Southeast Asian Fisheries Development Center
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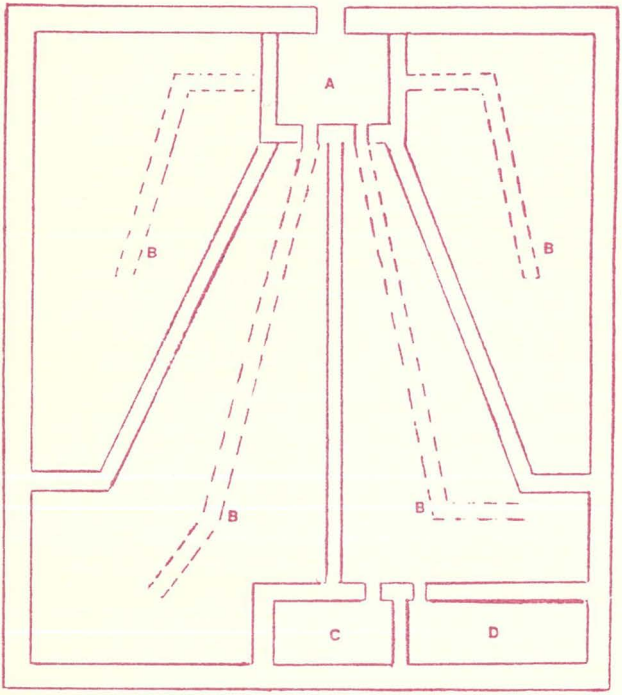
BRACKISHWATER POND CONSTRUCTION



SEC/SM/31 SAFIS Manual No. 31

BRACKISHWATER POND CONSTRUCTION

The Secretariat
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"Brackishwater Pond Construction" was originally published in Bahasa Indonesia in 1981 by the Directorate General of Fisheries (DGF) in Jakarta Indonesia under the title, Pedoman Tehnis Pembuatan Tambak. This is an English translation prepared by Mr. Suharyadi Salim, affiliated with DGF for the SAFIS project.

This manual has been adapted and edited by the SEAFDEC Secretariat.

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I. INTRODUCTION

The success of aquaculture in brackish-water ponds depends largely on the conditions in the area, and on pond construction and management. To avoid difficulties that would affect the profitability of the enterprise, these three points should be given careful consideration from the time the site is selected until construction of the brackishwater ponds is completed. Somtimes, water management problems take place after the brackishwater ponds are completed. These are caused by poor site selection, i.e., the elevation of the pond area was too high, or tidal fluctuation was too low for proper pond management. At times, the pond could not be properly filled because of faulty construction and leakage around a sluice gate or along the main dike.

To avoid such problems, this manual gives advice to fish farmers who intend to construct brackishwater ponds. This will also be useful to instructors and extension workers on brackishwater pond management.

II. SELECTION OF SUITABLE SITE

The suitability of the site should be considered before building a brackishwater pond, since it affects pond operation and management.

It is important to consider topography, vegetation, tidal fluctuations, water quality, flood-free areas, soil conditions, drainage, marketing prospects and others.

1. Topography

Suitable sites are tidal or swamp areas where the ground is relatively flat, with only a slight slope.

High areas which can be flooded only during high tides should be avoided. Removing the soil would be costly and disposal of waste soil might create further difficulties. Water pumps could be used to supplement the volume of water, but investment as well as operating costs would be increased.

Low areas which are always under water, such as lagoons and deep swamps, would result in drainage and harvesting problems, etc.

2. Vegetation

If there are many big trees or mangroves in the area, clearing the site of stumps and roots will be difficult and increase costs. Generally, clearing palm trees is easier and cheaper than uprooting mangroves.

3. Tidal fluctuation

The selected site must be supplied with sufficient water by the tides. Areas where tidal fluctuations range from 1 to 3 m are suitable for a brackishwater pond. At a location with differences in tidal fluctuation of less than 0.5 m, water pumps are required for drainage purposes. This entails higher investment and operating costs.

