Chapter 4

Supplementary Reports for Recommendations

CHAPTER 4 SUPPLEMENTARY REPORTS FOR RECOMMENDATIONS

At the end of each visit to Mexico, recommendations have been made to CPI regarding Mexican industrial ports development. Returning to Japan, we further discussed/reviewed fundamental matters or problems and wish to add following supplementary reports for reference.

1. Procedure of industrial port development
2. Method to determine the scale of industrial port
3. Port and harbour development system
4. Investigation system for the development of industrial port
5. Method of planning of port facilities
6. Soft-ground treatment
7. Environmental protection and administration of ports and harbours
8. Countermeasures of safety and prevention of disaster for ports and harbours
9. Execution and supervision of port construction
10. Port administration and operation

4-1 PROCEDURE OF INDUSTRIAL PORT DEVELOPMENT

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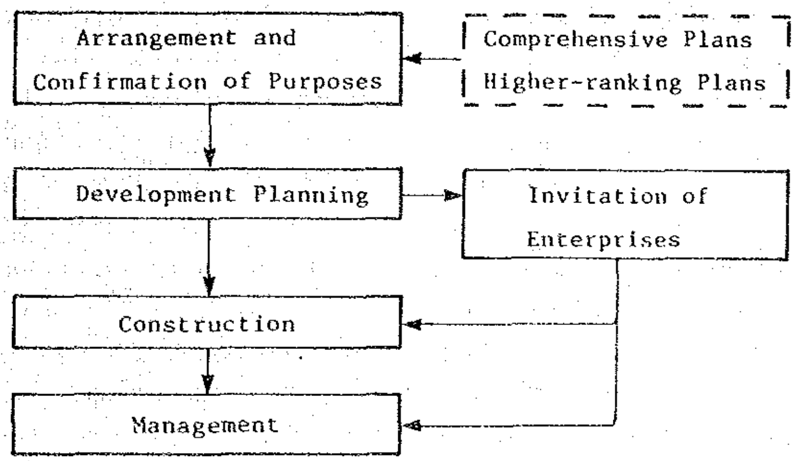
4-1-1 Introduction

The items and the procedures of basic works to be dealt with by a promoter in developing a new industrial port will be classified as follows.

(1) Arrangement and confirmation of purposes
(2) Development planning
(3) Port construction and invitation to enterprises
(4) Port administrations and operation

In this section, we wish to make clear the contents of above items and the important point in the development of industrial ports to serve as reference for planning of new industrial ports in Mexico.

Fig. 4-1-1 Operational Flows in Industrial Port Development



4-1-2 Arrangement and Confirmation of Purposes

(1) What for is the industrial port developed?

Before the commencement of the planning work, the purposes to develop an industrial port must be made clear and confirmed by thorough discussions among people or the authorities concerned. The port development has close relations with the higher--ranking plans or plans concerning other departments. These other plans must be therefore adequately studied for the confirmation of the development goals. The other relating plans will be checked in detail and this will simultaneously reveal the conditions precedent or limiting. Some of the goals are very often contradictory to each other; for example, a goal is to accomplish the labour--intensive and still highly productive industry. In these cases, the order of priority must be decided first and then the feasible goals must be accordingly chosen.

The purposes of the development of the industrial port or the industrial base must not be simple but complex, and the essential factors are categorized as follows:

① The self-support ratio of a specific product is to be increased.
② A further extent of product-processing is to be achieved.
③ Income levels in a region or a nation are to be raised.
④ Employment opportunities are to be increased.
⑤ Effective land-utilization is to be achieved.

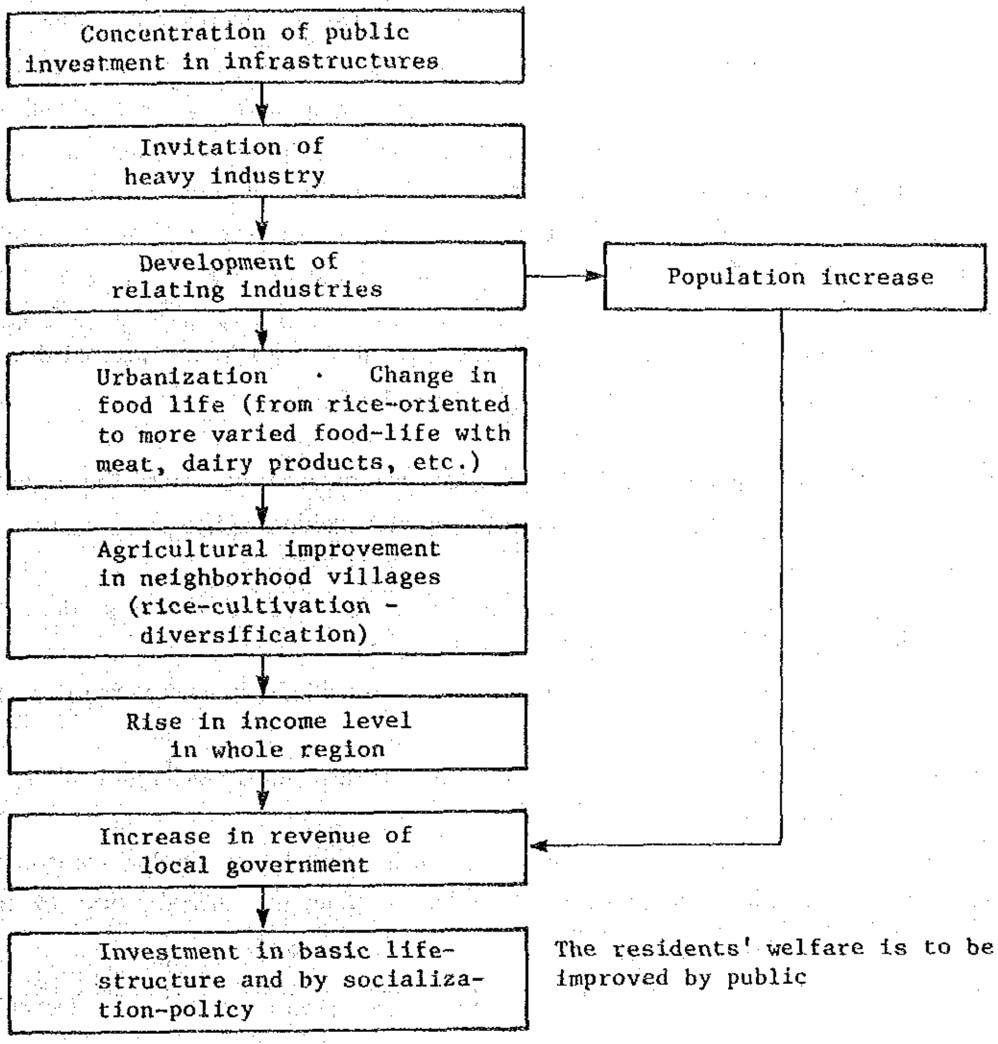
The item ①,"The self-support ratio of a specific product is to be increased", is the most specific development purpose. There are many developing countries which advocate the self-supportingness in the fundamental products such as cement and fertilizer. For this purpose they can start out only with the detailed planning of the industry concerning that specified product.

The item ②, " A farther extent of product-processing is to be achieved" is one of the purposes most typical to the development of industrial port. That is to say, in case that raw materials yielded in the hinterland are to be processed for domestic consumption or for export, then the construction of an industrial-port can be planned for a location where these materials have been loaded from.

There are many cases in which the item③,"Improvement of Income Levels" and the item ④, "Increase of Employment Opportunities" are the purposes for the development of industrial ports. In those case, there are many factors to be decided by planners with regard to the materialization of the basic plans such as the types and scale of the industry to be developed. The former tries to improve the income levels by shifting the industrial structure of a region or a nation from the primary-industry-oriented such as agriculture, forestry and fishery to industrilization where high labour-productivity and large value-addedness are expected. Most of the industrial ports developed in Japan have been planned for this purpose.

The philosophy in these cases are shown in the following flow-chart, Fig. 4–1–2.

Fig. 4-1-2 Concept in Development of an Industrial-Port to Achieve Regional Progress



The purpose, "Effective Land-Utilization" of Item ⑤, is a major factor leading to the industrial-port development. In Japan, "The Large-Scale Industrial Bases in Remote Area" which constituted a care of "New Comprehensive National Land Development Plan"; 1969 was one of those originated from this purpose.

(2) Are there any alternative?

Even with the clear-cut purposes for the industrial-port development, it is still recommended that the alternatives for the industrial-port development be studied prior to the planning commencement.

As a measure for the regional development, the industrial-port development has the following advantage:

- o It is possible to freely create site environments surrounding the industry as intended by a planner.
- o It has direct and vast effects.
- o It exerts much political pressure with its dynamic and vivid influences.

On the other hand, it has the following defects:

- o It requires a large investment.
- o It is risky with many technical problems.
- o It requires long time for development.

The industrial-port development is neither any only measure for the regional development nor necessarily successful under any conditions or at any times.

The reasons why Japan make such high economic growth in 1960's with the industrial-port development as its driving force are due to the following favorable conditions:

1 There was adeuate supply of labour available as a result of the modernization of agriculture and the post-war explosion of baby-births.
2 The resources such as raw-materials and fuel were supplied from overseas in good amount but still economically.
3 There was high demands for industrial products with rapid development of the domestic and the world economy.
4 The required reinforcement of production facilities and the technology renovation took place almost simultaneously, only to make possible the introduction of the latest production technology.
5 The Japanese economy was based upon the "process-and-trade" industrial type.

In addition to the conditions above which are directly related to the industrial production, there was a condition never to be forgotten that a clear-cut emphasis was given to the industrial-port development the Japanese government's comprehensive policy and it was supported in other administrative fields as well. One of such examples was the existence of a master-plan called "Comprehensive National Land Development Plan" advocating "Points Development Policy". Another is the secondary psychological and financial effects brought up by the two specific systems, "New Industrial Cities" and "Special Areas for Industrial Consolidation" which are nothing other than the materialization of the policy developed in the first example.

In order for the industrial-port development to be successful, it must be promoted as a port of overall policy to cover other administrative fields as well, and the construction of a port does not necessarily guarantee the automatic success of the development.

Only after confirming that the industrial-port development is most effective to fulfill the set goals and has very good chance of success, we can move on to the next step.

Even if the purpose for the industrial-port development is the industrial development itself as of item ① and ② mentioned earlier, the reasons why it must not be the inland development should be clarified. For example, in some industry-types, humidity and salt might be the things to be avoided and sea-born traffic might not be required for transportation of the raw-materials and of the products.

The comparison of merits and demerits between the inland industrial base and the coastal base is given in Table 4-1-1. These merits and demerits are based upon the relative appraisal applicable only for the comparison between the inland and the coastal and, furthermore, the remark "generally" must be duly noticed. The merits of the coastal industrial base which can be developed on the flat and vast reclaimed land are great in a country such as Japan where very limited land is available, with complicated topography and where highly dense land-utilization has been already reached, but this is not necessarily true for another country, it must be kept in mind.

Table 4-1-1 Merits and Demerits Between Inland and Coastal Bases

	Inland Industrial Base	Coastal Industrial Bases
Merits	• Land-preparation is easy	• Land-procurement in any shapes are possible because of reclamation • Marine-transportation is possible • Large amount of cooling water is obtainable
Demerits	• Coordination with already existing land is difficult • Topographical restraints are great • Limit on mass-transportation is great	• Salt-damage is possible • Risk for disaster-striking is high • Site-preparation cost is high

In case that the item ③, "Improvement of Income Levels" and the item④, "Increase of employment opportunities" are the purposes, there are many more items to be studied.

First of all, whether or not the industry development is the only solution must be checked. Whether or not the participation of undertakers is really possible must be investigated by making a feasibility study of the industry in comparison with the other industries.

This holds true even if it can create, as planned (artificially), the new employment opportunities and if it is most effective for the improvement of income levels. The above is applicable to the case of the item ⑤, "Effective land-utilization". Coastal vast land might be suited for the recreational resort zone, pending some regional conditions.

* Resorts project in Southern France is a good example of this. There are innumerable examples in which reclaimed land was more suited for agricultural use.

4-1-3 Development Planning

(1) Flow in Planning Work

An operational flow in planning the development of an industrial port is more complicated than the one for commercial ports. This is because the industrial port is a compound of port facilities and production facilities and by considering the fundamental operational processes, it can be organized as shown in Table 4-1-2.

This is divided into two parts, i.e. one to do with the arrangement of port facilities and another concerned with the new development of production-facilities. These are shown as follows; "C Choice of Measures" and "D–1. Land-utilization Plan" are deeply concerned with the new development of the production–facilities, and "D–2. Forecast of Numerical Dimensions" and other subsequent to that are the works same as is general port-planning. The work-process can be reversed; for example, a great portion of "C–2. Selection of Industry Types to be Developed" can be determined prior to the actual works if the improvement of self-supporting rate for a specific product is the development purpose as mentioned in "4–1–2 Arrangement and Confirmation of Purposes". Furthermore, if the effective land-utilization of a specific region is the development purpose than the works relating to "C–1. Selection of Site to be Developed" may be no longer required.

The work process in planning to develop a new industrial port is naturally different from the one for the extension of already existing ports. However, the basic operational flows in the process of the works should not deviate too much from the ones shown in the table, even though there are some differences in the details.

In Japan, there are very few purely industrial ports and most of the ports function both as industrial and as commercial, thus creating an image that they are public assets. Because of this image, only few investigation have been made regarding the financial aspects of the ports. The items to be checked at each stages are shown as follows:

Table 4-1-2 Flows in Planning Works

Characters of works	Work items
A. Decision of basic factors	A-1 Decision of basic concept (attitude) A-2 Clarification of constraints and pre-requisites
B. Data-collection, analysis and appraisal	B-1 Data-collection, analysis and appraisal
C. Selection of measures	C-1 Selection of site to be developed C-2 Selection of industry-type to be developed C-3 Determination of development scope
D. Planning	D-1 Land-utilization plan (determination of lay-out) D-2 Forecast of numerical dimensions D-3 Plan on port facilities D-4 Plan on supervision and management
E. Appraisal and selection	E-1 Check on effects of development E-2 Preliminary study of effects on environment
F. Planning procedure	

(2) Arrangement and Confirmation of Basic Factors

A-1 Arrangement and Confirmation of Basic Concepts

Once the development of an industrial port is decided, the next step is to arrange and confirm the basic concepts under which the planning is proceeded. There are many cases that the basic concepts are clarified in the higher-ranking plans.

A-2 Clarification of Constraints and Pre-requisites

The constraints and the pre-requisites must be made clear and some of those are often found in or deducted from other higher-ranking plans which initiated the industrial-port development concerned. Others can be clarified from the results of the analysis and appraisal of the collected data. Typical constraints and pre requisites are as follows:

- o Target year
- o Site to be developed
- o Capital available for development
- o Variety of industry types
- o Procurable labour-force
- o Plan to adjust social capitals relating to roads, rail-ways industrial water supply and electric-power supply, etc.
- o Environmental constraints
- o Other legal constraints

(3) Data-collection, Analysis and Appraisal (B)

When planning an industrial port, unlike other general ports, we must be especially careful about the data concerning the site conditions for the industry of interest. For this purpose, those data must be collected which are concerned with the items required in "C–2 (iii) Checking of Site Conditions" including existing situation about the relating industries and preliminary conditions like industrial water power, labour-force, transportation facilities, etc.

(4) Selection of Measures

C-1 Selection of Site to be Developed

a) Items of Appraisal

In most cases, the site to be developed has been dicided before-hand; however, whether or not the selected site is good for the industrial port must be still checked even in these cases. Furthermore, the ideal port location within the selected site is still to be chosen.

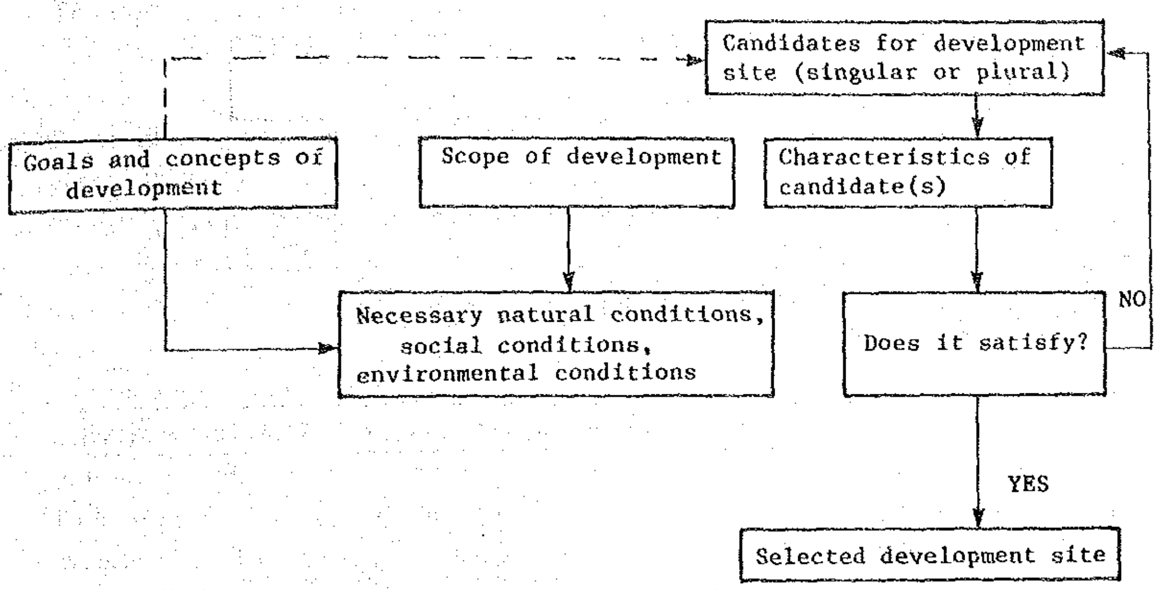
The following items must be checked to choose the site to be developed:

1. Whether it satisfies the purpose and basic concepts.
2. Whether the required scale of the development is feasible.
3. Whether it is technically feasible from a construction viewpoint under the existing ambient natural conditions.
4. Whether it is feasible from social and economical viewpoints.
5. Whether there are any environmental problems expected.

b) Procedure in Selecting a Development Site

The procudure used in the selection of the site to be deveoped is shown in Fig. 4–1–3.

Fig. 4-1-3 Procedure to Select the Development Site



C-2 Selection of a Type of Industry

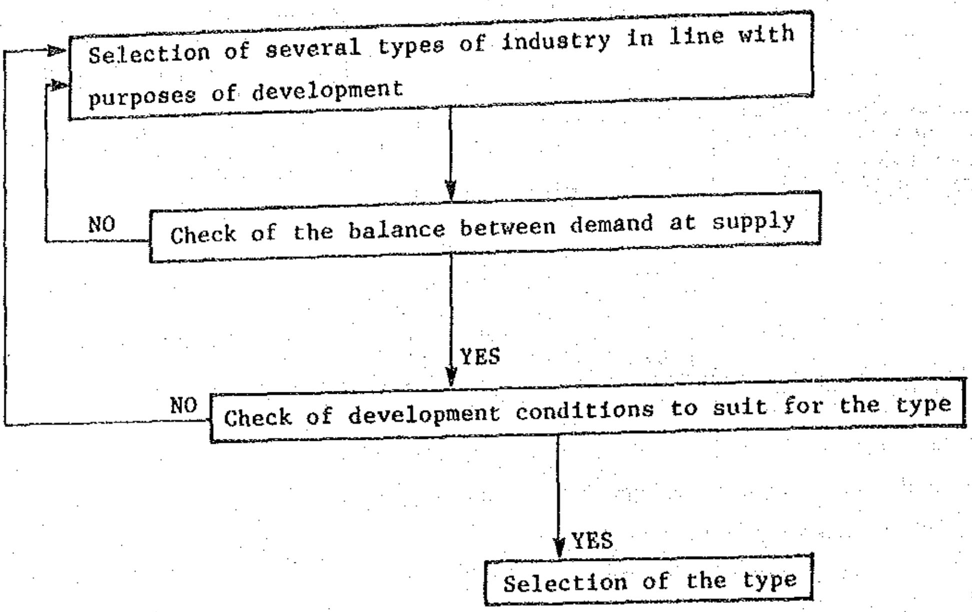
a) Conditions for Selection

Whether or not the industrial-port development is successful rests upon the choice of a type of industry. Furthermore, once the type is decided, the scale of the industrial port can be defined fairly well, and two-dimensional lay-out (land-utilization) is assumed to be possible to a certain extent.

The following three are the factors major in and most influential upon the selection of an industry-type.

1 Purpose(s) of development
2 Conditions of development
3 Whether there will be new demands for the type of industry (balance between supply and demand)

Fig. 4-1-4 Procedure in Selection of an Industry-type

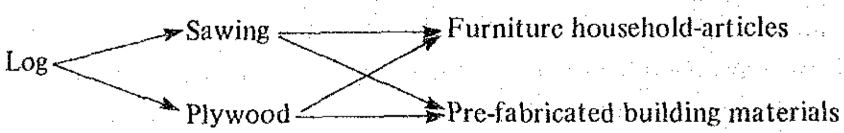


b) Industry Suited for Goals of the Development

If the purposes of the industrial-port development are

- o To improve the self-support ratio of a specific industrial product
- o To have more processing-involvement of raw-materials to be yielded in the hinterland of the port,

Then the industry type will be known by now. In the latter case of the above two a judgement on the degree of processing is required even after the type is known. The cases of logs, of ores and of crude oil are taken for examples and the processing stages for each are as follows.



Ore ⟶ Refined ore · hardened ore ⟶ Ingot

Crude oil ⟶ Petroleum products ⟶ Petrochemicals ⟶ Processed products

To what extent the material is to be processed is determined as a matter of policy-making and also in light of available technology level and the balance between demand and support for the product of concern.

In case that

- o The income levels of a region or a nation is to be increased.
- o The employment opportunities are to be inproved.
- o The effective land-utilization is to be achieved.

Then, all the industry types should be checked for type(s) to be chosen. In order to increase the income-levels, those types are desirable which require the large volume of production and also which produces the goods with highly added valves. In order to increase the employment opportunities, the labour-intensive industry-type will be desirable. However, this is not as limiting as in the first case and indeed there will be much freedom in choosing the industry-type.

The procedure to choose a type, in this case, is as follows:

1 A nation-wide trend (for some types, world-wide trend), in the various types of industry, complying with the economic policy of the nation must be checked, and general types suitable at the development location will be studied.

2 Whether the detailed plans about the facilities such as economically feasible scale, port and land development, or availability of water are within allowable range must be checked for each type of industry suitable at the location.

c) Industry-types Suited for the Site Development Conditions

Another barrier to remain to be overcome in choosing an industry type is a check if such site-development conditions are satisfied as water, land, labour-force, etc. required for the industry-type to be developed and the scope of the development.

Table 4−1−4 shows the relative weights of importance of each factors in the site-development for each at the industry types. The candidate-sites will be evaluated by referring to Table 4−1−6 "Typical details of main industry-types" for the specific contents of each factor such as the size of the required land. These site development conditions are varied not only by the size and the type of the development but also by the progress of technology. For example, the original units of water and of land are varying for each of the industry-types as shown in Table 4−1−5.

There are factors other than the progress of technology which contribute to the variation of the site-original units.

Once of such examples is a land-saving attempt caused by the rising prices of land. Another example is the issue of regulations to stipulate that the ratio of open spaces in the factory site be higher than a certain figure. An environment as one of the development conditions are nowadays paid a higher regard, it should be included in the labour force if treated as of the site-development conditions. However, the existing conditions of the educational, cultural and medical facilities of a city where workers are to live, have much importance if a labor-force must be procured.

Table 4-1-4 Site Selecting Factors for Each of Industry Types (Important factors)

Type of Industry	(1) Domestic resource	(2) Port	(3) Domestic market	(4) Relating industries	(5) Supporting industries	(6) Labour-force	(7) Others	Details of (7) Others
Steel		◎	○				△	Load-bearing water
Special steel			○	◎		△	◎	Road
Cast-iron steel			○			○		
Cast pig-iron			◎			○		
Frame, Bridge						△	◎	Trnasport
Screw			○		△	△		
Steel-spring			◎		△		○	Materials
Cultivator			△		○	○		
Tractor			△		◎	○	◎	Road
Machine Tool			△		○	○		
Plants			△		◎	○	◎	Transport
Sewing Machine			△		△	○		
Bearing					○	○		
Generator		○			△	△	◎	Transport
T.V-set					△	◎	◎	Road
Speaker						◎		
Condenser						◎		
Car		△			◎	○	◎	Road
Radiator				○	△	△		
Camera					○	○		
Wrist-watch			△		○	○		
Fertilizer		◎		○				
Soda		◎	○	○			◎	Railway
Petrochemistry		△	○	◎				
Detergent			◎			○		

Type of Industry	(1)	(2)	(3)	(4)	(5)	(6)	(7)	Details of (7)
Paint			○			△	◎	Dangerous article treating
Car tyre			○			○		Transport
Plate-glass			○				◎	Transport
Cement	○		○				◎	Electric power
Fire-proof brick			◎			○	△	
Concrete products			◎			◎		
Ready mixed concrete			◎			○		
Plastic (Form)				◎		○		
Vinyl chloride			◎				○	Road
Short fiber spinning						○	◎	Water
Paper, pulp		◎					◎	Water, Drainage
Wooden furniture	△	△	△		△	△		
Gard-board box			◎			○		
Rubber foot-wear						◎		
Machinery					◎	○		
Copper, Zinc etc.	○	◎					◎ ○	Power Railway
Aluminium		◎					◎ ◎	Power Railway
Refinery Oil-Refinery		◎	○	○			◎	Transport
Cable, Wire			◎			○		
City Gas		○	◎	△			◎	Cooling water Pipe line
Power plant (thermal)		○	◎	△			◎	"

Notes: ◎ : Absolutely important
○ : Very important
△ : Important

Table 4-1-5 Land-Original Unit, Water Original Unit

	Land original unit (1,000 ha/trillion yen)			Water original unit (m^3/day, one hundred million)		
	1965	1973	1974	1965	1973	1974
Basic-industry type	4.1	2.2	2.3	268	137	135
Local-resource type	3.6	2.7	2.8	114	82	79
Metal-processing type	2.4	1.1	1.2	24	13	13
Commodities type	2.2	1.6	1.9	53	27	29
Total	3.2	1.8	1.9	123	61	62

Source: "Industrial statistics (land, water)" by Ministry of Industry and Trade

Note: Land original unit = area of factory lot ÷ net industrial amount delivered from Water original unit = fresh water supplied ÷ net industrial amount delivered from

Table 4-1-6 Dimensions of Typical Factories

Type	Product	Capacity (per year)	Area ($x10^3$ m^2)	Water Consumption ($x10^3$ m^3/day) Fresh	Sea	Number of Employee	Location
Steel	Crude Steel	$50x10^t$ t	5,690	60	170	3,030	Kanto
Alumina & Aluminum	Alumina Aluminium	700,000 t 210,000 t	2,320	48	85	1,500	Hokkaido
Copper	Electrical copper	90,000 t	281	11	140	440	Tohoku
Zink	Electrical zink	80,000 t	210	43	0	510	"
Shipbuilding	Build (500,000 DWT) Repair	5 vessels 5	767	1.6	0	1,550	Tokai
Oil Refinery	Crude Oil Treatment	15,500 BPSO	1,300	26	239	344	Kanto
Petrochemistry	Ethylene	440,000 t	422	32	-	450	"
Paper & Pulp	Printing Paper Newspaper Craft-paper	100,000 t 88,000 t 36,000 t	450	180	0	1,340	Tokai
Cement	Portland Cement	$1.25x10^6$ t	3,820	8	85	520	Tohoku
Flour	Wheat flour	168,000 t	30	1.2	0	260	Kanto
Oil	Vegetable Oil	87,000 t	198	4	35	390	"

d) Check of Balance between Demand are Supply

There will be no undertaker interested in the industrial-site development if no demand for the product is expected, even if the type of industry is really suited for the development purpose. So, for each of the industry, candidates, a check must be made whether in the near future the demand exceeds the production capacity and whether in the additional investment is required to increase the production capacity. It is also necessary to check if the product is competitive enough in the international market with the transportation costs included. Today every industrial product is an international merchandise; therefore, if not internationally competitive, the domestic product will never necessitate a new industrial-site development without some protective measures such as introduction of tariff barrier and import-restrictions.

