Foundations

The tasks:

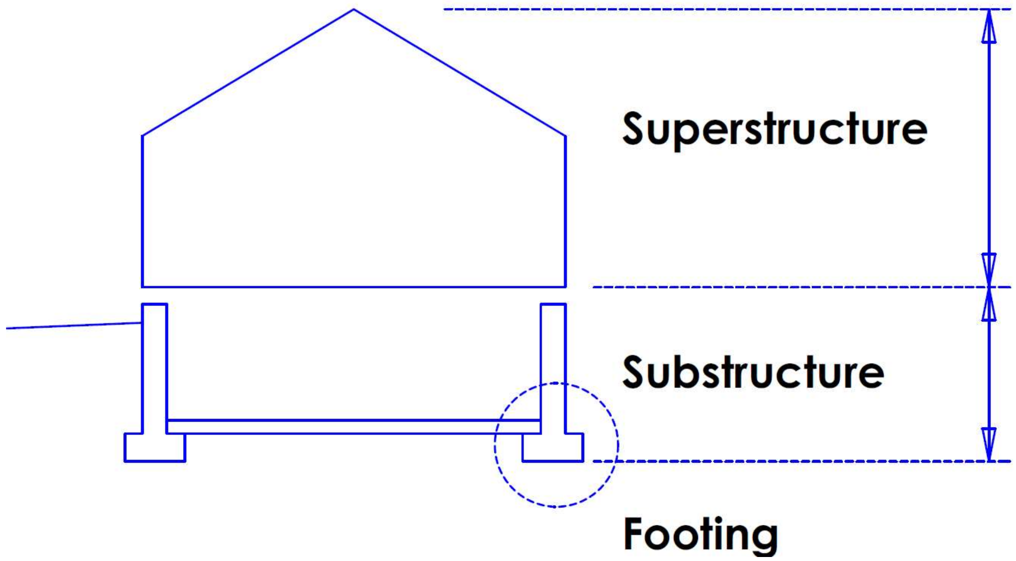
- choose the right types of the foundations
- plan the rhythm of the works
- choose the most economical method for the works

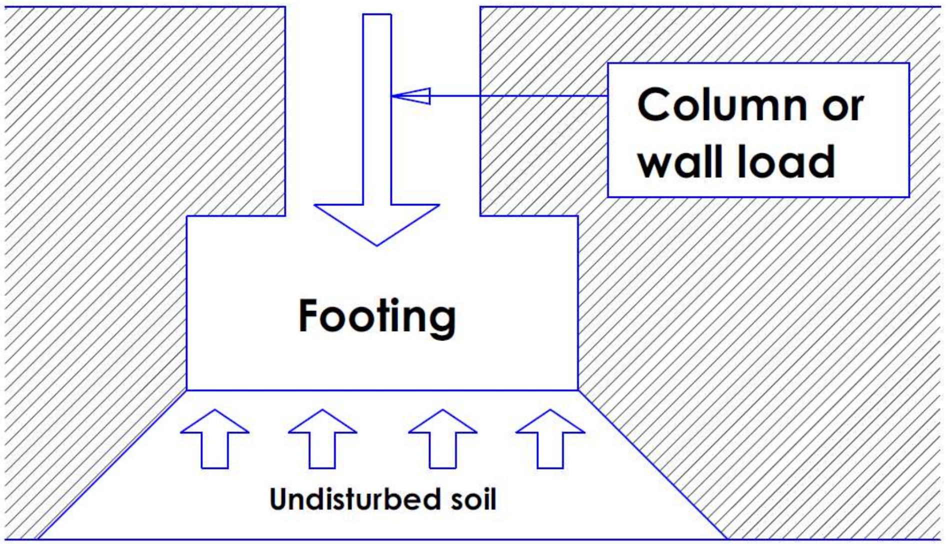
What is the foundation ?

- **Definition 1:** Foundation: The structure, that transmits the load of the building to the soil
- **Definition 2:** Load bearing soil (strata): The soil layer, that has the sufficient load bearing capacity in relation to the chosen foundation type
- The primary design concerns are settlement

(total settlement and differential settlement) and load bearing capacity.

What is the foundation ?





What is the foundation ?

Choosing a kind of foundation depends on:

- the ground conditions
- the groundwater conditions
- the site, the environment (the buildings nearby)
- the structure of our building

Requirements:

- structural requirements: safe, be able to carry the load of the building
- constructional requirements: schedule, minimal resources, minimal cost

The ground conditions

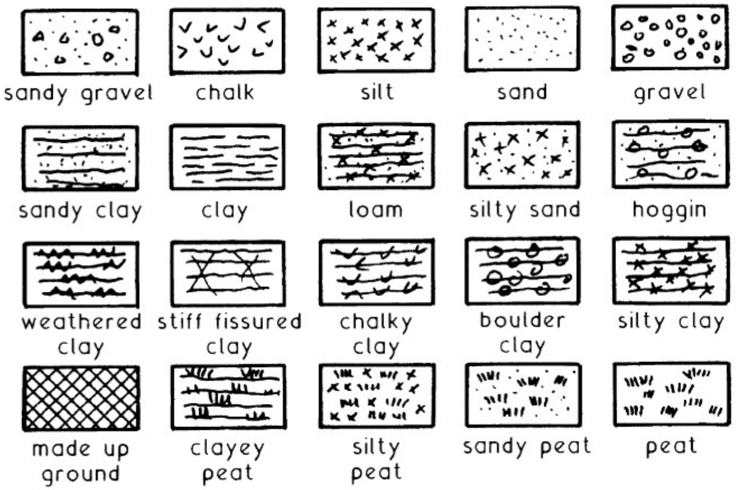
Triangular Chart ~ this provides a general classification of soils composed predominantly from clay, sand and silt. Each side of the triangle represents a percentage of material component. Following laboratory analysis, a sample's properties can be graphically plotted on the chart and classed accordingly.

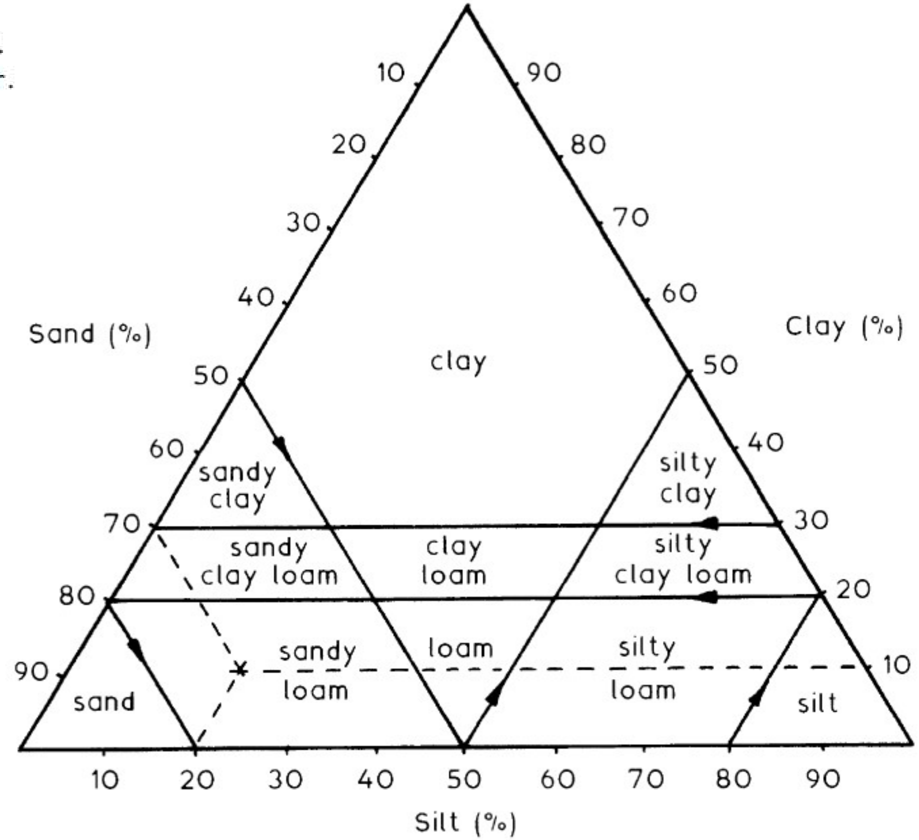
e.g. Sand – 70%, Clay – 10% and Silt – 20% = Sandy Loam.

Note:

Silt is very fine particles of sand, easily suspended in water.
Loam is very fine particles of clay, easily dissolved in water.

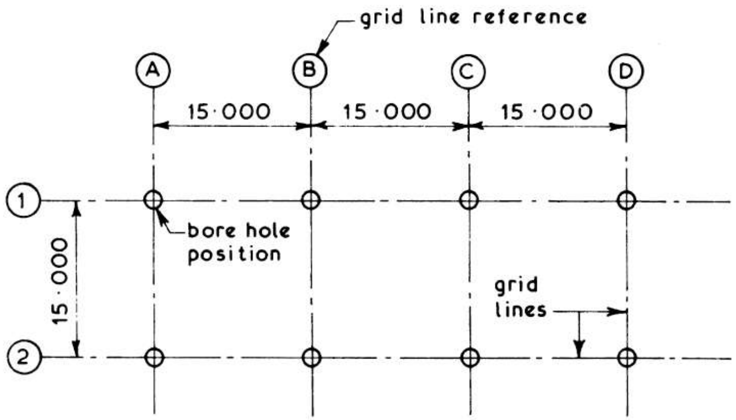
Standard soil symbols ~



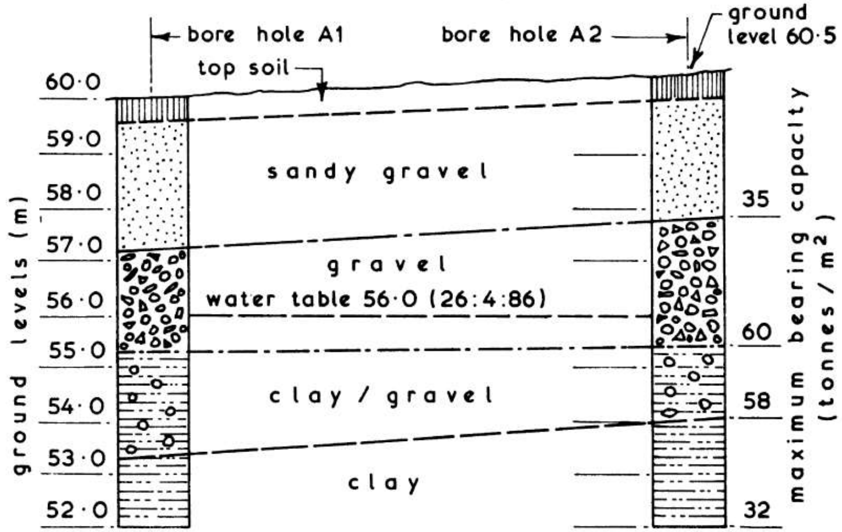


The ground conditions

Bore Hole Data ~ the information obtained from trial pits or bore holes can be recorded on a pro forma sheet or on a drawing showing the position and data from each trial pit or bore hole thus:-



LOCATION PLAN OF BORE HOLES



BORE HOLE DATA

Bore holes can be taken on a 15·000 to 20·000 grid covering the whole site or in isolated positions relevant to the proposed foundation(s)

As a general guide the cost of site and soil investigations should not exceed 1% of estimated project costs

The ground conditions

Soil Assessment ~ prior to designing the foundations for a building or structure the properties of the subsoil(s) must be assessed. These processes can also be carried out to confirm the suitability of the proposed foundations. Soil assessment can include classification, grading, tests to establish shear strength and consolidation. The full range of methods for testing soils is given in BS 1377: Methods of test for soils for civil engineering purposes.

Classification ~ soils may be classified in many ways such as geological origin, physical properties, chemical composition and particle size. It has been found that the particle size and physical properties of a soil are closely linked and are therefore of particular importance and interest to a designer.

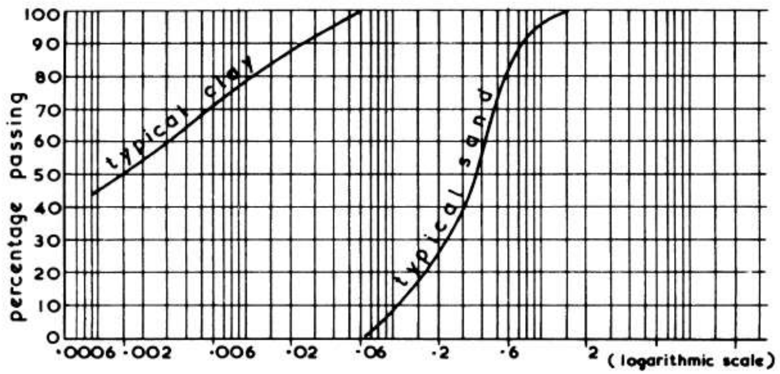
Particle Size Distribution ~ this is the percentages of the various particle sizes present in a soil sample as determined by sieving or sedimentation. BS 1377 divides particle sizes into groups as follows:-

Gravel particles – over 2mm
Sand particles – between 2mm and 0·06mm
Silt particles – between 0·06mm and 0·002mm
Clay particles – less than 0·002mm

The sand and silt classifications can be further divided thus:-

CLAY	SILT			SAND			GRAVEL
	fine	medium	coarse	fine	medium	coarse	
0·002	0·006	0·02	0·06	0·2	0·6	2	

The results of a sieve analysis can be plotted as a grading curve thus:-



What is the foundation ?

The specialities:

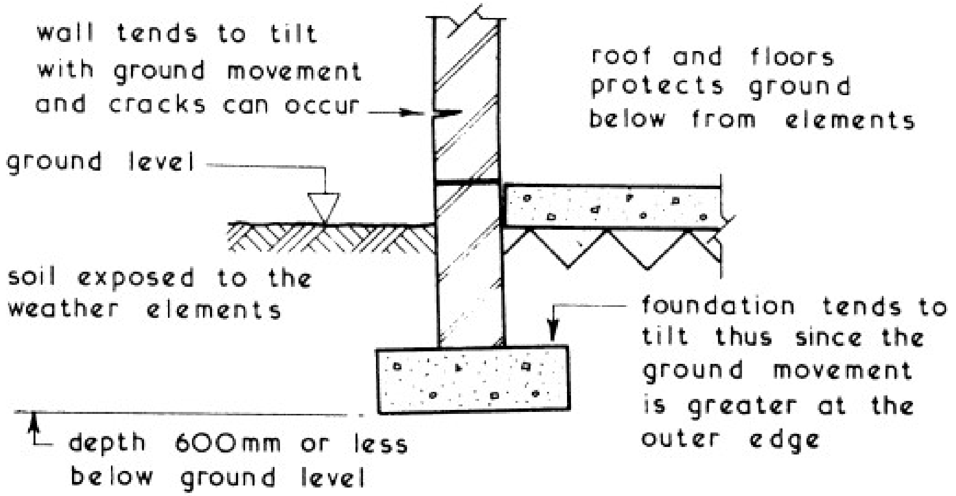
- it is expensive and difficult to repair
- usually it is constructed under the ground, so it is out of sight
- a bad/ misapplied foundation could demolish the building