On the other hand, a brackishwater pond constructed in a location with a difference in tidal fluctuation of 5 m or more necessitates a stronger construction, which must also be of a larger size to withstand the pressure of the tidal waters.

The pond bottom should be at the same level as that of the highest low tide or the mean high tide and mean low tide depending on the maximum difference of tidal fluctuations (Appendices 2 & 3). This is important to ensure sufficient water intake as well as proper drainage of the pond when required.

4. Water quality

In brackishwater ponds, salinity for milkfish culture varies between 0 to 40 per cent, the best range being between 5 and 25 per cent. For shrimp culture, the suitable range is 15 to 30 per cent.

Water temperature has to be taken into account. It is normally between 26°C to 37°C in brackishwater ponds. During the day, the water temperature at the shallow end of the pond may reach 45°C. This will affect the survival capability of the fish or shrimp. Therefore a peripheral canal is dug at the bottom of the pond to enable them to escape the high temperature at the water surface.

In a brackishwater pond, pH renges generally from 7.5 to 8.5 or slightly higher.

5. Flood-free area

It is preferable to select a site in a flood-free area, because periodic flooding may give rise to problems.

6. Soils

Soils, such as sandy-loam and silt-loam, are suitable for pond construction and for growing natural food. The suitability of the site will be enhanced if it contains 4 per cent organic matter. pH varies between 8.0 and 8.5. Sandy soil is not suitable for pond construction because it does not withstand water pressure and leakage is likely to occur.

On the other hand, an area with gravel which contains much organic matter should also be avoided, because it creates problems during construction, and fertility is low. Appendix 4 shows soil classification and size distribution of three types of soil. Appendix 5 shows pond fertility by important soil elements.

7. Drainage

It must be possible to drain off the water of a brackishwater pond whenever necessary to kill any pests and to prepare or treat the bottom in order to grow natural food by liming or by using fertilizers. A location with a natural slope is needed to achieve proper drainage.

8. Marketing and other facilities

A brackishwater pond should be located near a market with cold storage facilities and an ice plant.

Moreover, existing infrastructures, such as roads and bridges, as well as public transportation must also be considered since these will facilitate delivery of materials such as fertilizer, fishing gear and chemicals, and provide easy access to visiting fisheries personnel who supervise pond operations or give guidance for future development.

III. POND LAYOUT

1. General remarks

The layout of the brackishwater pond depends on the characteristics of the site and the purposes for which the pond is intended to serve.

The purposes may be as follow:

(a) For growing fry to fingerlings (about 3 to 5 cm in length), taking normally 1 to 1.5 months. In this case only nursery ponds are required.

(b) For growing fingerlings to marketable size, taking normally 4 to 5 months. In this case only rearing ponds are required.

(c) Milkfish/shrimp culture: growing fry to marketable size, taking 5 to 6 months. In this case nursery ponds, transition ponds and rearing ponds are required.

As regards culture systems, these can be divided into:

- monoculture of milkfish or shrimp;

  and

- polyculture of milkfish and shrimp.

Occasionally, polyculture includes other fishes such as tilapia, mullet and shellfish.

This brackishwater pond taken as one unit should have an appropriate layout; the rearing pond should be close to the transition pond and each pond should be separated by secondary and tertiary dikes, which have sluice gates or inlets.

The main function of the canal system is to supply water to the pond but the canals may also be used as harvesting ponds.

A brackishwater pond area is usually surrounded by a strong main dike capable of withstanding the water pressure. The main water gate is generally constructed in the main dike, and located at the lowest part of the pond. One main gate with a 1 to 1.2 m width is big enough to supply the volume of water needed for a 10 ha pond, but for a pond area exceeding 10 ha, one main gate with a series of inlets is generally provided in order to reduce investment and operating costs.

A brackishwater pond unit usually has a house manned by a guard to keep watch and protect the area against poaching.

2. Extent of area

For economical reasons, the minimum profitable area for a brackishwater pond is 5 ha. Based on both the economic and management aspects, some specialists from the Philippines have suggested an area of 5 to 10 ha for a brackishwater pond unit containing a 1 to 3 ha rearing pond.