When a decision about feasibility of the development, is to be made balance between overseas demand and supply must be also considered.

C-3 Determination of Development Scope

There is a certain range of the effective production scopes for each industry-types; therefore, the scope of development can be automatically determined once a industry type is chosen.

Table 4–1–6 gave the typical dimensions of the major industries, but the more detailed information will be discussed in another section, "4–2 Method of Determine the Scale of Industrial Ports".

(5) **Development Planning**

D-1 Land-utilization plan

The land-utilization plan of industrial ports, consists of two factors.

Two dimensional plan
- Plan on arrangement of industrial base (lay-out, size and shape)
- Plan of port facilities

When these two factors are determined, the type of the industrial port is also chosen.

There are two types of industrial ports, one by reclamation and another by (artificaial) excavation. The older industrial ports such as Keihin-yoh, Hanshin and Chukyo are mostly by reclamation and the latest large-scale industrial ports such as Kashima, Tomakomai and Mutsuogawara are by excavation. Which of the two is to be chosen should be judged mainly by topographical consideration.

Table 4-1-7 Types of Industrial Ports and Topographical Feature

Type	By reclamation	By excavation
(Coast)		
Location	Inland sea, inland bay or covered (protected) by islands or peninsulas	Facing outer sea
Sea-bed slope	Not steep	Steep
Water-surface utilization	Not or hardly utilized	Highly utilized
(Hinterland)		
Topography	Steep and complicated	Flat
Land-utilization	Advanced	Mostly not or hardly utilized
Land price	Expensive	Comparatively cheap
Marine phenomena	Quiet	Rough

The lay-out plan of an industrial base (lay-out of factories, size and shape of land) is judged from the following two aspects: The shape of a factory lot and the coast-line will be controlled by the logicalness of "Movement line", a flow of goods from inside the enterprise to inside the factory. Furthermore the desirable mutual locations will be decided by considering delivery-receiving system of half-products, raw-materials and fuels between the undertakers. The points to be checked in the two-dimensional planning from a port-standpoint are as follows:

1. The undertakers requiring larger ships for transportation are located near to the port entrance.
2. The dangerous articles are located in the rarely used areas.
3. The dirty cargo is separated from the clean cargo.
4. The relation between dust-causing materials and wind-direction.
5. The load bearing capacity of the soil.
6. The positions of inlets and out-lets with respect to the locations of undertakers which require cooling water from the sea.

D-2 Forecast of Quantitative Details

a) Volume of Cargo to be Handled

Once the industry type and the scope of production are determined, the volume of cargos relating to the factory can be fairly accurately predicted, and in that case the followings must be clarified:

1. The kinds, amounts and suppliers of raw-materials and half products.
2. The kinds, amounts and places delivered to of the product (including half-products)
3. Where are cargos handled, at public berth or at private berth?
4. Type of packing and transportation

As to the cargos to be dispatched from, the production plan should be referred to only if the enterprises are already known. If the enterprises are not yet known, and if the industry types and the production scopes are known, then the forecast can be made with reference to already existing development sites or to original units of cargos. It should be kept in mind that the original units will be varied for the different produciton scopes or for the varying technology levels.

b) Port-entering Ships

The transport plan of the undertaking enterprises, if any, should be referred to for the planning details regarding entering ships (types and shapes of ships and port-calling pattern). In case that the undertaking enterprises are not yet known or that there is not transport plan, the harbour conditions of material suppliers, sea-routes similar to the ones taken by ships in service and ship-building situation should be referred to for the decision.

D-3 Plan on Port-facilities

In planning the port facilities, there is no significant difference from the ones for ordinary distribution-ports. However, a careful observation is required about that there are more number of larger facilities and that the dangerous articles are more often handled.

D-4 Plan on Management and Administration

How to manage and administer an industrial port is very important. In Japan, industrial ports, like ordinary distribution ports, are administered by the port administrators. In case of the industrial-ports, however, as there are only limited number of users cooperative organizations by the undertakers to help the port administraiton are often formed or the expenses incurred in the adjustment of the hinterland are shared by the undertakers. Whether the industrial port to be developed is financially feasible under the proposed administration system or on what level the various utility fees or share of the expenses by the undertakers are to be fixed are to be studied in the next seciton together with the study about the effect or validity of the development.

(6) Appraisal and Selection

E-1 Study of the effects of the development

When the outline of the development plan an industrial-port is made, the effects of the development must be checked and the extent of the contribution to the goals set for the development must be made clear. Anything possible to be expressed in money term must be conducted an economy-analysis and in this way the effects will be evaluated more clearly.

E-2 Environmental Assessment

An environmental assessment must be performed in order to clarify the effects on the environment. If the effects exceed the allowable limit, then the lay-out of the industrial base must be modified and/or the protective facilities will be installed. If still not allowable even then, the basic frames of the plan such as the development scope, the industry-types etc. will be subject to revision.

(7) **Planning Procedure**

Once each factors in the plan of the industrial port are defined, we can proceed to the harbour-planning in accordance with the system fixed in a country of concern. Port planning procedure in Japan shows in "4–3 Port and Harbour Development System".

4-1-4 Port construction and Invitation of Enterprises

After the confirmation of planning and finances, the construction will be commenced, and at the same time or prior to that the initial invitation to potential enterprises shall be given to determine the undertakers to be located. The modification, if any, of the port development plan will be made with their advices or requests being taken into consideration, once they are known.

In connection with the construction, an important matter is where to locate the operational station. There will be no problem in case of the extension of or of the construction adjacent to the existing port; however, if a new port is to be constructed by reclamation or by excavation of the location where there is absolutely no port whatsoever, the operational base must be installed at a place safe and effective for the operation. The use of the temporary embankment in the Kashima port or the Mutsu-Ogawara Port should be studied for reference.

4-1-5 Points of Important in he Development of Industrial Ports

The procedure for the development of the industrial port and the points of importance in each item have been explained so far. The points of importance in the overall development of the industrial ports are discussed in this section.

(1) **Need of Great-sphere Appraisal**

a) Geological Great-sphere

The development of an industrial port exerts wider and greater influences upon the areas around the port than the case by commercial ports. For example, the employees' houses of the undertakers were built in the cities adjacent to the development area because of the rises of the landprices in the areas due to the development. Therefore, when planning the development of an industrial port, its influences for the spheres larger than the development area itself must be grasped, and the forecasts and the measures to be taken with regard to those must be either included in the plan itself, or a separate plan should be prepared.

b) Great-sphere with Respect to Veiwpoint

The development of an industrial port will bring up the increase of the production not only by the undertakers directly related. The effects resulting from the development include the increase of the population, renovation of agriculture and adjustment of the basic social capitals in the neighborhood as shown in Fig. 4–1–2. It is, therefore, important that when planning and assessing the project, the viewpoint be kept not in a small matter such as the construction of the industrial base but in a larger matter such as the construction or development of regional communities.

(2) Preparation of Plans by Steps

The industrial port is continuously making progress. This is true especially with the industrial port, even though other general ports have this characteristic to a certain extent. The reasons behind this are as follows:

1 The participating undertakers always to try to make the business bigger and to increase their production so long as they can.

2 The other enterprises in the relating industries will get together seeking the merits to be brought by the concentration.

3 There will be direct influences from the technology renovation.

If nothing is done about this, the industrial port would have an industrial base in its back which exceeds the capacity of the port. There are two ways ot deal with this. One is to relate the land-utilization plan of the hinterland to the port plan. The other is to make the port plan flexible so as to leave some measure to cope with the problem in the future. To this end, the so-called "Rolling System", in which the plan is divided into several stages and at each stage re-evaluation is made, is necessary and it is possible to give just an outline in its final stage so that the potential future extension can be made.

(3) City Planning for the Hinterland

A great impact will be given to the neighborhood regions by the development of the industrial port. The changes brought by that can be much varied and include the concentraiton of population, the increase of traffic volume and more energetic commercial activities, etc. The hinterland cities would be in great disorder, unless by predicting changes a proper city-planning is made and executed accordingly. We have a good lesson of this in the situation at a time of the development of the Kashima Port.

4-2 METHOD TO DETERMINE THE SCALE OF INDUSTRIAL PORTS

4-2 METHOD TO DETERMINE THE SCALE OF INDUSTRIAL PORTS

4-2-1 Introduction

The development scale of an industrial port is determined by a planner so as to satisfy the purpose of the development, even though he does not have an absolute control.

There are several limiting factors in relation to the scale of the industrial port. In this section therefore, main factors limiting the scale of the industrial port are clarified.

4-2-2 Scale of Industrial Port

The concept with respect to the scale of the industrial port consist of the following two items:

Scale of industrial port
- Scale of industrial base
- Scale of port

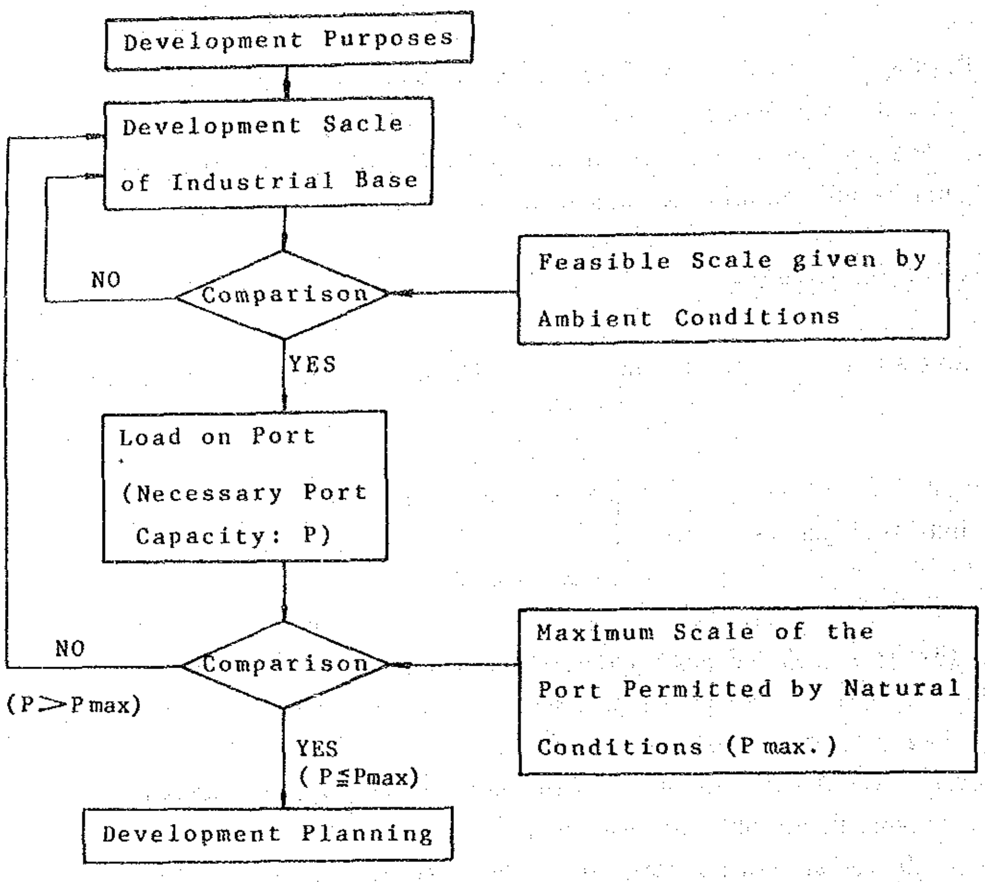
Of these two, the scale of port is determined on the basis of the type of the industry, its production capacities or transportation plans concerned, if the port to be developed as an industrial port and not as a commercial port.

However, if the natural conditions of the proposed site for the industrial port are to limit the development scale of the port, the scale of the industrial development in the hinterland must be governed by the capacity of the port. That is to say, the capacity of the port is a dominant factor in the decision of the whole scale of the industrial base.

For instance, suppose that only one crude-oil discharging berth can be constructed because of the limit of water area, then the scale of the possible oil refineries will b governed by the volume of the crude oil to be handled at the berth, regardless of the sizes of the industrial sites availble in the hinterland or of the demand for the products to be manufactured there.

The scale of the industrial port shall be chosen so as to meet with both of the limiting fctors, i.e. the scale of the port itself and the scale of the industrial base.

Fig. 4-2-1 The Scale of the Port and of the Industrial Base



4-2-3 Limiting Factors in Development Scale of Industrial Base

There are two factors to be considered in relation to the development scale of an industrial base and these are as follows:

1. Scale-limiting factors particular to industry types concerned
2. Factors limiting the total scale of an industry base

(1) Scale-limiting Factors Particular to Industry Types Concerned

a) Limiting Factors

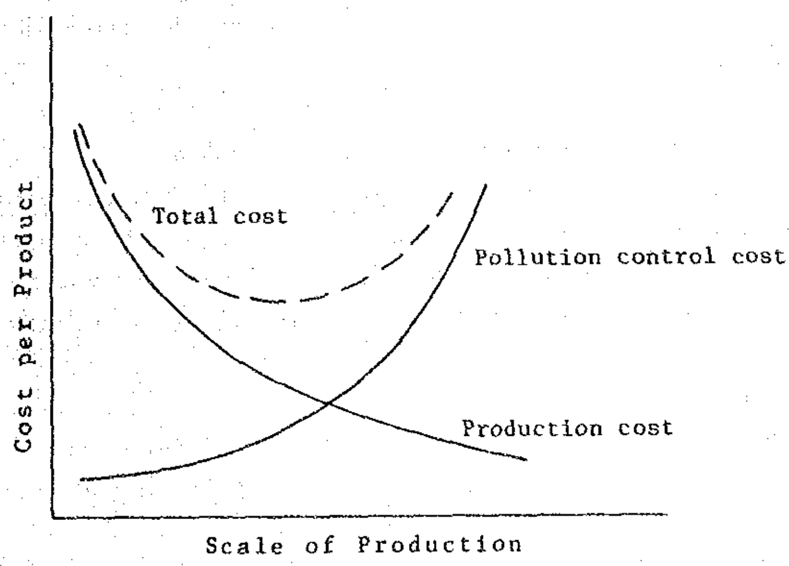
The scale limiting factors particular to industry types are determined mainly on the basis of production efficiency. In planning an integrated steel plant, it is impossible to assume the capacity of 100,000 tons for a new plant only because of the existing demand of 100,000 tons per year. On the other hand, in the case of the products such as plastic goods, less capable of bearing transportation costs, it is not feasible to try to cover a large market with just one factory.

Generally in the manufacturing industry, it is possible to lower the production cost per product by enlarging a production scale, and thus causing the fixed costs incurred in manufacturing the products to be less. This is so-called scale-merits. The scale-merits contribute not only to the smaller direct production-cost but also to the reduction of total costs by reducing the transportation costs with larger-size ships in the transportation of raw-materials or the selling expenses in the volume-sales.

However the scale-enlargement does not necessarily work to advantage. If the industrial refuse is increased to excessive extents due to the scale-enlargement, the costs associated with the pollution-controls e.g. the costs to get rid of the refuse, would be increased, thus increasing the total production costs. Furthermore if a factory is enlarged, the indirect costs such as supervising costs might be increased in excess of the savings made by the lowered production costs per product.

As a result of the inter-relating effects of the various conditions, the feasible production scales, called the model factories, have been determined for each type of the industries as mentioned later.

Fig. 4-2-2 Scale of Production and Cost per Product



b) Contents of Limiting Factors

The factors influencing the size of individual factories are classified into the two categories, i.e. general factors and particular factors. The size of the factory to be located will be determined after checking all the limiting factors and satisfying all the conditions.

General Limiting Factors

① Capital Required for Development

The capital available for the development is the most basic limiting factor, but not absolute yet. There are many ways to procure necessary fund; however, the decision on whether or not it is a good investment, or setting-up of a feasible limit of the investment will be an ultimate limiting factor concerning the development fund.

② Space Resource

The extent of site available for the development, the usable reclaimed area or the amount of water-resource available for the industrial use will b limiting factors concerning the size of a factory to be located.

As seen in "4-1 Procedure of Industrial Port Development" – Planning Development (Table 4–1–5), the original units on site area and water amounts are varying from time to time and it is therefore difficult to define them as absolute factors. However in view of the fact that it is almost impossible to make up for the shortages of sites and water by technical maneuvering, they can be still assumed to be absolute factors at the present stage.

③ Production Factors

If there are limits in the supply of such production factors as labour-force, raw-materials, energy, etc. then at the first stage of development-planning it should be studied whether or not it is possible to achieve a goal soecified within these restraint. If it is imperative that goal be achieved, the migration of the labour-force, the transportation of the raw-materials from other areas and the installation of the energy-supplying facilities must be investigated in the plan.

Table 4-2-1 shows the amounts of industrial water and the labour-force required for a large-scale industrial base.

④ Technology and Competition (balance between supply and demand)

Volume of demand for the products to be manufactured is a dominant factor for the factory size (capacity). The demand will be influenced considerably by the competitiveness of the products or the technology level used in the production. The technology level of a nation (or an enterprise) will be an ultimate factor to determine the production scale of a factory.

⑤ Environment Capacity

The pollution caused by the industrial production must not exceed the environmental safety-standard inacted for the area concerned. Then, the production scale must be always such as maintain such standard.

The technical improvement has been rather remarkable in such auti-air pollution installations as dust-proofing, sulphate and nitrate-freeing and the facilities for polluted-water-treatment, and the environmental capacities are nowadays less critical limiting factors. However, the costs incurred in the pollution-prevention measures are proportionally increased: therefore, these can be still fairly strong limiting factors.

⑥ Capacity of Related Social Overhead Capitals

The capacities of the social overhead capitals to be required as a result of production such as roads for transportation, houses for workers and families, water-supply and sewerage systems and schools constitute an upper limit on the development. It is, of course, possible to make a plan incorporating those related facilities as well. However, it is impossible that a limited number of the enterprises develop whole things including the related social overhead capitals.

Table 4-2-1 Water and Labour Force Required in Large-scale Industrial Bases

Type	Products	Capacity (x 10^3)	Area (x 10^3 m^2)	Water consumption(x 10^3 m^3/day)			No. of Employee
				Fresh water	Sea water	Total	
Integrated steel plant	Crude steel	20,000 t/Y	15,000	563	3,836	10,733	10,000
	Oxgen	2,400,000 m^3/Y		28	566	1,200	
Steel-related	Special steel products		3,470	35	8	399	3,670
Shipbuilding	Tanker, etc.	1,000 DWT	1,200	4	6	10	3,000
Alumina-Aluminium	Alumina	1,000 t/Y	600	30	120	150	1,080
	Aluminium	500 t/Y	1,250	50		50	3,050
Aluminium-related	Rolled products		1,080	15		138	9,760
Copper, Lead, Zinc	Electrolytic Copper	360 t/Y	1,920	57	720	803	1,350
	Electrolytic Zinc	240 t/Y					
	Electrolytic Lead	120 t/Y					
	Sulfuric Acid	1,080 t/Y					
	Rolled Copper	72 t/Y	500	7		16	240
	Wire and Cable	480 t/Y	1,080	62		423	5,700
Oil Refinery	Crude oil treatment	900 B/D	9,410	81		1,809	460
Petrochemistry	Ethylene, etc.	1,600 t/Y	11,400	900	3,340	9,880	7,074
Pulp	Pulp, Paper	3.2 t/D	1,200	710		900	
Thermal Power	Electric Power	8,000 kw	3,000	20	20,736	20,756	560
Newclear Power	Electric Power	9,000 kw	4,500	25	46,656	46,681	630
Total			51,410	2,564	29,332	47,269	61,574

⑦ Management Capacity

The management capacities of enterprises can become a scale-limiting factor. The excessively high density arrangement of plant facilities causes some safety-problems, while too big facilities would increase the costs relating to the supervision of the facilities and workers.

Particular Limiting Factors

① Expense of Market

The spatial expense of markets can place limit on the scales in relation to the features of products and transportation-costs-bearing capacities.

For example, in the case of a concrete-batching plant, the place to be concreted must be within two-hour drive by agitator-trucks in order to prevent concrete hardening. The plastic products such as plastic buckets, etc. have a low bearing capacity of transportation costs and therefore the market must be limited to nearby the factory.

c) Details of Factories of Main Industries

The various limiting factors mentioned above and the costs to remove such barriers must be in good harmony with the so-called scale-merits to appraise and determine a proper factory-size with the greatest production efficiency, or the best productivity. The figures showing factory-sizes in Table 4-2-2 below are the ones taken from typical factories in Japan:

If must be kept in mind that a country with differing limiting factors would have the details different from the above. The reduced costs achieved by the technology improvement will naturally cause the changes in the scale as well.

Table 4-2-2 Dimensions of Typical Factories

Type	Product	Capacity (per year)	Area (×10³ m²)	Water consumption (10³ m³/day) Fresh	Sea	Number of Employee	Location
Steel	Crude Steel	5 × 10⁶ t	5,690	60	170	3,030	Kanto
Alumina & Alminium	Almina Alminium	700,000t 210,000t	2,320	48	85	1,500	Hokkaido
Copper	Electrical copper	90,000t	281	11	140	440	Tohoku
Zinc	Electrical zinc	80,000t	210	43	0	510	"
Shipbuilding	Build (500,000DWT) Repair	5 vessels 5	767	1.6	0	1,550	Tokai
Oil Refinery	Crude oil Treatment	15,500 BPSO	1,300	26	239	344	Kanto
Petrochemistry	Ethylene	440,000t	422	32	-	450	"
Paper & Pulp	Printing Paper News paper Craft-paper	100,000t 88,000t 36,000t	450	180	0	1,340	Tokai
Cement	Portland cement	1.25× 10⁶t	3820	8	85	520	Tohoku
Flour	Wheat flour	168,000t	30	1.2	0	260	Kanto
Oil	Vegetable oil	87,000t	198	4	35	390	"

(2) Limits on Whole Scale of Industrial Base

a) Factors to Determine the Scale

The whole scale of an industrial base is obtained by summing up the size of the individual factories determined in accordance with the procedures described Section 3-1. However, the whole scale can not be determined independently from any other existing factors to form upper and lower limits.

Factors to Form an Upper Limit

The industrial base as a whole enjoys the scale-merits: i.e. like in the case of individual industries, the costs for the entire base will be reduced if the scale of the industrial base is made larger.

The enlargement of the entire base, on the other hand, might cause the environment capacity as a whole to be overpassed, thus in such a case constituting an upper limit for the base scale. This could be true even if the environment capacities by each factories are well observed.

As in the case above, the general limiting factors for each factory are likewise applicable to the entire base as a whole so as to form an upper limit.

1. Development fund
2. Space resources (land, water)
3. Production factors (labour-force, raw materials, energy)
4. Technology and competitiveness (balance between supply and demand)
5. Environment capacity
6. Capacity of related social overhead capitals (excluding ports)
7. Management ability

Factors to form a Lower Limit

The lower limit of an industrial base shall be determined based upon the relationship between the production benefits to be enjoyed by the entire base on one port and the costs incurred in the construction of the base and the relating industrial port and the management expenses on the other. The costs associated with the primary facilities necessary for the production such as open spaces, related roads, industrial-water-supply system or industrial-ports make it necessary to enlarge to a certain extent the scale of the base.

The amount of the capital possible to be invested or the scale of necessary development will be determined by the cost-benefit analysis, etc.

b) Land Utilization of Industrial Base

An industrial base is not just an assembly of factorysites of individual factories. Table 4–2–3 gives the example of the land-use in typical coastal industrial bases in Japan. As can be seen in the table, there is a various range of the land-use in the industrial base and the proportions of the direct use of land as of factory-sites range from 40% to 60%. A Japanese "Factory Code" (1974) stipulates that the proportion of open spaces in an individual factory shall be 25% or more, i.e.

20% for open spaces and 5% for view-giving facilities. Furthermore, in the case of the larger-scale industrial complex in addition to the above stiputation, it is recommended that the buffer zones of green belts be installed between the base and neighborhood zones.

The requirement of these secondary lots is anticipated to be further strengthened, and never to be weakened.

4-2-4 Limiting Factors in Development Scale of Industrial Port

Even with the possible procurement of large factory-sites in the hinterland or reclaimed coastal land the development scale of an industrial base is dominated by the capacity of the port to be constructed therefront.

The limiting factors concerning the port-development-scale are shown as follows:

Table 4-2-3 Land-use in Industrial Port

	Tomakomai (East)	Mutsu Ogawara	Ishikariwan New Port	Fukui	Remark
Warf Area	540 (5.2)	86[3)] (1.6)	370 (12.5)	60 (5.1)	Quay site artificially excavated channel
Industrial Area	5,670 (53.4)	2,830 (53.1)	1,370[6)] (46.1)	687 (58.4)	Infactrory green belts included
Distribution Area	–	80[4)] (1.5)	260[6)] (8.8)	46[4)] (3.9)	
Primary Road	160[1)] (1.5)	94 (1.8)	–	73 (6.2)	
Open Space (Park etc.)	3,370 (32.2)	1,772 (33.3)	880 (29.6)	199 (16.9)	
Others	710[2)] (6.8)	467[5)] (8.8)	90 (3.0)	111[7)] (9.4)	Supervisory site, Treatment facilities, etc.
Total	10,450 (100.0)	5,329 (100.0)	2,970 (100.0)	1,176 (100.0)	

Note: 1) Roads in green belt are excluded.
2) 50 ha lots for rivers are included.
3) Artificially excaveted water-channel is not included.
4) Dangerous articles treatment facilities.
5) The reserved lot of 333 ha is included.
6) The public-use lots incl. roads are included.
7) Reserved lot of 63 ha is included.

Limiting Conditions Given in Plane

a) Natural Conditions

① Topography

Elevation: The development of an industrial port in the coastal terrace is difficult.

Water-depth: The maximum water-depth for which economical exclamation is possible with todays technology is 20m. The anchor-depth of ships is normally around 30m. With the planned use of large ship, it is desirable to make it possible to obtain the required depth easily.

River, lake & swamp: The siltation of rivers has great influence on the feasiblity decision of port construction.

If agricultural irrigation-water or town water is taken from a river, a lake or a swamp, a salination limit must be carefully observed.

Coast & bay: The development of construction technology with regard to artificially excavated ports or breakwaters made it possible to overcome marine phenomenal conditions to a certain extent. However, a large amount of littoral drift, coast damage or area of anchorage basin to be obtained constitutes an upper limit of the development scale of ports.

② Geology

Surface soil: Whether this is a good holding ground or poor gives much influence on anchoring etc. and this is also critical in planning anchorage basins.

Depth of bearing layer: Too deep a bearing layer increase construction costs, and a shallow layer influences the plans for navigation channels and anchorage basins.

