Water Well Installation

Lecture 8

Overview

- Methods of drilling
- Installation and Development of wells
- Maintenance of wells
- Video of water well installation

Methods of Drilling of Tubewells

Deep tubewells are constructed by drilling. Methods for drilling deep tubewells are as follows:

1. Cable tool/ percussion/ standard method.
2. California stovepipe method
3. Jetting method
4. Direct rotary method
5. Reverse- circulation rotary method

Cable Tool Method

- This method is very useful for cutting consolidated rocks from soft clay to hardest rocks and is generally unsuitable in loosen formations such as unconsolidated sands and gravels or quick sands.
- Wells drilled by the cable tool method are constructed with a standard well-drilling rig, percussion tools and a bailer.
- Drilling is accomplished by regular lifting and dropping of a string of tools(falling and rising arrangements) into the borehole.

Fig- Cable tool method

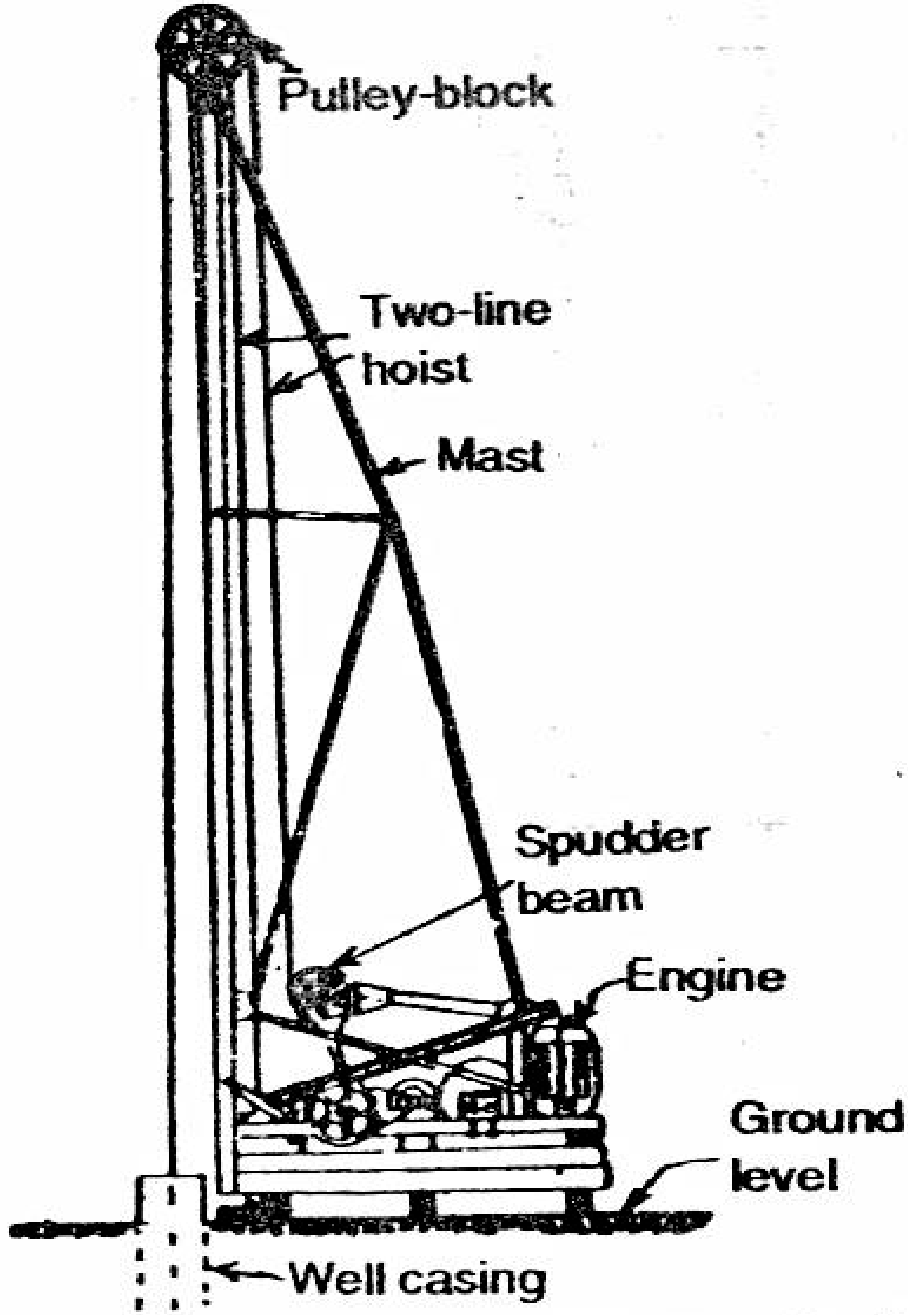

Fig. 4.33 (*a*) Basic components of Percussion Drilling Rig.

