Kursus Pengenalan Asas Cerun
Cawangan Kejuruteraan Cerun
Jabatan Kerja Raya Malaysia

TYPES OF SLOPE TREATMENTS AND RETAINING WALL

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PRESENTATION OUTLINE

- INTRODUCTION
- TYPE OF SLOPE TREATEMENT
  - SOIL NAILING
  - SHORTCRETE
  - REINFORCE GEOTEXTILE SLOPE
- TYPE OF RETAINING WALL
  - MSE WALL
  - RC WALL
  - GRAVITY WALL
  - CANTILIVER WALL

SLOPE INSTABILITY PREVENTION

STANDARD GUIDELINE

RESEARCH & DEVELOPEMENT

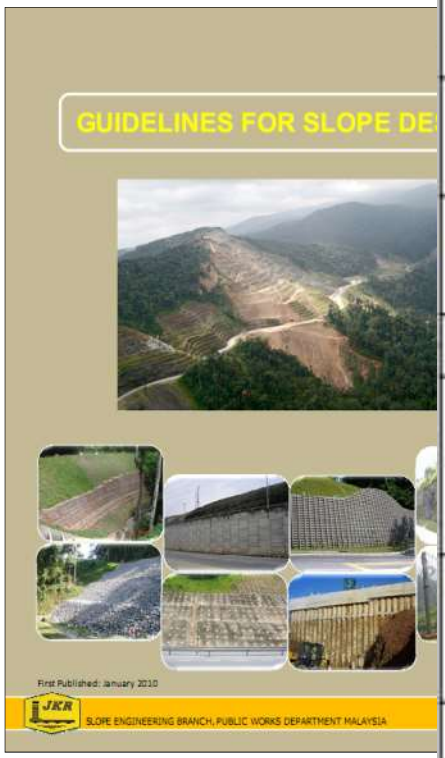
MAINTENANCE & SLOPE MANAGEMENT

LAW & REGULATION

PUBLIC AWARENESS

SLOPE EARLY WARNING SYSTEM

JADUAL FOS JKR



	DESIGN COMPONENT		MODE OF FAILURE	MINIMUM FACTOR OF SAFETY
1.	Unreinforced Slopes	1.1	Local & Global Stability (cut & fill slopes)	1.3
		1.2	Bearing (fill)	2.0
2.	Reinforced or Treated Slopes (not on soft ground)	2.1	Local & Global Stability (cut & fill slopes)	1.5
		2.2	Bearing (fill)	1.5
3.	Permanent Anchors	3.1	Tensile Resistance	2.0
		3.2	Resistance at Soil Grout Interface	3.0
		3.3	Creep/Corrosion	
4.	Rigid Retaining Structures	4.1	Overturning	2.0
		4.2	Sliding	1.5
		4.3	Overall Stability	1.5
		4.4	Bearing	2.0
5.	Reinforced Fill Walls/Structures	External Stability		BS 8006
		Internal Stability		
6.	Individual Foundation Piles (mainly under axial loads)	6.1	Shaft Resistance	2.0
		6.2	Base Resistance	2.0
7.	Individual Foundation Loads (mainly under lateral & bending loads perpendicular to axis of pile)	Ultimate Lateral Resistance		2.5
8.	Pile Group	Block Bearing Capacity		2.0
9.	Piles as Retaining Structures	As for 4, 6 & 7 above		As for individual foundation piles
10.	Embankment on Soft Ground	10.1	Bearing (short term)	1.4
		10.2	Local & Global Slope Stability (long term)	1.2

OPES DESIGN

IBLE MOVEMENTS	
ATERAL	DIFFERENTIAL
NUAL FOR	
g face of wall	1 : 150 along face of wall
m reference	1 : 100 along face of wall
endicular to axis of gn load	

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TYPES SLOPES TREATMENT

SOIL NAILING

SOIL NAILING

Soil nailing

Advantages :

1. Allow in-situ strengthening on existing slope surface with minimum excavation
2. Allow excellent working space in front of the excavation face,
3. Only requires light machinery and equipment,
4. Flexible at constraint site and excavation shape,
5. Can be used for strengthening of either natural slope, natural or man-made cut slopes,

Disadvantages :

