5.6 Drainage Pump

Drainage pump should be designed at the downstream end of the drainage channel when the gravity drain is hardly made in a low-lying area due to backwater effect of high tide or water level of the downstream river channel.

Explanation:

Drainage pump should not cause any severe trouble to the channel banks or the structures of the administration facilities. Pump room of pump station, pump well, outfall well and other pressure regulation part should be a structure of reinforced concrete or a structure similar thereto.

(1) Facilities of Drainage Pump Station

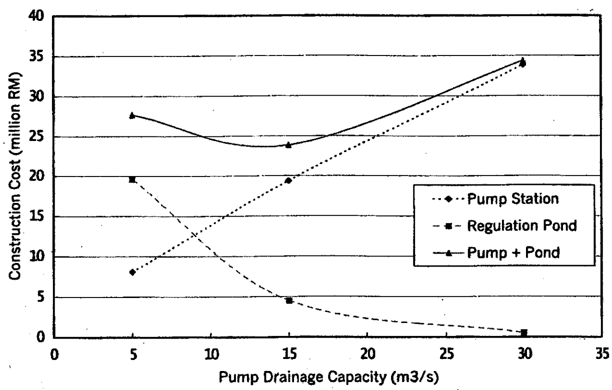
The pump station should be equipped with outfall well and other pressure regulation part. Top height of outfall well and other pressure regulation part should be higher than the height of the levee to be crossed by the drainage pump station. The pump station should also be equipped with sand basin, screen and/or other facilities suitable for removal of flowing materials. This should not apply, however, in case it is deemed that there is no hindrance against drainage administration[*5-5].

(2) Pumping Capacity

The design discharge for drainage pump will be analyzed at the downstream end of the sub-basin applying a 5 to 10 year return period of rainfall. To lighten the burden on pumping station and minimize the scale of connecting channels, inundation damage to some extent should be allowed, and also the capacity allocation between a pump station and a corresponding regulation pond should be studied as shown below.

In view of equipment cost and pump efficiency, a larger scale of one unit of pump is more economical. However, in light of the operation to meet a small change of interior water runoff, dispersion of risk at time of pump trouble, staged execution of work, at least two units of pump should be provided. The capacity of one unit of pump should be decided, considering various requirements such as the characteristic of interior water runoff, operation and maintenance, capacity of the drainage channel connected to the pumping station, power supply system, and etc.

Fig. 5.14 Drainage Capacity Allocation between Pump and Regulation Pond



(3) Type of Pump

Selection of the type of pumps is an essential issue on designing a pumping station, although this issue governs the structures of civil and building works for the station and the operation and maintenance works after completion. For reference three types of pump are introduced in the end of this section. The following three types of pump are usually studied for selection of the type of pump. Their general characteristics are summarized as tabulated in Table 5.6, and the general layouts of these pumping systems are illustrated as shown in Figs.5.15 to 5.1..

(a) Stationary(conventional) type with axial flow vertical-shaft pump,

(b) Mobile type with truck-mounted submersible pump;

(c) Unit type with submersible pump

(4) Design Water Levels for Pump and Appurtenant Structures

The design water levels should be fixed for designing pumping station, inlet channel, a corresponding regulation pond and gravity flow gate, considering the relationships and recurrences between outer-water/tide stage and interior-water stage. For economical pump operation throughout the year the starting/ending water levels for pump operation should be studied corresponding to seasons and run-off discharges.

