

Module 6 : Design of Retaining Structures

Lecture 30 : Dewatering [Section 30.1 : Introduction]

Objectives

In this section you will learn the following

- Introduction

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Lecture 30 : Dewatering [Section 30.1 : Introduction]

Introduction

Dewatering is a process of removal of water from a foundation pit when it is situated below the ground water table or when it is surrounded by a cofferdam. The purpose of dewatering is to keep the excavation dry so that concreting can be done. Dewatering is temporary if it is done at the time of construction. It is followed by restoration to its original water table after the structure has been completed. Permanent dewatering is required for removing subsurface gravitational water throughout the life of the structure. It may be necessary to keep the water away from the structure to check the dampness or other ill effects.

Dewatering is required for:

- Deep basement below water table
- power houses
- tunnels
- pumping stations

Purposes of dewatering:

- control seepage and lowering of water table
- to prevent piping or clay bursting
- increase slope stability

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Lecture 30 : Dewatering [Section 30.1 : Introduction]

Recap

In this section you have learnt the following.

- Introduction

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Lecture 30 : Dewatering [Section 30.2 : Methods of Dewatering]

Objectives

In this section you will learn the following

- Open sumps and ditches
- Well point systems
- Deep well drainage
- Vacuum Dewatering Systems
- Electro Osmosis

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Lecture 30 : Dewatering [Section 30.2 : Methods of Dewatering]

Methods of Dewatering

Ground water can be controlled by adopting one or more types of dewatering systems appropriate to the size and characteristics of the soil. The different types of methods involved in dewatering are:

- Open sumps and ditches
- Well point systems
- Deep well drainage
- Vacuum Dewatering Systems
- Electro Osmosis
- **Open Sumps And Ditches**

The essential feature of this method is a sump below the ground level of the excavation at one or more corners or sides.. a small ditch is cut around the bottom of the excavation , falling towards the sump. It is the most widely used and economical of all methods of ground water lowering. This method is also more appropriate in situations where boulders or other massive obstructions are met with the ground. There is also a disadvantage that the groundwater flows towards the excavation with a high head or a steep slope and hence there is a risk of collapse of the sides.