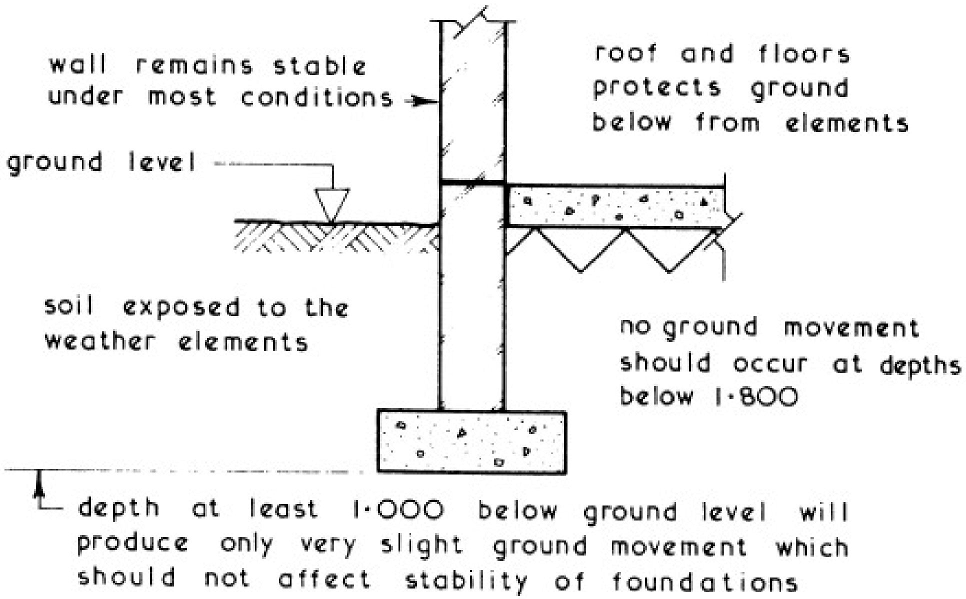
The mistakes:

- construction technology mistakes
- bad or not proper deep digging (always necessary!!!)
- planning mistakes: the type of foundation is inadequate for the ground layers / for the building

The damage of the foundations

Typical Examples~

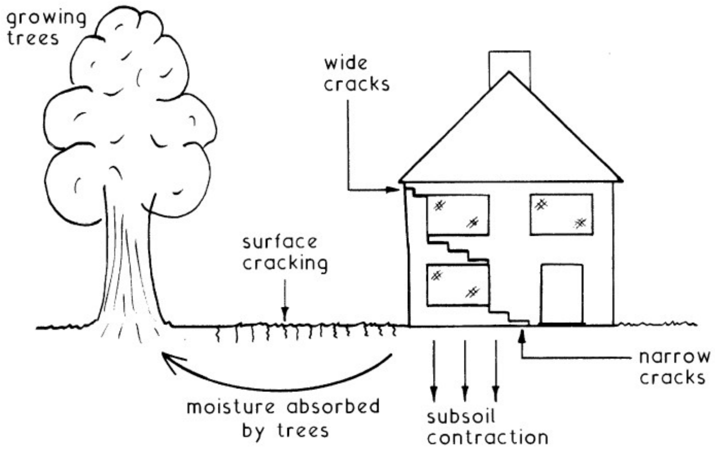


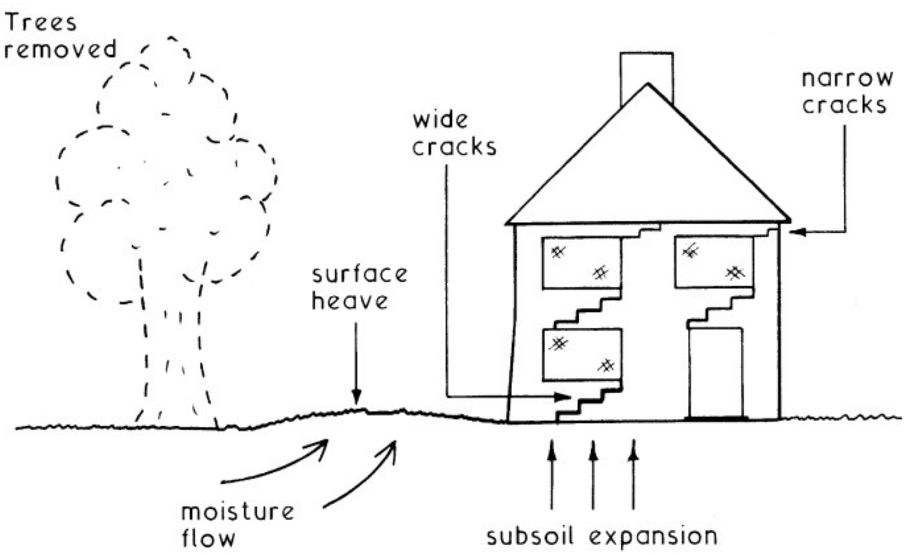


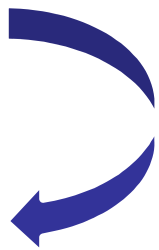
The damage of the foundations

Trees ~ damage to foundations. Substructural damage to buildings can occur with direct physical contact by tree roots. More common is the indirect effect of moisture shrinkage or heave, particularly apparent in clay subsoils.

Shrinkage is most evident in long periods of dry weather, compounded by moisture abstraction from vegetation. Notably broad leaved trees such as oak, elm and poplar in addition to the thirsty willow species. Heave is the opposite. It occurs during wet weather and is compounded by previous removal of moisture-dependent trees that would otherwise effect some drainage and balance to subsoil conditions.







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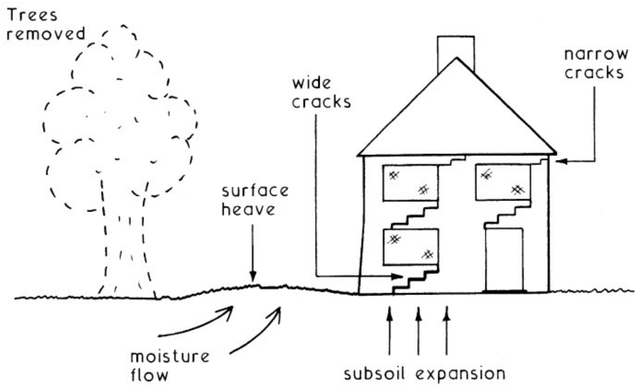
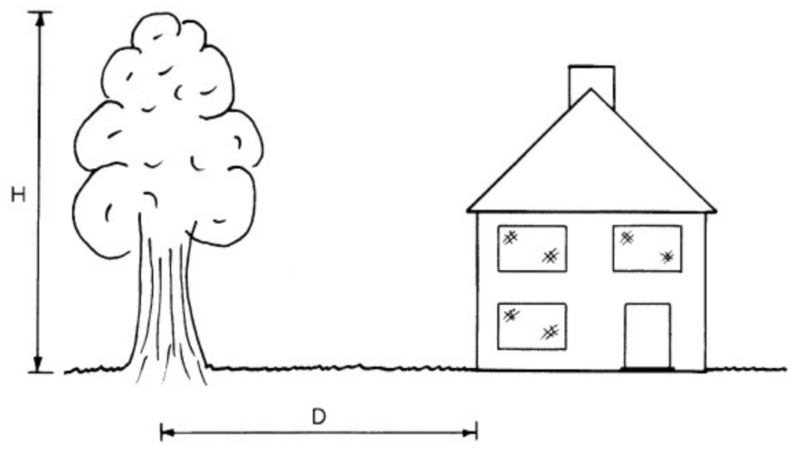




H = Mature height of tree
D = Distance to centre of tree

D/H - Distance from tree/Height of tree

Tree species	0·10	0·25	0·33	0·50	0·66	0·75	1·00
Oak, elm, poplar and willow	3·00	2·80	2·60	2·30	2·10	1·90	1·50
All others	2·80	2·40	2·10	1·80	1·50	1·20	1·00

Minimum foundation depth (m)

The damage of the foundations

The damage from the dynamic effects

If the buildings are too close from the roads they can be damaged.

Tasks

- **We have to plan „strong" reinforced concrete foundations**
- **Soild walls, with reinforced pillars and ceilings**

The damage of the foundations

The example for the damaged house

	Road to transport		2008																		2009														Σ (t)	Σ (trucks)	The buildings in 10 m (pieces)
Town	Febr.	tgk/nap	Febr	tgk/nap	March	tgk/nap	April	tgk/nap	May	tgk/nap	June	tgk/nap	July	tgk/nap	August	tgk/nap	Sept	tgk/nap	Oct	tgk/nap	March	tgk/nap	Apr	tgk/nap	May	tgk/nap	June	tgk/nap	July	tgk/nap	Aug	tgk/nap	Sept	tgk/nap			
Komló-Gesztenyés	171820	344	54607	109	131944	264	34698	69	96048	192	65079	130	102991	206	50986	102	21978	44	12468	25															571 940	1 142	19
Komló-Zobákpuszta	171820	344	54607	109	131944	264	34698	69	96048	192	65079	130	102991	206	50986	102	21978	44	12468	25															571 940	1 142	16
Hosszúhetény	171820	344	54607	109	131944	264	34698	69	96048	192	65079	130	102991	206	50986	102	21978	44	12468	25															571 940	1 142	123
Pécsudvard	12000	24							5180	10	31529	63	78201	156	56004	112	56954	114	36546	73															264 943	529	20
Szederkény	35440	71	27530	55	27529,5	55	75538	151	1024019	2 048	863124	1 726	235720	471	67668	135	58197	116	15526	31	42671	85													2 442 397	4 875	57
Szajk	30440	61	27530	55	27529,5	55			797962	1 596	750633	1 501	181402	363	40471	81	23677	47	7763	16	15914	32	15914	32	15914	32	15914	32	15914	32	15914	32	15914	32	1 972 270	3 937	2
Lánycsók	6800	14		0	39327,5	79	39327,5	79	105565	211	95920	192	196168	392	61361	123	61361	123			61361	123	15914	32	15914	32	15914	32	15914	32	15914	32	15914	32	757 355	1 512	20
Erzsébet	73380	147	27078	54	65030	130	34698	69																											127 059	254	31
Kékesd	73380	147	27078	54	65030	130	34698	69																											127 059	254	42
Geresdlak	73380	147	27078	54	65030	130	34698	69																											127 059	254	21
Himesháza	6140	12							105565	211	34559	69	134807	270																					275 481	550	80
Székelyszabar					39327,5	79	39327,5	79	105565	211	55013	110	155261	311	20454	41	20454	41			20454	41	5305	11	5305	11	5305	11	5305	11	5305	11	5305	11	488 651	975	33
Szűr	27040	54			129932	260																													130 192	260	31
Kisnyárád	6800	14			63464	127																													63 591	127	10
Lovászhetény	4000	8			39384	79			43062	86	52639	105	32461	65	58422	117	25183	50	14286	29															265 967	531	19
Véménd	4000	8			39384	79																													39 463	79	99
Palotabozsok											20454	41	20454	41	20454	41	20454	41			20454	41	5305	11	5305	11	5305	11	5305	11	5305	11	5305	11	134 358	268	134
Somberek											20454		20454	41	20454	41	20454	41			20454	41	5305	11	5305	11	5305	11	5305	11	5305	11	5305	11	134 317	227	100
																																				Σ	857

- No transport
- 0-100 trucks/day
- 100-200 trucks/day
- 200-300 trucks/day
- 300-500 trucks/day
- 500-2100 trucks/day

The damage of the foundations

The shape of the house before the transportation

The damage of the foundations

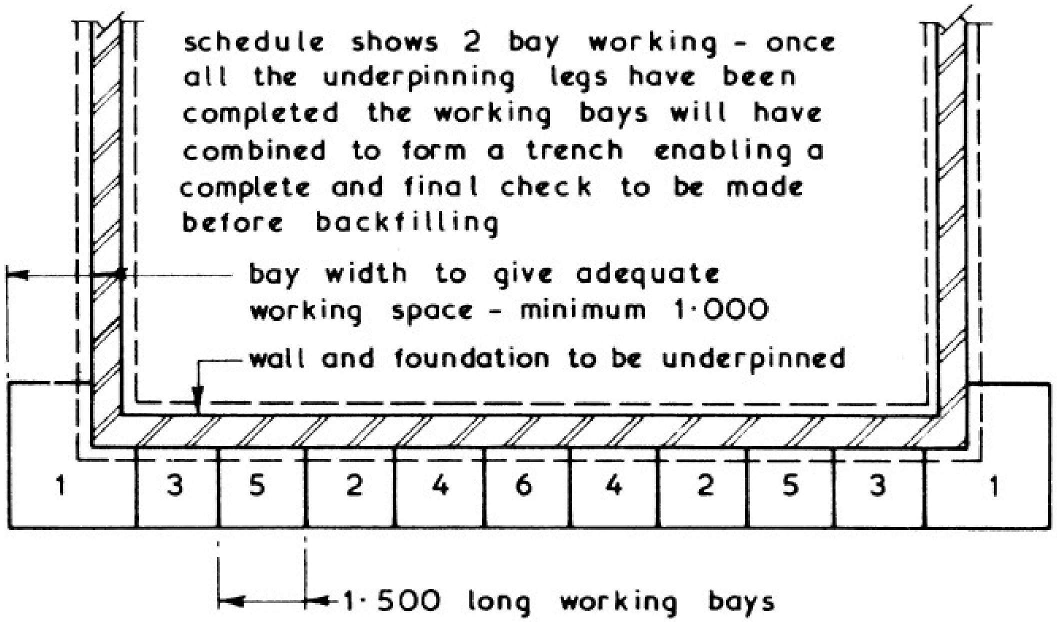
The shape of the house after the transportation

The damage of the foundations

Underpinning to Walls ~ to prevent fracture, damage or settlement of the wall(s) being underpinned the work should always be carried out in short lengths called legs or bays. The length of these bays will depend upon the following factors:-

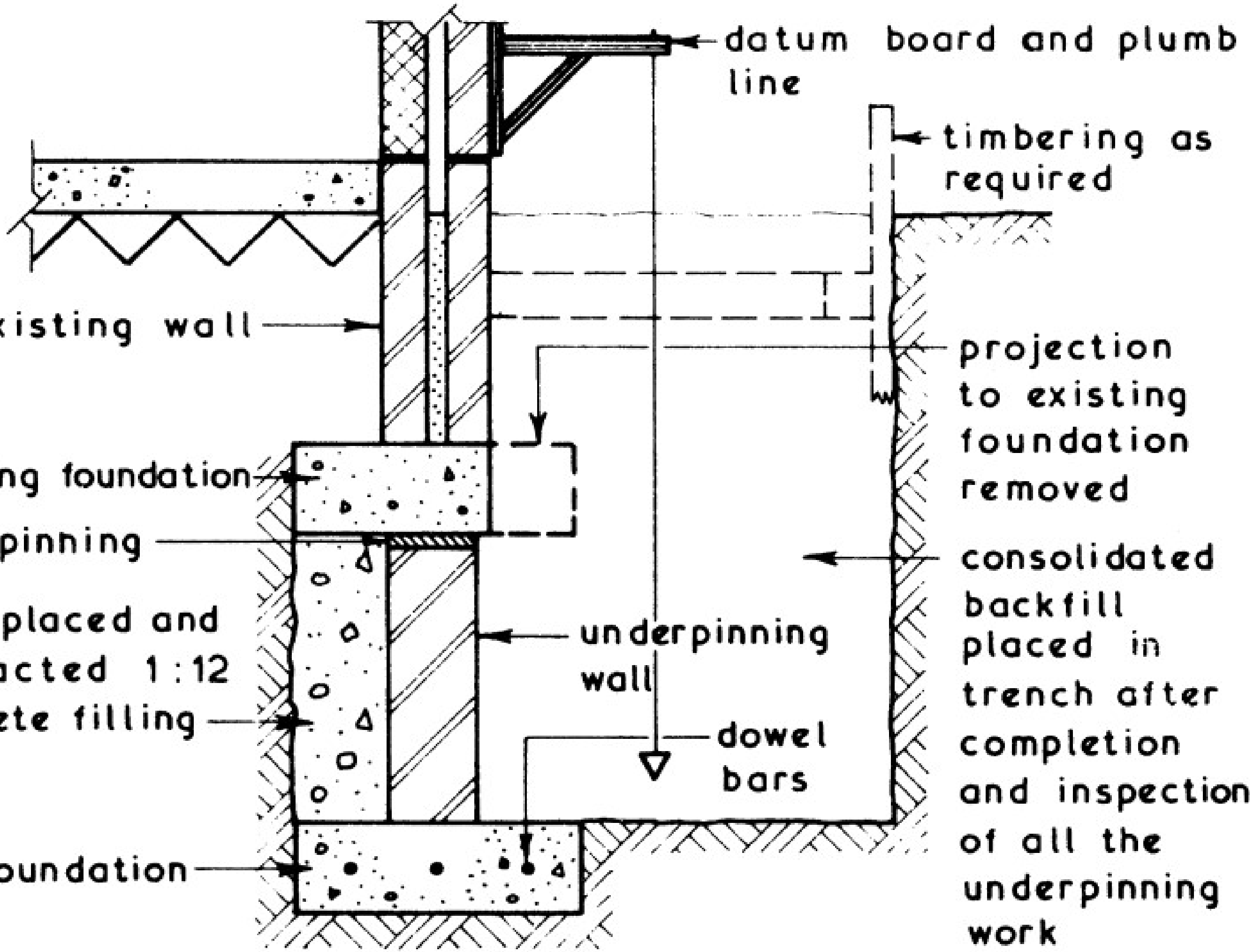
1. Total length of wall to be underpinned.
2. Wall loading.
3. General state of repair and stability of wall and foundation to be underpinned.
4. Nature of subsoil beneath existing foundation.
5. Estimated spanning ability of existing foundation.