③ Environment

Vegetation: The valuable vegetation must be given good protection in plans just like in legal stipulations to be mentioned later.

b) Social Conditions

① Present utilizing situation

Land utilization

Land ownership

Large facilities: Large facilities impossible to shift or transfer are to become a serious limiting condition.

② Regulations

Natural park

City planning

Marine-product industry and fishing port: Water-surface used for farming fishing-net installation, or water-surface important for algas and spawning will make an upper limit in the development size.

Conditions given in dots and lines

a) Cultural Properties

Important cultural assets (national treasures, buried cultural assets)

National monuments

Historical remains, old tombs, noted places, historic sites

b) Traffic-facilities

Road

Railway

Airport-related facility

Port facility

c) Public Facilities

Educational

Medical

Park and green belt

Others

d) Installation

River and coastal installation

Water-channel

Piped-way (water-supply system, sewerage, pipe-line, cable)

Others

e) Others

Crematory, grave yard, slaughterhouse

Prison

Others of special importance

4-2-5 Planning Check-items Relating to Scale of Industrial Port

In relation to the scale of industrial ports the check-items in planning are as follows:

(1) Preparation of Flexible Planning

With the remarkable improvement of production technology, manufacturing facilities are changing day by day.

In planning the industrial ports, plans must be made flexible to deal with unforeseeable factors and for example, keeping reserved lots will be one of such measures.

(2) Overall Appraisal of Secondary Effects

The size enlargement is desirable from an efficiency viewpoint but some limit should be placed from safety points.

The secondary effects due to the construction of industrial port reach over much distance to various fields and the influences of such effects much be therefore carefully studied at the planning stage.

4-3 PORT AND HARBOR DEVELOPMENT SYSTEM

4-3 PORT AND HARBOR DEVELOPMENT SYSTEM

4-3-1 Industrial Port Development System in Mexico

In the planning, construction and operation of ports and harbors in Mexico, construction has been controlled by Obras Maritimas and operation has been conducted by Operacion Portuaria in Subsecretario de Puertos y Marina Mercante belong to SCT. Therefore the above governmental authorities are the nucleus of the construction and operation system in general ports.

On the other hand, the development of four big industrial ports based on the Plan Grobal de desarrollo is planned and advanced by the CPI as the pivot of the system, partially referring to the opinion from the related authorities and the construction is undertook Obras Maritimas. Further the Fondeport of SAHOP is charged with the land acquisition and administration of industrial district.

Fig. 4-3-1 Port Development System in Mexico

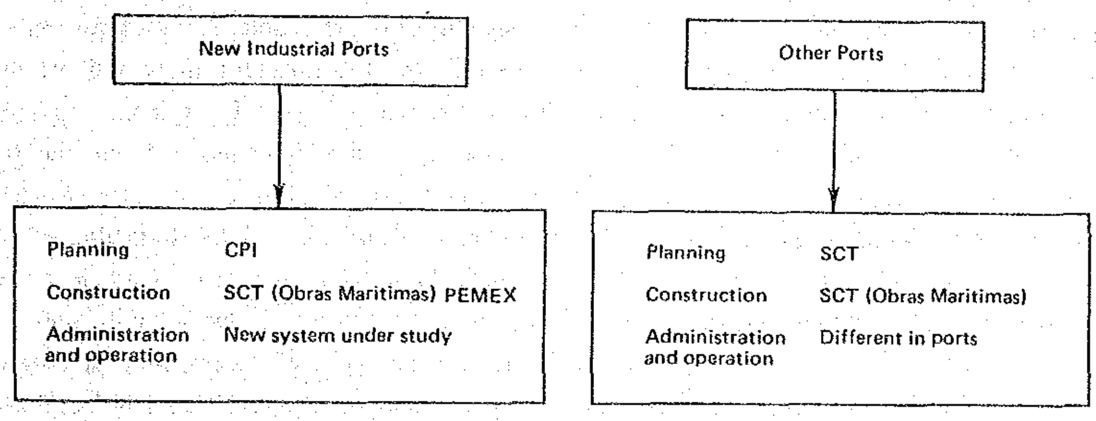


Table 4-3-1 Planning and Construction of Four Big Industrial Ports

	Altamira	Lazaro Cardenas	Salina Cruz	Ostion
Port	CPI (Field office located)	CPI (Field office located)	CPI and PEMEX (Field office located) (charged with survey and planning)	CPI and PEMEX (charged with survey and planning)
Port construction	SCT	SCT	PEMEX scheduled	PEMEX scheduled
Infrastructure	Road: SAHOP Railway: National Railways Water utilization facilities: SARH (Ministry of Agricultural Irrigation) Power supply: CFE (Electric Power Public Corporation) Urban and public facilities: CPD			

4-3-2. Suggestions on Industrial Port Development Program

As for the formulation of the ports and regional development program in the four big coast industrial districts that have been investigating by the C.P.I. as the nucleus, in corporation with the S.C.T., SAHOP, etc., due to the urgent demand of development of those areas, the following suggestions has been made through the site survey conducted in 1981.

In case of Japan, the master plan of a port is decided at the Ports and Harbours council which has long history and is consisted of experienced authorities and government representatives concerned. Port and regional development plans in Mexico ahd better be decided, since a council takes long time for a decision and the establishing a council will take more time, though it is the second best method, the C.P.I. formulates the master plan and short-term working plans as described below.

a) Determination of a master plan

The C.P.I. will formulate a master plan for the year 1990 and 2000 covering the development of the port and also necessary infrastructures (roads, railways, industrial water supply, parks, residential areas, commercial areas, sewerage, energy supply, etc.) and the location of each industry. However, the master plan should be flexible, for the moment there will be many undetermined factors left such as the location of the enterprises.

In formulating the master plan, it is necessary to obtain agreements from the other governmental authorities and main entrepreneurs concerned.

Finally the master plan has to be approved by the President of the Federal Republic.

b) Preparation of the working plans

In accordance with the Master plan, the C.P.I. should ask each governmental authority concerned to submit their working schedules aiming the end of 1982, 1983, 1984 and 1985. Each government authority is to submit a work schedule of a realistic, as fast as possible but appropriate to the conditions.

Taking into consideration of the opinions from enterprises who want to locate a factory in the zone, the C.P.I. is to adjust the working schedules submitted by the Ministries concerned.

Finally the comprehensive working schedule will be reported to the President of Federal Republic.

c) Responsibilities of the C.P.I. and the industries

The C.P.I. is to informe the industries of the progress with infrastructure construction at each end of the year 1983, 1984 and 1985, so that they may prepare their own programme for plant and equipment investments on their side.

The C.P.I. is responsible to the enterprises for the provision of necessary satisfactory infrastructure such as port, road and so on, the enterprises for their part are responsible for their realization of investment schedules and the prevention of pollution.

d) Modification of the master plan

Any change in the Master Plan is to be approved by the President.

(Comments:)

Though the C.P.I. should make every effort to build up a master plan to satisfy all the entrepreneur wishing to locate their factories there by responding to their demands, it does not necessarily mean that it can satisfy them all. It is in fact necessary for the C.P.I. to adjust the various demands in view of the whole even if the enterprises find it partially unsatisfactory.

Further, there will be often areas of dissatisfaction for the entrepreneurs in terms of time scheduling. For instance, the expected degree of completion with the infrastructure at the end of 1982 may not necessarily satisfy all the entrepreneurs. However, the C.P.I. must convince the enterprises by clearly indicating the expected progress for the end of 1983, 1984 and 1985; the entrepreneurs may then find it easier to prepare plant and equipment investment schedules.

In formulating the master plan, it is necessary to take into account the deployment of those enterprises according to their conditions; those to be located at an early date or those to be located later, along with the small and large scale industries, those which require the water front and those don't need it, etc.

The C.P.I. must also set down conditions for the enterprises with regard to investment schedules, improvement of the environment and the prevention of pollution.

4-3-3 Problems at the Present

(1) Setting up a Responsible Organization for Industrial Port Planning

Each work of the industrial port construction should be executed according to the well established plan which is finally decided through the sufficient physical and socio-economic studies.

At the Altamira industrial post site, I was surprised to here that a new alignment was chosen for the entrance channel recently according to the result of studies by the authorities on earth conditions. The contractors were going to dredge there following the order of the authorities who might depend upon an underfinite plan while the field soil conditions at the site were still understudy.

It could be explicable that this decision shows an engineering conscience which aims a better solution technically taking in to the latest studies. However, I feel it should be done before the stages of execution works, since it will create troubles at the work-responsibility to carry out the rigorous works.

It must be necessary to establish an attitude in which C.P.I. coordinates as a core to finalize the port plan giving them an authorization before the plan is opened for a tender. An amendment of the plan should be also examined formally through the almost same procedure only when it is ultimately needed.

(2) Giving an Official Goal to Each Port Planning

During the discussions with many Mexican authorities and consultants. I have found that they are making plans for ports respectively basing on their own judgement and estimations applying their own source materials.

Even if this situation could be inevitable at the actual stage, it is felt necessary that the real responsible authority (C.P.I. for example) will give a planning policy, target and data which are confirmed by that date for each industrial port project to make sure a balanced study by each authority or consultant on it.

That is to say, C.P.I. should indicate a common goal to each authority or consultant related with this industrial port project, of course the indication will include the latest defined values of the target and some unfinalized ones at the moment, which will be explained in its comment precisely.

(3) Determing the master plan

In determining the master plan of each port, it has been first proposed that a decision of the master plan should be granted by the president after consulting among government agencies to make it authentic.

For the drawing up of the present Salina Cruz plan, cosignatories of C.P.I., S.C.T. and PEMEX personnel concerned are required, which is an advanced measure compared with the conventional one. However, as it will require the consent of related government agencies and private businesses concerning railways, roads, water, power, industries, land, rivers, agriculture, etc., a system leading to the decision of the master plan must be studied further.

4-3-4. Port and Harbor Development System in Japan

As a reference in studying Mexican industrial port development system, the port and harbor development system popular in Japan will be described below.

(1) Establishment a Port Authority

In order to develop a new port and harbor, it is necessary to set up a port authority and a port area, and outline of the procedure for the establishment is, provided by the Port and Harbor Law as follows:

Local government that is about to develop a new port and harbor shall have the approval for the setting-up of the port authority (Port management body) from the local Diet, at the same time coordinating with organizations concerned, such as a fishermen's cooperative association.

After the approval from the local Diet has been obtained, a public notice shall be given of the scheduled port area and, if any opinion is offered from the another local organizations concerned, conference shall be held for the consultation.

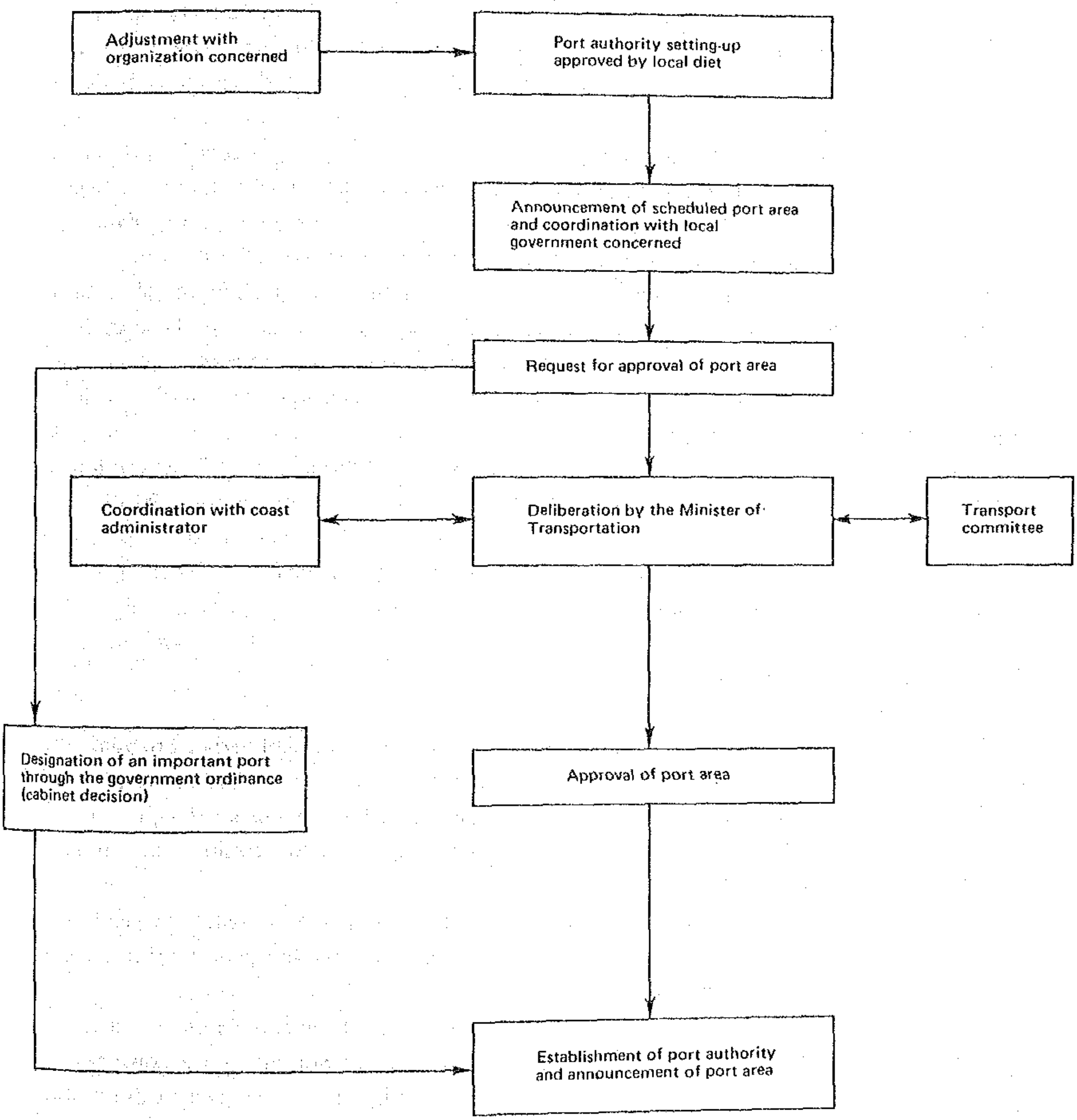
Further, an application for the approval of the port area shall be submitted to the Minister of Transportation (or a local governor controlling the scheduled port area) for the judgement on the request.

The Minister of Transportation submits the request to the transport committee as his advisory organ for the deliberation and has conference with the administrators for rivers and coasts to take care about the request for the approval of the port area. After that, the Minister shall approve the request if it is acceptable.

The procedure for the setting-up of the port authority is completed by making registration after the request has been approved. Then, the public announcement for the setting-up of the port authority and port area shall be conducted with delay.

This procedure for the setting-up of the port authority and port area is shown in Fig. 4-3-2.

Fig. 4-3-2 Procedure for establishment of a port authority



(2) Formulation of Port Development Plan (Master Plan)

It is thought that the formulation of a port development plan is one of the most important and basic duties of the port authority.

In accordance with the basic policy decided by the Government, the port authority shall set to the formulation of the port development plan, taking into consideration the requests from various fields concerned with the scheduled port.

For the actual preparation of the development plan, the port authority shall have the exchange of opinions and hearing of requests from all the organizations related to the port in order to formulate the draft plan, and, besides, it shall be obligated to hear opinions from the local council for ports and harbors by the Port and Harbor Law when the development plan is finally decided.

In the case of a local port and harbor, the port development plan approved by the local council is briefly announced at this stage and all the procedure for the approval of the plan is completed. On the other hand, in an important port and harbor, the approved port construction plan is, further, submitted to he Minister of Transportation for deliberation.

In order to deliberate the development plan in a fair and proper manner, the Minister of Transportation shall be obligated to submit the draft plan and hear opinions from the counsil for ports and harbors as an advisory committee for the Minister. After having received the conclusion from the council for ports and harbors, if the Minister of Transportation has thought it unnecessary to alter the original plan, he notifies the port authority of his decision and, at the same time, the outline of the port development plan is published through the Official Gazzettee. These actions bring about the completion of all the procedure for the approval of the port development plan.

The documents for the finally approved port development plan shall be offered for public perusal in the office of the port authority.

(3) Formulation of Construction Plan

The formulation of development plan means the preparation of port and harbor program over 10 years or so for the future of a port and harbour. Based on this port and harbor master plan, the development and improvement thereof are carried out. Among them, breakwaters, water-area facilities, mooring facilities, port traffic facilities and harbor environmental facilities, etc. utilized for public interest are carried out as public works.

The construction cost for the execution of the above program is all or partially charged to the National Government; otherwise, the Government makes an aid or loan to the port authority and the like, for the acceleration of the construction.

In "Port and Harbor Improvement Five-Year Program", the goal and scale in the execution of the port improvement for five years are set up in order to carry out the above construction according to their schedule. As the goal of execution, the subjects to be attacked during the period and the basic directions for attacking the subjects are provided in the program; and as the scale, the sum total of port and harbor improvement expenses and the amount of investment by the subjects are prescribed.

In the Port and Harbor Improvement Five-Year Program, concrete construction plan by ports are set up. Accordingly, the construction plan of each port during the program is formulated based on the Port and Harbor Improvement Five-Year Program, and the construction of each fiscal year is carried out according to the budget of each fiscal year (In Japan, single fiscal year is employed).

(4) Execution of Construction Works

The construction works are carried out in order of the port improvement work planned and approved but, in case of reclamation accompanied by the work, the operating organization must obtain the license from the Authorities in accordance with the description of the Public Water-Area Reclamation Law.

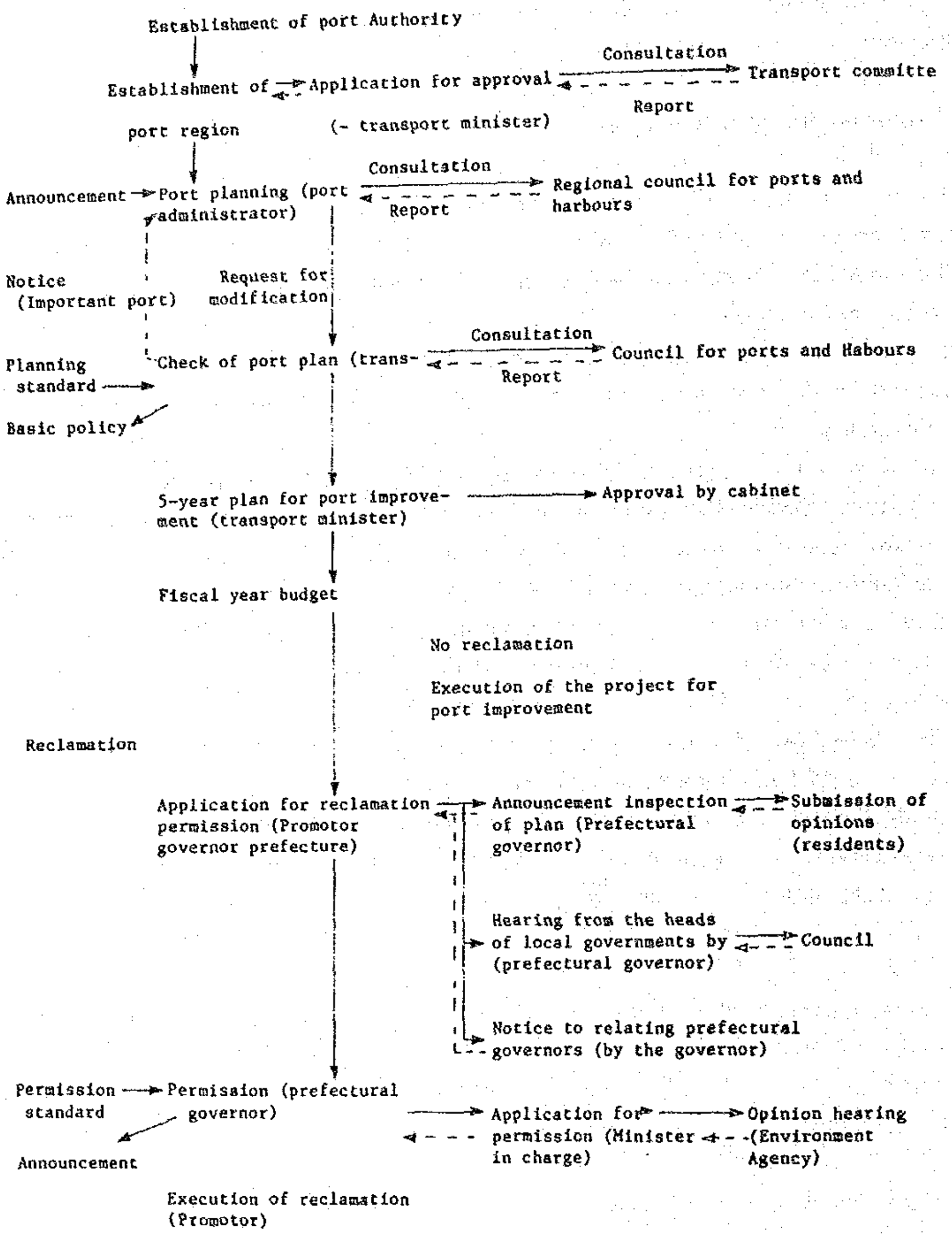
The Governor who has received the request for the license of reclamation, shall announce the plan, offer the request for public perusal and hear the opinions from the local municipalities and inhabitants.

The Governor shall have sufficient deliberation on the request for reclamation license and, at the same time, conduct the evaluation on the written opinions for the reclamation. When rational reasons are recognized in the written opinions, he shall give the reclamation license, the opinions reflected in the conditions of approval. Further, when it is requested by the port administrator or the river administrator or in the case of reclamation of a certain scale (50 ha) or more, it is necessary to obtain the approval from the competent minister, prior to giving the license to the requestor.

Fig. 4-3-3 shows the port and harbor development system popular in Japan by way of the procedure for port and harbor development project.

In addition, as an example of the development of an industrial port, the brief description of Mutsuogawara Development based on the typical large scale industrial base plan in Japan is shown in Table 4-3-2.

Fig. 4-3-3 Administrative Procedure of Port Development Project



Note: 1. - - - - - shows response
2. (   ) shows the subjects of the action and
(-   ) the objects of the actions.

Table 4-3-2 History of Mutsu-Ogawara Development

Date	Items
1970.5	"New Comprehensive National Development Plan" was approved.
71.3	"Mutsu-Ogawara Comprehensive Development Committee" was initiated.
72.9	The hearing in the Cabinet about "Mutsu-Ogawara comprehensive Development" was held and verbally approved.
75.12	The Second Basic Plan
77.3	Approval of the port region of the regional port, Mutsu-Ogawara by the transport minister.
8	Report on the environmental assessment
8	The verbal cabinet approval of the Mutsu-Ogawara development
9	Promotion to the higher rank of "Important port"
10	Draft report of the port plan (same as the original report)
10	Submission of the port plan to the transport minister
11	Port investigation committee
12	The outline of the port plan was officially announced.
78. 10	The construction of the test embankment was commenced

4-4 INVESTIGATION SYSTEM FOR THE DEVELOPMENT OF INDUSTRIAL PORTS

4-4 INVESTIGATION SYSTEM FOR THE DEVELOPMENT OF INDUSTRIAL PORTS

For the planning and construction of industrial ports, various types of surveys on natural conditions and investigations for economical and social problems are required. Therefore, in this section, the problems due to the shortage of investigations in the development of industrial ports in Mexico have been taken up and, at the same time, discussion has been made on the investigatons required at each stage of planning, designing and execution of work.

4-4-1 Shortage of Investigations in Development Plan for Industrial Ports in Mexico

In Altamira port, after contracts were made on the works of breakwaters and dredging and those works were actually started, such major changes as the alterlations in the location of port entrance and waterway, etc., as soft ground was found in the district prepared for factories. Further, with the advancement in dredging work, they encountered with a layer of hard rocks. These are all due to the insufficient surveys or investigations before the start of construction works, and it brought about the interruption of the work.

In order to make a plan for port and harbor and construct the facilities, various types of surveys are required in advance. Therefore, in case the work is expedited, a contractor should get to the work for which he has a confidence from the past experience; and, at the same time, field surveys for natural conditions, hydraulic model test, etc. must be carried out for the determination of the details of the plan.

In the development of Ostion port, there has been two plans of utilizing the Ostion lake for the construction of the port and using the southern area without utilizing the lake. The points at issues in two plans are the damage due to the subsurface, soil quality and flood, the possibility of development in future. The direction of developing of city and housing areas, the difficulty or ease in obtaining the land required, etc. First, the plan of utilizing lake was selected, but the results of soil investigation revealed the distribution of soft soil in Ostion area and the layer of rocks under the water and others. As the result, the southern area plan is now supported by most people.

Anyway, the prospective place shall be finally decided after the subsurface of the prospective area has been sufficiently surveyed. However, there is a tendency for a prospective place to be settled before the surveys have been completed. Therefore, great care should be exercised in treating these problems.

In addition, such measures as soil survey, model test and placement of test breakwater should be taken for the determination of the master plan. Generally, in Japan, the following investigations are conducted, spending, at least, one year from this stage and the master plan is finally settled.

① Study on the location of port-entrance breakwaters through plane model test
② Subsurface and soil surveys for land required for factories, waterway, berthing place, breakwater foundation and quay-wall base.
③ Survey for the details of wave
④ Security of construction materials and their transportation means
⑤ Study on the litteral drift and waves through the construction of test breakwaters

In this way, it is quite remarkable that each port has been short of important investigations at the planning stage. Therefore, the systematic surveys and investigation should be carried out at each stage from now on, so as not to alter the plan frequently and in order to set up a reliable plan. As for the surveys on natural conditions, it is much better to prescribe the methods of surveys and the standard, referring to the survey guidance for ports and harbors in Japan and other data.

4-4-2 Investigations for the Construction of Industrial Ports

The investigations for the construction of ports and harbors are generally carried out at the following three stages.

(1) Planning stage

(2) Designing stage

(3) Executing stage

The investigations at each of these stage differ from one another in the content and accuracy, which will be described below.

(1) Investigations at Planning Stage

In making a plan for port and harbor, the problem to be considered first of all is what capacities to be furnished to the port. The capacities to be furnished will determine the scale, location and other factors of the port.

According to the capacities of ports and harbors, observed from the aspect of vessel's utilization, all the ports are divided into the following types – commercial port, industrial port, fishing port, refuge port, recreation port, military port, etc. –, but the description in this section will be limited to the industrial port only.

In case of planning industrial ports, the following can be mentioned as the necessary conditions for determining the locaiton of the industrial port.

a) Natural conditions such as meteorological phenomena, marine phenomena, topography and geology.

b) Economical and social conditions such as centralization of cities, industrial structure, transportation means and labor power.

For the investigation of the above conditions, the contents and accuracy required at planning stage is as follows.

a) Investigation for the natural conditions

① Meteorological conditions

As meteorological conditions, there are the temperature, wind, rain, snow, fog, and typhoon, etc.

For the temperature, daily average, maximum value, minimum value, etc. are required. For the wind, the frequency by wind direction and frequency by wind velocity are required.

For rain and snow, rainfall and snowfall quantity, number of rainy days and snowy days. For the fog, number of foggy days. For typhoon, its course, wind velocity and others of the maximum typhoon each year must be surveyed.

② Conditions of marine phenomena

The items required as the conditions of marine phenomena are waves, tide level, tidal current, litteral drift, etc..

For the waves, mainly, wavehight and period are required. In addition, the frequencies by wave direction and by waveheight are required.

