Dewatering:

# Dewatering

GIT



Dewatering in its general sense indicates lowering the water table, redirecting the seepage (or) simply reduce the water content.

Objectives of dewatering:

* To provide dry working area for laying the foundation of bridges, dams etc.
* To increase the bearing capacity.
* To reduce the compressibility in case of coarse grained so
* To reduce the suseptability for Liquefaction.
* To reduce the damage due to freezing & thawing.
* To reduce the lateral pressures on foundation and retaining structures.
* To reduce the surface erosion.
* To reduce the Liquefaction potential due to Seismic activity
* To prevent migration of soil particles by ground water.
*

Dewatering is required for not only civil engineering projects but also these are useful in mining projects.

Soil is a multiphase system consisting of solid phase called skeleton and fluid phase called pore fluid. The physical & chemical interaction b/w mineral skeleton and pore fluid in general dictates the engineering behaviour of any soil.

Under many field situations during construction operations it may be necessary to eliminate seepage pressures to increase shearing resistance (or) to reduce erosion, frost damage etc... It can be done by reducing the neutral stresses (caused by pore fluid). effectively by adopting "dewatering" methods.

Ground water is usually considered as one of the most difficult problems that has to be handled in any civil engineering constructions.

The Methods of dewatering are based on the various forms of ground water existence in soil can be graphically ~~sep~~ represented as

Ground water.

- Free/Gravity water.
- Capillary water
- Adsorbed water.

## Methods of dewatering:

The following methods are controlling the Groundwater, they are

1. open sumps and ditches.
2. Well point system.
3. Deep well Drainage system.
4. Vaccum dewatering system.
5. Dewatering by electro-osmosis.

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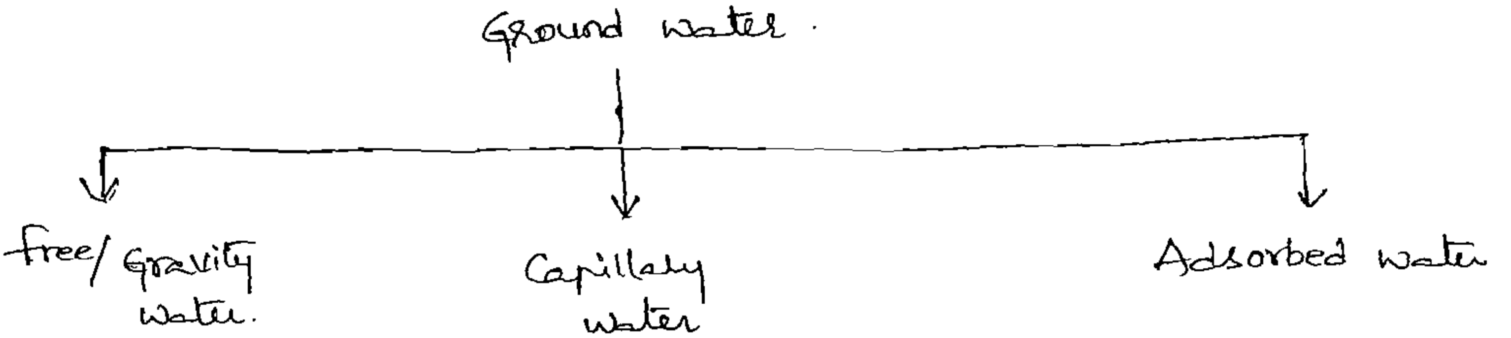


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Well point system:

Filter well (or) Well points are small well - Screens of sizes 50 to 80 mm in diameter and 0.3 to 1m length. Well points are either with brass (or) Stainless - steel screens and are made with either closed ends (or) self jetting type.

Page: 50: filter requirements.

Page: 78 to 81: Drains (topics 3.8 to Interceptor drains). with sketches.

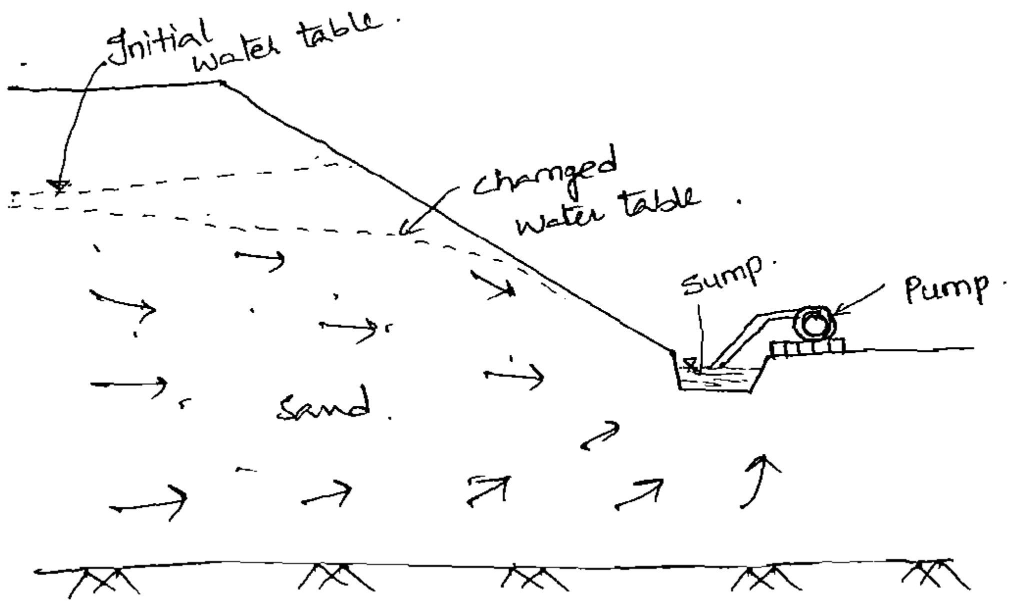
- open
- closed
- Horizontal
- Drainage after construction.
- foundations drains.
- Blanket drains.
- Interceptor drains.

