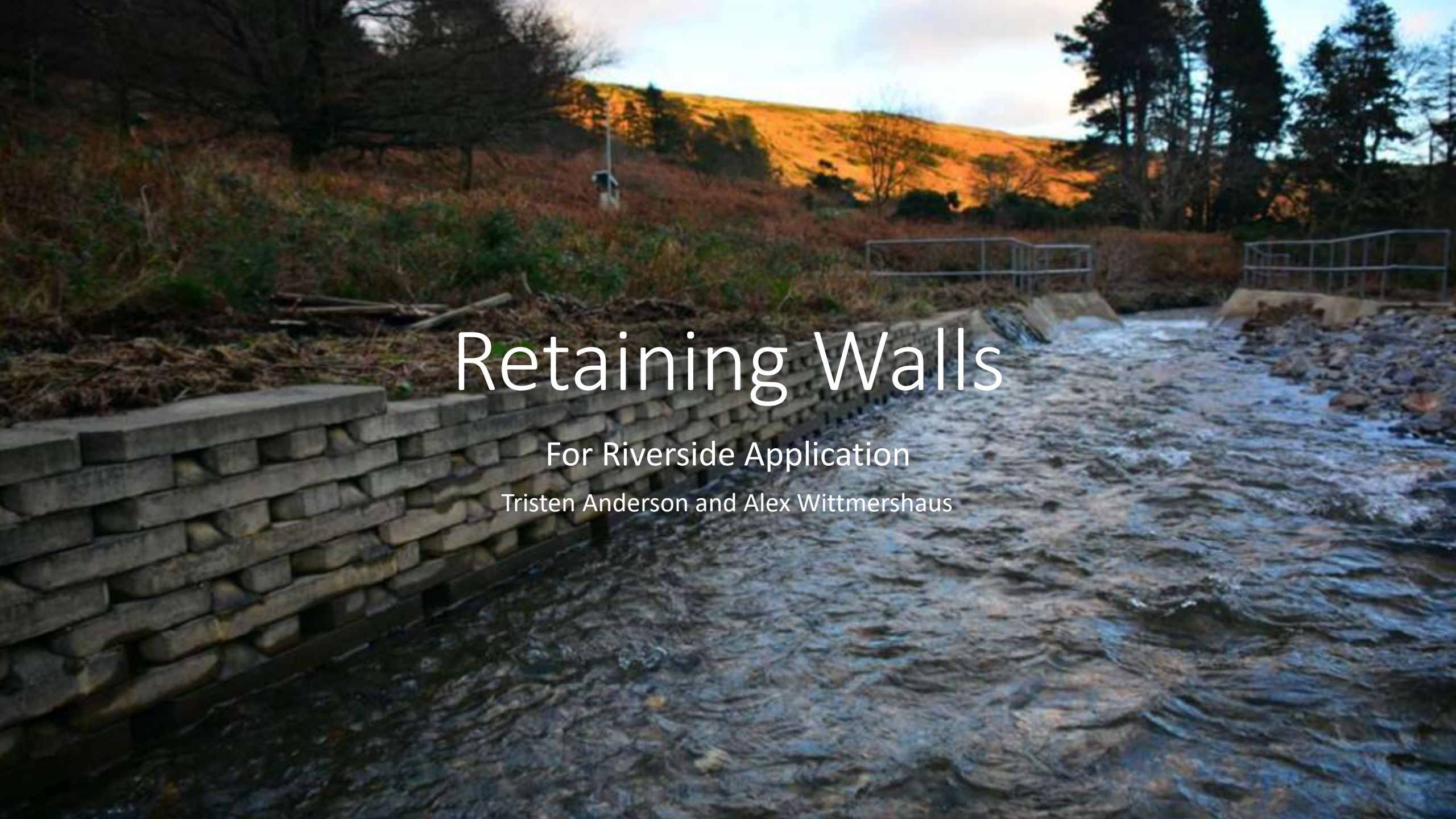


Retaining Walls

For Riverside Application

Tristen Anderson and Alex Wittmershaus

Introduction

Definition

- A retaining wall is a near-vertical structure that holds back earth and/or water.