Table 5.6 General Comparison on Pump Type

Item	Stationary Type (Vertical-shaft Pump)	Mobile Type (Movable Pump)	Unit Type (Submersible Pump)
1. Civil and Building Works			
• Space Required	Comparatively small in width and length, but relatively higher due to lifting height of crane.	Local pump pit with parking space may be required to operate pump effectively.	Comparatively small in width and length
• Substructure and Foundation Work	Costly due to heaviness and requirement of accuracy of the machinery	Not necessary	Comparatively not so costly due to light weight of equipment
• Superstructure/ Building Works	Superstructure is necessary.	Garage for mobile unit is necessary	No superstructure is required. An operation building only is required. Simple structure with smaller areas are required.
2. Mechanical and Electrical Works			
• Pump Characteristics (Cavitation)	Less cavitation is concerned commonly, since impellers are set below water level.	Low-head, large capacity and no cavitation.	No cavitation is concerned commonly since impellers are set below water level.
• Ancillary Equipment	Ancillary equipment for prime action is not required.	Tractor (Track mounted generator)	Ancillary equipment for prime action is not required.
• Applicable Capacity Per Unit	~30m3/s	~1m3/s	~5m3/s
• Operation	Automation is easily done because prime action is unnecessary.	Prime action for operation should be the manual basis.	Automation is easily done due to no concerns about priming and cavitation.
• Maintenance and Repair	Difficult : Since main components of pump are installed below water level, and bearings are placed under water.	Very easy : Frequent maintenance can be done easily. However, durability of pump unit is relatively short.	Rather easy : Periodical inspection and maintenance can be easily done by lifting electric motor and pump from water. Durability of electric motor is currently shorter than stationary type.
• Noise	Relatively less noisy because of submerged impellers installed, while more noisy than submersible type because electric motors are installed on floor.	Noisy	Little noise emission with impellers and electric motors submerged
3. Cost per Unit Rate	140%	150% (incl. tractor's cost)	100%
4.Evaluation	This conventional type is recognized as most reliable pump system, although a rather higher construction cost will be required	Since a capacity of one unit is limited, a whole cost to cope with total design discharge will amount to rather big. This type may be more suitable for local and/or temporary drainage due to easy handling and installation.	As a ready-made pump with light superstructure can be furnished, required construction cost can be held down relatively. Pumps are transferable to other sites.
5.Reference Figures	Fig. 5.15	Fig. 5.16	Fig. 5.17

