Fayoum University

Faculty of Engineering

Department of Civil Engineering

CE 406: Part B

Retaining Walls

Lecture No. (11): Introduction

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Function of Retaining structures

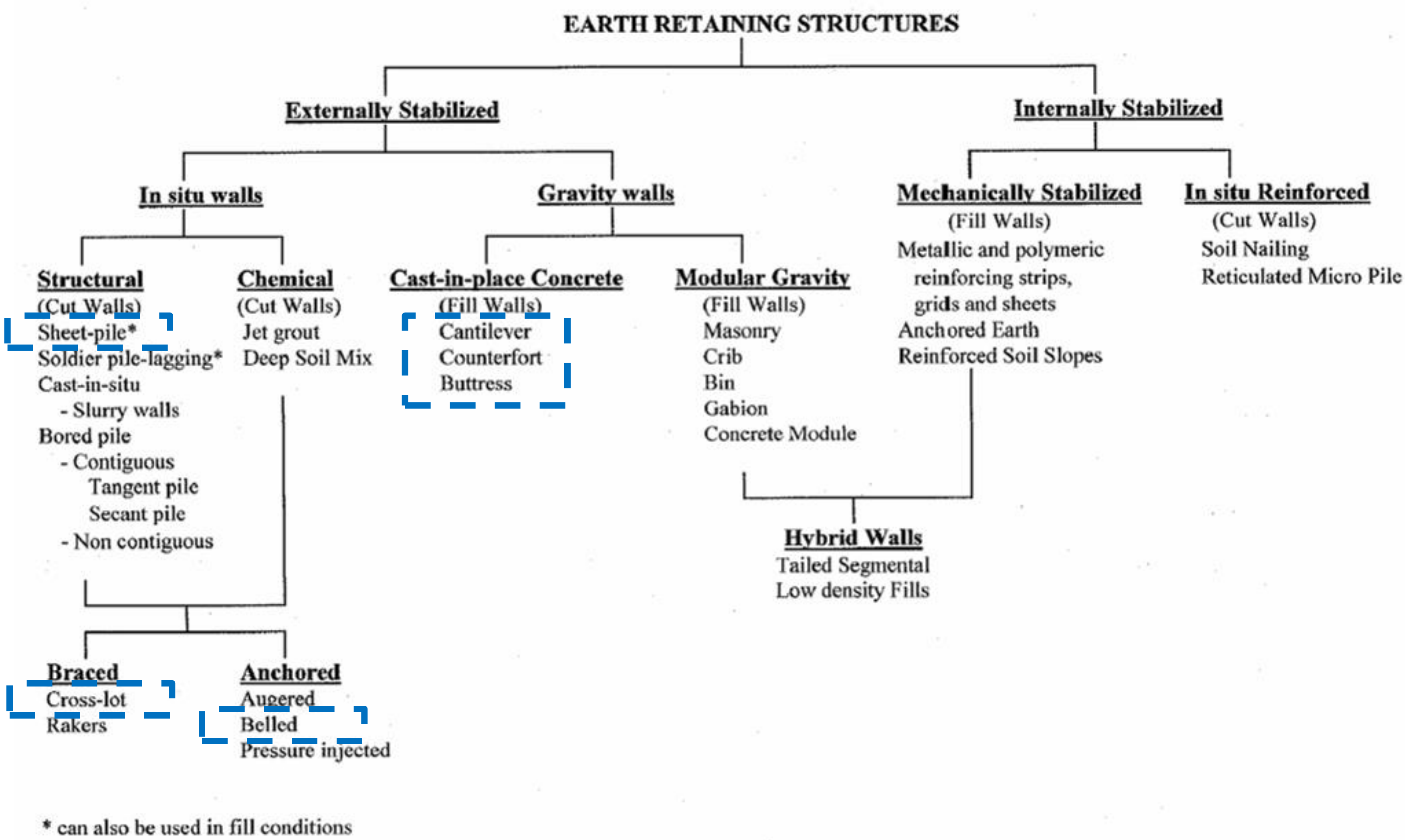
- Earth retaining structures are used to hold back earth and maintain a difference in the elevation of the ground surface.
- The retaining structures is designed to withstand the forces exerted by the retained ground or “backfill” and other externally applied loads, and to transmit these forces safely to a foundation.