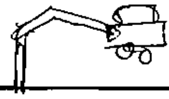
① . Open sumps & Ditches :

In this method the important feature is a sump below the ground level of the excavation at one (or) more corners. In order to reduce the standing of water on the floor of excavation, a small grip is cut around the bottom of excavation. care should be taken while designing the ditches which are kept open for a long period.

This method is widely used for the lowering of ground water. this method is economical and easy to install and as well as simple Maintainance requires. This method is effective in situations where boulders (or) massive obstructions are met with the ground.

The max. depth to which the water table can be lowered by this method is about 8m below the pump. effective in coarse sand & clean gravels.





## Well point system

Filter wells (or) well points are small well screens of sizes 50 to 80 mm in diameter and 0.360 1m length well points are either with Brass (or) stain less steel screens and are made with either closed Ends (or) self jetting types. Usage of plastic disposable well points in the places where revuires to remain in the ground for Long period.

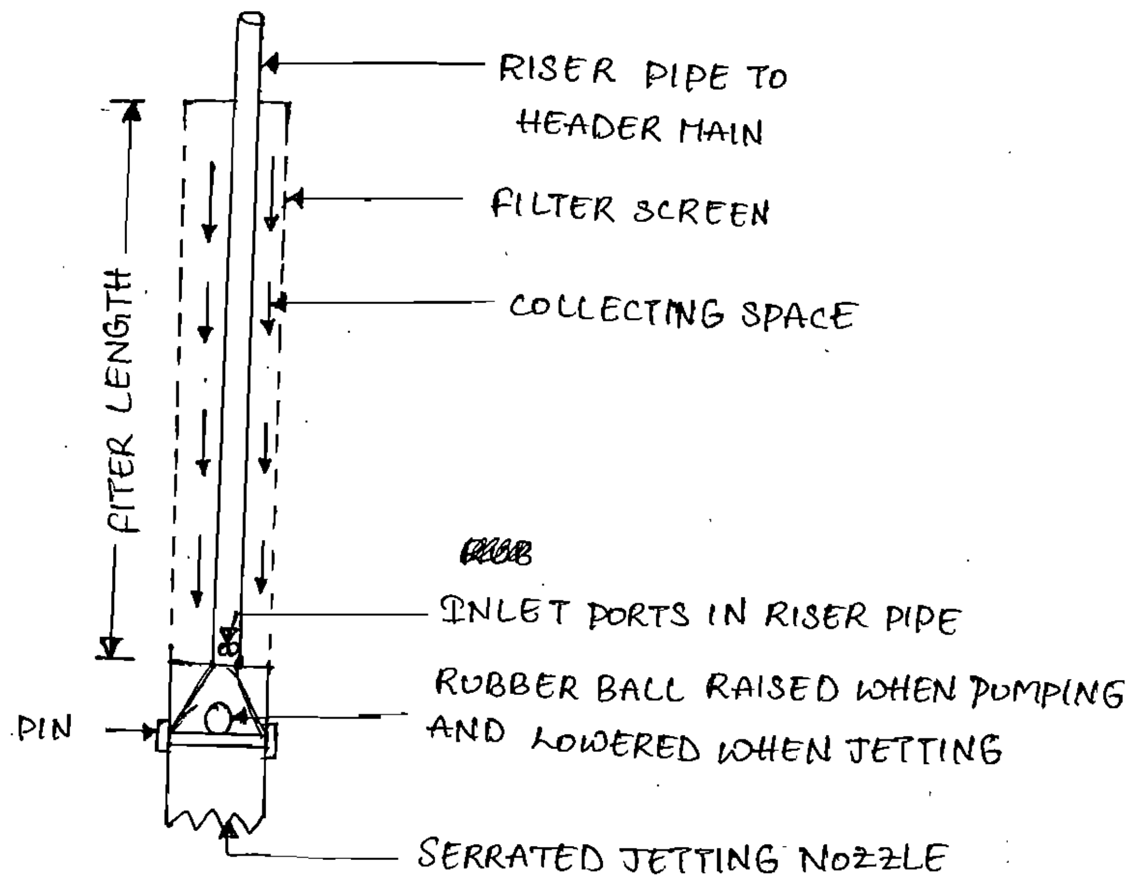
Water draun through the screen Enters the space Between the gauge and the outside of the riser pipe to holes drilled in the bottom of this pipe and then reaches the surface. The well points are installed by jetting them into the ground.

The capacity of a single well point with a 50 mm riser is about 10 litres/min. Spacing of well points depends on the permeability of the soil and on the availability of time to effect the drawdown.

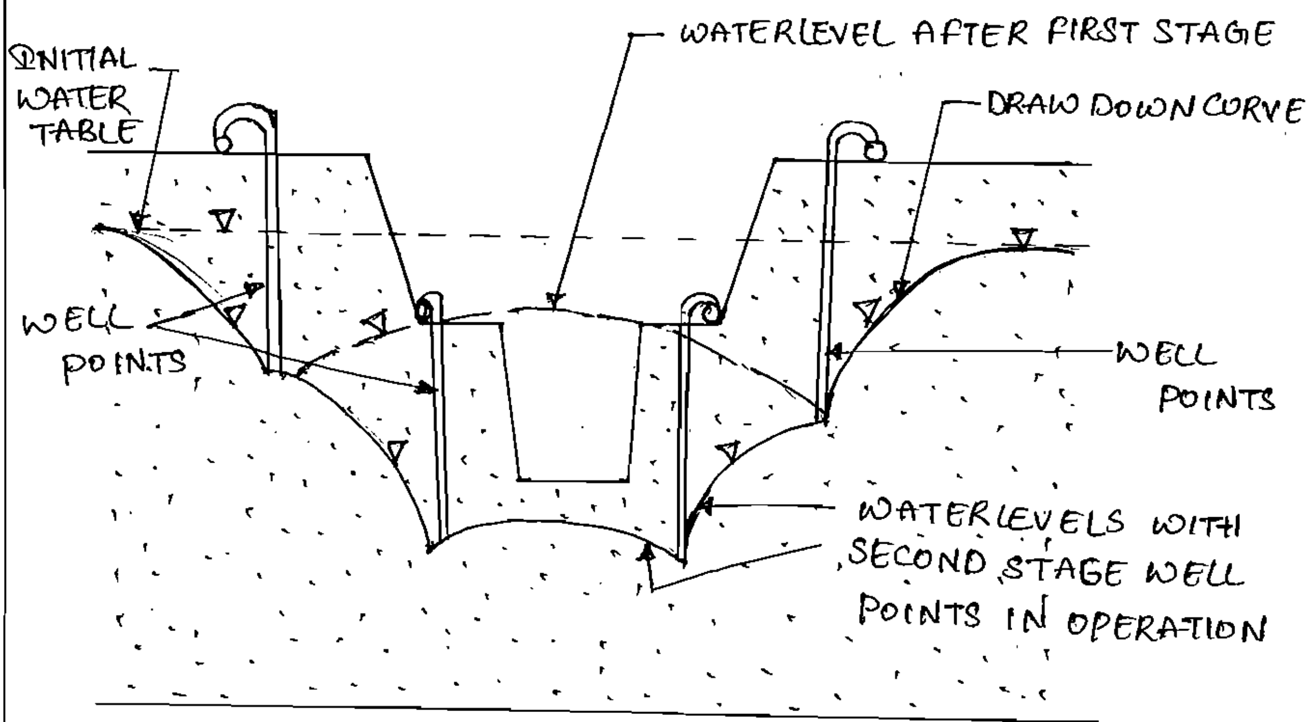
A spacing of 1.5m for silty sands & 0.3 m Breaks for coarse gravels.

