Earth moving and excavation (Soil challenges)

It is not easy to excavate any type of soil, see the below figure to understand how much the problem is complicated (figure-14) and see also (figure-15) the recommended trench side slope angle (Θ) in function of (H, L[kg/m2], Ø).

H: maximum allowable depth of the trench.

L[kg/m2]: acceptable load on the soil.

Ø: Pipe diameter

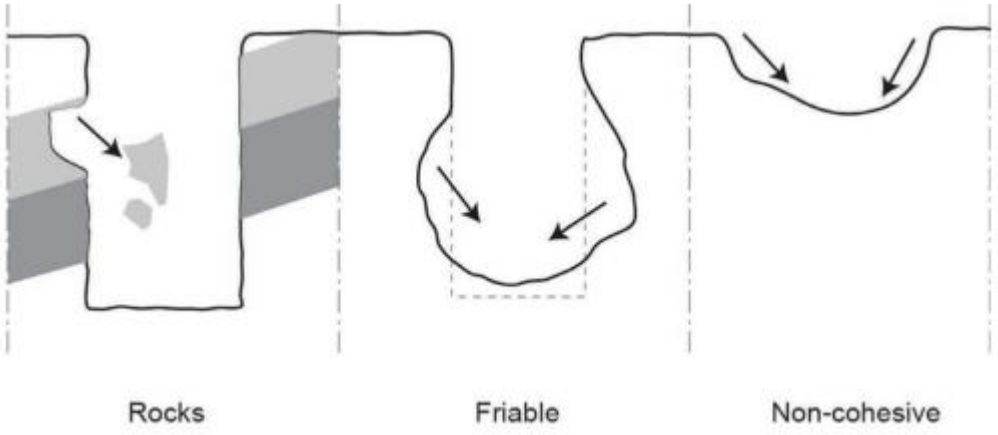


Figure-14:Soil types

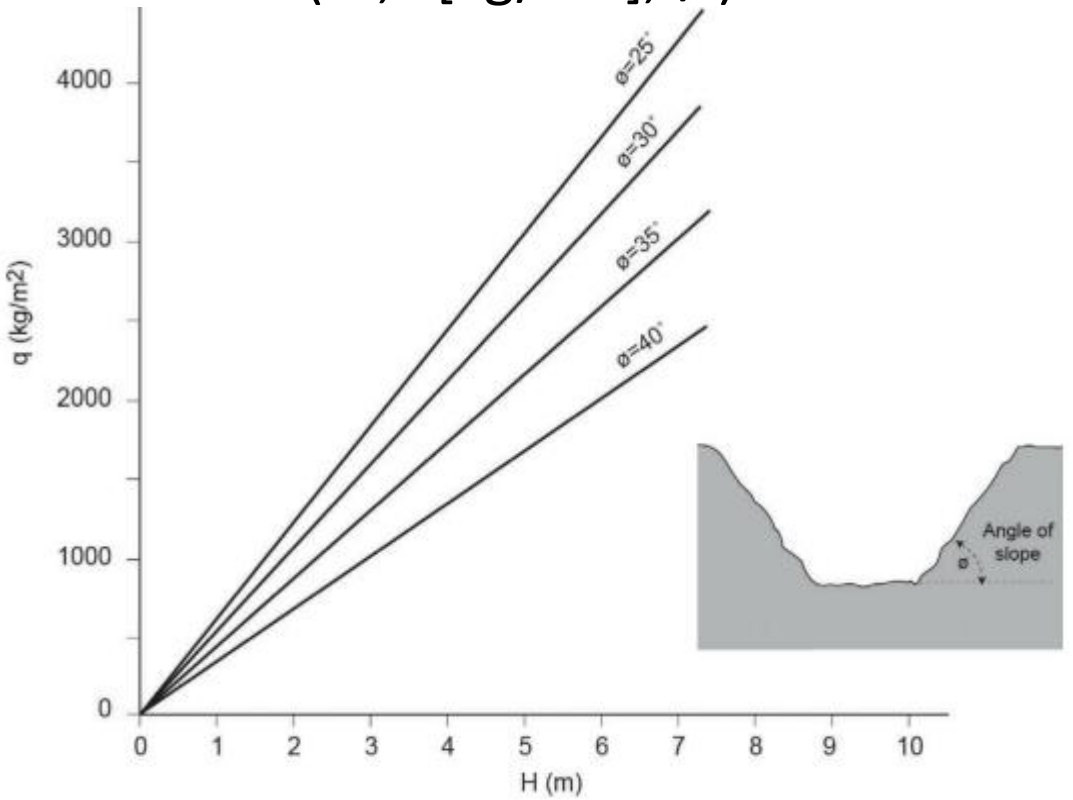


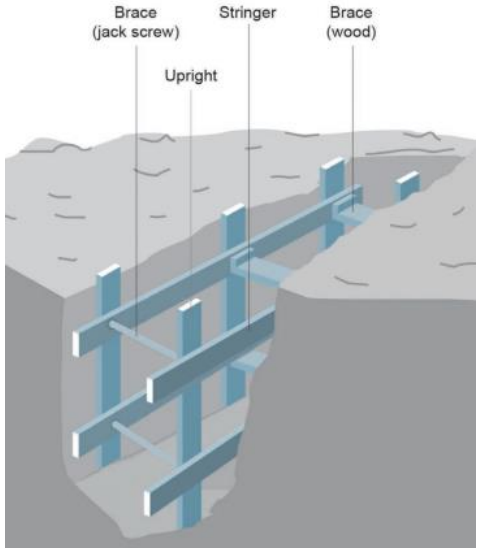
Figure-15: Trench slope angle

Earth moving and excavation (Soil challenges)

For quick and small project that not require high standards we can use the below norms from the american water wroks association as reference at different type of soil figure 16, slope marker is (Hz/ver).

To ensure trench slope from collapse differents

Techniques of protection can be applied see below:



wooden panel

Palplanche (fr)

Steel panel

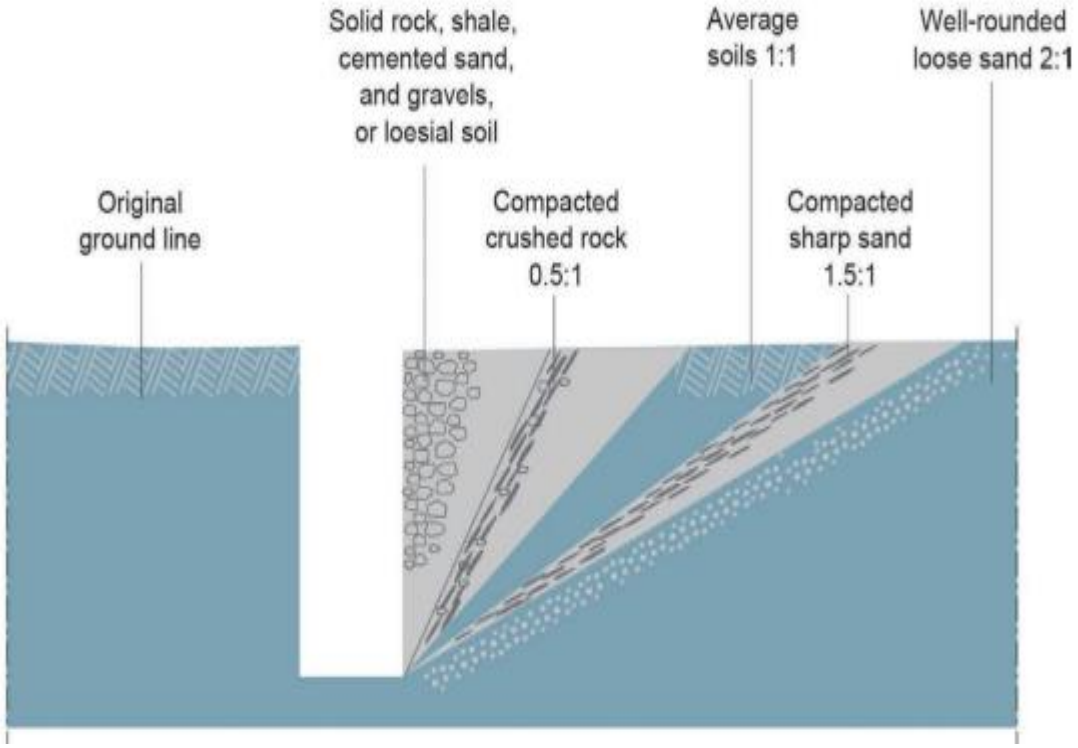


Figure-16:Trench slopes according to soil type.

Earth moving and excavation (Terassement)

For big projecst of water transfer, especially for large diameter and long distance cost are very high (In Salah- Tamanraset water Transfer for 740 Km, 100000 m3/Day) , mecanisation and planning are the key elements to make it cost effective. One of the best machine that reduce the pharaonic cost (US$2.5 billion) is the use of Trencher Machine mainly for soft to medium formation.

This Trencher is used for big diameter pipelines and

deep trenching works (sewage, water, drainage networks).

Benifits:

- Superior performances compared/ traditional excavators
- Fuel consumption reduction
- Safe & easier trencher operation (No skilled operator)
- Smart tracker; GPS data recorder

Figure 17:Chainsaw Trencher for big diameter and deep trench 1.8 m (Courtsey Tesmec)

Earth moving and excavation (Terassement)

For smaller trenches (Less than 300 mm wide and 1 m deep) vacuum excavation can be used. After cutting the surface and removing the top layer in a conventional manner, a special pneumatic digging tool is used. so, the soil is then removed through a flexible hose. This technique is used in urban areas where traffic is high see the below figure-18 and watch the following video at this link https://www.youtube.com/watch?v=NYU_46yaSXo.