Fig. 5.15 General Layout of Stationary Type Pumping System

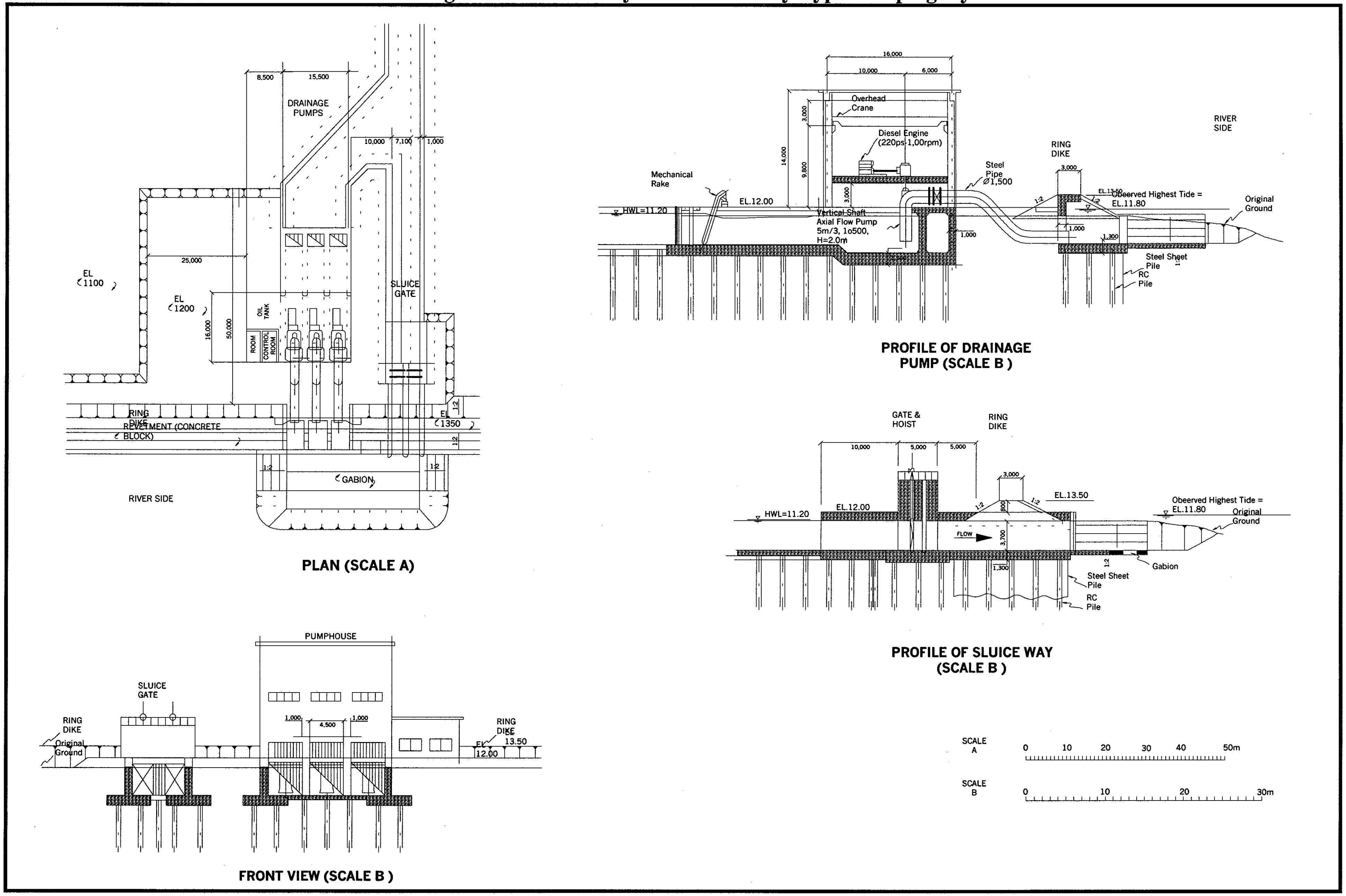


Fig. 5.16 General