For the tide level, the following are required. Standard sea level (C.D.L.), Mean sea level (M.S.L.), High water level (H.W.L.), Low water level (L.W.L) and highest high water level (H.H.W.L.)

For the tidal current, the direction and the velocity of tide are required.

In addition, the surveys for littoral drift, erosion on coastal line, tsunami and others are required.

③ Topographical conditions

For the construction of an industrial port, a great deal of land is required as its site. Especially when the site is prepared through reclamation, the presence of a water area having a small depth is important as a factor, so that the topographical survey and depth-sounding survey are carried out to prepare the topographic map and depth map.

④ Geological conditions

In order to grasp the outline of geology in the planned area and the condition of basic ground (approximate conditions of soil quality), the surveys through boring and physical exploration are conducted.

b) Investigation for economical and social conditions

As the investigations required for determining the possibility of locating an industrial port, the following conditions of location can be investigated: Centralization of cities, population and labor power, industrical structure, transportation means such as roads and railways, industrial water, power supply, etc..

c) Other investigations

In addition to the above surveys for natural conditions, and for economical and social conditions, the following investigation are necessary: hydraulic model test, Construction materials survey and environmental influence survey.

① Hydraulic model test

The hydraulic model test for the plan configuration of a port should be conducted for the estimation of the degree of calmness inside the port and the condition of siltation. Then, utilizing those data, a favorable plan should be prepared.

② Construction material survey

This survey is necessary for preparing the execution plan. The items to be surveyed are concrete, stone material, reclaimed materials, working machines, working craft, etc.

③ Environmental influence survey

In order to investigate the influence of port construction and operation upon the environment, the current condition of the air, water quality, ground quality, etc. must be investigated.

As mentioned above, there are a variety of methods for investigating the factors as the conditions of development area, but those are summarized in Tables 4-4-1 and 4-4-2. The governing factors for selection of development site depends upon the characters of each port. Therefore, the classification of industrial ports are shown below, by dividing them into 4 types, according to their characters.

Classes of Industrial Ports

Industrial port A (Port where available water area is critical)	A_1	Industrial port for super-large ships
	A_2	Off-shore storage base
Industrial port B (Where available land area is critical)	B_1	Ordinary industrial port
	B_2	On-shore storage base

(2) Investigation at designing stage

As the necessary conditions for designing a port there are such factors as wind, tide level, wave, water depth and soil. Among them, wind, tide level, wave are nearly sufficiently investigated at the preceding planning stage. However, for the conditions of water-depth and ground, much further investigation is required. To know more detailed configuration and water-depth, a topographic map having the scale of 1/3,000 or r/10,000 and a sounding chart having the isodepth line drawn at depth-intervals of 1 m are required.

As for soil conditions, further investigation must be made, so that they can be used as the condition of soil quality, which will be used to compute the stability of a foundation ground and reclaimed ground or to compute the settlement of the ground.

(3) Investigation at executing stage

As the necessary investigations for of the execution of port work, the following can be mentioned.

a) Survey of execution area

As the survey required for the execution of work, there are on-ground survey and a depth-sounding survey.

As the on-ground survey, there are a control point survey, configuration survey, level survey etc.

b) Magnetic exploration in execution area

In the scheduled worksite for the construction of a port, this investigation is necessary for checking the presence or absence of explosives such as mine and bomb.

Table 4-4-1 Natural Conditions to be Checked

Condition		Type A_1	Type A_2	Type B_1	Type B_2
Topographical	Location	○	○	○	○
	Bay-shape	◎	◎	○	○
	Seabed slope	○	○	○	○
	Coast slope	○	○	○	○
	Area of possible land preparation	○		◎	◎
	Coastal shape			◎	◎
	Sands extension				
Meteoro-gical	Wind	○	○	○	○
	Fog	○	○	○	○
	Weather			○	○
Marine-phenomenal	Wave	◎	◎	○	○
	Sea-level	○	○	○	○
	Tidal-current	◎	◎	○	○
	Littoral drift			○	○
Geolo-gical	Surface-soil	○	○	○	○
Environ-mental	Water-quality				
	Vegetation				

Note: ◎ Critical condition

Table 4-4-2 Social and Economical Conditions to be Checked

Conditions		Type A_1	Type A_2	Type B_1	Type B_2
Locational condition	Distance from central city			○	
Land condition	Existing land utilization	○	○	◎	◎
	Existing price-level of land	○	○	○	○
Legal condition	Designation situation, ex. natural park	◎	◎	◎	◎
	Legal designation to promote development			○	
Transportation condition	Existing and confirmed future roads			○	
	Existing and confirmed future railways			○	
Community condition	Reaction of the communities to the port	○	○	○	○
	Marine-industry existing	○	◎	○	○
	Present industrialization extent		○	○	

Note ◎Critical condition
○Other condition
Items kept blank mean no check required

c) Supply and transportation of construction materials

In order to supply such construction materials as concrete, stone material and reclaimed materials, this investigation must be done in advance to secure the supply and transportation means.

d) Supply of construction machines and working craft

Sufficient investigation for the utilization state of machines and working craft required with the progress of operation, must be conducted in advance.

e) Continuous investigation during the construction

For the meteorological phenomena and marine phenomena, such as wind, tide level and waves, as they greatly influence the each stage of construction, thorough investigation must be done to give necessary information in advance.

f) Environmental influence investigation

During the construction, investigation at a certain intervals must be conducted as to check whether or not the construction influences the air, water quality, ground quality, ecosystem and others.

4-4-3 The Results of Investigation in the Development of Ports and Harbors in Japan

The results of investigation carried out for the development of a new port and harbor in Japan is shown below for information.

(1) Example of an Industrial Port (Mutsuogawara Port)

a) Basic Investigation for Development Project of Mutsuogawara area

(Unit: Million Yen)

Year of investigation / Investigation item	1970 ~ 1976				Remarks
	Government	Prefecture	Enterprises	Total	
Land	146	139	119	404	land survey, soil survey, preparation of topographic map etc
Meteorological phenomena	0	9	0	9	general meteorological phenomena, snowfall quantity, fog survey and analysis
Water source	641	58	14	713	flow rate, water quality, industrial water survice
Port and harbour plan	646	134	29	809	meteorological and marine phenomena, soil, plan investigation
City	104	14	0	118	wide area land utilization plan, basic city plan
Traffic facilities plan	109	37	5	151	road and railway
Forestory fishery plan	410	97	24	531	Mutsu bay fishery basic survey, source distribution, Mutsu bay environmental, fishery circumstance
Public pollution prevention	463	197	1	661	industrial pollution integrated presurvey air environmental survey
Burid culture treasure	0	25	28	53	distribution, test digging, discovery survey
Environment prevention	156	10	6	172	
General plan	126	52	51	229	basic development plan, industrial location plan economical survey, construction material survey
Total	2,801	772	277	3,850	

b) Investigation of Port and Harbor Plan

From the above list, the typical surveys for development of a port have been enumerated below.

- o Investigation for natural conditions
  Meteorological phenomena survey (all the aspects)
  Marine phenomena survey (Tidal current, littoral drift, waves, tidal wave measures)
  Underground phenomena survey (Soil quality, underground water)
  Topographic survey (Water-depth survey, Coastal line survey)
- o Study on the large-scale industrial base plan
  Study on industrial base development pattern, Study on industrial base plan, Study on land utilization plan.
- o Study on large-scale industrial port plan
  Industrial port pattern study, Port and harbor capacity study, Wharf arrangement plan study, Crude oil mooring buoy survey, Study of countermeasures for refuge port, Tanker operation survey, Harbor calmness survey.
- o Hydraulic model test
  Great-water depth breakwater model test, Industrial port model test, Harbor calmness model test
- o Construction plan survey
  Rocky mountain survey, Belt conveyer transportation facilities survey, Dredged soil disposal plan, Investigation on deposit disposal method, Grasping force test
- o Port and habor safety measure study
  Disaster countermeasure study of industrial port petroleum, Safety countermeasure survey of seaberth
- o Port and harbor environment survey
  Fishing boat operation status survey, Pollution prevention survey
- o Others
  Discussion on breakwater designing method, Design wave survey, Others

(2) Example of distribution port (Ibaragi new port)

Ibaragi new port is a newly planned port as a large-scale distribution port. Different from the industrial port, the new distribution port is considered not to get to its maturity before years have passed.

For formulating the plan, arrangement is required with other area development plan and, at the same time, consideration must be paid to the harmoney with the hinterland. The investigation on this plan was started in 1970, it has been still continued. The basic frame on this plan has been already arranged to formulate this plan. It is thought that the port will be able to be constructed from the standview of technology.

At present, weight has been placed on the survey on harbor facilities plan and environment accessment for the final settlement of this plan.

The following are the surveys that have been conducted so far. They have been divided into three types, surveys on the frame of the plan, the surveys on facilities design and the surveys on environment accessment.

a) Surveys on the frame of the plan

① Basic survey on the plan

a. Port capacity survey

b. Port-handling cargo volume survey

c. Utilizing vessel survey

② Conditions of port and harbor

a. Distribution port establishment accelerating survey

b. Development effect estimation survey

c. Survey on operation system and management system

b) Survey on facilities plan

① Natural conditions survey

a. Meteorological phenomena survey

b. Waves survey

c. Tide level survey

d. Tidal current survey

e. drift sand survey

f. Topographic survey

g. Soil survey

② Port facilities plan survey

a. Basic facilities plan survey

b. Port and harbor circumstance creating plan survey

c. Ship navigation simulation survey

d. Harbor calmness survey

e. Coastal line influence survey

f. Safety measure survey

g. Port and harbor-related plan survey

③ Construction technology survey

a. Construction plan survey

b. Green breakwater survey

c) Environment accessment survey

① Environment current condition survey

a. Open air survey

b. Water quality survey

c. Ground quality survey

d. Biological phase

e. Appearance survey
f. Cultural treasure survey
g. Fishery survey
h. Noise survey
i. Underground water survey
j. Radioactivity survey

② Environmental influence evaluation survey

a. Open air survey
b. Tidal current survey
c. Water quality survey
d. Noise survey
e. Biological phase fishery survey
f. Appearance survey
g. Underground water survey

4-5 METHOD OF PLANNING OF PORT FACILITIES

4-5 METHOD OF PLANNING OF PORT FACILITIES

4-5-1 Introduction

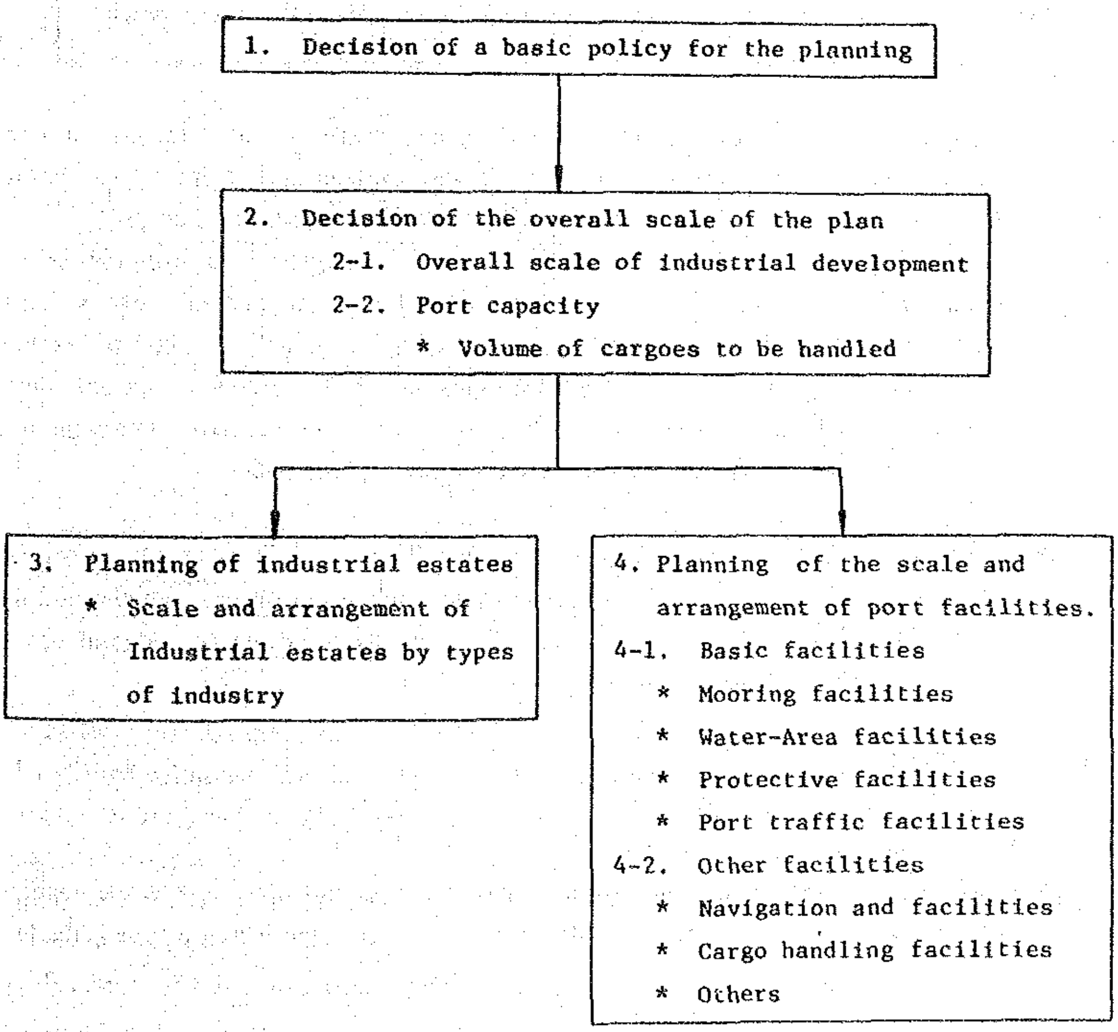
Port planning for the development of an industrial port usually follows the flow shorn in Fig. 4-5-1. And usually the scale and the arrangement of facilities and lands that have been planned are indicated on drawings on a reduced scale of 1/5,000 to 1/20,000.

In preparing a port plan, the following studies: should be carried out;

a) Study on technical and engineering problems relative to construction works.
b) Study on how to raise necessary construction funds.
c) Study on administration and management after completion.
d) Study on environmental problems.
e) Study on the effects of development.

Below is the description of the planning methods in Japan for "4-1. Basic facilities" included in "4. Planning of the scale and arrangement of port facilities" in the flow chart of Fig. 4-5-1.

Fig. 4-5-1 Flow of the Industrial Port Planning



4-5-2 Planning of Mooring Facilities (a wharf plan)

(1) Outline

Ships moor, other than their own anchorage, offshore at buoys or dolphins for cargo handling and others. They also moor alongside quaywalls and piers for the same purpose. These facilities offered for ships mooring are defined as mooring facilities.

A wharf, in general, is an intergrated name for a group of facilities comprised with berthing facilities, cargo handling facilities, transit sheds, warehouses, land transportation facilities and others, and has a transitional function between land and sea transportations.

Table 4-5-1 Classification of mooring facilities

Type	Name	Remarks
Offshore Mooring Facility	Mooring buoy	
	Dolphin	
Berthing Facility	Wharf, pier	For larger vessels
	Floating pier, landing quay, Slipway	For smaller vessels

Functions required for a wharf are safe, fast and secured berthing and detaching of a ship, cargo handling, cargo storage, a sufficient services for transportation and saving of port labours. Wharves are classified as follows depending on their characteristics of use, ship and cargo.

a) Use; In principle, a wharf used by unfixed shippers, consignors and shipping agents is called as "public wharf", and mostly used for liners and general cargoes. On the contrary, a wharf exclusively used by a specific business entity is called as "exclusive wharf". It is mostly offered for the trampers with bulk cargoes or special cargoes, and, although in some cases, used by the liners and general cargoes. The same terms is used also for a wharf used by ships engaged in a specific route.

b) Nature of cargo; A wharf exclusively used for handling the bulk cargo like as oil, coal, ore, grain, and timber and other special cargoes such as containers, vehicles and ferry cargoes is called as "specialized terminal". A wharf handling the general cargo is defined as "General cargo terminal".

(2) Layout of a Wharf

a) Shape of a Wharf

A wharf can be classified by its shape into a marginal type and pier type. Advantages and disadvantages of respective types should be carefully studied when selection of a type is made.

① Pier Type Wharf

A pier type wharf is formed by protruding a pier out of the land onto watersurface, and accommodate ships at both sides of the pier. This type is advantageous in allocating more berthes within a limited coastal length. But, a wharf of this type is apt to be insufficient with its total area (for cargo handling, cargo storage and so on). Therefore, in order to overcome this shortcoming, a neutral type between the pier type and marginal type is recently planned, and a sufficient width of a pier is given for this type.

As a kind of the pier type wharf, there exists a twin-type wharf to which a narrow slip is provided at the center to accommodate smaller crafts alongside and undertake the cargo transition readily from larger ships moored outside. This twin-type wharf is more adopted at ports which have larger volume of the international transit cargoes.

② Marginal type wharf

This type of wharf accommodate ships in parallel to the coast. At its advantages, it can be provided with a sufficient area as a wharf, and smooth connection with the land transportation becomes available. Therefore, this type is frequently adopted at ports having a large hinterland, estuary ports, excavated ports and private enterprises.

Fig. 4-5-2 (1) Pier Type Wharves

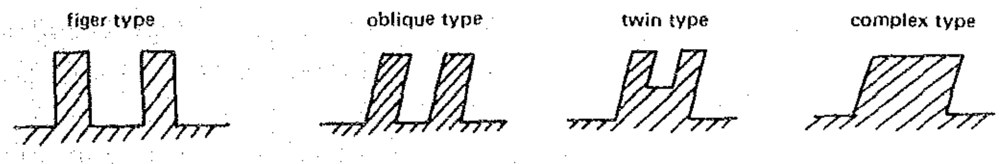
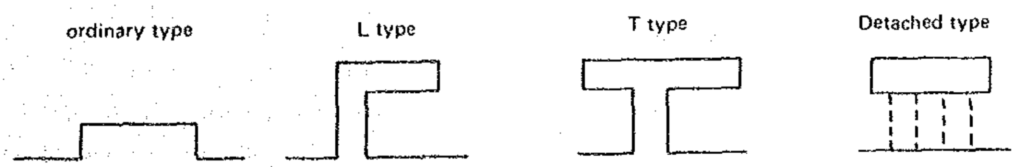


Fig. 4-5-2 (2) Marginal Type Wharves



b) Considerations required for a wharf layout

① A required calmness shall be obtained at the water area in front of a wharf.

② A place must be correctly selected in order to avoid siltation or scoring by the littoral drift and river discharge.

③ Ship's access from the harbour entrance must be easy. Especially, easy berthing and detaching should be possible.

④ A direction of berth must be selected not to bother a ship with strong side wind when she is berthing or detaching.

⑤ Facilities for the same use such as public wharves, exclusive wharves, foreign trade wharves, domestic wharves and specialized terminals must be consolidated respectively in order to enable the rationalized operations of port functions.

In particular, wharves for dangerous cargo like oil products should be secluded from other wharves to secure the safety.

⑥ A layout of wharves shall be given with enough attentions on the future expansion, and pier-head lines for the future expansion shall be clearly given.

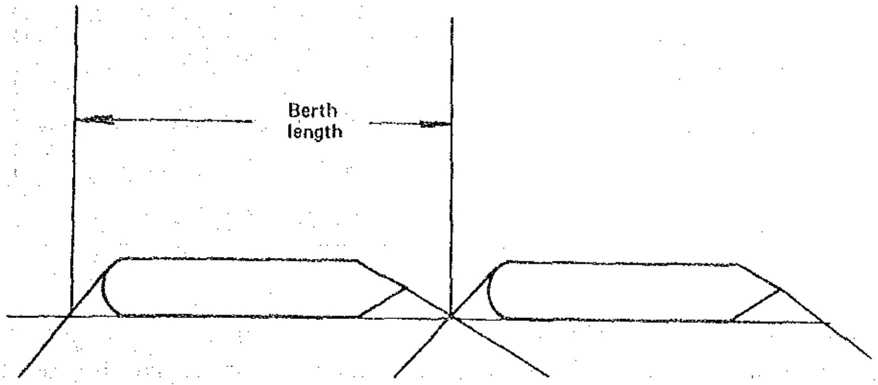
(3) Waterdepth and Length of the Berth

The standard berth length and waterdepth in Japan are as shown in Table 4-5-2.

Table 4-5-2 The Standard Dimension of Berth

ship	berth length	water depth	objective ships size
Passenger ship	80 m	5.0 m	1,000 GT
	125	6.0	3,000
	155	7.5	5,000
	180	9.0	10,000
	225	10.0	20,000
	250	11.0	30,000
Cargo ship	60 m	4.5 m	700 DWT
	70	5.0	1,000
	90	5.5	2,000
	105	6.5	3,000
	130	7.5	5,000
	165	9.0	10,000
	185	10.0	15,000
	210	11.0	20,000
	240	12.0	30,000
	260	13.0	40,000
	280	14.0	50,000
Tanker	60 m	4.5 m	700 DWT
	70	5.0	1,000
	90	5.5	2,000
	105	6.5	3,000
	130	7.5	5,000
	165	9.0	10,000
	195	10.0	15,000
	210	11.0	20,000
	240	12.0	30,000
	260	13.0	40,000
	280	14.0	50,000
	290	15.0	70,000
Ore Carrier	165 m	9.0 m	10,000 DWT
	185	10.0	15,000
	210	11.0	20,000
	240	12.0	30,000
	270	13.0	50,000
	290	15.0	70,000
	300	16.0	90,000
	330	18.0	100,000
	370	20.0	150,000

Fig. 4-5-3 Berth Length



The waterdepth in Table 4-5-2 is a little greater than 110% of the full draft of a standard ship, and the berth length is obtained adding the length of a standard ship to the breadth. As for the berth length, premises are made that mooring lines taken from neighbouring ships are intersected, and an angle of the mooring line taken to a berth is about 45°. The berth length given in Table 4-5-2 shall be extended to a required extent when a smaller line angle than 45° is needed (30° – 35°) or a berth is discontious. In addition to the above, an individual study on required waterdepth and berth length is needed for a wharf where the objective ship size is concretely known, because the standard might be insufficient due to the change of ship size.

(4) Method to Determine the Number of Berthes

The number of berthes required to handle a given volume of cargo greatly differs depending on nature of the port, a kind of cargo, cargo handling facilities, capacity of transit sheds and marshalling yard, etc.. It is, however, decided in planning stage as follows.

a) Empirical Method

This method is applied to set a macroscopic and rough scale of the entire port with a considerable scale of facilities. Therefore, an application of this method for determination of a specific wharf size may cause some errors.

① Empirical Handling Volume per Berth

A number of berth is calculated from the empirical cargo handling volume per berth in the same port or another port of the same type.

Example Table 4-5-3 Annual Cargo Handling Volume at a Berth for Large Vessels

cargo	Handling volume per berth
General cargo	100,000 – 200,000 t/year
Bulk cargo	150,000 – 400,000
Oil	1,500,000 – 3,000,000
Container	800,000 – 1,200,000

② Estimation from the Improvement Standard

Estimation of the number of berthes is made from the appropriate handling level per meter of berth which is calculated from the past records.

$$\text{Improvement standard} = \frac{\text{Cargo volume (converted cargo volume)}}{\text{Berth length (concerted berth length)}}$$

$$= 700 - 1{,}100 \text{ t/m/year}$$

(Note 1) Converted cargo volume is a cargo volume converted to a general cargo volume witha premise that the general cargo is 1 and the bulk cargo is 0.5.
A classification of cargoes into the general cargo and bulk cargo is made in a cordance with Table 4-5-4.

Table 4-5-4 Classification of Cargoes

Classification		Export general	Export bulk	Import general	Import bulk	Domestic general	Domestic bulk
1	grain	○			○	○	
	Aquatic prod.	○		○		○	
	Agr. Prod.& wood	○		○		○	
Forestry prod.		○			○		○
2	Coal		○		○		○
	Sand & gravel		○		○		○
	Crude oil		○		○		○
	Crude salt & ores		○		○		○
3	Metals	○		○		○	
	Mechineries	○		○		○	
4	Petrolic prod.		○		○		○
	Cement	○		○			○
	Furtilizer & chem	○		◐ ½	◐ ½	⅓	⅔
Light ind. prod.		○		○		○	
Misc ind. prod.		○		○		○	
Special cargo		○			○	◐ ½	◐ ½
Unclassified		○		○		○	

1 ; Agr. & Aquatic prod.
2 ; Mineral Prod.
3 ; Metal & Machinery
4 ; Chemical prod.

The above conversion rate is not applicable for the petrolic products which require special handling facilities.

(Note 2) The converted berth length is obtained by following formula.

waterdepth of berth		converted berth length
2.1 – 3.9 m	....	$\ell \times 1/3$
4.0 – 7.4 m	....	$\ell \times 2/3$
7.5 m –	....	$\ell \times 1$

Where ℓ is the berth length.

b) How to Determine the Number of Berths for a Specific Cargo Wharf

The following formula is included among the methods to determine the number of berths for a wharf exclusively used to handle specific cargoes, such as petroleum, liquified petroleum gas, coal, grain, lumber and so on.

$$B = \frac{S \times t}{\alpha \times T}$$

Here, B : Necessary number of berths

S : Number of ships using berths in a year (1/year) (= Annual volume of cargoes handled/per-ship average loadage)

t : Per-ship duration of berth occupancy (hours or days)

T : Total time for which berths can be used a year (hours/year or days/year)

α : Using ratio

Usually, 0.5 to 0.7 is used as a using ratio. If the use of berths by ships is according to plan, a relatively large value may be used as a using ratio but if the use of berths is random, it is advisable to use a smaller value.

c) Application of Operation Research Method

This method is to determine the optimum berth numbers with an application of the O.R. Method which was rapidly progressed due to development of the computors. Practical method so far developed are;

1. Method based on the inventory theory.
2. Method based on the queuing theory.
3. Optimum capacity method.

In Japan, there are several cases where the above methods were practically applied for planning. The details of the above must be referred to other books. Anyway, the above are the subjects to be studied for practical applications.

(5) Area for Cargo Handling and storage

a) Calculation of Apron

The apron is provided in between a berth and a transit shed or an open storage for temporary placing of loading or unloaded cargoes, transition of cargoes and vehicles for cargo handling.

A width of the apron must be decided in view of safe and smooth cargo handling with consideration of utilization method of a berth, type of transit shed and warehouse, existance of cargo handling equipment and type of land transportation facility. The width of an apron, on which a shed is located in rear and folklifts are used, shall be not less than 15 – 20 m. The apron adjoined to an open storage with trucks accommodated for direct loading/unloading shall have 10 – 15 m as its width. In Japan, the following width are adopted as the standard width.

Table 4-5-5 Standard Width of Apron

Waterdepth of berth	Apron width (m)
4.5 or less	10
4.5 – 7.5	15
7.5 and over	20

b) Area for Transit Shed and Warehouse

① Cargo handling done at the transit shed are collection and distribution, cargo sorting, marshalling, inspection, primary storage and etc.. In view of these, a transit shed is clearly distinguished from a warehouse which is purposed for long term storage of cargoes. The transit shed is usually located right behind an apron so to enable vessels and land transportations to leave the port quickly. The transit shed is classified as follows.

- General cargo shed
- Reefer shed
- Fresh food shed
- Grain shed
- Ore shed
- Shed for dangerous cargo
- Lumber shed
- Vehicle shed
- Shed for aquatic products
- etc.