Typical Underpinning Schedule ~



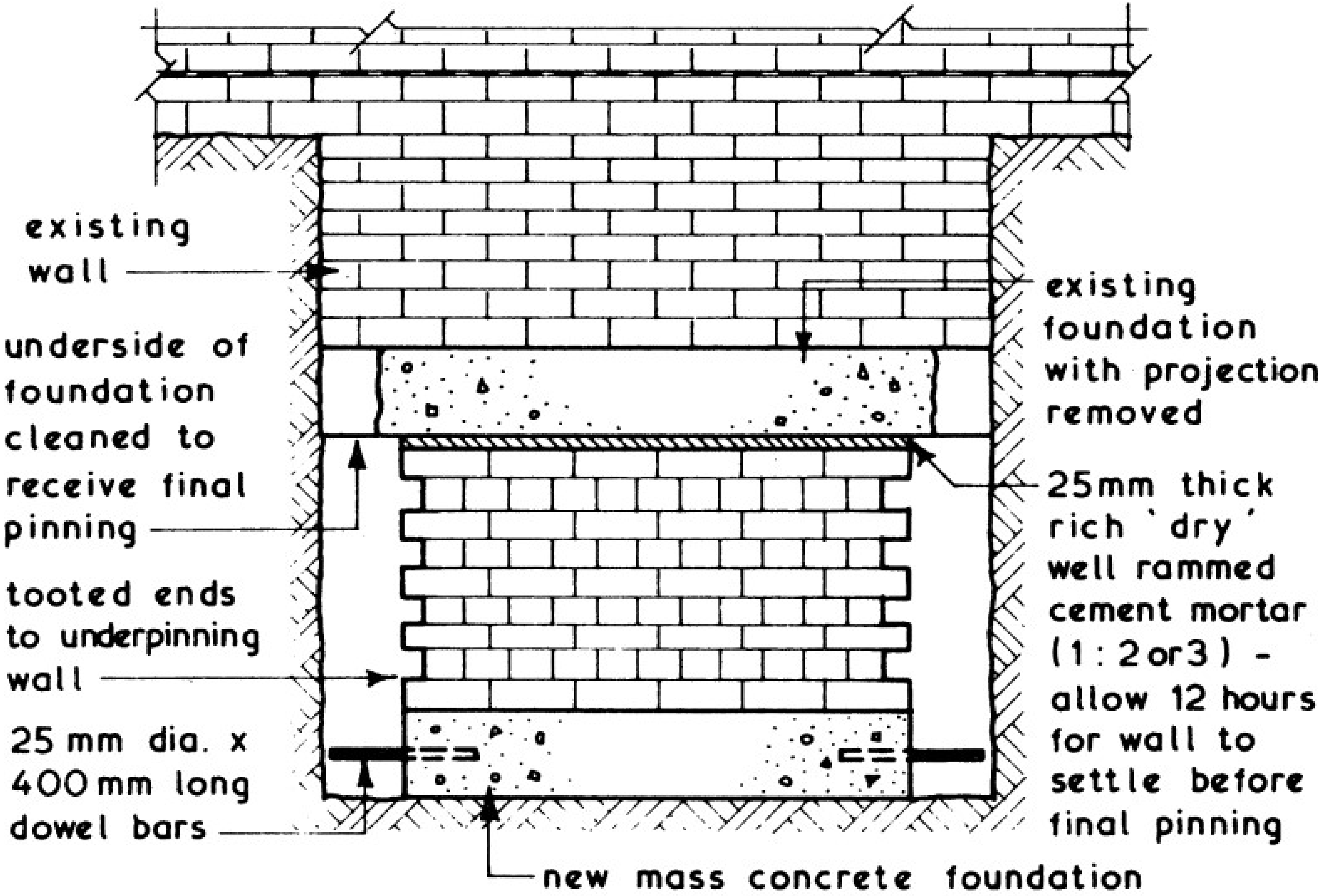
The damage of the foundations

Typical Traditional Underpinning Details ~



UNDERPINNING BAY ~ TYPICAL SECTION

The damage of the foundations

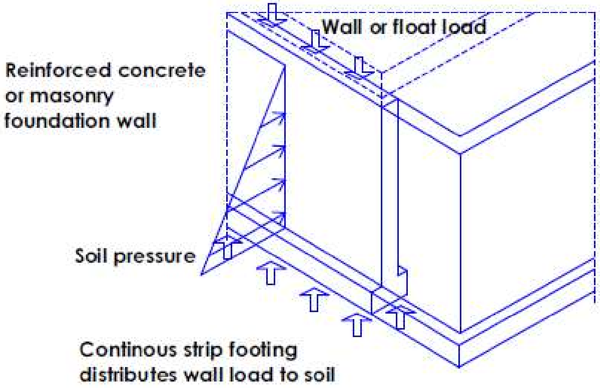


UNDERPINNING BAY ~ TYPICAL ELEVATION

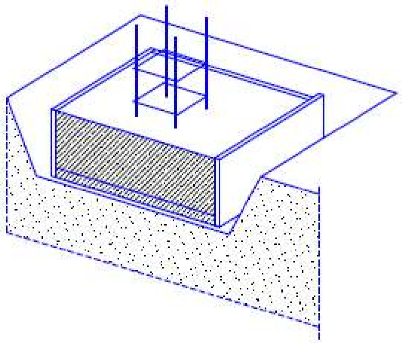
Types of the foundations ?

- Spread (shallow) foundations

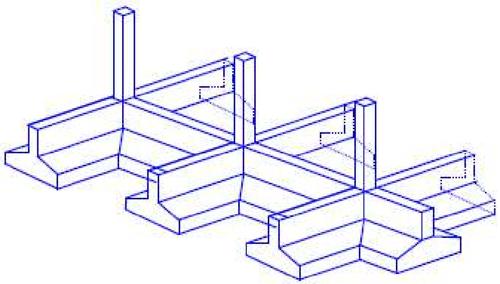
strip foundation (wall footing)



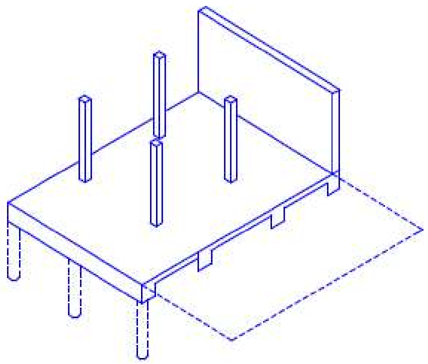
pad foundation



(beam) grillage fondation



mat foundation

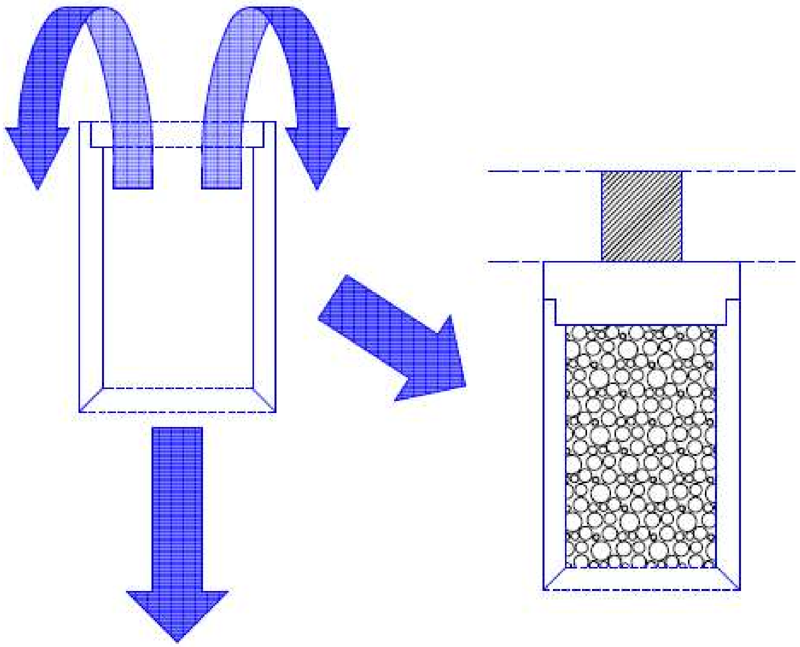


slab foundation

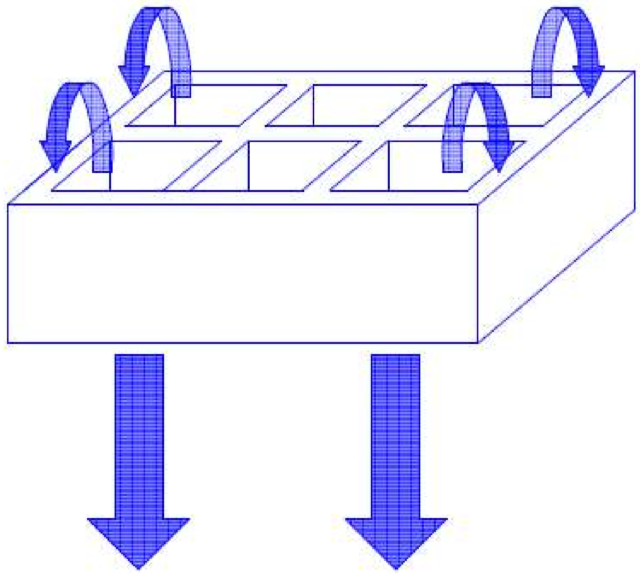
Types of the foundations ?

- **Transitional (semi-deep) foundations**

well foundation caison



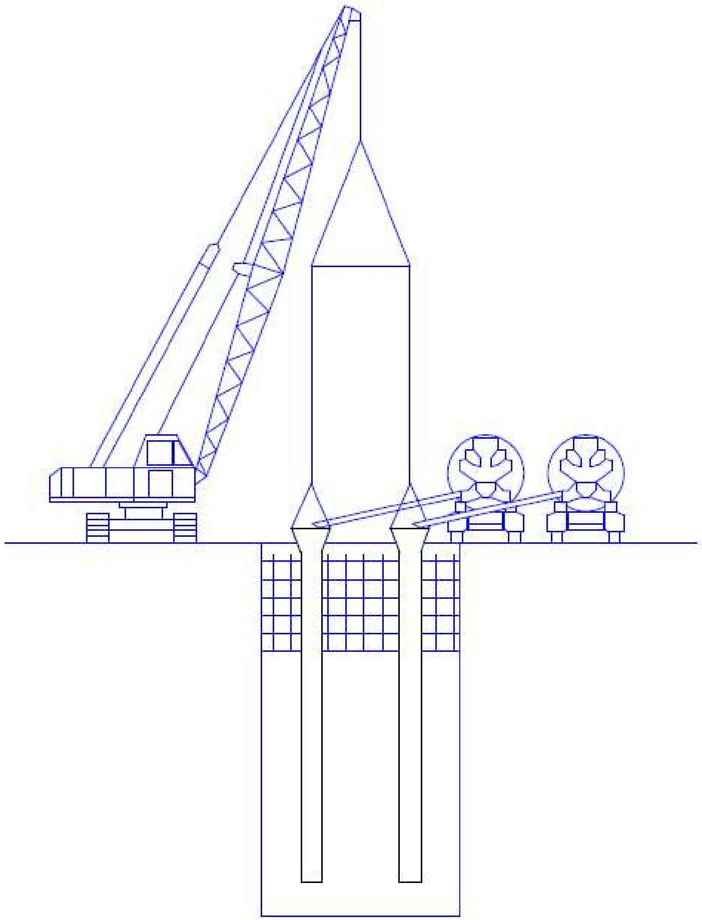
foundation framework cofferdam



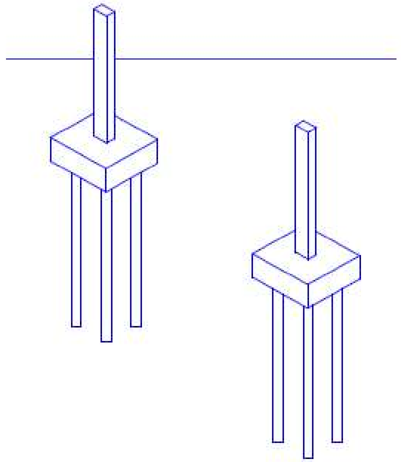
Types of the foundations ?

- **Deep foundations**

slury wall



pile foundations



Types of the foundations ?

- Spread (shallow) foundations

When is it applicable?

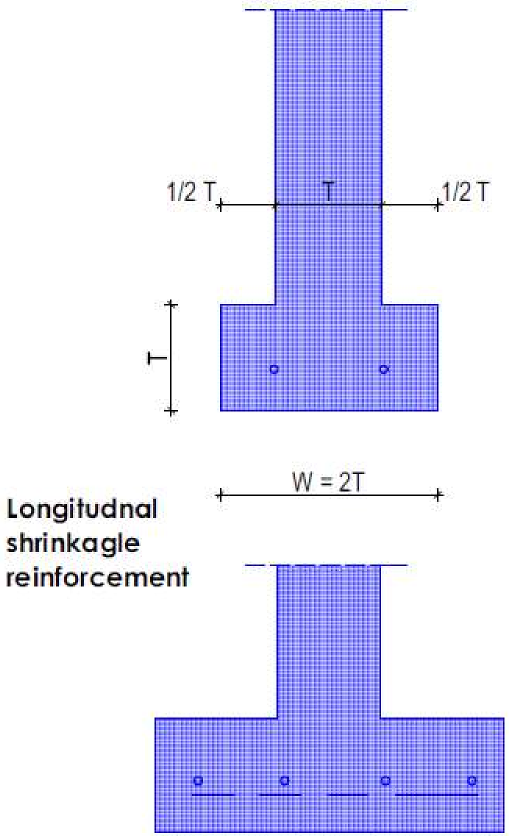
- The load-bearing layer is near to bottom floor level
- The loads of the building are light-medium

Types

- Strip foundations
- Pad foundations - Bucket foundations
- Beam foundations
- Mat (slab) foundations

Types of the foundations ?

- **Strip foundations**

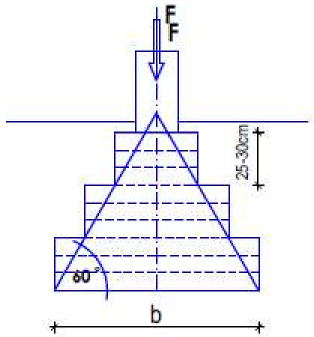


Steel reinforcement is required when footing projects more than half of foundation wall thickness and becomes subject to bending.