Layout of Movable Type Pumping System

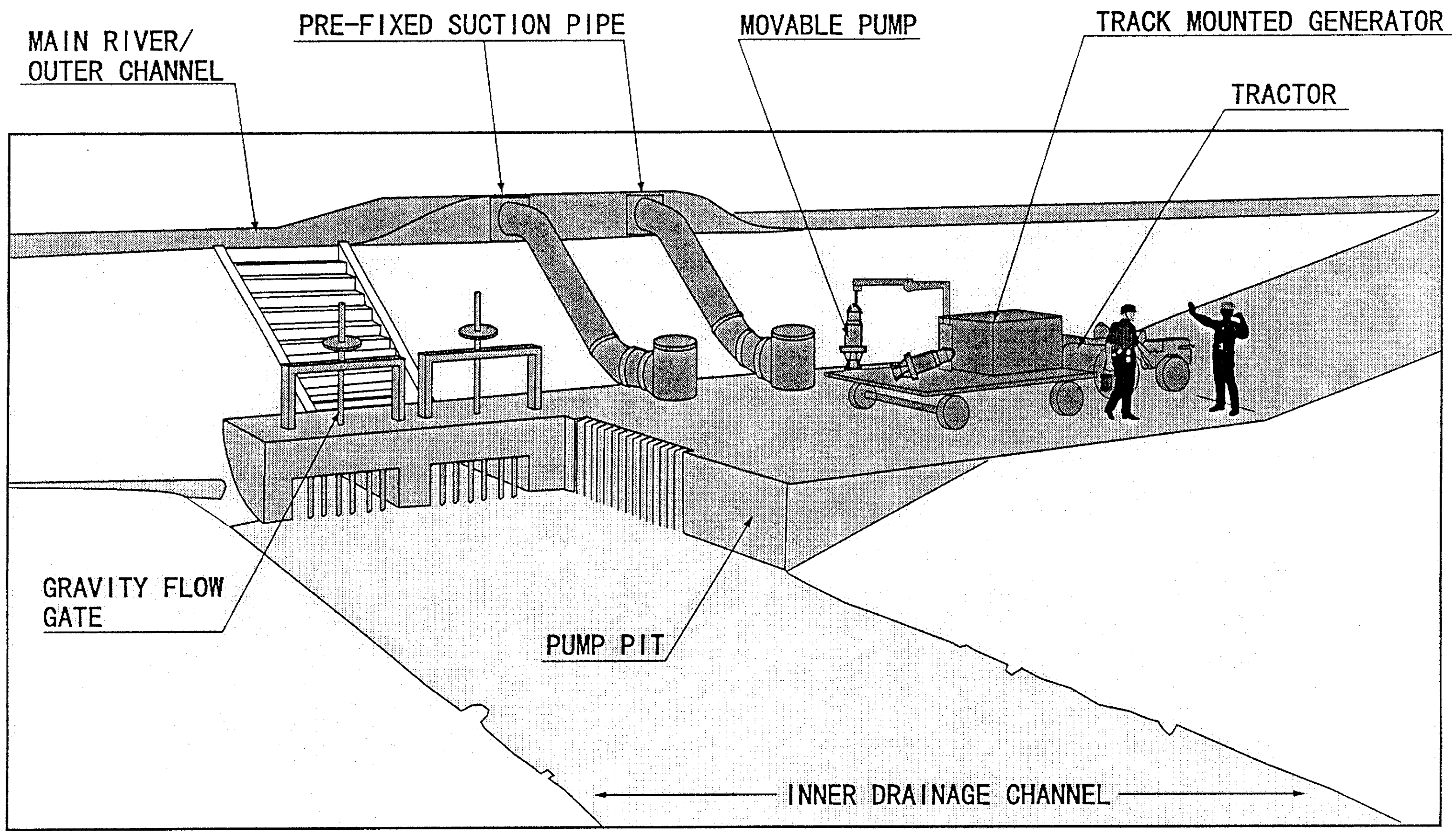
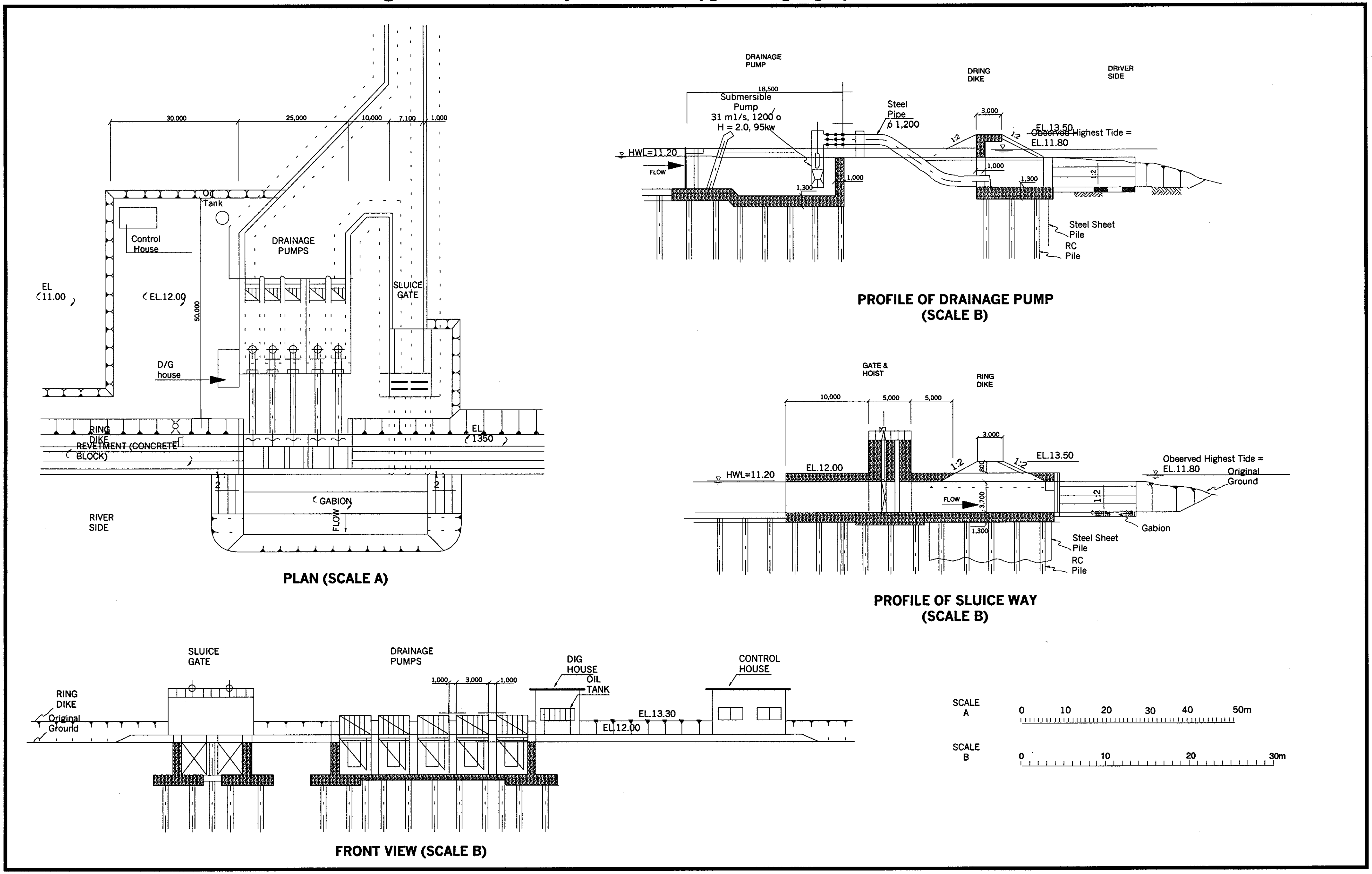


