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1 Introduction

Kawasaki Steel has developed an industrial park in the Philippines in cooperation with Ayala Land, Inc. and Mitsubishi Corp. The industrial park, known as the LAGUNA TECHNOPARK, successfully began operations. The industrial park is located about 40 km south of Manila, the capital, and is the first park of its kind to be developed by the private sector (**Fig. 1**). The LAGUNA TECHNOPARK covers an initial area of 220 ha and has been designed for use by light and medium industries. Under the project, areas adjacent to the park are scheduled to be developed as commercial and residential districts, and a new town complex is expected to boom with the industrial park as the core in the future.

This paper presents a brief overview of some of the construction engineering challenges which Kawasaki Steel faced during the development of the industrial park, from the planning stages through construction of the infrastructure. In addition, a brief explanation is also given regarding the engineering services provided to tenant companies for the construction of factory and related facilities.

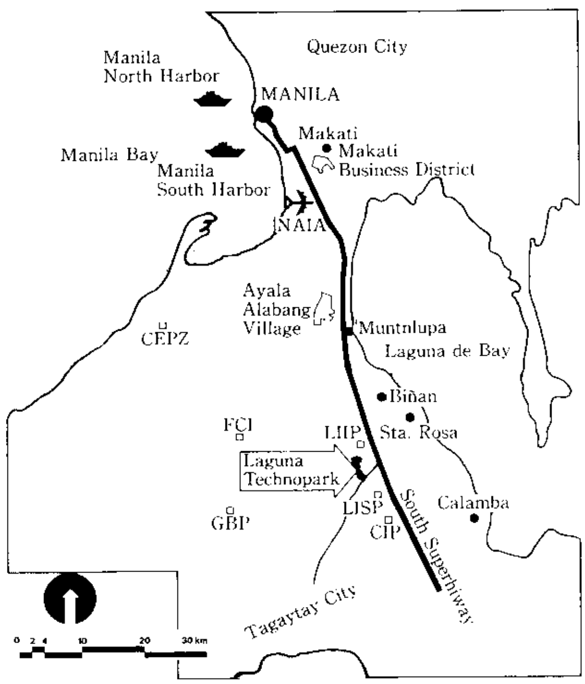

Fig. 1 Vicinity plan of LAGUNA TECHNOPARK

* Originally published in *Kawasaki Steel Giho*, **28**(1996)3, 170-175

2 Feasibility Study

2.1 Concept of the Project

In starting the feasibility study for the development of the industrial park, a survey was carried out regarding the status of industrial parks in Japan as well as in Southeast Asia. On the basis of the results of the survey, the following guidelines were established as the main concepts for the preparation of the basic development plan for this project.

(1) The park is to be primarily intended for labor-intensive, environmentally friendly, pollution-free light and medium industries.

(2) Tenant companies are to be provided with a safe and secure working environment.

(3) The most important aspects of infrastructure for

Table 1 Contents of field survey

1	Field reconnaissance		
2	Topographic survey		
3	Geological survey		
4	Soil survey	In-situ test	Standard penetration test
			Field permeability test
		Laboratory test	Specific weight
			Moisture ratio
			Grain size analysis
			Liquid limit,Plastic limit
			Unconfined drained test
			Consolidated drained test
5	Groundwater investigation		
6	River surveying		

Table 2 Investigation of water supply and drainage system

System	Item of investigation	Result	Standard, Guideline
Water supply	Source	Well (150 m depth)	Water Code
	Groundwater discharge	Pumping discharge : 23ℓ/s, 2 000 m^3/d/well	
	Location of well	9 wells : Min. well distance 600 m	Water Code
	Water quality	Colon bacilli - a little No problem for chemical and physical properties	National Standards for drinking water
	Possibility of water Intake from river	Average stream flow 1.0 m^3/s Water quality - mixed domestic waste water Downstream : Irrigation water · Impractical	River administrator : DPWH Water Code
	Standard of water quality	Drinking water - necessary for chlorination	National Standards for drinking water
	Industrial water consumption	Water consumption : Min. 85 m^3/d/ha	
	Potable water consumption	Min. daily water consumption : 75ℓ/person/d	
		Max. daily water consumption : 1.2 × Mean daily water consumption	
		Max. hourly water consumption : 2.5 × Mean daily water consumption	
	Fire protection	1.9 m^3/min.	Fire Code
Rainfall drainage	Rainfall intesity	170 mm/h	Metro Manila drainage project
	Probable rainfall	10 years	
	Runoff coefficient	Industrial area 0.80, Commercial area 0.85 Residential area 0.80, Park 0.50, Road 0.90	
	Destination of release	Sta. Rosa River → Laguna de Bay	
Industrial waste water	Discharge of Industrial waste water	Drainage discharge of each type of industry	
	Standard of treatment water quality	Effluent regulation class A	Effluent regulation
Sewage	Sewage discharge from industrial area	Mean daily sewage discharge = 95% of potable water consumption	
	Sewage discharge from residential area	Mean daily sewage discharge = 80% of potable water consumption	
		Max. daily sewage dischage = 1.2 × Mean daily sewage discharge	
		Max. hourly sewage dischage = 2.5 × Mean daily sewage discharge	
	Standard of treatment water quality	Effluent regulation class A	Effluent regulation