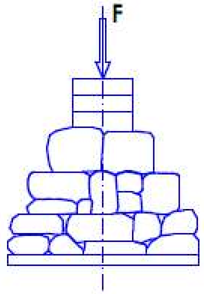
Types of the foundations ?

- **Strip foundations**

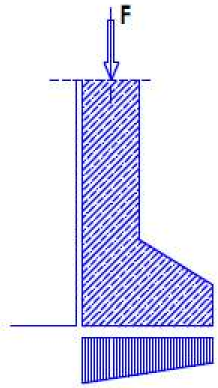
MATERIALS



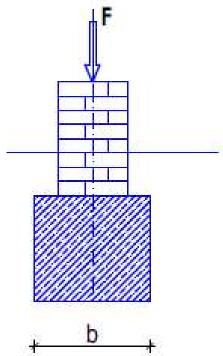
brick

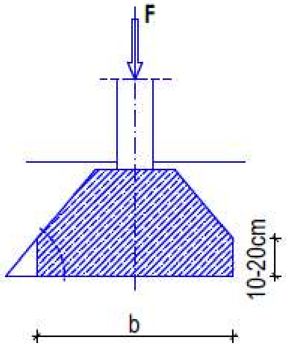


stone

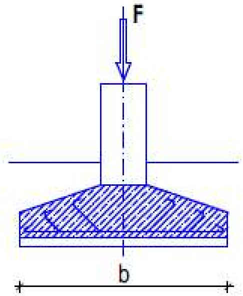


in case of assimetrical load

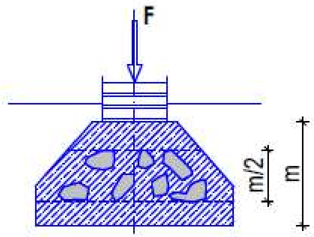




concrete



reinforced concrete



ligthweight concrete

Types of the foundations ?

CONSTRUCTIONS

- We have to use special accessories to place the steel.

http://www.reinforcing.com.au/our-products/accessories

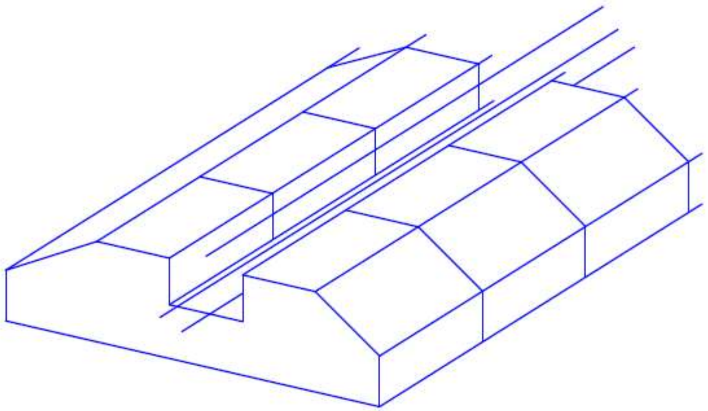
- We can plane a floor slab from concrete
- The question is: what is the large of the workplace?

Types of the foundations ?

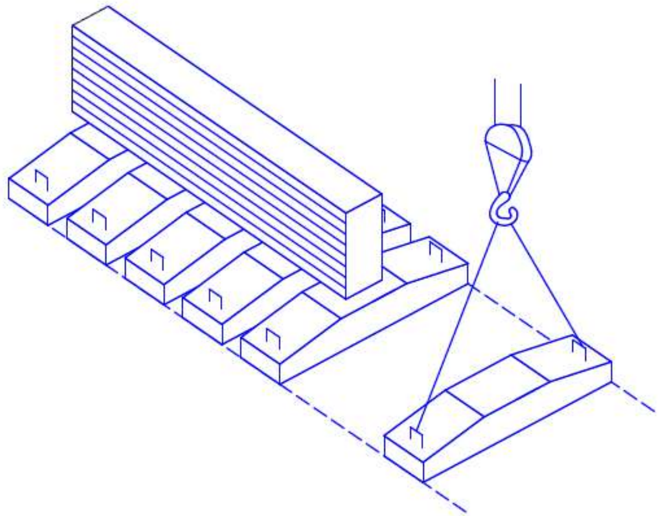
Types of the foundations ?

Types of the foundations ?

Prefabricated reinforced concrete

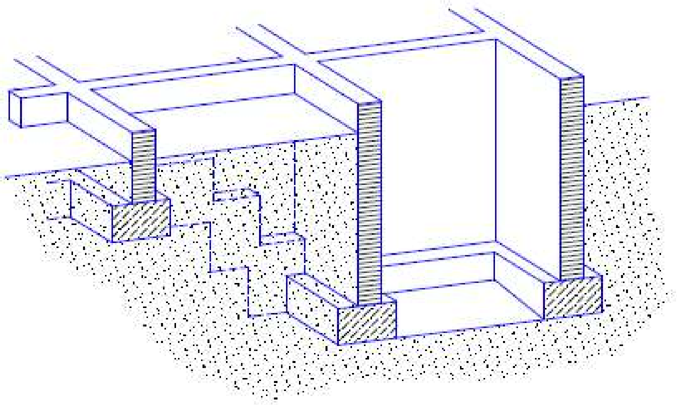


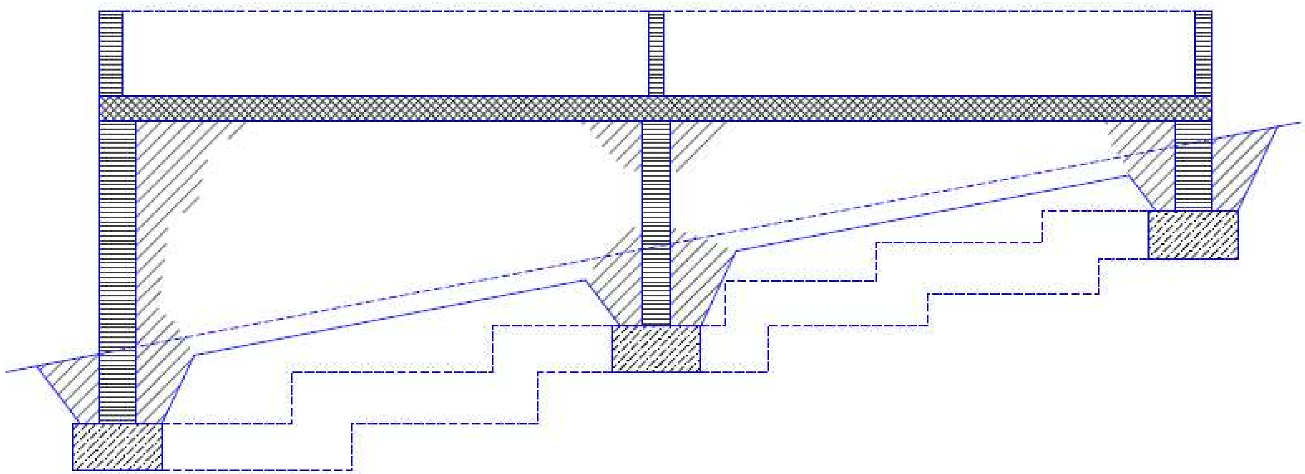
Reinforcing bars



Prefabricated elements

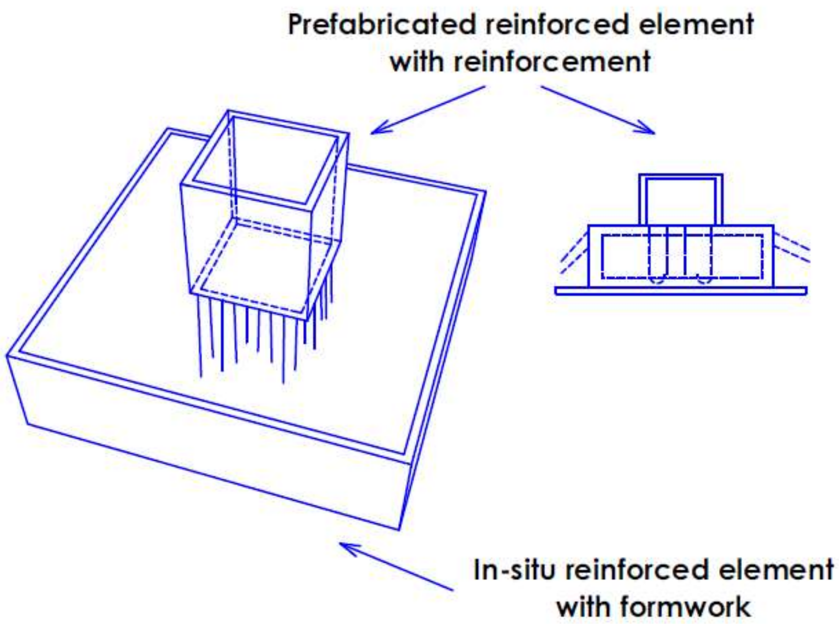
Strip foundations - construction

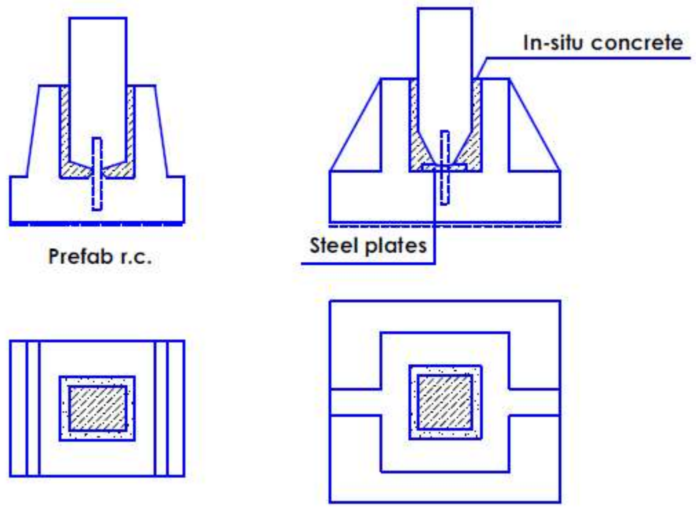




Pad foundations - construction

Partly in-situ and prefabricated pad (bucket) foundation

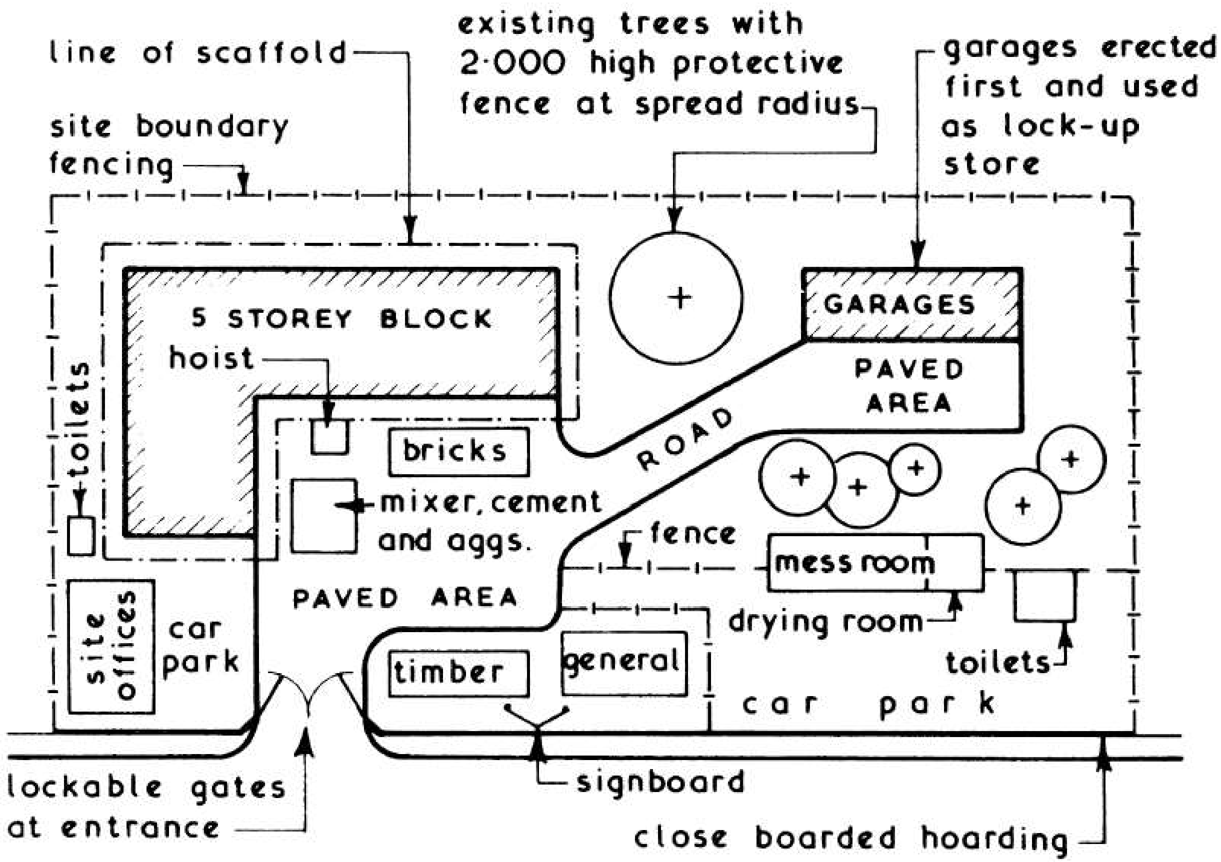




Preparation of the building area

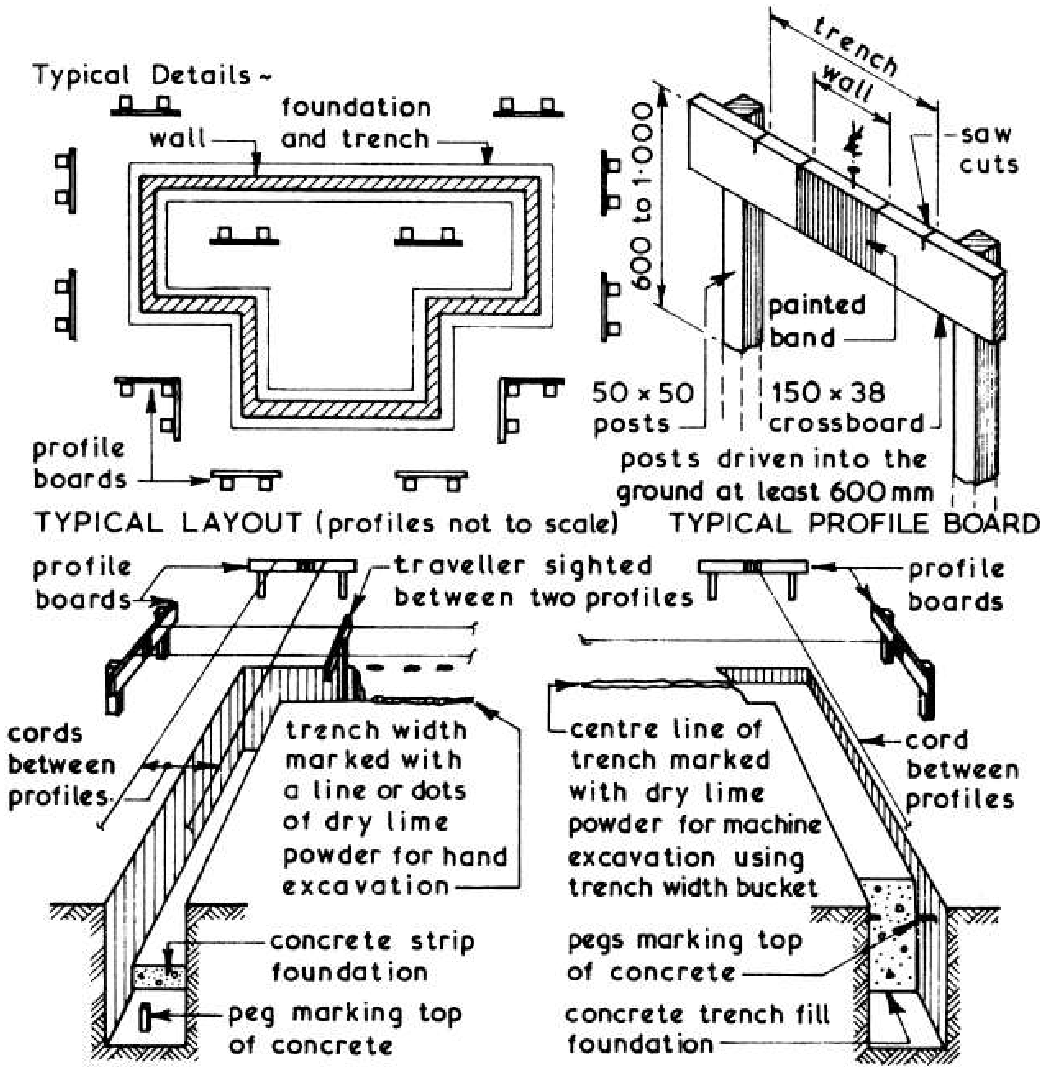
The organization of the site

Typical Example ~



NB. temporary site services omitted for clarity.