Well point system is the most commonly used Method for construction purposes. A well point system is suitable when the site is accessible, and where water Bearing stratum to be drained is not too deep from the Excavation.

## Diagramatic arrangement of a Well point




## Multi stage Well point operation



The installation of well point system is very rapid and requires reasonably simple and cheap equipment. In this there is an advantage that the water is filtered and carries little (or) no soil particles. The serious limitation of the well point system is the suction lift. A lowering of about 6m below pump level is generally possible beyond which excessive air shall be drawn into the system through joint in the pipes ~~pipes~~, valves, etc., resulting in loss of pumping efficiency.

For dewatering deeper excavations, the well points must be installed in two (or) more stages. There is no limit to the depth of drawdown in this way, but the overall width of excavation at ground level becomes very large. On the other hand it is possible to avoid multi-well point stages by excavating down to water level before installing the pump and header.

When well points are used in braced excavations they are placed close to the toes of the sheet piles. This is done in order to ensure lowering the water level between the sheet piles rows. Well points are provided in conjunction with the sheet piles under the following conditions:-

(i) To prevent quick condition of the bottom when the sheet piles are of limited penetration and.

(ii) To eliminate hydrostatic pressure on the back of a sheet pile cofferdam thus allowing higher bracing to be used.

As an alternative to the conventional wellpoint system with surface pumps, one can use a jet-Eductor well point system, with one pressure pipe and a slightly larger return pipe. These two pipes along with the wellpoint and jet-Educator pump are installed in a cased hole and surrounded with a filter sand, if necessary.

This method has the advantage that the drawdown of the groundwater is not limited in depth by the suction lift of a pump at ground level. The serious disadvantage with this system is that the jet-Eductor pumps usually have a low efficiency.

For large excavations (or) where the depth of excavation below the water table is more than 10 to 15 m (or) there is a necessity to reduce the artesian pressure from a deep aquifer it is desirable to use deep-wells with (or) without wellpoints.

Wellpoints are installed either by the progressive system or the ring system. In this progressive system the header is laid out along the sides of the excavation.

# Deep-Well Drainage

Deep well drainage system consists of deep wells and submersible or turbine pumps which can be installed outside the zone of construction operations and the water table lowered to the desired level. Deep-Wells are usually spaced from 8 to 80 m depending upon the level to which water table must be lowered, permeability of the sand stratum, source of seepage and amount of submergence availble.

Deep-well system is suitable for lowering the ground water table where the soil formation is pervious with depth, the Excavation Extends through or is underlain by coarse-grained soils. The method is also suitable when a great depth of water lowering is required or where a head due to artesian pressure has to be lowered in a permeable strata at a considerable depth below the Excavation Level.

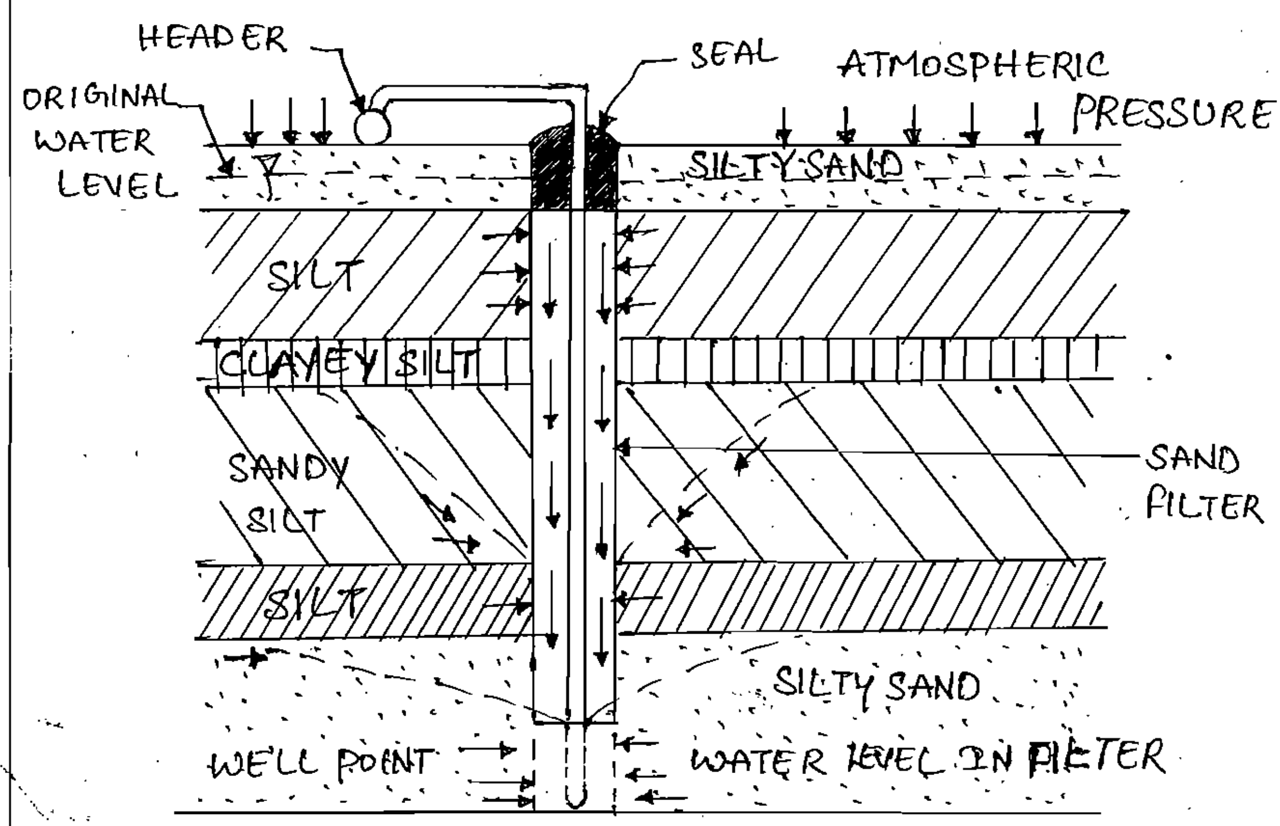
The installation of a deep well is done by sinking a cased bore hole having a diameter of about 200-300 mm larger than the well casing which depends on the size of the submersible pump. A perforated screen is installed over the length of soil which required de-watering and is terminated in a 3 to 5 m Length of unperforated pipe to act as a sump to collect any fine material. which might be drawn through the filter mesh. Graded filter material is placed between the well casing and the outer bore hole casing over the length to be de-watered.