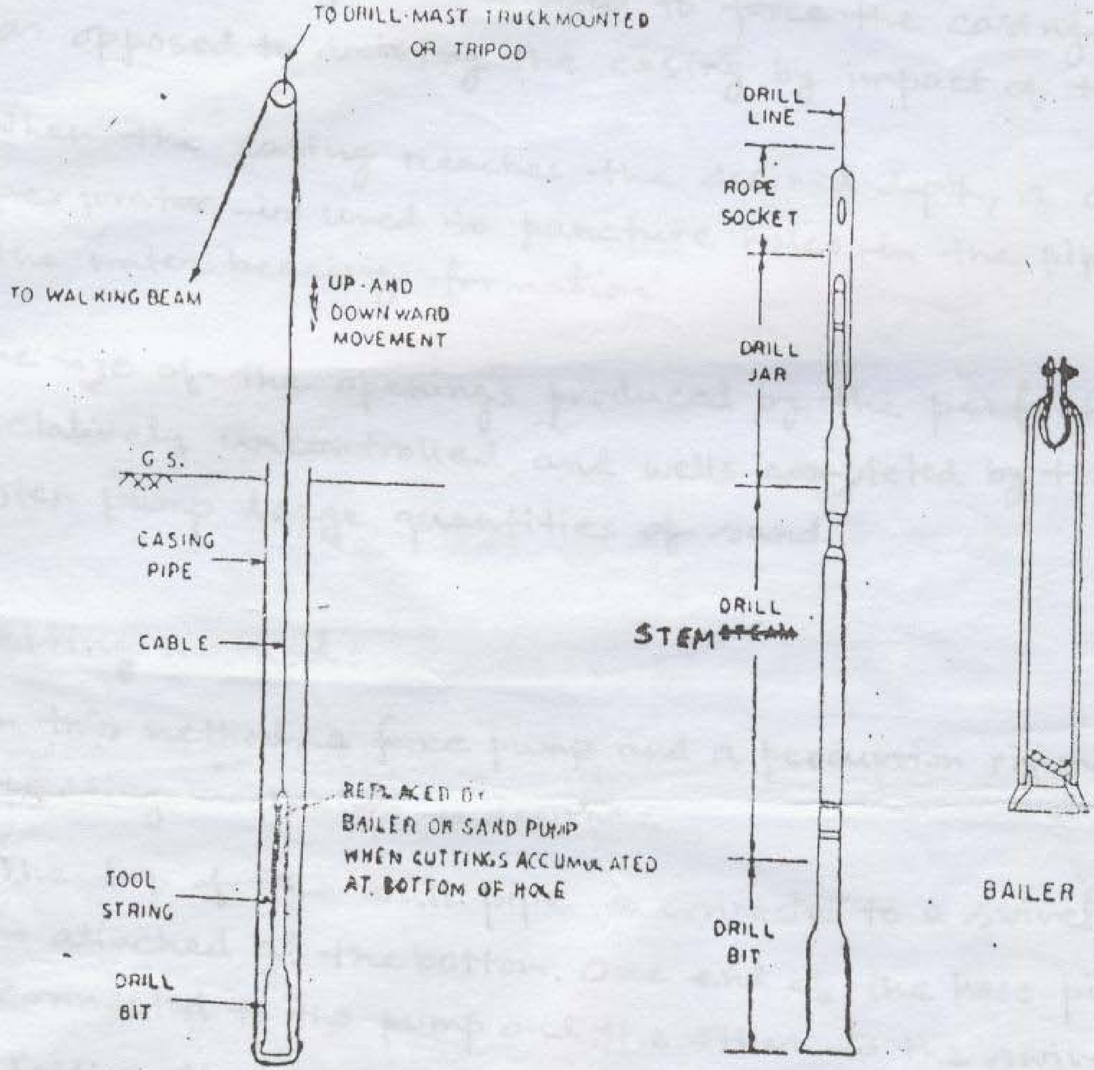

Fig. Cable tool method.