Preparation of the building area

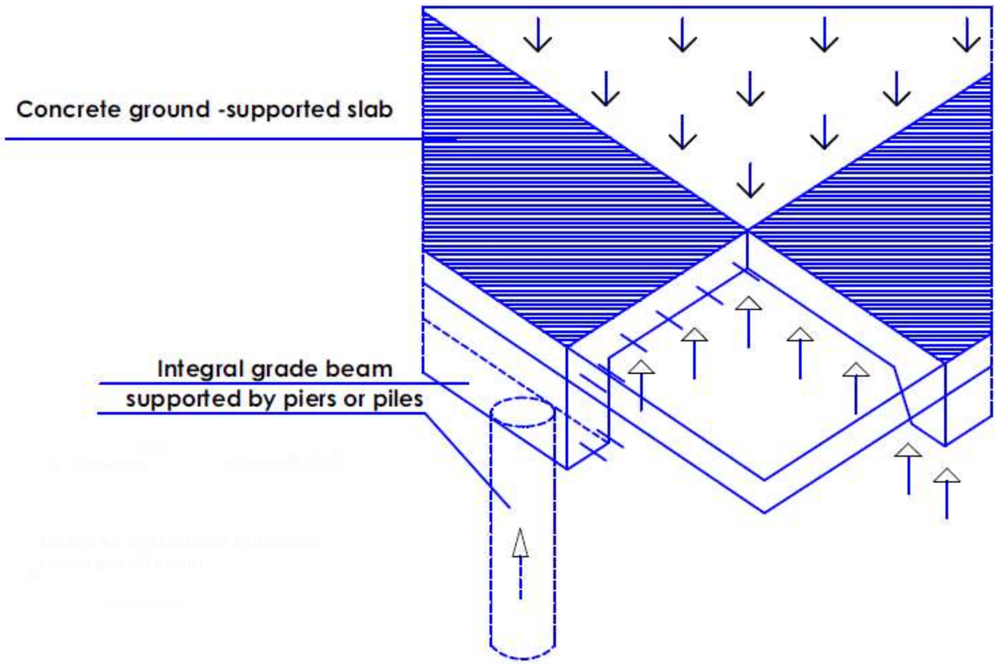


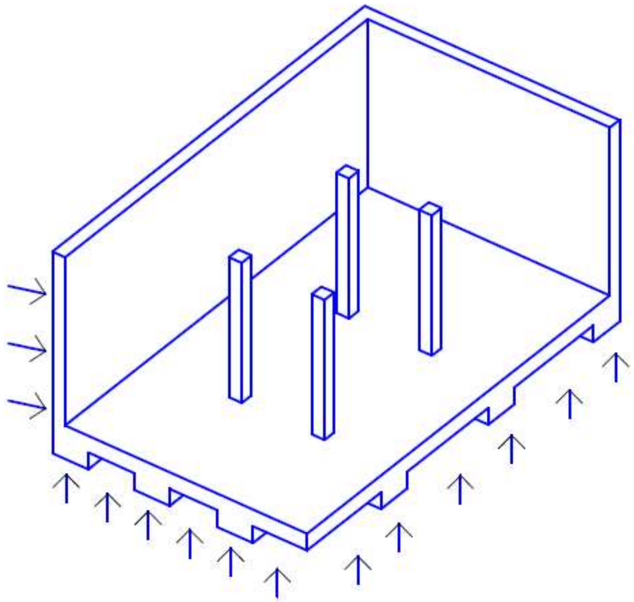
NB. Corners of walls transferred from intersecting cord lines to mortar spots on concrete foundations using a spirit level

Pad foundations - construction

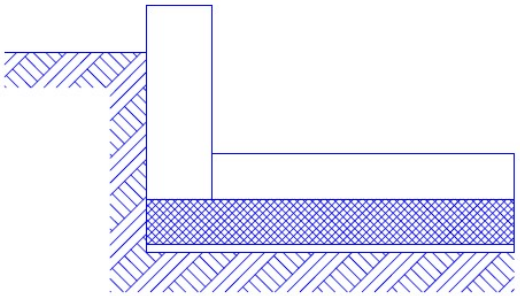
Pad foundations - construction

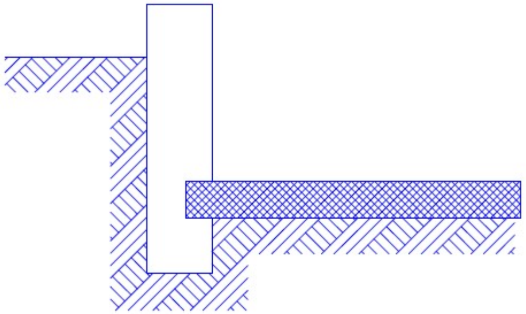
Mat(slab) foundations - construction





Mat(slab) foundations - construction





Mat(slab) foundations - construction

Mat(slab) foundations - construction

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Deep foundations

When is it necessary?

- The load-bearing layer is in deeper location
- The loads of the building are too heavy
- Other special cases

Types

- Piles
- Slurry wall
- Other

Piles

Material: wood, steel, concrete, reinforced concrete

Geometry:

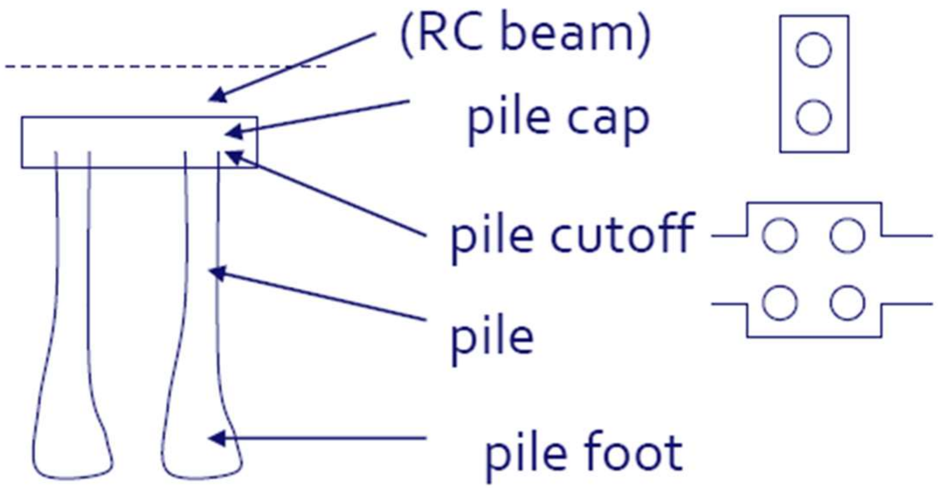
length>5D, D>60 cm (large-diameter),

D<30 cm (Micro-pile)

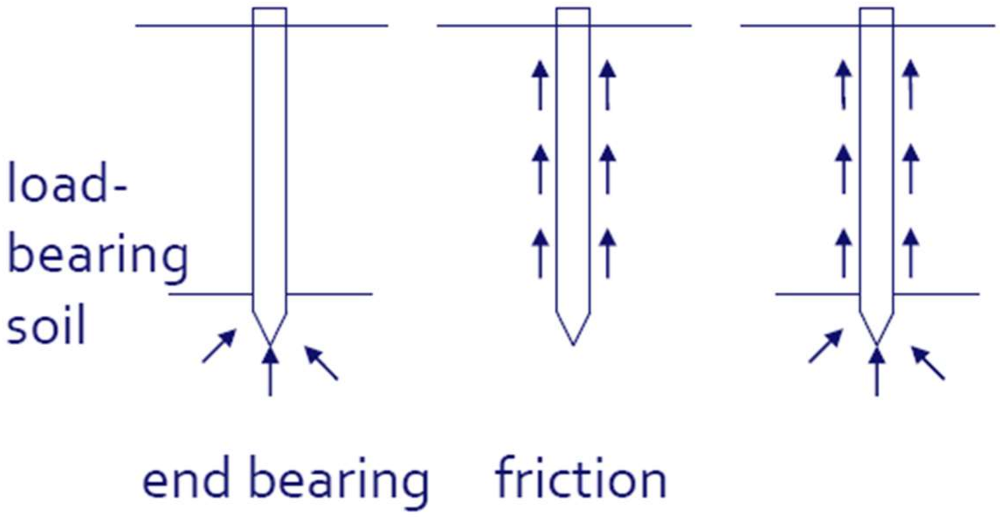
Direction: vertical or leaning

Construction: prefabricated or cast-in-place

Piles



(RC beam)
pile cap
pile cutoff
pile
pile foot

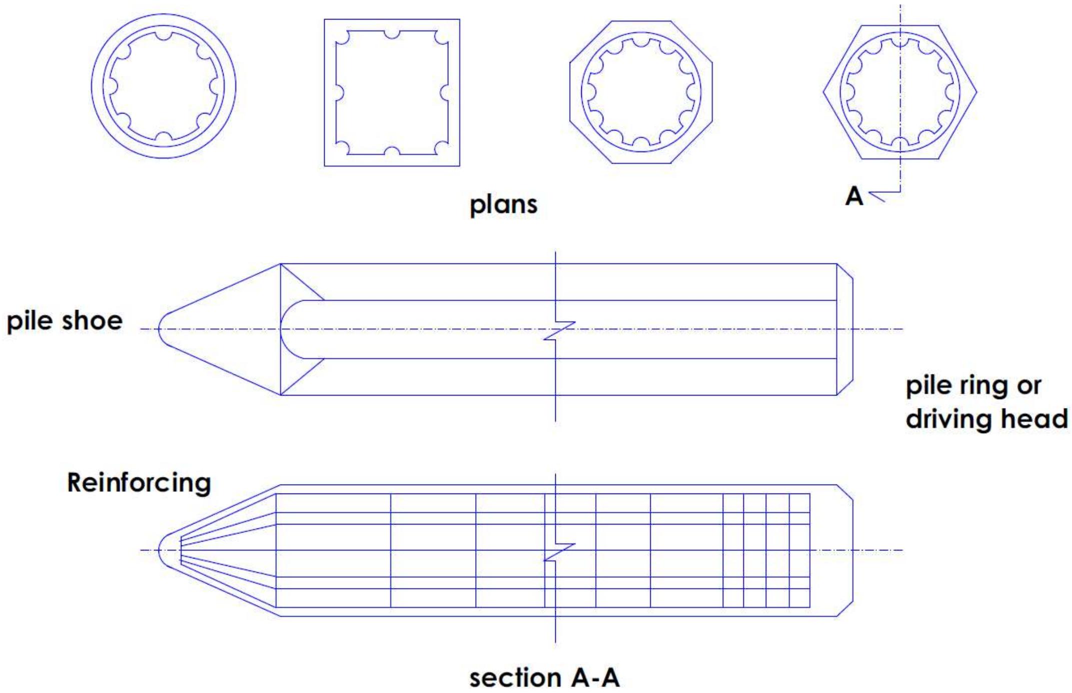


load-
bearing
soil
end bearing
friction

Piles - contsruction

Prefabricated piles

- **Hammered, grouted, vibrated, twisted**
- **(dynamic impacts)**



Piles - contsruction

Precast piles

Piles - contsruction

Cast-in-place piles

- Shell-type or shell-less type
- Many different technologies

Constructing the foundation

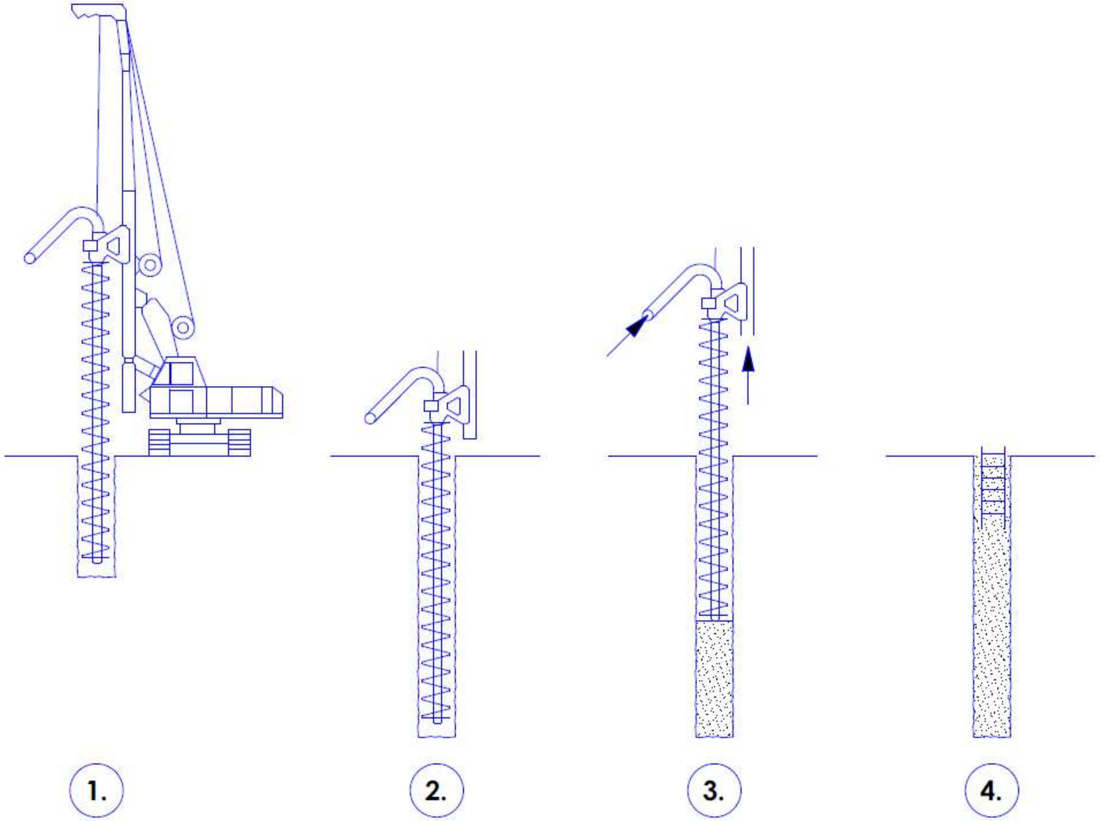
0. alignment
1. creating a test-pile
2. checking the load-bearing capacity (endurance test)
3. making the piles
4. removing the top of the piles
5. constructing the pile caps
6. connecting the pile caps with RC beams if necessary