Function of Retaining structures

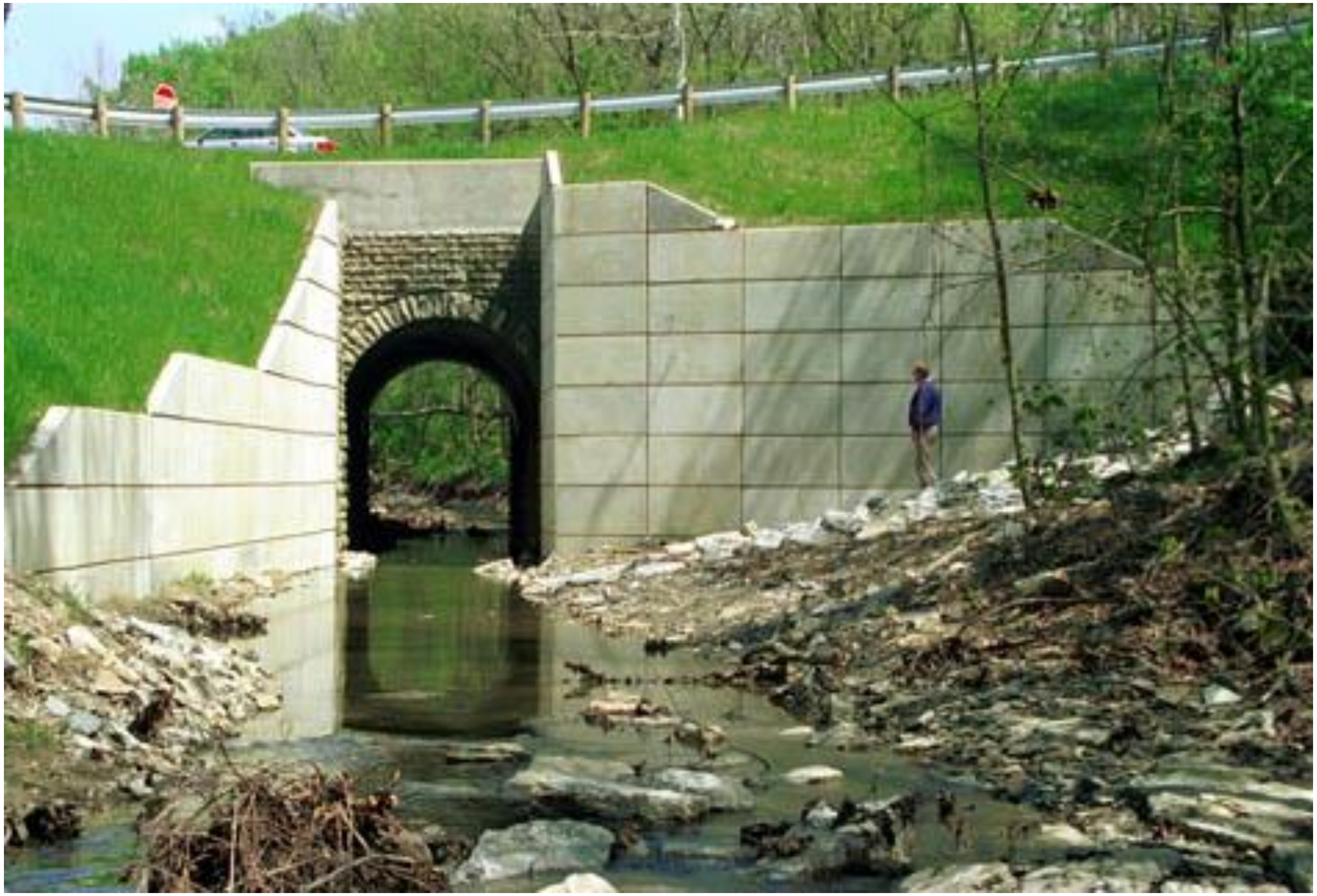
- In general, the **cost** of constructing a retaining structure is usually high compared with the cost of forming a new slope. Therefore, the need for a retaining structure should be assessed carefully during preliminary design and an effort should be made to keep the retained height as low as possible.