Purpose

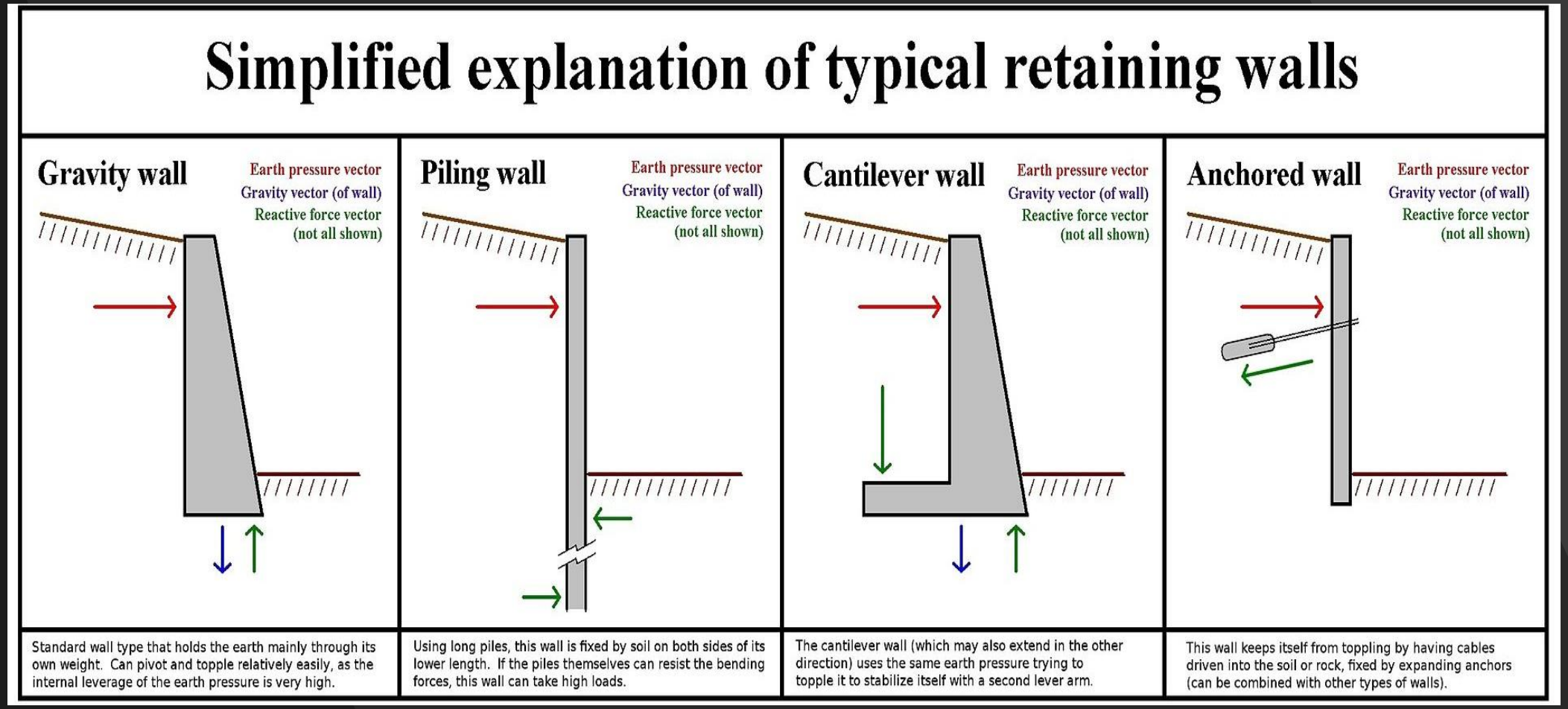
- To stabilize the riverbank on which the retaining wall is constructed.
- To prevent riverbank erosion, lateral migration, and mass failure.

