泰國坡地災害管理訓練

Thai-Tai Workshop on landslides and surface erosion prevention

山坡地之農地水土保持作業

Soil and water conservation on hillside farmland



Director

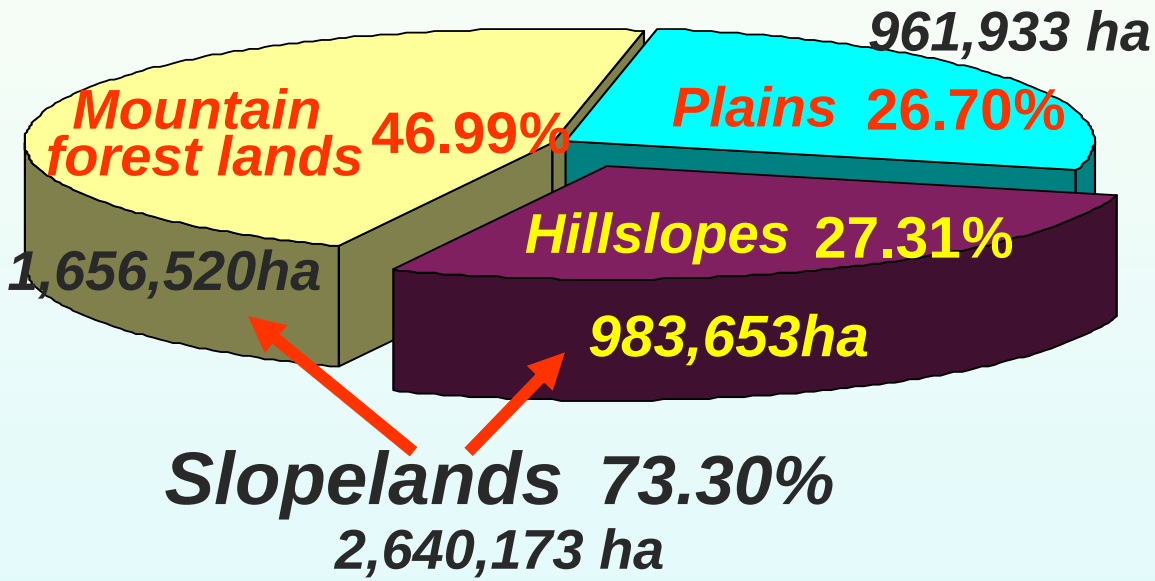
Chen-Chuan Huang Ph.D.

Tainan Branch, Soil & Water Conservation Bureau

Council of Agriculture, Executive Yuan, R.O.C

July 3, 2012

Land Resources Distribution in Taiwan



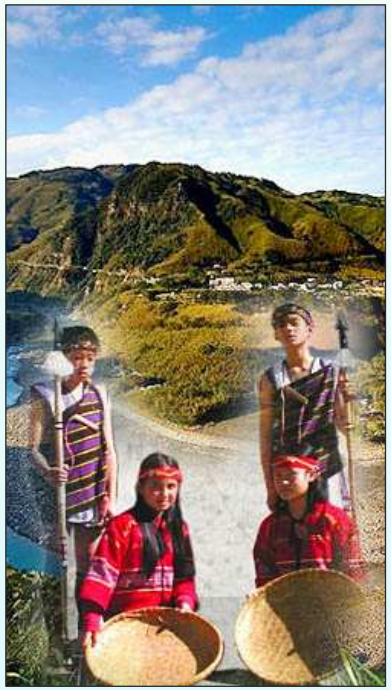
台灣山坡地面積73.3%

New Thoughts of Slopeland Conservation

坡地保育新思維

水 土 林 動 人

Water, Land, Forest, Wildlife & Human

水資源保育	土砂控制	植生復育	生態保育	心懷人文
				
Water Conservation	***Erosion Control***	***Revegetation***	***Wildlife Conservation***	***Human Concern***

水土保持手冊

Guidebook of soil and water conservation

1. 總論篇（新增）：水土保持之意義與目的、內容、方法、台灣水土保持工作範圍
2. 坡地保育篇（原農地篇）：通論、 農地水土保持、蝕溝控制、安全排水、坡地用水與灌溉、農路系統、附錄
3. 工程方法篇（原工程篇）：通論、處理單元、附錄
4. 植生方法篇（原植生篇）：通論、處理單元、附錄
5. 生態工法篇（新增）：通論、處理單元
6. 53年起歷經8次修正

坡地保育篇

Chapter 2. Slopeland Conservation

1. **通論**：坡地保育土壤沖蝕、土壤流失量之估算、坡地水土保持方法及配置、林地水土保持、分段截流、覆蓋與敷蓋、蝕溝處理、農路系統、坡地用水與灌溉、坡地農場水土保持規劃
2. **農地水土保持**：等高耕作、山邊溝、山邊溝植草、平台階段、寬壟階段、台壁植草、石牆法、草帶法、覆蓋、敷蓋、綠肥、坡地防風、農地沉砂池
3. **蝕溝控制**：
4. **安全排水**：截水溝、草溝、排水溝、路面排水、小型涵管、L型側溝、過水溝面、跌水
5. **坡地用水與灌溉**：水源設施、抽水設施、輸配水管線、農塘蓄水設施
6. **農路系統**：農路、聯絡道、園內道、作業道、步道
7. **附錄**：土壤流失量之推估、山坡地可利用限度分類標準

坡地保育篇

一、通 論 (Concepts and Principles)

1.1 坡地水土保持方法

Way of slopeland Conservation

1. 分段截流：

分段截流之採用，主要在坡面上分段以接近平行方式，開鑿山邊溝或截水(截洩溝)，以小幅度降坡排除逕流，截斷坡面逕流，可防止坡面因逕流累積所造成之沖蝕力。

2. 覆蓋與敷蓋：

- 可遮蔽地表，避免雨滴直接打擊土壤，防止土 壤沖蝕
- 枯枝落葉增進土壤有機質，增加土地生產力
- 固結土壤，增加土壤滲透功能，保護地表減免表土流失

3. 蝕溝處理：

- 穩定蝕溝，防止沖蝕再擴大。
- 調整溝床降坡，攔阻泥砂，減免下游災害及公共設施維護費。
- 恢復沖蝕荒廢土地之生產力。
- 營造植物生長環境

1.4　坡地水土保持方法及配置

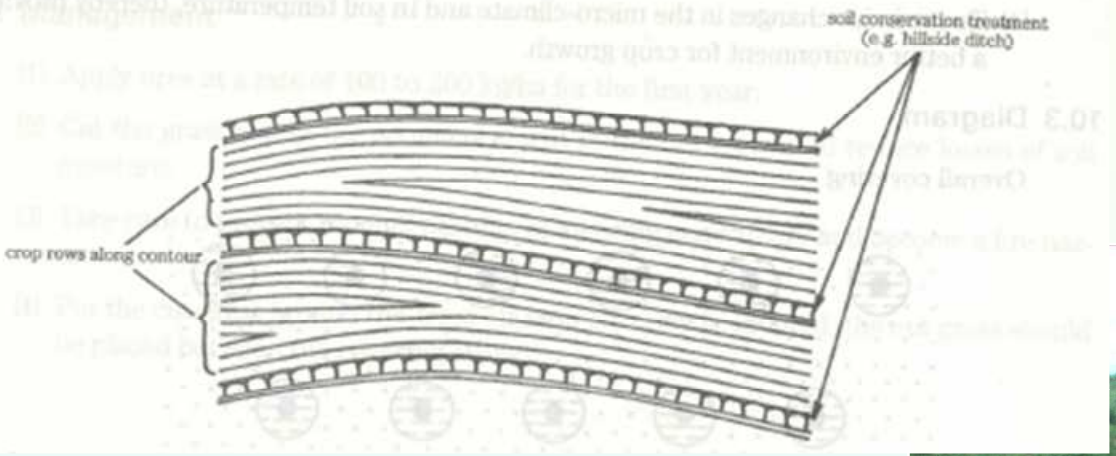
1.4.2 水土保持方法選用原則

1. 土地利用要在合理原則下，妥善規劃開發區域內之各種設施。
2. 避免雨滴直接打擊地表，發生飛濺沖蝕現象。
3. 增加土壤抗蝕力。
4. 促使達地表之雨水滲入土中，減少地面逕流。
5. 增加地面粗糙率，降低地面逕流水之流速。
6. 地面逕流須妥善導入安全排水系統。
7. 對易發生沖蝕、崩壞之地點，應予加添適當保護措施，先擇各種安全排水處理。