CLASSIFICATION OF EARTH RETAINING STRUCTURES

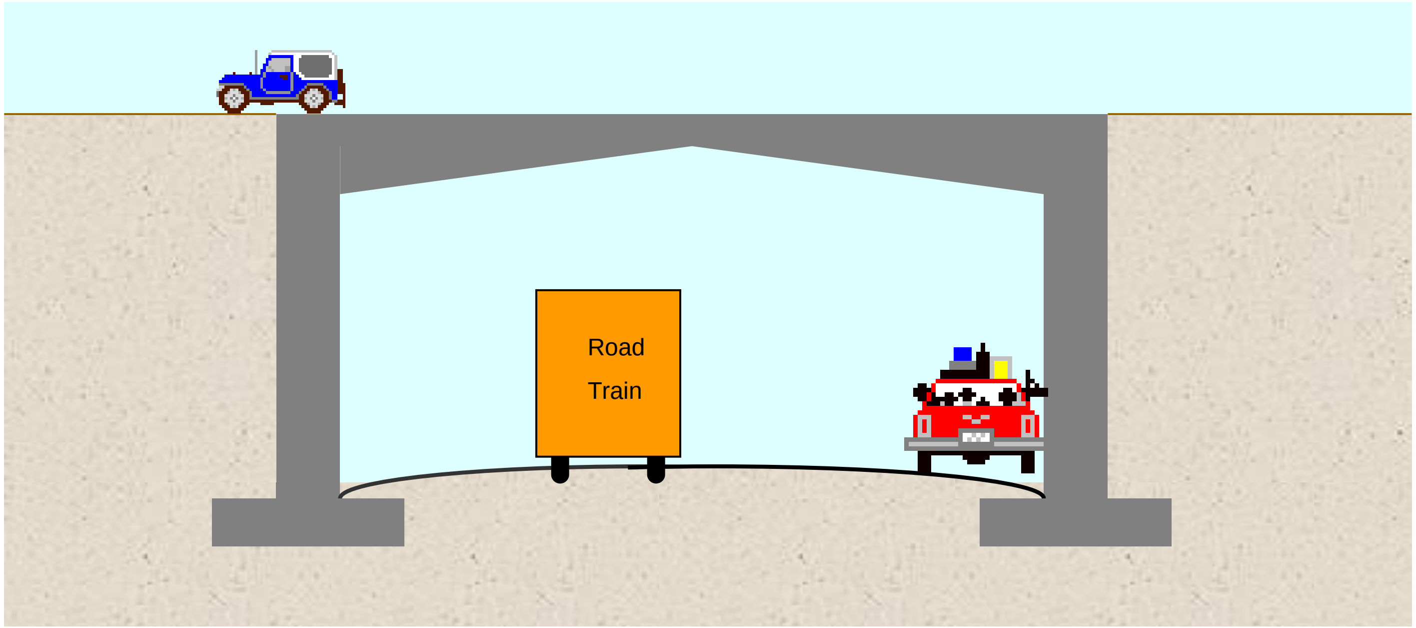
- **Load support mechanism,**
  - i.e., externally or internally stabilized walls.
- **Construction method,**
  - i.e., fill or cut walls.
- **System rigidity,**
  - i.e., rigid or flexible walls.


EARTH RETAINING STRUCTURES
Externally Stabilized
Internally Stabilized
In situ walls
Gravity walls
Mechanically Stabilized
(Fill Walls)
Metallic and polymeric
reinforcing strips,
grids and sheets
Anchored Earth
Reinforced Soil Slopes
In situ Reinforced
(Cut Walls)
Soil Nailing
Reticulated Micro Pile
Structural
(Cut Walls)
Sheet-pile*
Soldier pile-lagging*
Cast-in-situ
- Slurry walls
Bored pile
- Contiguous
Tangent pile
Secant pile
- Non contiguous
Chemical
(Cut Walls)
Jet grout
Deep Soil Mix
Cast-in-place Concrete
(Fill Walls)
Cantilever
Counterfort
Buttress
Modular Gravity
(Fill Walls)
Masonry
Crib
Bin
Gabion
Concrete Module
Hybrid Walls
Tailed Segmental
Low density Fills
Braced
Cross-lot
Rakers
Anchored
Augered
Belled
Pressure injected
* can also be used in fill conditions