Importance

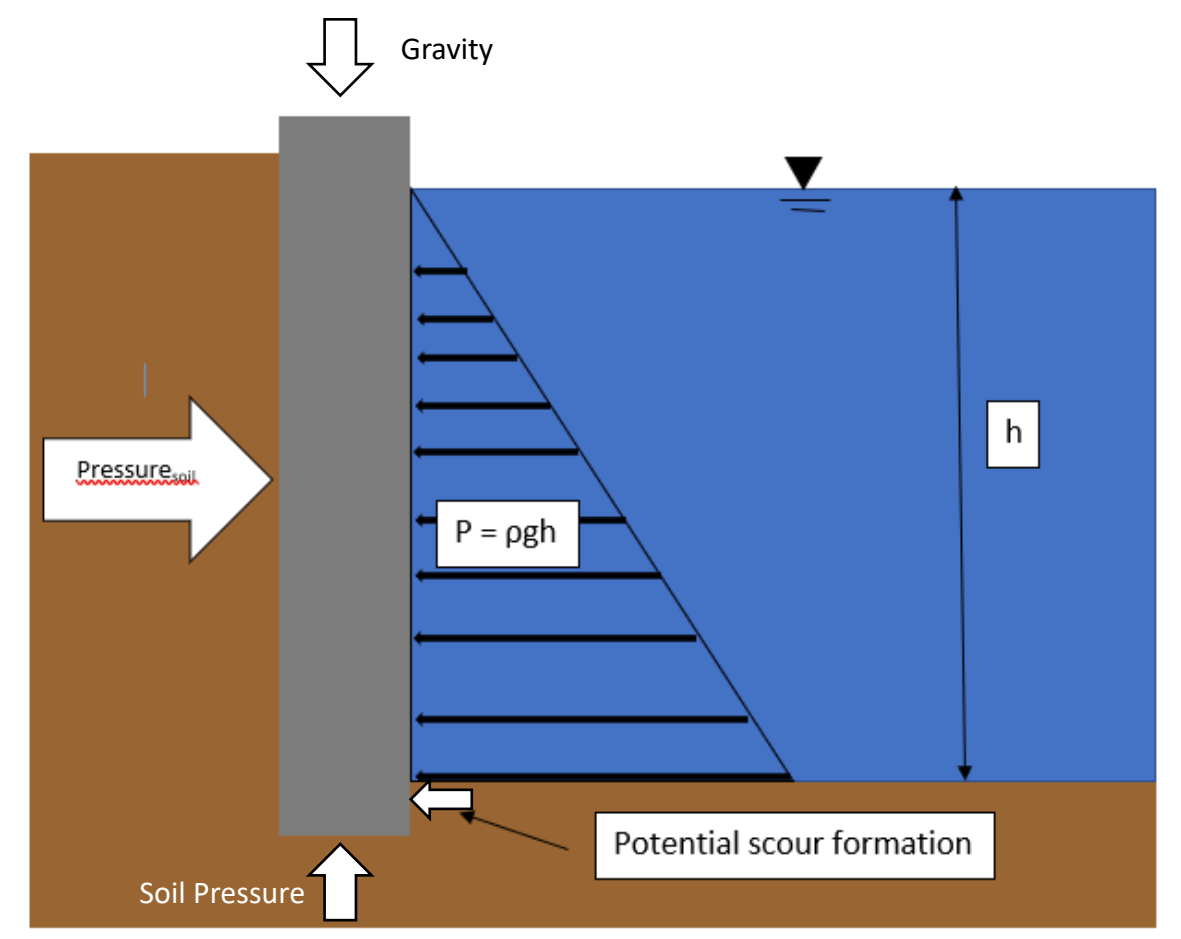
- Valuable for protecting waterfront property and infrastructure.