二、農地水土保持
(Soil and Water Conservation Measures for Farmland)

2.1 等高耕作*(Contour Farming)*
2.2 山邊溝 *(Hillside Ditch)*
2.3 山邊溝植草 *(Grass planting on Hillside Ditches)*
2.4 平台階段 *(Bench Terraces)*
2.5 寬壠階段 *(Broad Based Terrace)*
2.6 台壁植草 *(Planting Grass on Rise)*
2.7 石牆法 *(Stone Walls)*
2.8 草帶法 *(Grass Barriers)*
2.9 覆蓋 *(Cover)*
2.10 敷蓋 *(Mulching)*
2.11 綠肥 *Green Manure*
2.12 坡地防風 *(Windbreak for Slopeland)*
2.13 農地沉砂池 *(Sedimentation Pond for Farmland)*

2.1 Contour Farming



2.2 **Hillside ditch** 山邊溝間距 VI＝0.1(S%+6)

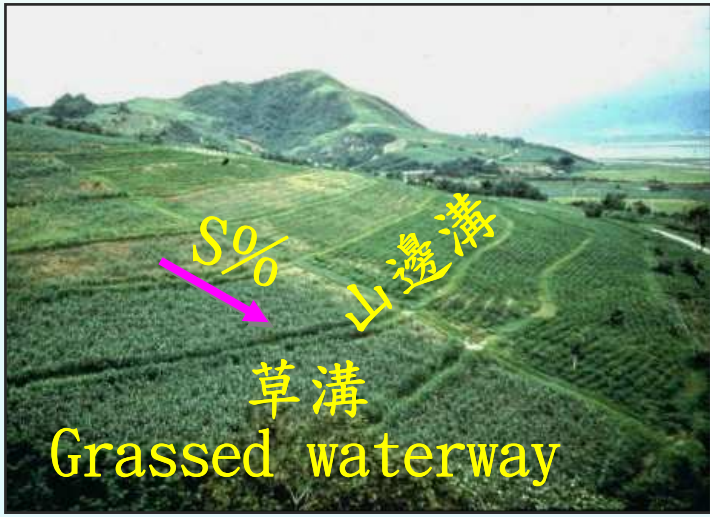
- **Definition**

  A series of shallow ditches built along the contour lines of a hillside slope at proper intervals.

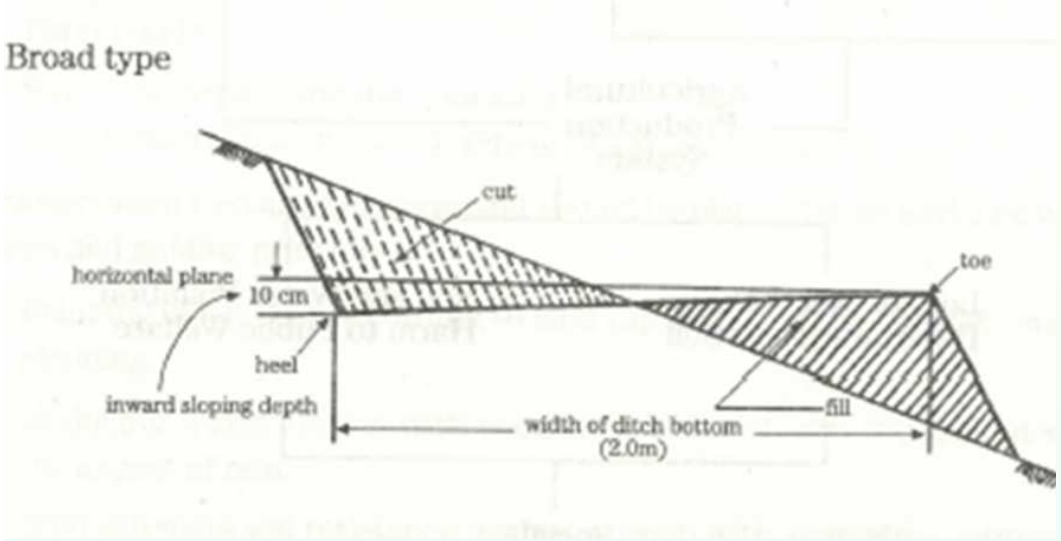
- **Objectives**

  (1) To break up a long slope into several short slopes, in order to intercept runoff water.

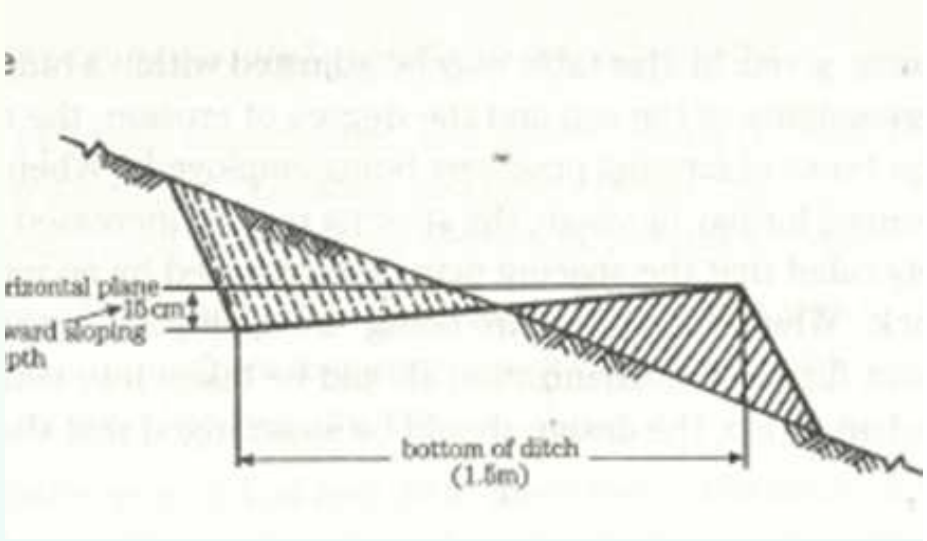
  (2) The ditches may also serve as farm paths to facilitate transporation that the operating cost may be reduced.



寬型 Broad type

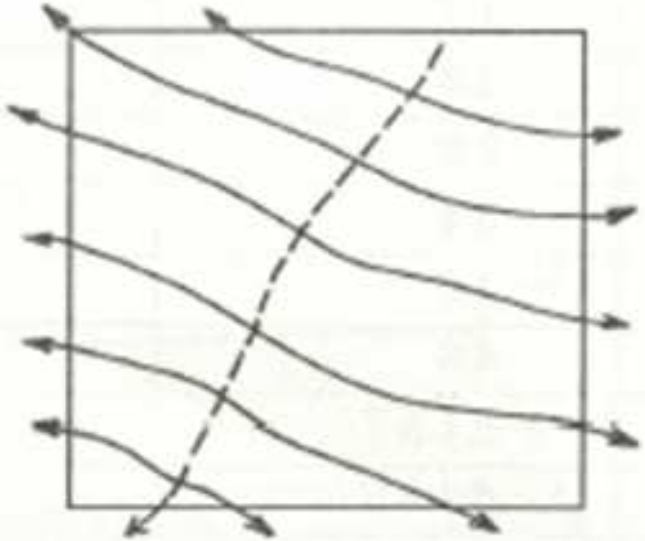


窄型 Narrow type



山邊溝排水
Drainage of Hillside Ditches

Natural water channel
or grass waterway



Grass or forest land

2. 3 Grass planting on Hillside Ditches

- **Definition**

  The establishment of specific grasses on hillside ditches, including both the bottom and side slopes of each ditch.