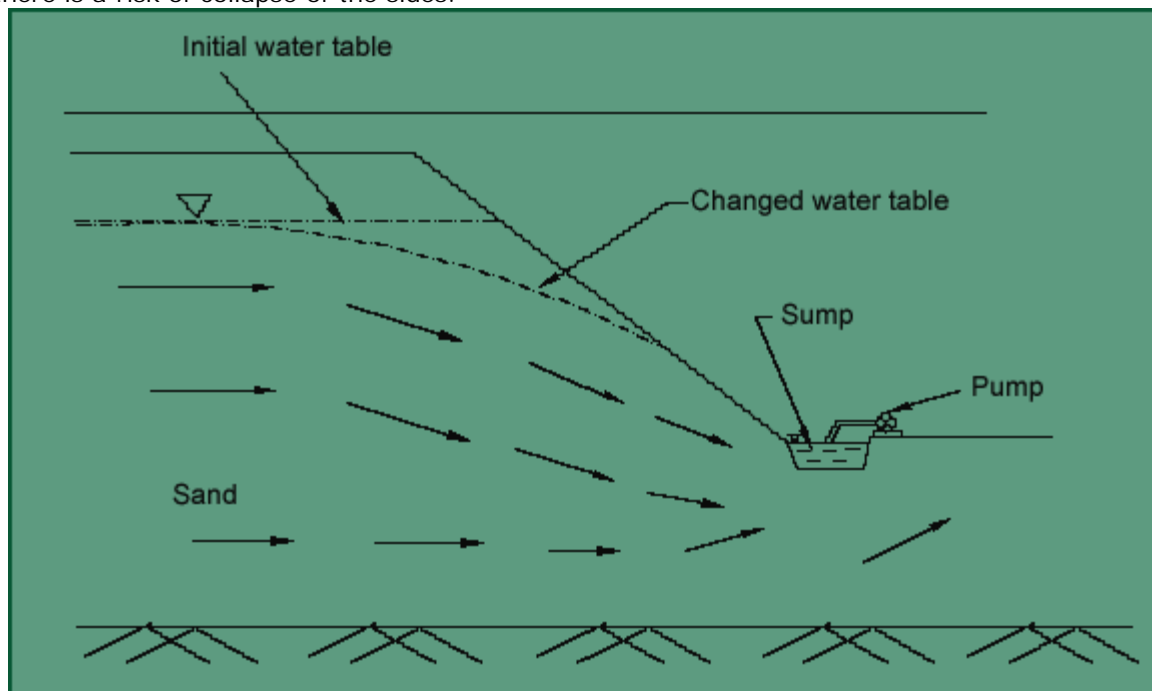


Fig 6.45 Dewatering Through Sumps

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Lecture 30 : Dewatering [Section 30.2 : Methods of Dewatering]

■ Well Point System

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 braces or stainless steel screens and are made with either closed ends or self jetting types.

spacing of the well points depends on the permeability of the soil and on the availability of the time to affect the drawdown. In fine to coarse sands a spacing of 0.75 to 1m is satisfactory. A spacing of 1.5 m may be necessary in silty sands of fairly low permeability. In highly permeable coarse gravels they may be as close as 0.3m.

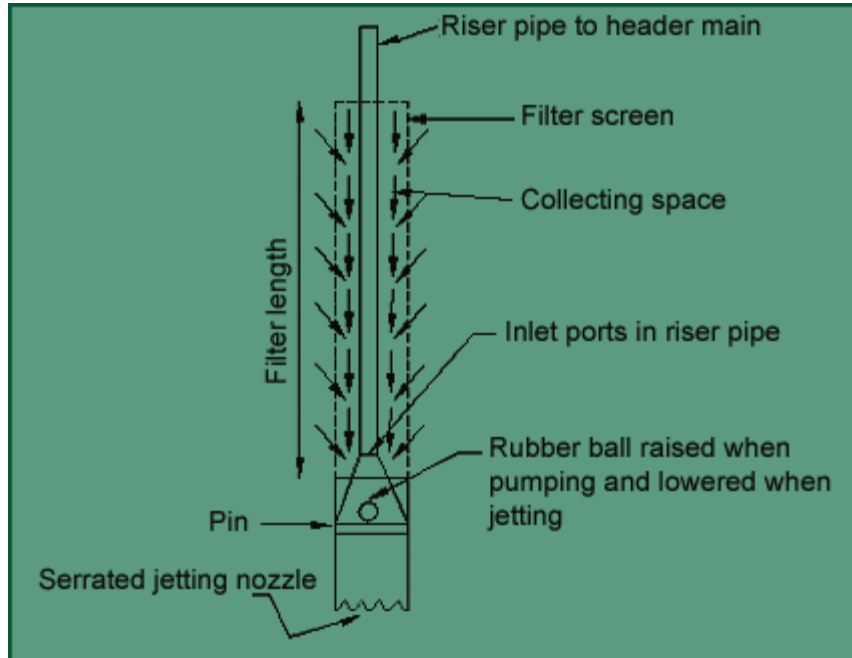


Fig. 6.47 Well Points in Braced Excavation

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Lecture 30 : Dewatering [Section 30.2 : Methods of Dewatering]

A serious limiting of 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, valves etc., resulting in loss of efficiency. If the ground is consistently mainly of large gravel, stiff clay or soil containing cobbles or boulders it is not possible to install all points. For dewatering deeper excavations, the well points must be installed in two or more stages as shown in figure 6.8.1c. There is no limit to the depth of draw down 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, figure 6.8.d, they are placed closed to the toes of the sheet piles. This is done in order to ensure lowering the water level between the sheet pile rows. Well points are provided in conjunction with the sheet piles under the following conditions.