Types & Basic Theory

Three Main Types: Gravity, Sheet-Piling, and Cantilever. (Anchors are used when extra support is needed)



Basic Theory



Basic forces acting on a retaining wall

- Hydrostatic Pressure
- Soil Pressure
- Gravity

Scour may develop at structure base if located in a channel bend

- Needs armoring
- Extend the structure past the maximum predicted scour depth

Basic Equations

Slope Stability (Julien 2010)

$$\theta = \tan^{-1}\left(\frac{\sin\theta_0}{\sin\theta_1}\right)$$

$$a_\theta = \sqrt{\cos^2\theta_1 - \sin^2\theta_0}$$

$$\eta_0 = \frac{\tau_0}{\tau_c} = \frac{\tau_0}{(G-1)\rho g d_s \tau_{*c}}$$

$$\beta = \tan^{-1}\left(\frac{\cos(\lambda+\theta)}{\frac{M+N}{N} * \frac{\sqrt{1-a_\theta^2}}{\eta_0 \tan\phi} + \sin(\lambda+\theta)}\right)$$

$$\eta_1 = \eta_0 * \frac{\frac{M}{N} + \sin(\lambda+\beta+\Theta)}{1+\frac{M}{N}}$$

$$SF = \frac{a_\theta \tan\phi}{\eta_1 \tan\phi + \sqrt{1-a_\theta^2} * \cos\beta}$$

Hydrostatic Pressure

$$P = \rho g h$$

Soil Pressure

$$P = \rho g K$$

Moment Equation

$$M = F_1 x_1 + F_2 x_2 + \cdots + F_n x_n$$

Gravity Walls

- **Crib walls (a)**

Interlocking structural members, typically filled with rocks to increase the weight of the overall structure.