② Scale of the transit shed

i) The scale of a transit shed is decided referring to the following formula.

$$W = \frac{N}{n \times R} = k \times w \times a \times b$$

W ; Cargo storage capacity per shed (t)

N ; Required annual handling volume (t/year)

R ; Cargo rotation (times/year)

w ; Stored cargo volume per unit area (t/m^2)

a ; Frontage (m)

b ; Depth (m)

n ; Number of sheds

k ; Occupancy rate k = 0.5

ii) It is desired that the scale of a transit shed is good enough to accommodate at least all cargoes loaded and unloaded to/from a ship to be berthed in front of the shed.

iii) The cargo rotation differs from port to port, and it must be decided based upon the past record in a specific port. When the past record is not in existance, reference is made to another port which is in the similar economic situation and of the same scale. The standard rotation adopted in Japan is 20 – 25 times/year.

iv) As for the stored cargo volume per unit area (w), a reference shall be made to existing examples of cargo shape and piled height. A load values of warehouse cargo can be otherwise adopted as the standard.

v) Decision of a transit shed size can be made also with the O.R. Method based on distribution of arriving ship numbers, distribution of berthing days distribution of cargo loading/unloading and distribution of stored cargo in shed.

vi) Land area required for a transit shed shall be reserved in consideration of the building coverage as follows:

$$A = \frac{\text{Area of transit shed}}{0.6 - 0.7}$$

Table 4-5-6 Surcharges for an Ordinary Transit Shed

(weight-ton)

Item	Shape	Load/unit area (t/m^2)	Piled height (m)
Grain	Straw bag, sack	2.0 - 3.5	3.0 - 4.5
Oil & fat	Can, box	2.0 - 3.5	3.5 - 5.0
Cotton & wool	Textile sack	1.0 - 2.0	3.0 - 4.0
Silk & thread	"	1.0 - 2.0	3.0 - 4.0
Cement	Bag	1.5 - 3.0	2.0 - 3.0
Metal & Metal Prod.	Wooden box	1.0 - 3.5	1.0 - 4.0
Fertilizer	Straw bag	2.0 - 4.0	2.0 - 4.0
Sugar, canned food, food	Box, bag	1.5 - 3.0	1.5 - 4.0
Textile & its products	Textile bag, wooden box	1.0-3.0	2.0 - 3.5
Paper, pulp products	Roll, Package	1.5 - 3.5	3.0 - 5.0
Minerals and chemicals	Can, Box	1.5 - 3.5	3.0 - 5.0
Machines, equipments	Box, Package	1.0 - 2.0	2.0 - 4.0

③ Scale of a warehouse

i) A warehouse is planned in the same manner as for a transit shed.

ii) The scale of a warehouse can be decided with the formula given for a transit shed except that the followings are changed.

* Cargo rotation is 8 – 12 times a year.
* Occupancy rate is 0.7 or around.

c) Open Storage

① The area for an open storage is determined with reference to the following formula.

$$W = \frac{N}{R} = k \times W \times A$$

where ; w ; Cargo storage capacity (t)
N ; Required cargo handling volume per year (t/year)
R ; Cargo rotation (times/year)
A ; Required area for the open storage (m^2)
w ; Stored cargo volume per unit area (t/m^2)
k ; Occupancy rate (usually, about 0.7)

② The cargo rotation, stored cargo volume per unit area and occupancy rate must be decided with consideration of existance of mechanical equipments, capacity of equipment, type of cargo and connection with the hinterland. A reference would also be made to the past record for the same purpose.

③ Cargo rotation is understood as equal to that of the warehouse. The stored cargo volume is calculated in accordance with Table 4-5-7.

Table 4-5-7 Specific weight of bulk cargo

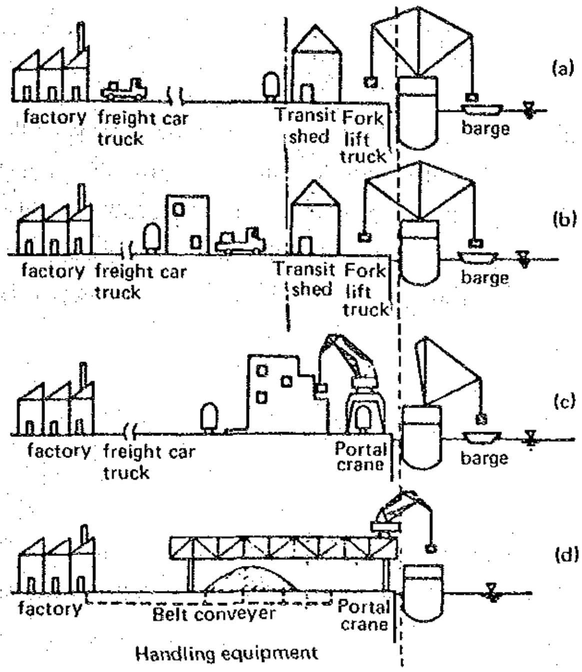
Item	Specific weight (t/m^3)
Coaks	0.5
Coal (lump)	0.9 - 1.0
Coal (powder)	1.0 - 1.1
Iron ore	2.0 - 3.0
Cement	1.5
Ind. salt	0.5
Nitrate of sode	0.9
chips	0.4

(6) **Others**

a) Layout of Land Facilities on a Wharf

Fig. 4-5-4 presents typical arrangement of land facilities on a public wharf for general cargo. Principal facilities are either the storage facilities like as aprons, cargo handling machines, transit sheds and warehouses and the terminal facilities which are represented by parking lot. Dock transportation facilities such as road and railway are provided on aprons or in front/rear of transit shed and warehouses. Attached to these, are the security and service facility, bunkering facility, telegraph and telephone facility, illuminations and drainages.

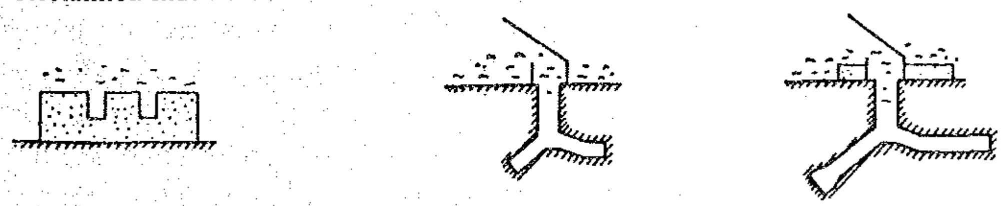
Fig. 4-5-4 Layout of land facilities on a wharf



b) Type of Industrial Ports

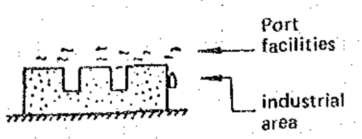
① Formation of industrial port in terms of development method.

a. Reclaimed ind. Port b. Excavated Ind. Prot c. Combined Ind. Port

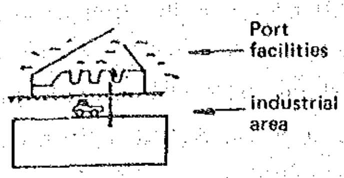


② Formation of industrial port in terms of utilization method.

a. Adjoined type
(No transp. system exists)



b. Separated type
(Transp. system exists)



4-5-3 Planning of Water-area Facilities

(1) Outline

The water-area facilities are to be provided for allowing vessels to navigate, moor and handle their cargoes in safe condition. The water-area facilities comprise "channel" for ship's navigation and "basin" for ship's temporary mooring or for cargo handling. It is desired that the water-area facilities receive less influence by the natural forces such as wind and waves, and therefore, the calmness is obtained by sheltering the water-area facilities by protective facilities.

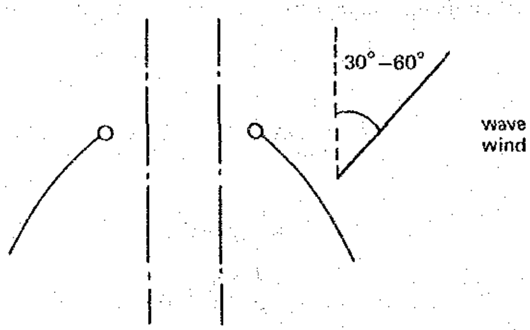
(2) Channel

a) Centerline of Channel

① Direction of the centerline

i) It is desired that the direction of channel has deviation of 30° – 60° as shown in Fig. 4-5-5 against the prevailing wave direction and direction of the maximum wind direction so that the calmness and ship's maneuvability is secured.

Fig. 4-5-5 Channel and the prevailing wind direction

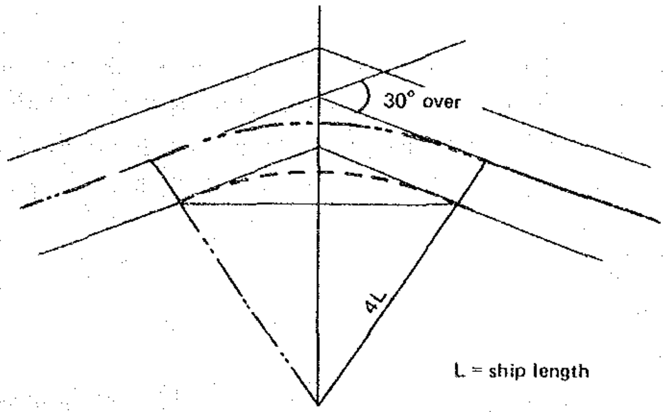


ii) It is desired that the direction of channel has smaller angle against the tidal current in order to preserve the current speed not more than 2 knots.

② Bend of channel

The bend of channel should be avoided as much as possible. When the bend is however inevitable, an arrangement shall be given so that an angle of intersection by the centerlines of channel at the bend exceed not more than 30° and the bend shall have 4 times of the objective ship's length as its radius of curvature as shown in Fig. 4-5-6. It is necessary to widen the bend when the angle of intersection exceeds 30°.

Fig. 4-5-6 Method of bend cut



③ Length of channel

A ship has to maintain, when she is entering the harbour with her own thrust, a certain speed outside break-waters in order to avoid influences by wind and current. (Entering speed of vessels into the harbour is generally 6 knots or around.) Therefore, the distance of channel from the end of a sheltering facility to a mooring facility must be 5L or over, which is the stopping distance of 4L added to 1L as the clearance. The stopping distance of a mammoth vessel is however decided individually in consideration of her maneuvaring performance. By the way, L means length of a ship.

b) Width of Channel

① Channel inside the harbour

(When the cruising speed is 6 knots or under)

The width of a channel with two way traffic shall be determined as provided at table 4-5-8 depending on the length of channel and condition of traffic. But, another consideration shall be given when the length of channel is extremely short.

Moreover, further clearance shall be added to the width given below for the channel having conspicuous heavy traffic or traverse traffic. The same arrangement must be given to the channel offered for mammoth vessels.

Table 4-5-8 Width of channel

Lengh of Channel	Traffic condition	Width
Channel with relatively long length	Frequent encouters by objective vessels	2 L
	Other than the above	1.5 L
Other channels	Frequent encounters by objective vessels	1.5 L
	Other than the above	L

This table is applicable for vessels of 500/GT and over.

② Channel outside the harbour

The width of a channel outside the harbour where abreast and outrunning traffic exist shall have larger clearance than the channel inside the harbour in view of the natural conditions, traffic volume, navigating speed, mutual absorpitivity by ships and psychological influence to ship's operators.

c) Waterdepth of Channel

① Channel inside the harbour

(Navigating speed is less than 6 knots)

For the channel inside the harbour where less influence by wave and current is received, the waterdepth is obtained according to the following formula.

$$d > 1.1\,D$$

d : Waterdepth of channel

D : Full drart of an objective ship

② Harbour entrance and channel outside the harbour

The waterdepth is obtained from the following.

$$d > D + D' + \frac{H}{2} + (o.3 - 0.5)^{m}$$

d ; Waterdepth

D ; Full draft of an objective ship

D'; Clearance for ship's squat and trim

H ; Wave height outside the harbour

In many past plans, it is the waterdepth of the port waterway plus one or two meters.

(3) Basin

a) Principle Consideration for Basin Planning

The basin can be classified into anchoring basin, buoy basin and operational basin. These basins shall be properly arranged with considerations of influence given by external forces such as wind, wave, and wave reflection maneuvability of an objective ship, layout of breakwaters and wharves.

The following conditions are required for the basin with better functions.

1. Sufficient area with calm water
2. Good holding ground
3. Preparation of buoys
4. Good natural conditions

b) Anchoring Basin

An anchoring basin is a circular anchorage centered around the point where the anchor is cast.

The standardized size of anchoring basin or the radius of anchoring basin is given by Table 4-5-9.

Table 4-5-9 Size of anchoring basin

Purpose	Method of Use	Holding ground and Wind Speed	Radius (m)
Berth waiting or Cargo handling	Single Point mooring	Good holding ground	L + 6D
		Poor holding ground	L + 6D + 30
	Double point mooring	Good holding ground	L + 4.5D
		Poor holding ground	L + 4.5D + 25
Refuge from storm		Wind speed 20m/sec.	L + 3D + 90
		Wind speed 30m/sec.	L + 4D + 145

(L : Ship length, D : Waterdepth)

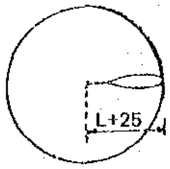
c)Buoy Basin

The standardized size of buoy basin is given below in accordance with a mooring system.

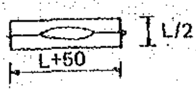
Table 4-5-10 Size of Buoy Basin

Method of Use	Size of basin
Single buoy	A circle with the radius of L + 25 m
Double buoy	A rectangle with sides of L + 50 m and $\frac{L}{2}$

Fig. 4-5-7 Basins for Single Buoy Mooring and Double buoy mooring (m)



(a) Single buoy mooring



(b) Double buoy mooring

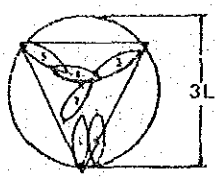
d) Turning basin

The following figure is adopted as the standard of the turning basin.

i) Turning by self thrust—A circle with diameter of 3L or longer.

ii) Turning by tug boat—A circle with diameter of 2L or longer.

Fig. 4-5-8 Turning Basin



② Slip

Width of slip must be decided taking the presence of tug boats into account. The width is, however, in accordance with the following standard when a number of piers are arranged in parallel.

a) When a pier has 3 berths of less 1L

b) When a pier has 4 berths or more .. 1.5L

e) Waterdepth of Basin

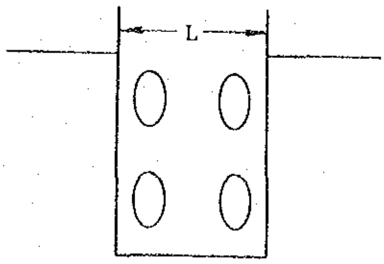
The waterdepth of basin is generally obtained according to the following formula.

$d = 1.1 D$

d : waterdepth of basin

D: full draft of an objected ship

Fig. 4-5-9 Slip



f) Calmness of Basin

① Critical wave height for cargo handling

It is preferable that the harbour area is always tranquil. But maintenance of sufficient calmness even in stormy weather is quite difficult in practice. The cargo handling would become possible if wave height in front of a berthing facility is controlled as within the Table 4-5-11. Therefore, it is desired that layout of the water facility could be decided as to maintain the wave calmness within the undermentioned heights even in strong wind (10 – 15 m/sec.).

In Japan, a port plan is so made that the under mentioned wave heights in Table 4-5-11 are obtained by 90 – 95%.

Table 4-5-11 Critical wave height for Cargo handling

Ships size (D/T)	Critical wave height (H 1/3)
1,000 t or less	0.3 m
1,000 t — 5,000 t	0.5 m
5,000 t or over	0.7 m

② Critical wave height and wind speed for refuge mooring in harbour

The critial wave height of basin and critical wind speed for refuge mooring in harbour is standardized as follows. The water-area facilities should be arranged to secure mooring in the harbour.

Table 4-5-12 Critical Condition for Refuge Mooring in the Harbour

Ships size	Wave / Wind	Critical limit for refuge mooring			Harbour entrance
		Quay mooring	Buoy mooring	Anchor mooring	
300 t 1,000 t	Wind speed Wave height	20m sec 0.7 m	20m sec 1.0 m	30m sec 1.0m	25/sec 1.5 m
1,000 t	Wind speed	20m sec	20m sec	30m sec	20m/sec
5,000 t	Wave height	0.7 m	1.0 m	1.5m	1.5 m
5,000 t	Wind speed	20m sec	20m sec	30m sec	15m/sec
over t	Wave height	1.0 m	1.5m	1.5 m	1.5m

(Note) The wind speed is the average wind speed for 10 min.
Wave height is H1/3.

4-5-4 Planning of Protective Facilities

(1) Outline

The protective facilities are the facilities such as breakwaters which are installed with the aim to prevent waves, tsunami, storm tide and sand drift invading the port and harbour area.

Facilities classified as the protective facilities are breakwaters, groins seawalls, training walls, ates, lock gates, revetments, embankment, jetties and parapets.

In this section, description is made putting emphasis on layout plan of breakwaters.

(2) Layout of Breakwaters

Layout of breakwaters shall be determined after examining the following items.

a) Calmness in the Harbour

① Direction of the breakwater shall be arranged as to shelter the harbour area efficiently against the prevailing and maximum waves, and thus preserve the required calmness so that demanded ratio of berth operation or accommodation for refuging vessels is satisfied.

② Estimation of harbour calmness is possible by examination of drawing or simulation with use of computors, however, determination of the breakwater centerline is more preferable with the model test for sheltering performance.

b) Easiness of Ships Operation

① Harbour entrance shall have an effective width not to hinder the ships navigation, and the direction of entrance should be set in consideration of easy navigation.

② A sufficient water area shall be reserved in order not to obstruct ships berthing, cargo handling and mooring.

③ The influence by concentration of reflected waves and running waves shall be minimized in channels and basins.

Requirements in a) and b) sometimes contradict each other. For example, narrower is better for the calmness of harbour area, however, it is inconvenient for ships navigation. Moreover, directions of the prevailing waves and the maximum wave does not always coincide. In such a case where contradictions exist, the final decision must be made with comprehensive studies on ships' utilization, construction cost, easiness of construction and maintenance, and others.

When an examination is made on the above a) and b), a reference shall be made to a section on planning of water area facilities.

c) Maintenance of Water Quality in the Harbour

Interchange of water shall be reminded in order to prevent water stagnation inside the harbours.

d) Construction and Maintenance Cost

① In prior to the construction of breakeater, studies shall be made not only on natural conditions and execution conditions but also on the economics. Especially, the followings shall be considered carefully.

i) A shape which causes wave concentration must be avoided.
ii) Construction on bad bed conditions should be avoided, and the site shall be of easy execution.
iii) Usable topography such as a cape or an island should be put in best use.
iv) A layout must be made not to roll in the sand drift when construction is done at a beach where the littoral drift exists.

② A wave height is amplified around shoal due to influence of wave refraction, and the impact wave pressure sometimes act upon breakwaters installed on steep bed slope. Therefore, careful attention should be paid when breakwaters are installed either on shoal or right behind shoal as it may contrary requires larger breakwaters.

e) Influence of Breakeater Installation on the Surroundings

When a breakeater is to be constructed, the layout and structure shall be decided after careful consideration of influence given on the adjacent water area, facilities, topography and current. The following area considered as its influence.

① Installation of a breakwater at the coast where littoral drift exists has a general probability to cause siltation on the upperside (against the flow of running waves) of the structure and errosion on the lowerside.

② Construction of a breakwater may cause turbulent water outside the breakwater due to reflected waves, and running wave may score the outer foot of the breakwater.

③ The harbour calmness is sometimes disturbed by repeated reflections of propagated waves into the harbour. Disturbance is also occured by resonant oscillation depending on the characteristics of propagating waves and a shape of the water area in the harbour.

④ The harbour calmness is sometimes disturbed by repeated reflections of propagated waves into the harbour. Disturbance is also occured by resonant oscillation depending on the characteristics of propagating waves and a shape of the water area in the harbour.

⑤ Construction of a breakwater may cause some changes of current conditions in the area, and lower the water quality if a river runs into the harbour.

f) Trend of Future Development of the Port (Port plans in future)

It is necessary to arrange a breakwater in order to display a sufficient effectiveness within a short range port plan. The arrangement of the breakwater, however, should be made with enough consideration of future development trend of the port so that the arrangement would not hinder a future port plan.

4-5-5 Planning of Port Traffic Facilities

(1) Outline

The port traffic facilities are necessary to perform a smooth linkage between a wharf and the hinterland. Because a port is a node between the sea and land transportation. The dock transportation facilities are comprised of roads, railway and canals, and when necessary, tunnels and bridges are prepared.

The port traffic facilities to be planned would be different according to a nature and status of the port and kind, volume and shape of cargoes handled there. But, they enable, with their characteristics, the quick and economic transportation. In Japan, in view of that the centers of economic activities are mostly located in the coastal zone, a higher ratio is shared by the road transportation.

(2) Dock Road

a) Outline

A road has advantages that it can be planned on any route, and is low in construction cost. Besides, it can be constructed into a form to meet the traffic volume.

Layout should be prepared as to enable the traffic to flow smoothly and reach a dock access road without causing heavy congestion.

For this purpose, an arrangement is needed for the traffic to avoid a town area.

In Japan, roads in the hinterland are classified into National highway, Prefectural highway, Express way and town street to which different entities are appointed for management, planning and construction.

And dock roads linked with these roads are supposed to be planned and constructed by port management bodies. In such a case where the administrative entities of road are separated, the mutual coordination on road construction and utilization becomes of vital importance.

Additionaly, it is also important to reserve wide parking space at suitable places in a wharf.

b) Decision of traffic lanes and road width

① Number of traffic lanes

In the first place, a planned traffic volume is obtained from port cargo handling volume as given below. (Two-way vehicle traffic volume per hour is determined, with thoughts of future traffic conditions, development trend in the locality and etc., as a basic criterion for designing)

An examination is made with an hourly traffic volume owing to a reason that the generated traffic volume has a possibilities of concentration within a certain hours due to a nature of the port.

Planned traffic volume (cars/hr) = annual cargo handling volume

$$\text{(ton/year)} \times \frac{\alpha}{W} \times \frac{\beta}{12} \times \frac{\gamma}{30} \times \frac{(1+\delta)}{\epsilon} \times \sigma$$

where;

α : Share by vehicles = car transportation/all transportation (1.0 or less)

β : Monthly variation = cargo volume in the peak month/Average monthly cargo volume (about 1.2)

γ : Daily variation = cargo volume on the peak day/Average daily cargo volume (about 1.5)

W : Loading ratio of trucks (t/truck)
= Cargo transportation volume per loaded truck
(should be found by survey or reference to other ports)
(4t truck = general cargo, 8t truck = bulk cargo)

ϵ : Loaded truck ration = Number of loaded truck/Total truck Number (about 4t)

δ : Rate of related vehicles = Number of related vehicles/Number of total truck (about 0.5)

σ : Hourly variation = Traffic generation per peak hour/Daily traffic generation volume (about 0.12)

When the planned traffic volume is smaller than the standard design traffic volume as shown in Table 4-5-13, a number of traffic lanes on the road is decided as 2.

Table 4-5-13 Standard design traffic volume

Type of road	Std. design traffic volume (cars/hr)
Connection road between a port and a truck highway	650
Other road	500

A number of traffic lanes on a road other than the roads specified above shall be 4 or over. (a number of lanes shall always be a multiples of 2 except a case especially demanded due to the traffic condition)

And the final number of traffic lanes shall be decided by the rate of a planned traffic volume of the road to a corresponding standard design volume per lane which is given in Table 4-5-14.

Table 4-5-14 Standard design traffic volume per lane

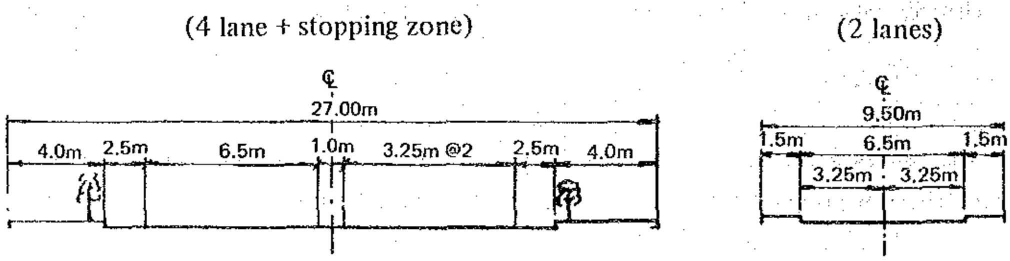
Type of road	Std. design traffic volume(cars/hr)
Connection road between a port and a truck highway	600
Other road	350

② Width

The width of a traffic lane shall be 3.25 m or 3.5 m in principal. When necessary, a stopping zone of 2.5 m width shall be provided on the left of a road aiming to avoid a stopped car from safe and smooth traffic.

The width of the lane, however, can be reduced to 3.0 m subjected that the traffic volume is extremely small and reduction is inevitable due to the topography and other.

Fig. 4-5-10 Standard Layout of Roads



(3) Dock Railway

a) Outline

Dock railway in general is a siding prepared from a main track to a whard. Although the dock railway is advantageous in mass transportation for relatively long distance, the dependence on railway is in a trend of decline (in Japan) owing to reasons that it requires a considerable area of marshalling yard and longer time to discuss about pass-through traffic to an adjacent main railway tracks, besides by development of motorization.

b) Layout of Dock railways

Sorting tracks are prepared in order to distribute freight cars to aprons, sheds, warehouses and open storages. Sometimes these are prepared together at the marshalling yard for the main track. But, the sorting tracks are usually provided in between the main track and cargo handling sites in a port. It is preferred to be arranged in a direct-loop formation.

Installation of the railway tracks on aprons are observed in ports which has the direct loading and unloading or freight wagon shipments to a remote area. In Japan, railway tracks are usually installed into a transit shed or right behind a transit shed.

Instead of this method, a railway terminal can be prepared at one section of a wharf, and linkage between the terminal and each berth can be done in small lot by trucks if railway cargo volume from each berth is relatively small. In either case, it is desired that the level of railway track would be arranged at the same levels as floors and paved.

Two or three tracks shall be prepared alongside transit shed in order to use the first track for cargo handling while others are used for exchanging and passing.

A number of joint tracks shall be provided between the first and second tracks.

4-6 SOFT GROUND TREATMENT

4-6. SOFT-GROUND TREATMENT

4-6-1. General

With the progress of soil survey for the development of industrial ports, the existence of soft subsoil in each port has been gradually clarified. In Altamira port, there are soft layers in the portion of the scheduled waterway, and the dredged spoil is planned to be utilized as reclamation material. In Fertimex district of Lazaro Cardenas port, the construction of structures on the soft ground has been scheduled. In Ostion port, the location of the port has been changed from the originally planned site to the better district south of Ostion lake due to the confirmation of soft subsoil in the originally planned area.

In the construction of structures, it is not favorable to utilize the soft ground, but due to the remarkable advancement of technology in recent years, the improvement of soft soil is available so that the soft ground is often utilized without a great difficulty.

Accordingly, in order to formulate the development plan for each port, it is necessary to study the application of the latest advanced method for soil improvement to the soft ground.

Generally in the ports and harbors, the soil improvement is often used to stabilize the foundation ground of structures and the reclaimed ground, and the main purposes of the improvement is classified as follows:

(1) To increase the strength of an exist ground and stabilization against slip – Mainly for the stabilization of the foundation ground of structures

(2) To decrease the residual settlement through its acceleration and control the total settling volume – Mainly for the countermeasure against the settlement of the reclaimed ground and the foundation ground of structures.