A brackishwater pond for growing fry to marketable size should utilize 1 to 3 per cent of its area for nursery ponds, 30 to 35 per cent for transition ponds and 60 per cent for rearing ponds.

3. Units of a brackishwater pond system

A brackishwater pond system, which can also be utilized for polyculture (milkfish and shrimp or other fishes) is composed of: (1) Nursery pond, (2) Transition pond, (3) Rearing pond, (4) (4) Division pond/catching pond, (5) Main gate and secondary gates, (6) Peripheral canal, (7) Platform, (8) Main dike, and secondary and tertiary dikes, (9) Main canal and secondary canal, and, (10) Guard house (for details, see Section V).

IV. PREPARATION

1. Clearing and cleaning the site

After the criteria for site selection have been considered, the work of clearing the ground of tall trees or mangrove should be started. The available capital will have a bearing on this activity.

Digging generally starts from where the main dike is to be built towards the center of the pond. Machinery, such as bulldozers, excavators, and chain-saws, are generally used for this work. For a small area, the work is carried out manually using traditional tools such as spade and axe.

2. Methods of pond construction

There are two construction methods for brackishwater ponds, as follows:

- Construction of main dike and secondary dikes, using the soil from the lateral canals, without digging the platform;
- Digging all pond units, including the platform.

In terms of cost, fertility of the soil, and other factors, the first method is more advantageous than the second, but it can be applied only in an area where the elevation is suitable as regards tide levels.

V. CONSTRUCTION

1. Dike construction

A brackishwater pond generally has the following two kinds of dike:

- Main dike, wide and strongly built, constructed around the pond;

- Secondary dikes, smaller than the main dike constructed inside the pond, and separating the small pond section.

1.1 Main dike

Since the main dike is one of the important components of a brackishwater pond, particular attention has to be given to its construction. The stability of the dike depends on the quality of the bottom soil.

The main dike is constructed in an area from which the vegetation has already been removed and follows to the prepared track.

The soil which has been dug out for building the lateral canal is generally used for dike construction, after removing roots, etc. Sandy-loam is a good material for dike construction.

If the main dike is built in an area with sandy soils, the construction must be strengthened by providing at the center of the dike, a trench (about 50 cm deep and 40 to 50 cm wide) and filling it with clay in order to prevent leakage. Generally, the main dike is 1.5 to 3 m wide at the top and 3 to 5 m wide at the base with a height of 1 to 2 m. The level of the water is kept 30 to 40 cm below the top of the dike to allow for the highest tide.

The ratio between height and the slope of the inside wall of the dike is 1:1 and for the outside wall of the dike, 1:1.5. A cross-section of the main dike is shown in Fig. 2.

1.2 Secondary dikes

The construction of a secondary dike and that of the main dike are basically the same, the only difference being the size of the secondary dike which is smaller.

The dike specifications are as follows:

- Width at top : 1 to 1.5 m
- Width at base : 2 to 3 m
- Ratio between height and slopes: 1:1

A cross-section of a secondary dike is shown in Fig. 3.

2. Sluice gates

A brackishwater pond has two types of sluice gate; these are:

- Main gate, constructed on the front of the peripheral canal which connects directly with the main canal.
- Secondary gates, constructed on the secondary dikes.

2.1 Main gate

The main gate is installed at the lowest part of the pond. The materials used can be wood or concrete. Availability of skilled manpower to carry out this construction should be ascertained.

Reinforced concrete is much stronger than wood, but also more costly. Moreover, some of the required materials such as sand and stones as well as skilled manpower are difficult to find in some areas.

The dimensions of the main gate may be as follows:

- Width : 1 to 1.25 m
- Height : 2 to 3 m
- Length : 1.50 to 3 m

The base of the main gate should be at the same level as the surrounding area or slightly lower than the average low tide to avoid leakage under the gate.

Experience has shown that a main gate with a width of 0.80 to 1.20 m is adequate for supplying water to a 10 ha brackishwater pond. A diagram of a simple sluice gate is given in Fig. 4. The main gate consists of a double wooden plank with two filters, one towards the inside, the other towards the outside. The wings should be underpinned to strengthen them against erosion and water pressure.