Table 3 Comparison for standard of drainage quality

Parameter	Unit	Philippines	Japan	Taiwan	South Korea	Indonesia	Great Britain
ırsenic	mg/ℓ	0.1	0.5	0.3	0.5	0.05	0.5
:admium	mg/ℓ	0.02	0.1	0.05	0.1	0.01	0.5
:hromium	mg/ℓ	0.05	0.5	0.25	0.5	0.05	0.5
:yanogen	mg/ℓ	0.1	1.0	0.5	1.0	0.1	0.3
,ead	mg/ℓ	0.1	1.0	0.5	1.0	0.05	0.5
ʌlercury	mg/ℓ	0.005	0.005	0.003	NIL	0.005	0.5
²CB	mg/ℓ	0.003	0.003	NIL	0.003	--	—
›H	—	6 ~ 9	5.8 ~ 8.6	6 ~ 9	5.8 ~ 8.6	5 ~ 9	6 ~ 9
:OD(Cr)	mg/ℓ	60	160(Mn)	120	150	--	—
3OD	mg/ℓ	30	160	45	150	100	20
Total suspended solids	mg/ℓ	50	—	—	—	—	—
)il/Grease	mg/ℓ	5	5	5	6	5	4
Total dissolved solids :TDS)	mg/ℓ	1 000	–	—	—	—	—

operation of the industrial park, including electric power, communication facilities, water supply and sewage systems, rainfall drainage and industrial waste water systems, sewage treatment plants, roads, administration offices, a customs office, bonded warehouse, among other facilities, are to be prepared in their entirety and put in place.

4) The grading of sites for factories is to be left to the discretion of tenant companies.
5) Water intake and supply to tenant companies is to be controlled by the park administration.
6) Industrial waste water is to be treated and effluent water quality is to be monitored by each factory. On the other hand, sewage discharge is to be treated by a central sewage treatment plant to be constructed by the park administration.

2.2 Technical Survey

On-site, surveys for actualizing the industrial park onsisted of general and field surveys. The general sur'ey was carried in order to determine the natural, social, nd site conditions as well as the conditions for preparaion of the infrastructure. The field survey, on the other ıand, was conducted to examine the site in terms of its ;eological characteristics (**Table 1**) in order to deternine the adequacy of the site for development as an ndustrial park. The actual site is located in a fairly flat ırea in hilly country and is divided by a river down the niddle. The ground is generally good and the site had ›een previously used for sugar cane fields.

In preparing the infrastructure of any industrial park, t is essential for the proper operation of the park that a ;ecure supply of water for industrial use which should ıot ever be produced artificially. In addition, treated vaste water discharge and its water quality have an important effect on the environment. As a result, a major priority of the survey was placed on water supply and waste water treatment. **Table 2** shows an outline of the results of this investigation.

Pumping tests of already existing as well as newly installed wells confirmed that there was an adequate amount of water available in the area. As a result of estimates made from drops in the ground water level, however, it became clear that the number of wells that could be provided had to be limited to nine because of required distances between wells and other factors. When the demand for water increases in the future, it will be necessary to adopt some alternative measures to ensure an adequate supply of water. Such measures would include the use of river water, recycling industrial waste water, using public water taken from lakes, and the like.