- The string of tools is suspended by a cable from a spudder beam (truck mounted).
- From top to bottom , the string of tools consists of a swivel socket, a set of jars, a drill stem and a drilling bit.
- The drill bit break the crushes consolidated rock into small fragments, whereas the bit primarily loosens the particles with water to form a slurry at the bottom of the borehole.
- In both instances, the reciprocating action of the tools mixes the crushed or loosened particles with water to form a slurry at the bottom of the borehole.

- If little or no water is present in the penetrated formation, water is added to form a slurry.
- The slurry is removed at intervals from the borehole by a sand pump or a bailer.
- In unconsolidated formations, the casing closely follows the drilling bit, adding length of casing as the hole is deepened , to prevent caving.
- The top of the casing is fitted with a drive head which serves as an anvil.
- Usually drilling is started with a large diameter and diameter is reduced telescopically after drilling certain depth when the frictional forces on the casing increases too much.

Jetting method:

- In this method , a force pump and a percussion rig machine with spudding mechanism is desirable.
- The top of the drill pipe is connected to a swivel and a bit is attached at the bottom . One end of the hose pipe is connected to the pump and the other to the swivel.
- Jetting fluid under pressure is pumped and is carried into the drill pipe and is forced down to the nozzle in the jetting bit against the bottom of the borehole.