2.2 Secondary gates

A secondary gate (including a secondary gate for a nursery pond) is generally built of wood and some of its components are the same as those of a main gate. A secondary gate is smaller than the main gate and has the following specifications:

- Width : 0.60 to 0.80 m

- Height : 2 m

Details of the construction of secondary gates are shown in Fig. 4.

3. Peripheral canal

The peripheral canal is important in brackishwater pond culture, especially for shrimp culture and for polyculture of shrimp and milkfish. The function of the peripheral canal is to provide protection against pests and birds, and shelter from high temperatures during the day. A peripheral canal is between 0.70 and 1 m wide and, taking into account the range of tidal fluctuations, is built 50 to 60 cm below the mean high tide level. When drying a pond the water must be drained off completely from the peripheral canal to prepare the bottom soil for other uses.

4. Diversion canal

Specifications of a diversion canal are as follows:

- Width at top : 3 to 5 m

- Depth : about 1 m, same as peripheral canal

The depth of the diversion canal depends on tidal fluctuation, but in principle it must be 5 to 10 cm lower than the lowest tide level. The length of the diversion canal depends on the size and shape of the brackishwater pond.

5. Irrigation canal

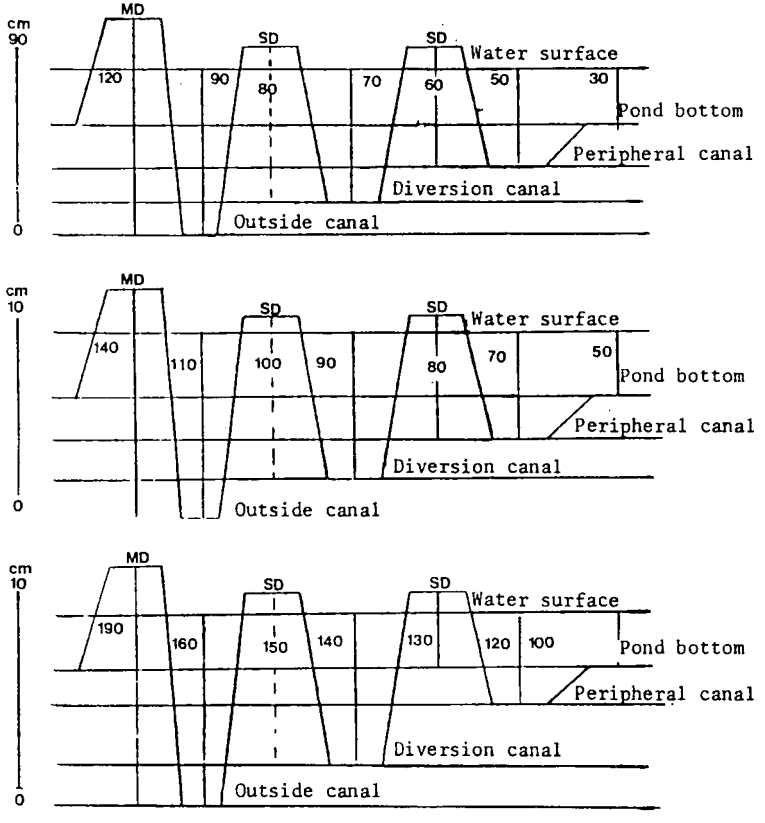
The dimensions of the irrigation canal must be adequate in order to supply the water to the brackishwater pond through the main gate. The bottom of the canal should slope up slightly towards the pond to enable mud or sand to settle when the pond is filled with water. The irrigation canal may have the following dimensions:

- Width at top: 4 to 10 m depending on the size of the pond

- Width of base varies between 1 and 1.5 m, and should be 5 to 10 cm above the lowest tide level, in areas where tidal fluctuation is 100 cm, and at the same level as the mean low tide, in areas where tidal fluctuation is between 1.50 and 2 m.

