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# Drainage Engineering (BTAI3103)

## Module 3

### Surface and Subsurface Drainage Systems (Lecture-06: Design of Surface Drainage Systems)

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# Land forming for surface drainage

Operation carried out to change the micro-topography of land for orderly movement of water.

- ✓ **Land Smoothing** → To eliminate minor humps and depressions to ensure continual flow from all points to field drains
- ✓ **Land Grading** → Operation of forming the landscape by cutting, filling and smoothing to a design grade.



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## Land smoothing

- ✓ Generally required once in a year after completion of all tillage operation for **seedbed preparation**.

## Land grading

- ✓ The grade should be minimum of 0.05%, preferably 0.1% to a maximum of 0.5%.
- ✓ The grade and length of the sloping field depends on the type of soil.
- ✓ It involves considerable cost. **(a topographical survey is required to fix a minimum earthwork and designed grade)**



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## Different types of surface drainage system

1. Random drain system
2. Bedding system
3. Parallel field drain system
4. Parallel open ditch system
5. Cross slope/interception ditch system
6. Pipe outlet
7. Surface inlet



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## Random drain system

- ✓ Random field drains are best suited to the drainage of scattered depressions or potholes where the depth of cut is not more than 1 m.
- ✓ The ditches constructed for drainage should have the sufficient capacity to remove the water rapidly and completely.
- ✓ Where farming operations cross the channel, the side slope should be flat, i.e., 8:1 or greater for depths of 0.3m or less and 10:1 or greater for depths over 0.6 m.
- ✓ Minimum side slope of 4:1 is desired if the field is farmed parallel to the ditch.



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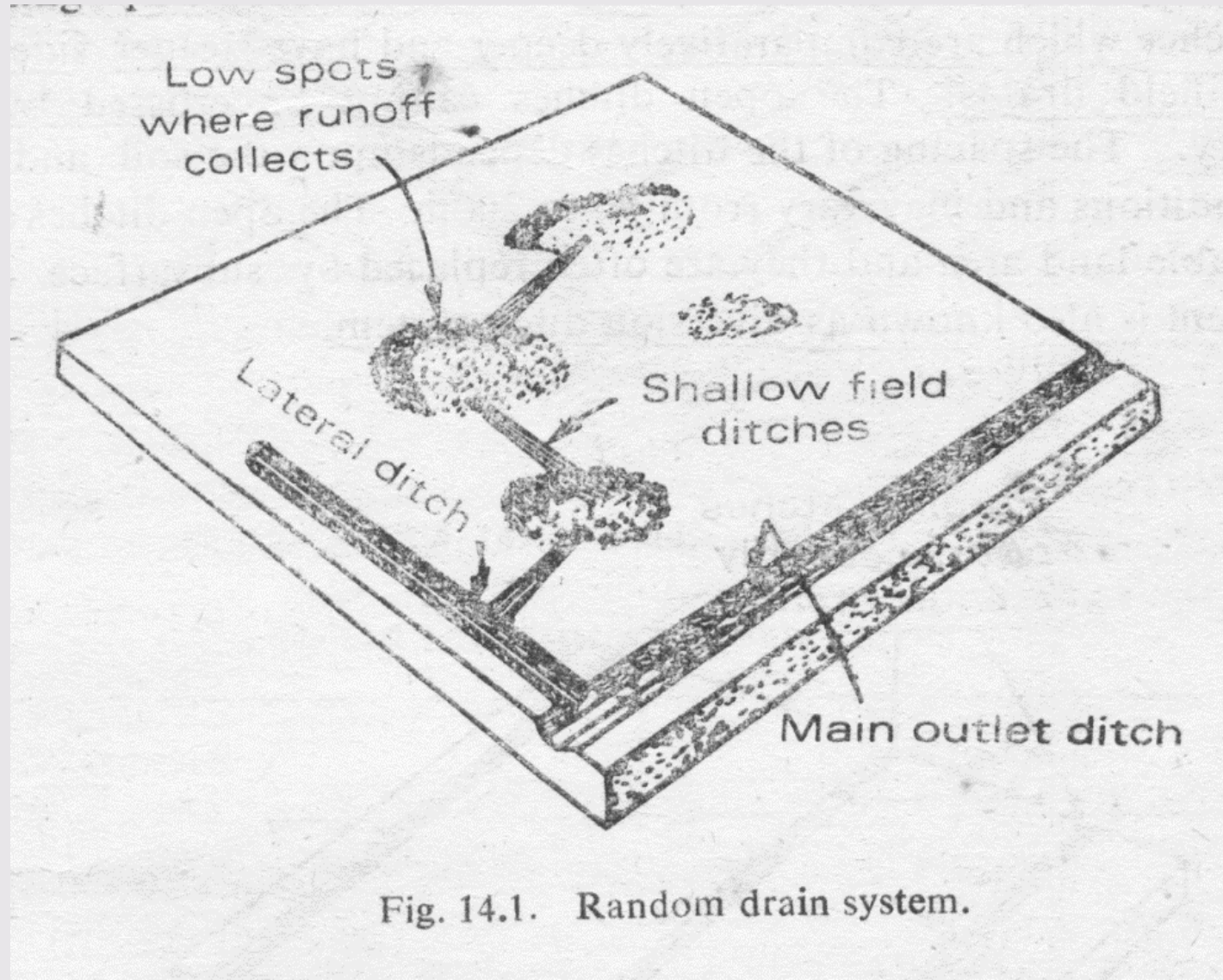