1. Expensive
2. Tendency of high ground loss due to drilling technique, particularly at course grained soil,

Soil Nailing & Shotcrete

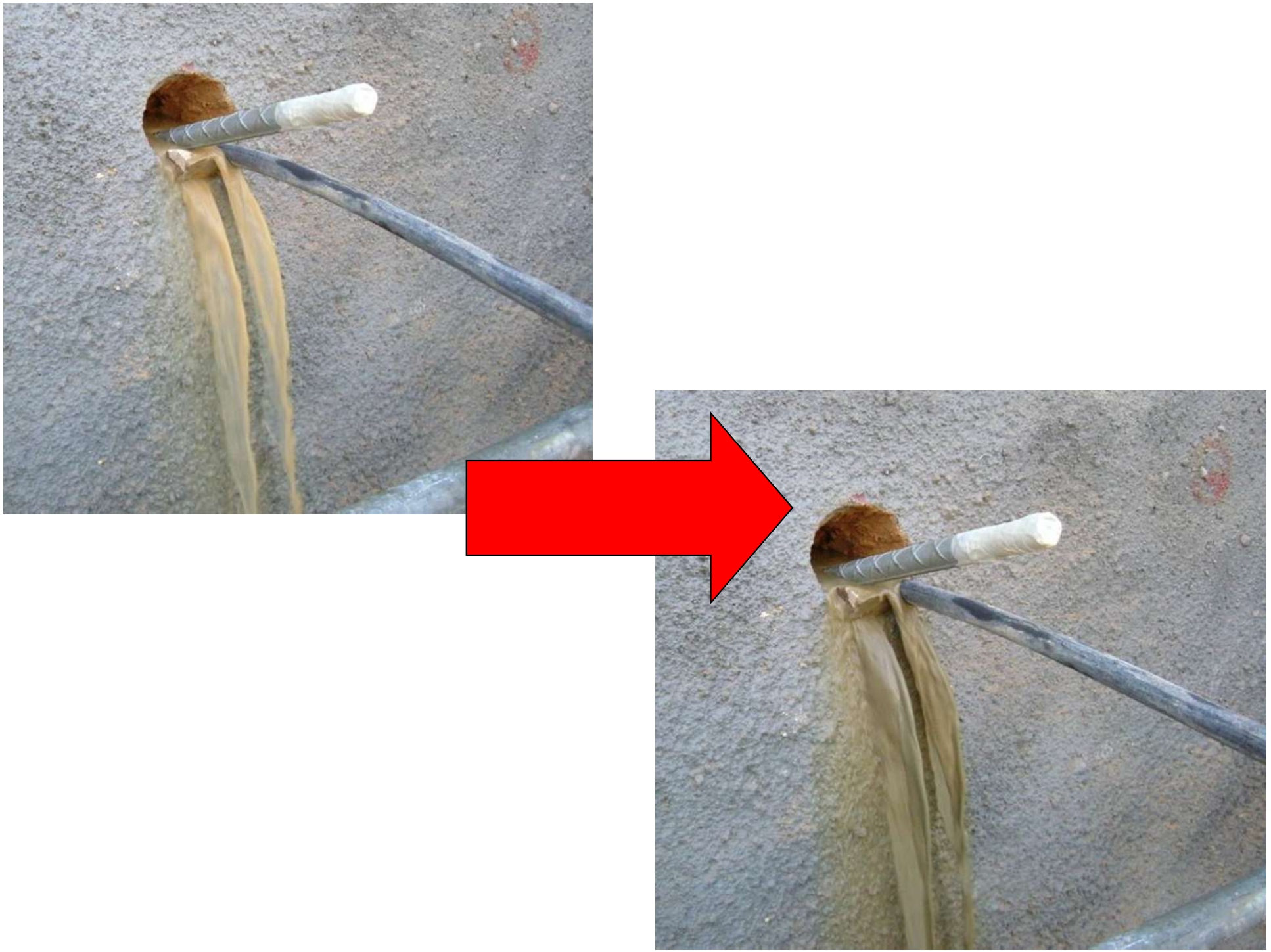
Earthworks for soil nailed slope

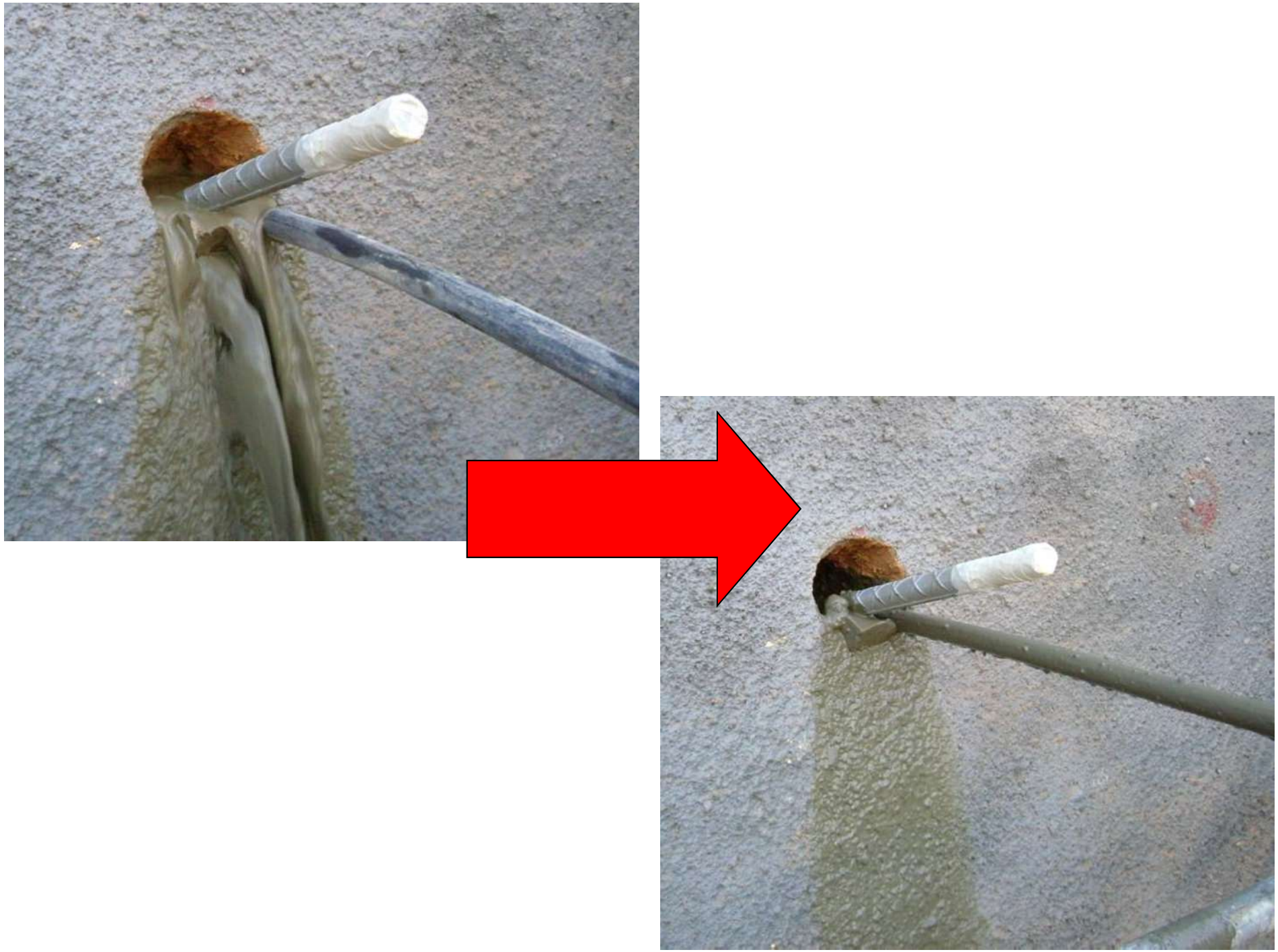
Centraliser


25FEET

Mark clearly and accurately the point of the soil nail location


Grout Pipe in the end





GROUTING

SHORTCRETE

SHOTCRETE

Advantage

- Less formwork
- Quicker construction cycle
- Lower water/cement ratio concrete
- Better controlled finish
- No need to vibrate
- Ability to offer a variety of finishes
- Lower cost

SHOTCRETE

BRC Wire Mesh

Lapping of BRC

RETAINING WALL

Retaining Wall Design Consideration

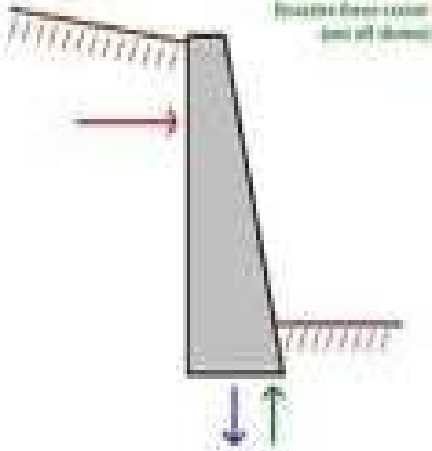
- Earth Water Pressure
- External Stability
- Sliding Stability
- Overturning Stability
- Bearing Stability
- Global Stability
- Structural Check

TYPE OF RETAINING WALL

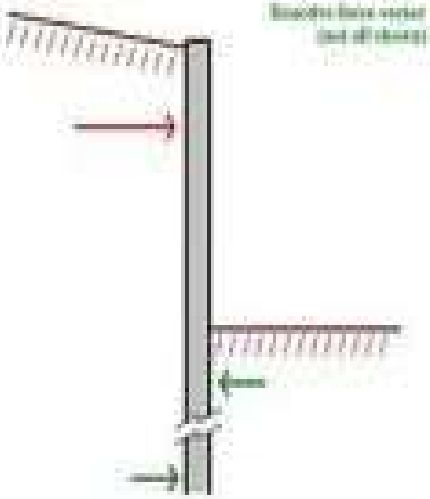
- Gravity Wall – Gabion Wall, Keystone Wall, Crib Wall
- MSE Wall
- Sheet Pile Wall
- Reinforced Concrete Wall
- Contiguous Bored Pile Wall
- Secant Pile wall
- Diaphragm Wall
- Soldier Pile Wall

Simplified explanation of typical retaining walls

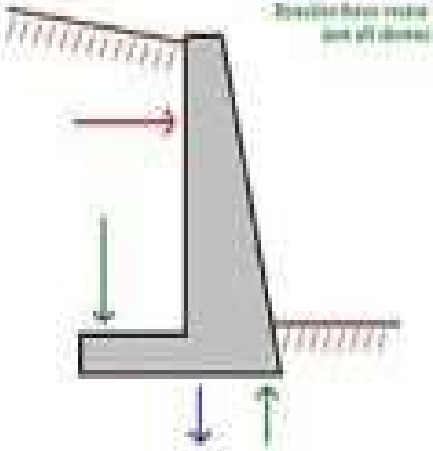
Gravity wall



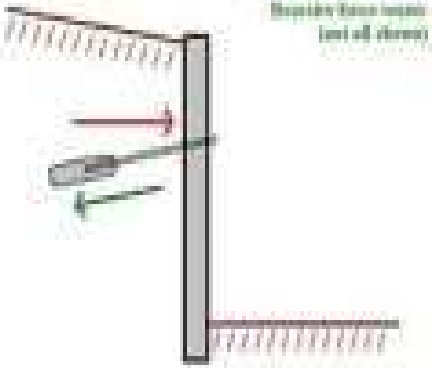
Piling wall



Cantilever wall



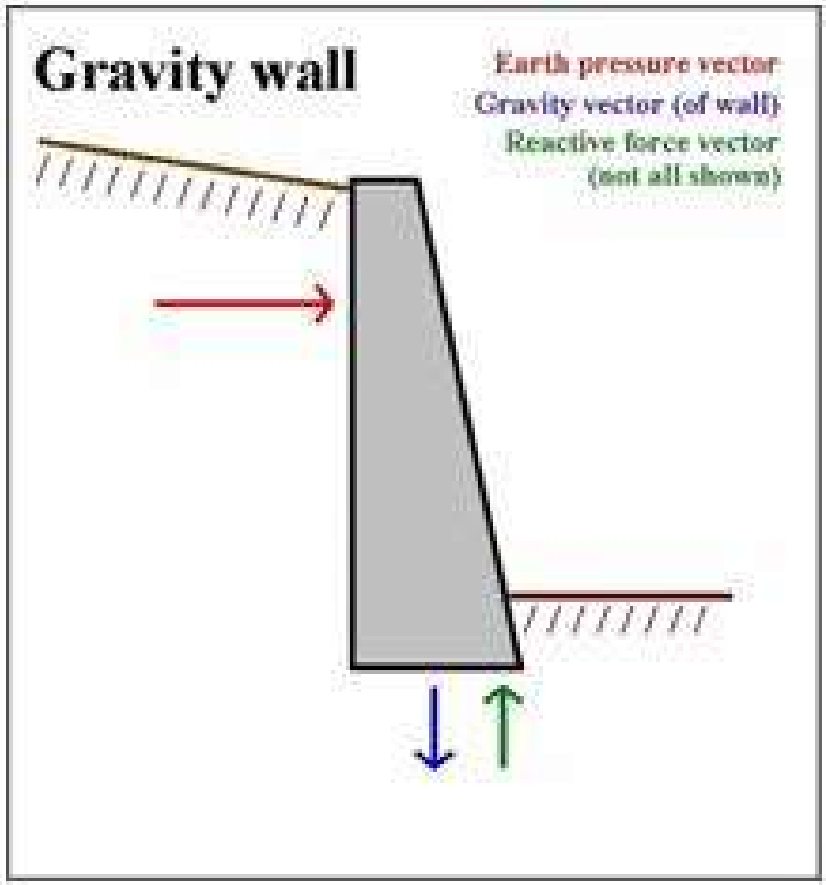
Anchored wall



GRAVITY WALL

GRAVITY WALL

Gravity walls **depend on the weight of the material** (stone, concrete or other heavy material) **to stop pressures from behind and improve stability by leaning back into the retained soil.** For short landscaping walls, they are often made from dry-stacked stone or segmental concrete units. Dry-stacked gravity walls are somewhat flexible and do not require a rigid footing.



Gravity wall

- This is the most simple retaining wall. It can be made from concrete or masonry. Its stability comes from its weight. They are suitable for wall heights up to about 5m.

Advantages:

- i) Cheap and simple to build – particularly suitable for remote areas where they can be built from locally available materials (e.g. rocks).
- ii) When constructed from natural materials can look attractive.

Disadvantages:

- i) Limited to about 5m height
- ii) Space needed behind wall for construction and backfilling.
- iii) Not suitable for soft soils due bearing failure.

