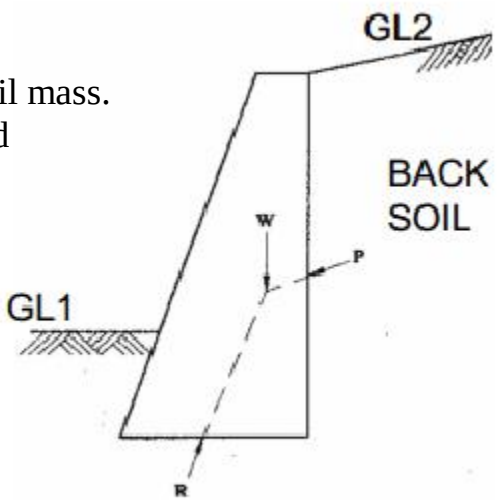
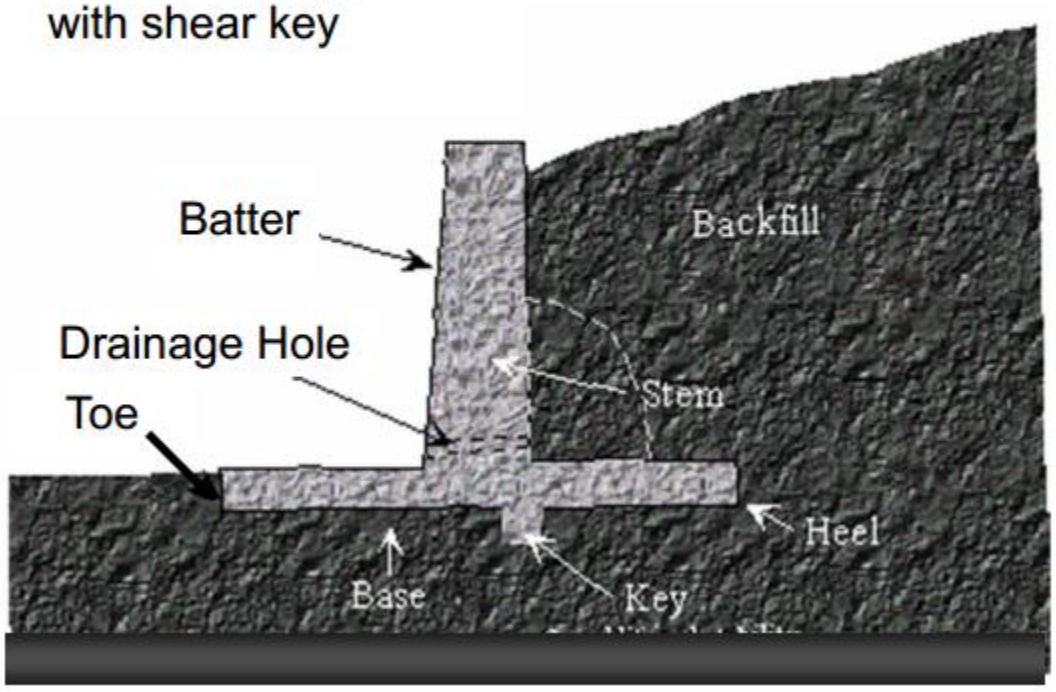
## RETAINING WALL :-

Retaining walls are usually built to hold back soil mass. However, retaining walls can also be constructed for aesthetic landscaping purposes.