If centrifugal pumps are used in a deep-well system, the tops of the screens should be set below the computed water surface in the well. As heavy boring plant is used to sink the well in very adverse formations like boulders, rocks or under other different field environment, the cost of deep-well system is relatively high. Thus, it is advised to restrict this method to jobs which have a long construction period such as dry docks or access shafts for long sub-aqueous tunnels.

**Vaccum Dewatering Systems:-**

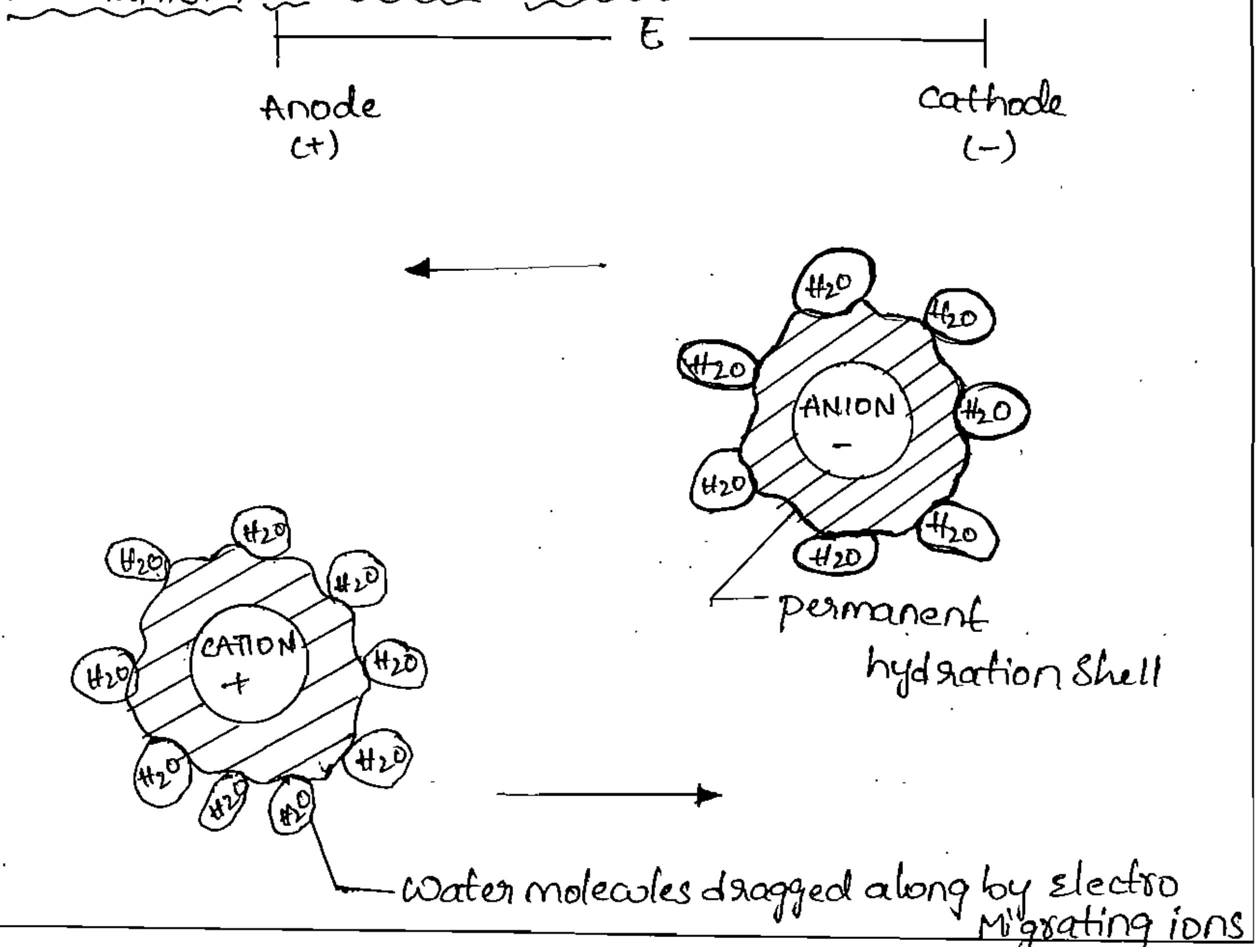
Gravity methods, such as well points and deep-wells, are not much effective in the fine-grained soils, with permeability in the range of 0.1 to $10 \times 10^{-3}$ mm/s. A vaccum dewatering system requires that the well or well point screens, and riser pipe be surrounded with filter sand extending to within a few metres of the ground surface.