Appendix 1

WATER LEVEL AND POND BOTTOM

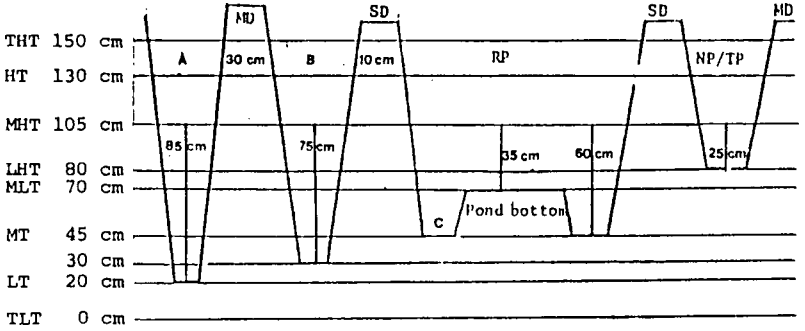


MD = Main dike

SD = Secondary dike

Appendices 2 and 3

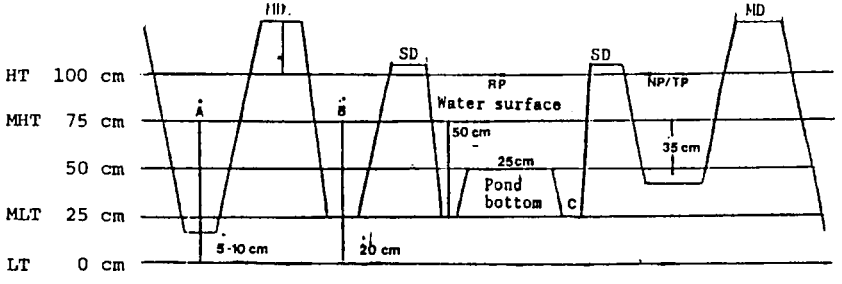
POND DEPTH AND CANALS (MAXIMUM TIDAL FLUCTUATION 150 CM)



THT = Temporary High Tide
HT = High Tide
MHT = Mean High Tide
LHT = Lowest High Tide
MLT = Mean Low Tide
MT = Mean Tide
LT = Low Tide
TLT = Temporary Low Tide

MD = Main Dike
SD = Secondary Dike
A = Outside Canal
B = Diversion Canal
C = Peripheral Canal
RP = Rearing Pond
NP = Nursery Pond
TP = Transition Pond

POND DEPTH AND CANALS (MAXIMUM TIDAL FLUCTUATION 150 CM)

