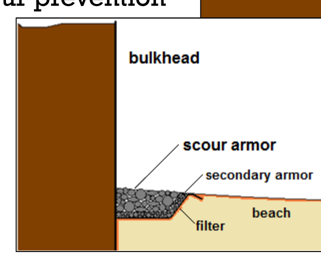
CONVENTIONAL ANCHORED BULKHEAD

- Sheetpile face buried
  - Deep enough to anticipate future scour
- Horizontal waler tied back to buried anchors
  - Anchor pile or buried "deadman"
  - Resistance to horizontal soil pressure
- Toe scour protection important for scour prevention
- Splash apron at crest
- Drainage of fill
  - May be lined with filter fabric
  - Scuppers and weep holes provided





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TYPICAL SHEETPILE BULKHEAD DESIGN STEPS

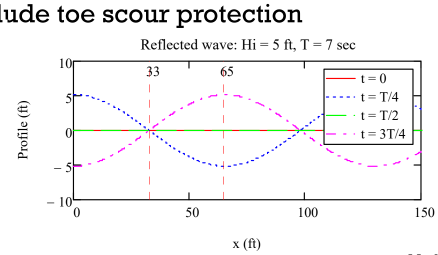
1. **Determine site conditions**
   - **Water level variations**
   - **Ground water variations behind wall**
   - **Characteristics of available fill material**
     - **Unit weights, moist and submerged**
   - **Dead and live loads, based on use of site**
2. **Derive lateral pressure diagrams**
   - **Passive earth pressure**
   - **Active earth pressure**
   - **Hydrostatic (lag in tide drainage)**
   - **Wave forces, *e.g.*, submerged toe, non-breaking:**
     - $F_{max} = \rho g \frac{4d^2+H^2}{8} + \rho g d \frac{H}{2} \frac{tanh(kd)}{kd}$
3. **Determine depth of burial (penetration) of sheetpile**
4. **Determine tie rod tension**
5. **Compute bending moment in sheet piling**
6. **Determine size and spacing of tie rods**
7. **Determine bending moment in and size of waler**
8. **Design anchors to resist tie rod tension**
9. **Design corrosion control**

Note: Geotechnical and structural details of these steps are available in various texts

WAVE REFLECTION

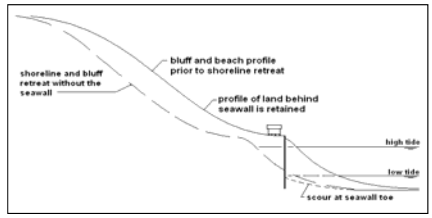
- Smooth, vertical, and impermeable seawalls reflect near 100% of incoming waves
  - Incoming waves resonate with outgoing reflected waves
  - Vertical motion is doubled at wall (standing wave motion)
  - Scour of bed is exacerbated at wall
- At port berths or along navigation canals, this may be okay
- Seawalls with shallow faces should include toe scour protection

$$\eta = H_i cos(kx) sin(\sigma t)$$



SEAWALL IMPACT ON COASTAL BLUFFS

- Bluffs and shoreline naturally retreat together
- Seawall protects bluff
- Beach is lost seaward of seawall
- Seawall-protected reach extends beyond adjacent retreating bluff and beach
  - Ultimately resulting in a barrier to longshore sediment transport



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SEAWALLS AS STORM DEFENSE

- Seawall located above normal sea levels
  - Above normal wave-induced longshore sediment transport motion
- Storm-surge water levels and waves cause scour seaward of wall
  - Beach may be partially restored by normal longshore sediment transport


Fabric-lined, sand-filled, wire-mesh gabions, Barrow, Alaska 2006
Photo by Mikal Hendee


Gabion seawall at Barrow, Alaska 2015
Photo by Orson Smith

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TOE SCOUR

- Face of seawall must be buried deep enough to accommodate scour
- Toe scour protection should be included

Contractors struggle to extend exposed toe of seawall downward at Bishops Beach, Homer, Alaska. Photo by Orson Smith

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LOW-COST MATERIALS

- Walls built of gabions or other low-cost materials are likely to eventually fail
  - Wave forces
  - Scour
  - Loss of fill through porous wall
  - Ice forces
  - Corrosion of metal components

Remnants of gabions filled with sandbags, Shishmaref, Alaska Photo by Mikal Hendee

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