One point which became clear from the various results obtained from the (field) survey, is that the most careful consideration must be given to the standard of drainage quality of the Philippines; in this case in particular, the Effluent Regulation of Laguna Lake. The quality standard of drainage discharged into Laguna Lake which is already heavily polluted is particularly more severe and stringent than those in other countries. Allowable limits of heavy metals are 1/2 to 1/10 those set in other countries as shown in **Table 3**. Each factory must have its own waste water treatment facility to process waste water in order to reduce the level of heavy metal content to levels below those stipulated by the standard values in the Effluent Regulation. When the project first started, the content of total dissolved solids (TDS), which is not included in the waste water standards of other countries, was specified as being the same level as the values set forth in the potable water stan-

Table 4 Basic design for industrial park

No.	Item	Basic design
1	Type of industry	(1) Electronics, (2) Semiconductor, (3) Motorcar, Motorcycle, (4) Precision machine, (5) Metal products, (6) Medicine, (7) Spinning, (8) Foods
2	Industrial area	70 ~ 75% of total area
3	Employees	100 persons/ha, Industrial area 16 800 persons, Admin. office, etc. 500 persons, Total 17 300 persons
4	Water supply	Potable water : Industrial area 75ℓ/person/d × 1.5(3 shifts), Admin. office, etc. 150ℓ/person/d, Total 2 000 m^3/d
		Industrial water : 85 m^3/day/ha → Total 14 400 m^3/d
5	Drainage	Industrial waste water : All of industrial water, Total 14 400 m^3/d
		Domestic waste water : 85% of potable water, Total 1 760 m^3/d
		Rain water discharge : rainfall intensity 170 mm/h, Estimated concentration time 15 min, Total 371 000 m^3/h
6	Electricity	80 MW (350 kW/ha)
7	Volume of goods	30 t/d/ha (10 h/d, 250-d/year operation), Total 5 050 t/d
8	Industrial waste materials	0.72 t/d/ha (10 h/d, 250 d/year operation), Total 121 t/d

dards of the World Health Organization (WHO), that is, an average of 500 ppm, not to exceed a maximum of 1 000 ppm, as shown in Table 3. However, this requirement has been excluded from the standard as a result of a reexamination into the necessity of specifying TDS in the waste water quality standard by the Board of Investments and the Environmental Management Bureau.

2.3 Determination of Basic Units

Projections regarding the types of firms which would become tenant companies and their ratios of introduction were assumed by taking into consideration the present status of those companies expanding into the Philippines. The projected level of industrial water consumption and number of employees per hectare were determined based on these projections. Then, the basic units[1] which would form the basis of the infrastructure of the industrial park were determined (**Table 4**) from the results of the survey described in the preceding section and from the results of surveys of industrial parks in Japan and in other ASEAN countries.

2.4 Basic Plan

A description is given in the following paragraphs of the various items in the basic plan carried out according to the results of surveys and the basic units with regard to the development plan (layout) together with the water supply and waste water system.

2.4.1 Development plan

The layout shown in **Fig. 2** was decided upon as a result of examinations of various plans from the perspective of plans for land use, estimates of traffic volume, arrangements of roads, minimum factory site area, land demarcation plans, land view, and the like. Some of the special features of this layout include the following.

(1) From the viewpoint of security, the industrial area and commercial and residential areas were separated into eastern and western areas with a north-south spine road serving as a border between the two divisions.

(2) Utility facilities such as the administration office were arranged such that they would be on either side of the river in the middle. A green area having a width of 40 m was placed under the 230 kW high-voltage power lines in the center since no buildings are allowed to be constructed in the immediate vicinity of the power lines. Further, the sewage treatment plant was set on the north side of the site where the ground elevation is low, thereby taking advantage of the lower position to have sewage automatically drain down to the plant by gravity.

(3) The plan for the factory areas was prepared such that the south-side of the river would be used for large scale factories (Phase 1), while the north side of the river would be used for small and medium scale factories (Phases 2, 3).

2.4.2 Water supply and waste water treatment system

The water supply and waste water treatment system of the industrial park is summarized by the flow diagram shown in **Fig. 3**. The capacity of potable water supply was designed taking into account fluctuations in load. Thus, 10% was added to the estimated value for average consumption. Plans were drawn up for the water treatment facilities which comprise a part of the infrastructure with the following points taken into consideration.

(1) A chlorination system would be installed for potable water.