In this section, various types of soil improvement methods to be used for such purposes will be outlined and, at the same time, the examples of soil improvement for port construction in Japan will be described. Further, the procedure for soil improvement program will be described for the help to the selection of the improvement method for each port.

4-6-2. Soil Improvement Method

The soil improvement methods currently used or considered are as shown in Table 4-6-1, and those methods are summarized as follows:

(1) Replacement of soft soil with better soil

(2) Strengthening of the original ground through any practice.
As the methods of increasing the strength, there are consolidation, compaction and chemical solidification.

(3) Combined use of the replacement and the strengthening.

In the large-scale construction of ports and harbors, widely employed methods are limited to a few methods. The most popular method used for the improvement of foundation ground for structures is a simple base replacement method, which is often used in combination with counterweight fill and others. In Japan, however, it is thought that the employement of a large-scale replacement method will gradually difficult due to the poor resources of sand, the difficulty in discarding the excavated soil and others. In addition, the sand drain method, large-sized sand column method (forced replacement method), etc. are used and, especially, in sandy soil, compaction type of methods are employed. Further, in the reclaimed land, the paper drain method and others are used.

The water-absorption hardening method in which lime is used has already be employed in port and harbor work and injecting cement milk with stirring instead of lime has come to a stage of practical use and will be widely used in future due to the poor resource of sand and the difficulty in dumping of excavated soil. Besides, drain types of methods, chemical grouting methods and others are used, but in the employment of chemical grouting methods, care must be taken for the pollution of underground water and others.

Table 4-6-1 Classification of Soil Stabilization Methods

A. For Clayey Soils		
a. Replacement		Mechanical Method
b. Preloading		Methods based on the consolidation of the clay by loading
c. Sand drain	vertical drain	Methods based on the consolidation of the clay by loading
d. Paper drain	vertical drain	Methods based on the consolidation of the clay by loading
e. Vacuum method		Methods based on the consolidation with no external load
f. Osmotic pressure		Methods based on the consolidation with no external load
g. Quick lime pile		Methods based on the consolidation with no external load
h. Deep Mixing Method		Chemical reaction between clay and additives
i. Sand compaction pile method		Mechanical Method
j. Heat treatment		Chemical reaction
k. Electro-chemical grouting		Chemical reaction
B. For Sandy Soils		
a. Compaction pile		Densification, essentially horizontal compression by piles or vibration
b. Sand compaction pile		Densification, essentially horizontal compression by piles or vibration
c. Vibroflotation		Densification, essentially horizontal compression by piles or vibration
d. Blasting compaction		Densification, essentially vertical compression by impact
e. Electric Shock compaction		Densification, essentially vertical compression by impact
f. Gravel column		Vertical drainage
g. Grouting		Filling the void space
C. For Temporary Purpose		
a. Well point		Dewatering to lower water table
b. Freezing		Freezing the pore water temporarily
c. Electro-osmosis		Electric dewatering
D. Other Methods		
a. Sand spreading		Sand mat
b. Netting		Reinforcement
c. Dynamic consolidation		
d. Other improvements		
Sandwich method, Flocculation, Capollary Dessication, Chemical treatment, etc.		

Source: "Soil Stabilization Method" Mr. Masaaki TERASHI, Port and Harbour Research Institute, Ministry of Transport, July 1979.

4-6-3. Brief Description of Main Soil Improvement Methods

The Soil Improvement Methods comparatively often used in port and harbor works are as follows:

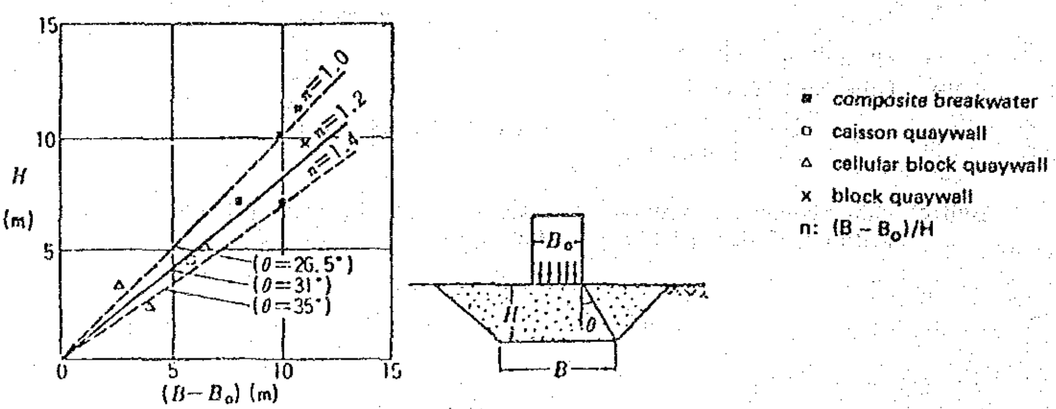
(1) Replacement Method

In this method, the soft soil in the surface layer of ground is partially or completely removed and replaced by the material of a good quality, which has been most frequently used in port and harbor works. As the effects of the Replacement Method for the improvement of soils, the increase in the stability of soils and the decrease in the settlement due to consolidation and in the consolidation time can be mentioned.

The increase of the stability is due to the increase of shearing strength in the replaced portion and to the diffusion-over of stress under the ground. Further, the decrease in the settlement due to consolidation and in the consolidation time is caused by the decrease in the thickness of the consolidation layer and by the increase in draining area.

In this method, as the soft soil itself is replaced with the soil of a good quality, more definite results of improvement can be obtained than those of other methods, but due to the difficulties, such as the shortage and price hike in a good quality of sand, and the dumping problem of the excavated soil, the change-over to other methods or the combined use with other methods, or the like has been frequently found. When the displacement method is used, the range of the soil to be displaced is determined, referring to Fig. 4-6-1 or calculating the bearing power, circular failure and other factors required for the decision on the section to be displaced. According to the type of execution, this method is divided into the following: Excavation Process (complete or partial), Forced Process (or Extruding process), Explosion process, etc.

Fig. 4-6-1 Experienced replacement in Japanese port and harbor construction



(2) Drain Method

In this method, a great number of drains (drain canal) are piled into the soft ground to shorten the drainage distance of underground water and accelerate the consolidation for the improvement of the soil. According to the consolidation theory by K. Terzaghi, the time required for the consolidation of soft soils can be expressed as follows:

$$t = \frac{Tv\ H^2}{Cv}$$

Where:

Tv = Coefficient of time

Cv = Coefficient of consolidation

H = Distance of drainage.

Accordingly, if drains are piled into the ground for shortening the drain distance, the consolidation time is shortened in proportion of the quare of the time.

For an example, suppose that a clay layer having the thickness of 20 m is drained on the upper and lower interfaces. The drain distance is 10 m in this case. If drains are piled at a pitch of 1 m, the distance H is given as 1 m, which means 1/10 times the distance in case of no drains. Therefore, the consolidation time is shortened as (1/10) = 1/100 times, if assuming same as horizontal and vertical coefficient of permeability.

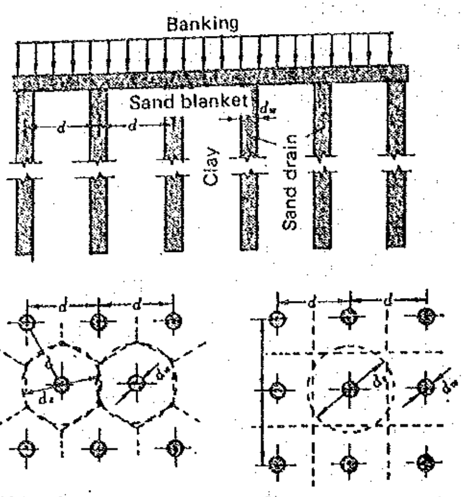
In this drain method, when the drain material is sand, it is called "Sand Drain Method", and when it is paper, the method is called "Paper Drain Method or Cardboard Drain Method". In addition, as a similar method, "Pack Drain Method" can be mentioned

The sand drain method as well as the displacement method has been used in port and harbor works as the major method for the improvement of soils.

For the piling intervals of sand drains, determination is made through the calculation, taking into consideration the given term of construction, the strength of drains required and the consolidation time. Fig. 4-6-2 *shows the arrangement of sand drains. The symbol* (de) *given in the* figure indicates the radius of influence circle. If the drain interval is expressed as (d), it will be 1.13 (d) in the square arrangement, and 1.05(d) in the triangle arrangement.

As for the limit of the applicability of this method to the port and harbor works, the maximum length of sand piles is about 40 m (about 50 m below the surface of the water) on the sea works and on land works it is, in general, 20 m or thereabouts, even though it depends upon the height of a driving frame.

Fig. 4-6-2 Sand drain method



(3) Compaction Method

This method is used in the areas where the soil particles of the ground to be improved are comparatively large and, besides, they accumulate loosely. Practically, it is suitable for the ground immediated after reclamation has been done using sands and others or for the sands (the delta zone at the mouth of a river) where sand has been carried by the river and accumulated loosely. In the method of this improvement, vibration and impact are given to the soil for reducing the voids, and the newly produced gaps among the particles are filled with a good quality of sand for the increase of the density in the soil (in most cases). Therefore, this method is not available for the clay soil in which vibrations and impacts brings about the weakness, or the decrease in the strength of the soil.

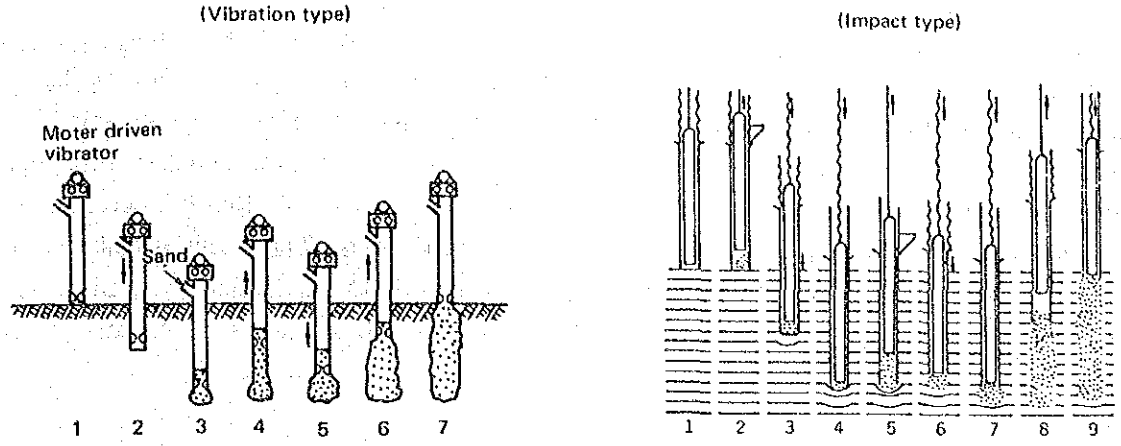
As comparatively well-known methods of this type, there are the "Sand Compaction Method", "Vibro-Composer Method", Vibro-Flotation Method", etc. Among the methods of this type, there is a method for improving the clay soil, called "Large-Sized Sand Pile Method (Forced Displacement Method). In this method, improvement is made in such a manner that the piles of sand having a large particle size are driven closely into the soft clay soil to form the composite soil composed of sand and clay soil.

Among the above methods, the most frequently used method, "Sand Compaction Method" will be described below.

In the Sand Compaction Method, sand pile press-in compaction is conducted through the application of impacts and vibrations to the loose sandy soils, so that the increase in the shearing stress in addition to the increase in the density due to the decrease of the total voids, and, at the same time, the reduction in settlement can be obtained through the compaction of this method.

Fig. 4-6-3 shows the order of execution of this method.

Fig. 4-6-3 Execution order of sand compaction pile



As the features of this method, the following can be mentioned:

a) In case of ordinary sand, as the compaction can be done until the relative density reaches to nearly 1, the stability for liquefaction and settlement can be obtained.

b) In addition to the increase in the biting power of sand particles, the increase in the angle of internal friction and the bearing power can be obtained and, at the same time, the water pressure in the produced voids can be lowered.

c) This method is applicable to the sand soils including the silt and the subsurface of thin clay layers overlapped, in which the compaction with vibration only is difficult in most cases.

d) The machines used in this execution are of simple type; the term of execution is comparatively short; and it can be applied to the large-scale construction without difficulties.

(4) Lime Stabilizing Method

In this method, lime (quick lime or slaked lime) is allowed to react with the water in the soil and the fine clay particles in the soft soil, and the strength, consolidation and permeability of the soft soil are improved. Through the contact of the soil with lime, the following effects of improvement can be obtained.

a) Due to the ion exchange reactions and others between the calcium ions of lime and the minerals of clay soil, the soil particles are allowed to aggregate electrically, and the elastic strength of the clay soil is increased.

b) The soil particles that has absorbed calcium ions of lime, is further made to react with lime and strengthen, forming crystalline minerals having a high stability, for a long period of time; and the stability and durability of the soil are remarkably improved.

c) In the case of using quick lime, the water content is lowered by the reaction of quick lime with the water in the soil and the consolidation in the surroundings is increased by the volume expansion of quick lime accompanied by the hydration. Thus, the strength of the soil is improved.

In this method, as the chemical reaction of quick lime against the water contained in the soil, the range of application of this method is limited to the ground where the particle of soil is fine and a high water content can be obtained without furnishing unnecessary water to the soil.

In this method, almost no settlement takes place during the reaction, and less unfavorable influence is given to the structures in the surroundings than in other methods. Therefore, this method is frequently used in the excavation works in urban areas. The material to be used is mainly quick lime prepared by sintering artificially lime stone. It is thought that the utilization of this method instead of the sand drain method and others will be increased because of the shortage of good sand and gravel.

4-6-4. Examples of Soft Ground Improvement Works in Japan

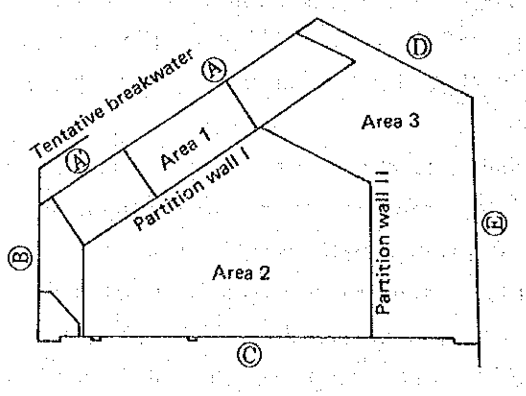
As the examples of soft ground improvement in port and harbor works, the construction of the revetments at Osaka North Port in which the three methods of displacement, sand rain and sand compaction were used, and at Chiba Port in which the cement deep layer mixing method was used, will be briefly described below.

(1) Revetment works at Osaka North Port Waste Treatment Station

The Osaka North Port Disposal Station was constructed as the final treatment station for the general waste, urban facilities waste, dredged soil and industrial waste generating in Osaka City. The scale of the station is as follows. In addition, the plan of the station is shown in Fig. 4-6-4.

Area: 208.9 ha
Maximum volume of waste treated: 25000000 m
Extended revetment: 5,880 m

Fig. 4-6-4 Plan of Osaka North Port Disposal Station



a) Soil Quality of Soft Ground

The soil in the neighborhood is soft alluvial clay soil peculiar to Osaka in the range from the sea-bed (−3 to −8 m) to about 20 m under the sea-bed. As C = 1 − 3 t/m. it can not be used a foundation ground. Under the layer lies a transfer layer and a gravel layer in this order. Accordingly, in order to construct structures, it was necessary that the displacement or other improvement of the clay soil layer should be done and the bearing piles had to be driven to the travel layer.

b) Revetment and Soil Improvement Method

Description of the revetment structure is shown in Table 4-6-2.

Table 4-6-2 Structure of each revetment

Revetment	Type	Foundation improvement	Planned height of crown (m)	Front water depth (m)	Bach filling width (m)	Length (m)
A	Composite revetment	Sand drain	+3.5	-2	20	1,000
A'	Double sheet pile	Sand compaction pile	+3.5	-4	20	460
B	Composite revetment	Base displacement Sand compaction pile	+4.5	-4	20	586
C	Sheet pipe pile anchored batter pile	Sand compaction pile	+5.3	-4	20	1,995
D	Caisson	Replacement	+3.5	-4	20	780
E	Caisson	Sand compaction pile	+6.7	-10	20	1,060
Partition I	Double sheet pile	Sand drain	+4.9	-3	–	2,060
Partition II	Double sheet pile	Sand drain	+5.7	-2	–	1,185

① Revetment A

The portion north of the Disposal Station was scheduled to be improved at the second half of the execution period, as the waste was to be dumped in this area.

Accordingly, sand-blanket and sand rain was conducted for the soft ground of the sea-bed, and the strength of the clay soil was increased through the loading by the sand banking and the rubblestones. The sand drain was 40 cm in diameter; the driving depth DL was −22 m; and 2 m square piling was conducted with 4–8 piles driving boats. The sand mat was 1.2 m in thickness, and its laying was done by a sprinler boat. For the measurements of settlement in sand blanket and the rubblestone, a double-wall monitoring tube reaching the bearing layer was set for the control of execution. The top cellular block was executed directly by the City authorities.

The area 400 m west of the Revetment A was scheduled to be used as temporary quaywall, so that the vertical sheet pile structure was employed and the water depth of 4 m was secured. Further, cranes was installed on the revetment.

② Revetment B

The revetment B had almost the same structure with that of the revetment A, but the execution had to be done, first of all, as the waste was received in this area. Therefore, sand compaction pile method were frequently used for the improvement of foundation soil.

In this case, it is thought that the employment of bed excavation and sand replacement most favorable and even economical. However, the reclamation area is required due to the generation of a great deal of the excavated soil. Therefore, the utilization of removal of soft and weak foundation was limited to the minimum extent, and the deep portion was improved by use of the sand compaction pile (The length of a pile: 9 m, Replacement rate: 50%, Angle of internal friction after improvement: 23°). The top of the height of the installed cellular block was 1 m higher than that of the planned elevation crown. This is because the settlement after the execution was taken into consideration. The extent of the settlement was unexpectedly great, which was 1 m or more only for two years following the installation. For the back filling the mountain soil from Awaji island was used, and the execution was done by reclaimer barges.

③ Revetment C

This area was located south of the disposal station and can be utilized as port and harbor facilities in future. Accordingly an sheet pipe piles anchored batter pile was employed so that this portion can be utilized as mooring quay having a water depth of 10 m or thereabouts through the construction of a piled wharf at the front. The soft ground was improved by using the sand compaction pile to the deep portion of the foundation ground.

The steel sheet pile pile used was 711.2 mm in diameter, 9–14 mm in thickness and 39 m in the length. The weight per pile was 7.8 t, and the piles were driven by the 4-t hammer of the pile-driving barge.

④ Revetment D

This area is located northeast of the disposal station, and was scheduled to be used as waste-receiving place. In future, this area will be utilized as a cargo handling facilities. The structure of this revetment was of the ordinary caisson section. When this type was compared with other types, the stability and security was required. Therefore, the base replacement method was employed for this work. Further, dredging was done with an unmanned dredger *in a certain portion of this works.*

⑤ Revetment E

This work was the rainforced construction of the former breakwater to utilized a seawall. However, this breakwater was not originally designed to bear the earth pressure from the banking soil at the back. The foundation was prepared by placing stones in the clay soil and forcibly replacing the clay soil with the rubblestones. The section of the breakwater was irregular and unstable, and dredging around the foundation could not be done. Accordingly, sand compaction pile was conducted at the front for the prevention of circular failure due to the reclamation at the back. At the same time, sand blanket and rubblestones was carried out at the front for the counterbalance.

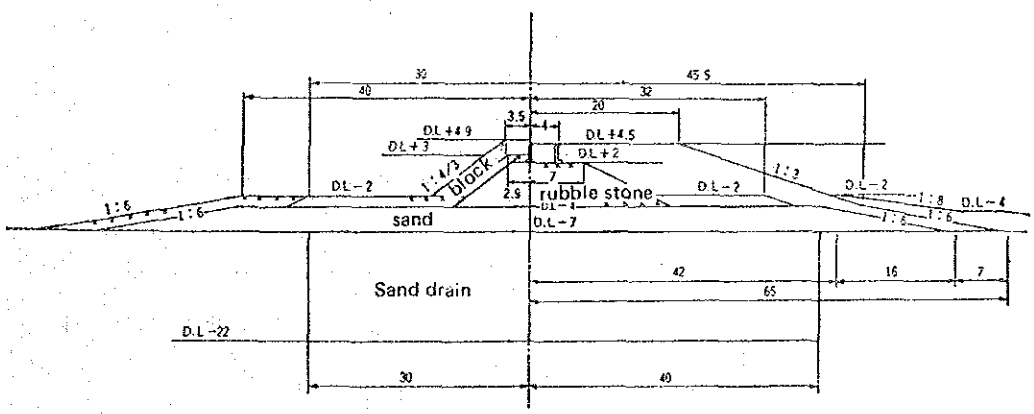
⑥ Partition bank

As the partition banks, there were two types – Partition No. I and Partition No. II. The former was prepared for dividing the Area No. 1 and the Area Nos. 2 & 3. The Partition No. II was located between the Area No. 2 and Area No. 3.

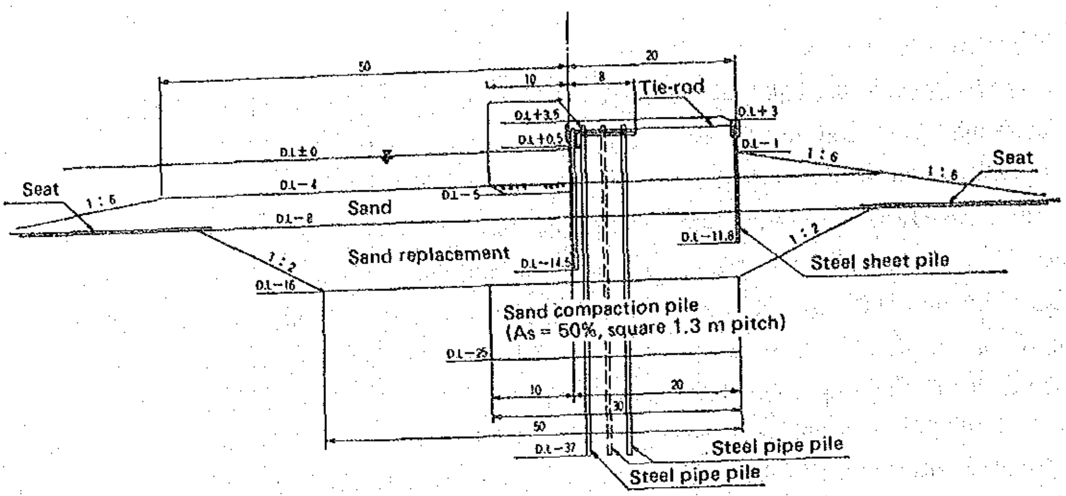
The Partition No. I was used for dumping of soil and sand on one side, while on the other side, it was used for discarding of wastes. Therefore, unbalanced pressure sometimes took place. On the other hand, the Partition No. II divided the soil and sand throw-in area into two portions. The load of the partition was determined by the water or clay level of both sides, formed with the blowing-out of the dredged soil by the pump dredgers. Accordingly, the control of the pressure was easily conducted by management to receive the dredging spoil. Therefore, the Partition No. I had a firm structure due to the length of piling pipes. Partition No. II was designed mainly for the purpose of construction of a bank. As the rise in the level of dredged soil was presumed before long, the structure in which the sheet pile could be pulled up according to the level of the deposit, was selected. For the both of partitions, the improvement works for the foundation was conducted by the method of sand drain. Therefore, the construction cost was rather economical. Further, these partitions will be utilized as the transfer the route of unnecessary soil and sand produced on the ground for their disposal in future.