- To prevent quick condition of the bottom when the sheet piles are of limited penetration.
- To eliminate hydrostatic pressure on the back of a sheet pile coffer dam, thus allowing higher bracing to be used.

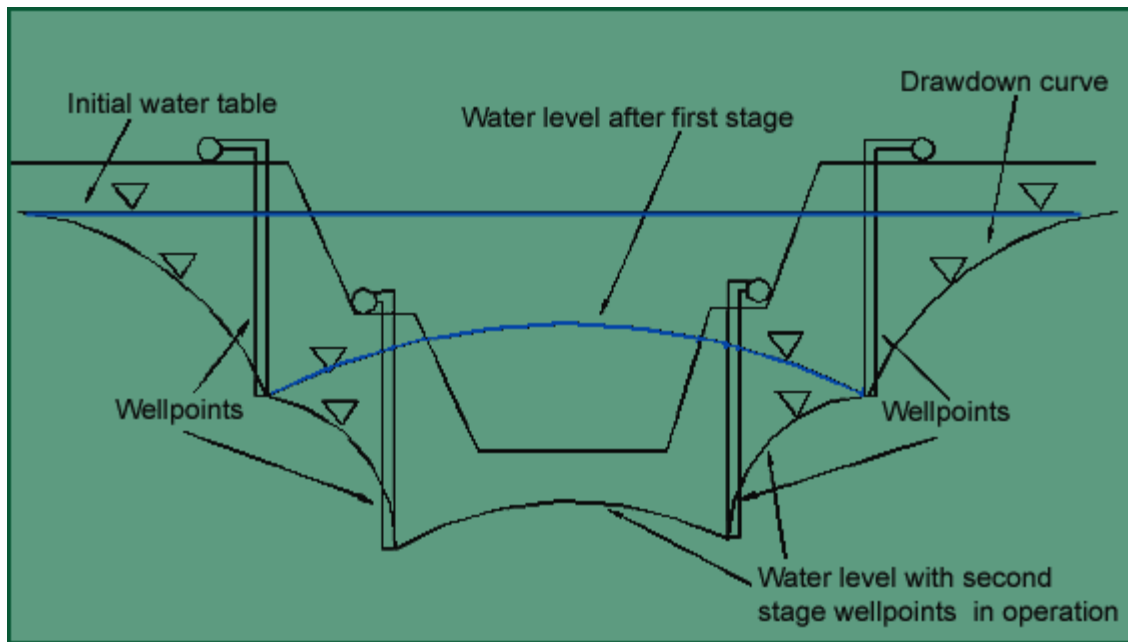


Fig 6.48 Multi Stage Well Point System

- **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 8-80 meters depending upon the level to which water table must be lowered, permeability of the sand stratum, source of seepage and amount of submergence available.