- **Masonry Walls (b)**

Stacked blocks or bricks

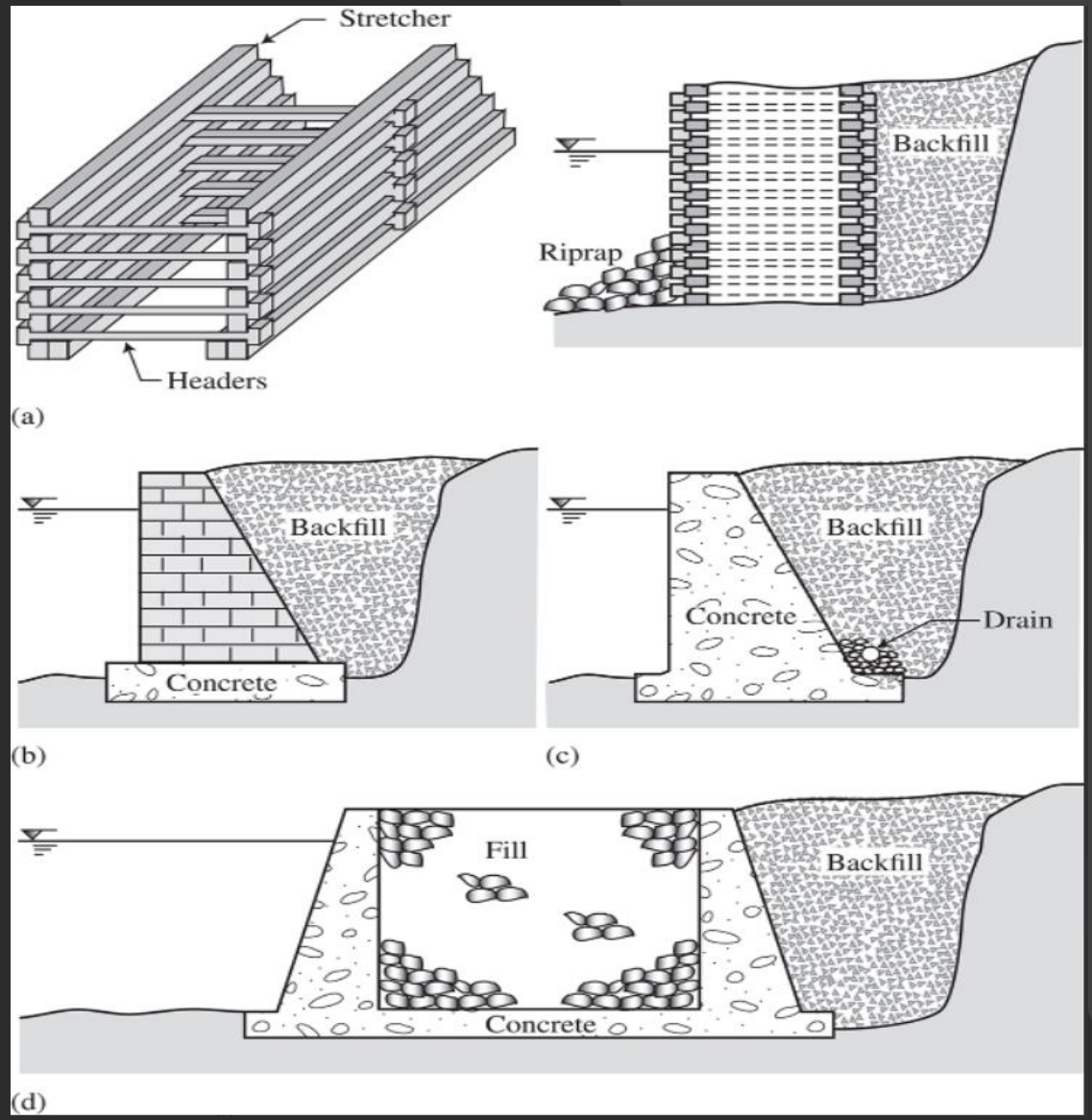
- **Concrete (c)**

Cast-In-Place concrete with reinforcing steel

- **Caissons (d)**

Precast with reinforcing steel and compacted fill

Note: All gravity walls need permeable backfill to relieve hydrostatic pressures on the backside of the wall



Gravity Walls

Gravity walls rely on their self-weight to resist lateral earth pressures and hydrostatic forces.

Pros

- Simple design (typically)
- Durable

Cons

- Large amount of concrete needed
- Not economical for heights greater than 3 meters
- Needs a good foundation

Masonry Wall

Crib wall

Concrete

Cassion

Cantilever Walls

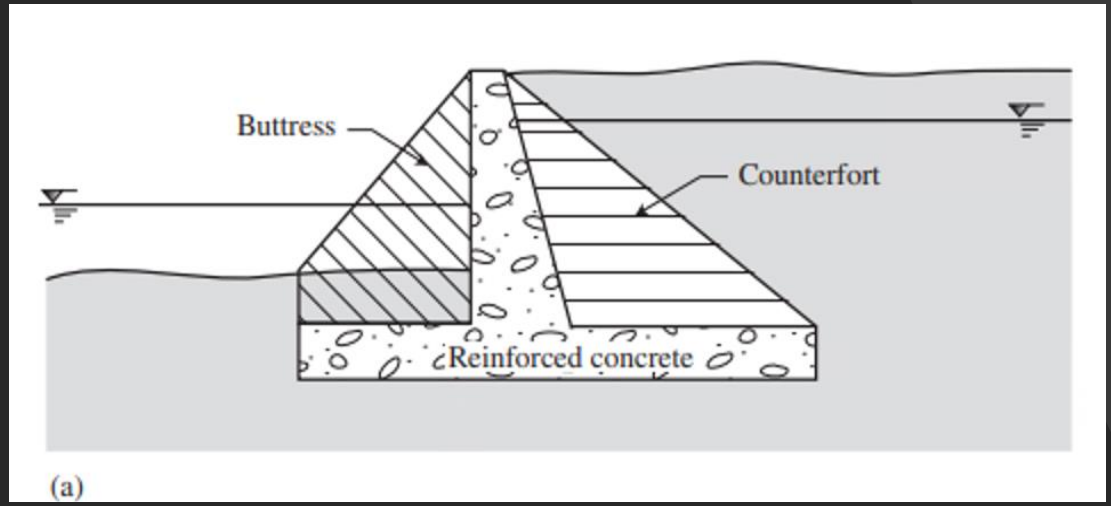
The cantilever wall system uses a reinforced concrete base that extends behind (heel) and, optionally, in front (toe) of the vertical wall to resist the active soil and hydrostatic forces.