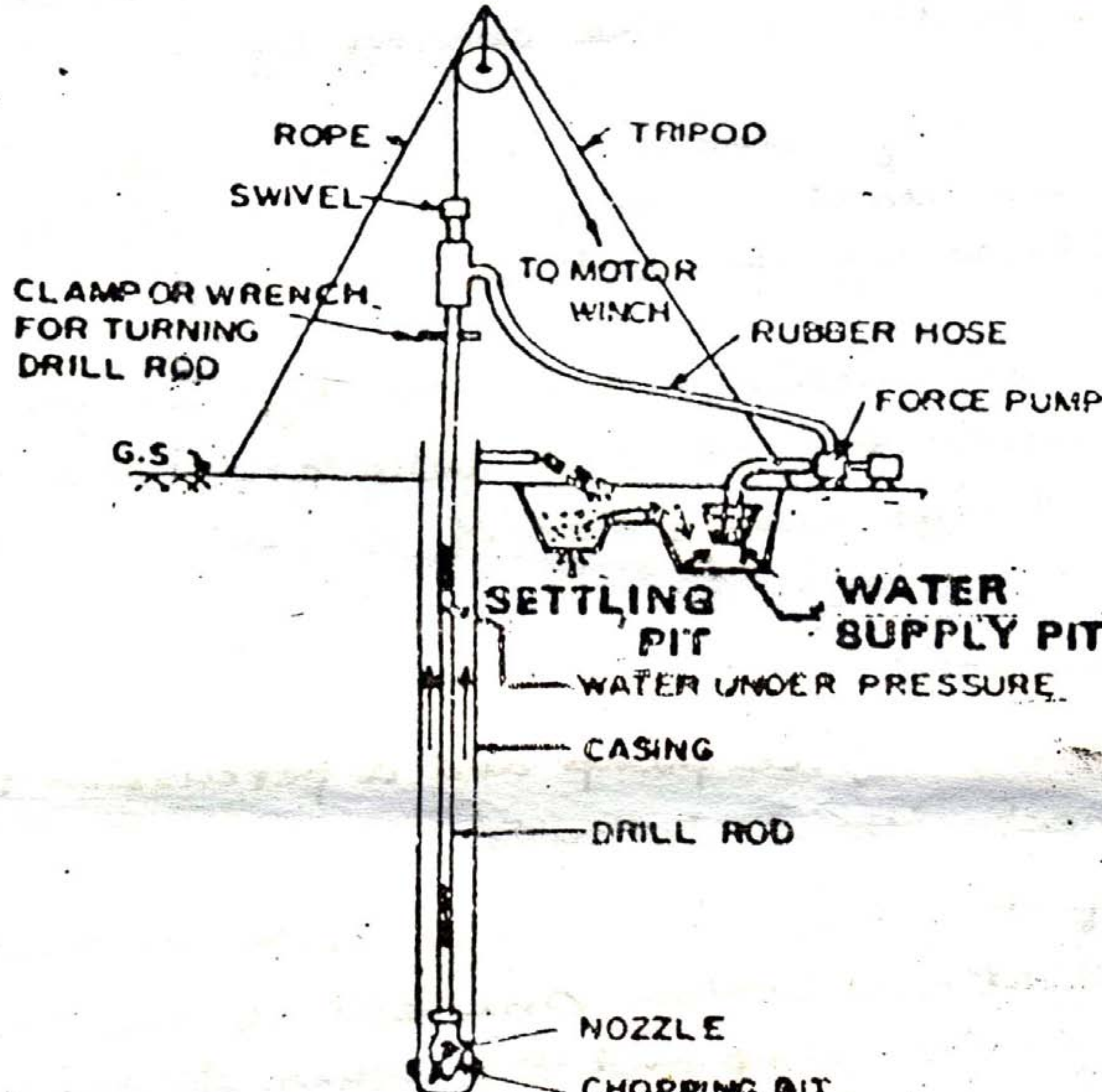

Fig. Jetting method.

- The jet steam of water loosens the soil, which in form of slurry, rise to the surface through the annular space between drill pipe and casing pipe and discharges into a settling tank. Clear water overflows into a second pit from where it is recircualated down the drill pipe.
- The casing pipe usually sinks by its own weight or extra weight added to it at the top.
- Slow rotation can also be imparted to the casing pipe to expedite its sinking.
- If a layer of hard material is encountered, the drill pipe is attached to the spudding mechanism on the rig and a special drill bit is attached at the bottom of the drill pipe.

Direct rotary method:

- In this method, the borehole is drilled by a bit attached to a hollow drill rod rotating rapidly by an engine driven rotary table.
- A drilling fluid is pumped down through the drill pipe and out through the port or jets in the bit , the fluid then flows upward in the annular space between the hole and the drill pipe, carrying the cuttings in suspension to the surface.