Fig. 4-6-5 Typical Cross Section of Revetment

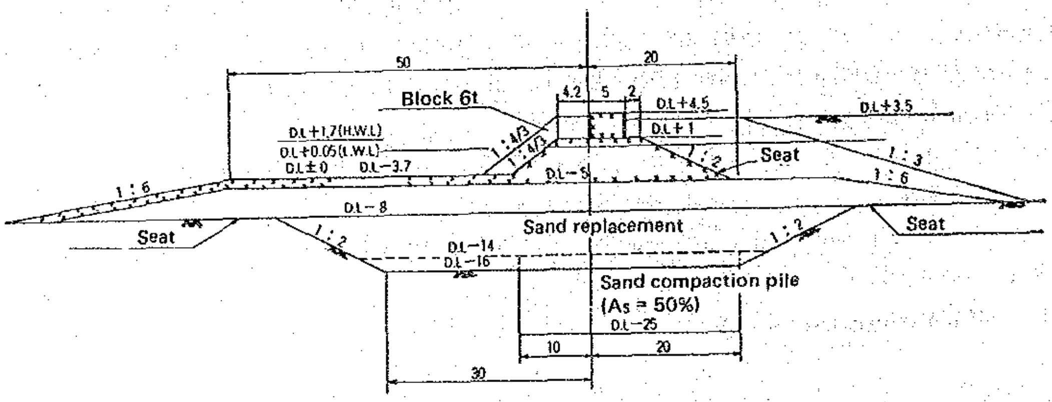
(1) Revetment A



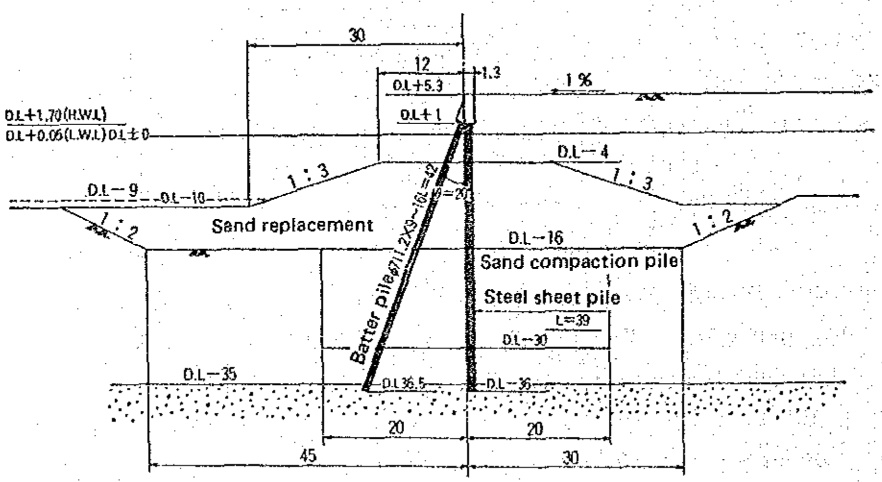
(2) Revetment A'



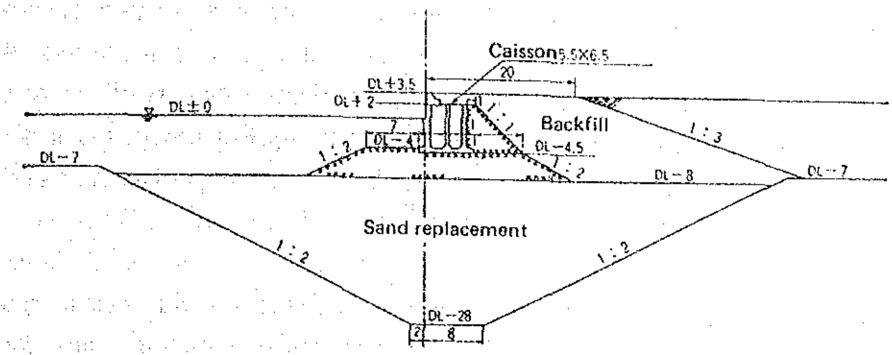
(3) Revetment B



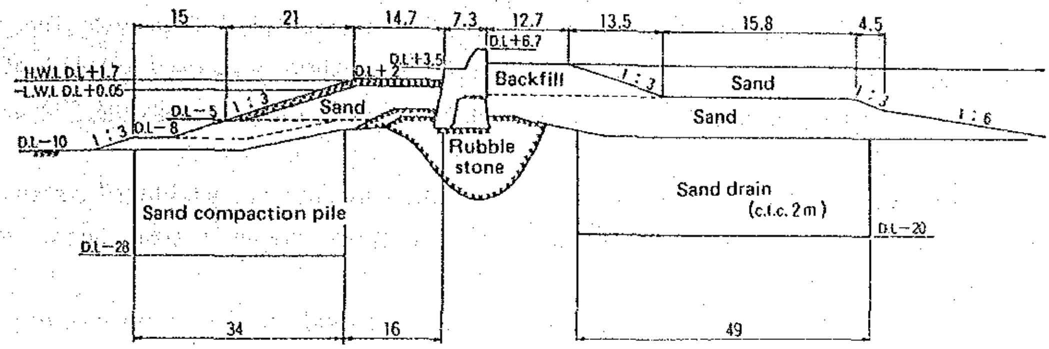
(4) Revetment C



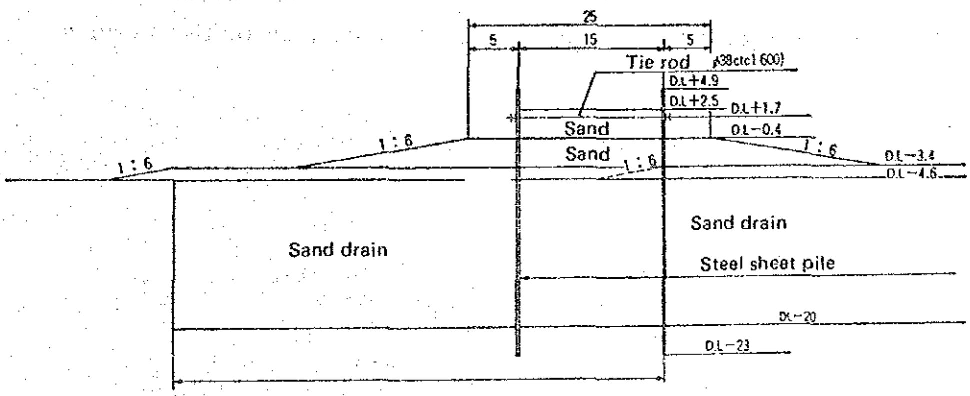
(5) Revetment D



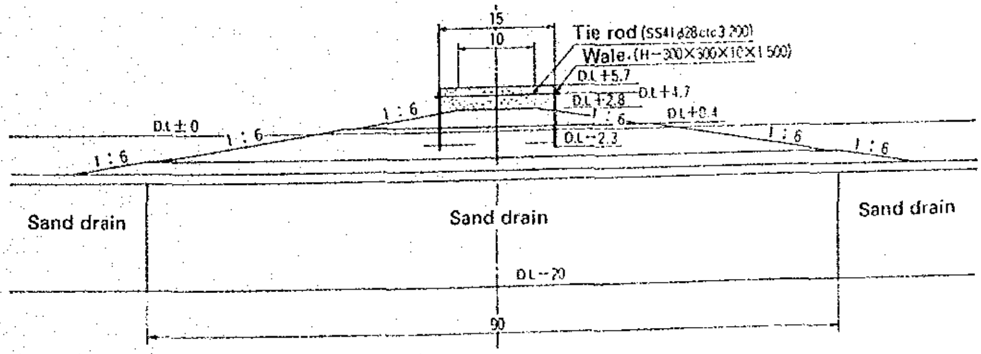
(6) Revetment E



(7) Partition wall I



(8) Partition wall II



(2) Bulkhead Foundation Work for Chiba Port Waste Treatment Station

Soil condition of the execution site of Chiba port waste treatment station, was the area where sandy silt layers had terribly accumulated, which required any soil improvement for the construction of bulkhead. Therefore, after the results of preliminary survey, the results of boring and the conditions of structures around the area has carefully examined, the soil improvement method suitable for this area was selected. Further, the construction districts was determined as follows:

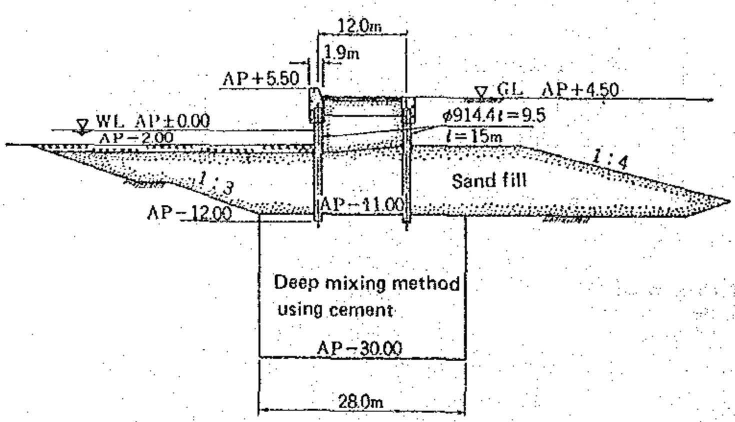
a) For the bulkhead on the side of the west factory, Chiba Plant, Kawasaki Steel Corporaiton and on the sea-side (west side), the replacement method was employed, especially, where the districts were comparatively far from the existing structures.

b) For the installation site on the side of the west factory and the bulkhead on the side of the big iron factory, the cement deep layer mixing method was used instead of base replacement method if it was employed the influence was considered against the existing revetment.

This new method had been developed to meet such demands as the speed-up of construction work, adaptability to the large-size construction of structures having a great head, and the increase in weight of structure.

In the conventional methods, their principle were the consolidation, hydration, compaction and displacement, but in this method, the principle, called as "Solidification Treatment" has been employed, and remarkable results, such as the earlier stabilization of soft soils, high strength in improvement, and no pollutions had been obtained. The typical cross section of the revetment is shown in Fig. 4-6-6 through the employment of deep mixing method using cement.

Fig. 4-6-6 Typical Cross Section



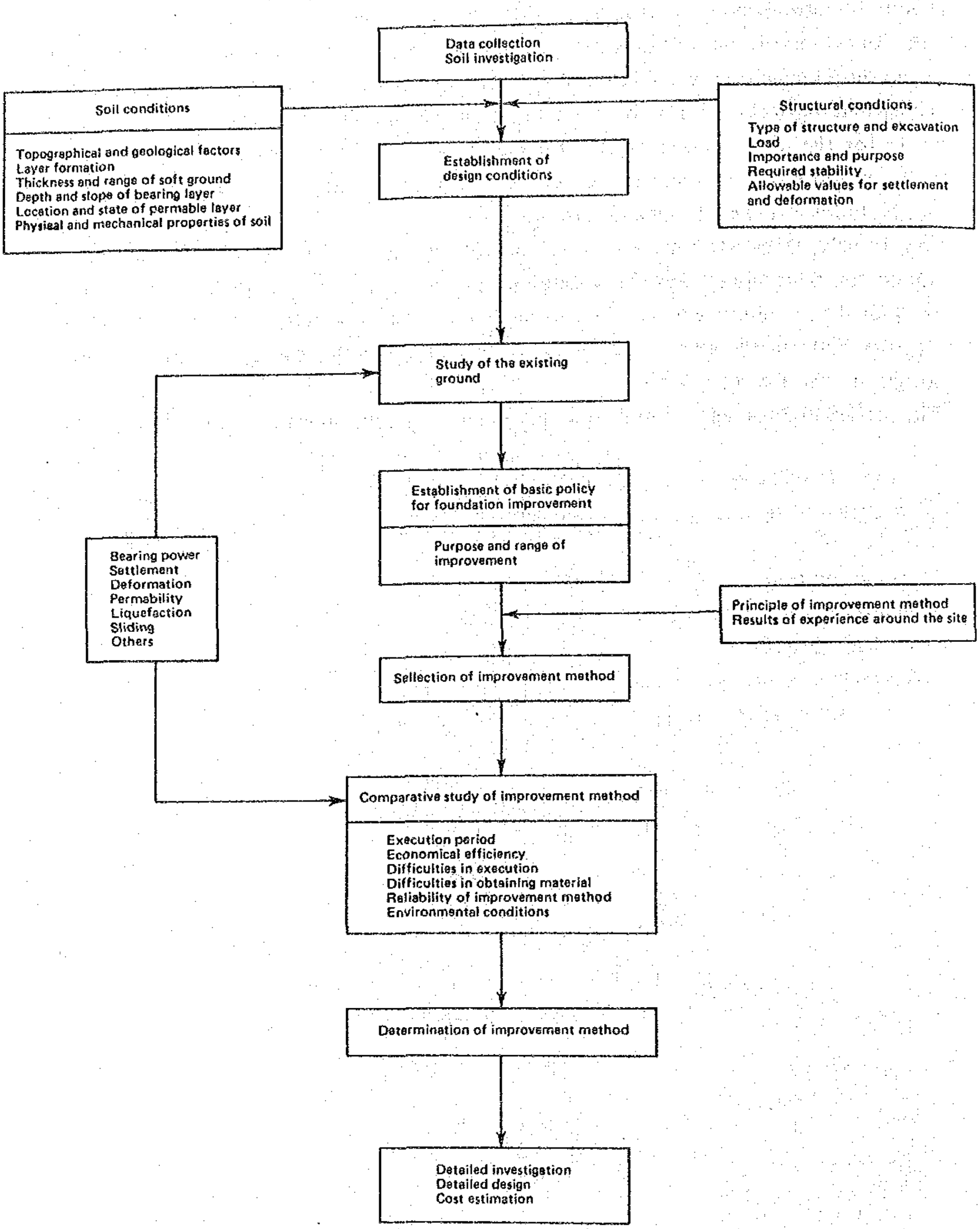
4-6-5. Procedure for The Preparation of Improvement Program Foundation

In case port and harbor works are carried out on the soft soils, the countermeasures for the soft ground depends upon the properties of the soils, such as the layer state, the quality of soil, and the thickness of the soft soil layer, and upon the shape of structures and the scale of construction. In general, the soft ground in which no serious problems take place on introducing the construction machines into the worksite or on the completion of the construction, are not taken up for the improvement of the foundation. The allowability in such cases, also,depends upon the purpose of structures to be built up, the degree of the importance, the construction period, economical and environmental problems, etc.

Accordingly, when the construction on the soft ground is planned and executed, first of all, determine the basic policy for the countermeasure against the soft ground, and investigate the necessity of the soil improvement. Then, examine their respective improvement methods based on the factors and finally select the soil improvement method most suitalbe for the planned construction of structures.

The procedure for preparation of foundation improvement program is shown in Fig. 4-6-7.

Fig. 4-6-7 Procedure for the preparation of soft ground improvement program



4-7. ENVIRONMENTAL PROTECTION AND ADMINISTRATION OF PORTS AND HARBOURS

4-7 ENVIRONMENTAL PROTECTION AND ADMINISTRATION OF PORTS AND HARBOURS

4-7-1 Introduction

In Japan, industrial pollution problems have recently (for the past 20 years) become a great issue and various laws and standards have been published and countermeasures have been established to prevent pollutions.

Especially for constructing industrial ports, sufficient study must be carried out so that changes in natural environments and industrial wastes may not cause the destruction of nature and create source of pollution.

This chapter introduce Japanese cases for environmental protection and administration which should give some references in constructing industrial ports in Mexico.

4-7-2 Definition of Pollution

Pollution is a by-product of human activities which tends to spread over relatively broad areas, and is detrimental to human health and living environment. Pollution may be categorized into the following 7 types:

- Air Pollution
- Soil Pollution
- Offensive Odor
- Vibration
- Water Pollution
- Noise
- Ground Subsidence

4-7-3 Pollution Prevention Program

Pollution prevention programs is prepared by governors of the related prefectures by the direction of the Prime Minister for the basic principle of the programs (pollution prevention programs) related to the prevention of pollution in areas where population is concentrated and pollution is presently eminent and where its prevention is difficult to achieve unless overall measures for pollution prevention are enforced. The programs are prepared upon approval of the Prime Minister.

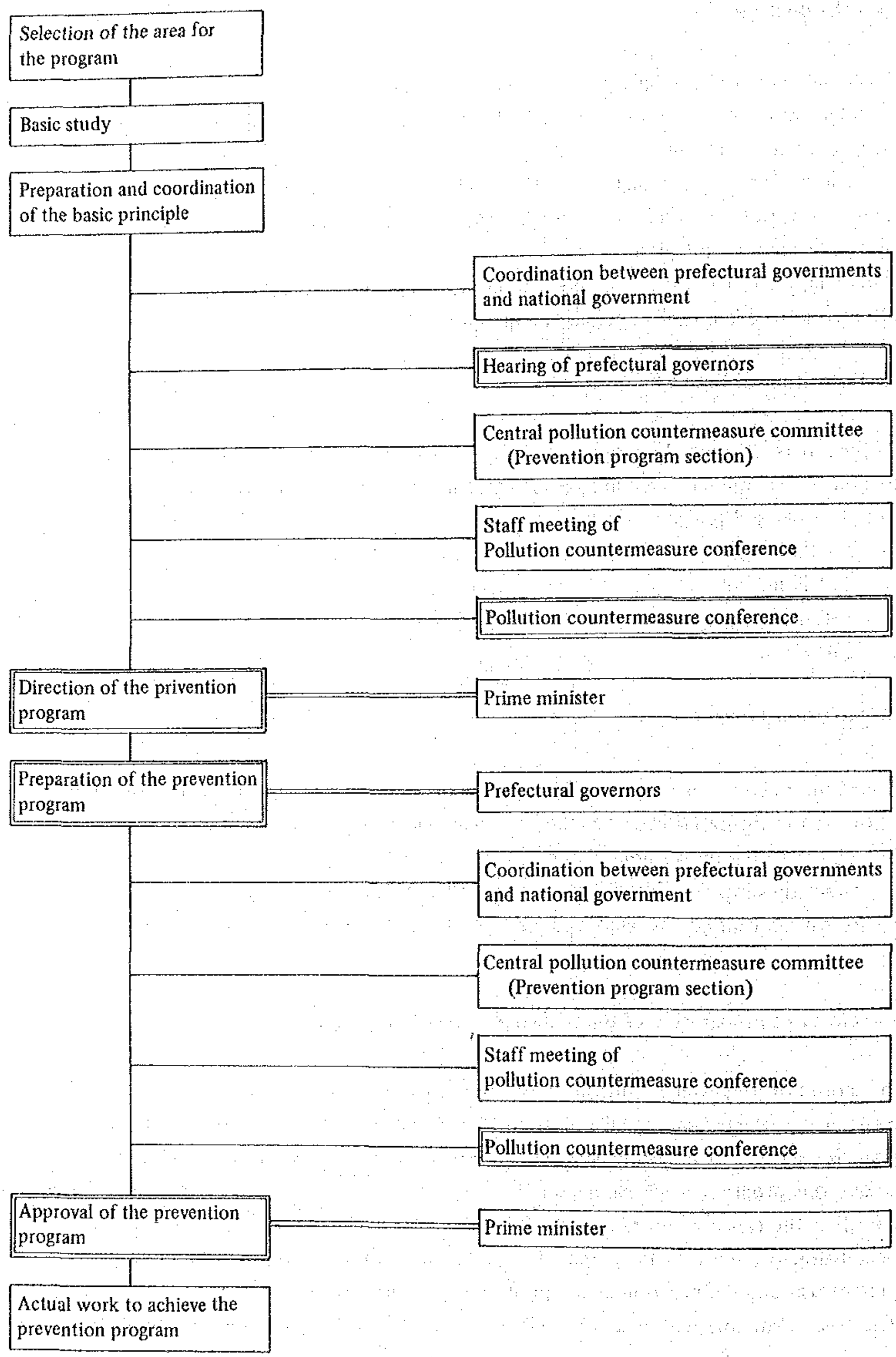
(1) Order of preparation of the pollution prevention program

Procedure of preparing pollution prevention program is as shown in Fig. 4-7-1.

Basic study of environmental pollution in the proposed area of the pollution prevention program is carried out commissioned by the Environmental Agency first to determine areas for which the program is prepared and then to determine type of measures to be employed. Based on the result of the study, the Prime Minister will direct basic principle of the pollution prevention program to be prepared by each area after hearing of governors of the related prefectures and deliberation at the pollution countermeasure conference.

The basic principle will generally give roles, objectives, and completion date of the pollution

Fig. 4-7-1 Procedure of Preparing Pollution Prevention Program



prevention program, enforcement of prevention measures, protection of natural environments, establishment of monitoring measuring system of pollutions, securing of cooperation system of pollution and relationships with other plans.

According to this basic principle, related prefectures prepare a pollution prevention program and the prepared program is submitted to the Prime Minister together with governor's application for approval.

Upon receipt of the application for approval, the Prime Minister will call for pollution countermeasure conference and after its deliberation will approve the pollution prevention program.

(2) Objectives and Content of Pollution Prevention Program

(a) Objectives

Generally the pollution prevention program carries out overall measures related to pollution prevention systematically according to the actual condition of each area. Its objectives are to achieve drastic and immediate solution of pollution problems, thoroughly prevent occurrence of pollution, protect the health of local inhabitants and to secure living environment by carrying out these measures as well as measures related to the protection of natural environment.

(b) Content of the Program

The pollution prevention program embodies first the degree and period required to achieve the quality of environment, followed by the evaluation of the present condition of pollution and establishment of policies and countermeasures.

Table 4-7-1 shows a typical example of the content of the program which has been already prepared.

A period of the program is generally 5 years except in large cities and surrounding areas such as Tokyo metropolitan area, and etc. The period is set for each polluting substance such as sulphuric oxides, etc.

For each area the analysis of the present condition and forecast of each polluting substance is undertaken.

Total amount of waste discharge permitted by ares is estimated and respective countermeasures are set for each polluting substance.

Table 4-7-2 roughly shows countermeasures undertaken by local businesses and local public bodies, etc. to achieve/maintain respective objectives and further protect the health of the inhabitants and natural environment and secure overall living environments of the respective area.

Table 4-7-1 Content of Pollution Prevention Program

Preamble	Summary of preparing pollution control program Range of area Objective of the program
Outline of area	Natural conditions (geology, weather, etc.) Population, Area Industries Environment of cities
Present condition of environmental pollution	Present condition of local environmental pollution Air pollution Water pollution Noise, Vibration Ground settlement Offensive odor Soil pollution Wastes

Table 4-7-2 Countermeasures Undertaken by Local Business and Local Public Bodies, etc.

Countermeasures to prevent pollution	Basic policy Land use plans Air pollution countermeasures Water pollution countermeasures Noise and vibration countermeasures Ground settlement countermeasures Offensive odor countermeasures Soil pollution countermeasures Waste disposal countermeasures
Other countermeasures	Development of pollution prevention related matters and other city facilities Environmental health measures Small and medium business countermeasures
Development of Systems of Research and Monitoring/Measuring	Development of systems monitoring pollution sources Development of systems monitoring environment Development of monitoring center Development of research and study systems Administative organization of pollution countermeasures
Protection of natural environment	
Summary of the program	Follow up to achieve objectives Estimated costs Securing cooperation systems Coordination with the existing plans.

(i) Businesses shall carry out various pollution prevention measures such as changing raw materials/fuel, improving method of combustion, installing desmoking/desulfurizing/denitrating facilities, dust collection system for air pollution countermeasures and installing/improving waste disposal system and changing process of production for water pollution countermeasures.

(ii) Local public bodies shall carry out various public work (A. developing sewage system, dredging rivers and harbours, installing greens as buffer, waste disposal system, countermeasures for pollution of farmland, countermeasures for noise caused by airplanes, improving school environment, developing monitor/measure systems and other pollution countermeasures. B. developing parks and green areas, countermeasures for ground settlement, countermeasures for traffic and other pollution related works) in addition to carrying out environmental assessment, control of pollution sources, site regulation and other measures.

4-7-4 Environmental Assessment related to Development of Port and Harbours

(1) Environmental assessment related to the development of ports and harbours is carried out by making studies from the standpoint of environmental security of the ports and surrounding areas to serve as adequate development of the ports and harbours as elements for study of the development, use and security of the ports.
Basically in the course of developing ports, environmental assessment is carried out at the time of the completion of the plan in the stage of basic planning, at the time of the completion of the plan in the stage of execution planning of the project and at the time of execution of the project.

(2) The following cover the range of subjects for environmental assessment related to the development of ports and harbours.

(a) Range of space
Environmental assessment is carried out on areas affected by the development of ports and those related to the affected areas.

(b) Range of environment
Environment assessment is carried out on the living environment and natural environment but not on the economic environment.

(c) Range of influence
Basically influence is limited to direct influence caused by the development of ports and indirect influence upon plants, animals and cultural assets is included if necessary.

(3) Environmental objectives

The following environmental objectives are set in environmental assessment related to the development of ports.

a) For all changes of environment which is subject to assessment, objectives for environmental protection are set up.
b) In case environmental standards are set up in respective area, basically the environmental standards are set up as environmental objectives.
c) In case environmental standards are not set up in respective area, adequate environmental objectives are set up in consideration of the characteristics the area.

(4) Matters to be considered in the execution and general procedure

In the environmental assessment related to the development of ports, following matters must be taken into consideration.

a) Situation in the course of port development
b) Local characteristics of the area subject to port development and surrounding areas
c) Laws and regulations covering the area subject to port development and surrounding areas.

Environmental problems subject to environmental assessment occur in areas surrounding where the project is carried out and those areas considered a part thereof. Therefore it is necessary to understand the natural, social and environmental characteristics of the areas. Natural characteristics include geographic location of the areas where port development takes place (areas facing outer ocean, inland sea or rivers, hinterlands are hills or plains), while social characteristics include the hinterland of the port being cities?, already developed?, etc. and environmental characteristics include the areas already polluted or not. These must be known beforehand and environmental assessment must be made according to the characteristics of the areas concerned.

Environmental assessment related to port development is basically carried out in the following procedure as shown in Fig. 4-7-2.

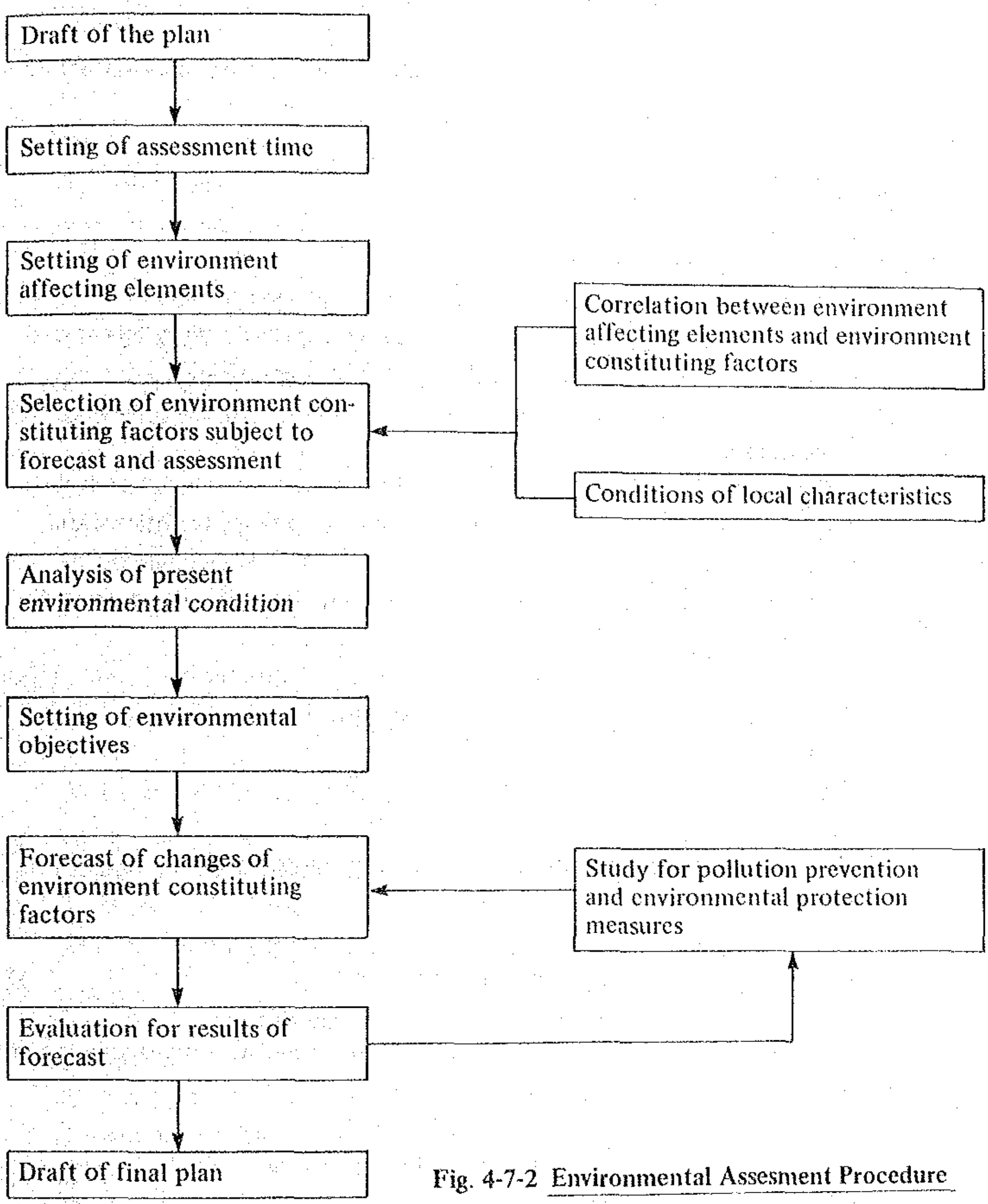


Fig. 4-7-2 Environmental Assesment Procedure

After appropriately selecting environment constituting factors, subject of forecast and assessment, using the draft plan and in consideration of the scale of the port development and area characteristics, environmental assessment is carried out for each individual environment constituting factors for analyzing the present environment and carrying our subsequent measures.

(5) **Composition of Environment Affecting Elements**

In environmental assessment related to port development, environment affecting elements to be considered are as follows.

a) Environment affecting elements related to use
- Use of channels and basins (ships)
- Use of mooring facilities (ships)
- Use of sorting areas, storage area and mobile bases (general cargo and bulk cargo)
- Use of industrial area (various manufacturing, electrical supply businesses)
- Use of land for traffic functions (land for railway and road)
- Use of land for handling dangerous cargo (land for handling dangerous cargo, oil distribution base)
- Use of land for recreation facilities (land for apron, boat yead, hotels)
- Use of land related to industrial wastes (waste disposable facilities site)
- Use of other site
  Other site includes port related site, city function site, greens, sand disposal site and public site.

b) Environment affecting elements related to existence.
Port facilities
Site

c) Environment affecting elements related to construction work
Type of work

(6) **Composition of Environment Constituting Factors**

In environmental assessment related to port development, environment constituting factors to be considered are as follows.

a) Environment constituting factors related to air quality
① Sulpharic oxide (SOx)
② Nitrogen oxide (NOx)
③ Soot and dust
④ Fine dust
⑤ Fluorine, fluoride
⑥ Carbon monoxide (CO)

b) Environment constituting factors related to water quality and bottom quality
① Chemical oxygen demand (COD)
dissolved oxygen (DO), nitrogen (N), phosphorous (P) if necessary.
② Warm waste water.