Application of Gabion Wall

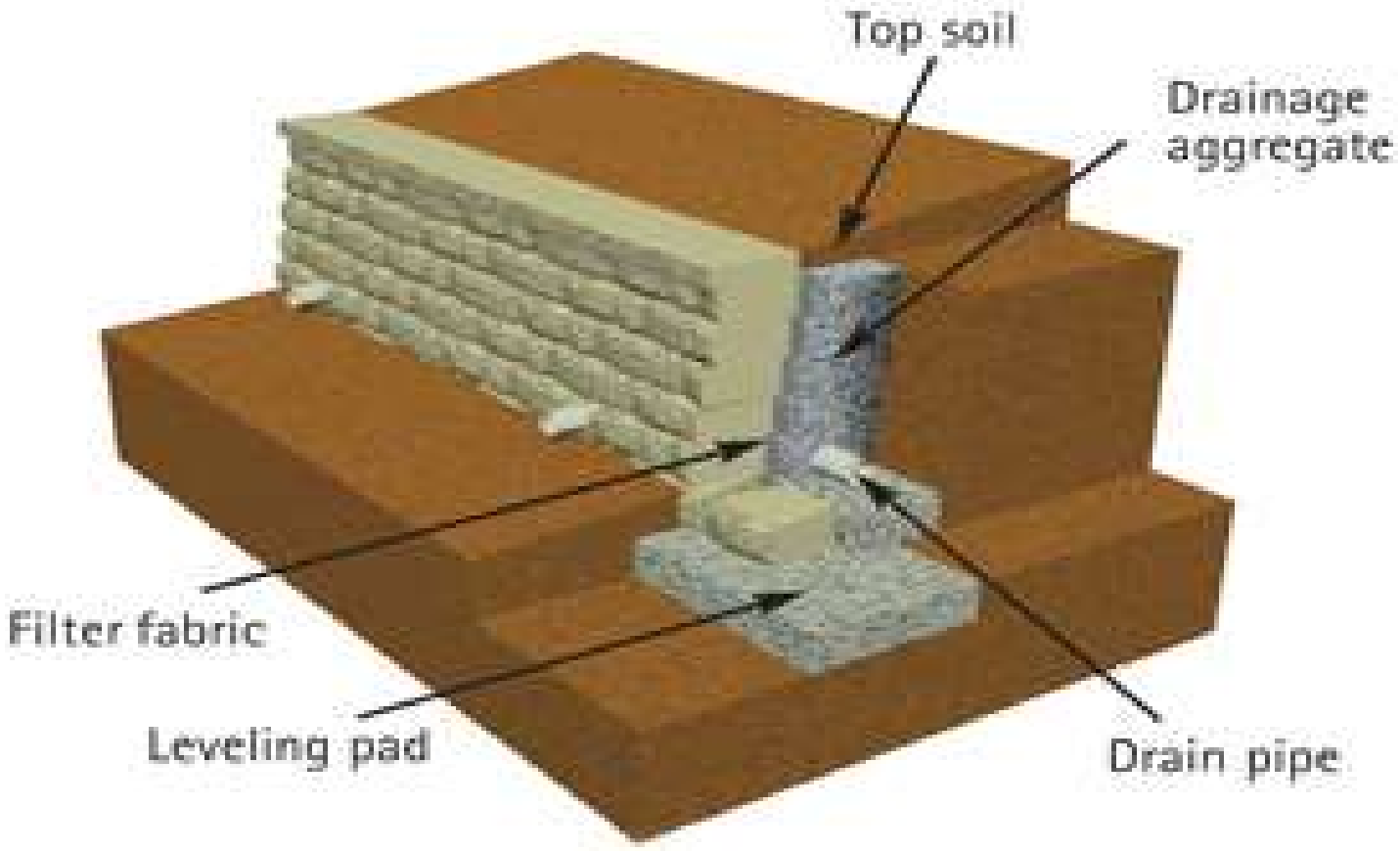
KeyStone Wall

CRIB WALL

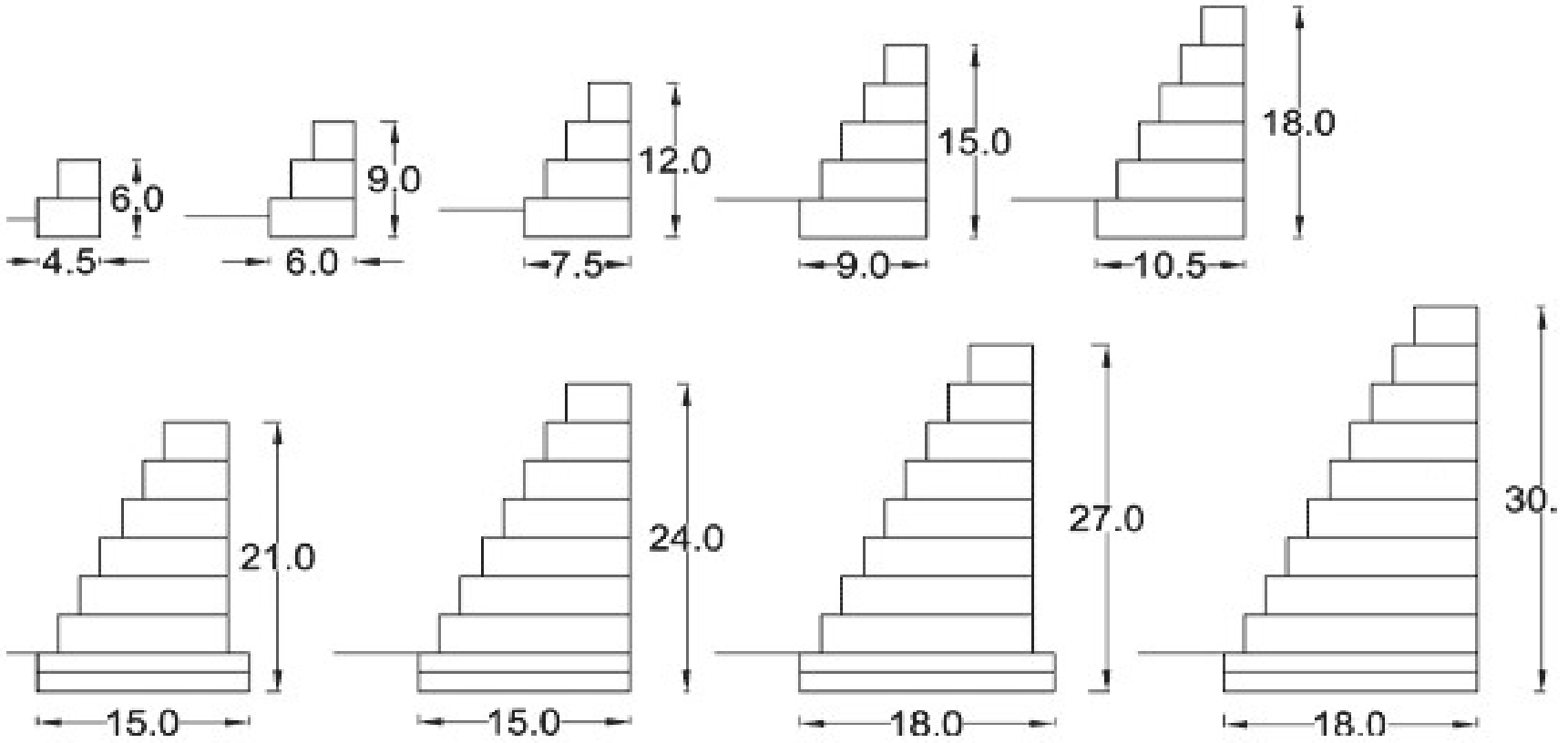
Crib walls are gravity retaining walls, constructed from interlocking, precast, concrete components. They are filled with free draining material and earth backfill to eliminate the hazards of hydrostatic pressure building up behind the wall.