Fig. 5.17 General Layout of Unit Type Pumping System



5.7 Gate

The gate should be designed at the outlet point of drainage area in order to prevent the reverse flow from the exterior river or sea into the interior drainage channel, when the exterior water level is higher than the interior water level. The gate should be safely operated against flood flow at a water level equal to or lower than the design water level (or the design high tide level in case of a high tide section).

Explanation:

The gate will be installed as part of sluice or sluice way to form the outlet of continuous levee. As an appurtenant structure for pumping station the gate will be usually provided to release the interior water gravitationally. The gate structure is classified into four types, that is; (a) roller gate (girder structure), (b) long span roller gate, (c) flap gate (gross main girder structure) and rubber fabric gate (bag structure). The general features of these gate types are as shown in Table 5.7, and their profiles are as illustrated in Fig. 5.19.

The gate should be a structure which will not hinder drainage flow at a water level equal to or lower than the high water level and will not seriously hinder channel banks and channel administration facilities in the proximity. And it will be designed by paying proper attention to prevention of scouring in channel bet which connect with the gate. [*5-5.].

(1) Structure and Cross-section Features

The structure except for gate and administration facilities should be a reinforced concrete structure or a structure similar thereto which will not hinder release of sediment. The cross section features of the spillway portion of a gate should be fixed in consideration of the design discharge (or the design discharge and the size of boats to pass through in the case of a sluice to be used for passage of boats).

