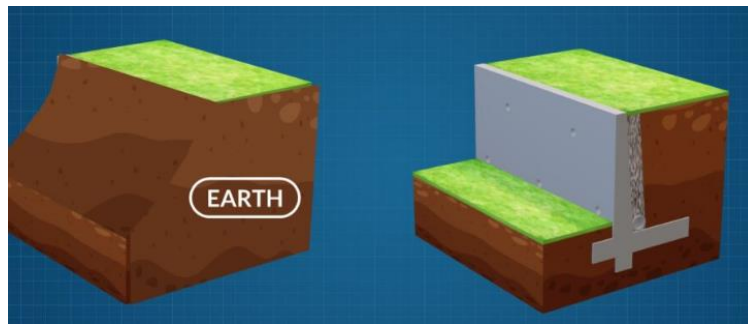
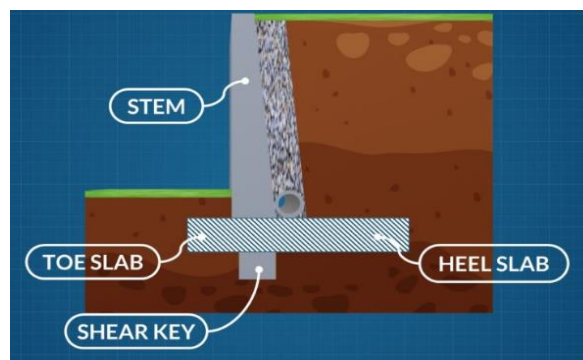


RETAINING WALLS

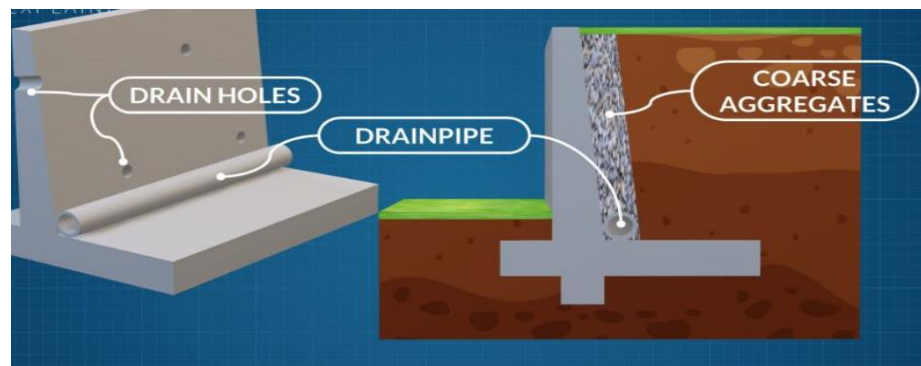
Retaining walls are used to hold earth or any other material. It prevents soil from taking its natural position and makes area above and below it usable.



- The wall has basically 3 parts. Stem, Toe Slab and Heel Slab.
- Toe and Heel slab make up for the foundation of the wall.
- Some walls have a key provided in footing to prevent it from sliding.



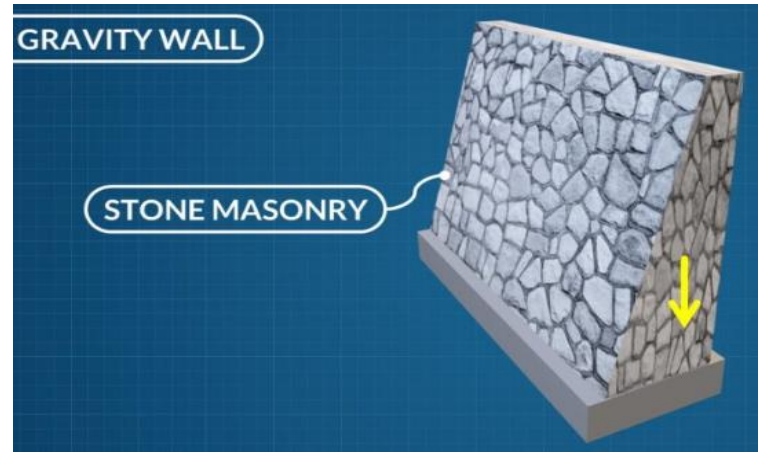
- The stem may be provided with drain holes with slope for the water drainage. Similar sloping perforated pipe may be provided below the same for water drainage. The soil behind the stem can be coarse aggregates so that water percolates and exits via drains.