Retaining Walls - Applications



Retaining Walls - Applications



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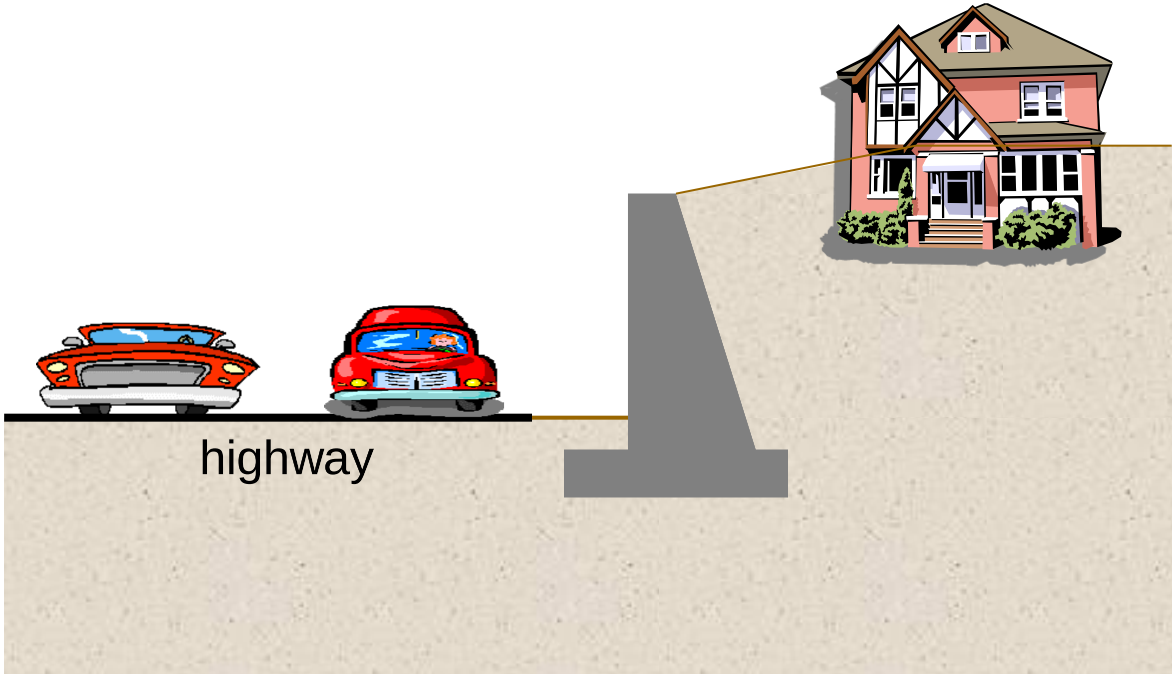
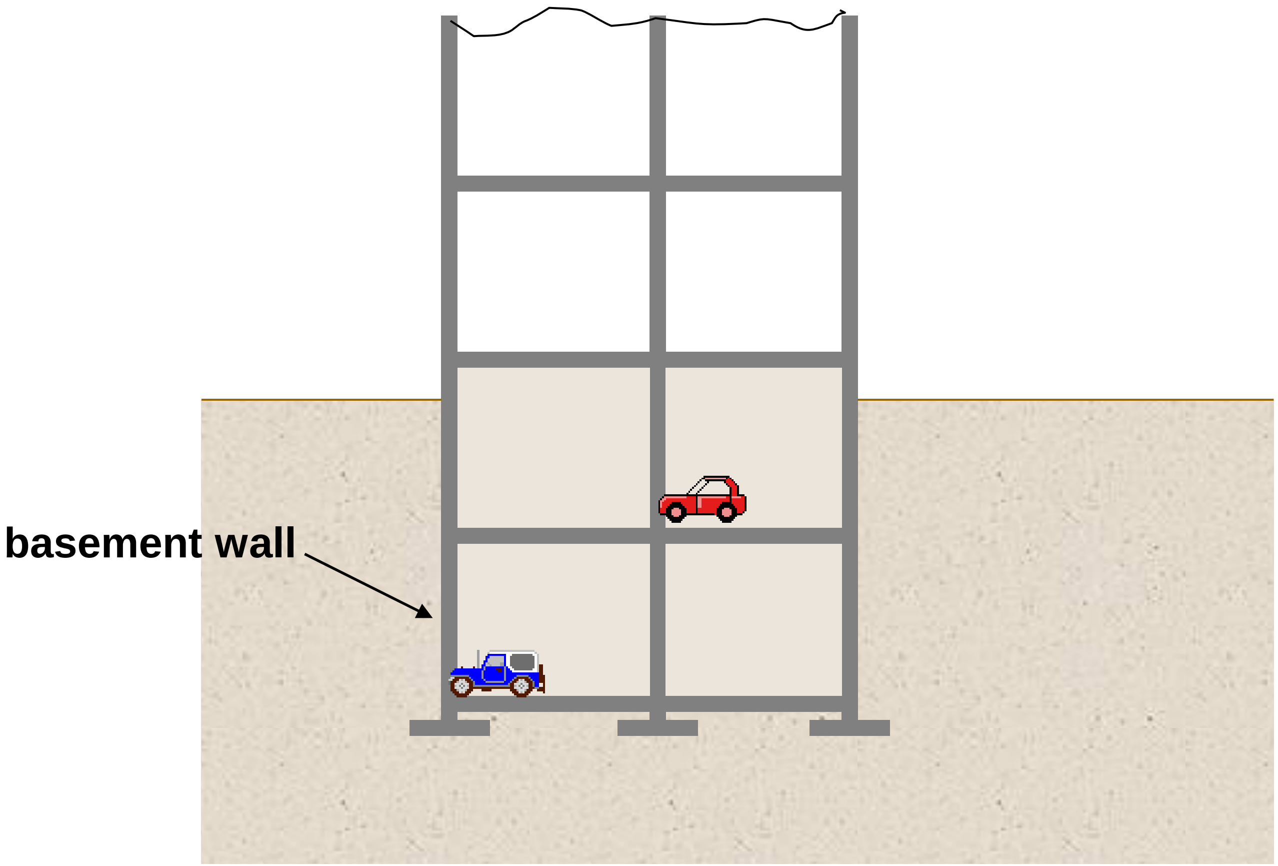