CRIB WALL

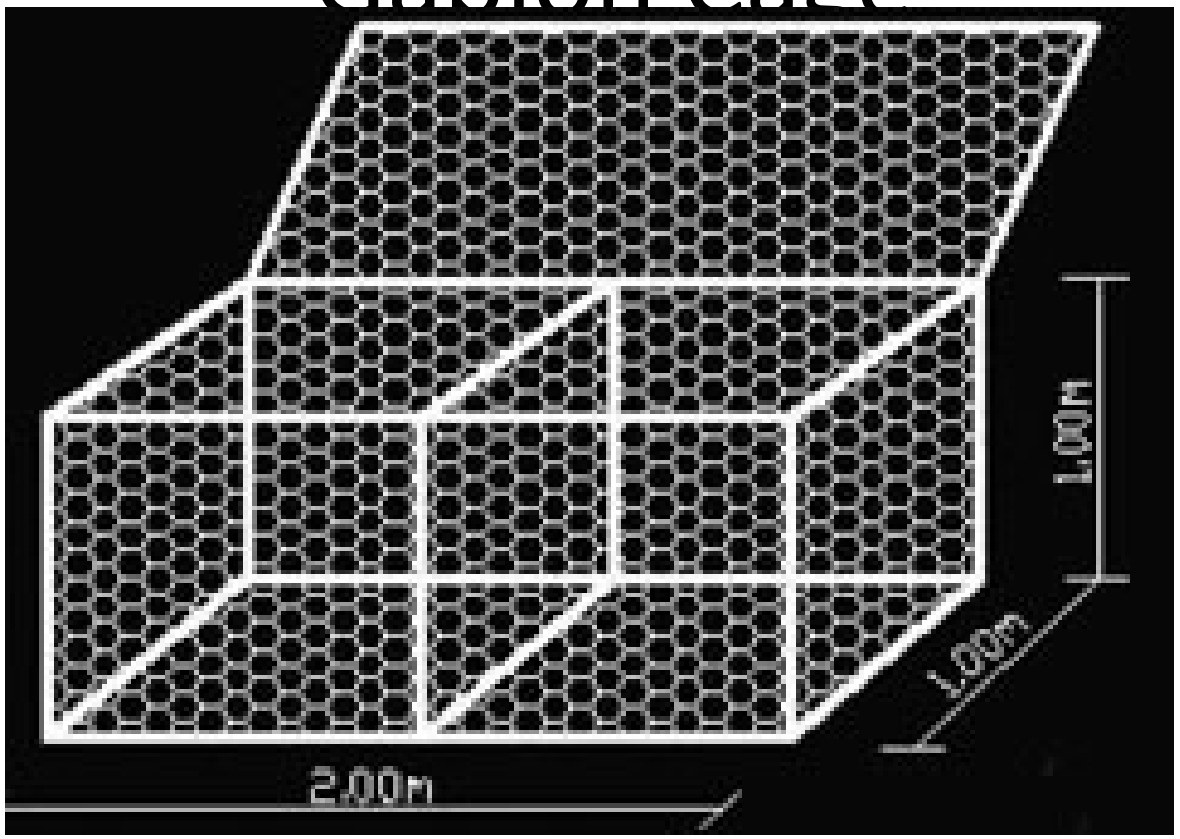
Gabion Wall


Top soil
Drainage aggregate
Filter fabric
Leveling pad
Drain pipe

Typical proposed height and base of gabion wall



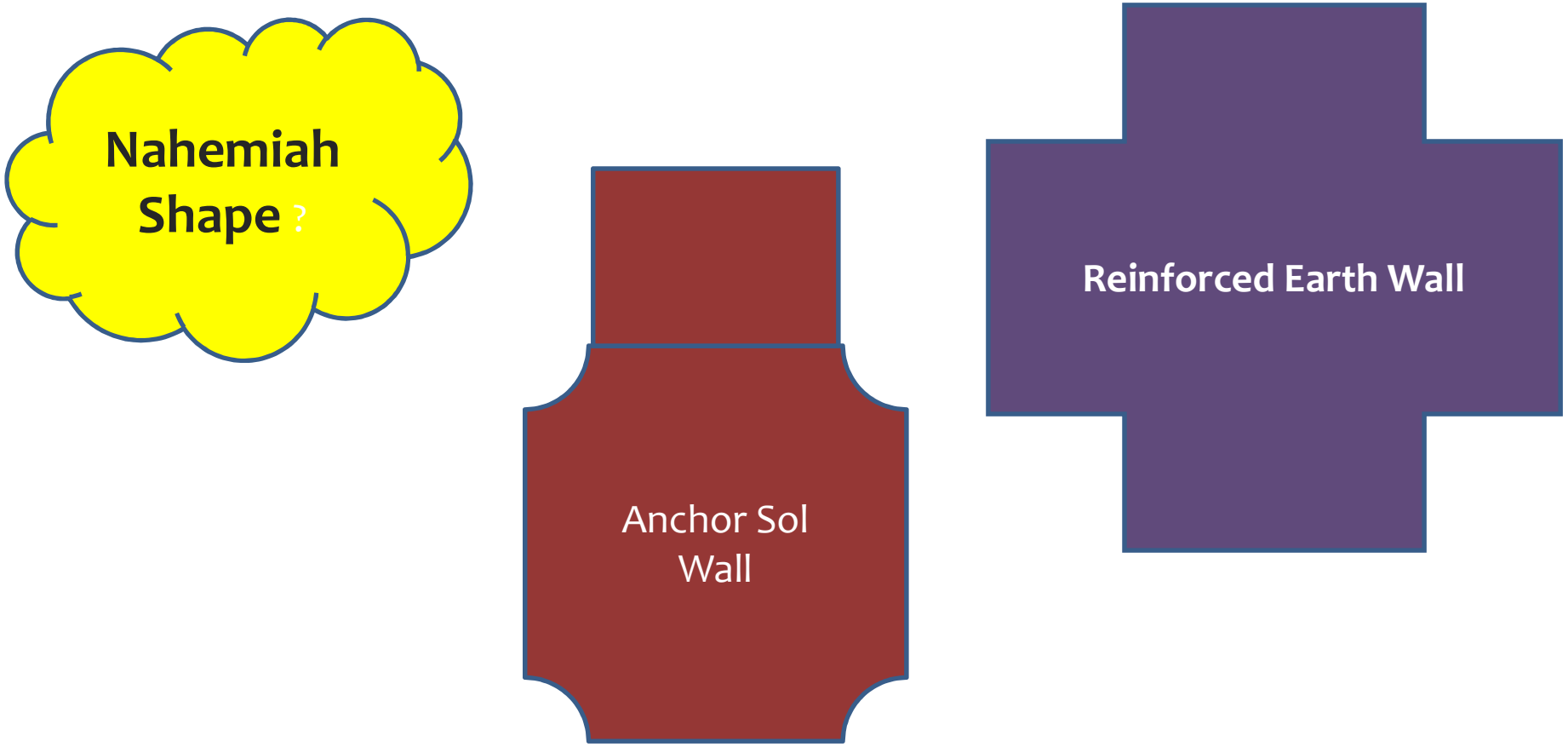
Gabion Cage



MECHANICAL STABILIZATION EARTH WALL
(MSE Wall)

MECHANICAL STABILIZATION EARTH WALL (MSE Wall)

Shape Of Mse



MSE Wall

ADVANTAGES

- Use simple and rapid construction procedures and do not require large construction equipment.
- Do not require experienced craftsmen with special skills for construction.
- Require less site preparation than other alternatives.
- Need less space in front of the structure for construction operations.
- Reduce right-of-way acquisition.
- Do not need rigid, unyielding foundation support because MSE structures are tolerant to deformations.
- Are cost effective.
- Are technically feasible to heights in excess of 25 m (80 ft)

Disadvantages

- Require a relatively large space behind the wall or outward face to obtain enough wall width for internal and external stability.
- Require select granular fill.
- Suitable design criteria are required to address corrosion of steel reinforcingelements, deterioration of certain types of exposed facing
- Since design and construction practice of all reinforced systems are still evolving, specifications and contracting practices have not been fully standardized.

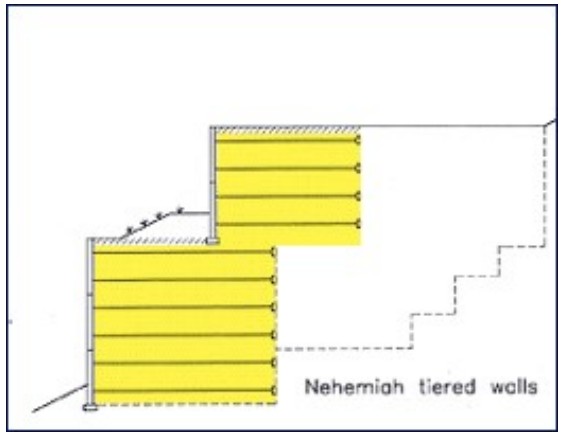
RE Wall

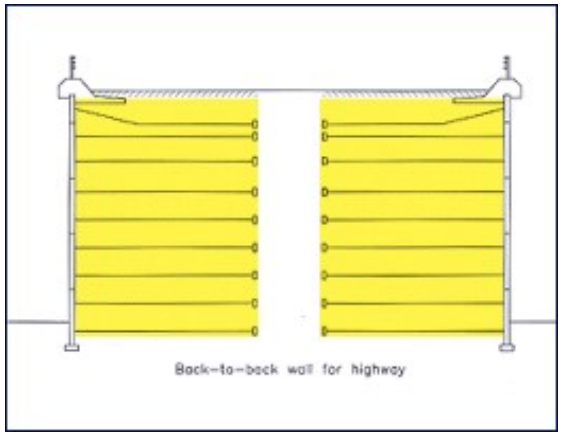

General backfill
Facing Panel
Reinforced Earth Block
Reinforcing Strip
Drainage Layer
Rock
Geotextile between select fill and rock

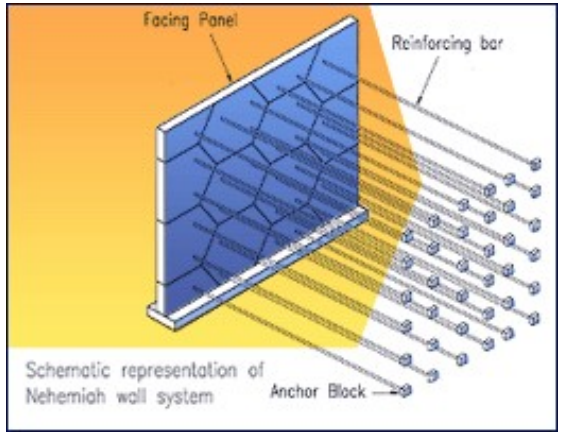
Nehemiah Wall

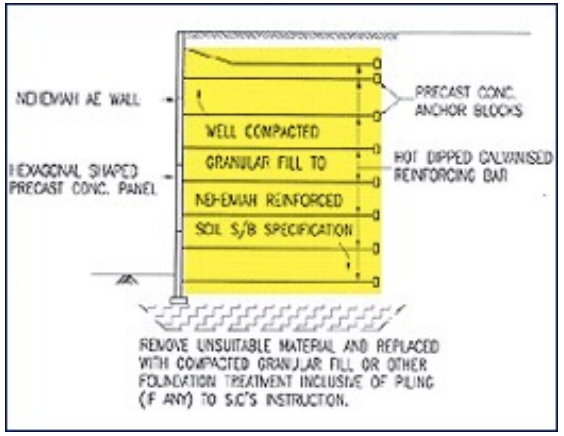
NEHEMIAH WALL

NEHEMIAH









APPLICATION NEHEMIAH WALL

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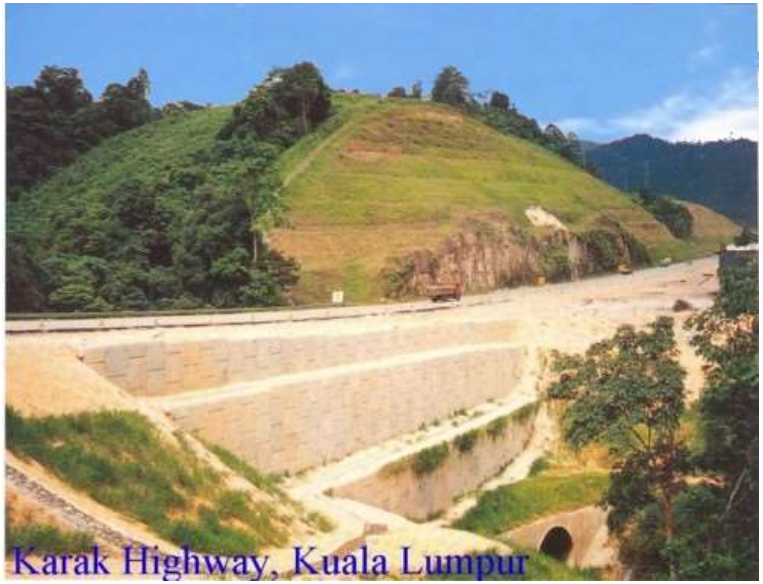


ANCHORSOL WALL

SHEET PILE WALL

SHEET PILE WALL

Sheet pile

- Advantages:
  1. Provides high resistance to driving stresses.
  2. Light weight
  3. Can be reused on several projects.
  4. Long service life above or below water with modest protection.
  5. Easy to adapt the pile length by either welding or bolting
  6. Joints are less apt to deform during driving.