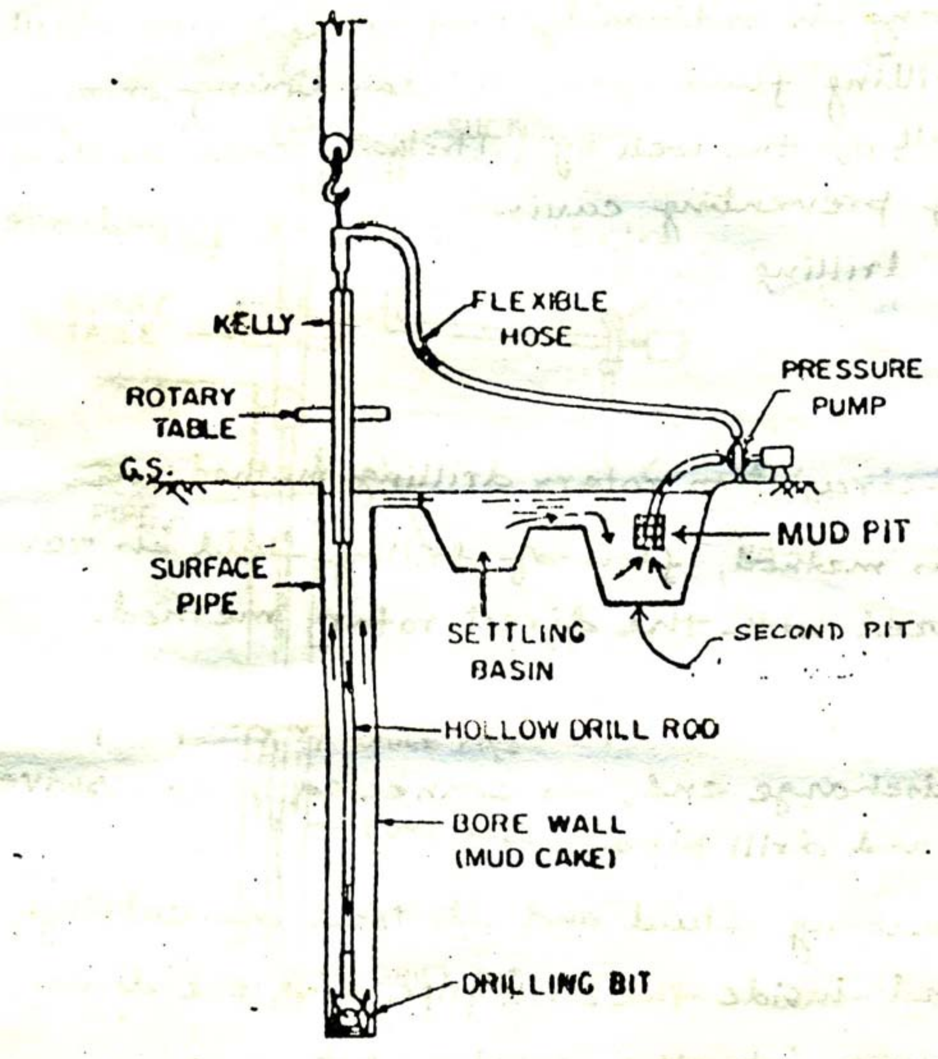

Fig. Direct rotary method.

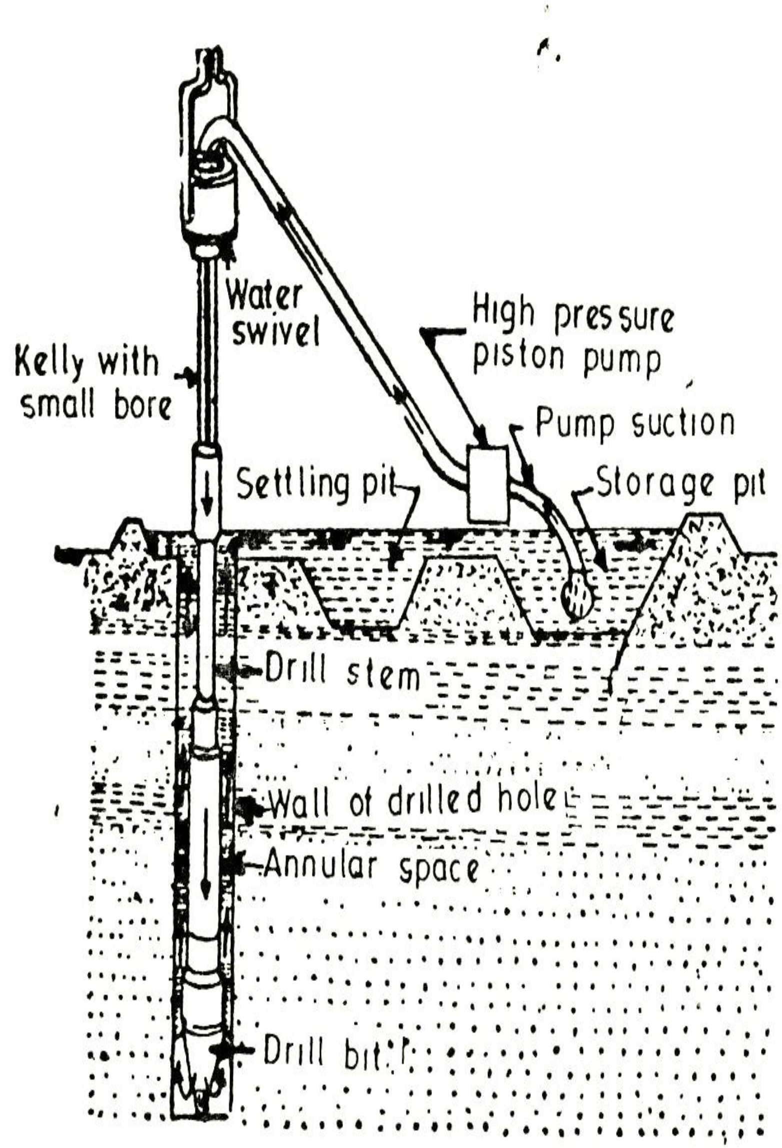

Fig. 4.34 (*a*) Schematic sketch illustrating the basic principles of Direct rotary drilling.

- At the surface , the fluid is channeled into a setting pit where most of the cuttings drop out.
- Clean fluid is then picked up by the pump from the second pit and is recirculated down the drill pipe.
- The properties of the drilling fluid are such as to provide adequate support for the wall of the hole and are usually viscous mixture of water and bentonite.
- No casing is ordinarily required during drilling because the drilling fluid forms a clay lining or mud cake or the wall of the well by filtration. This seals the walls thereby preventing cavity entry of groundwater and loss of drilling fluid.