Types of Retaining Walls

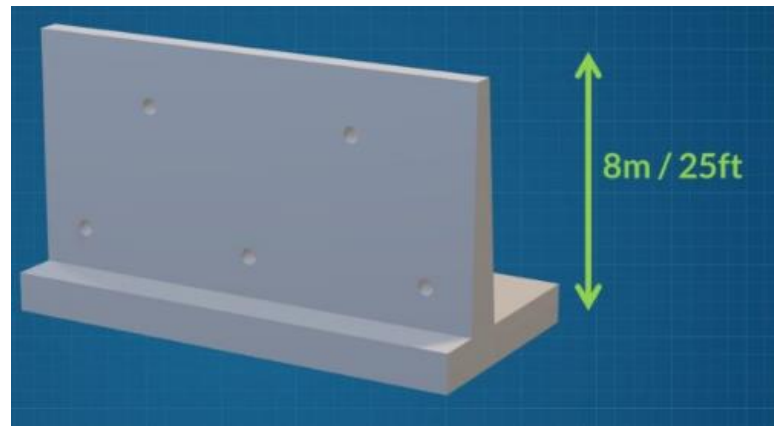
1. Gravity Wall

Gravity Wall which retains soil by its own weight. Gravity wall is of a bigger size and usually built by stone masonry and rarely in plain concrete.



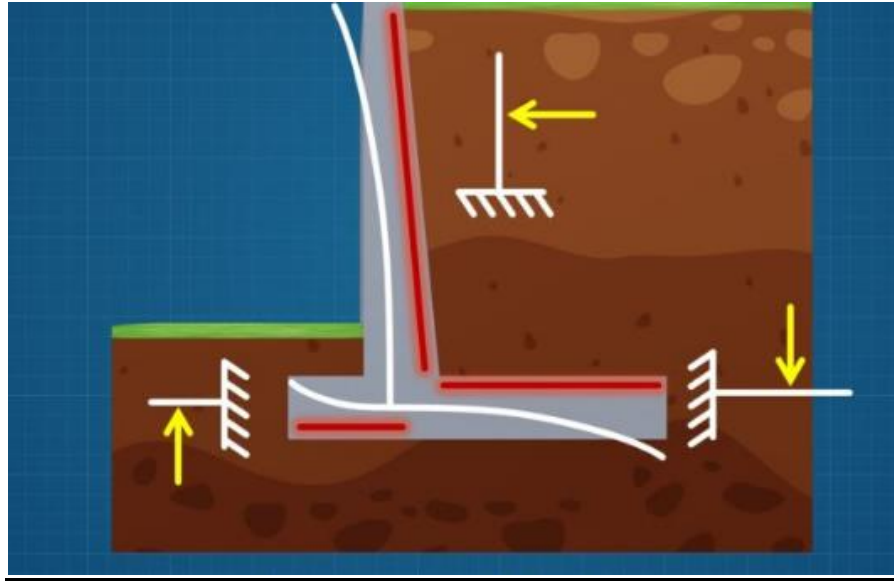
2. Cantilever Wall

Cantilever Wall is the most common type of retaining structure. It is usually used for retention height up to 8 meters or 25 feet.