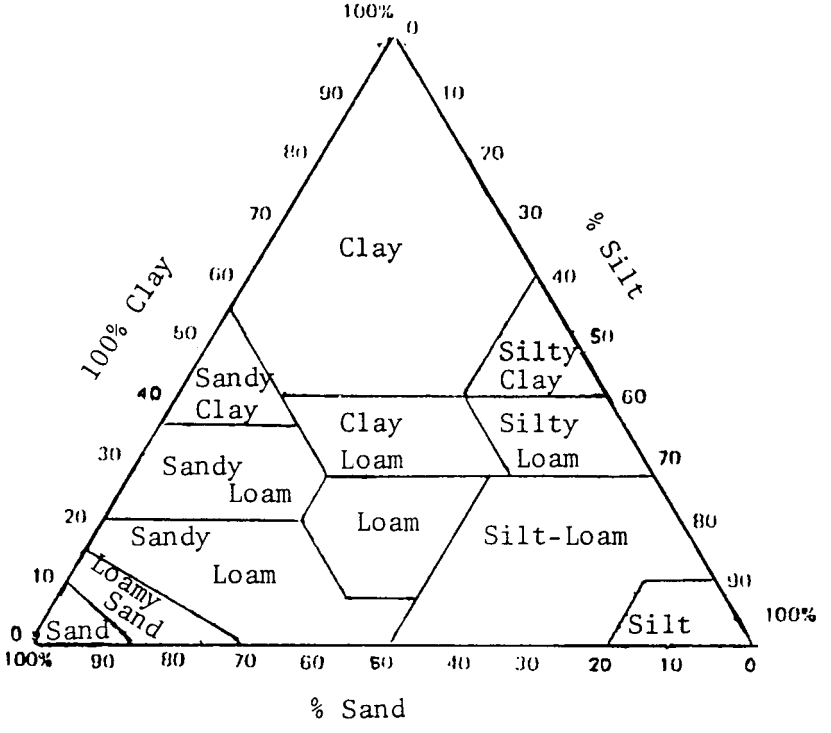


HT = High Tide
MHT = Mean High Tide
MLT = Mean Low Tide
LT = Low Tide

MD = Main Dike
SD = Secondary Dike
A = Outside Canal
B = Diversion Canal
C = Peripheral Canal
RP = Rearing Pond
NP = Nursery Pond
TP = Transition Pond

Appendix 4

DIAGRAM OF SOIL CLASSIFICATION AND PERCENTAGE DISTRIBUTION OF THREE TYPES OF SOIL

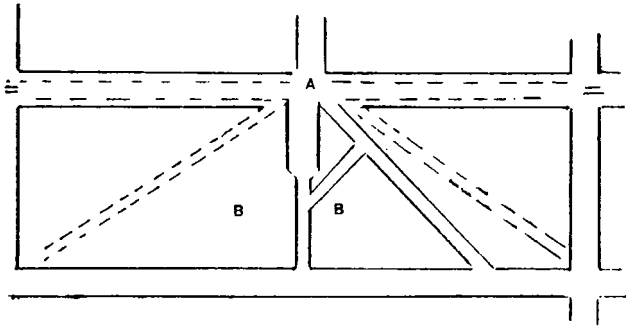


Appendix 5

POND BOTTOM FERTILITY BY IMPORTANT SOIL ELEMENTS

1.	Organic matter (%)		1.5	1.60-3.50	3.60
2.	Total Nitrogen (%)	0.10	0.11-0.15	0.16-0.20	0.21
3.	Phosphorus (ppm)		35	36-45	46
4.	Potassium (ppm)	350		350-500	500
5.	Calcium (ppm)	700		700-1,200	1,200
6.	Magnesium (ppm)	300		300-600	600
7.	Chloride (ppm)	2,000		2,000-2,500	5,000