Retaining Walls - Applications



Typical applications for earth retaining structures

- New or widened highways in developed areas;
- New or widened highways at mountain or steep slopes;
- Grade separation;
- Bridge abutments, wing walls and approach embankments;
- Culvert walls;
- Tunnel portals and approaches;
- Flood walls, bulkheads and waterfront structures;
- Stabilization of new or existing slopes and protection against rock falls

Types of Retaining Walls

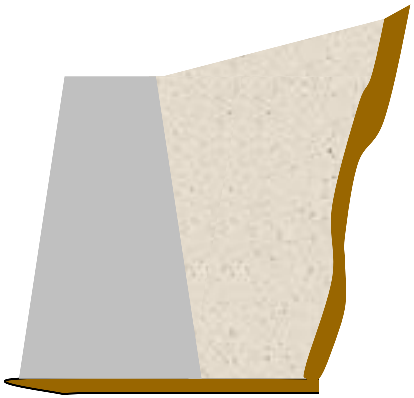
- Gravity Walls:

Walls rely on the mass of the wall for stability,

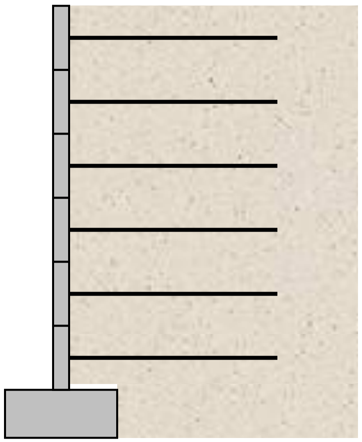
Unreinforced Concrete and masonry (bricks and stone).

- Cantilever walls.
- Counterforted walls.
- Buttressed walls.
- Gabions (wire baskets filled with stone).
- Crib walls (hollow crib formwork filled with soil).
- Reinforced earth wall

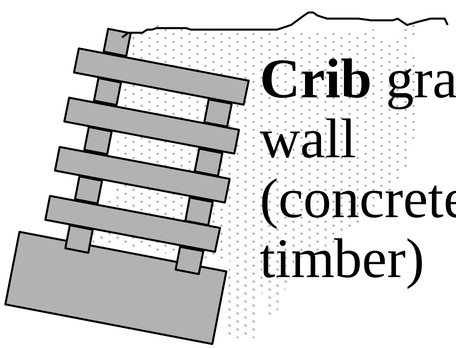
Types of Retaining Walls



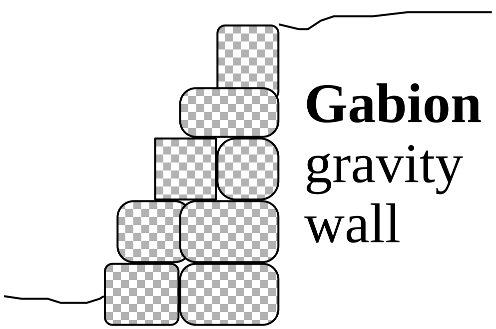
Gravity Retaining wall



Reinforced earth wall



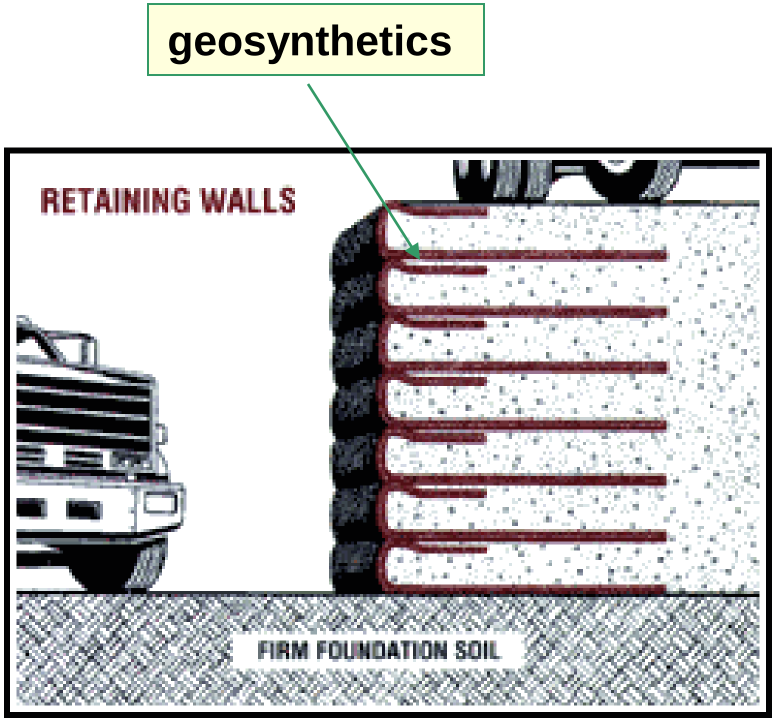
Crib gravity wall (concrete, timber)