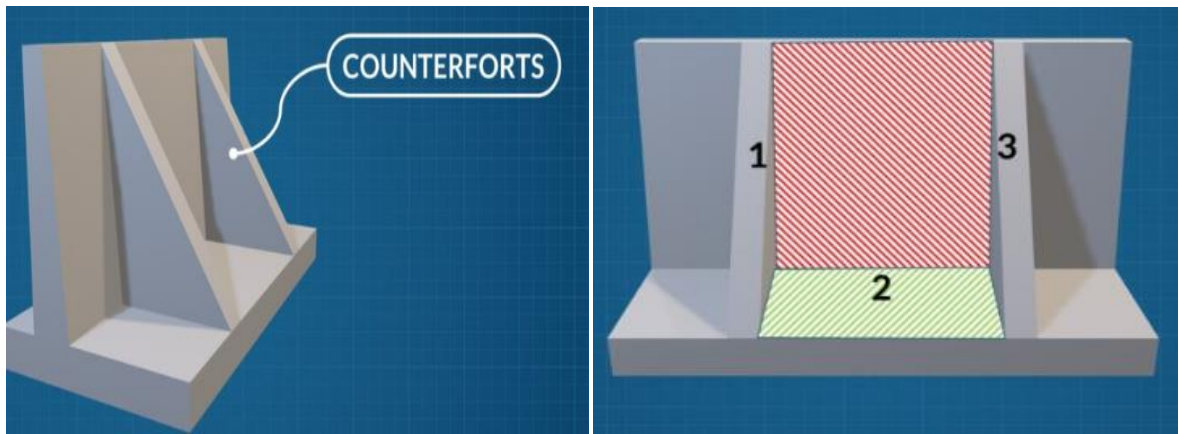
- The 3 components, which are stem, toe, and heel act as one-way cantilever slabs.
- The stem acts as a vertical cantilever under lateral earth pressure.
- The heel acts as a vertical cantilever under the action of net weight of the retained earth and the toe acts as a cantilever under the action of net soil pressure.

- The resulting deformed shape would look something like in the picture.
- The main reinforcement resisting the tension forces will be provided in 'red marked' regions as the concrete is weak in tension.



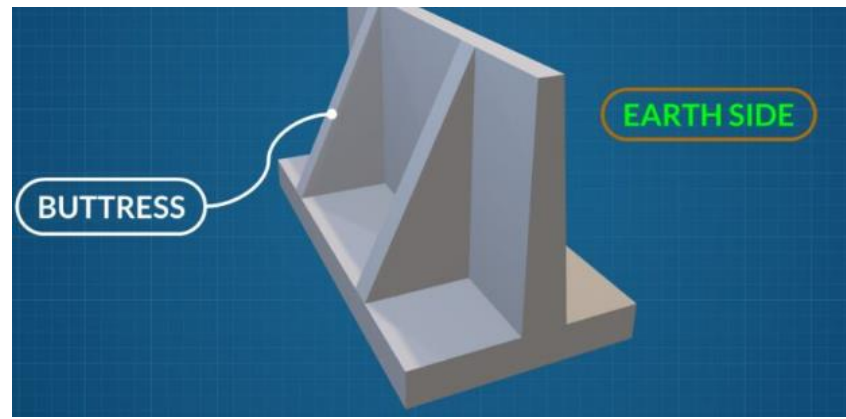
3. Counterfort Wall

- Counterfort Walls have supports called 'counterforts' connecting stem and heel slabs.
- The counterforts are concealed in the retained earth.
- These walls are provided where retention height is more than around 7 meters or 23 feet.
- The counterforts subdivide the Stem and heel into rectangular panels. These panels are now supported on 3 sides and free at one edge.



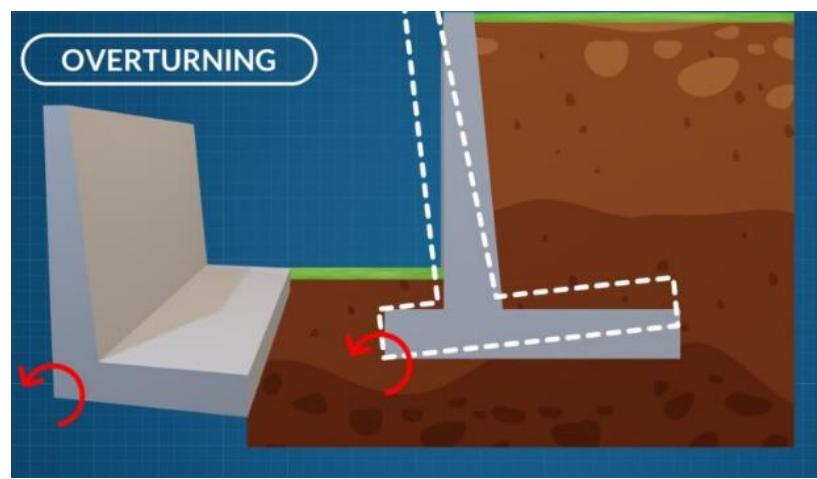
4. Buttress Wall

- Buttress Walls are similar to the Counterfort walls but the supports are now on the toe side and not buried in earth.
- Between the two, counterfort and buttress, Counterfort wall is preferred as it provides usable space in front of the wall and looks clean.
- In terms of efficiency and economy Buttress wall is preferred.