Pros

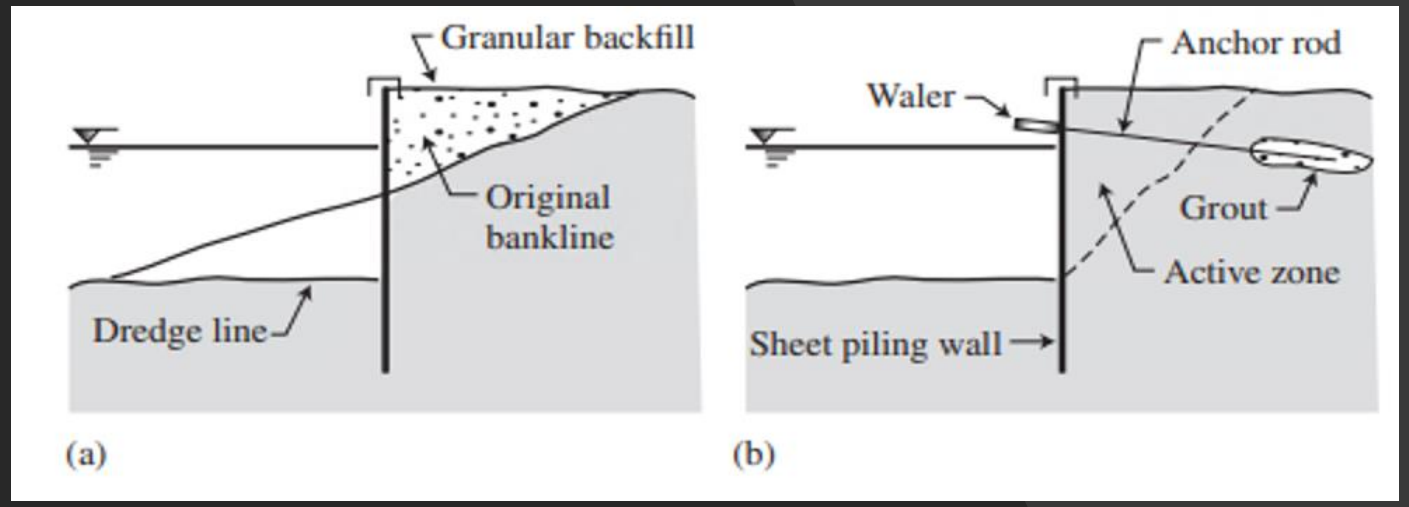
- Less concrete than traditional gravity wall
- Durable
- If precast, easy constructability.

Cons

- More complex design
- Prone to sliding
- Needs a good foundation



Sheet-Pile Walls



- Utilizes interlocking steel sheet piles that are driven into the ground
- Typically used in flood and erosion control
- Creates a smooth channel

Sheet-Pile Walls

Pros

- Temporary remedy for flood control
- Useful when there is no room for a sloped bank