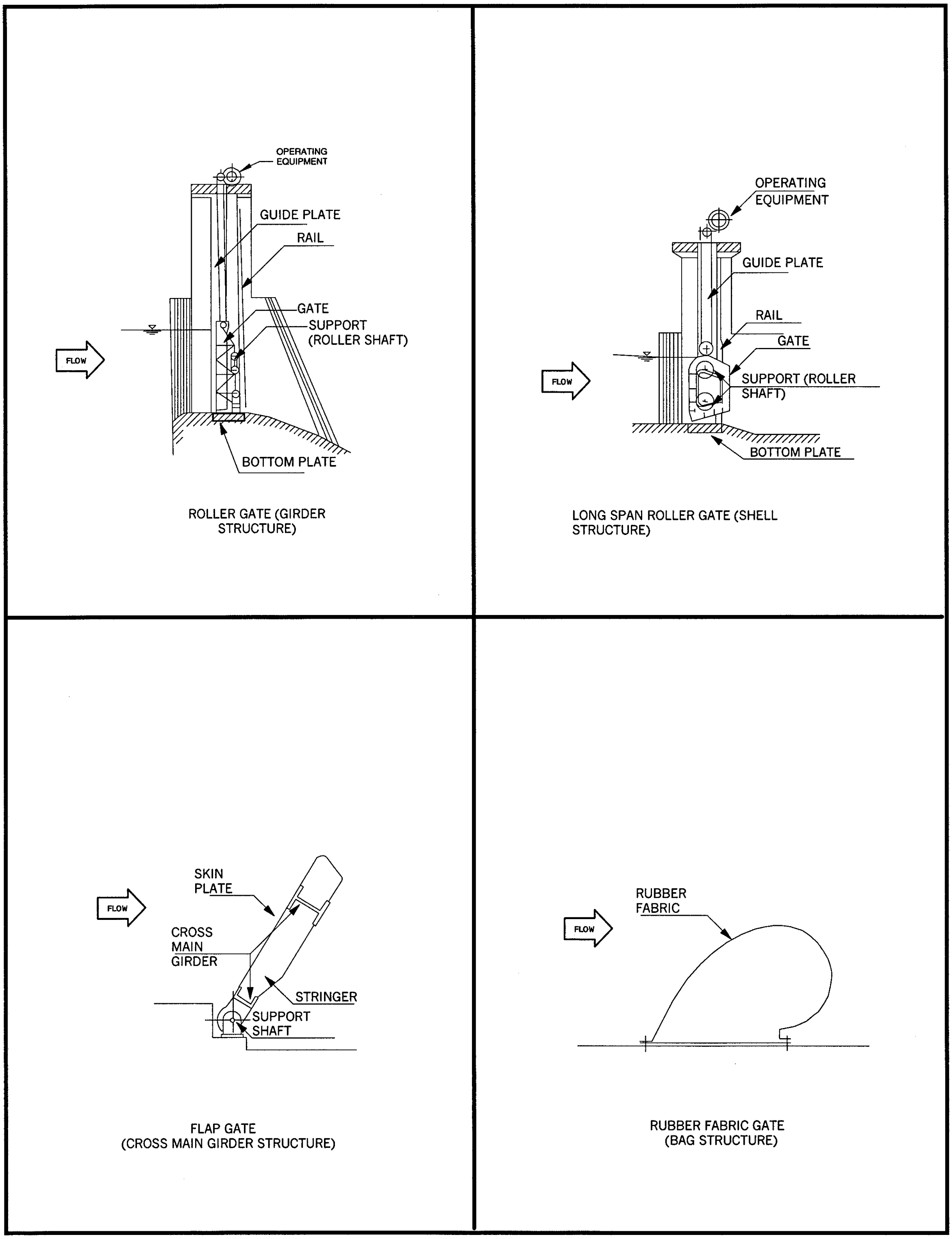
(2) Structure of Gate

The gate should be a structure which is sure to open or close and has necessary watertightness. The gate should be a steel structure or a structure similar thereto.