Fig. 14.1. Random drain system.



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# Bedding system

- ✓ The area between two adjacent dead furrows is known as a bed.
- ✓ Bedding is most practicable on flat slopes less than 1.5%, where the soils are slowly permeable and pipe drainage is not economical.
- ✓ The design and layout of a bedding system involves the proper spacing of dead furrows, depth of bed, and grade in the channel.
- ✓ The depth and width of the bed depend on land slope, drainage characteristics of the soil, and cropping system.



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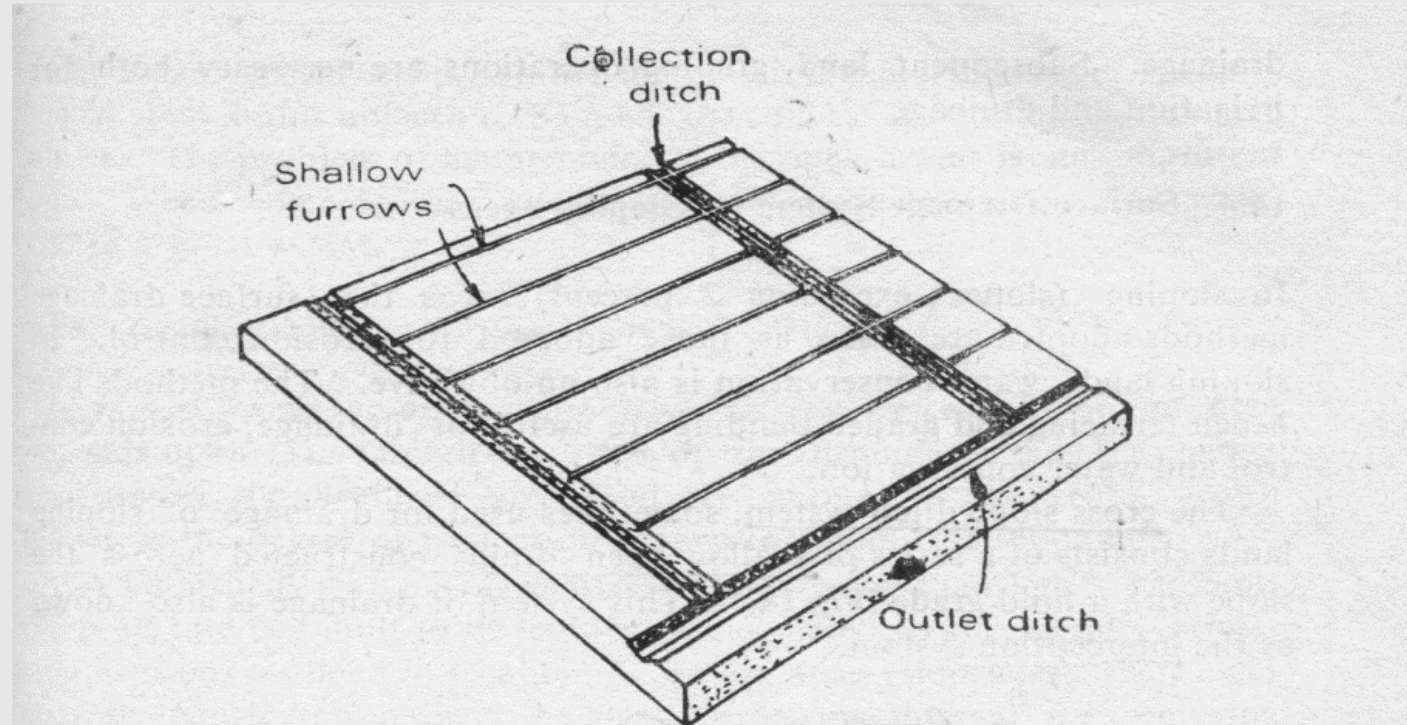


Fig. 14.4. Bedding system.