Figure 18: Vacuum Excavator

Earth moving and excavation (Terassement)

Vacuum excavator is the safest, fastest, and most economical method of excavation. Its benefits include:

- **Reducing noise and keep the work area clean,**
- **Reduce considerably man power and equipment required,**
- **Minimising traffic disruption in big cities,**
- **Reduce cost of service.**

The preferred excavation method depends on:

available space on the site, soil conditions,

and width and depth of the trench.

Of course the contract will indicate this

Conditions.

In confined space and unknown

Pipe route it is mandotory to do

it manually , see figure-19.

Figure-19: Manually excavated trench

Earth moving and excavation (Terassement)

Contracts are well defining the excavation types according to soil type and network size and type, digging depth is a standard for each type of network (water, sewer,…..). The Algerian authority made the DTR_2006 as a main guide to define most of networks works, you can dowload it from here: https://kupdf.net/download/dtr-vrd-2006_58cd53d5dc0d608a57c3463a_pdf.

If the network/pipe route present some hills and up/down topography a grading is necessary using graders and/ or backloader (Most common equipment in Algeria) as polyvalent machine.

Figure-20: Motor Grader (Niveuleuse)

Figure-21: Back-loader

Earth moving and excavation (Trench dewatering)

In some situation water can influx from ground into trench and precipitation can also fill up the trench while bad weather conditions. So, the solution is dewatering techniques.

For surface water, it will be handled by centrifugal or vacuum/diaphragm pumps.

For saturated water, we must opt for wellpoint dewatering technique (see figure-22).

Wellpoint dewatering: is a groundwater control method that removes water from saturated soils. It is a small-diameter, closely-spaced shallow well, which offers a highly economic and versatile method of groundwater control where drawdown requirements onsite are less than 5-6 m in depth.

To understand how the technique it works please watch the Video in this link:

https://www.youtube.com/watch?app=desktop&v=lUjTjADapcc

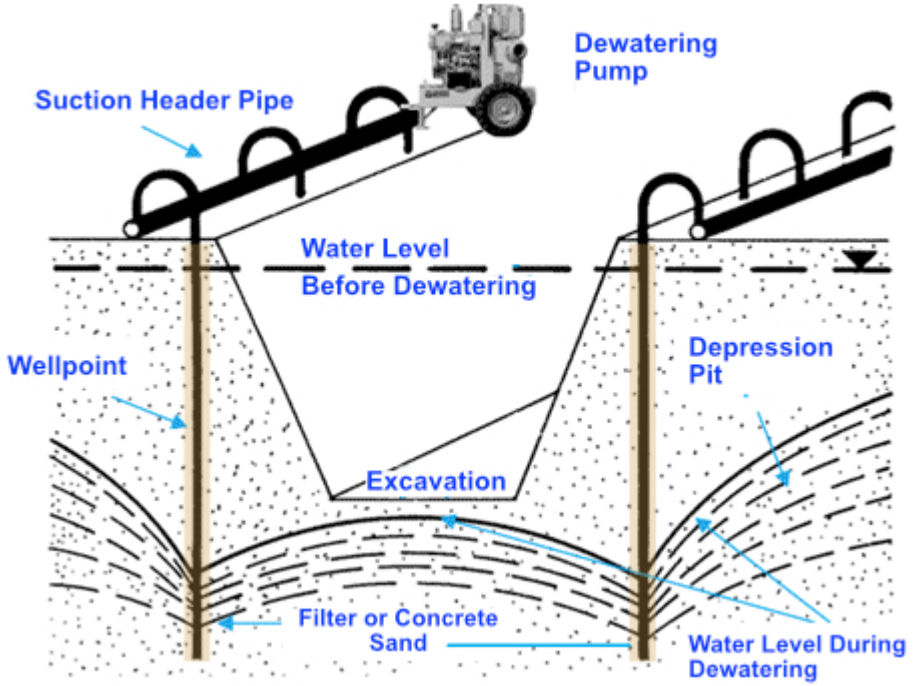


Figure-22: Wellpoint dewatering technique

Source: www.prattandsons.com/product

Network construction: Pipes laying (Terrassement)

To select the right pipe for water transfer/supply we should consider the following:

- Application Type and future expansion,
- Codes/References and standards required by the client,
- Material Compatibility to the environment (soil+water+salt), corrosion is big challenge for Iron pipes,
- Size/diameter, pressure and temperature,
- Durability and future maintenance.