Gabion gravity wall

Types of Retaining Walls

Reinforced earth walls are increasingly becoming popular.

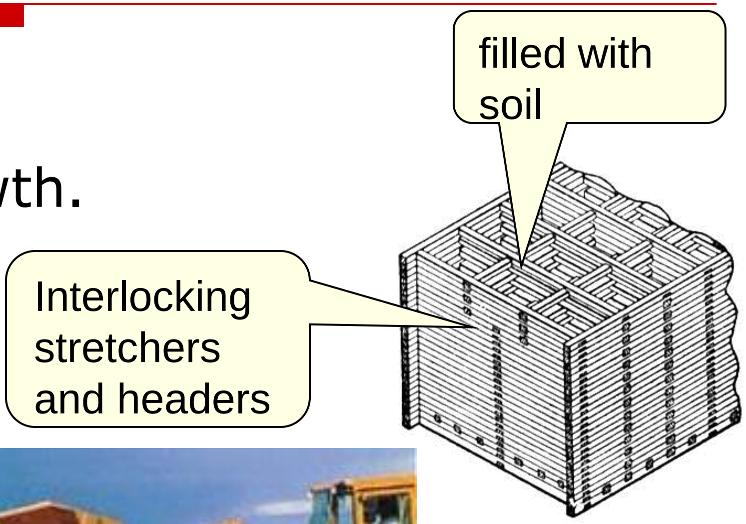


Types of Retaining Walls

Crib walls:

Good drainage & allow plant growth.

Looks good.



Reinfo

Gabion R

Slope Retention works

Wall Selection Considerations

- (1) Ground type,
- (2) Groundwater,
- (3) Construction considerations,
- (4) Speed of construction,
- (5) Right of way,
- (6) Aesthetics,
- (7) Environmental concerns,
- (8) Durability and maintenance,
- (9) Tradition and
- (10) Local contracting practices.

Lateral Earth Pressures

Three different types of lateral earth pressure are usually considered:

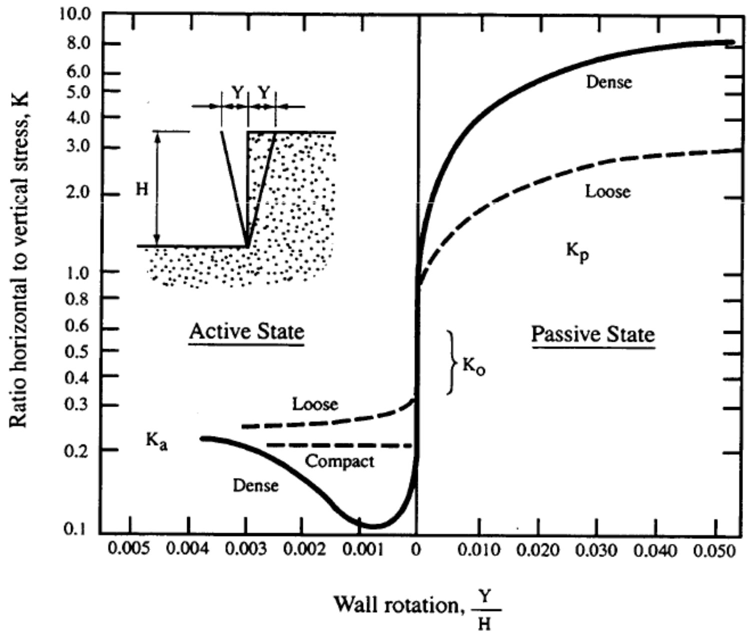
(1) At-rest earth pressure;

(2) Active earth pressure; and

(3) Passive earth pressure.

These conditions are relative to lateral deformation of the walls.