- **Objectives**

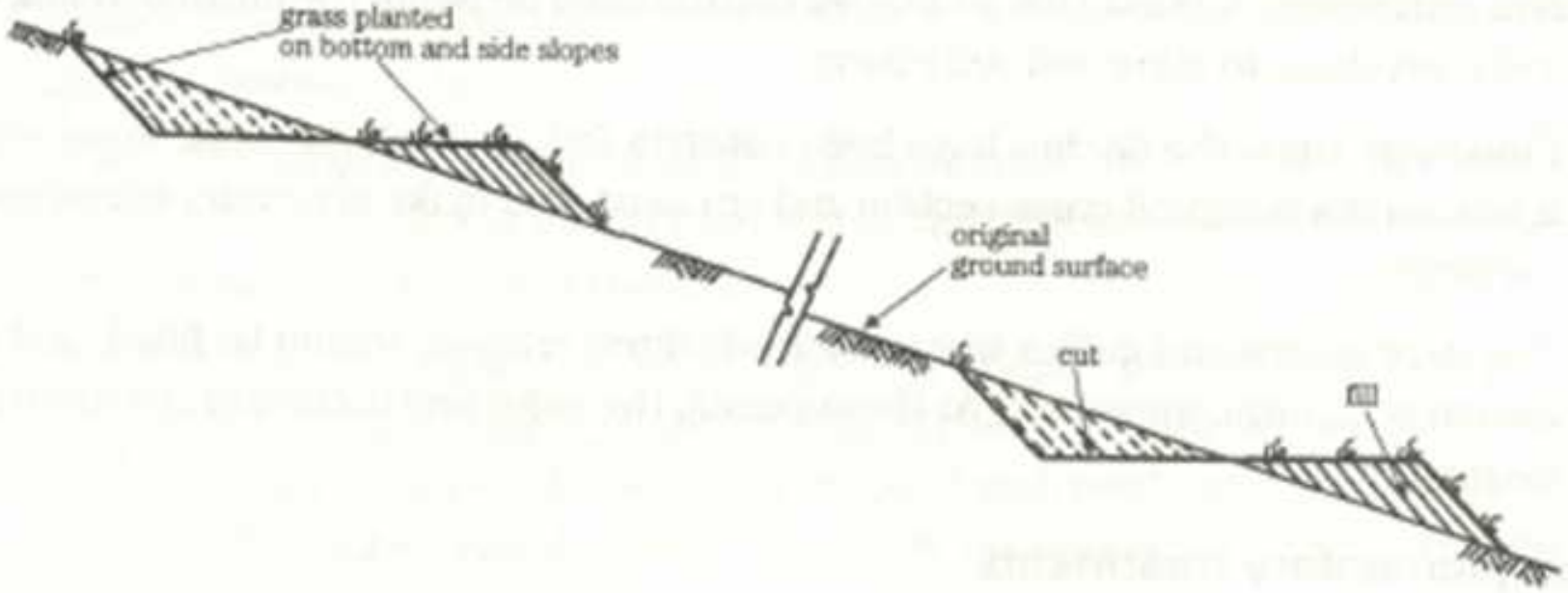
  (1) To stabilize the hillside ditch and thus reduce maintenance costs.

  (2) To save the labor costs of weeding

  (3) To prevent soil erosion on the upper side-slope of the ditch and gradually reduce the slope as sliding soil is trapped by the grass.

2.3山邊溝植草

3.3 Diagram



2.4 Bench Terraces

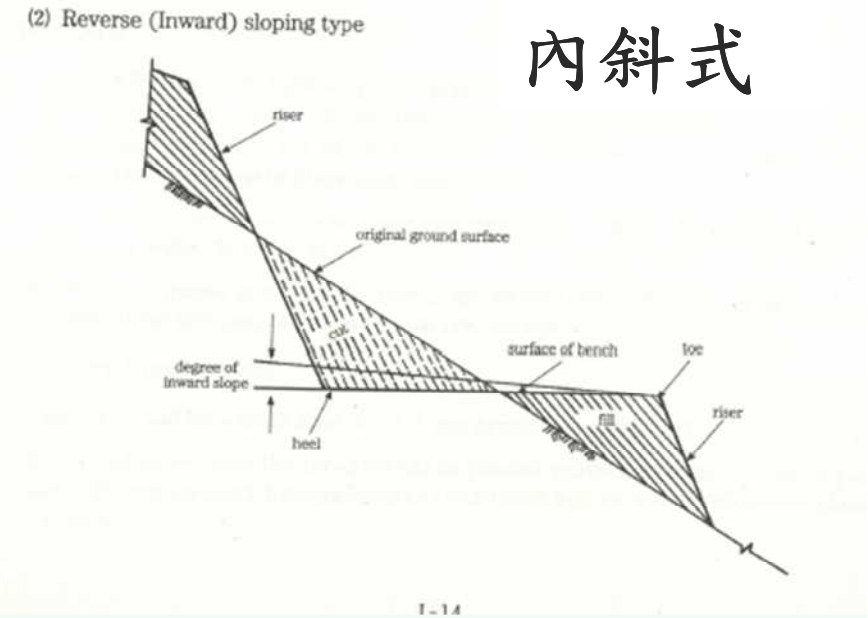
- **Definition**

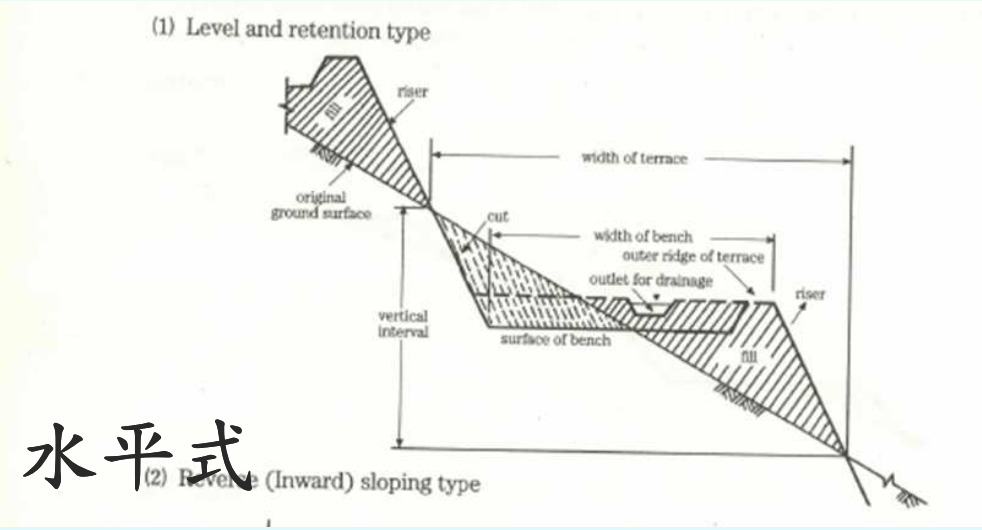
  A series of level or nearly level platforms built along contours at suitable intervals.

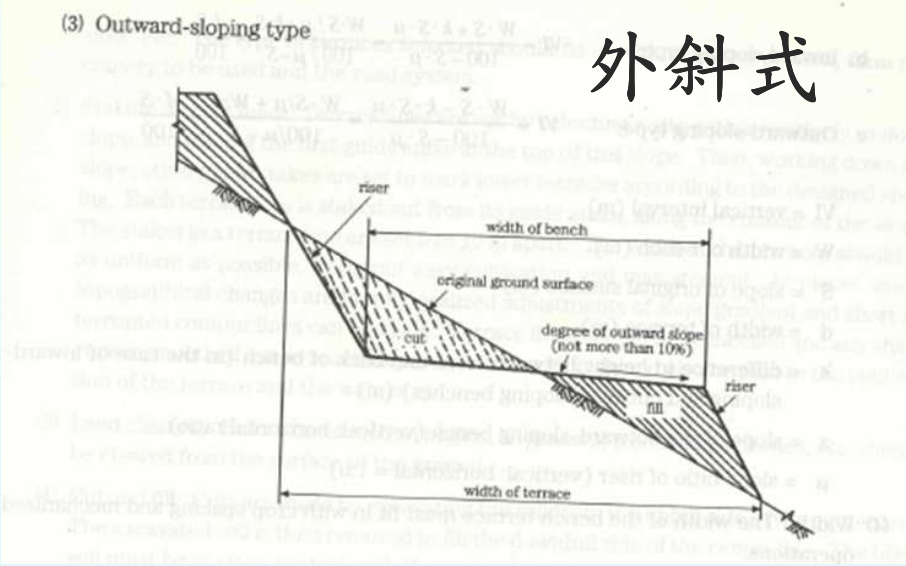
- **Objectives**

  (1) To intercept runoff and control soil erosion.

  (2) To make cropping operations possible and safe on slopeland.