Table 14.1 RECOMMENDED BED WIDTHS

<i>Permeability</i>	<i>Bed width</i>
Very low ( $K=0.5$ cm/day)	8-12 m
Low ( $K=5$ to 10 cm/day)	15-17 m
Good ( $K=10$ to 20 cm/day)	20-30 m





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## Parallel field drain system

- Parallel field drains are similar to bedding except that the channels are spaced farther apart (100-30 m) and may have a greater capacity than the dead furrows.
- ✓ Adapted to flat, poorly drained soils with numerous small depressions that must be filled by land grading.
  - ✓ The design and layout are similar to those for bedding except that drains need not be equally spaced and the water may move in only one direction.
  - ✓ It is most effective method of surface draining and well suited both for irrigated and rainfed areas



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✓ The depth of the ditch should be a minimum of 0.2 m and have a minimum cross-sectional area of 0.5 m<sup>2</sup>. For trapezoidal cross sections, the bottom width should be 2.4 m (ASAE, 1986). The side slopes should be 8:1 or flatter to facilitate crossing with farm machinery.

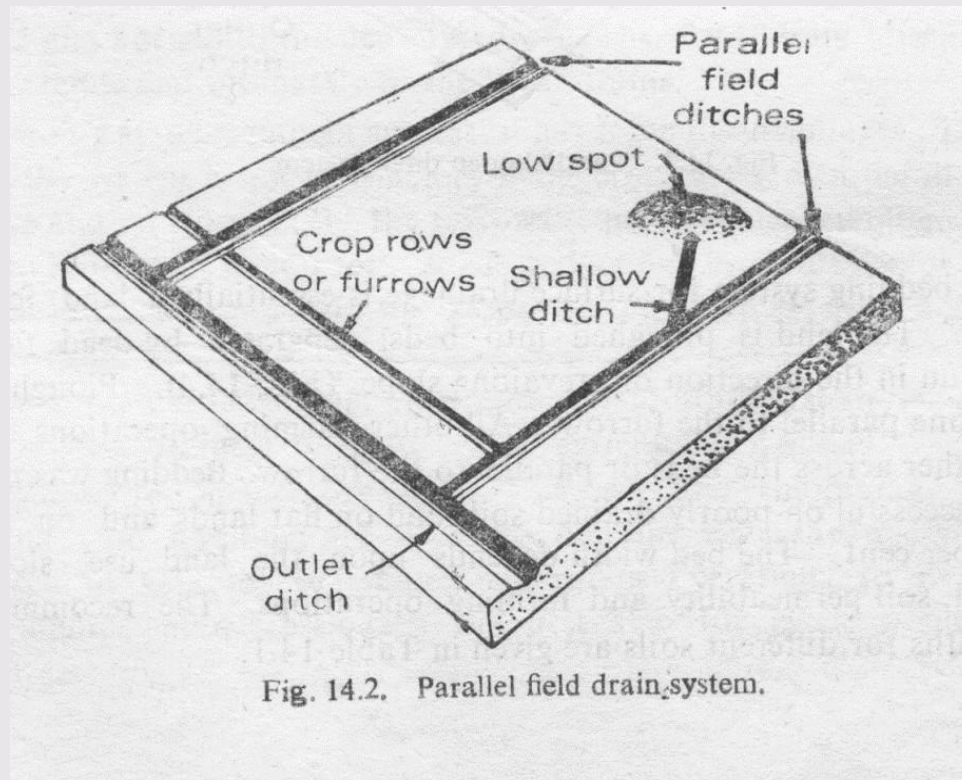


Fig. 14.2. Parallel field drain system.