- Disadvantages:
  1. Sections can rarely be used as part of the permanent structure.
  2. Installation of sheet piles is difficult in soils with boulders or cobbles. In such cases, the desired wall depths may not be reached.
  3. Excavation shapes are dictated by the sheet pile section and interlocking elements.
  4. Sheet pile driving may cause neighborhood distrurbace
  5. Settlements in adjacent properties may take place due to installation vibrations

REINFORCED CONCRETE WALL

REINFORCED CONCRETE WALL

- **RC Cantilevered walls** are made from a somewhat thin stem of steel-reinforced, cast-in-place concrete.

- These walls cantilever loads to a large, structural footing and convert horizontal pressures from behind the wall to vertical pressures on the ground below.

- Sometimes cantilevered walls are supported from the back or front to improve stability against high loads.

- These walls require rigid concrete footings below seasonal frost depth.

- This type of wall uses much less material than a traditional gravity wall.

Reinforced concrete cantilever walls

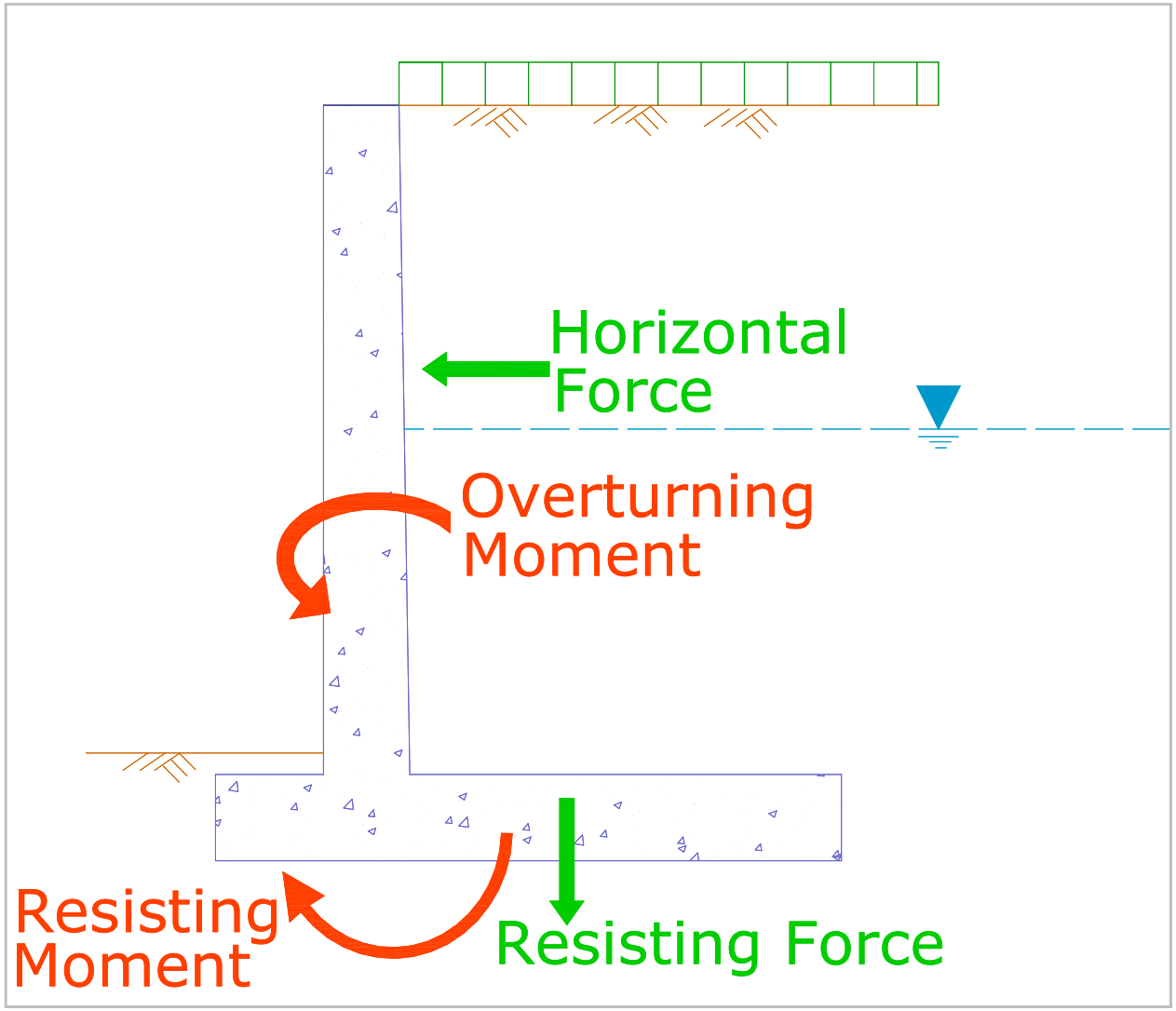
Advantages:

- i) take up small space with much of structure below ground
- ii) no specialist equipment required – standard reinforced concrete skills required for construction

Disadvantages:

- i) prone to sliding failure – often require propping
- ii) space required behind wall for construction and backfilling
- iii) height limited to about 6m.
- iv) not suitable for soft soils due bearing failure

FORCES AND MOMENT ACTING ON RC WALL



Failure Of Reinforced Concrete Wall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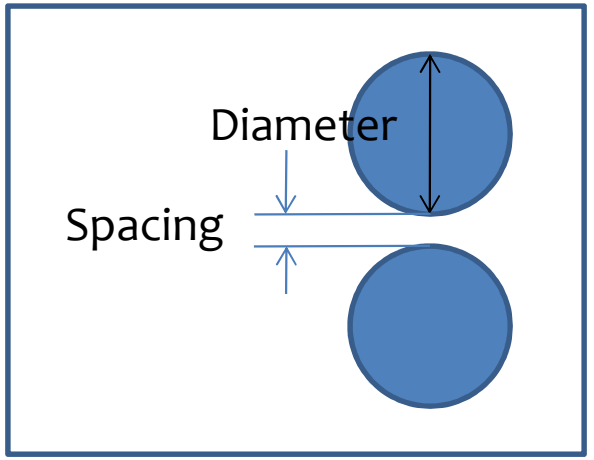
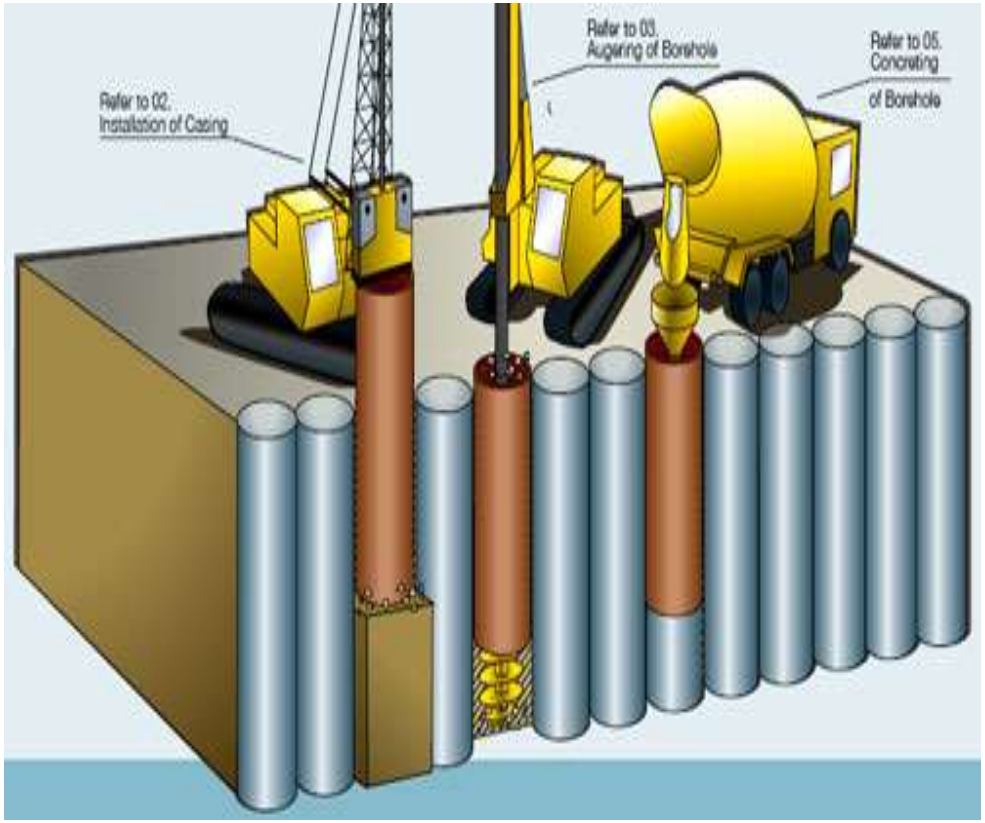
CONTIGUOUS BORED PILES (CBP) WALL

CONTIGUOUS BORED PILES (CBP) WALL

- Ease coring into rock
- Lack water-tightness
- Minimum noise and vibration disturbance