茶園平台階段

Bench Terraces of tea plantation

2.5 Broad-based Terraces

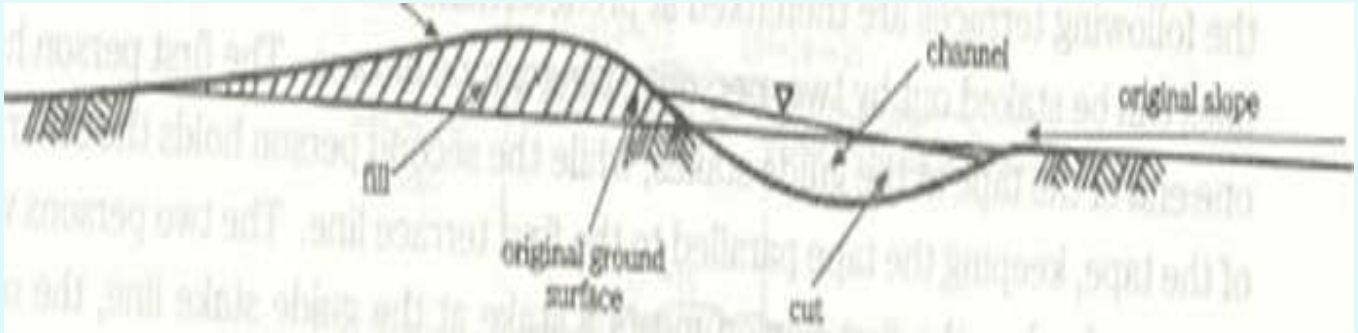
- **Definition**

  A series of shallow, broad based terraces constructed on gently sloping land at a suitable spacing along the contour lines.

- **Objectives**

(1) To break the length of a slope to control soil erosion.

(2) To conserve soil moisture so as to help crop growth.



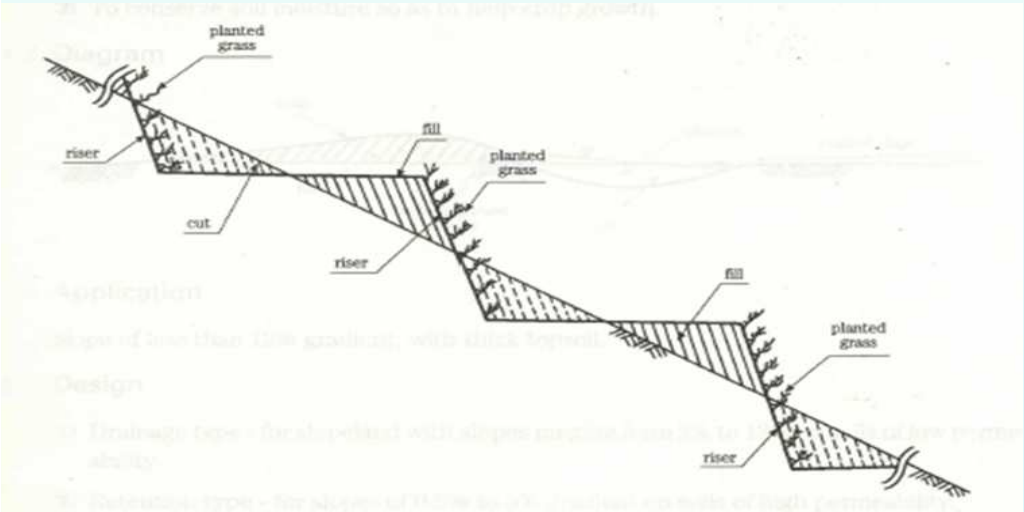
2.6 Planting Grass on Risers

- **Definition**

  The planting of suitable grasses on the risers of bench terraces.

- **Objective**

  To prevent soil erosion from the risers and to maintain the stability of the terraces.



2.7 Stone Walls

- Definition

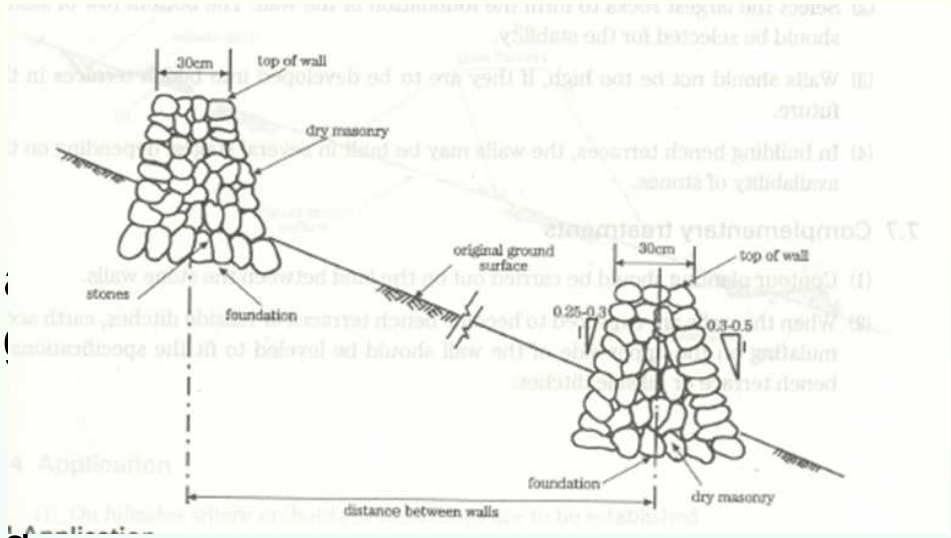
  Using stones to construct walls at a suitable spacing on slopeland along contour lines.

- Objectives

(1) To make good use of rocks and stones existing on slopes, thereby clearing the land for cultivation.

(2) To reduce soil and water losses and to trap the soil washed down from above, thus gradually building up bench terraces and hillside ditches in later years.

(3) To minimize the gradient of a slope to facilitate cultivation, mechanized operations, and soil conservation.



2.8 Grass Barries

- **Definition**

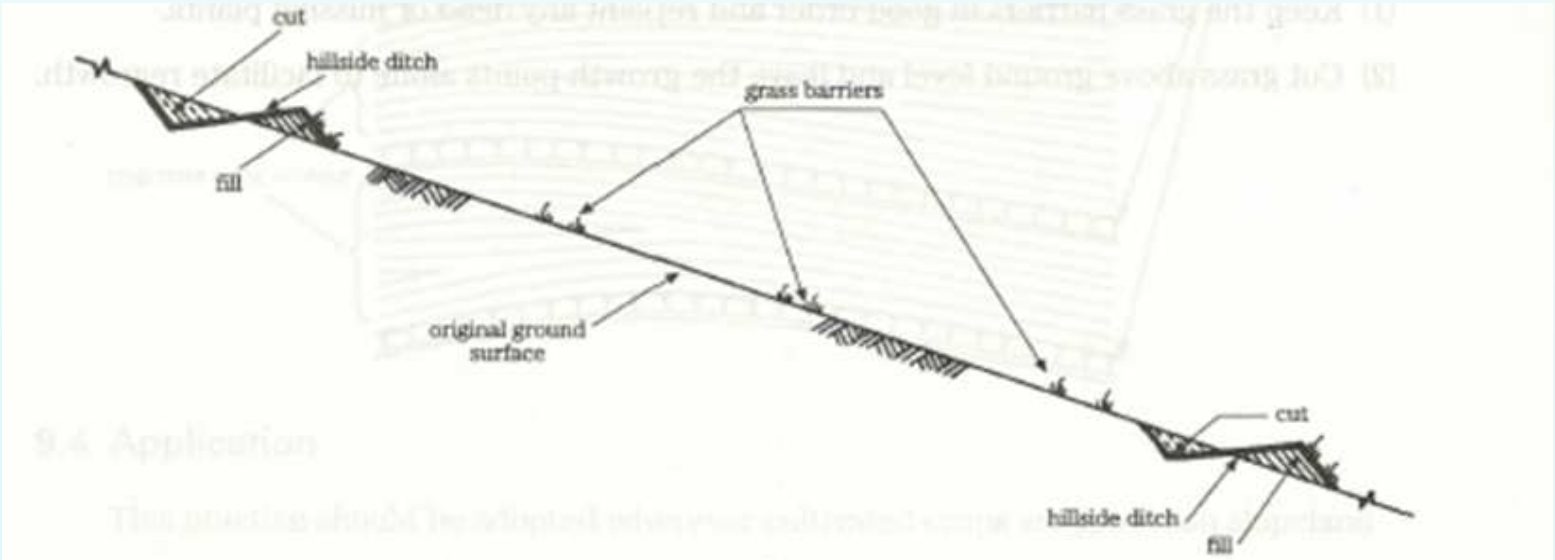
  Contour planting of suitably spaces strips of grass on slopeland.