Gravity retaining wall

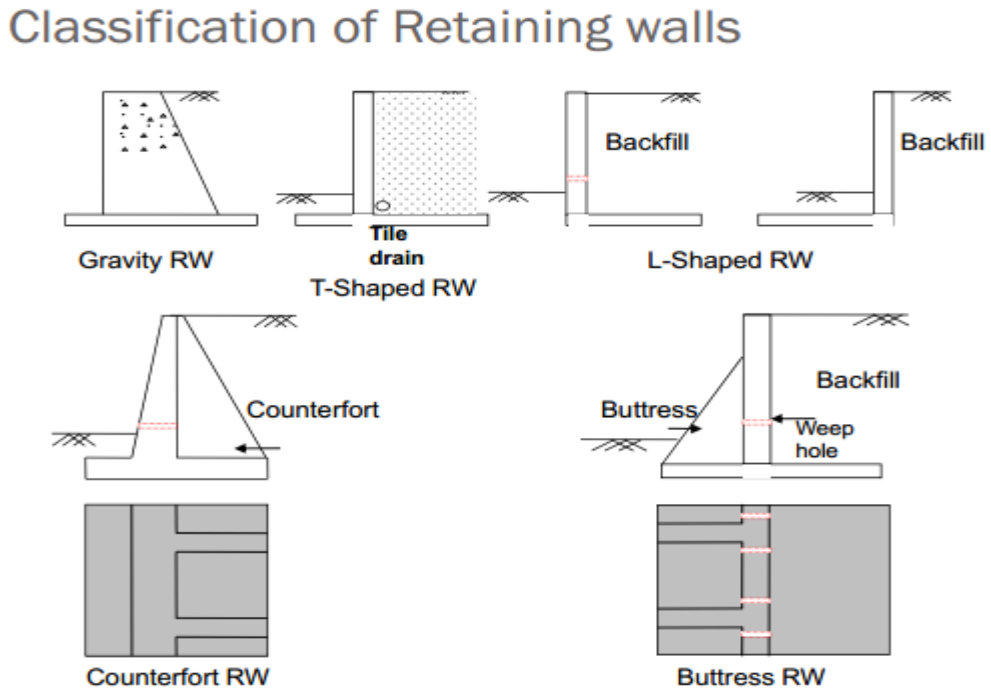
Cantilever Retaining wall with shear key



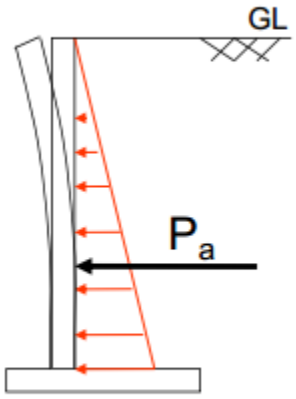
## Photos of Retaining walls

## Classification of Retaining walls :-

- Gravity wall-Masonry or Plain concrete .
- Cantilever retaining wall-RCC (Inverted T and L) .
- Counter fort retaining wall-RCC .
- Buttress wall-RCC .



## Earth Pressure (P) :-



Variation of Earth pressure

- Earth pressure is the pressure exerted by the retaining material on the retaining wall. This pressure tends to deflect the wall outward.

- Types of earth pressure:
- Active earth pressure or earth pressure (Pa) and.
- Passive earth pressure (Pp).
- Active earth pressure tends to deflect the wall away from the backfill.

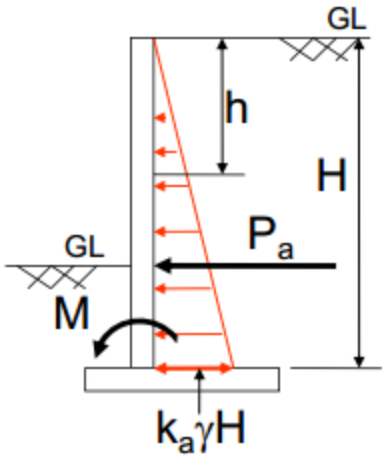
## Factors affecting earth pressure :-

Earth pressure depends on type of backfill, the height of wall and the soil conditions .

**Soil conditions: The different soil conditions are :-**

- Dry leveled back fill .
- Moist leveled backfill .
- Submerged leveled backfill .
- Leveled backfill with uniform surcharge .
- Backfill with sloping surface .