Table 5.7 General Characteristics of Typical Gates

Item/Type	Roller Gate (Girder Structure)	Long Span Roller Gate (Shell Structure)	Flap Gate (Cross Main Girder Structure)	Rubber Fabric Gate (Bag Structure)
1. Civil and Building Works				
• Space Required	Comparatively large in width and length, and also higher due to lifting height of operating equipment.	Comparatively large in width and length, and also higher due to lifting height of operating equipment.	Comparatively small in width and length	Comparatively small in width and length
• Substructure and Foundation Work	Costly due to heaviness and requirement of accuracy of the machinery.	Costly due to heaviness and requirement of accuracy of the machinery.	Comparatively not so costly due to light weight of equipment	Comparatively not so costly due to light weight of equipment
• Superstructure / Building Works	Comparatively large size superstructure consisting of pier and beam/slab for operation equipment is necessary.	Comparatively large size superstructure consisting of pier and beam/slab for operation equipment is necessary.	No large size superstructure is required. An operation house only is required.	No large size superstructure is required. An operation house only is required
2. Mechanical and Electrical Works				
• Rolling Up Equipment	Rolling up equipment is required.	Rolling up equipment is required.	None.	None.
• Hydraulic Equipment	None.	None.	Hydraulic piston is required.	Water or air pump is required
• Operation	Prime action for operation should be the manual basis.	Prime action for operation should be the manual basis.	Automation is easily done.	Automation is easily done
• Maintenance and Repair	Very easy : Frequent maintenance can be done easily.	Easy: Frequent maintenance can be done easily. However, structure is rather complicated compared to girder type.	Rather easy : Periodical inspection and maintenance can be done easily. Durability of hydraulic equipment is shorter than rolling up equipment.	Rather easy : Periodical inspection and maintenance can be done easily. Durability of rubber fabric and pump equipment is considerably shorter than rolling up equipment.
3. Applicability	The most general type. Various sizes can be applicable. In the case of small size gate, manual operation system also can be applicable.	A long and large size structure is preferable making the most of the scale merit from an economical point of view.	Suitable for low water pressure and small size.	Suitable for low water pressure and small size.
4. Appurtenant to Pumping Station	Many examples. (Refer to Figs.5.15 to 5.17)	Few examples.	Not suitable.	Not suitable.

Fig. 5.18 General Profiles of Typical Gate



ROLLER GATE (GIRDER STRUCTURE)

LONG SPAN ROLLER GATE (SHELL STRUCTURE)

FLAP GATE (CROSS MAIN GIRDER STRUCTURE)

RUBBER FABRIC GATE (BAG STRUCTURE)

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5-5 "Government Ordinance for Structural Standards for River Administration Facilities, Japan"

CHAPTER 6 MAINTENANCE

6.1 General

The drainage facilities are subject to constant wear and tear, and should be well maintained and repaired to sustain their prescribed functions.

Explanation:

Maintenance for drainage facilities is indispensable as a part of the drainage improvement and its work plan should be prepared in due consideration of necessary work items/procedures and administrative arrangement (such as budgeting arrangement and man-power arrangement for maintenance). Major works for maintenance of drainage facilities have no significant difference from those for other infrastructures including removal of sedimentation, solid waste and other drifting materials and repair/replace of the part of the facilities. Among the drainage facilities, the flood detention/retention facilities placed in a public open space and a private house lot will take a space which is used for various purposes other than flood mitigation. Accordingly, maintenance work for those facilities is subject to cooperation from and agreement with owners and/or users of the space.

6.2 Required Maintenance Works

The regular maintenance program should be prepared specifying the points, frequencies and methods of inspection for every major drainage facilities. The program should be well acknowledged to the competent agencies and personnel for maintenance works, and in accordance with the program, maintenance works should be constantly made during a non-flooding time as well as during and after flooding time.