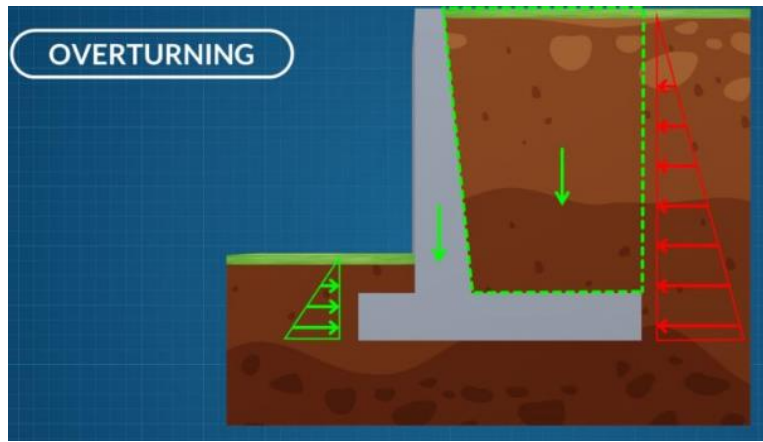


Types of failure of a Retaining Wall

1. Failure by Overturning



- In this failure mode, the toe will act as centre of rotation and the wall would deform something like in the above image.
- In absence of toe, the footing base below the stem will act as centre of rotation.

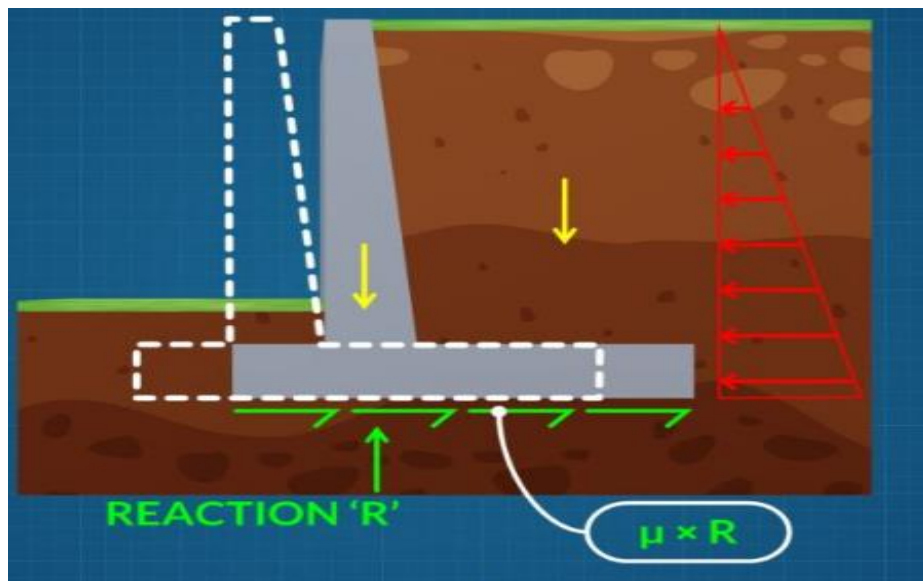


All the lateral pressures will act as overturning forces while the weight of the wall and soil on the heel will act as stabilizing forces.