## Analysis for dry back fills :-



H=stem height

Maximum pressure at any height, p=ka y h
Total pressure at any height from top,
a=١/٢[ka y h]h = [ka y h٢]/٢
Bending moment at any height
M=paxh/٣= [ka y h٣]/٦

Total pressure, Pa= [ka y H٢]/٢
Total Bending moment at bottom,

M = [ka y H٣]/٦

- Where, $k_a$ = Coefficient of active earth pressure
- $= (1-\sin\phi)/(1+\sin\phi)=\tan^2\phi$
- $= 1/k_{p,}$ coefficient of passive earth pressure
- $\phi$= Angle of internal friction or angle of repose
- $\gamma$=Unit weigh or density of backfill

- If $\phi = 30°$, $k_a = 1/3$ and $k_p = 3$. Thus $k_a$ is 9 times $k_p$

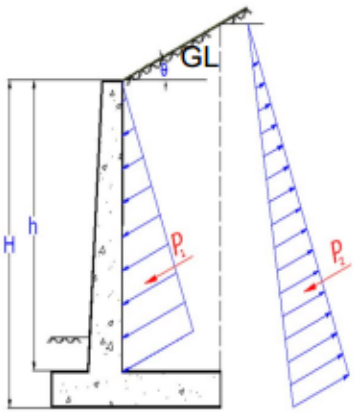
## Backfill with sloping surface

- $p_a = k_a \gamma H$ at the bottom and is parallel to inclined surface of backfill

- $k_a = \cos\theta\left[\dfrac{\cos\theta - \sqrt{\cos^2\theta - \cos^2\phi}}{\cos\theta + \sqrt{\cos^2\theta - \cos^2\phi}}\right]$
- Where $\theta$=Angle of surcharge

$\therefore$ Total pressure at bottom

$= P_a = k_a \gamma H^2/2$




SOIL PRESSURE DUE TO INCLINED SURCHARGE

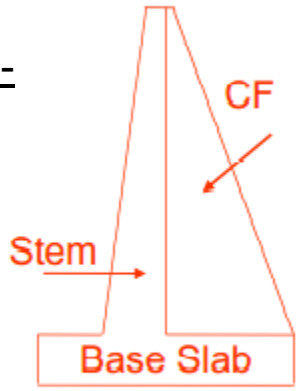
## Stability requirements of RW

- Following conditions must be satisfied for stability of wall (IS:456-2000).

- **It should not overturn**
- **It should not slide**
- **It should not subside**, i.e Max. pressure at the toe should not exceed the safe bearing capacity of the soil under working condition

**Design and Detailing of Counter fort Retaining wall :-**

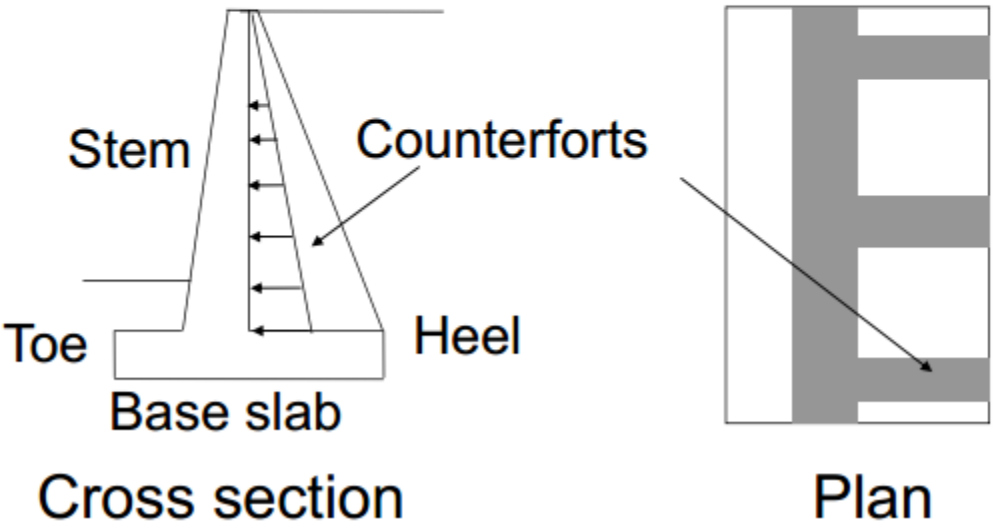
- When H exceeds about ٦m,
- Stem and heel thickness is more.
- More bending and more steel.
- Cantilever-T type-Uneconomical.
- Counter forts-Trapezoidal section.
- ١.٥m -٣m c/c.