Cons

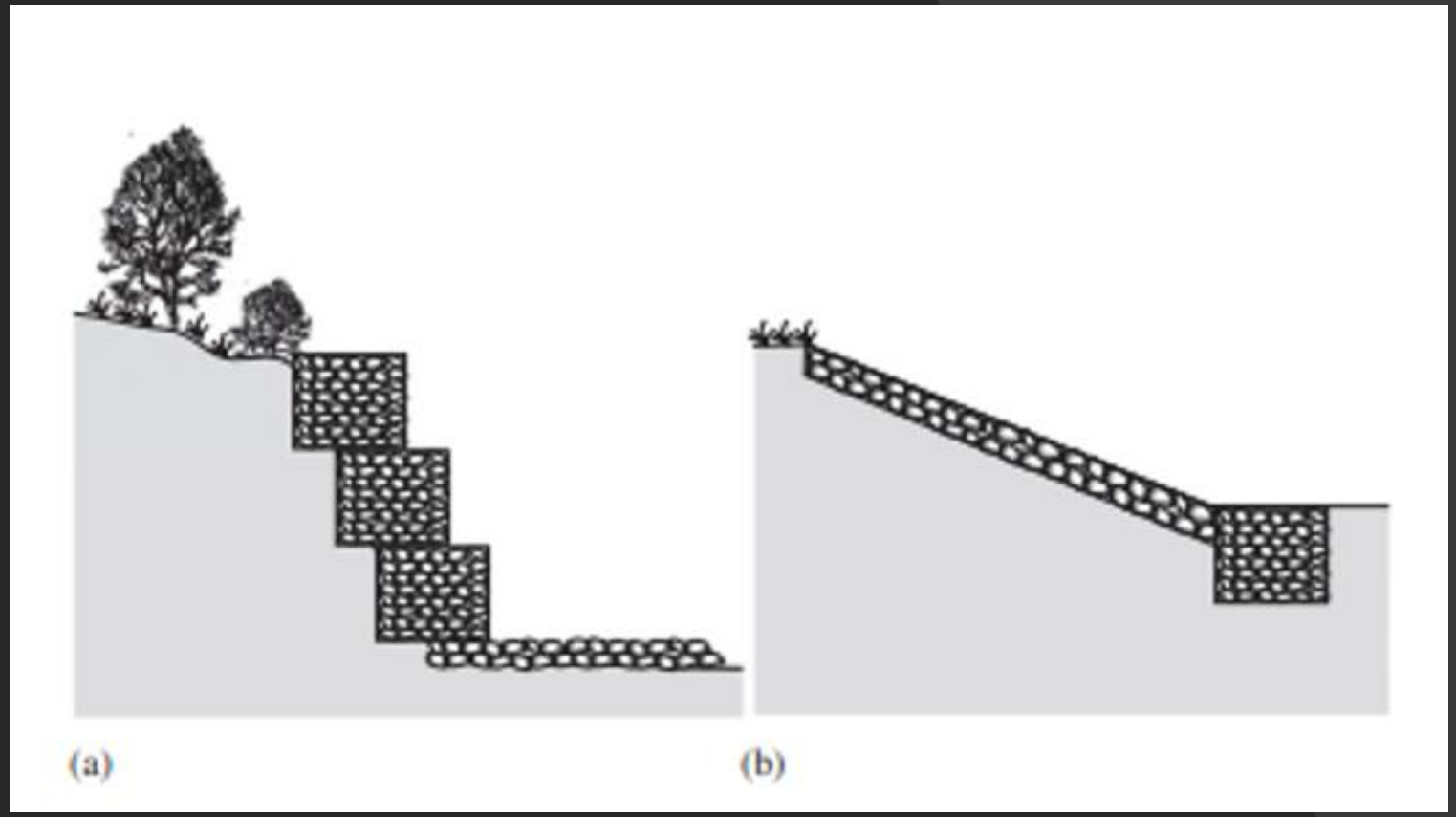
- Limit stream access to the floodplain
- Lead to down-cutting in the channel bed
- High velocities and erosion may occur downstream
- Structure steepness makes it harder to access the stream
- Expensive

Gabion

A gabion is a multi-celled wire mesh structure filled with rocks.

Gabion Types

- Box (a)
- Bag (not shown)
- Mattress (b)