Explanation:

The maintenance works required for the drainage facilities are as described below:

(1) Storage Facilities

The following items are enumerated as the major maintenance works for storage facilities (refer to Table 6.1 *[6-1]:)

(a) Securing of Storage Function

The maintenance work aims at securing the storage capacity as well as the flow capacity of inlet/outlet structures of the storage facilities. In order to fulfill the storage function, required are the periodical removal of sediment, solid waster and other drifting materials from the inlet/out and flood storage space. Backhoe or other heavy excavation equipment will be required for removal of deposits from a large scale of storage ponds. Moreover, a periodical inspection should be made on the damage of the inlet/outlet structures and leakage of water from the ponding space, and repair works should be made as required through the inspection.

(b) Safety Control

The sign board nearby and fence around the storage facilities should be installed and periodically inspected/repaired in order to prevent personnel from falling into the ponding area and trespassing into the inlet/outlet structures and other danger zones of the facilities.

(c) Sanitary Control

The periodical inspection on the water quality of the ponding water should be made. In accordance with inspection, impounding water should be drained and pollution control measures should be taken as required.

(2) Drainage Channel

The most critical issue on the maintenance works is to secure the prescribed channel flow capacity. In order to cope with the issue, required is periodical and emergency removal of sediment, solid waster and other drifting materials accumulated in the drainage channel. Mowing of grass on the channel slope of the earth drain is also required. A lot of drifting debris tend to accumulate and clog at the hydraulic critical points such as inlets of diversion point and pipe culvert, piers of bridge and drop structure. Therefore, a special attention should be paid to those points through the periodical maintenance during non-flooding time as well as the emergency maintenance during and after flooding time. Among others, the inspection of drainage facilities immediately after flooding will facilitate to clarify the trouble points and structural weak points, and the revision of maintenance program should be made on the basis of the inspection.

Table 6.1 Maintenance Items of Detention Pond

Case	Descriptios of Maintenance Managements					Maintenance Time
	Inspection Place				Inspection Point	
Normal Condition	Inspection	Outlet Facility	Outlet Tower		Condition of structure	Rainy season : 2 times/month Dry seson : 1 time/3 months
			Orifice		Clogging of screen, sedimentation	
			Conduit Pipe		Leakage of water	
			Spillway		Condition of structure, revetment, obstacle and damage	
			Others			
		Pond	Slope		Slope failure, crack, leakage, spring, damage, subsidence, collecting drain, clogging of box, turffing and weeding	
			Crest		Damage, settlement, subsidence, condition of crest drainage, damage of pavement	
			Sedimentation Basin		Sedimentation, condition of drainage, rubbish, weeding, obstacle for releasing water	
			Others			
		Periphery of Facility/Downstream	Periphery of Facility		Change of ground, influence against safety of facility	
			Cut Slope		Slope failure, crack, leakage, spring, turffing	
			Downstream of Spillway		Increment of dangerous condition	
			Downstream Channel		Condition of structure, obstacle	
			Others			
		Observation Facilities and others	Observation Facility		Conditions of water level gauge and structure	
			Air Supply Pipe		Damage, clogging	
			Guard Fence		Damage, collapse	
			Sign Board		Damage, collapse	
			Others			
		Materials and Equipment	Materials		Quantity and quality, condition of custody	
			Equipment		Quantity and quality, condition of custody	
			Others			
	Removal of Sedimetation					
	Weeding and Clearing					Flooding time
At Flooding	Inspection same as the above					In case of forecasting flooding
	Patrol	Inspectio Point			Reasons	Flooding time
		Does water level reach High Water Level?			Due to overflow from spillway sever influence to downstream can be expected.	
		Does water level surge or draw down rapidly?			It might be caused by clogging of orifice/screen or crack of embankment. Sudden fluctuation of water level might suggest some possibility to produce slope/embankment failure.	
		Does quantity of releasing water decrease?			Clogging of orifice/screen can be considered as main cause.	
		Does seepage or slope failure occur at embankment ?				
After Flooding	Inspection same as the above					After flooding

BIBLIOGRQPHY

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