CRW

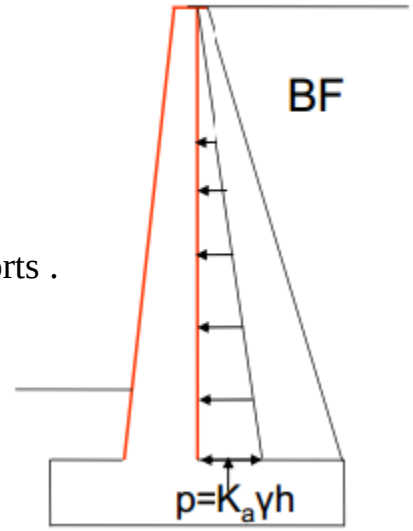
## Parts of CRW

- Same as that of Cantilever Retaining wall Plus Counterfort



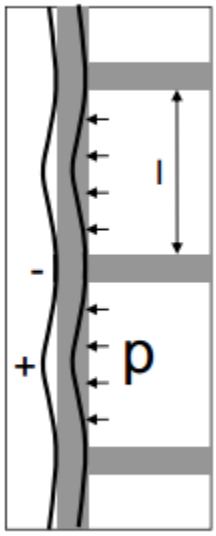

**Design of Stem :-**

- The stem acts as a continuous slab .
- Soil pressure acts as the load on the slab.
- Earth pressure varies linearly over the height .
- The slab deflects away from the earth face between the counter forts .
- The bending moment in the stem is maximum at the base and reduces towards top .
- But the thickness of the wall is kept constant and only the area of steel is reduced.



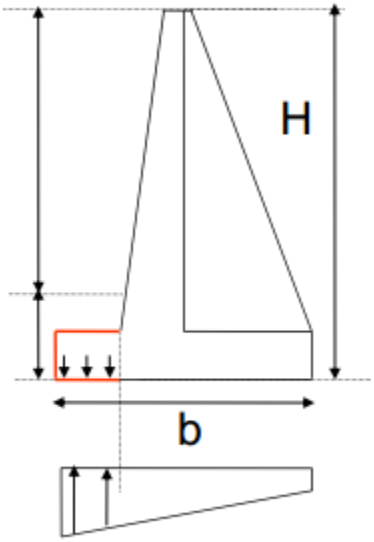
## Maximum Bending moments for stem :-

- Maximum +ve B.M= pl٢/١٦
- (occurring mid-way between counter forts)
- and
- Maximum -ve B.M= pl٢/١٢
- (occurring at inner face of counter forts)
- Where ‘l’ is the clear distance between the counter forts
- and ‘p’ is the intensity of soil pressure

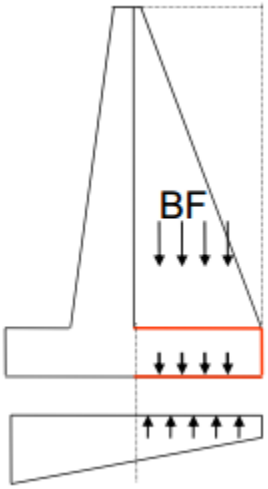



## Design of Toe Slab :-

- The base width=b =٠.٦ H to ٠.٧ H .
- The projection=١/٣ to ١/٤ of base width.
- The toe slab is subjected to an upward soil Reaction and is designed as a cantilever slab fixed at the front face of the stem.
- Reinforcement is provided on earth face along . the length of the toe slab.
- In case the toe slab projection is large i.e. > b/٣, front counter forts are provided above the toe slab and the slab is designed as a continuous horizontal slab spanning between the front counter forts .