Piles - contsruction

CFA - constuction

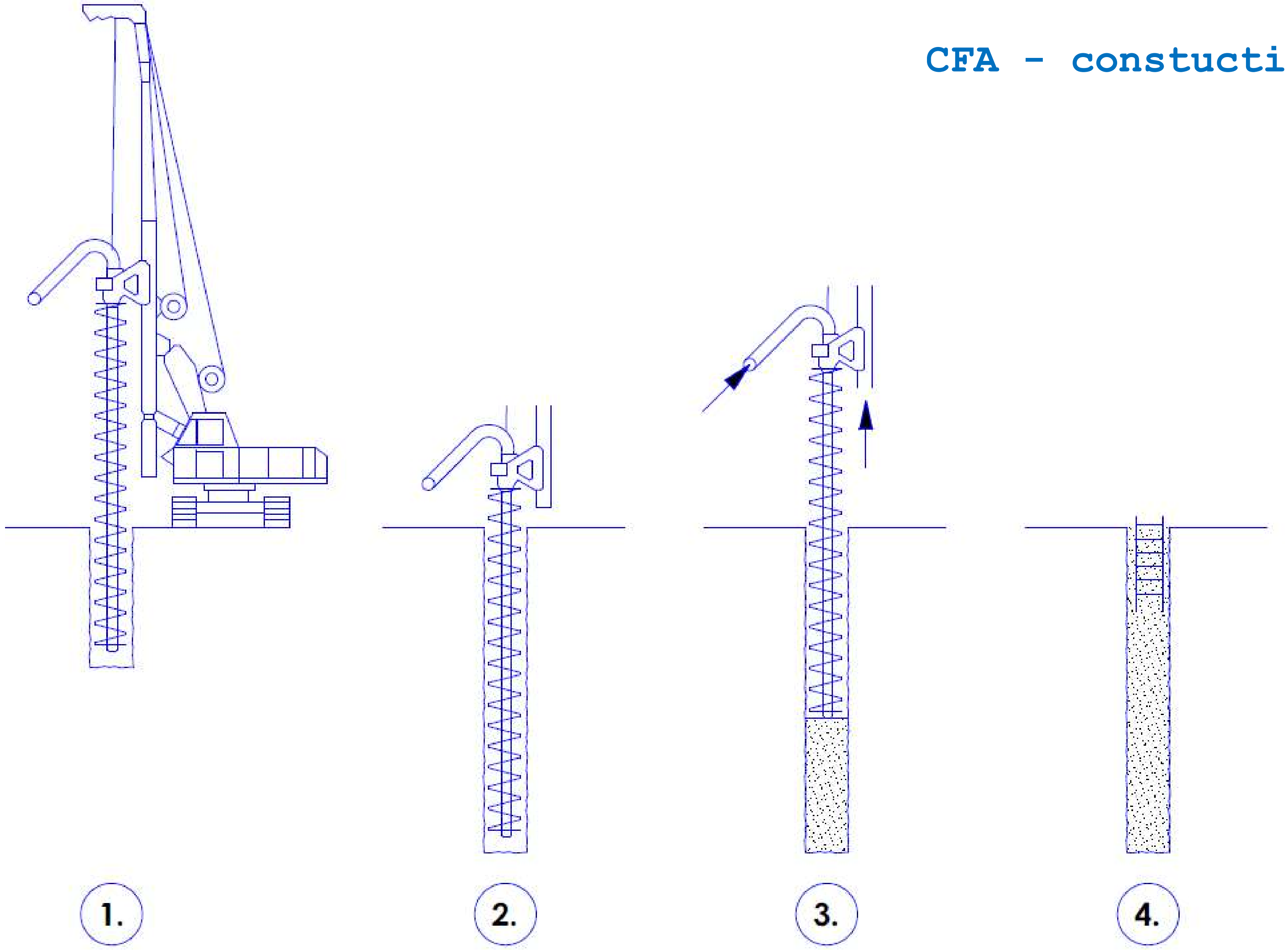
- **Drilling continuously until planned depth (using guiding tube if necessary)**
- **Placing the concrete and removing the drill**
- **Placing reinforcement (vibration)**

(CFA= Continuous Flight Auger)



Piles - contsruction

CFA - constuction



Piles - contsruction

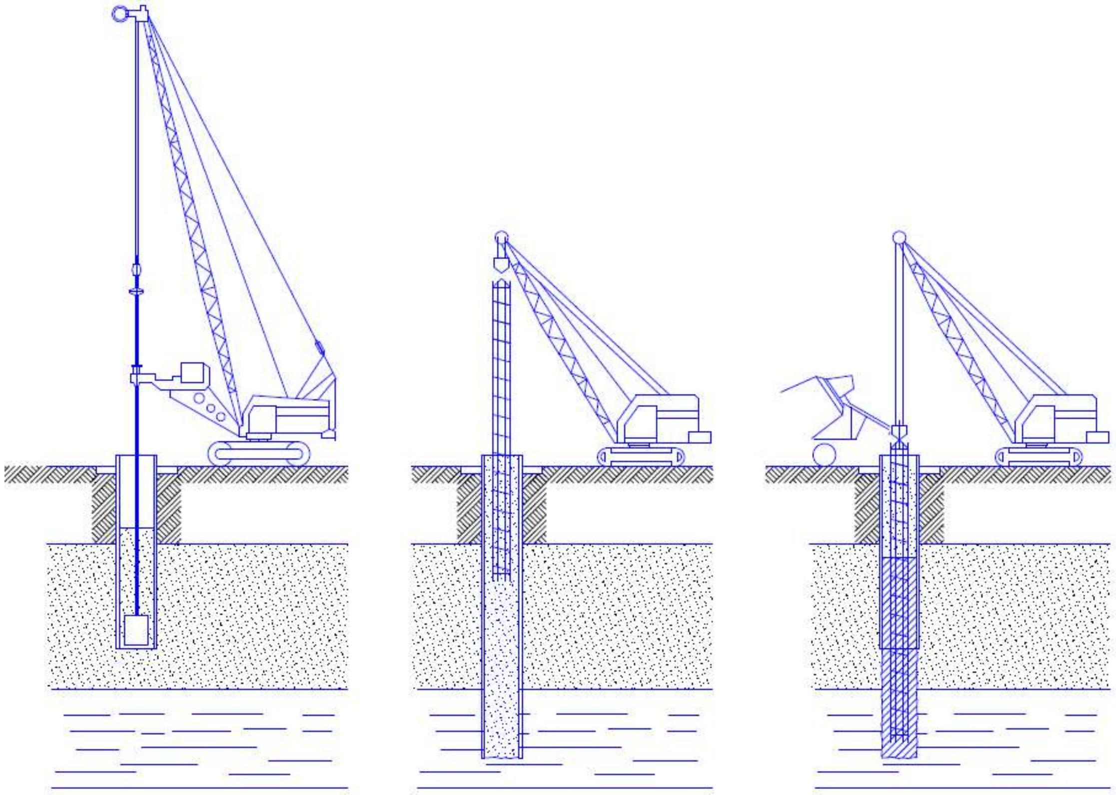
CFA - constuction

Pictures and videos

Piles - contsruction

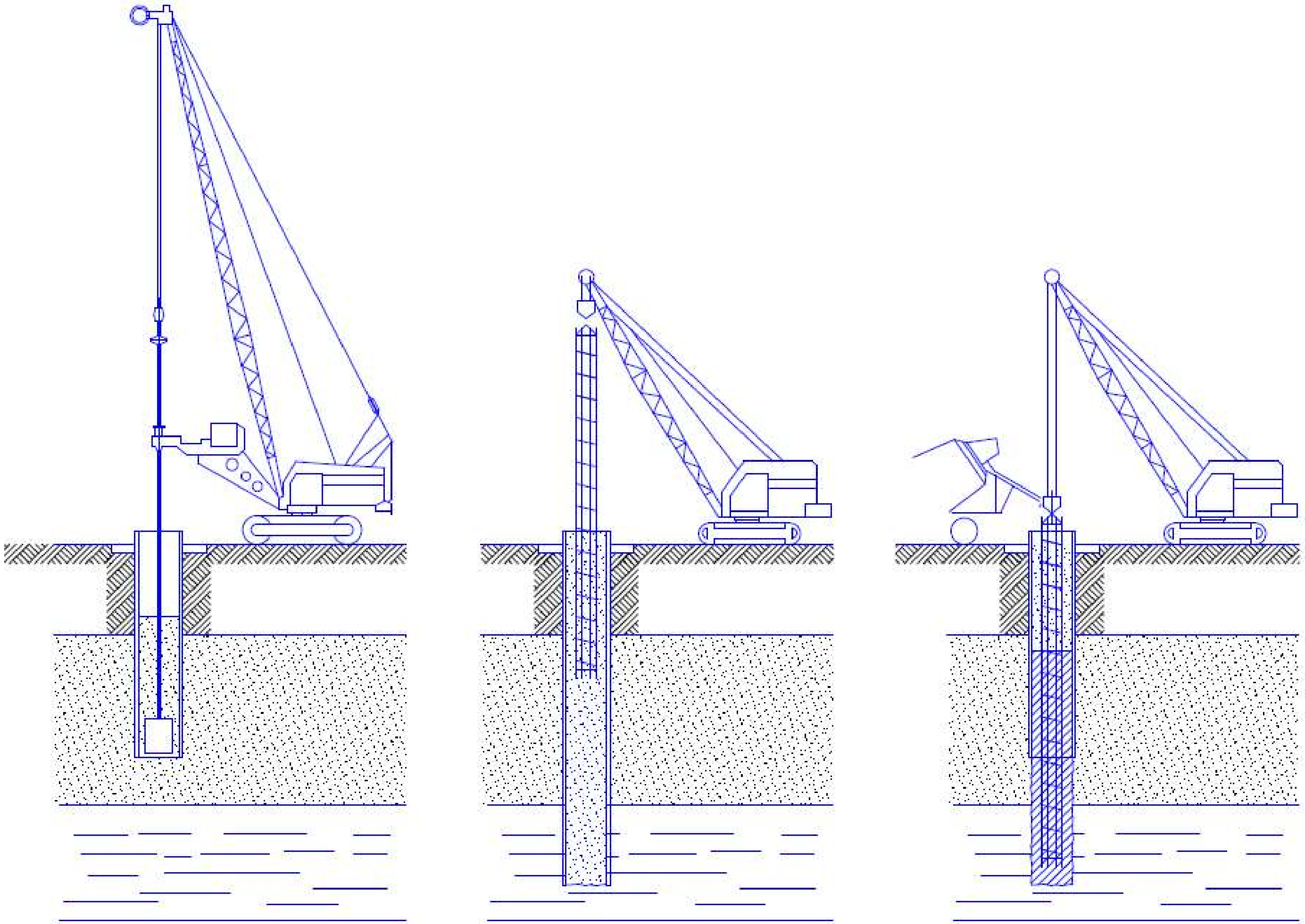
Soil-Mec technology

- Boring until planned depth (using a guiding tube)
- Using bentonite mud (slurry) under the groundwater level
- Placing reinforcement
- Placing the concrete and removing the guiding tube



Piles - contsruction

Soil-Mec technology

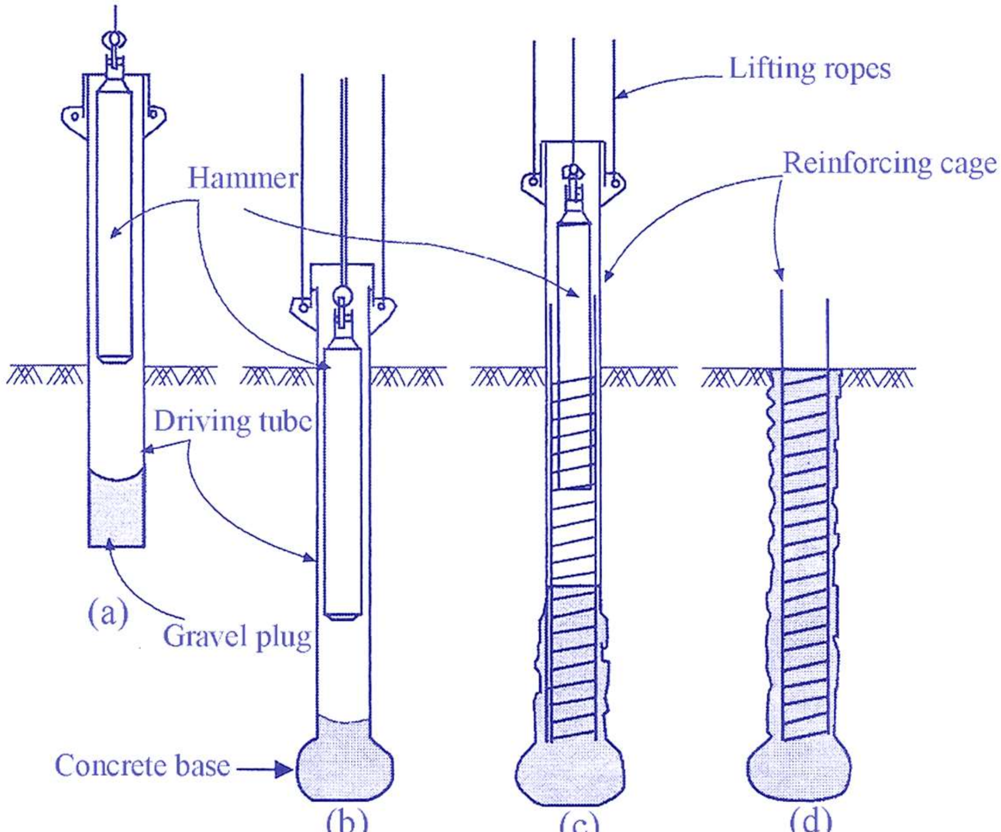


Piles - contsruction

Franki technology

(bulb pile or compacted concrete pile)

- **Filling concrete in a steel pipe (creating a plug)**
- **Pushing down the pipe using a heavy drop hammer**
- **Fastening the pipe and creating the foot**
- **Placing the concrete and compacting while removing the pipe (reinforcing)**



(a) Driving piling tube (b) Placing concrete in piling tube
(c) compacting concrete in shaft (d) Completed pile

Fig 1 Stage in Installing a Franki Pile

Concrete slurry walls

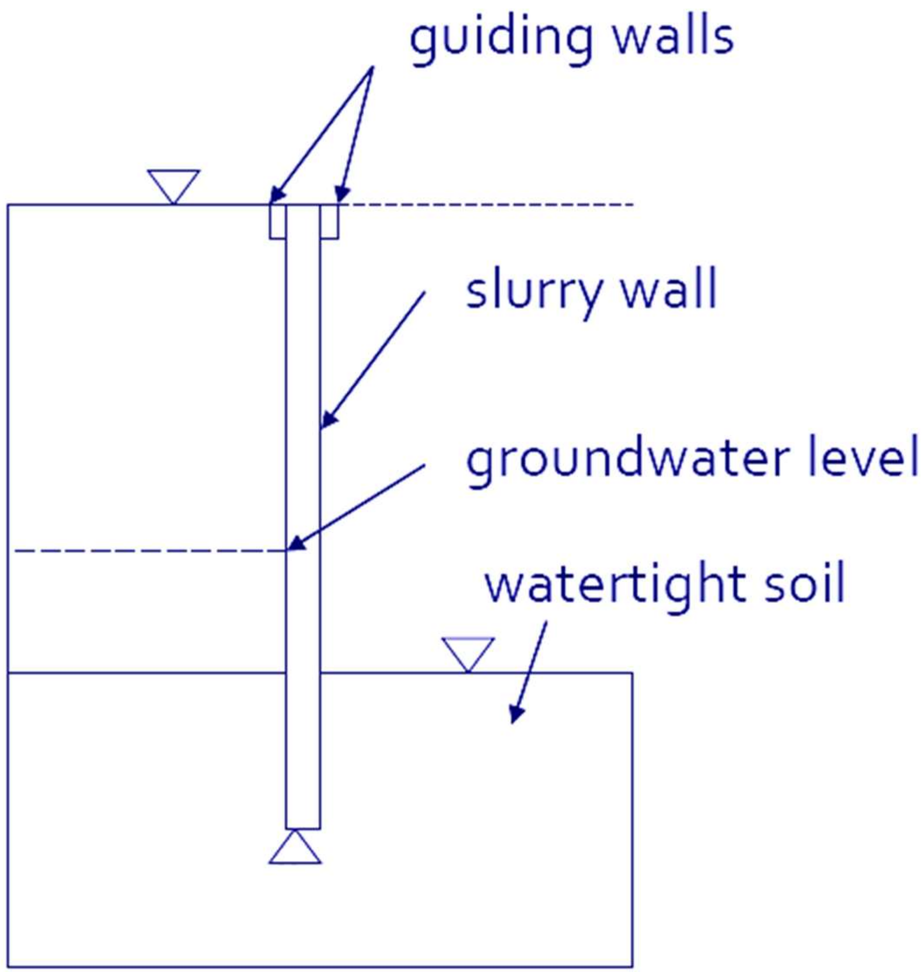
Franki technology

What is…?