- **Objectives**

  (1) To arrest runoff so as to reduce soil and water losses and to hold soil and prevent it from being washed downhill.

  (2) To reduce the slope of a hillside to facilitate cultural practices and mechanical operations.

  (3) To gradually convert the barriers into bench terraces.



2.9 Cover Crops

- **Definition**

  Plants which are grown to cover the surface of the ground with dense foliage, to control soil erosion and improve the soil.

- **Objectives**

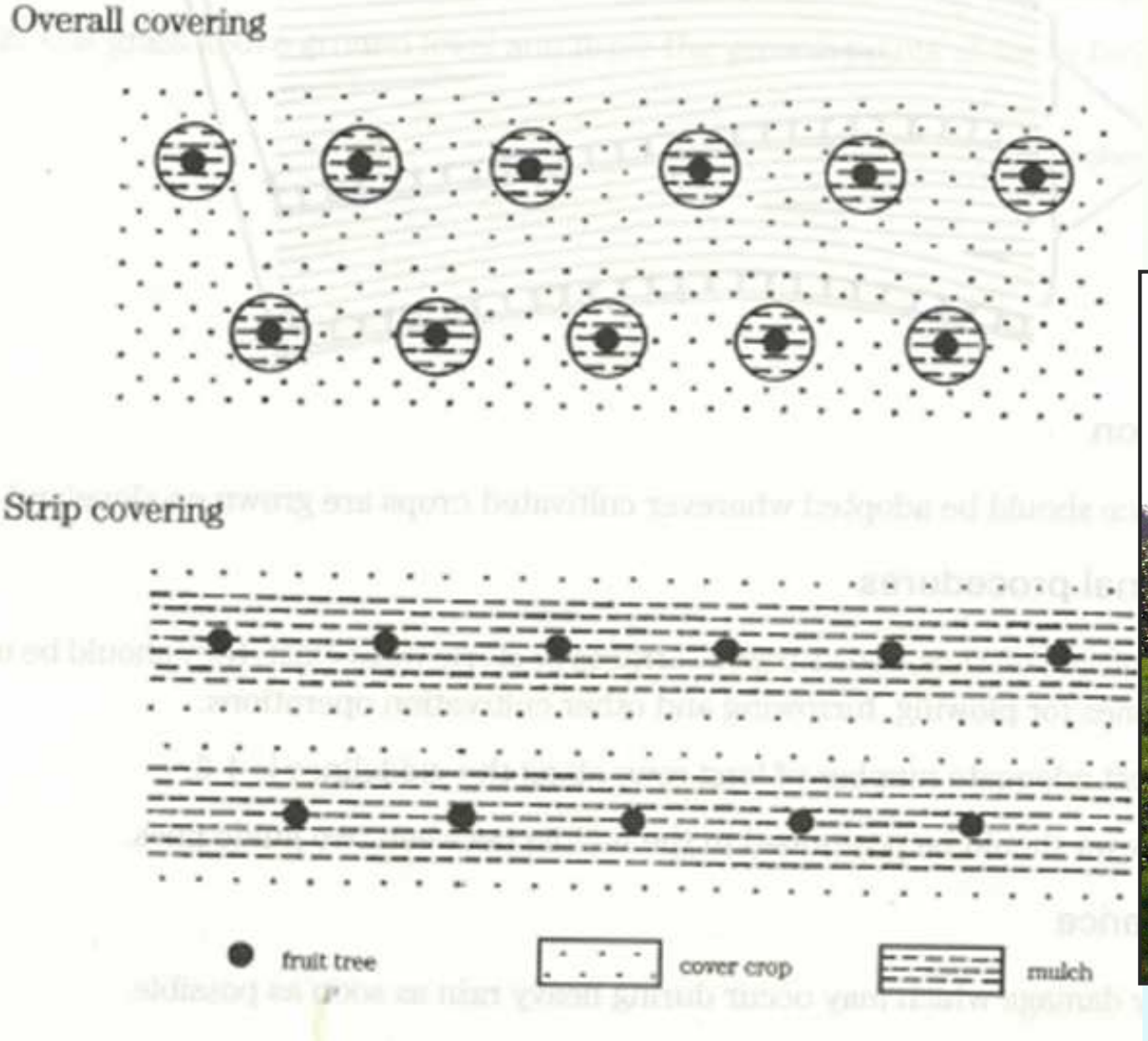
  (1) To protect the surface of the soil from the splashing of rain drops.

  (2) To build up soil organic matter and improve its physical and chemical properties.

  (3) To suppres weed growth and reduce management costs.

  (4) To minimize changes in the micro-climate and in soil temperature, thereby providing a better environment for crop growth.

覆蓋示意圖


Overall covering
Strip covering
fruit tree
cover crop
mulch

2.10 Mulching

- **Definition**

  A protective covering of grass, crop residues or other material spread over the ground between crop rows or around the trunks of fruit trees.

- **Objectives**

  (1) To reduce runoff and soil loss, and to increase soil moisture.

  (2) To suppress weeds and save labor costs of weeding.

  (3) To adjust soil organic matter.

  (4) To increase soil organic matter.

  (5) To reduce evaporation of soil moisture.

2.11 Green Manure

- **Definition**

  A green manure crop is grown specifically to improve soil and act as a fertilizer. It is plowed into soil while still green, or shortly after it matures.

- **Objectives**

  To increase organic matter and nutrients in soil, and to improve the physical and chemical characteristics of soil to increase the resistance of soil to erosion.

2.12 Windbreaks

- **Definition**

  Strips of trees or tall grasses planted at appropriate intervals to prevent or reduce wind erosion and crop losses caused by wind.

- **Objectives**

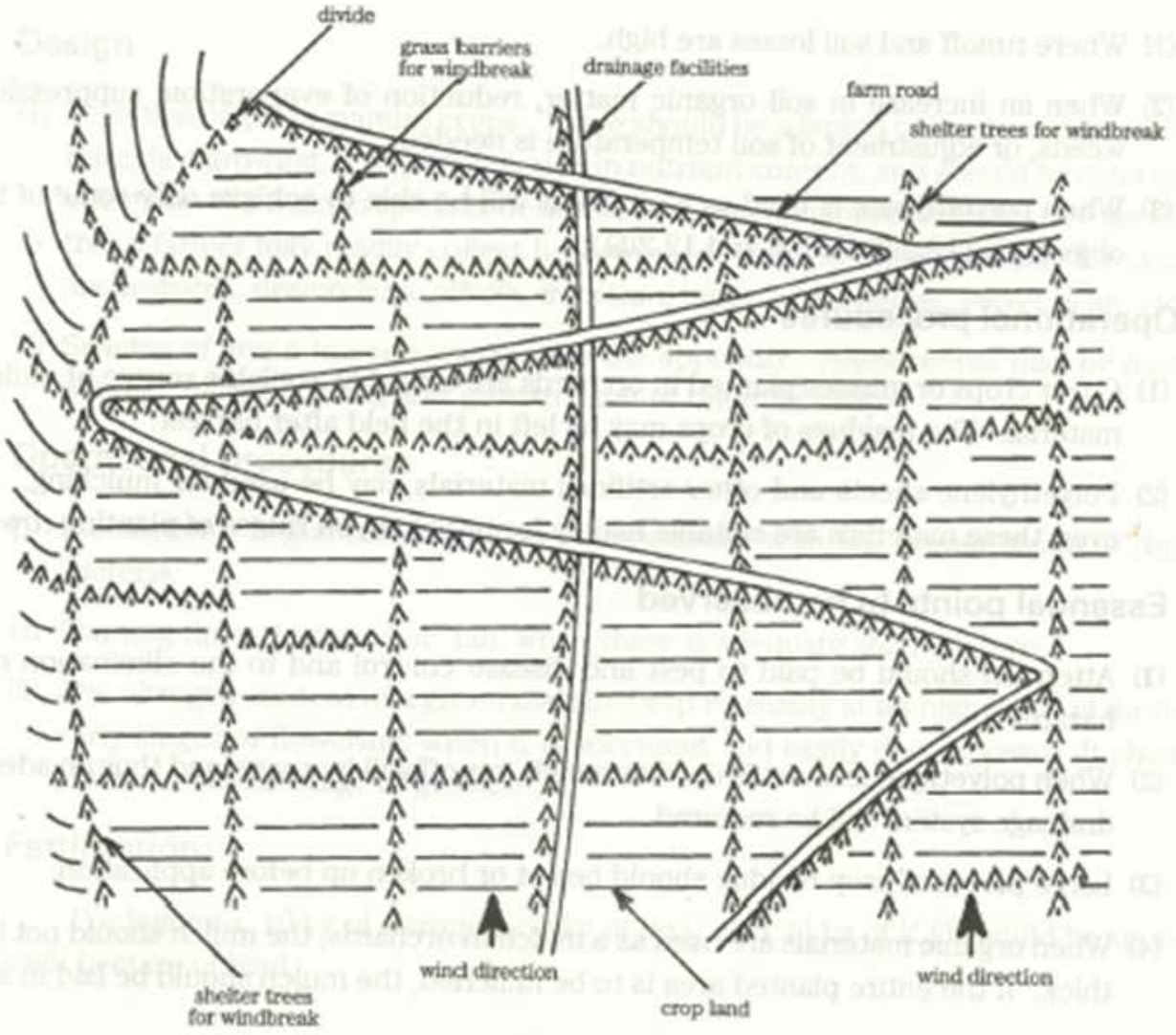
  (1) To control wind erosion.