This method is most suitable in layered or stratified soils with co-efficient of permeability of the range 0.1 to $10 \times 10^{-4}$ cm/sec.

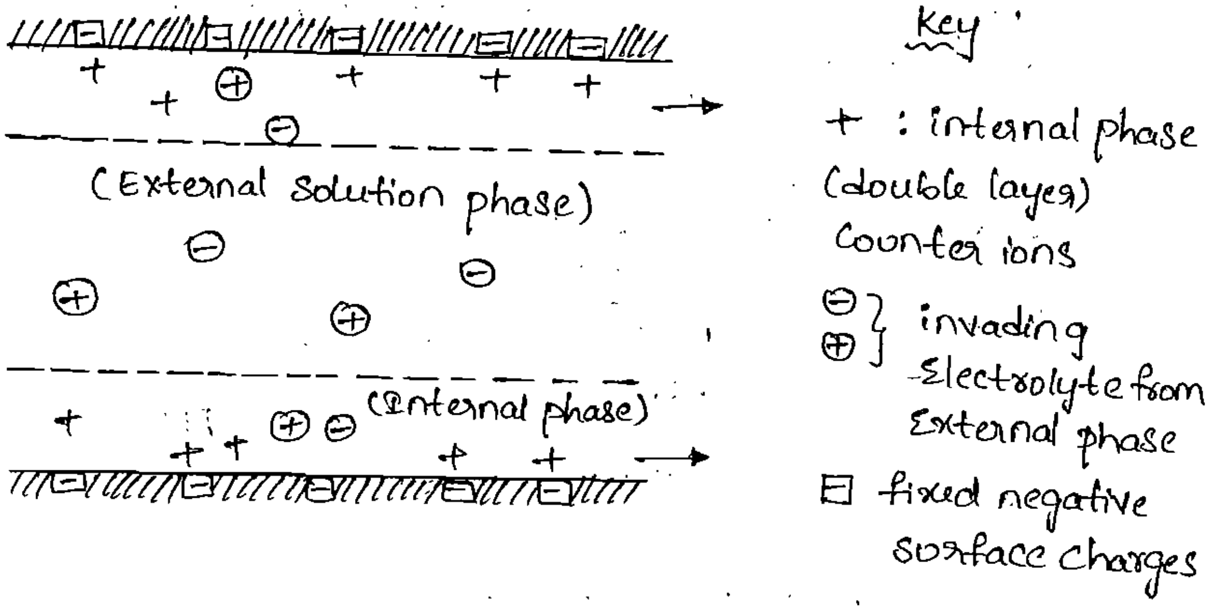



# Dewatering by Electro-osmosis

## Mechanism of Electro-osmosis



## Hypothetical distribution of ions between External and internal phases in a clay pore :-




$$Q_e = K_e i_e A$$

The potential gradient should not exceed 0.5 Volts/cm in order to prevent considerable loss of Energy due to heating of the ground.

## Electrodes :-

The general layout of the electrodes depends upon the purpose for which they are intended. Sheet piles of any shape can be used. The simplest type of anode for Normal application are old pipes, of 25 mm or 50 mm diameters, which can be easily driven into the soil.

These can either be placed singly (or) in groups of two (or) three.

Since the anodes corrode considerably in the course of a few weeks of electro-osmotic treatment they should be replaced as soon as the current drops to less than 30% of the initial consumption.

In contrast to normal well points these cathode wells should extend from the surface to the bottom. so as to allow the water to discharge into them over the whole of their height. Such cathode-wells have the advantage of serving also as drainage wells for layers and pockets of sand which are frequently present in silty soils and which otherwise would hardly be affected by electro-osmosis.

## Safety Measures

The following simple rules should be made, which everyone knows on the site:-

i, only persons wearing rubber boots should be admitted into the neighbourhood of the electrodes.

ii, while working between anode and cathode neither the electrode nor the wiring should be touched in such a manner that while one hand is on the electrode, the other gets into contact with the ground (or) with the other electrode. Serious harm could be the consequence, even with less than 100 volts.

(iii) Where the excavation is carried out by machinery special attention has to be paid by the operator to avoid the occurance of short circuits. This may endanger the operator himself in the first place. No particolar precautions are necessary if the machine operates within a space enclosed by anodes such as sheeted excavations.

## Filter Requirements

In any drainage system perforated pipes and conduits of perforated pipes or pipe lines with open joints are usually provided. The space between the natural soil and the pipe is filled with a coarse grained Material known as filler. If the voids of filler are larger than the finest grains of the adjoining soil, there is a possibility of these fine particles to fill the voids and accumulate and Block the flow. On the other hand if the voids in the filler are as small as those in the soil, then there is a possibility of the filler material washed into the conduits and pipes and thus leading to erosion of the natural soil. Both these are undesirable conditions. A filler material that overcomes the ~~natural~~ above two Conditions is referred to as a filter.

Filters are also used in Earthdams, Cofferdams and sheet pile structures as a transmission medium or to prevent piping. To prevent piping, the filter material should have adequate weight. If a filter extends across a boundary between coarse and fine soils, different materials have to be used.

Thus in general a filter or a drain material should satisfy the two requirements apart from adding weight.

(i) the gradation of filter material should be capable of forming small size pores such that migration of adjacent particles through the pores is prevented.

(ii) the gradation of the filter material should be such that it allows a rapid drainage without developing large seepage forces.

The above requirements are satisfied by adopting a suitable grain-size distribution for the filter material based on the material to be protected. The following filter criteria are to be adopted (Bertram, 1940).

$$\frac{D_{15}\text{ (filter)}}{D_{85}\text{ (protected soil)}} < 4 \text{ to } 5$$

The criterion emphasizes that the $D_{15}$ size of the filter soil should not be more than four or five times the $D_{85}$ size of the protected soil. The second criterion is

$$\frac{D_{15}\text{ (filter)}}{D_{15}\text{ (protected soil)}} > 4 \text{ to } 5$$

This criterion emphasizes that the $D_{15}$ size of the filter soil should be more than four or five times the $D_{15}$ size of the protected soil.