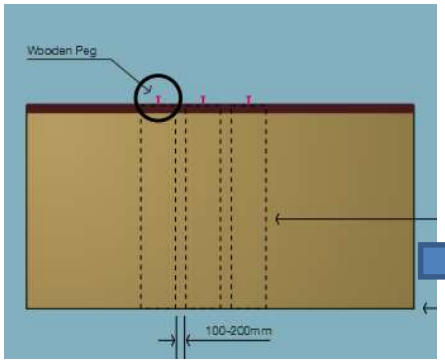


CONTIGUOUS BORED PILE WALL

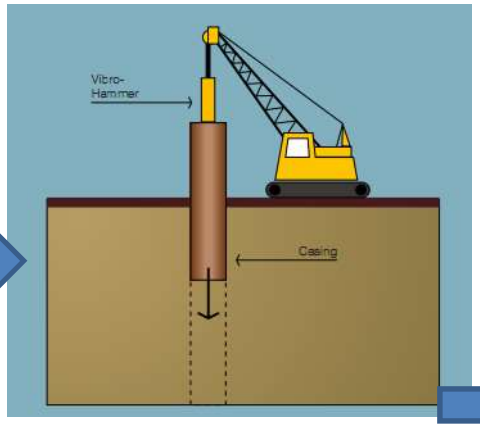


CONSTRUCTION OF CBP WALL

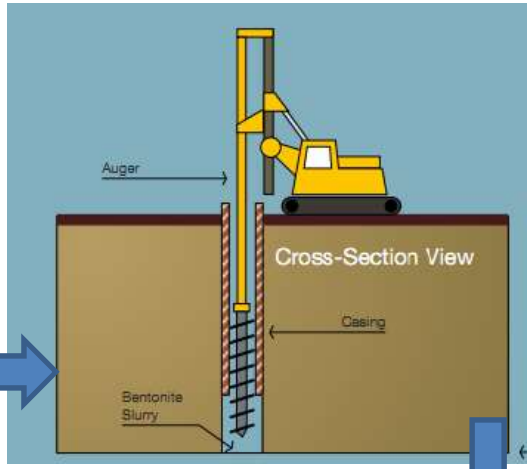
Position of Bored Pile

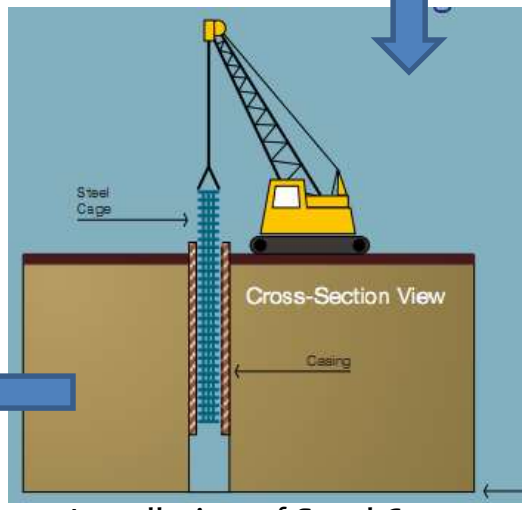


Installation of Casing



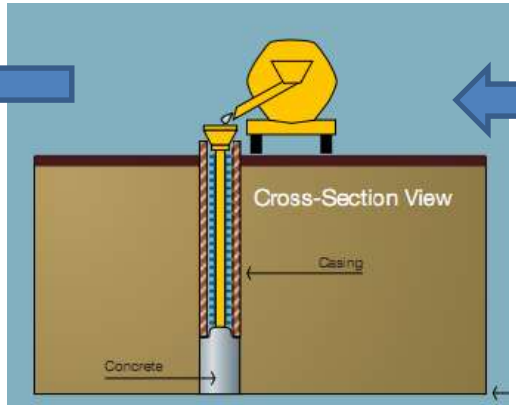
Augering of Borehole

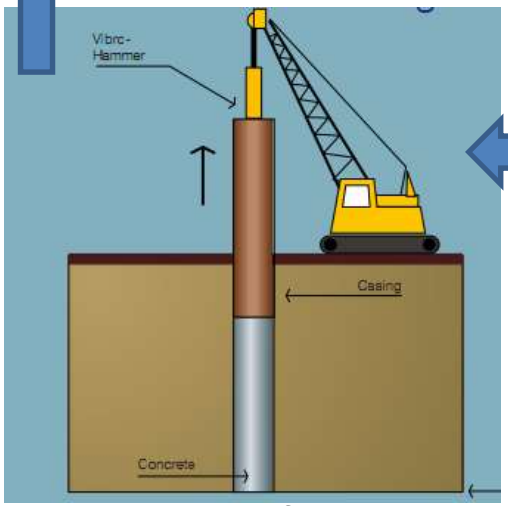




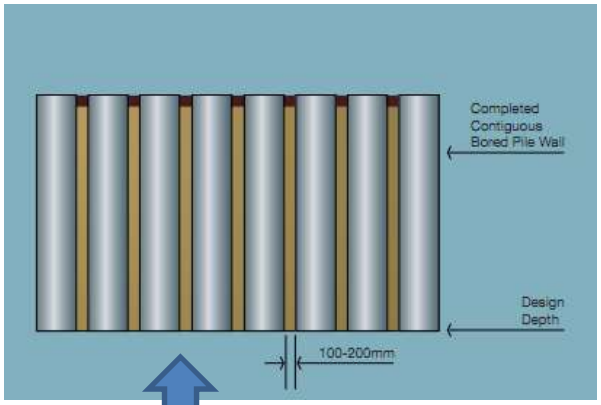
Installation of Steel Cage

Concreting

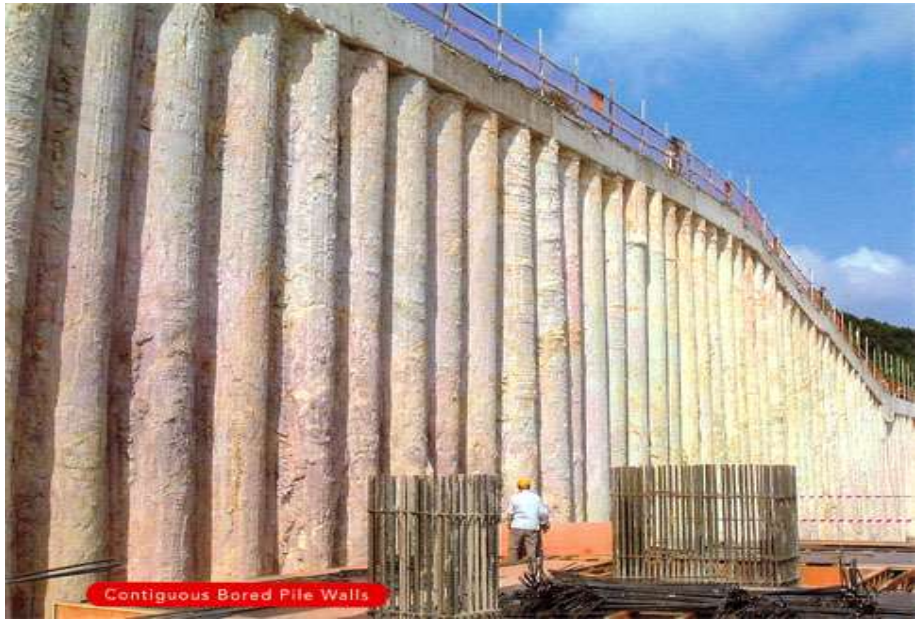


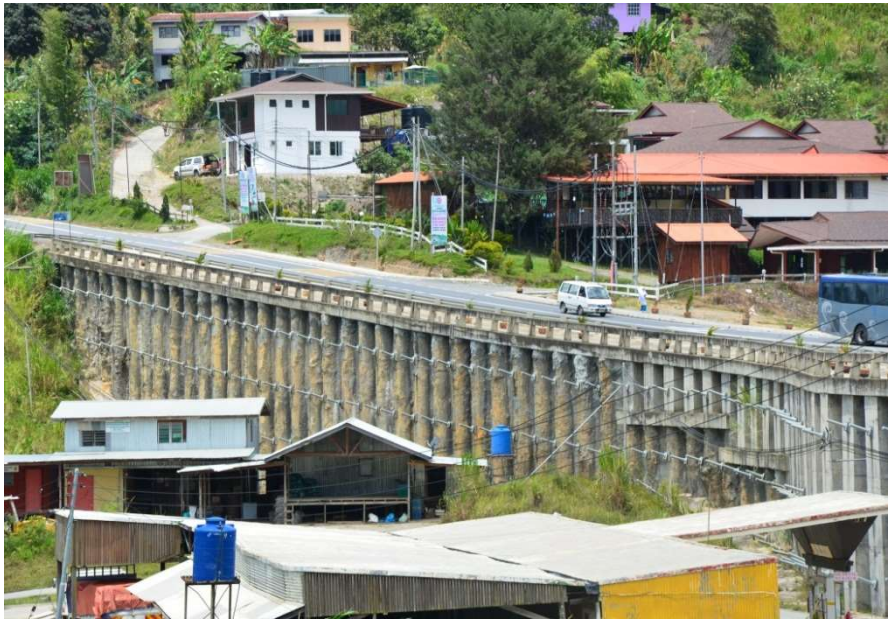


Extraction of Casing



Application of CBP Wall

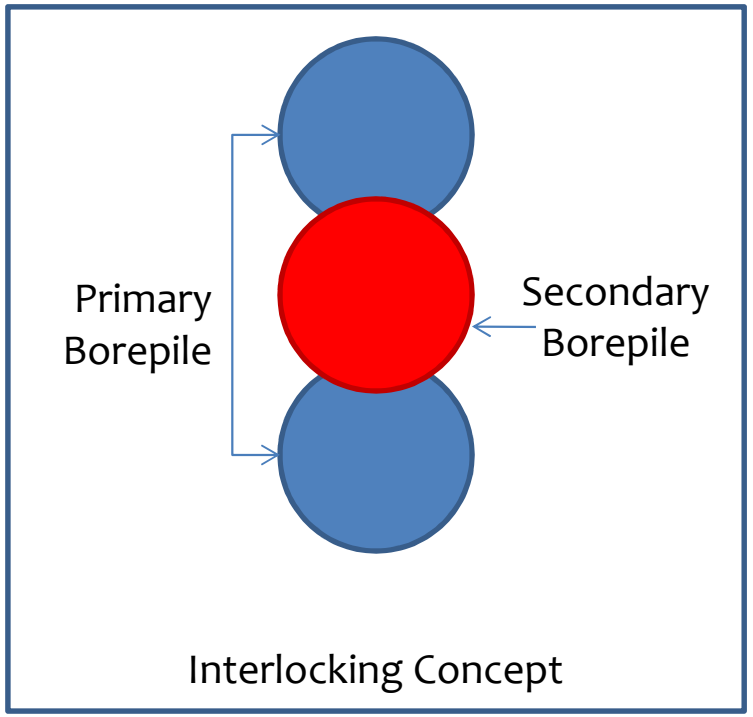




Failure Of CBP Wall

SECANT PILES WALL

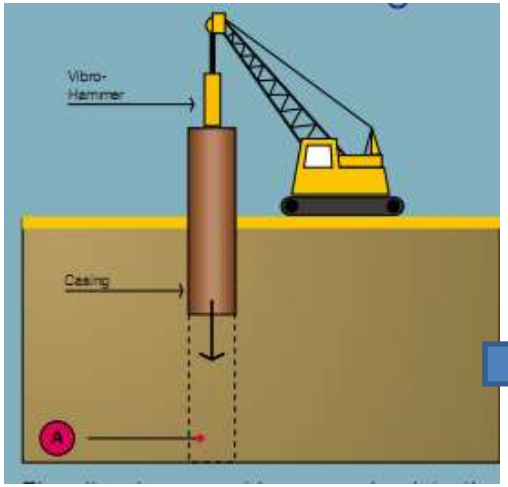
SECANT PILES WALL



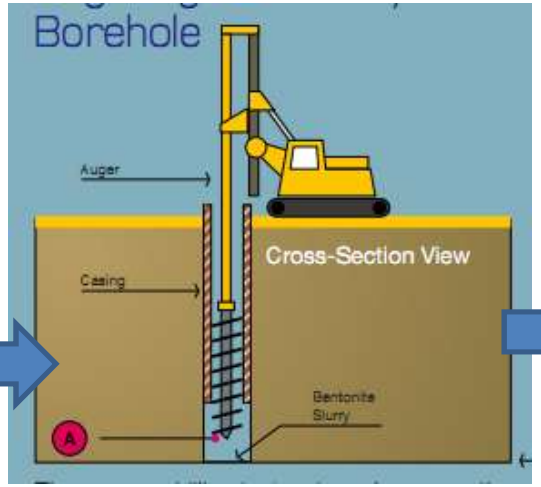
- Water-tightness effective by interlocking concept
- Possible full temporary protection in collapsible soil
- Ease coring into rock
- Minimum noise and vibration disturbance