  (2) To reduce physiological or mechanical injuries to crops caused by strong winds.

  (3) To reduce evapotranspiration.

  (4) To reduce salt damage if the locality is near the sea.

坡地防風示意圖


divide
grass barriers for windbreak
drainage facilities
farm road
shelter trees for windbreak
wind direction
wind direction
shelter trees for windbreak
crop land

2.13 Sediment Basin

- **Definition**

  A device installed in a drainage channel or at the junction of drainage ditches to detain silt in runoff.

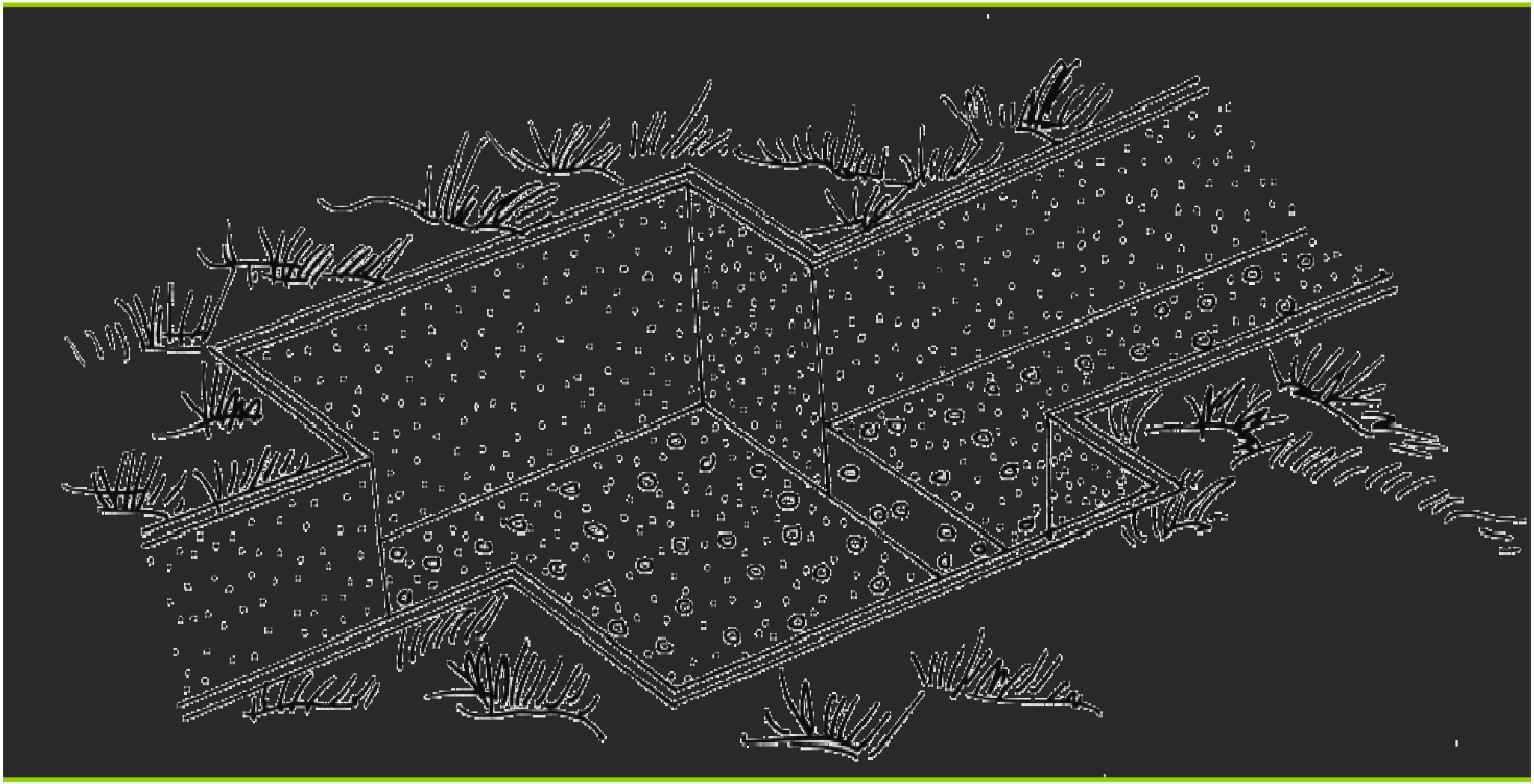
- **Objectives**

  (1) To keep silt from damaging land and properties.

  (2) To keep silt from polluting waters.

  (3) To utilize silt for top dressing on farmland.

農地沉砂池示意圖



3. Check Dams

- **Definition**

  A structure installed across an active gully to stabilize the gully through control of the erosion of gully botton and banks.

- **Objective**

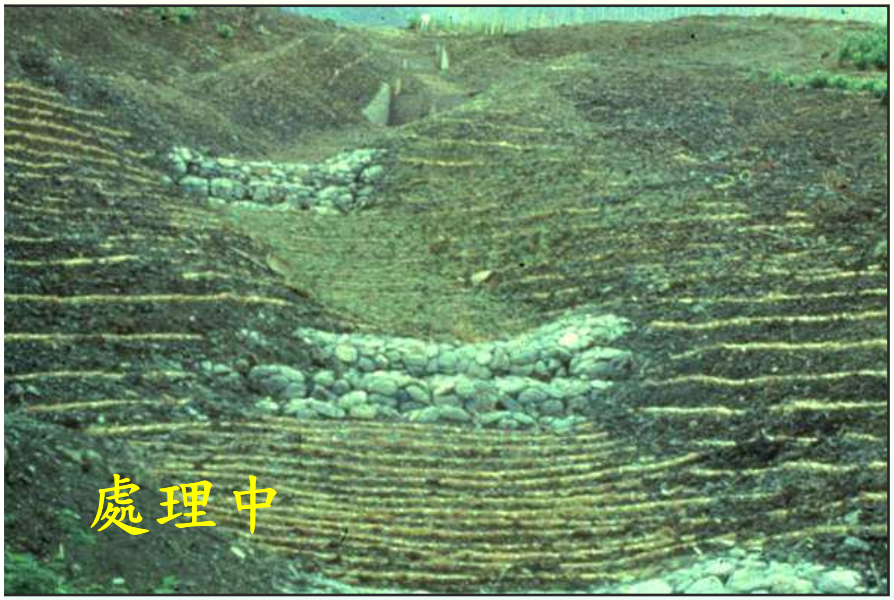
  (1) To reduce runoff tractive force by slacking off the gradient of a gully.

  (2) To control the course of flow so as to minimize impact on the banks.