Lateral Earth Pressures

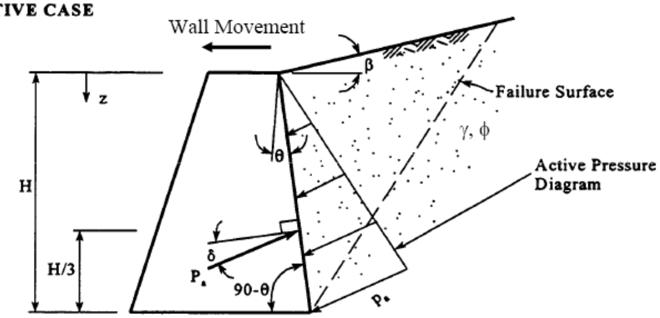


Magnitude of Wall Rotation to Reach Failure

Soil type and condition	Rotation, Y/H	
	Active	Passive
Dense cohesionless	0.001	0.02
Loose cohesionless	0.004	0.06
Stiff cohesive	0.010	0.02
Soft cohesive	0.020	0.04

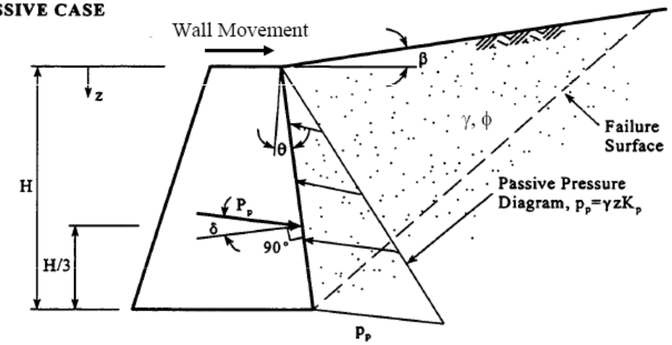
Coulomb coefficients K_a and K_p

ACTIVE CASE



$$K_a = \frac{\cos^2(\phi-\theta)}{\cos^2\theta\cos(\theta+\delta)\left[1+\sqrt{\dfrac{\sin(\phi+\delta)\sin(\phi-\beta)}{\cos(\theta+\delta)\cos(\theta-\beta)}}\right]^2}$$