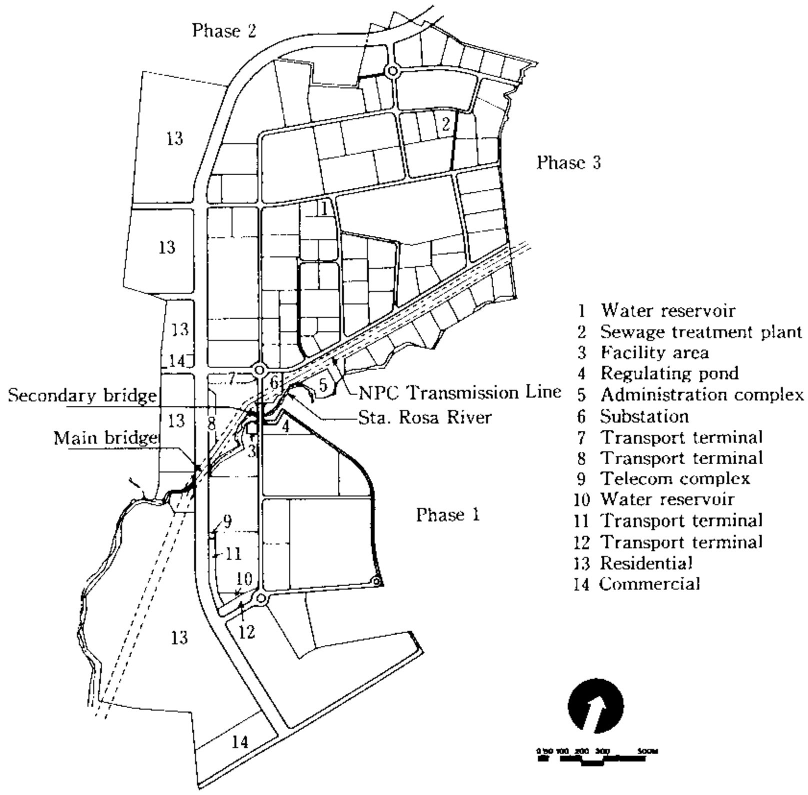

Fig. 2 Layout of LAGUNA TECHNOPARK

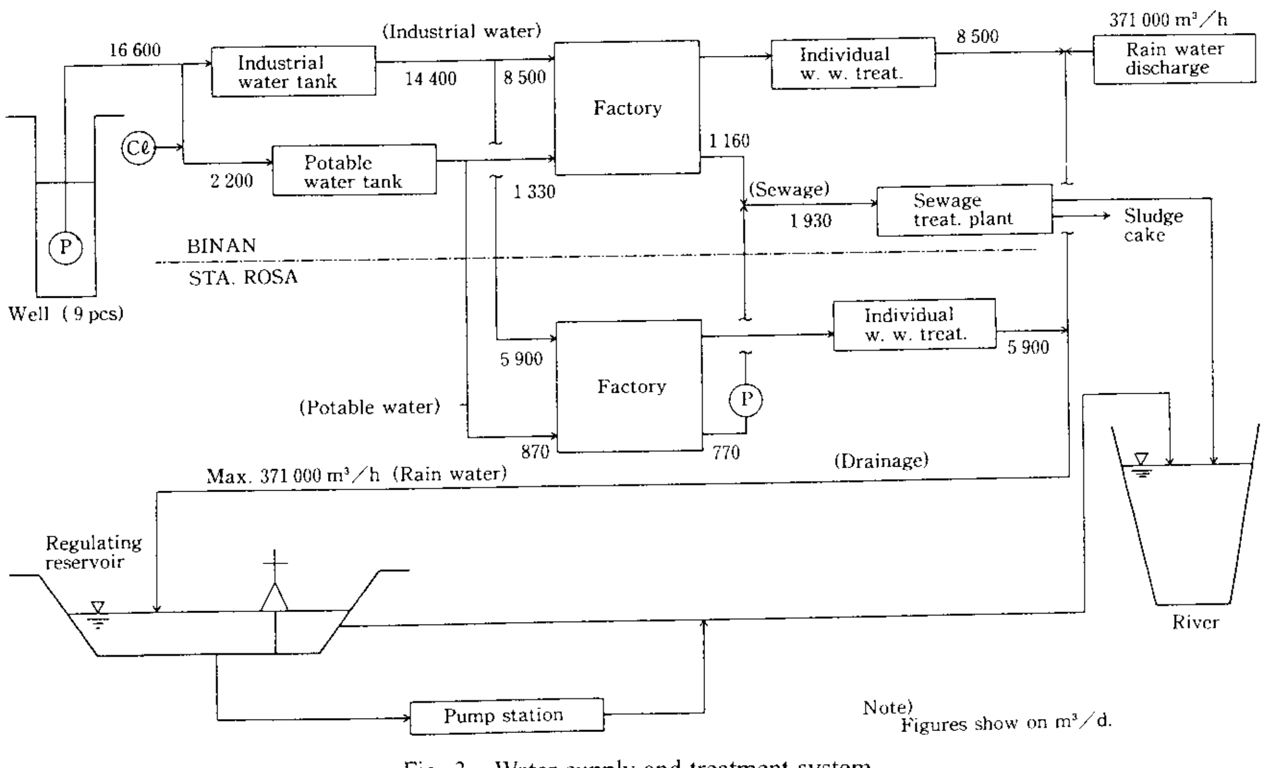

Fig. 3 Water supply and treatment system

(2) A central sewage treatment plant would be installed.
(3) A flood regulating pond with a capacity sufficient to accommodate rainwater falling at maximum intensity of 15 min would be installed for treatment of rainfall drainage.
(4) Each factory is to be equipped with in-house treating system such that it can meet its obligations to treat industrial waste water to levels which will satisfy the Effluent Regulation of Laguna Lake. A system must be established on the part of the industrial park so that the values of pH and COD among many other items included in the waste water standard can be periodically measured using water quality monitors and also so that tenant companies are properly guided and supervised.

3 Design and Construction of the Infrastructure

3.1 Design of the Infrastructure

As a result of the feasibility study regarding the development of the industrial park described above, it was determined that it would be possible to realize the operation of the park in terms of both its technical feasibility and economic profitability. Therefore, detailed design work regarding the infrastructure followed based on the basic plan mentioned above.

Detailed design work was carried out jointly by Japanese and Philippine engineers with regard to the items shown in **Table 5**. The standards adopted in the Philippines were applied and the details of the facilities were designed in accordance with those specifications which are suitable for the local conditions considering the convenience of procurement and maintenance. Since it was also assumed that some Japanese companies would also become tenant companies, the specifications were made so as to take the needs of Japanese companies into account.

Table 5 Detailed design for infrastructure of industrial park

1	Site grading plan for road and utility area
2	Road
3	Bridge
4	Water supply system
5	Sewage system
6	Rainfall drainage system
7	Sewage treatment plant
8	Electrical facilities
9	Building(Administration office,etc.)
10	Landscaping

3.2 Construction of the Infrastructure

Major civil work in constructing the infrastructure was carried out by construction companies in the Philippines. However, Riofil Corp., a Philippine affiliate of Kawasaki Steel, was in charge of construction of the buildings including the administration office, the symbol of the industrial park, and the erection of the steel bridges (**Photos 1** and **2**).

The launching method was adopted in erecting two of the steel bridges as heavy erection machines such as crane could not be used due to interference resulting from the presence of the high voltage transmission lines.

4 Engineering Services for Tenant Companies

Land sale in the industrial park began in 1991, and thus far, 50 companies have either started operations or have decided to move in by now. Of these, the number of Japanese companies has reached as many as 28. Nearly 70% of the total area is occupied by plants for the production of automobiles, automobile parts, as well as