Box Gabion

Construction

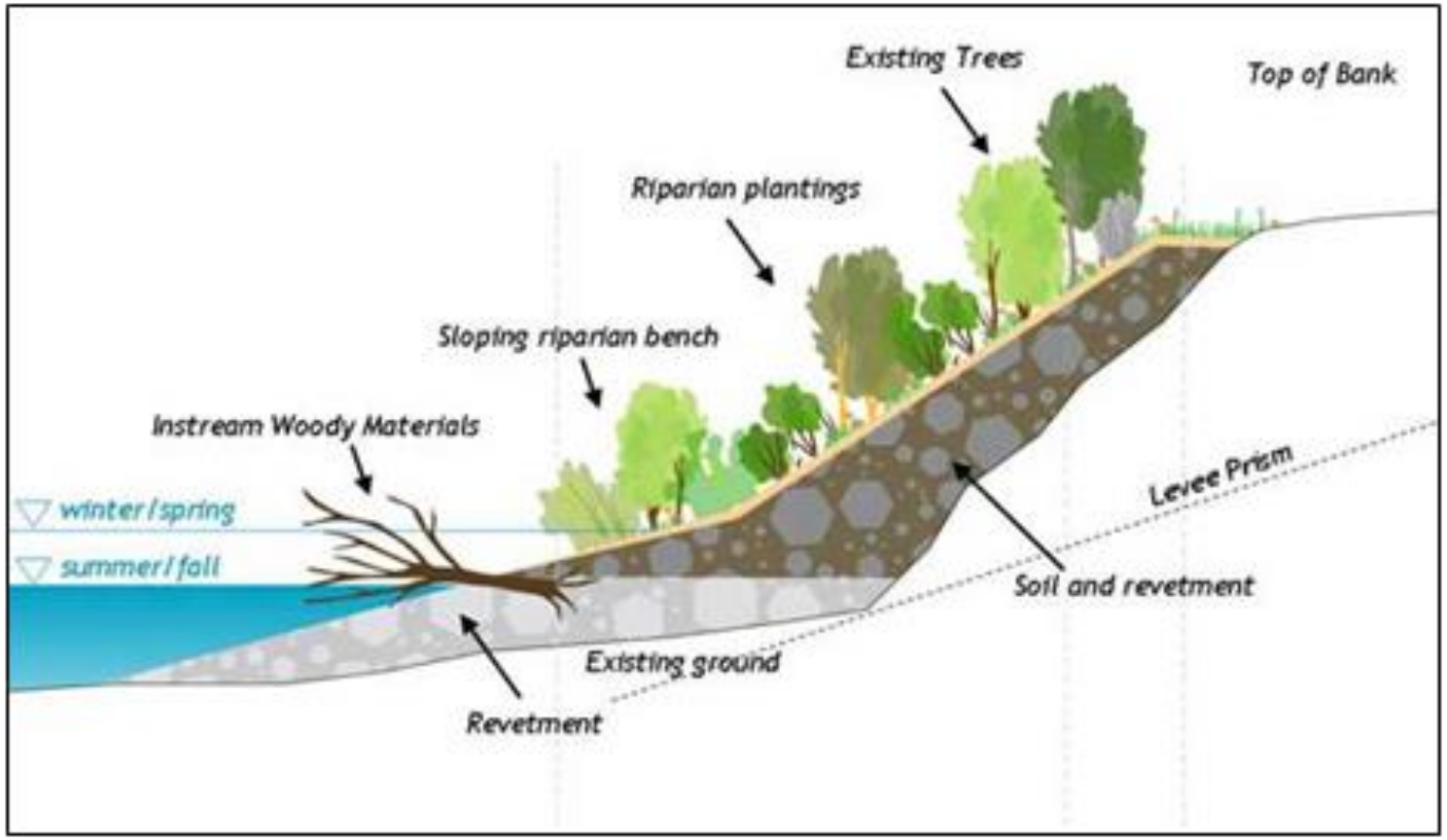
- Box and bag gabions can be stacked, where the cages are attached by wire or handles. Acting, mechanically, as a gravity retaining wall.

Pros

- Durable
- Flexible
- Permeable

Cons

- Frequent inspection required



Alternatives

<u>Revegetation</u>

- Shown to the left

<u>Soil Bioengineering</u>

- Brush Revetment
- Pole Plantings
- Post Plantings
- Brush Mattress
- Fiber Schines
- Brush Layer
- Brush Trench
- Vertical Bundles
- Willow Wattles
- Erosion Control Fabric

Conclusion

Retaining wall structures, when designed properly, do an excellent job of stabilizing the riverbank on which they are constructed, preventing riverbank erosion, lateral migration, and mass failure, and protecting waterfront property and infrastructure. However, today's emphasis is on more natural and environmentally friendly solutions to our engineering problems renders traditional retaining walls "unpopular" with some of them having larger carbon footprints and ugly aesthetics. More natural based solutions are being developed as alternatives to these structures to meet the changing demands of society.

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