CONSTRUCTION OF SECANT PILE WALL

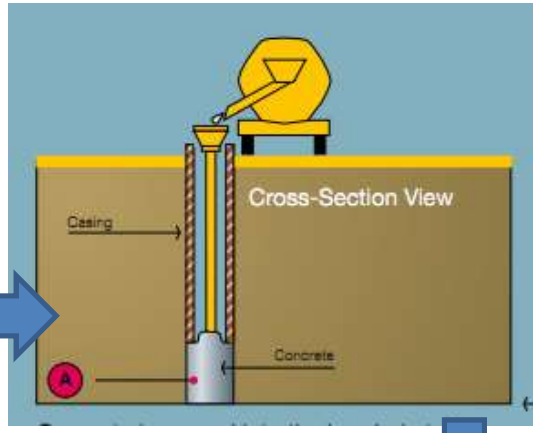
Installation of Casing

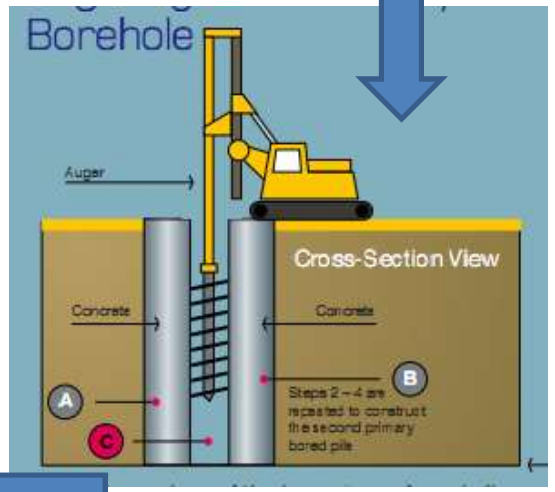


Augering of Primary Borehole

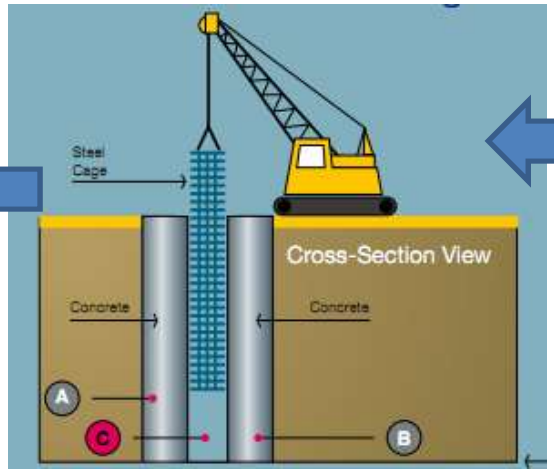


Concreting

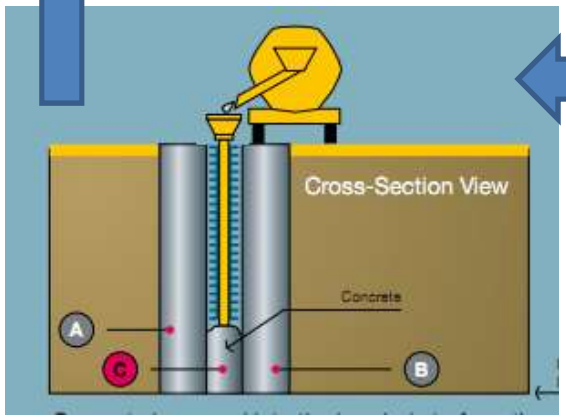




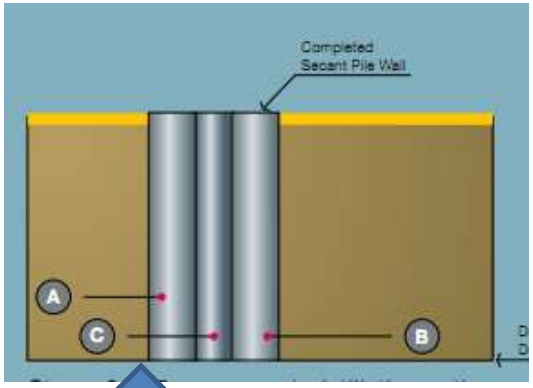
Augering of Secondary Borehole



Installation of Steel Cage



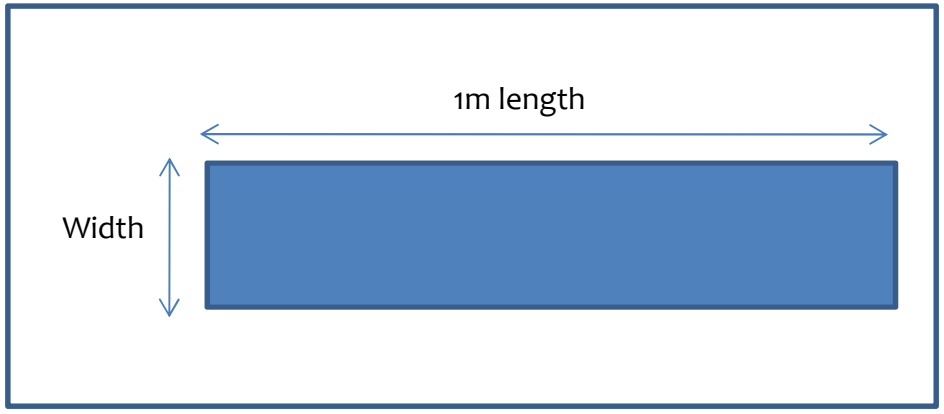
Concreting



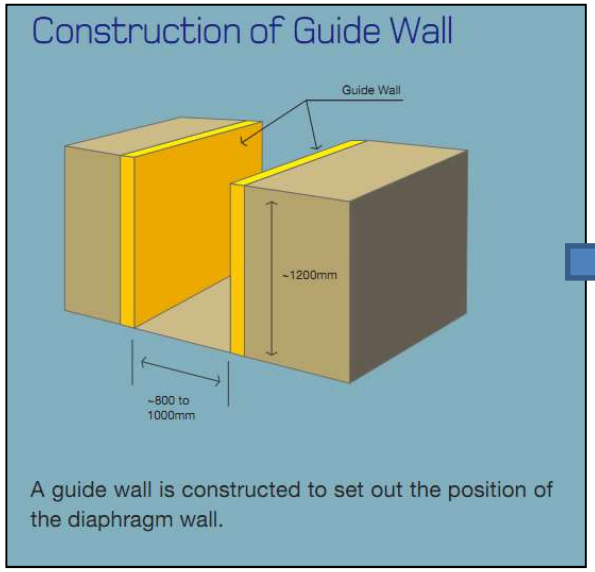
DIAPHRAGM WALL

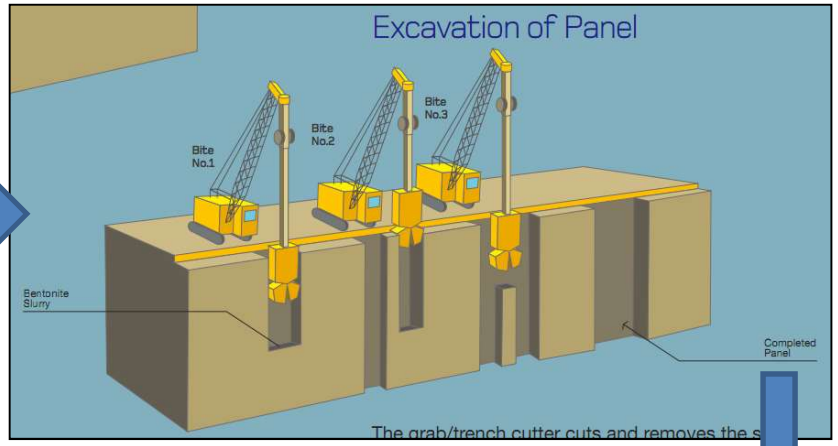
DIAPHRAGM WALL

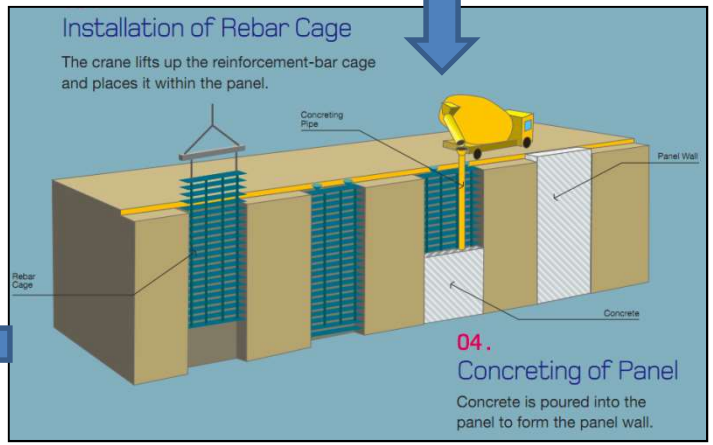
- Efficient water-tightness
- Minimum noise and vibration disturbance

