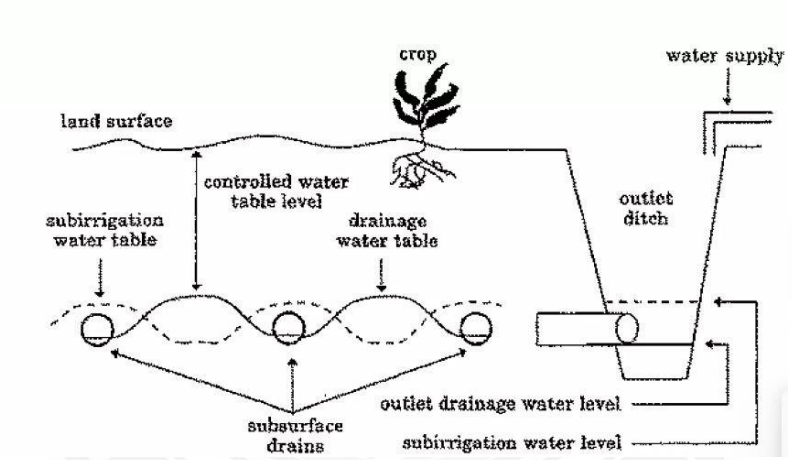
5.2 DESIGN OF SUBSURFACE DRAINAGESYSTEMS



5.2.1 ADVANTAGES

- Provides aeration to root zone
- Improves soil structure and maintains soil temperature
- Avails land for early cultivation
- Facilitates easy movement of farm machines

5.2.3. DESGIN CRITERIA

- Placed at suitable depth and grade below the ground surface
- Lowers the capillary surface and water table
- Aerates the root zone

- Removes undesirable salts from root zone
- Decreases chances of flood hazards
- Occupies no surface land
- Small capacity drains are required
- Less maintenance cost compared to surface drains

- Tile drains
- Mole drains
- Drainage wells
- Deep open drains
- Combination of tile and mole drains

5.2.4 DISADVANTAGES

5.2.5. SUBSURFACE DRAINAGE METHODS

- Require high initial cost
- Requires steeper gradient
- Repair works are costly and inconvenient
- Only seepage water is removed
- Construction is difficult

Investigations for subsurface drainage

- Topographic map of the area
- Data of soil physiochemical properties
- Position of ground water table and its fluctuation
- Quality of groundwater
- Logs of soil and subsurface material
- Crops to be grown and their drainage requirements
- Irrigation practices and their requirements

5.2.6 GROUNDWATER STUDIES FOR PLANNING

- 3 parameters:
  - Depth and fluctuation of groundwater table
  - Quality of groundwater
  - Hydraulic conductivity of the subsoil material

5.2.7. DESIGN OF TILE DRAINAGE SYSTEM

1. Layout of the system
2. Depth and spacing of the drain
3. Size and grade of the tile lines
4. Material of tiles
5. Envelope materials and accessory structures
6. Installation of tile drains

1. Layout of tile drainage system

- Drainage system comprises of laterals, main drains and an outlet

Laterals
↓
Main drains
↓
Outlet

2. Depth and spacing of tile drains

- Depth and spacing are closely inter related
- Depends on:
  - Texture of soil
  - Hydraulic conductivity
  - Types of crops grown
  - Extend of surface drainage
  - Outlet conditions
  - Topography of land
  - Salt content of soil
  - Agronomic practices

- Drain depth: From ground surface to the bottom of the tile, usually 1-1.5m
- Tiles are placed above impermeable layer, if any

- Deeper the drain, wider the spacing, lesser the number of drains required
- Drain spacing–

'Hooghouts drain spacing formula'

$$S^2 = 4K/R\,[H^2-2hd+2Hd-h^2]$$

where,

d– Depth to the impermeable layer from the drain bottom

h– Height of water in the drain

H–Height of water in midway between 2 drains

S– Drain spacing

D–Distance from the impermeable layer to the maximum height of water between the drains

K– Hydraulic conductivity

3. Size and grade of the tile drains

- Drains are designed based on

  Manning's formula

- Drains are laid on longitudinal slope:

  0.05-3%

- Working grade: 0.2%
- Size of tiles pipes: 30-90cm long,

  10-15cm diameter

- Diameter of tile drains,

$$d = 5.3(D_c)^{0.375} A^{0.375} S^{-0.1875}$$

where,

d– Internal diameter of tile drain, cm

D_c – Drainage coefficient, cm/day

A–Drainage area, ha

S– Hydraulic gradient or tile grade, m/m

4. Material of tiles

- Clay, Concrete, PVC/Plastic pipes, Bituminous fibre or steel
- Pipe material should be:
  - Resistant to weathering and freezing
  - Have high density
  - Have sufficient strength to withstand static and dynamic loads
  - Have uniformity in shape and wall thickness

5. Envelope materials and accessory structures

a) **Envelope materials:**

- Materials that cover the drains placed in less pervious strata
- Gravel, coarse sand etc.

- Prevents inflow of soil into the drains
- Increases effective drain diameter

- Coarsest material is placed immediately over the tile
- Minimum thickness of envelope: 7.5cm

- Recommendations for gravel envelope (USBR):
  - For uniform soils,

    D_{50} of envelope/D_{50} of soil = 5 to 10
  - For graded soils,

    D_{50} of envelope/ D_{50} of soil = 12 to 58

b) Manholes and sedimentation basins:

- Vertical structures
- Installed at regular intervals along the tile lines
- Constructed by concrete or brick masonry
- Helps in cleaning and inspection

- A man can enter and work within it
- Placed about 60 cm below ground surface
- Covered by concrete block

c) Inlet to tile drains:

- Allows water into the drain
- Two types:
  - Blind inlet– cheaper but chances of clogging
  - Surface inlet– have provisions to prevent the trash

entering into the drains but costly

Fig: Blind inlet

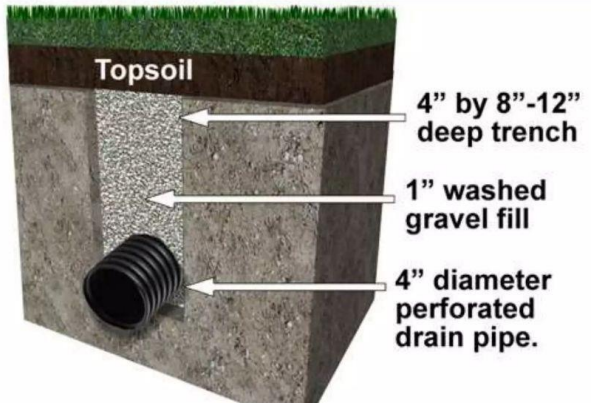
Fig: Surface inlet

d) Outlet for drains:

- Water from tile drains are discharged into big size surface drains
- Either by gravity or pumping
  - Gravity outlet– invert level of tile drain is higher than fully supply level of surface drain
- Pump outlet– bed level of the outlet is higher tan the discharging tile drain

e) Installation of tile drains:

- Consists of:
  - Excavation of a trench
  - Laying the tile at predetermined grade, depth and spacing
  - Putting the envelope material and backfilling the soil
- Installation of tile should start from out let



MULTIPLE WELL SYSTEM

- Multiple wells are installed in a common area of influence
- Cone of depressions overlap each other
- Results in increased drawdown in each well
- Provides more drainage effect

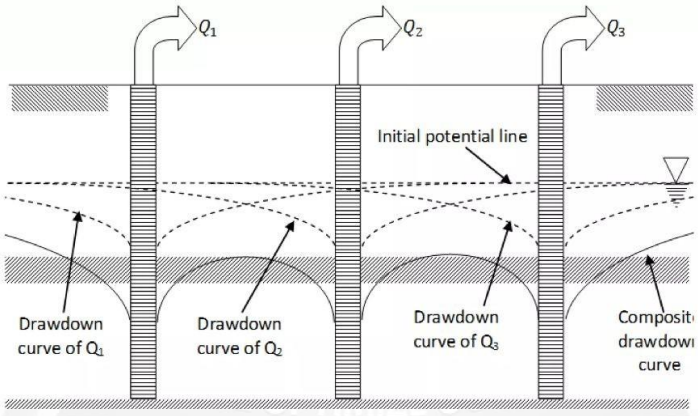


Fig: Multiple well system

- Wells are arranged in various patterns
- Isolated groups or continuous pattern
- Suction lines of each well is connected to a common pump

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