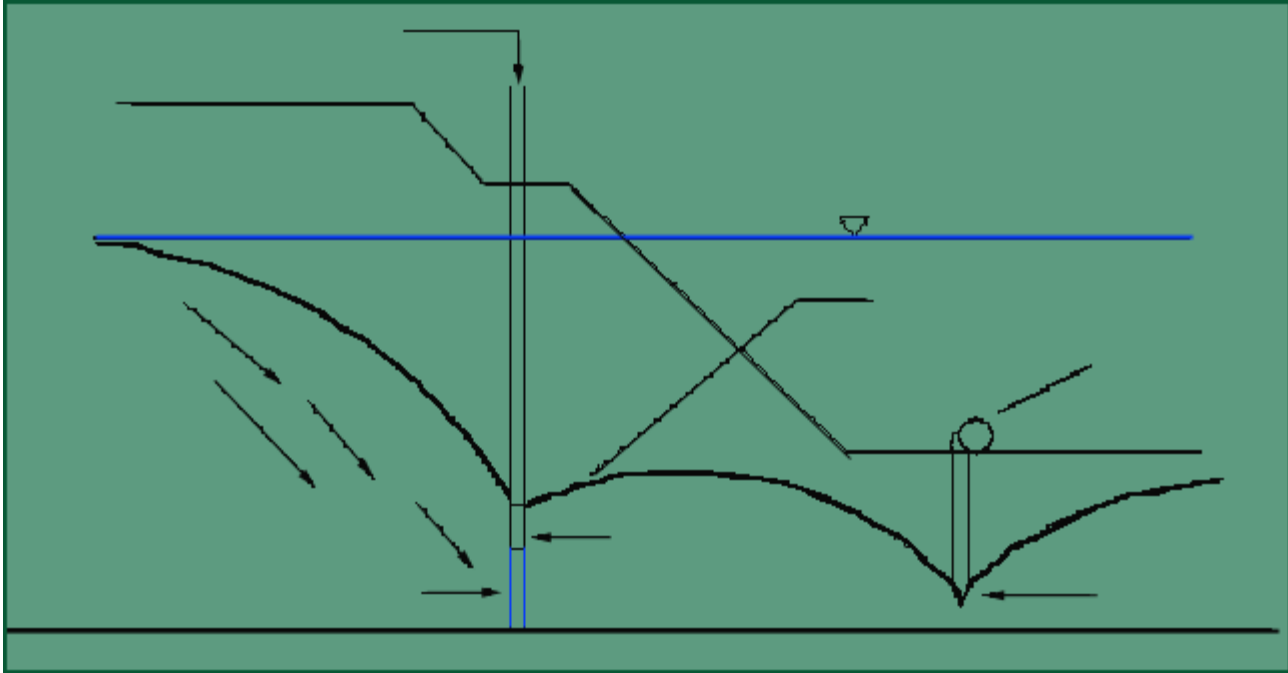


Fig. 6.49 Deep well dewatering

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. This 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 permeable strata at a considerable depth below the excavation level. Deep wells may be combined with the well point system on certain field conditions for lowering the ground water tables.

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Lecture 30 : Dewatering [Section 30.2 : Methods of Dewatering]

- **Vacuum 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 $0.1 - 10 \times 10^{-3}$ mm/s. Such soils can be dewatered satisfactorily by applying a vacuum to the piping system. A vacuum dewatering system requires that the well-point screens, and rise a 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 coefficient of permeability of the range $0.11 - 0 \times 10^{-4}$ cm/s.