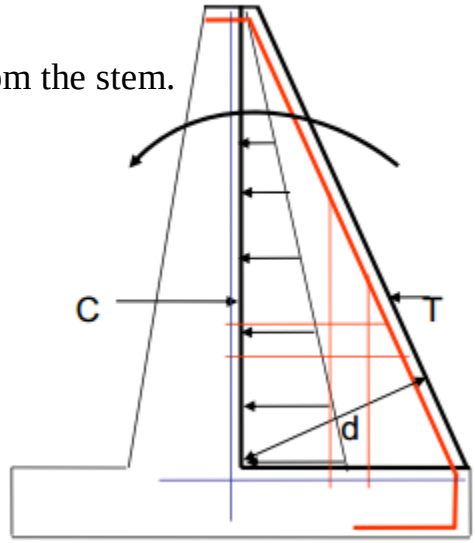


## Design of Heel Slab :-




- The heel slab is designed as a continuous slab
- spanning over the counter forts and is subjected
- to downward forces due to weight of soil plus self
- weight of slab and an upward force due to soil reaction.
- Maximum +ve B.M= pl٢/١٦ .
- (mid-way between counter forts) .
- And
- Maximum -ve B.M= pl٢/١٢ .
- (occurring at counter forts) .

## Design of Counter forts :-




• The counter forts are subjected to outward reaction from the stem.

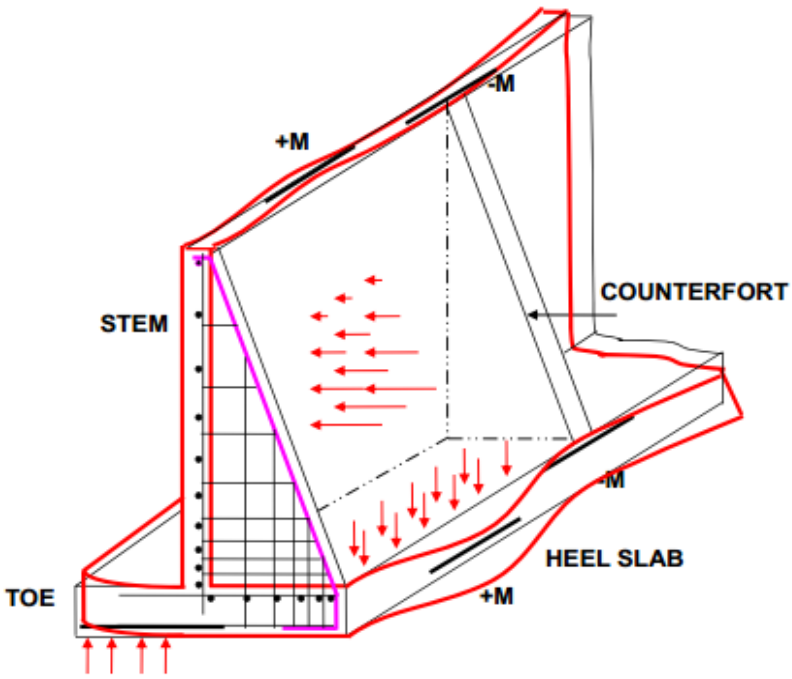
• This produces tension along the outer sloping face of the counter forts.

• The inner face supporting the stem is in compression Thus counter forts are designed as a T-beam of varying depth

• The main steel provided along the sloping face shall be anchored properly at both ends.

• The depth of the counter fort is measured perpendicular to the sloping side.

## Behaviour of Counterfort RW




Important points

- Loads on Wall
- Deflected shape
- Nature of BMs
- Position of steel
- Counterfort details