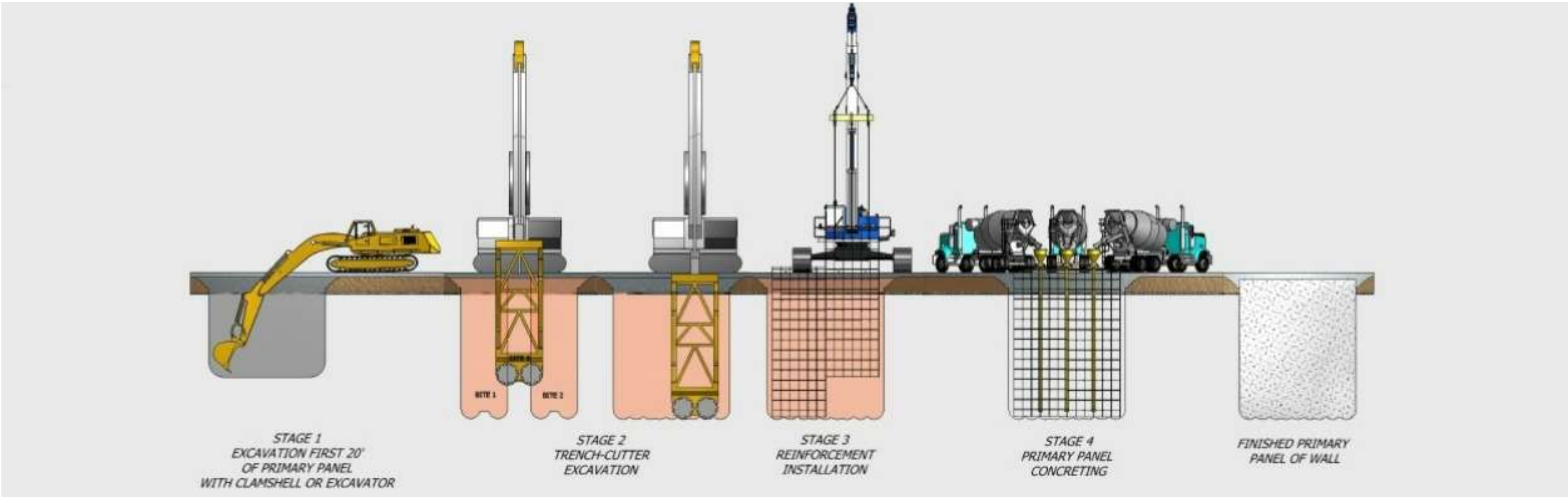
- A deep, narrow trench filled with concrete (and reinforcement)

Functions

- Retaining wall during excavation (can be watertight)
- Foundation
- Wall of the basement



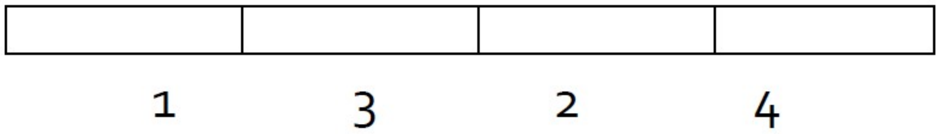
Concrete slurry walls



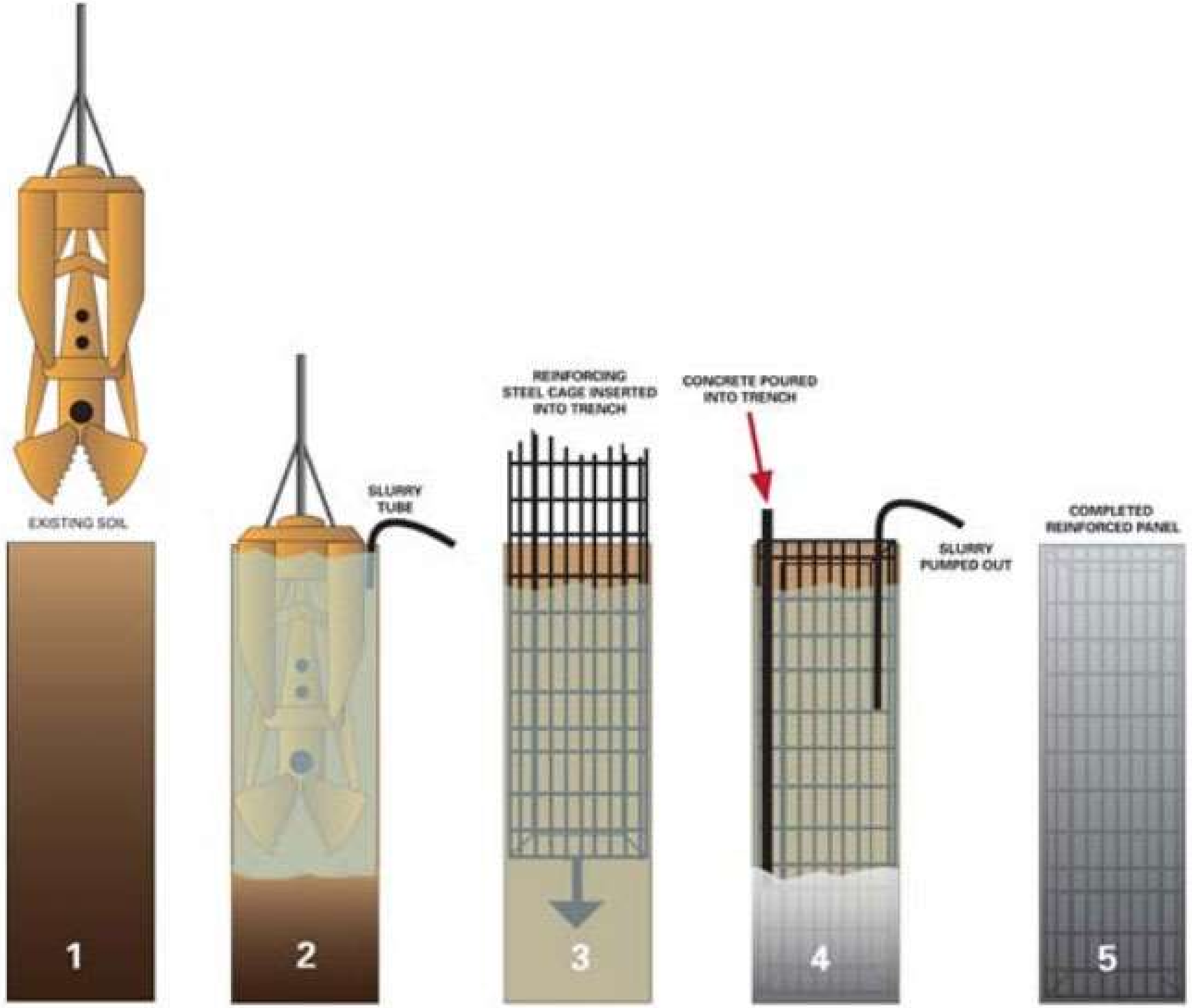
Creating panels

(w:40-120 cm, l: 8-10 m)

- **Creating the guiding walls**
- **Excavating the soil from the trench and piping in bentonite slurry (placing end pipes)**
- **Placing the reinforcement**
- **Placing concrete (by tremie method) displacing slurry (can be reused)**
- **(withdrawing end pipes)**

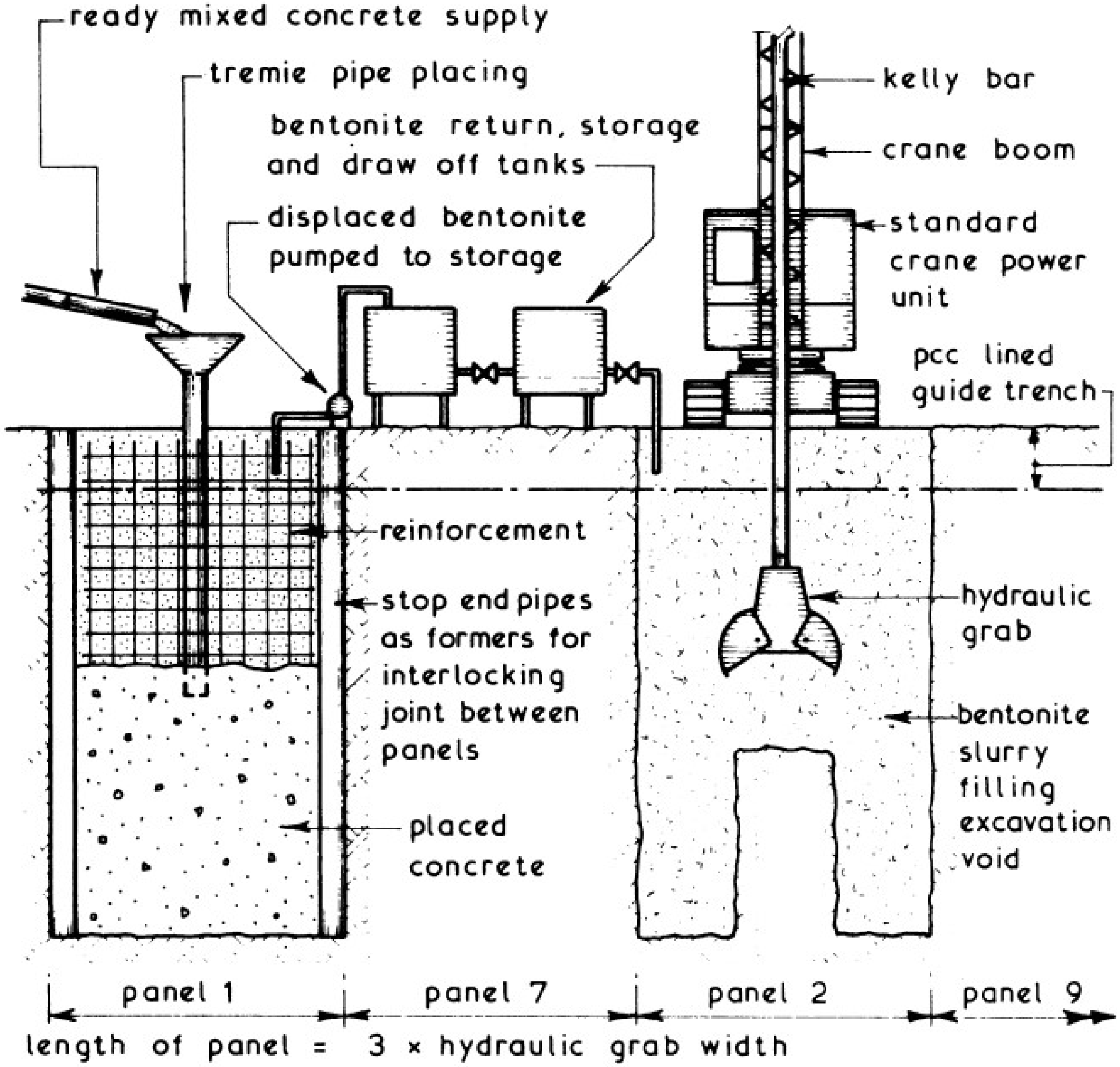


Concrete slurry walls



Concrete slurry walls

Typical Cast In-situ Concrete Diaphragm Wall Details ~



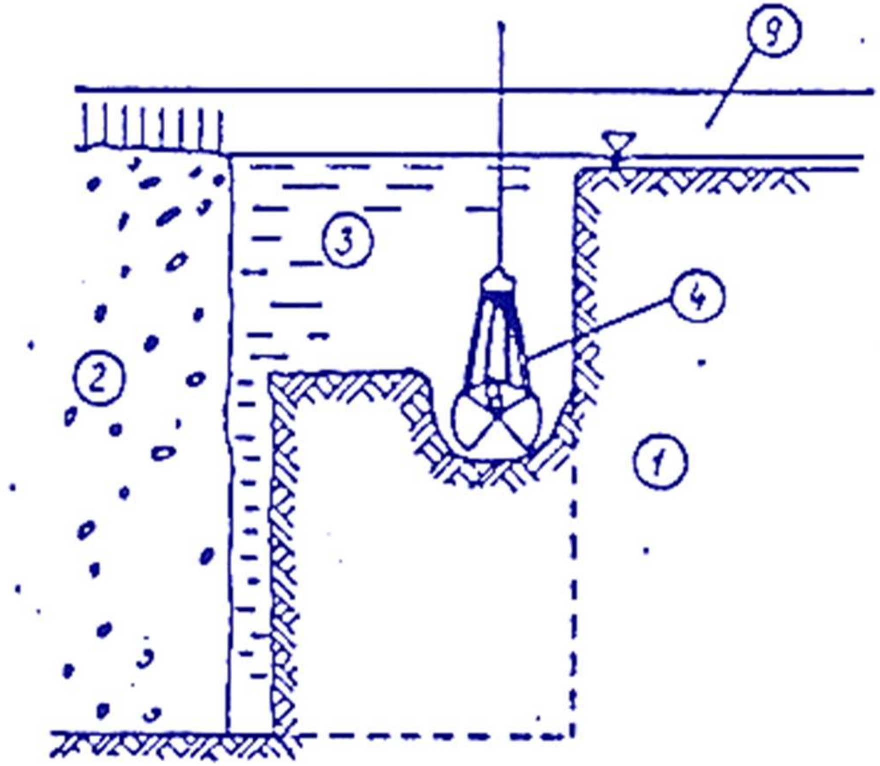
What is bentonite slurry?