③ Suspended substances (SS)
④ Oil
⑤ Harmful substances

c) Environment constituting factors related to noise and vibration.
① noise level
② vibration level

d) Environment constituting factors related to offensive odor.
① Hydrogen sulfide
② Methylmelkaptan
③ Methylsulfide
④ Trimethylamine
⑤ Ammonium
⑥ Methyldisulfide
⑦ Acetaldehyde
⑧ Styrene

e) Environment constituting factors
① Drift sand
② Ground settlement
③ Underground water system

f) Environment constituting factors related to marine conditions.
① Waves, wave current
② Tide current (including constant current)

g) Environment constituting factors related to animals and plants
① Bacteria
② Plant plankton
③ Animal plankton
④ Sea weeds
⑤ Parasites
⑥ Bottom lives
⑦ Animals and plants for fishery
⑧ Birds at tidal flat
⑨ Land plants

h) Environment constituting factors related to views
① Position of view point
② Relationship between view point and structures
③ Components of views
natural views, field views, city views, port views, greens

j) Environment constituting factors related to cultural asset

① Tangible cultural asset

② Folk cultural asset

③ *Historical buildings*

④ Memorials (burried memorials, etc.)

(7) Correlation between Environment Affecting Elements and Environment constituting factors.

Correlation between environment affecting elements and environment constituting factors is shown in the following Table 4-7-3.

Table 4-7-3 Correlation between environment affecting elements and environment constituting factors

Environment affecting elements \ Environment constituting factors		Atmospheric quality	Water quality and bottom materials	Noise and vibration	Offensive odor	Topography	Marine phenomena	Animals and vegetables	Scenery	Cultural assets	Wastes
Existence	Port facilities		○			○	○	○	○	○	
	Land		○			○	○	○	○	○	
Utilization	Channels, anchorages and basins	○						○		○	○
	Mooring facilities	○						○		○	○
	Land for cargo handling facilities land for storage facilities and movable facilities	○	○	○	○			○		○	○
	Industrial land	○	○	○	○	○		○		○	
	Land for traffic function	○		○				○		○	
	Land for dangerous material handling facilities	○	○					○			
	Land for recreation facilities	○						○			○
	Land relating to wasted	○	○		○			○		○	○

4-7-5 Environmental Quality Standards of Japan

Environmental quality standards are the target of improvement toward which the administrative efforts are exerted. They should be distinguished from effluent standards, etc. which have been set for the surveillance of individual plants and businesses.

(1) Ambient Air Quality

Table 4-7-4 Ambient Air Quality

Substance	Sulfur dioxide	Carbon monoxide	Suspended particulate matter[1]	Nitrogen dioxide[3]	Photochemical oxidants[2]
Environmental conditions	Daily average of hourly values shall not exceed 0.04 ppm, and hourly values shall not exceed 0.1 ppm.	Daily average of hourly values shall not exceed 10 ppm, and average of hourly values in eight consecutive hours shall not exceed 20 ppm.	Daily average of hourly values shall not exceed 0.10 mg/m^3, and hourly values shall not exceed 0.20 mg/m^3.	Daily average of hourly values shall be within the range between 0.04 ppm and 0.06 ppm or below.	Hourly values shall not exceed 0.06 ppm.
Measuring methods	Conductometric method	Nondispersive infrared analizer method	Weight concentration measuring methods based on filtration collection, or light scattering method yielding values having a linear relation with the values of the above method	Colorimetry employing Saltzman reagent (with Saltzman's coefficient being 0.84)	Absorptiometry using neutral potassium iodide solution, or coulometry

Notes: 1. Suspended particulates matter shall mean airborn particles of 10 microns or less in diameter.
2. Photochemical oxidants are oxidizing substances such as ozone and paroxiacetyl nitrate produced by photochemical reactions (only those capable of isolating iodine from neutral potassium iodide, excluding nitrogen dioxide).
3. a) In an area where the daily average of hourly values exceeds 0.06 ppm, efforts should be made to achieve the level of 0.06 ppm by 1985.
b) In an area where the daily average of hourly values is within the range between 0.04 ppm and 0.06 ppm, efforts should be made so that the ambient concentration be maintained around the present level within the range or not significantly exceed the present level.
c) Not only emission control measures against individual sources but also other various countermeasures should be implemented in an integrated, effective and appropriate manner in order to maintain or achieve the ambient air quality standard.

(2) Noise (May 25, 1971)

(i) General area

(in dB(A))

Category of area	Division of hours		
	Daytime	Morning & evening	Nighttime
	Not more than	Not more than	Not more than
AA	45	40	35
A	50	45	40
B	60	55	50

Note: Standard values vary depending on the area type. Therefore, classification of areas is left to the discretion of prefectural governors.
AA — Areas which require particular quite. For instance, areas where medical facilities are concentrated.
A — Primarily residential areas.
B — Areas where a substantial number of residences are located among shops and factories

Table 4-7-5 Noise

(ii) Roadside area

(in dB(A))

Categories of areas	Division of hours		
	Daytime	Morning & evening	Nighttime
	Not more than	Not more than	Not more than
Type A areas bordering on a two-lane road	55	50	45
Type A areas bordering on a more than two-lane road	60	55	50
Type B areas bordering on a not more than two-lane road	65	60	55
Type B areas bordering on a more than two-lane road	65	65	60

Table 4-7-6 Noise

(3) Water Quality (Dec. 28, 1971)

① Standards relating to human health

Item	Standard values[1]
Cadmium	0.01 ppm or less
Cyanide	Not detectable
Organic phsphorus[2]	Not detectable
Lead	0.1 ppm or less
Chromium (sexivalent)	0.05 ppm or less
Arsenic	0.05 ppm or less
Total mercury	0.0005 ppm or less
Alkyl mercury	Not detectable.
PCB	Not detectable

Notes: 1. Maximum values. But with regard to total mercury, standard value is based on the yearly average value.
2. Organic phosphorus includes parathion, methyl parathion, methyl demeton and E.P.N.

Table 4-7-7 Water Quality

② Standards relating to living environment

(i) Rivers

Category	Item / Purpose of utilization	pH	Biochemical oxygen demand (BOD)	Suspended solids (SS)	Dissolved oxygen (DO)	Number of coliform groups
		Standard values[1]				
AA	Water supply, class 1; conservation of natural environment and uses listed in A–E	6.5–8.5	1 ppm or less	25 ppm or less	7.5 ppm or more	50 MPN/100 ml or less
A	Water supply, class2; fishery, class 1; bathing and uses listed in B–E	6.5–8.5	2 ppm or less	25 ppm or less	7.5 ppm or more	1,000 MPN/100ml or less
B	Water supply, class 3; fishery, class 2, and uses listed in C–E	6.5–8.5	3 ppm or less	25 ppm or less	5 ppm or more	5,000 MPN/100ml or less
C	Fishery, class 3; industrial water, class 1, and uses listed in D–E	6.5–8.5	5 ppm or less	50 ppm or less	5 ppm or more	
D	Industrial water, class 2; agricultural water[2], and uses listed in E	6.0–8.5	8 ppm or less	100 ppm or less	2 ppm or more	
E	Industrial water, class 3; conservation of environment	6.0–8.5	10 ppm or less	Floating matter such as garbage should not be observed	2 ppm or more	

Notes: 1. The standard value is based on the daily average value. (The same applies to the standard values of lakes and coastal waters.)
2. At the inlet or agricultural water, pH shall be between 6.0 and 7.5 and dissolved oxygen shall not be less than 5 ppm. (The same applies to the standard values of lakes.)

3. Conservation of natural environment: Conservation of scenic spots and other natural resources.
4. Water supply, class 1: Water treated by simple cleaning operation, such as filtration.
Water supply, class 2: Water treated by normal cleaning operation such as sedimentation and filtration.
Water supply, class 3: Water treated through a highly sophisticated cleaning operation including pretreatment.
5. Fishery, class 1: For aquatic life such as trout and bull trout inhabiting oligosaprobic water, and those of fishery class 2 and class 3.
Fishery, class 2: For aquatic life, such as fish of the salmon family and sweetfish inhabiting oligosaprobic water and those of fishery class 3.
Fishery, class 3: For aquatic life such as carp and silver carp inhabiting β-mesosaprobic water.
6. Industrial water, class 1: Water given normal cleaning treatment such as sedimentation.
Industrial water, class 2: Water given sophisticated treatment by chemicals.
Industrial water, class 3: Water given special cleaning treatment.
7. Conservation of environment: Up to the limits at which no unpleasantness is caused to people in their daily life (including a walk by the riverside, etc.)

Table 4-7-8 Water Quality

(ii) Lakes (natural lakes, reservoirs, marshes and artificial lakes with more than 10 million cubic meters of water)

Category	Item / Purpose of utilization	pH	Chemical oxygen demand (COD)	Suspended solids (SS)	Dissolved oxygen (DO)	Number of coliform groups
		Standard values				
AA	Water supply, class 1; fishery, class 1; conservation of natural environment and uses listed in A–C	6.5–8.5	1 ppm or less	1 ppm or less	7.5 ppm or more	50 MPN/100 ml or less
A	Water supply, classes 2 and 3; fishery, class 2; bathing and uses listed in B–C	6.5–8.5	3 ppm or less	5 ppm or less	7.5 ppm or more	1,000 MPN/100ml or less
B	Fishery, class 3; industrial water, class 1; agricultural water, and uses listed in C	6.5–8.5	5 ppm or less	15 ppm or less	5 ppm or more	–
C	Industrial water, class 2; conservation of environment	6.0–8.5	8 ppm or less	Floating matter as garbage shall not be observed	2 ppm or more	–

Notes: 1. With regard to fishery, classes 1, 2 and 3, the standard value for suspended solids shall not be applied for the time being.
2. See notes for Rivers.

Table 4-7-9 Water Quality

(iii) Costal waters

Category	Item / Purpose of utilization	Standard values: pH	Chemical oxygen demand (COD)	Dissolved oxygen (DO)	Number of coliform groups[1]	N-hexane extracts
A	Fishery, class 1; bathing; conservation of natural environment and uses listed in B–C	7.8–8.3	2 ppm or less	7.5 ppm or more	1,000 MPN/100 ml or less	Not detectable
B	Fishery, class 2; industrial water and uses listed in C	7.8–8.3	3 ppm or less	5 ppm or more	–	Not detectable
C	Conservation of environment	7.0–8.3	8 ppm or less	2 ppm or more	–	–

Notes: 1. With regard to the water quality of fishery, class 1 for cultivation of oysters, the number of coliform groups shall be less than 70 MPN/100ml.
2. Fishery, class 1: For aquatic life such as red sea-bream, yellow tail, seaweed and those of fishery.
Fishery, class 2: For aquatic life such as gray mullet, laver, etc.
3. Conservation of environment: Up to the limits at which no unpleasantness is caused to people in their daily life (including a walk by the shore, etc.).

Table 4-7-10 Water Quality

4-7-6 Effluent Standards of Japan

The purpose of this Law is to control the emission of soot and smoke or the discharge of effluent into public water bodies, by plants and businesses.

(1) Soot and dust (Latest amendment, June 22, 1971)

(Unit:g/Nm^3)

Name of facility	Ordinary emission standard: large scale		Ordinary emission standard: small scale	Special emission standard: large scale	Special emission standard: small scale
Boilers (using liquid fuels or gas)	0.10	0.20	0.30	0.05	0.20
Boilers (using lower-grade coal)	0.80			0.40	
Boilers (of other types using coal, etc.)	0.40			0.20	
Gas generating furnace, catalytic regeneration tower	0.60			0.40	
Roasting furnace, sintering furnace, calcining furnace converter (combustion type), openhearth furnace	0.30		0.40	0.20	
Blast furnace	0.10			0.05	
Heating furnace, converter (excepting the combustion type), petroleum pipe stills, *sulfur-collecting combustion furnace*	0.20			0.10	
Lime stone calcining furnace (underground furnace), aggregate drying furnace	0.80			0.40	
Lime stone calcining furnace (others), electric furnace (for steel making)	0.60			0.30	
Electric furnace	0.40			0.20	
Blast furnace (of types not covered by any of the above items), metal melting furnace, metal-heating furnace, calcining and melting furnace (excepting lime stone calcining furnace), reactors, direct fire furnace, drying furnace (other than aggregate drying furnace), electric furnace (of types not covered by any of the above items)	0.20		0.40	0.10	0.20
Glass melting furnace (crucible furnace)	0.50			0.50	
Waste incinerator (continuous furnace)	0.20		0.70	0.10	0.20
Waste incinerator (others)	0.70			0.40	

Notes: 1. Prefectures may, by decree, set more stringent standards.
2. The gas emission rate of 40,000 Nm^3/h is the criterion used for scale classification. However, heavy oil boilers alone are classified into three scales with the criteria of 200,000 Nm^3/h and 40,000 Nm^3/h for ordinary emission standards.
3. For further details, refer to Table 2 attached to the Enforcement Ordinances of the Air Pollution Control Law.

Table 4-7-11 Soot and Dust

(2) Harmful substances (June 22, 1971)

Name of substance	Name of facility	Standard value
Cadmium and its compound	Baking furnace and smelting furnace for manufacturing glass using cadmium sulfide or cadmium carbonate as raw material	1.0 mg/Nm³
	Calcination furnace, sintering furnace, smelting furnace, converter and drying furnace for refining copper, lead or cadmium	
	Drying facility for manufacturing cadmium pigment, or cadmium carbonate	
Chlorine	Chlorine quick cooling facility for manufacturing chlorinated ethylene	30 mg/Nm³
	Dissolving tank for manufacturing ferric chloride	
	Reaction furnace for manufacturing activated carbon using zinc chloride	
	Reaction facility and absorbing facility for manufacturing chemical products	
Hydrogen chloride	Same as above	80 mg/Nm³
	Waste incinerator	700 mg/Nm³
Fluorine, hydrogen fluoride, and silicon fluoride	Electrolytic furnace for smelting aluminium (Harmful substances are comitted from discharge outlet)	3.0 mg/Nm³
	Electrolytic furnace for smelting aluminium (Harmful substances are emitted from top)	1.0 mg/Nm³
	Baking furnace and smelting furnace for manufacturing glass using fluorite or sodium silicofluorate as raw material	1.0 mg/Nm³
	Reaction facility, concentrating facility and smelting furnace for manufacturing phosphoric acid	
	Condensing facility, absorbing facility and distilling facility for manufacturing phosphoric acid	
	Reaction facility, drying facility and baking furnace for manufacturing sodium tripoli-phosphate	
	Reaction furnace for manufacturing super-phosphate of lime	15 mg/Nm³
	Baking furnace and open-hearth furnace for manufacturing phosphoric acid fertilizer	20 mg/Nm³
Lead and its compound	Calcination furnace, drying furnace, smelting furnace, and drying furnace for refining copper, lead, or zinc	10 mg/Nm³
	Sintering furnace and blast furnace for refining copper, lead or zinc	30 mg/Nm³
	Smelting furnace etc. for secondary refining of lead, for manufacturing lead pipe, sheet, wire, lead storage battery or lead pigment	10 mg/Nm³
	Baking furnace and smelting furnace for manufacturing glass using lead oxides as raw materials	20 mg/Nm³

Table 4-7-12 Harmful Substance

(3) Nitrogen oxides (Latest amendment June 16, 1977)

	Type of facility (Existing facilities)	(Unit: 1,000 Nm³/h)	Existing: New standard	Existing: Old standard	Newly built facilities (Unit: 1,000 Nm³/h)	Newly built: New standard	Newly built: Old standard	Residual oxygen concentration in stack gas (On)
Boiler	Gas combustion	Over 500	130 ppm	130 ppm	Over 500	60 ppm	100 ppm	5%
		100 – 500	130	130	100 – 500	100	100	
		40 – 100	130	130	40 – 100	100	130	
		10 – 40	150	150	10 – 40	130	130	
		5 – 10	150	–	5 – 10	150	–	
					Up to 5	150	–	
	Solid material combustion	Over 100	480*	600 (750)	Over 100	400	480	6%
		40 – 100	600 (750)	600 (750)	40 – 100	400	480	
		10 – 40	600 (750)	600 (750)	10 – 40	400	480	
		5 – 10	480	–	5 – 10	400	–	
					Up to 5	400	–	
	Others (Liquid combustion)	Over 1,000	180	230 (280)**	Over 500	130	150	4%
		500 – 1,000	180 (210)	230 (280)**	100 – 500	150	150	
		100 – 500	190 (210)	230 (280)**	40 – 100	150	150	
		40 – 100	190 (210)	190*(280)**	10 – 40	150	150	
		10 – 40	230 (250)	– (280)**	5 – 10	180*	–	
		5 – 10	250 (280)	–	Up to 5	180*	–	
Sintering furnace		Over 100	260	–	Over 100	220	–	15%
		10 – 100	270	–	10 – 100	200	–	
Alumina calcination furnace					Over 10	200	–	10%
Metal heating furnace		Over 100	160 (200)	220	Over 100	100	100	11%
		40 – 100	170 (200)	220	40 – 100	130 (150) < 180 >	150*	
		10 – 40	200	200	10 – 40	130 (150) < 180 >	150*	
		5 – 10	170 (200)		5 – 10	150*	–	
					Up to 5	180*	–	
Petroleum heating furnace		Over 100	170	210*	Over 100	100	100	6%
		40 – 100	170**	210*	40 – 100	130	100	
		10 – 40	180***	180*	10 – 40	130	150	
		5 – 10	180 (190)		5 – 10	150	–	
					Up to 5	180	–	
Cement calcination furnace			480	–	Over 100	250	250	10%
					Up to 100	350	–	
Coke oven			350	–	Over 100	170	200	7%
					Up to 100	170	–	
Waste incinerator					Over 40	250	–	12%
Nitric acid production facility			200	200	–	200	200	Os

Notes: 1. Reference to Boiler-Solid material combustion category, marked * in the "existing" column shows 650 ppm for ceiling burner and 550 ppm for divided wall type. ( ) are applied for low-grade coal combustion burners.

2. Reference to Boiler–Others (Liquid combustion), ( ) in the "existing" column are applied for the ones equipped with flue gas desulfurization facilities. Marked * indicates excluding the ones equipped with desulfurizer.
Mark ( )** are for crude oil combustion burners, and the standards marked * in the "newly built facilities" are applied from September 10, 1977.

3. Reference to Sintering furnace, "existing" does not cover pellet sintering furnaces.

4. Reference to Metal heating furnaces, "existing" does not cover the heating furnaces for welded steel pipe. ( ) are applied for heating furnaces of the radiant tube type. Marked * in the "newly built" column shows not including heating furnaces for welded steel pipe. ( ) in the "newly built" column are applied for radiant tube type heating furnaces. < > are applied for heating furnaces for welded steel pipe.

5. Marked * in the "existing" column of Petroleum heating furnace are not applied for ethylene resolving furnaces, independent superheating furnaces, methanol refining furnaces and ammonium refining furnaces. Marked ** are not applied for independent superheating furnaces and methanol refining furnaces. Marked *** are not applied for ethylene resolving furnaces. ( ) are applied for those equipped with a stack gas desulfurization facility.

6. Reference to Cement calcination furnace, standards in the "existing" column are not applied for wet type furnaces, and application from April 1, 1981.

7. Reference to Coke ovens, standards in the "existing" column are not applied for Otto type ovens.

8. The NOx emission concentration shall be converted through the following equation. (Except in the case of nitric acid production facilities.)

$$C = \frac{21 - On}{21 - Os} Cs$$

C: NOx emission concentration
On: Oxygen concentration in stack gas (set values in the above table)
Os: Actual oxygen concentration in stack gas
Cs: Actual nitrogen oxides emission concentration

Table 4-7-13 Nitrogen Oxides

(4) Effluent standards into public water bodies.

① Substances related to the protection of human health

Toxic substances	Permissible limits
Cadmium and its compounds	0.1 mg/l
Cyanide compounds	1 mg/l
Organic phosphorus compounds (parathion, methyl parathion, methyl demeton and EPN only)	1 mg/l
Lead and its compounds	1 mg/l
Sexivalent chrome compounds	0.5 mg/l
Arsenic and its compounds	0.5 mg/l
Total mercury	0.005 mg/l
Alkyl mercury compounds	Not detectable
PCB	0.003 mg/l

Note: By the term "not detectable" is meant that the substance is below the level detectable by the method designated by the Director General of the Environment Agency.

② Items related to the protection of the living environment

Item	Permissible limits
pH	5.8~8.6 for effluent discharged into public water bodies other than coastal waters 5.0~9.0 for effluent discharged into coastal waters
BOD, COD	160 mg/l (daily average 120 mg/l)
SS	200 mg/l (daily average 150 mg/l)
N-hexane extracts	5 mg/l (mineral oil) 30 mg/l (animal and vegetable fats)
Phenols	5 mg/l
Copper	3 mg/l
Zinc	5 mg/l
Dissolved iron	10 mg/l
Dissolved manganese	10 mg/l
Chrome	2 mg/l
Fluorine	15 mg/l
Number of coliform groups (per cc)	3,000 (daily average)

Notes: 1. The discharge standards in this table are applied to the effluents from industrial plants and other places of business whose volume of effluents per day is not less than 50 m^3

2. The discharge standards for BOD are applied to public waters other than coastal waters and lakes, while the discharge standards for COD are applied only to effluents discharged into coastal waters and lakes.

Table 4-7-14 Effluent Standards into Public Water Bodies

4-7-7 Volume of Water Utilization in Industrial Ports (for reference)

In the industrial port area, large volume of water for industries and used water by industries must be gathered or discharged.

In this section, the volume of water utilization in KASHIMA Port and TOMAKOMAI Port will be introduced for reference.

(1) KASHIMA Port

Following Tables and Fig. 4-7-3 show the volume of water flow at the indicated intakes or outlets.

a) Volume of water discharge (m^3/Day)

Outlet	Present	Future	Outlet	Present	Future
1	2,951,430	3,186,411	14	9,807	20,890
2	11,600	36,000	15	9,807	14,862
3	19,000	259,300	16	4,183	9,560
4	8,800	282,500	17		3,839,590
5	591	2,915	18		21,730
6	35,804	332,502	19		2,360
7	540,788	2,278,733	20		6,866
8	262,550	402,760	21		2,980
9	11,403	54,960	22		2,580
10	500		23		9,200
11	158,400	855,260	24		10,406
12	7,836,924	12,650,000	25		571
13	111,190		Total	11,972,777	24,282,736

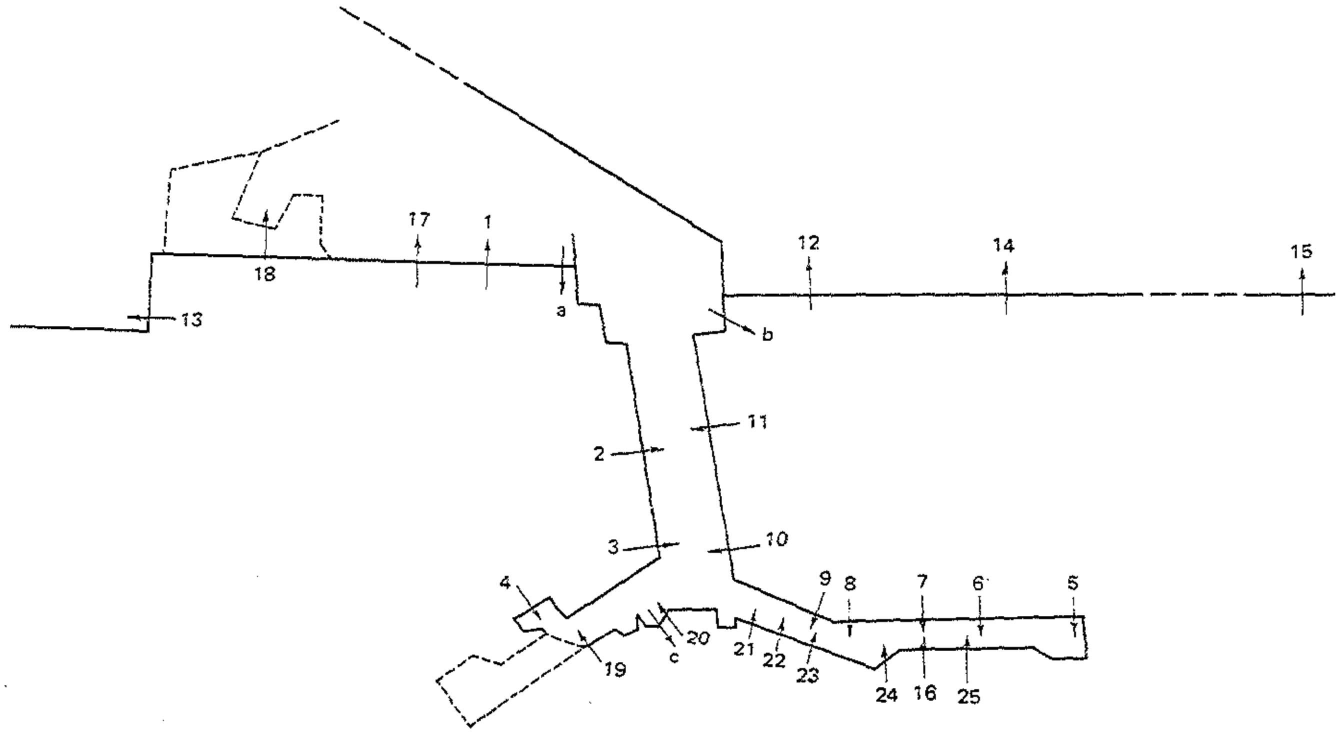
Table 4-7-15 Volume of Water Discharge

b) Volume of water to be gathered (m^3/Day)

Intake	Present	Future
a	2,773,610	7,414,400
b	8,735,478	17,300,000
c	360	14,400
Total	11,509,448	24,728,800

Table 4-7-16 Volume of Water to be gathered

Fig. 4-7-3 Location of Intake and Discharge



(2) TOMAKOMAI Port

Following Tables and Fig. 4-7-4 show the volume of water flow at the indicated intakes and outlets.

a) Volume of water discharge

(m^3/Day)

Outlet	Remarks	Present	Future	Outlet	Remraks	Present	Future
1	River	191,000	189,000	23	River	1,039,000	952,000
2	River	87,000	118,000	24		–	76,000
3		443,000	474,800	27		–	745
4	River	40,100	43,100	28		–	2,371,600
6		39,900	90,900	29		–	1,260,400
12		500	12,000	30		–	487,000
13		5,500	9,100	31		–	1,275,000
18		73,400	322,300	32	River	359,000	408,000
19		1,920,200	2,333,600	33		–	100
20		61,600	120,500	34		–	1,000
21		11,600	116,700	35		–	6,000
22		128,100	170,600	Total		4,399,900	10,838,445

Table 4-7-17 Volume of Water Discharge

b) Volume of water to be gathered (m^3/Day)

Intake	Present	Future
5	29,800	70,000
14	–	3,000
15	61,100	120,000
16	1,920,000	2,333,300
17	63,000	300,000
25	–	1,651,000
26	–	3,630,000
Total	2,073,900	8,107,300

Table 4-7-18 Volume of Water to be gethered

Fig. 4-7-4 Location of Intake and Discharge