Reverse –circulation rotary drilling method:

- In this method, flow of drilling fluid is reversed compared with the direct rotary method.

The suction end of the centrifugal pump , rather than the discharge end, is connected to the swivel to the kelly and drill pipe.

- The drilling fluid and its load of cuttings move upward inside the drill pipe and are discharged by the pump into the settling pit.
- The clean fluid returns to the borehole by gravity flow.

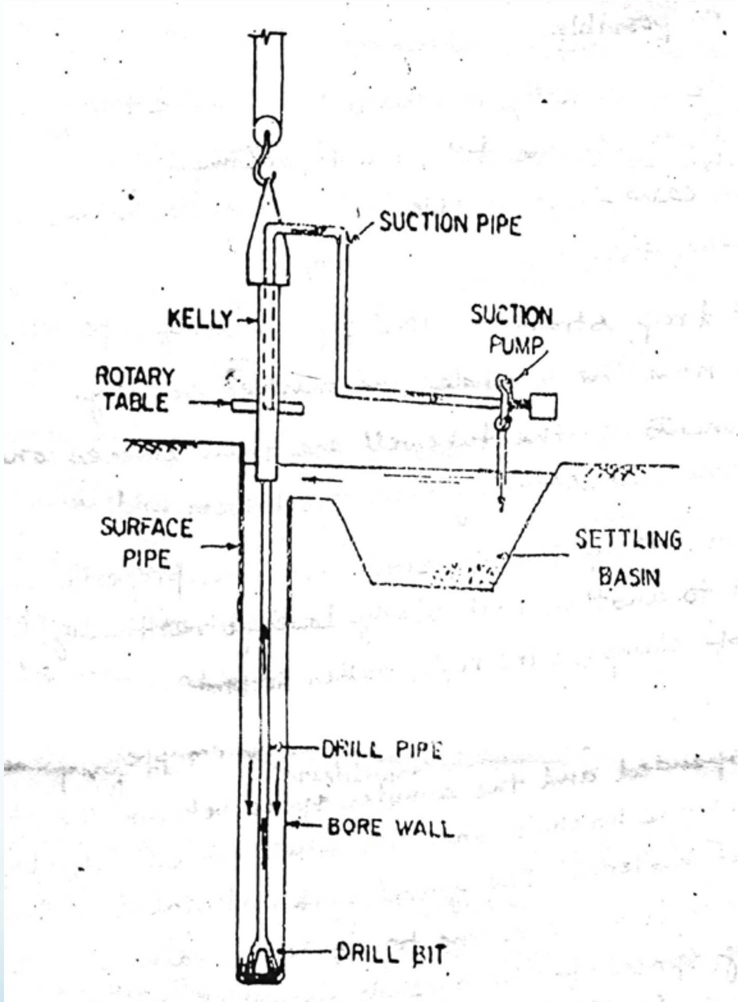

Fig. Reverse-circulation rotary drilling me

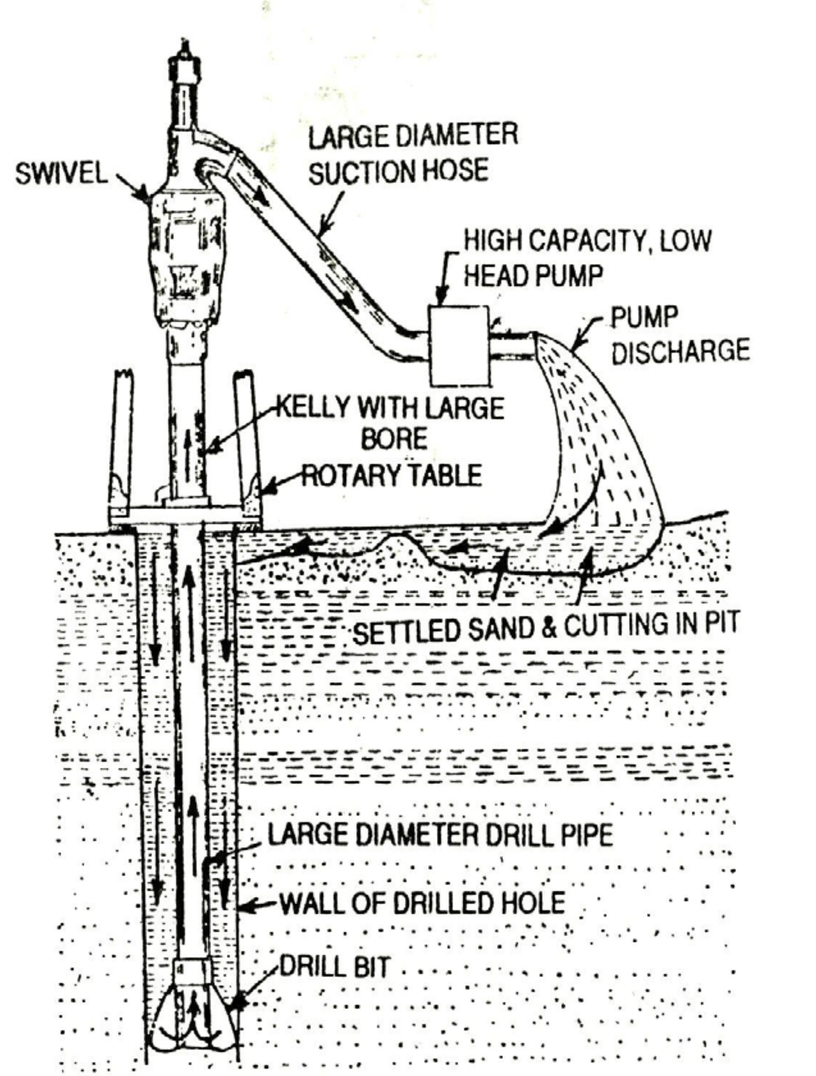

Fig. 4.35. Schematic sketch illustrating the basic principles of Reverse rotary drilling.

- Relating high velocity of the fluid in the drill pipe enables the cuttings to be carried to the surface without the deliberate use of clay or other additives to increase the viscosity.
- The boring is done without a casing and the hydrostatic pressure is used to support the walls of the borehole during construction.

Installation of tubewells:

- When a borehole is completed to the desired length, the tubewell assembly is to be lowered and fixed in position as soon as possible.
- The borehole is usually drilled a little more than the installed depth of the tubewell to accommodate the materials which may cave in or settle in the borehole before installation of the tubewell.
- The sand trap(is an extension of a blank pipe of about 4 to 6 ft long fixed at the bottom end of the filter. The purpose of the sand trap is to receive the incoming sand which settles ultimately in the trap and thus save the strainer from blocking) ,

strainers, blind pipe, housing pipe etc are assembled near the borehole and marked serially.

- The components of the tubewell is to be properly screwed or welded to another and slowly lowered vertically with the help of clamps, wire rope, pulley, tripod and crab winch.