The additional requirement which has to be satisfied as regards to openings in the mesh screen or perforated pipe is that the maximum size of the filter material should be at least twice that of the openings in the mesh screen.

## Drains

A complete drain consists of three components, viz, filter, conduit or collector and disposal system.

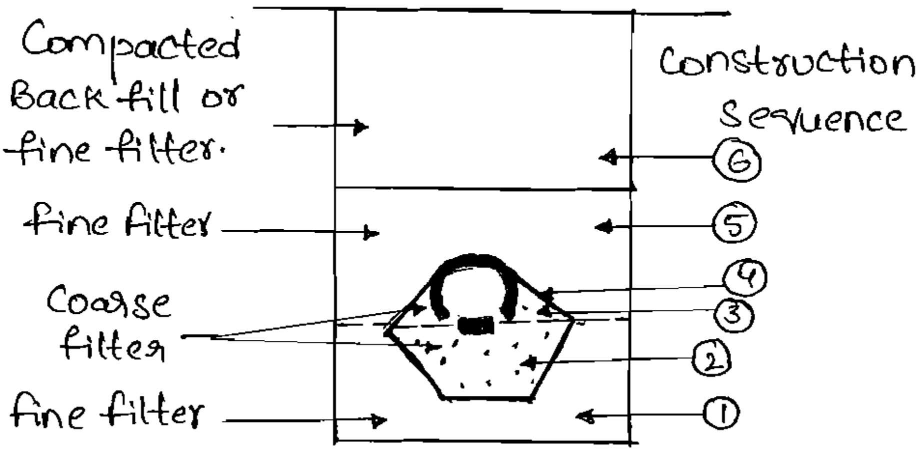
As discussed earlier a filter is essential for continued efficiency of the drain and to prevent seepage erosion during high hydraulic gradients. The water is collected in the drain conduits from the filter and is carried away. ordinarily, the conduit is 5 to 10 times larger than its hydraulic dictate to allow for variation in soil permeability and to accomdate some silting. commercial pipes have perforations of 8 to 9 mm in diameter and require a gravel filter with a maximum size of 12-15mm. The permanent and simple disposal system is Gravity. During adverse conditions such as wet weather, high water table and a difficult topography, gravity system of disposal cannot function. In such situations pumps has to be resorted to which will be costlier over a long period.

## Open Drains

The oldest method of draining excavations, roads etc. is by open Drains, viz., a ditch or a sump. A sump is merely a shot ditch which could be constructed easily with unskilled labour. Details of this method are discussed earlier.

## Closed Drains

When seepage erosion or piping is troublesome or where a permanent drain is desired, perforated pipe can be laid at a required depth in ditches and the ditch is back filled with a suitable filter material. As far as possible pipes should be laid in straight lines. openings should be provided for every 30 to 50 m to flush out the pipe occasionally. Also manholes should be provided at changes in direction and at intervals of 100 to 150 m along straight sections.




Pipe drain with double filter layers.

## Horizontal Drains

If field situations warrent to avoid open-cut work or non-availability of adequate submergence, the ground water can be lowered by means of a Ranny drainage system. This system consists of a reinforced concrete shafts or wells from which a number of horizontal perforated pipes are fixed. These pipes may be extended to a required length in any direction. Water collected in the well is pumped out by means of a turbine pump. This system may not be effective in lowering water in stratified soils.