PASSIVE CASE

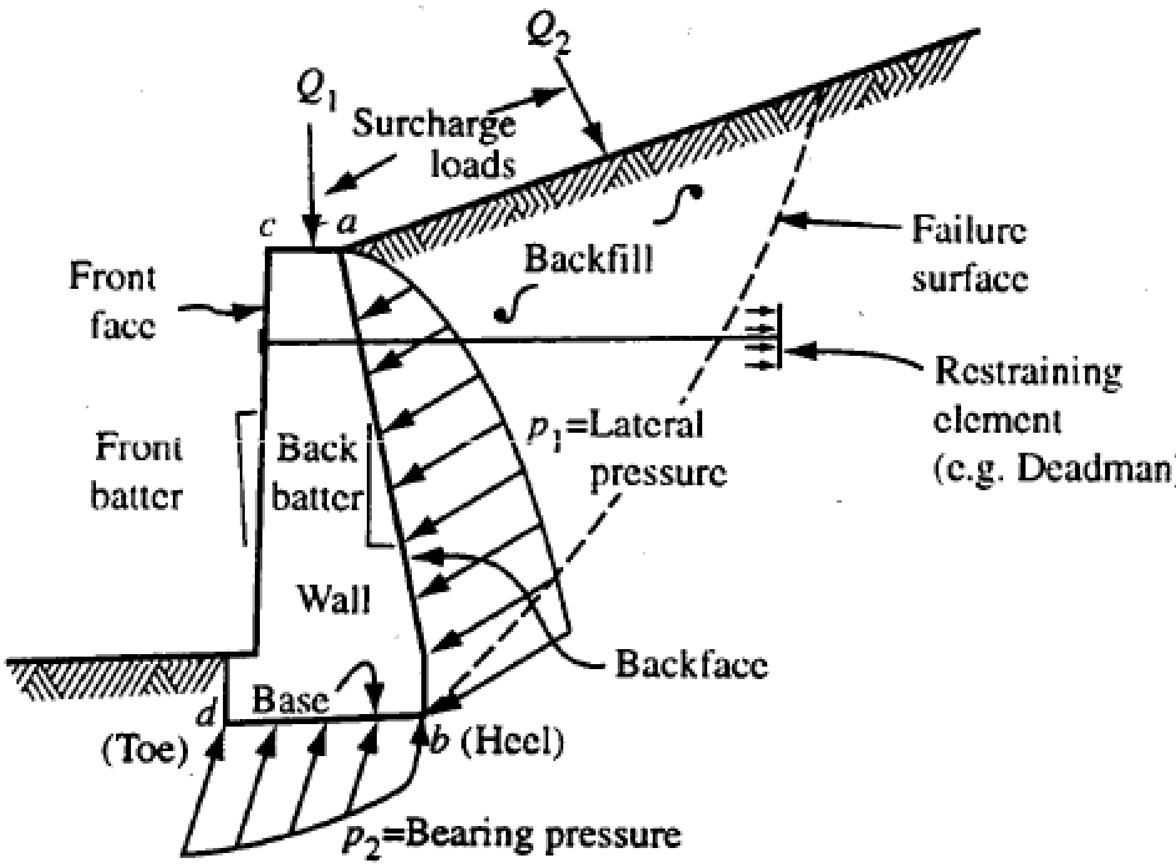


$$K_p = \frac{\cos^2(\theta+\phi)}{\cos^2\theta\cos(\theta-\delta)\left[1-\sqrt{\dfrac{\sin(\phi+\delta)\sin(\phi+\beta)}{\cos(\theta-\delta)\cos(\theta-\beta)}}\right]^2}$$

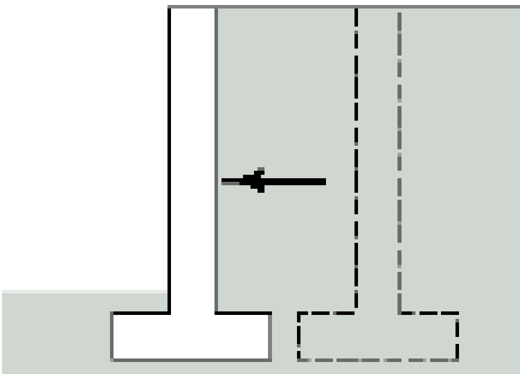
Clayey Soils As Backfill For Fill Wall Applications

- Clayey backfills generally have lower drained shear strength than cohesionless soils.
- Clayey backfills have poor drainage and the potential for the development of water pressures behind the wall.
- Clayey backfills have the potential to undergo creep deformations that can lead to higher earth pressures.

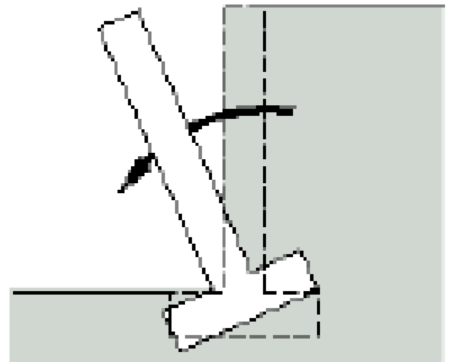
Terminology for Retaining Wall



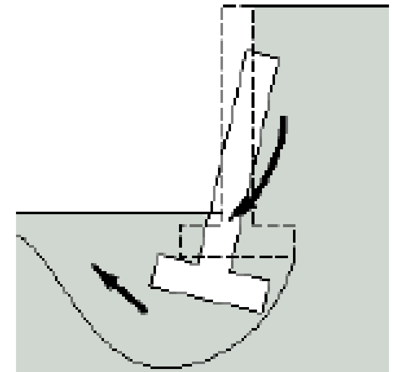
Modes of Failure



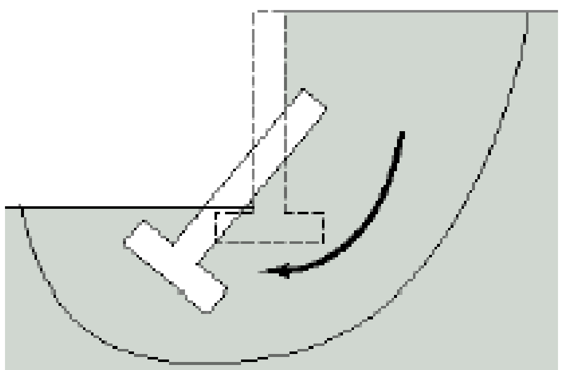
Sliding



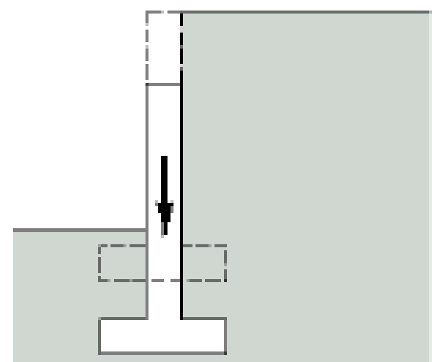
Overturning



Overstress



Deep Seating



Excessive Settlement

Design Steps

1. Select the suitable type of wall
2. Determine the dimensions of the wall (empirical)
3. Estimate Earth Pressures.
4. Estimate uplift forces
5. Estimate gravity forces (weights)
6. Determine external forces
7. Check factor of safety against sliding
8. Check factor of safety against overturning
9. Check soil over stress
10. Check deep seated Failure (slope failure)