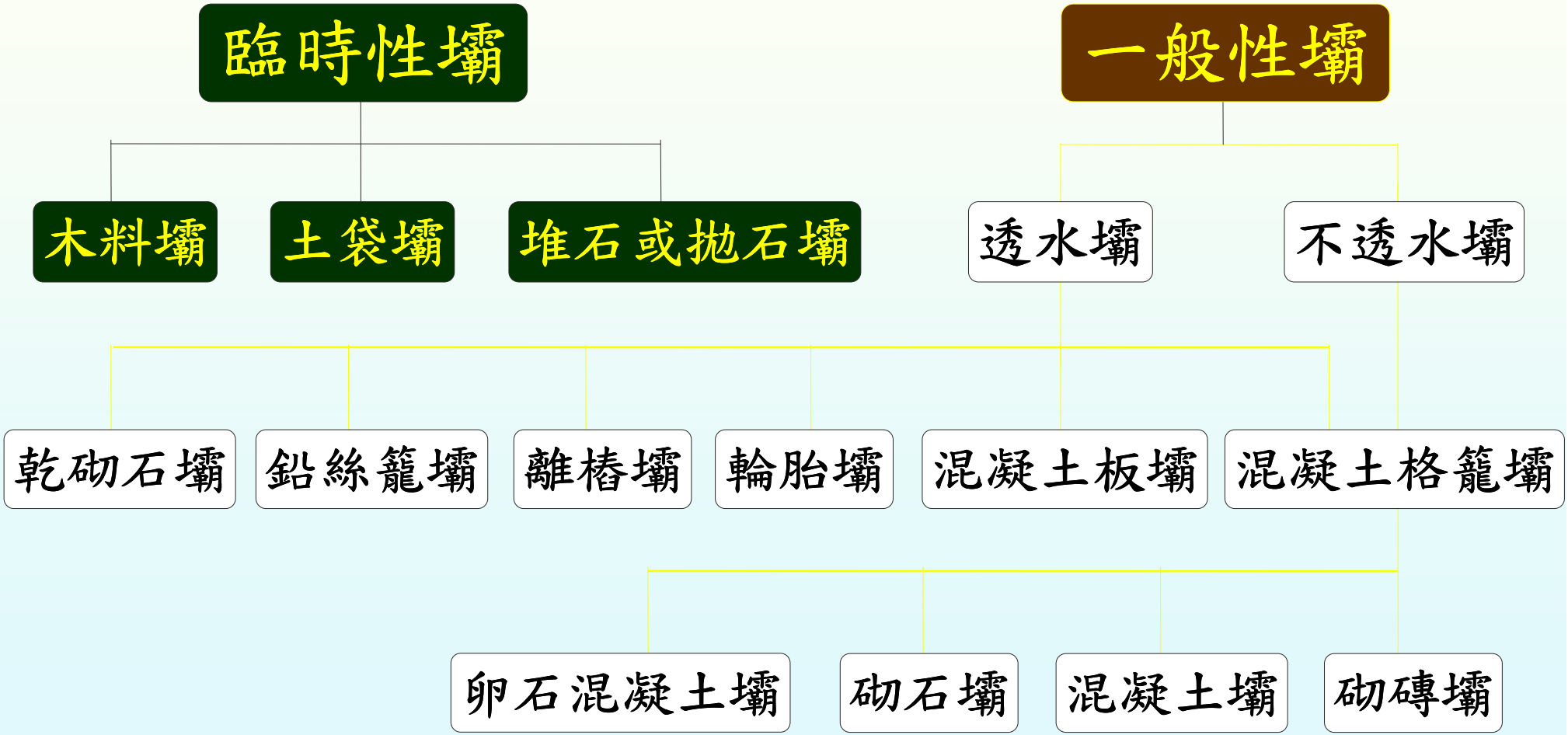
  (3) To block sediment to keep it from damaging the downstream environment and public utilities.

  (4) To maintain the stability of soil when vegetative cover is being established.

蝕溝控制



應用說明及設計


臨時性壩
一般性壩
木料壩
土袋壩
堆石或拋石壩
透水壩
不透水壩
乾砌石壩
鉛絲籠壩
離樁壩
輪胎壩
混凝土板壩
混凝土格籠壩
卵石混凝土壩
砌石壩
混凝土壩
砌磚壩

臨時性壩

透水性壩

4. Safety Drainage

- **Diverse Ditch**
- **Grassed Waterways**
- **Drainage Ditch**
- **Road Surface Drainage**
- **Culvert**
- **L-type Side Ditch**
- **Cross Road Surface Drainage**
- **Drop Structure**

4.1 Diversion Ditches

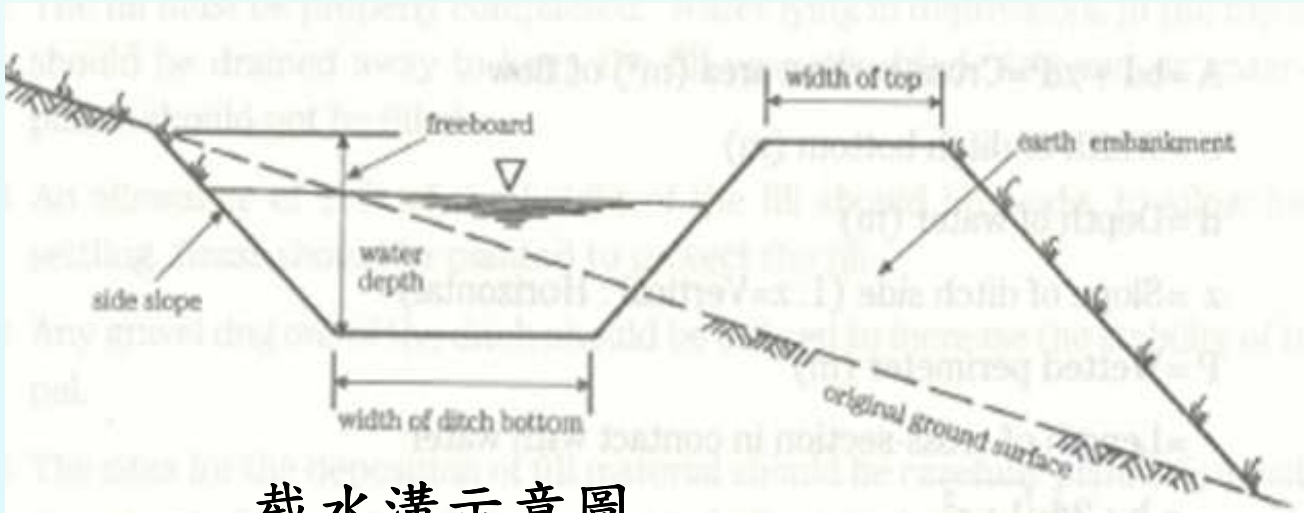
- **Definition**

  A ditch constructed approximately along the contour of a slope for the purpose of intercepting surface runoff and diverting it to a suitable outlet.

- **Objectives**

  (1) To protect farmland and buildings by diverting runoff from hill slopes.

  (2) To control gully erosion.



截水溝示意圖

4.2 Grassed Waterways

- **Definition**

  Earth watercourses planted with grasses to control soil erosion.

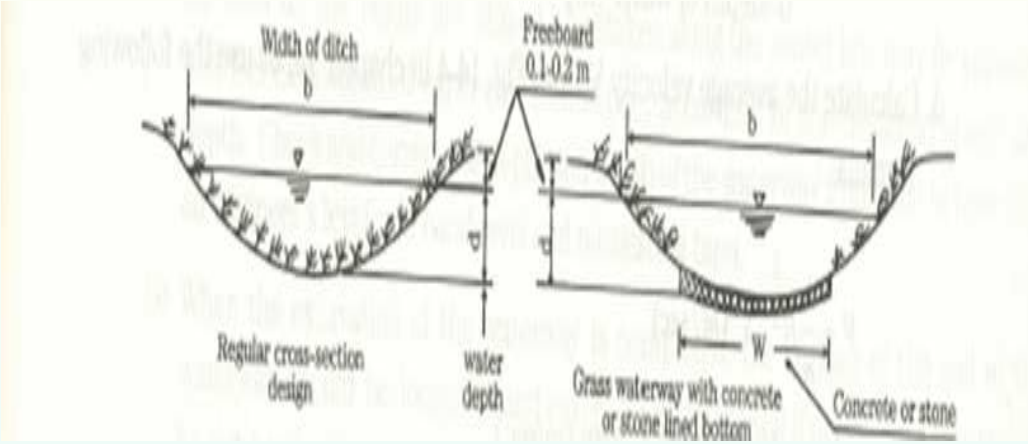
- **Objectives**

  (1)To provide safe outlets for runoff water.