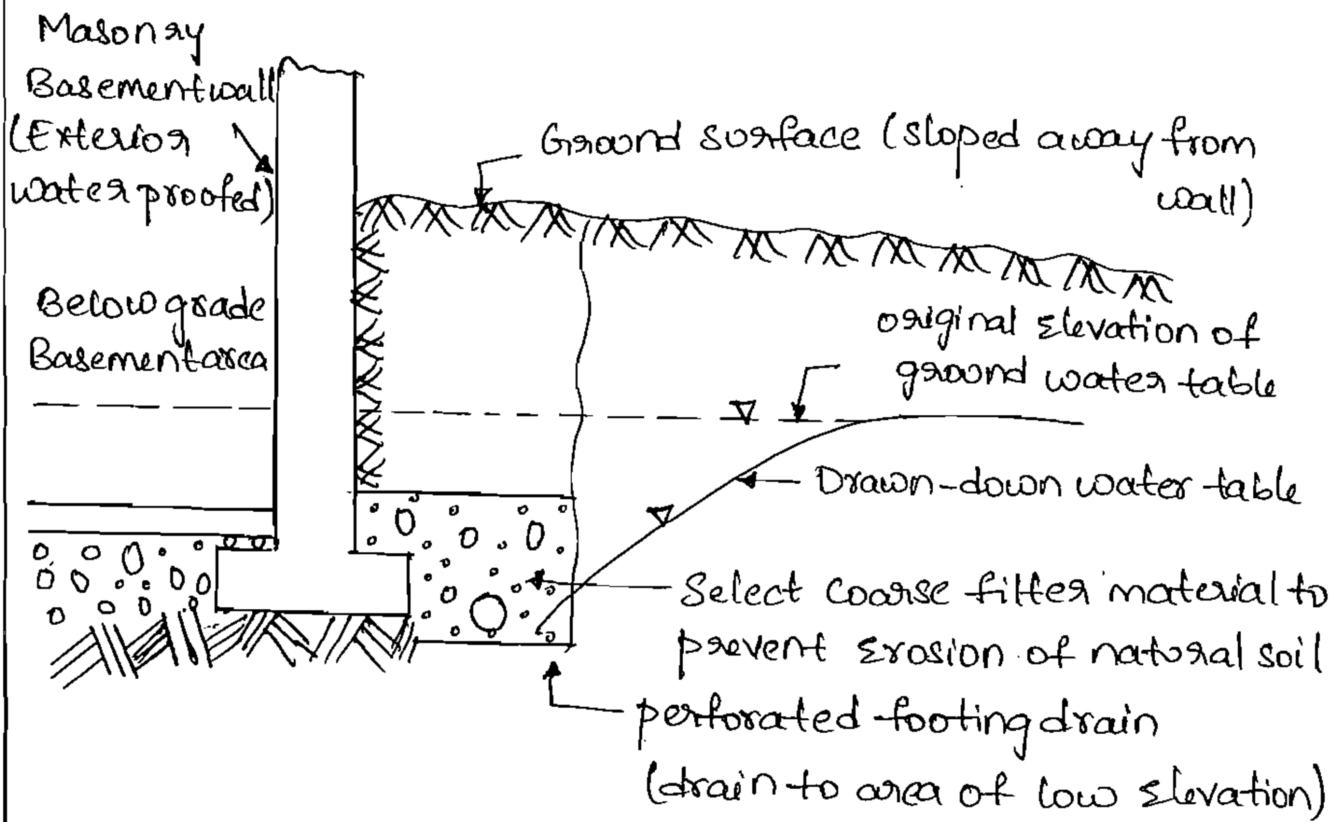
## Drainage After Construction

preventing groundwater from seeping into an structure or through a finished structure may be necessary in order to obtain proper use of the structure or to protect it from drainage. In some situations, the dewatering systems utilized during construction may be further used to protect the structure.

In a particular field condition if it is necessary that an usable part of a structure has to be located below the ground water table, it is essential to build the facility utilizing water proof design and construction techniques. one of the desirable features for a sub-aqueous structure is to have all seams and joints with water stops or to avoid completely seams and joints.

## Foundation Drains

Where groundwater is present in the vicinity of a structure, provision should be made to quickly carry away the water from the Building. In the worst condition the effect of ground water may be allowed only on the Exterior side of a Building. when the depth below the water table is not too great, it is feasible to control the water by foundation Drains. An arrangement of such a drain is shown Below. However, such drains should not be placed lower than the bottom of the footing. such drains consist of perforated pipes or pipes with open joints so that the ground water can enter into the pipe. A suitable filter should surround the pipes. The collected water in the pipes is disposed off by gravity flow to a storm drain system or other drainage facility such as ditch, dry well, etc. If disposal by gravity flow is not possible, the drainage water has to be directed to sump pit or other collector and pumped to a disposal.

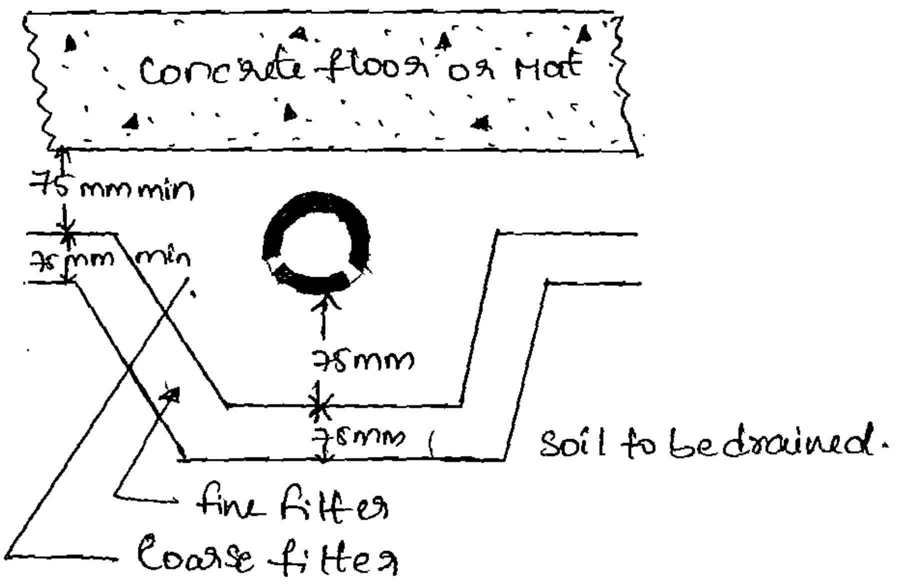



footing drain tile installation for disposing of ground water against a Basement wall.

## Blanket Drains

Continuous Drainage Blankets are sometimes constructed beneath dams and Basement floor slabs to provide a highly permeable drainage path for removal of ground water acting against the bottom of the slab. If an escape path is provided the uplift pressure can be reduced and the possibility of seepage through the floor arrested. The blanket consists of a fine filter layer in contact with the soil followed by a coarse filter cum collector layer and the latter is in contact with the underside of masonry dam or Basement floor. The Blanket is connected by conduits to a sump where the Collector water is pumped out or to drainage pipe where disposal is by gravity. such Blankets are also provided beneath pavements to prevent capillary flow upward.

Blanket under drain with pipe disposal - minimum



## Interceptor Drains

In paved highways and airfield runways trench drains are provided parallel to the shoulder. such drains are termed as interceptor drains which are provided to lower the ground water table to a level beneath the pavement and to permit easy lateral drainage facility is to keep the base and subgrade soils dry so as to maintain adequate strength and stability. The drains also provide a means for disposal of surface and near surface water and also shall help to intercept underground flow trying to enter the pavement from the side areas. similarly, open drainage ditches located adjacent to shoulder area may help to intercept surface and near surface water flowing towards the road way area from the sides also prevent development of excess pore water pressure.