- When the lowering of the tubewell is complete, it is kept suspended and the annular space between the strainer and wall of the borehole shall be filled immediately by gravel pack material . **The gravel pack material is filled to at least 10 to 15m above the top of the strainer. The remaining space of the borehole is filled with clayey materials and plain concrete to prevent percolation of contaminated water from the surface.**

- These materials grip the whole assembly of pipes on the outside and hold the tubewell in position.
- It is important that the entire tubewell is installed straight and vertically. Centralizers are placed at a certain distance apart for concentric installation of the tubewell, to permit uniform filling of gravel pack materials around the well and satisfactory operation of the pumping unit and without damage.

Well development:

The act of cleaning out the clay and silt introduced during the drilling process as well as the finer part of the aquifer directly around the well screen prior to putting the well into service is called "well development".

Effective well development:

- increases the rate of water movement from the aquifer into the well.
- stabilizes the aquifer to prevent sand pumping, thereby producing better quality water and increasing the service life of the pump cylinder and well.
- removes organic and inorganic material which may inhibit effective well disinfection.

Methods of well development are as follows:

1. Overpumping and backwashing.
2. Mechanical surging.
3. Surging with air.
4. Hydraulic jetting.
5. Dispersing agents.

1. Overpumping :

Overpumping means pumping the well at a higher rate than the designed yield to create excess drawdown to washout the fine particles.