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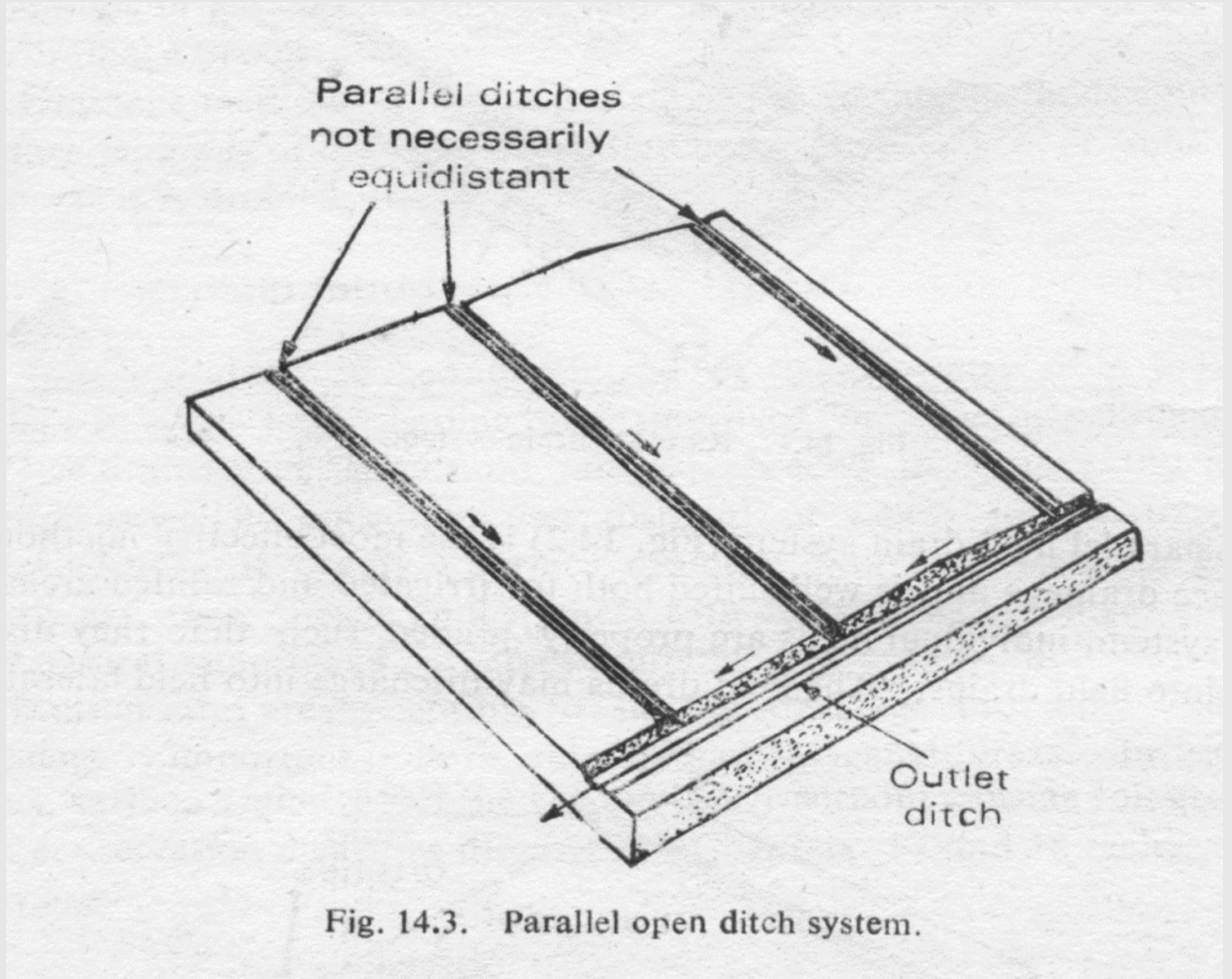
## Parallel open ditch system

- ✓ The parallel lateral ditch system is similar to the field drain system except that the ditches are deeper.
- ✓ This system works in the soil where both surface and subsurface drainage are required.
- ✓ The minimum size for open ditches is 0.3 m deep and side slopes are steeper than 6:1.
- ✓ The system is suitable for controlling the water table and permits sub irrigation if the soil is deep and permeable.
- ✓ Deep permeable soils underlain with an impervious material provide the best conditions for successful water table control.



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## Cross slope/interception ditch system

- ✓ The ditches are made across the slope resembles terracing that's why sometimes it is referred as drainage type terrace.
- ✓ The system is suitable to soils with poor internal drainage, numerous depressions to collect rainwater and land slope is too great for bedding and subsurface drainage is not feasible.
- ✓ The side slope of the ditch is usually not less than 10:1.
- ✓ The ditches should be constructed as straight as possible to avoid the difficulties in farming.



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## Pipe outlet

- ✓ Sometime the pipe may be used to divert the ponded water to the disposal channel.

## Surface inlet

- ✓ The surface inlet is a device or structure which carry the pit water to the subsurface drain.
- ✓ At the inlet of the pipe mesh grate is provided to check the entry of the debris inside the drains.



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