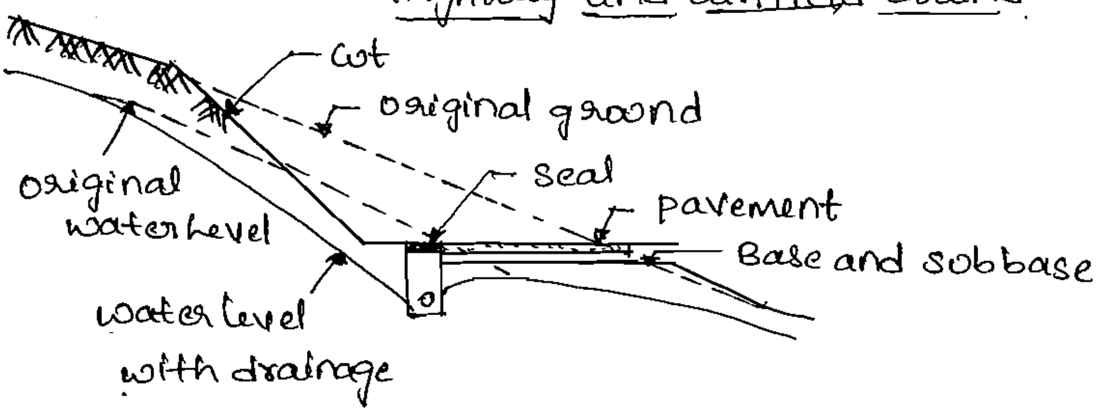
(a) Interceptor drain for Highway constructed in a side hill (Adopted from cedergren, 1967);

(b) Interceptor drain for Highway in flat terrain (Adopted from cedergren, 1967);

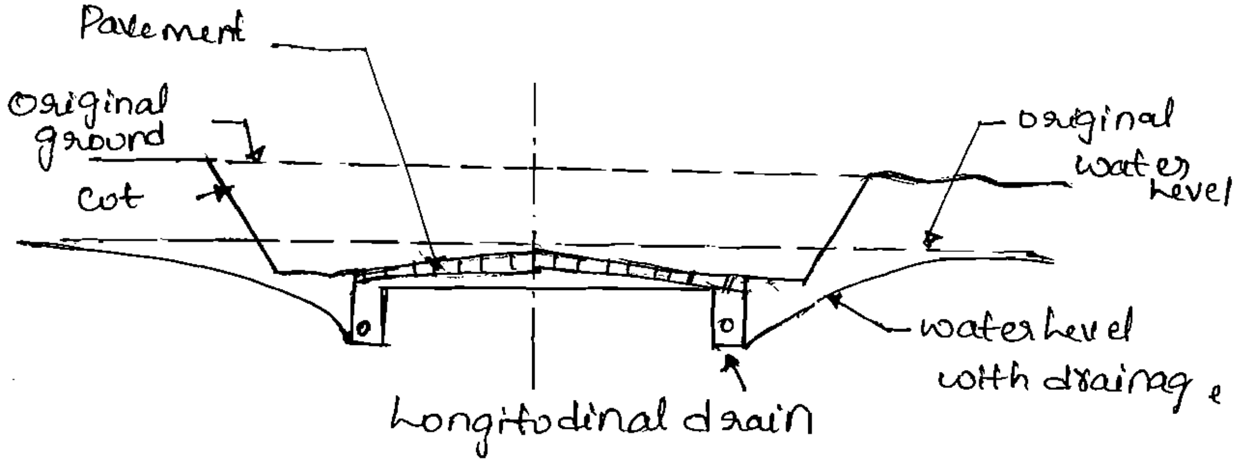
(c) Typical airport runway interceptor drains (civil Aeronautics Admistration)

(d) Typical open - shoulder ditch for roads.

# Highway and airfield drains




(a)

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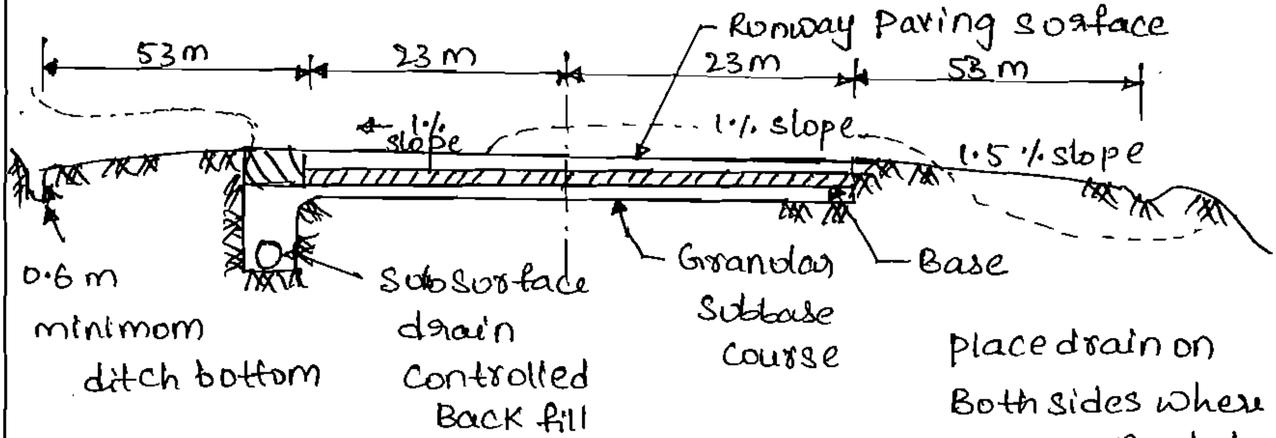
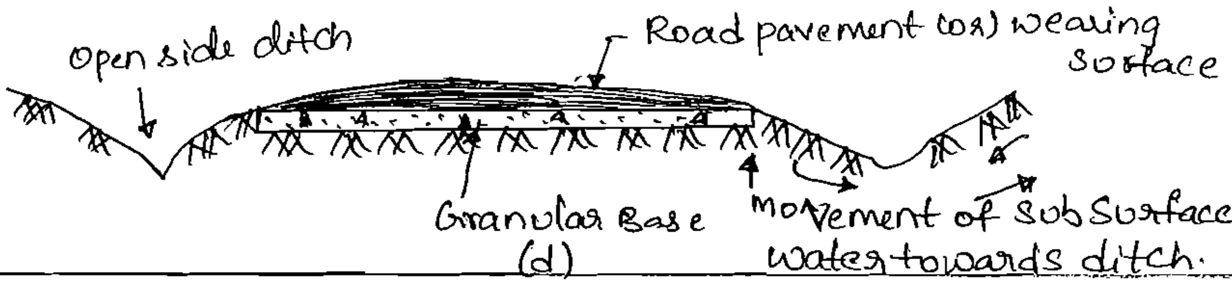



(c)




(d)