- A mixture of bentonite and water (a dense fluid)

- Produces a positive static pressure on the walls of the trench avoiding soil and water to enter the trench (supporting the surface of the soil)

- Piped in while excavating the trench, piped out while placing the concrete

- Can be reused after filtering (removing soil particles)



Concrete slurry walls

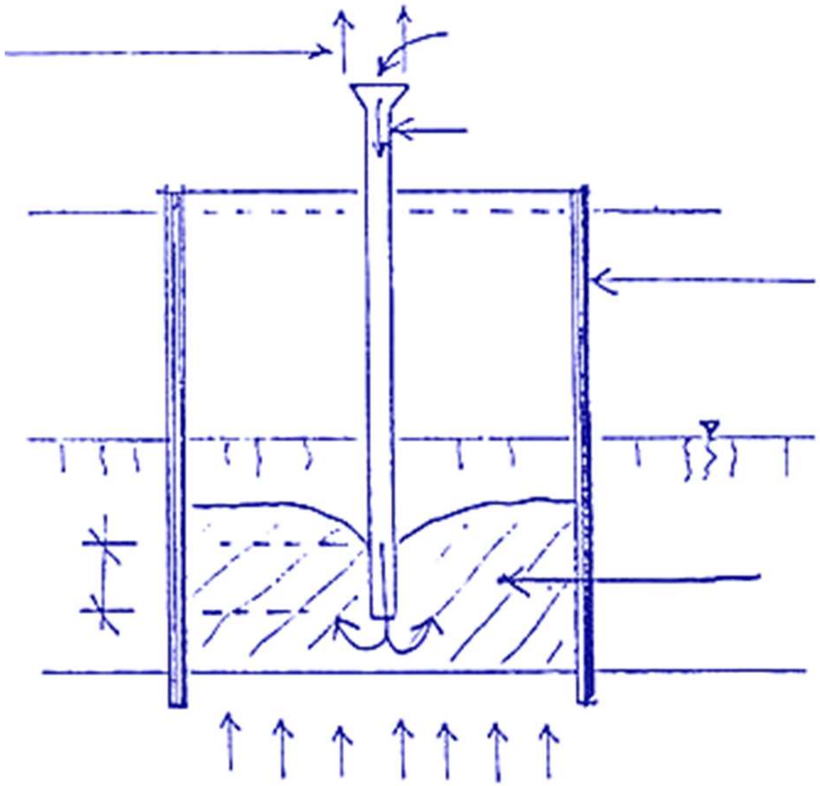
Placing the concrete (underwater concreting)

- Using concrete pipe

- Start filling in the concrete at the bottom

- Pulling out the concrete pipe with the speed of filling in the concrete so that the end of the pipe is constantly under the level of the concrete

- x=60 cm
- (meantime piping out the slurry)



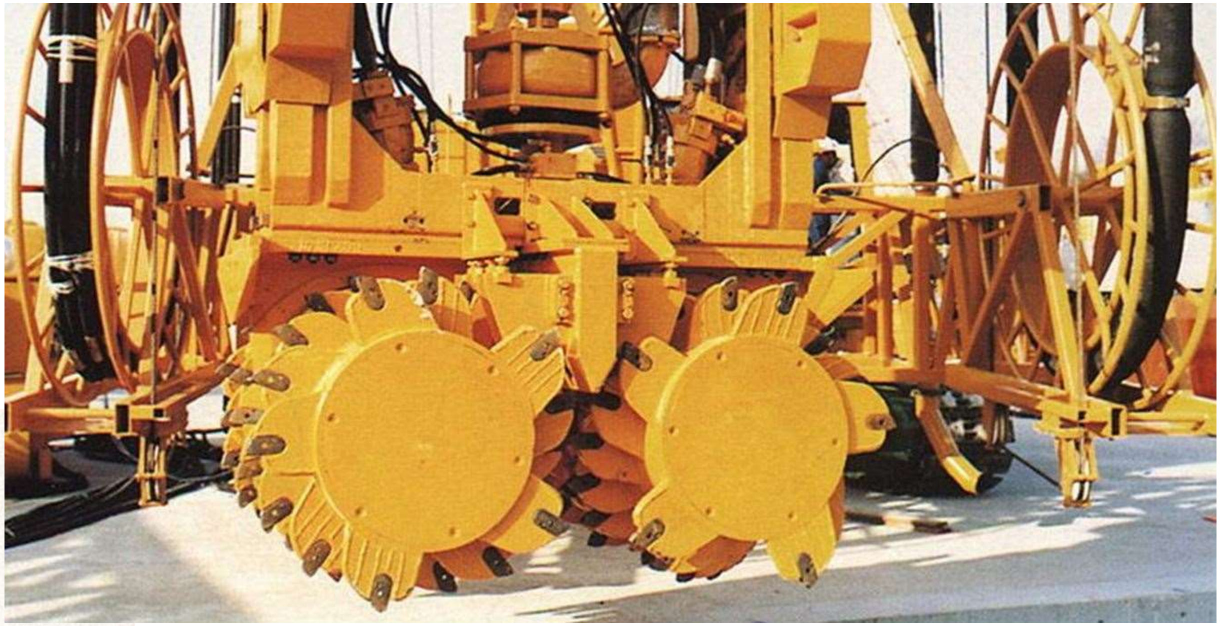
Concrete slurry walls

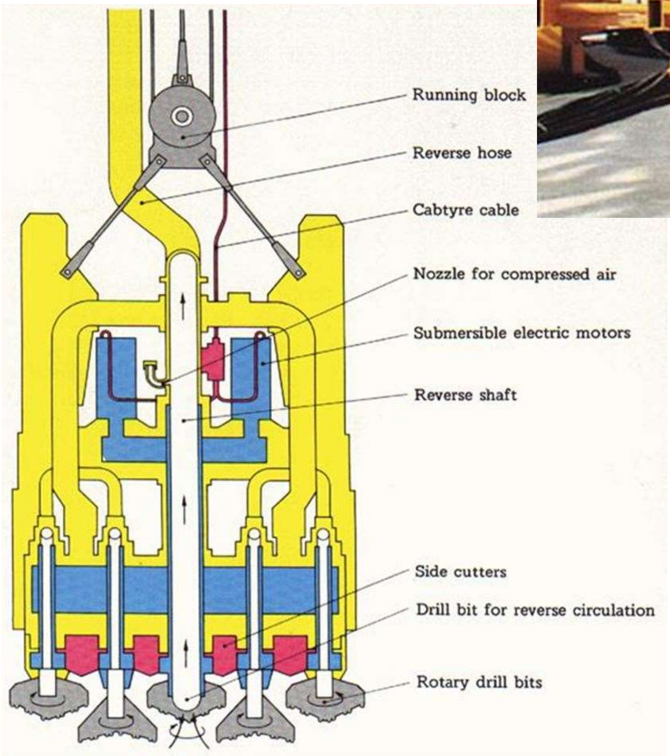
Excavation

Using clamshell buckets

Hydrofraise technology

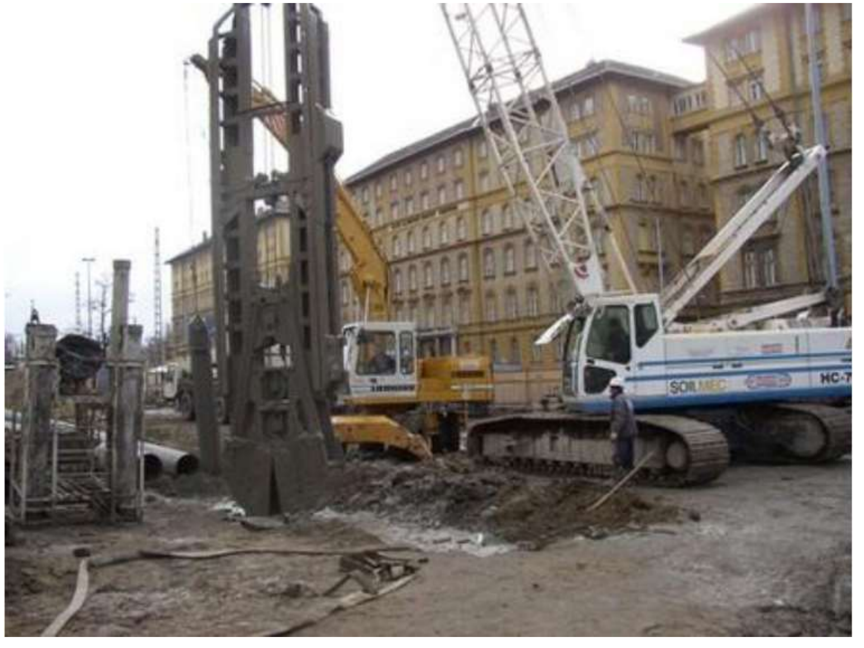
Concrete slurry walls





Concrete slurry walls

Concrete slurry walls



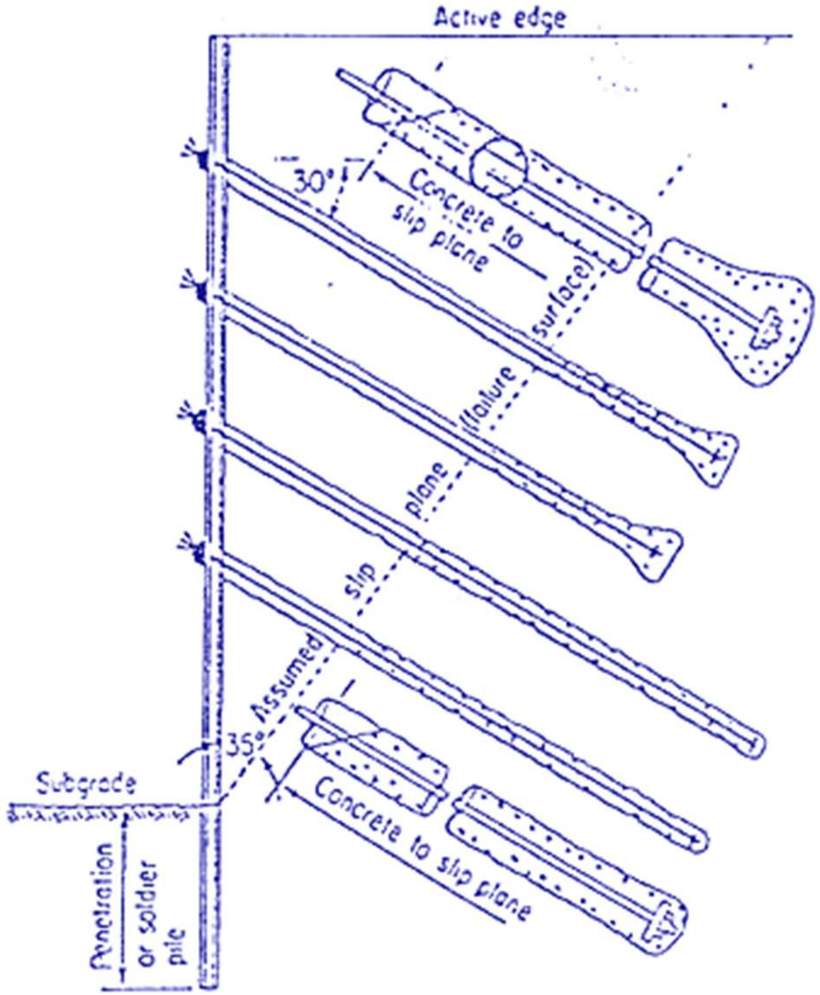
Concrete slurry walls

Concrete slurry walls

Tie-back

- Anchorage to brace against earth and water pressure

- Steel and concrete ties



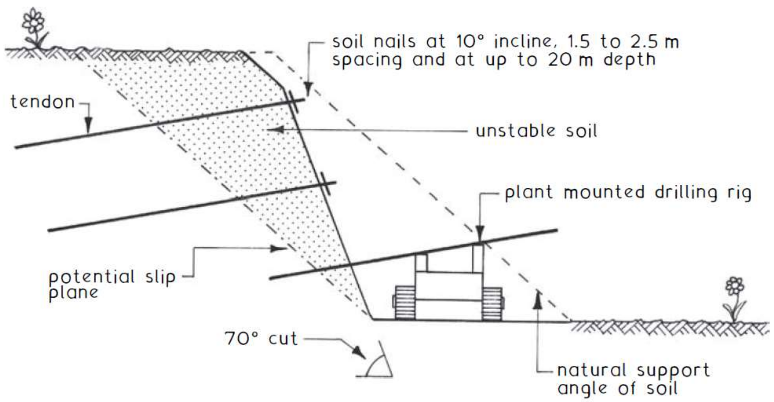
Concrete slurry walls

Tie-back

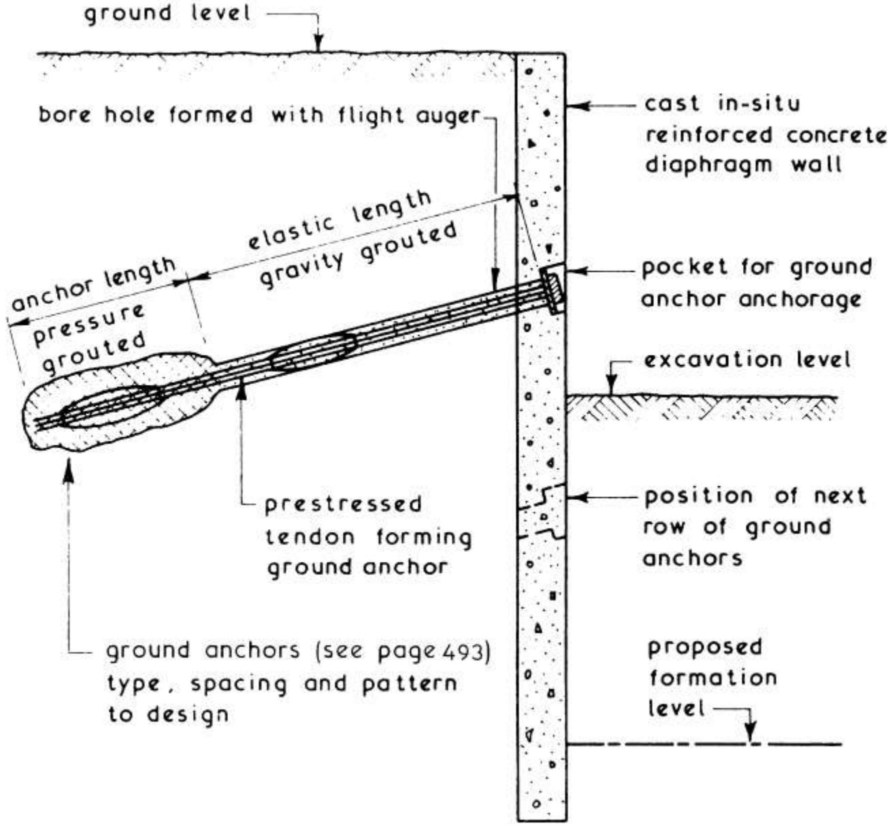
- Anchorage to brace against earth and water pressure

- Steel and concrete ties

Typical Application ~

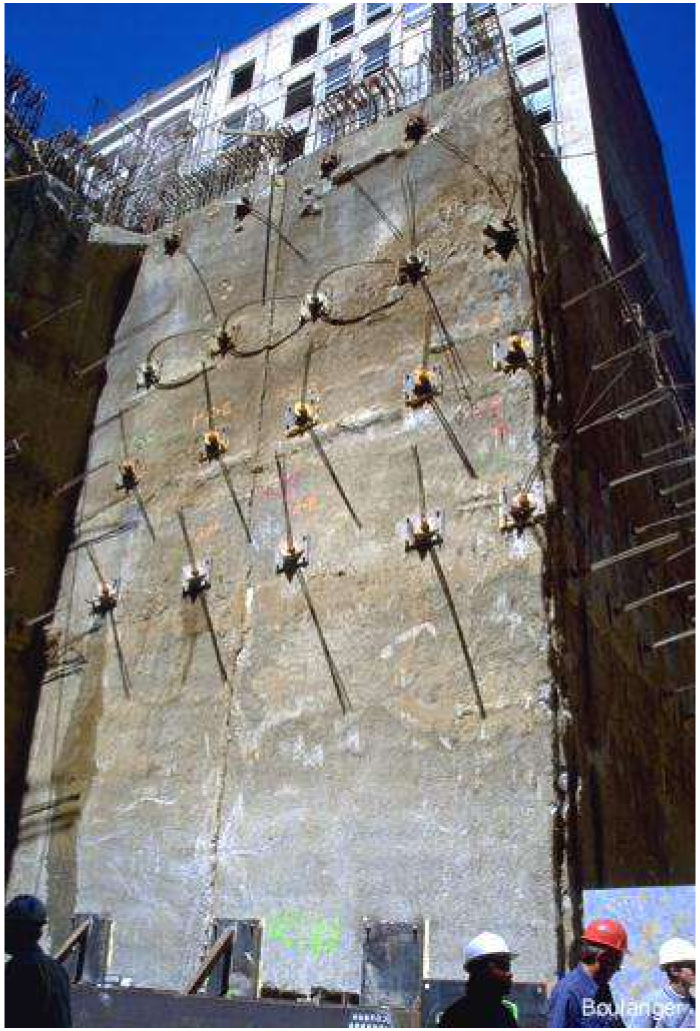


Typical Ground Anchor Support Details ~



NB. vertical ground anchors installed through the lowest floor can be used to overcome any tendency to flotation during the construction period

Concrete slurry walls



Concrete slurry walls