When laying the pipe inside the trench and according to the pipe material, the trench bed can be made of **sand**, **gravel** or **dry concrete**, which assumes that the surface of the trench bottom is even and properly compacted. A huge care should be taken to avoid point loads being transmitted to the PVC pipes in particular because of soil seasonal behavior due to **moisture**

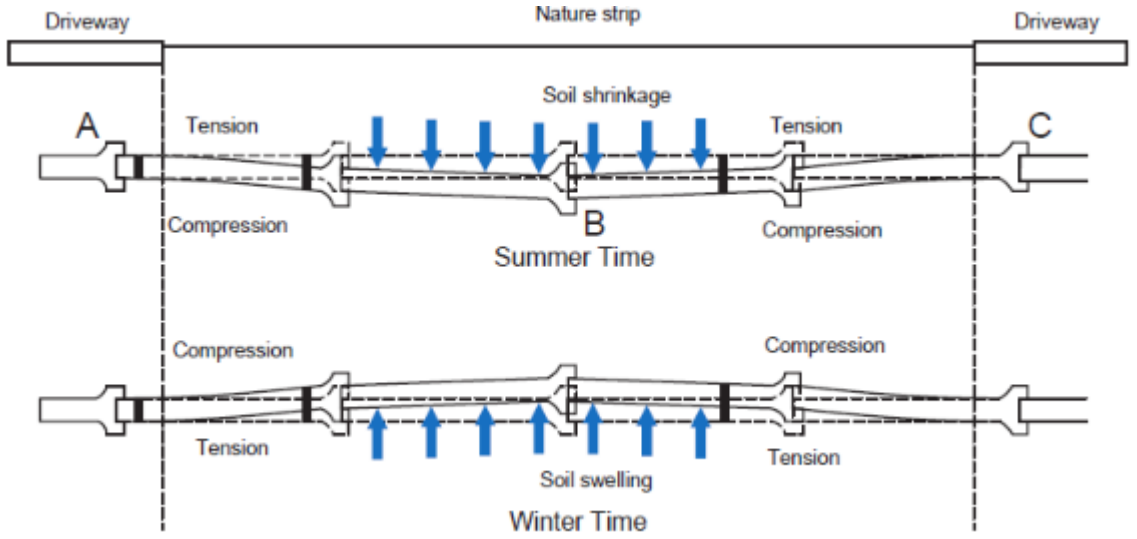


Figure 23: Pipe –soil movement due to moisture change (Rajeev et al 2012) in PhD Thesis BOUATIA 2021

Network construction: Pipes laying (Terrassement)

To ensing a good pipe laying we should consider the following :

- The bed of the trench should be free from any large grain size rocks and masonry remains, see typical trecn back fill Fig-24 a.
- The distance between the trench wall and the pipe external diameter is function of pipe diameter Fig-24-b.
- Pipe of potable water network is always the most elevated network see Fig-24-c.
- Warning grid is a must after laying the pipe, it is about 20-30 cm from surface.
- While back fill, the soil is normally placed in the trench in layers of 15-20 cm, and each layer is well compacted by machines that prevent pipe from damage see Fig-25.

a) **b)** **c)**

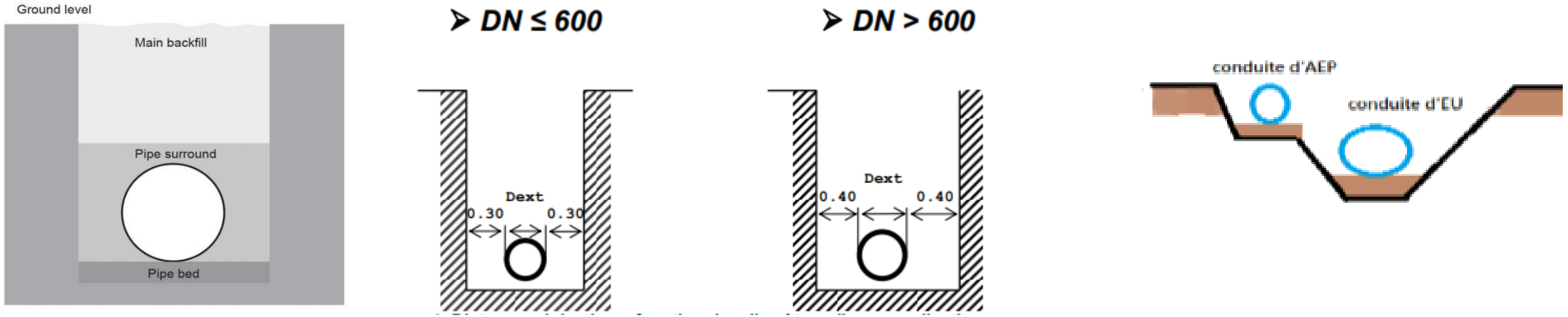


Figure 24: Back fill and pipe positionning inside thrench