  (2)To prevent soil erosion and to stabilize waterways.

  (3)To facilitate the operation of farm machinery.

  (4)To maintain a stable field environment.



4.3 Drainage Ditches

- **Definition**

  Drainage channels running along a slope, which are lined with stone, brick, or concrete etc.

- **Objectives**

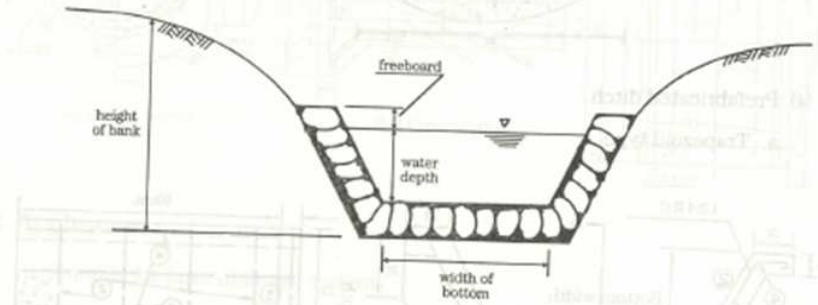
  (1) To ease the flow of runoff water and to protect the ditch from erosion.

  (2) To gather water flow in hillside ditches and contour drainage channels, and carry the flow to a safe place to be discharged.

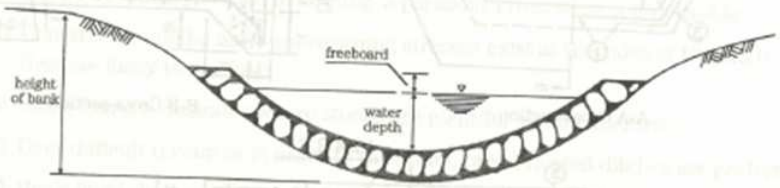
排水溝示意圖

(1) Cobble lined ditch

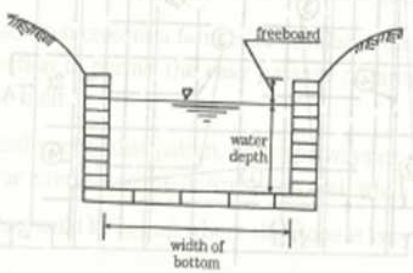
a. Trapezoid type ditch



b. Parabolic type ditch

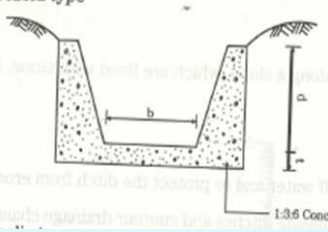


(2) Brick lined ditch

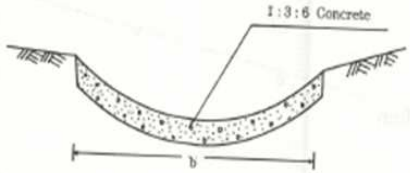


(3) Concrete ditch

a. Trapezoid type



b. Parabolic type



(4) Prefabricated ditch

4.4 Road Surface Drainage

- **Definition**

  The security exclusion road faces to directly flow and accumulate water and protect the stability that the road faces.

- **Objcectives**

  (1) Expel road to face to directly flow, protect road to face and roadbed firmness.

  (2) Prevent road area water from, maintain road to smoothly go through.

4.5 Culverts(small)

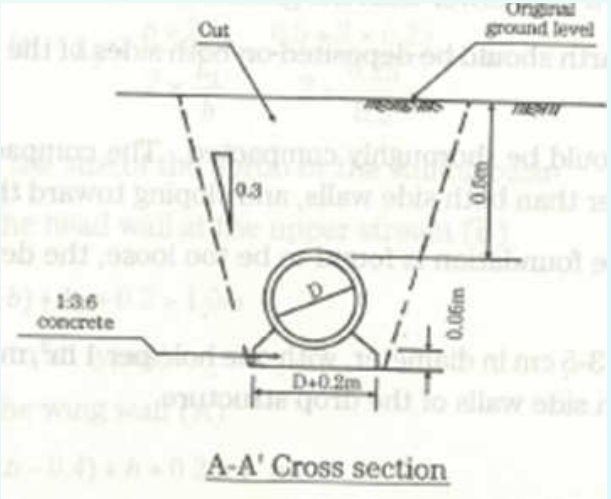
- **Definition**

A drainage pipe laid under the ground where a drainage channel intercepts a farm road.

- **Objectives**

(1) To protect the farm road from erosion by providing a safe channel for runoff water.

(2) To enable farm machinery to cross drains.



A-A' Cross section

4.6 L-shaped Roadside Ditches

- **Definition**

  An L-shaped concrete drainage ditch built along the inside of a road.

- **Objective**

  (1) To drain runoff

  (2) To protect the road against erosion.

  (3) To keep slopes beside roads from sliding or crumbling.

  (4) To facilitate the passage of farm vegicles.

L型側溝

4.7 Dips

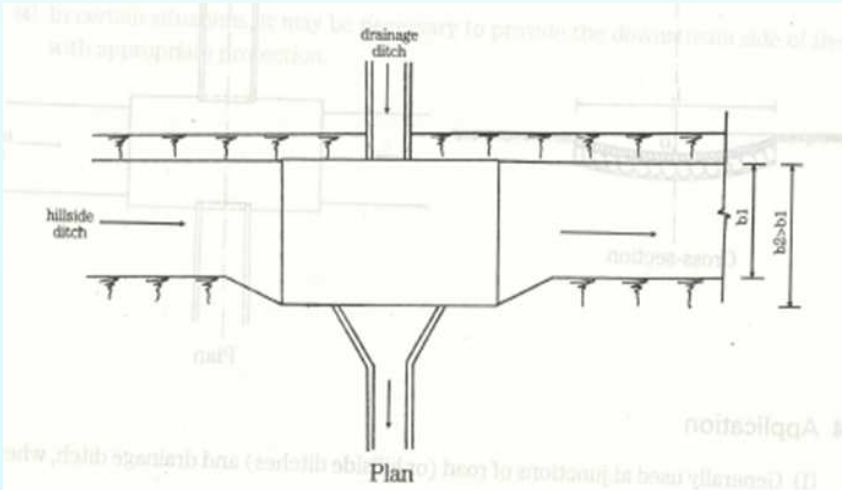
- **Definition**

  Dips, which serve the dual purpose of drainage and a road way, is a wide, shallow open channel with a curved base, across a road or a hillside ditch, at the point where there is a junction with a drainage ditch. It is covered by grass, stones or bricks. It may also be built of concrete.

- **Objective**

  (1) To substitute for a culvert.

  (2) To facilitate the passage of farm vehicles.



4.8 Drop Structures

- **Definition**

  A structure constructed at an appropriate site to reduce the excessive velocity and energy of water flowing down through a steep channel, thereby protecting the channel bottom from damage.

- **Objective**

  To reduce water flow velocity and energy in the channel, thus reducing erosion on the channel bottom and restraining the current.

5. Water Use and Irrigation on Slopeland

- **Water Source Facilities：Structures for collection and storage of water for slopeland irrigation and farming.**
- **Water Withdraw Facilities：The machine motive goes to water Yang to infuse the facilities of the area.**
- **Water Transportation Pipe：Water Yang go to infuse an area disaster headwaters by gravity of ability Gao bad transport water to the facilities of infusing the area.**
- **Farming Pond：To build a reservoir in a depression or along a stream, by excavation or with a dam, for storage of runoff.**
- **Water Storage Facilities：Store parts of amount of water, build a thing by going together with the Gou that water facilities adjustment infuses area bitter end irrigation water.**

6. Farm Road System

- **Access Roads：The road leading from a highway or other main road to the cropping area. Width2.5~4m**
- **Link Roads：A road connecting hillside ditches farm paths with a main farm road. Width2~2.5m**
- **Farm Paths：A passage-way which is constructed to facilitate field operations on the farm. Width: The path is usually1~2m in width.**
- **Footpath：The sloping fields conducts the on foot road of management or visitor usage. Width 1.2~2.3m**