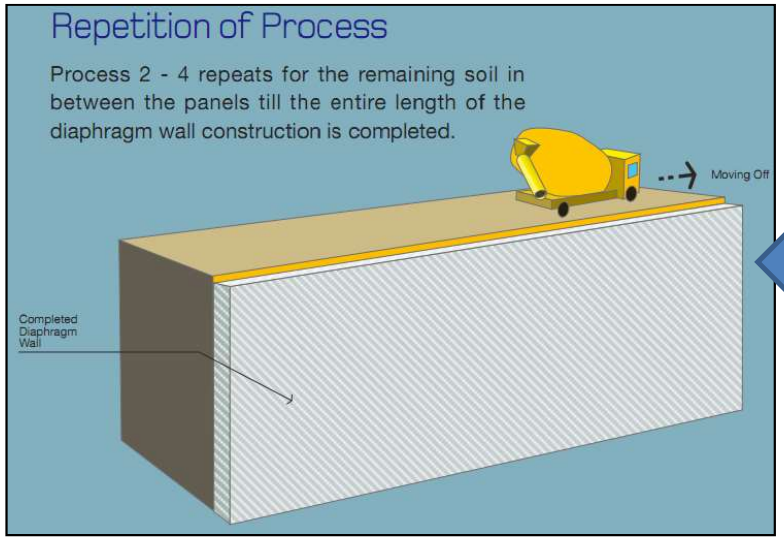


Construction of Diaphragm Wall

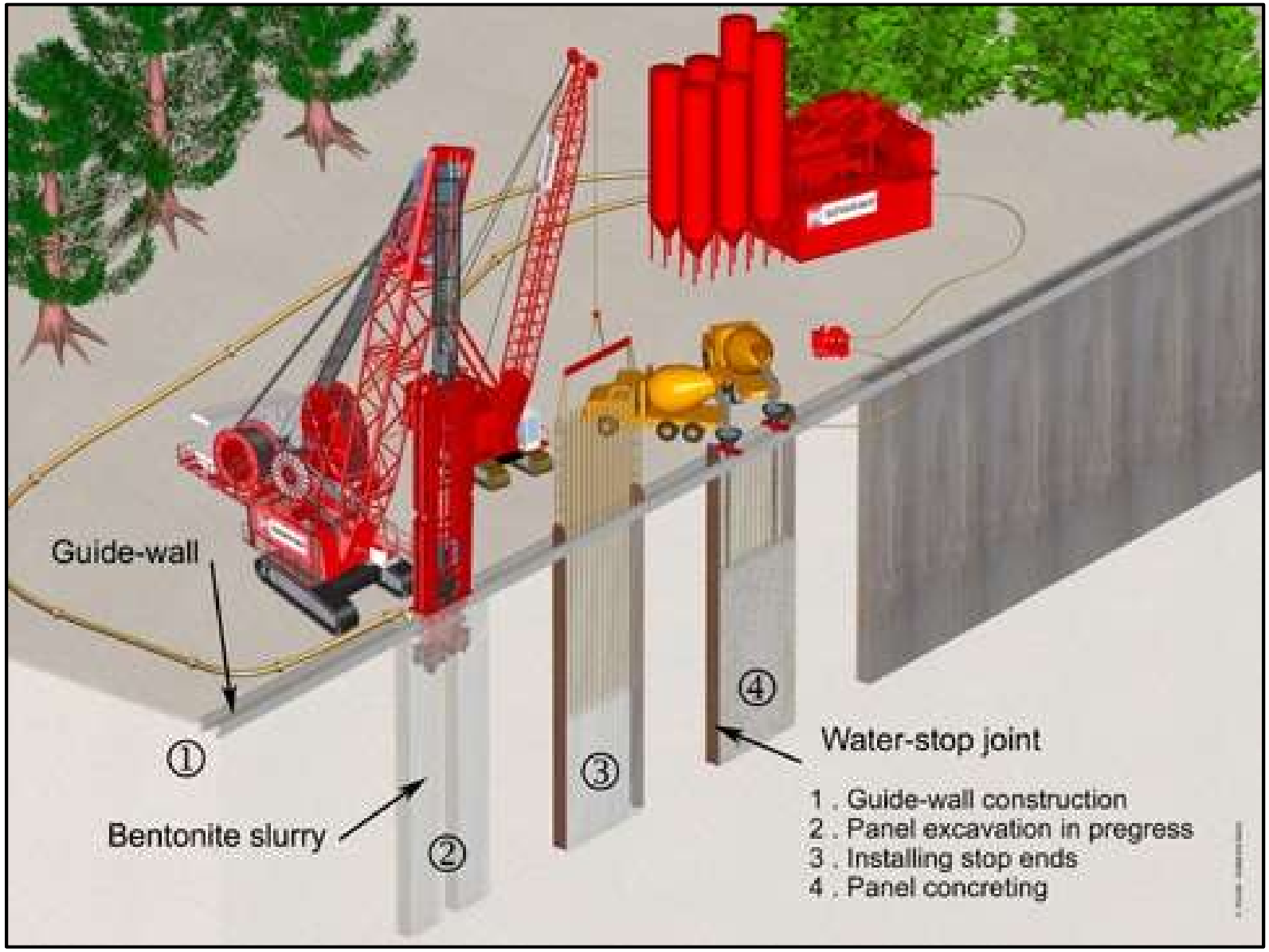








DIAPHRAGM WALL



APPLICATION OF DIAPHRAGM WALL

APPLICATION OF DIAPHRAGM WALL

Kelly Mount Hydraulic Grab

Cable Mounted Hydraulic Grab

Diaphragm Walls

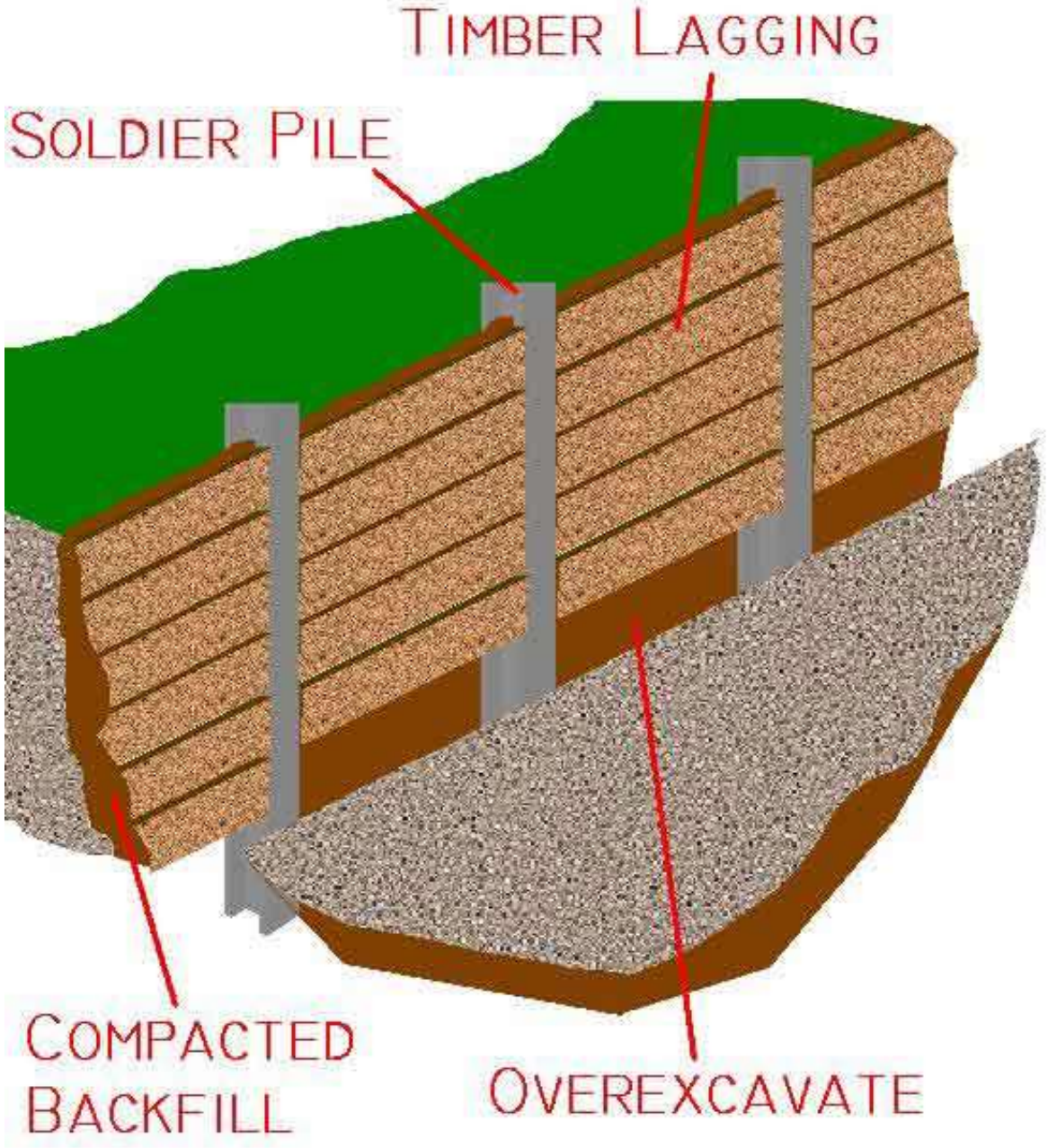
Thomas D Richards, Jr P.E. Nicholson Construction Company

Central PA Geotechnical Conference - March 23-25, 2005

APPLICATION OF DIAPHRAGM WALL

Cage Placement Note blockouts for floor slabs and trumpets for anchors .

SOLDIER PILE WALL



SOLDIER PILE WALL

APPLICATION OF SOLDIER PILE WALL

THANK YOU