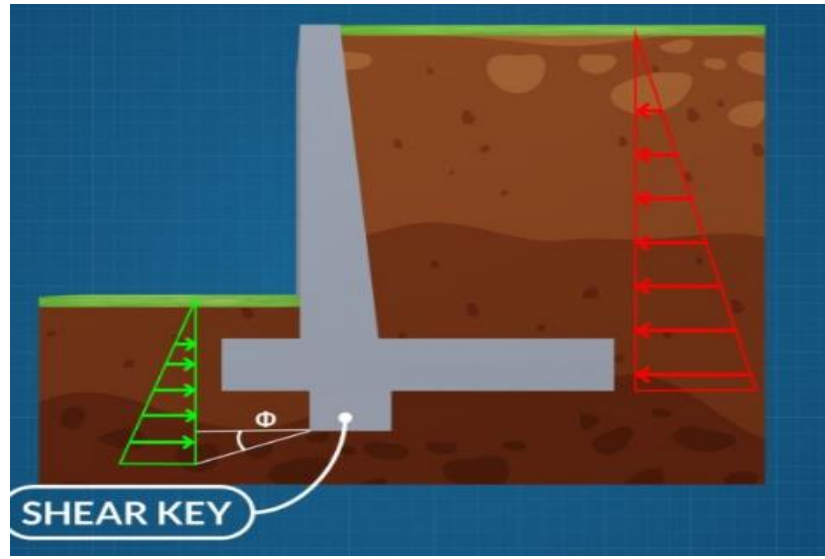
FOS= resisting moment / overturning moment

FOS> 1.5

2. Failure by Sliding

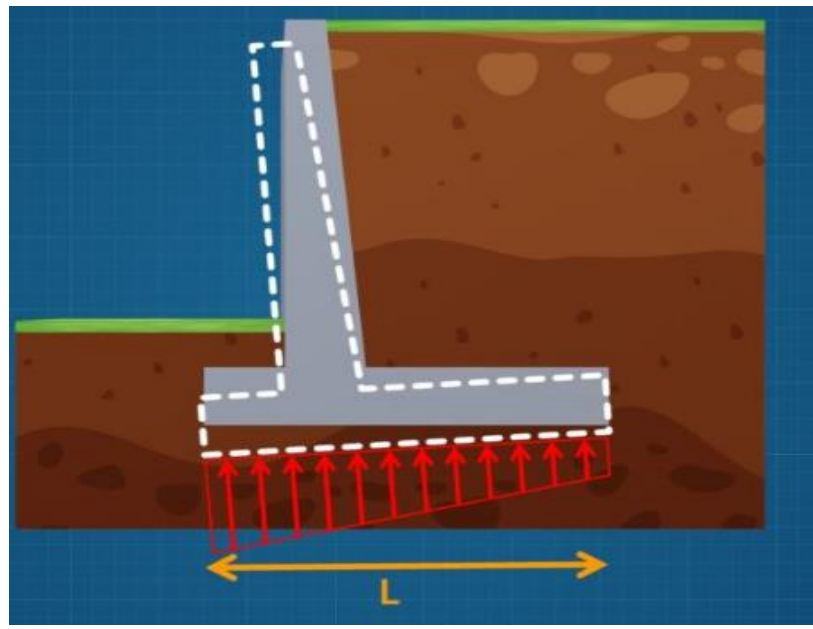


- All the lateral forces try to slide the wall.
- The resistance against sliding is mainly provided by the friction between the base slab and the soil below it.
- The frictional force is given by ' μ ' times R where μ is the static friction coefficient between soil and concrete, and R is the resultant soil pressure.



- When the lateral pressures are high and the wall fails in sliding, a shear key can be introduced to increase the sliding resistance.
- The position of the shear key is decided in such a way that the flexural reinforcement from the stem can be extended straight into the shear key, and it can create maximum counter pressure. The pressure generated on the shear key resists the lateral forces.
- **FOS= resisting force /sliding force**

3. Failure by Bearing Pressure



- Third kind of failure occurs when the soil below the wall fails in bearing pressure.
- A soil can bear a certain amount of allowable pressure which is found by geotechnical study.
- Hence the width 'L' of the base slab must be adequate to distribute the vertical reaction.

FILLER MATERIAL FOR DRAINAGE IN RETAINING WALL

- The best material for the backfilling of a retaining wall is gravel, and it should be well graded.
- The main reason for using gravel is because it does not retain water (small void ratio); hence lateral loads experienced will be minimal.
- We should also have weep holes for draining excess water that may be retained.