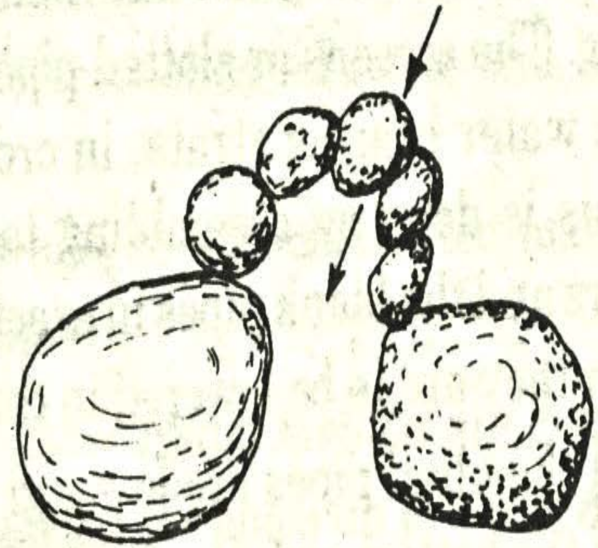

Fig. 4.36. Bridging action caused by one directional flow.

But since there is no reversals of flow , bridging of sand can occur.

Backwashing:

- This too is a relatively simple method of development which requires a water lifting device and a container in which water can be stored and then from which it will be allowed to flow easily back into the well. Backwashing provides a surging effect to well development. A deep-well turbine pump without a foot valve is required for this purpose. Water is pumped to the surface until the container is full; it is then rapidly dumped back into the well. Repeating this motion many times can provide some development of the surrounding water bearing formation.

- It is crucial that the water which is pumped to surface be allowed to sit until the suspended material has settled. The clear water should then be decanted into a second container and from there dumped back into the well. This will ensure that fine particulate is not inadvertently re-introduced into the well.

Mechanical surging:

In this method, a surge block attached to the bottom of a drill stem is moved up and down in the screen resulting in a surging action to the water. The down stroke causes backwash to break up any bridging which may occur, while the upstroke pull displayed sand grains into the well.

Surging with air:

- This process involves combination of surging and pumping . By means of sudden release of a large volume of air, a strong surge is produced. Pumping is done with an ordinary air lift pump.

Hydraulic jetting:

- A high velocity of water is directed horizontally through the screen openings with the tip of the nozzle from the inner wall of the screen. The jetting tool is slowly rotated and gradually raised or lowered so that the entire surface of the screen receives the jetting action.

- The well is pumped by another pump during the jetting operation to maintain the hydraulic gradient so that water and loosened particles will keep entering the well.

Dispersing agents:

- Sometimes it is necessary to add a chemical agent to disperse clay particles in the mud cake or in the formation to avoid their sticking to sand grains and to speed up the development process. **For this purpose, several polyphosphates are used. About 600g of the chemical is added to every 100litres of water in the well. The mixture is allowed to stand for about an hour before starting development.**

Well maintenance:

- While the expected life of a well depends upon the designing construction, development and operation of the well, proper maintenance helps to improve the performance and increases the life of the well.

- The sudden pressure drop and increase in the entrances velocity near the screen due to high pumping rate, releases carbon-di-oxide and cause precipitation of calcium carbonate and iron deposits near the screen. The presence of oxygen in the well can change soluble ferrous iron insoluble ferric hydroxide.

- The perforations can be cleaned by adding **hydrochloric acid** followed by agitation and surging which remove the incrusting deposits. Normally the volume of acid required for a single treated will be about 1.5 to 2.0 times the volume of water in the screen.
- The yield of the well may decrease due to the deposition of incrustation of fine particles of silt and clay near the screen. This can be removed by the use of a dispersing agent such as **polyphosphates**. For effective treatment , 15 to 30 kg of polyphosphates is added to every 1000liters

of water in the well. The solution of polyphosphates is poured into the well and a surge plunger is used to agitate the water. The well may be treated 2-3 times for better results.

- The perforations may become plugged with bacterial growths . **Chlorine** treatment of well has been found more effective than acid treatment in loosening bacterial growths and slime growth which often accompany the deposition of iron oxide . Calcium or sodium hypochlorite may be used and the chlorine solution in the well must be agitated by using a surging plunger.

- Depletion of groundwater supply can sometimes be remediated by decreasing pumping drafts and resetting the pumped into greater depth.