Figure 1.a. Taman type, Indonesia



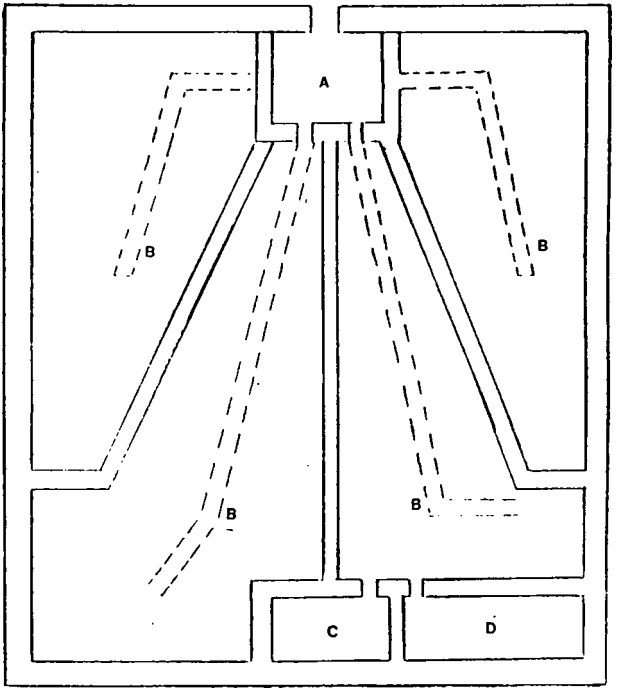
Scale 1 : 2,000

A = Transition pond

B = Rearing pond

Figure 1.b. Porong type, Indonesia

Scale 1:1 1:2,000



A = Transition pond
B = Rearing pond
C = Nursery pond
D = Nursery pond

Figure 1.c. Brackishwater pond, Philippines

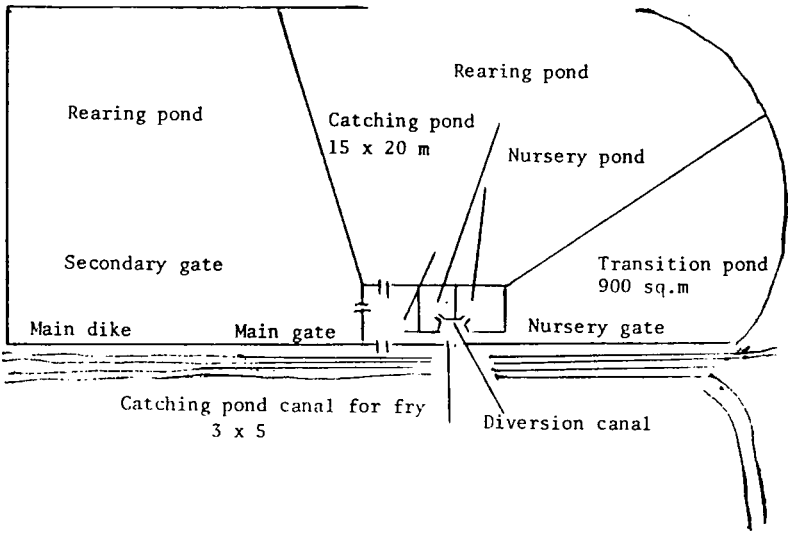
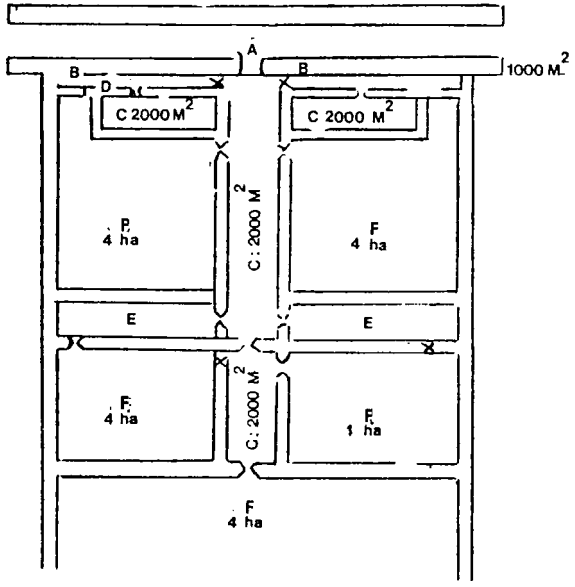