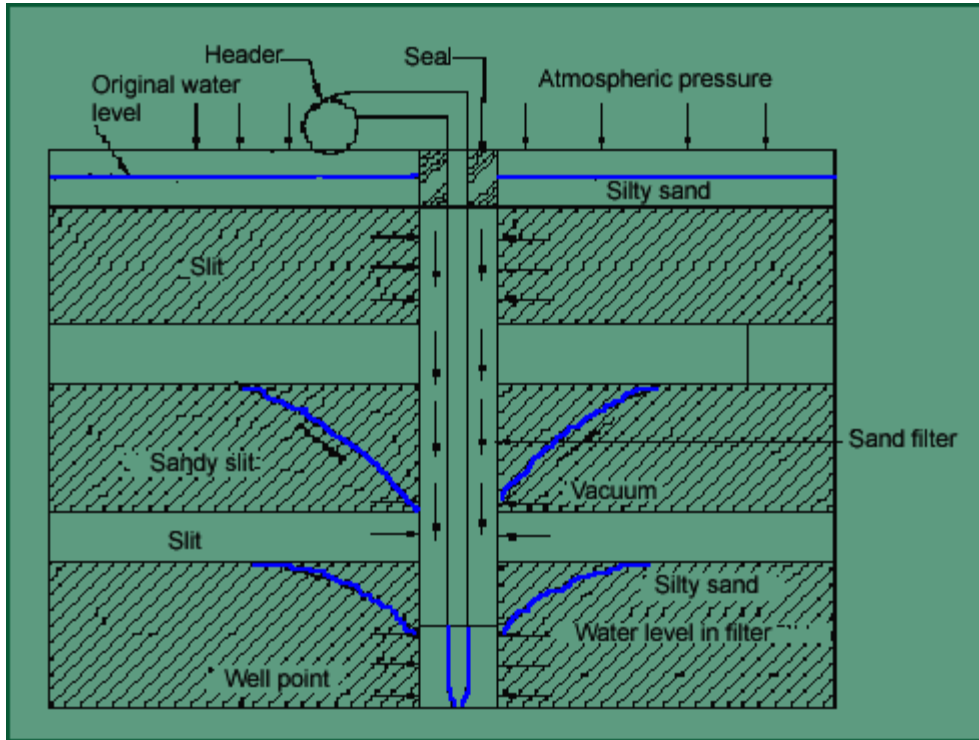


Figure 6.50 Vacuum Dewatering Systems

- **Dewatering by electro osmosis**

When an external electro motive force is applied across a solid liquid interface the movable diffuse double layer is displaced tangentially with respect to the fixed layer. This is electro osmosis. As the surface of fine grained soil particles causes negative charge, the positive ions in solution are attracted towards the soil particles and concentrate near the surfaces. Upon application of the electro motive force between two electrodes in a soil medium the positive ions adjacent to the soil particles and the water molecules attached to the ions are attracted to the cathode and are repelled by the anode. The free water in the interior of the void spaces is carried along to the cathode by viscous flow. By making the cathode a well, water can be collected in the well and then pumped out.

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Lecture 30 : Dewatering [Section 30.2 : Methods of Dewatering]

Recap

In this section you have learnt the following.

- Open sumps and ditches
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- Deep well drainage
- Vacuum Dewatering Systems
- Electro Osmosis

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Lecture 30 : Dewatering [Section 30.3 : Design steps for dewatering systems]

Objectives

In this section you will learn the following

- Subsoil investigation
- Source And Water Table Details
- Distance of well points from the source of seepage
- Effective Wall Radius r_u
- Discharge computations

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Lecture 30 : Dewatering [Section 30.3 : Design steps for dewatering systems]

Design steps for dewatering systems

Design of a dewatering system requires the determination of the number, size, spacing, and penetration of wells or well points and the rate at which water must be removed from the pervious strata to achieve the required groundwater lowering or pressure relief. The size and capacity of pumps and collectors also depend on the required discharge and drawdown.

The essential steps involved in the designing of the dewatering system are given below:

- **Subsoil investigation**

The characteristics of the soils adjacent and beneath the excavation should be investigated well. Grain size distribution and permeability are the two parameters to be determined. Indian Standard recommends a field pumping test for this case.

- **Source And Water Table Details**

Source of seepage and knowledge of the water table at a particular site are the most important factors to be considered while designing a dewatering system. The source of seepage depends on the geological features of the area, nearby streams or water bodies and amount of drawdown. A flow may be from an aquifer being drained the distance to which is known as the radius of influence. It can be estimated from the draw down curve established from a field pumping test.

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Lecture 30 : Dewatering [Section 30.3 : Design steps for dewatering systems]

- **Distance of well points from the source of seepage**

- If the radius of influence R is large compared to the radius of the well, only an approximate estimation of R may be sufficient since the discharge is not much sensitive to the value of R
- An accurate estimation of the distance L from the well to the river should be made for a particular dewatering system, since the discharge is inversely proportional to the value of L.

- **Effective Wall Radius r_w**

The effective wall radius is decided based on the installation of the wells with or without filter. If a well is installed without gravel or a sand filter the effective radius can be taken as one half the outer diameter of the well screen. If a filter is used, the well radius is taken as one half the outside diameter of the filter.

- **Discharge computations**

The discharge Q of the well is then calculated using the formula given below:

$$Q = \pi k \frac{H^2 - h^2}{2.3 \log_{10} \left(\frac{R}{r} \right)}$$

where Q is the discharge, k is the permeability, H is the depth of strata, h is the height of water in the well, r is the radius of well, R is the radius of influence.

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Lecture 30 : Dewatering [Section 30.3 : Design steps for dewatering systems]

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