Figure 1.d. Brackishwater pond in Taiwan



A = Main Gate

B = Transition gate

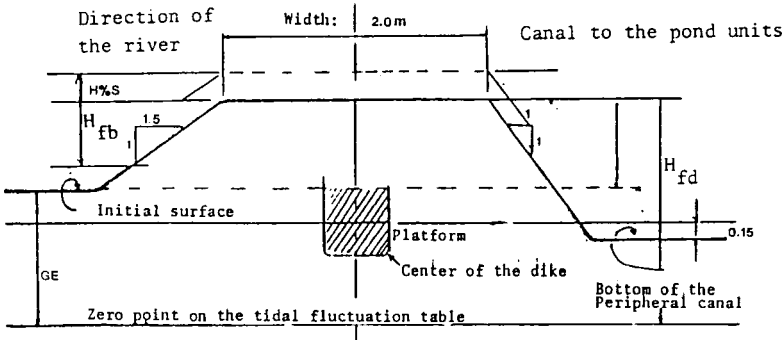
C = Nursery pond

D = Nursery gate

E = Transition gate

F = Rearing pond

Figure 2. Cross-section of the main dike



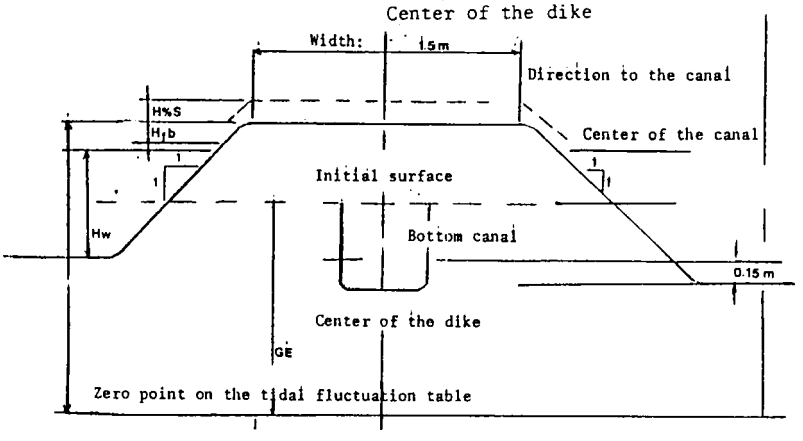
GE = High level area from the zero point

H_{fd} = Water level at the highest high tide (within 15-year period)

H%S = Estimation of soil erosion of dike surface (30%)

H_{fb} = Difference between the dike surface and the high tide (60% from the dike surface)

Figure 3. Cross-section of a secondary dike



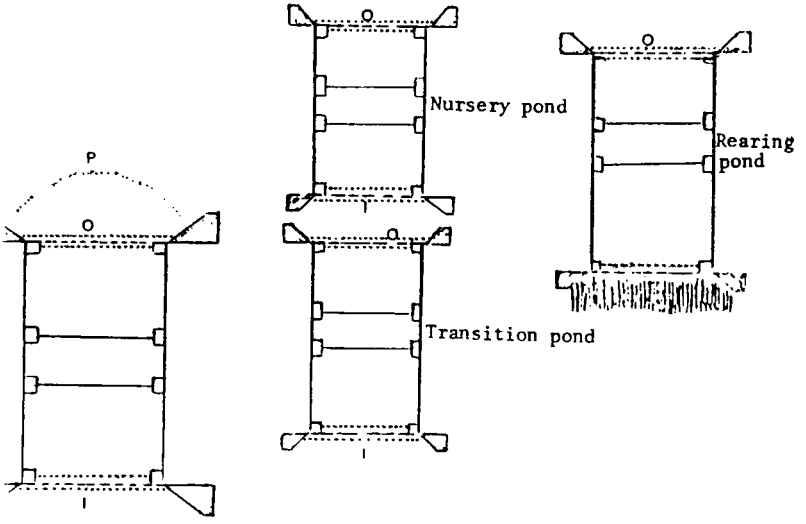
Hw = Water level of pond

GE = High level area from the zero point

H%S = Estimation of soil erosion of dike surface (30%)

H_{fb} = Difference between the dike surface and the high tide (60% from the dike surface)

Figure 4. Design of sluice gates for monoculture of milkfish



O = Outside
I = Inside
P = Protector

..... = Bamboo screen
---------- = Wooden slabs
-.-.-.-.-.-.-. = Plastic netting
- - - - - - - - = Small mesh

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SEC/SM/31 Brackishwater Pond Construction (original: Bahasa Indonesia; translated: English)

SAFIS

o What is SAFIS?

SAFIS is the Southeast Asian Fisheries Information Service. It is a project of the SEAFDEC Secretariat set up to provide extension materials for small-scale fishermen and fish farmers in the region.

o What are its objectives?

The immediate objectives are to collect and compile fisheries extension manuals, brochures, pamphlets and related aids for small-scale fisheries development, and to translate selected literature into local languages for distribution to fisheries extension workers in Southeast Asia.

o What services will SAFIS provide?

SAFIS will attempt to provide information and publications such as:

- lists of available texts in fisheries extension services,
- translation of suitable manuals,
- manuals of appropriate technologies,
- photocopies of appropriate fisheries extension literature,
- a current awareness service of regional fisheries.

o How much will these services cost?

A nominal cost of US $0.15 per page will be charged for photocopying, handling, and surface mail. Airmail costs will be extra. The publication cost per manual will vary according to the book.

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SAFIS is the Southeast Asian Fisheries Information Service. It is a project of the SEAFDEC Secretariat set up to provide extension materials for small - scale fishermen and fish farmers in the region. For additional information, contact the Project Leader of SAFIS

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