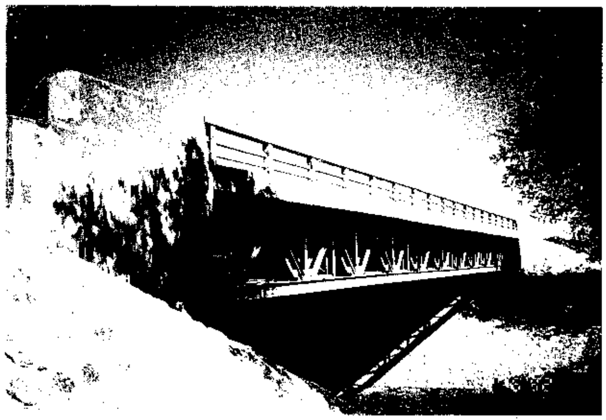

Photo 1 Steel bridge

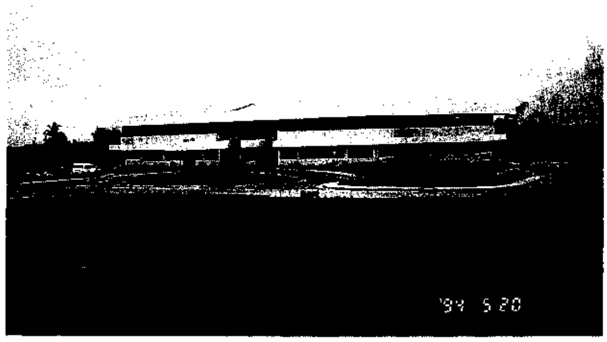

Photo 2 Administration office

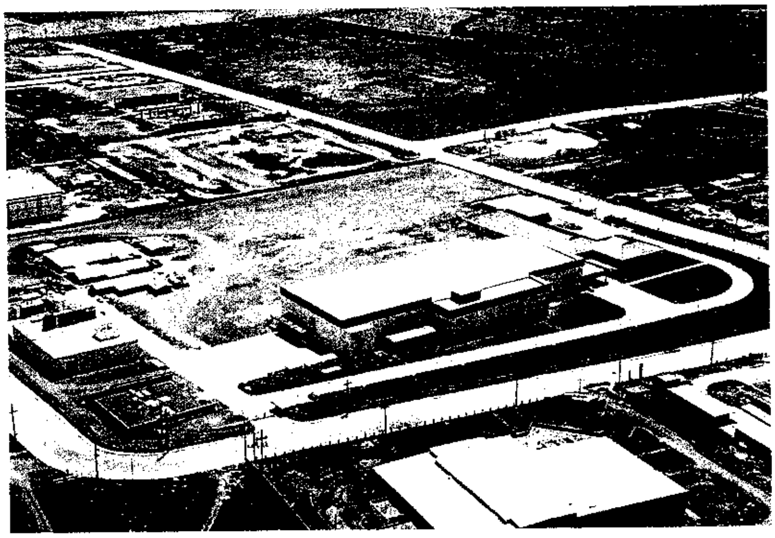

Photo 3 Present view of LAGUNA TECHNOPARK

home appliances and electronic parts. The assumption regarding the types of industries that would become tenants of the park made in the feasibility study was almost correct with the exception that there have been fewer semiconductor plants coming to the park than expected. **Photo 3** shows the general view of the Laguna Technopark as it is at present.

Throughout the period from inviting factories to locate to the park until construction of factories after the conclusion of tenant contracts, Kawasaki Steel, together with Riofil Corp. has offered various engineering services to tenant companies as outlined below.

(1) Technical assistance has been offered with regard to the manner in which area blocks were selected so as to best accommodate the needs and demands of each tenant company. Further, advice was also provided concerning site grading plans which would be more cost effective and have a high land utility efficiency. As a result, eleven different sites were graded by Kawasaki Steel/Riofil Corp.

(2) When constructing factory buildings, a major need of the tenant is to complete construction at low cost within a short period of time by the start of operations. Consequently, engineering work was carried out with regard to the construction of steel frame factory buildings utilizing the expertise of Kawasaki Steel in design technology, guidance and supervision of local fabricators, procurement of materials from other countries including Japan, and the like. As a result, the capability for constructing high quality buildings within a short time period was appreciated by the tenant companies, and factories for 4 tenant companies were constructed by Riofil Corp. in their entirety from design through the completion of construction (**Photo 4**).

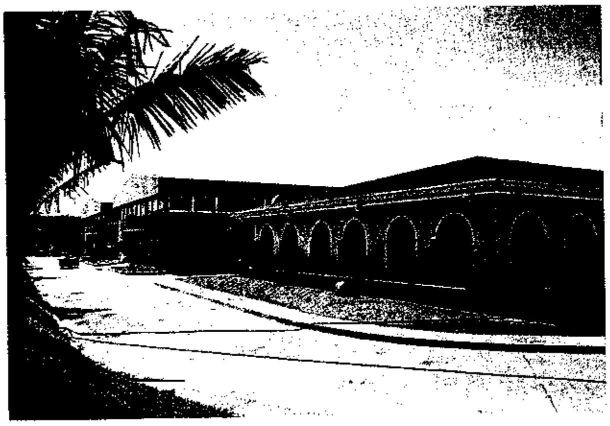

Photo 4 Construction of factory building

(3) Treatment of waste water discharged from factories is the responsibility of tenant companies. In this connection, Kawasaki Steel constructed two waste water treatment facilities which guaranteed the level of water quality specified in the Effluent Regulation of Laguna Lake. In constructing these facilities, the design particulars for each facility were determined by performing waste water treatment tests so that waste water from tenant company factories could be securely treated to a level of quality which would satisfy the requirements set forth in the Effluent Regulation. Furthermore, by making every effort to design the facilities in such a way as to enable the construction work of the site to be completed in the shortest period of time possible while at the same time avoiding any risk in the conduct of the actual work itself, it was possible to complete the facilities by the delivery date requested by the tenant companies.

5 Conclusion

The construction engineering work done by Kawasaki Steel in developing Laguna Technopark in the Philippines included the following activities.

(1) Technical surveying, setting of basic units for the industrial park, as well as preparation of the basic plan during the feasibility stage.

(2) Detailed design and construction of the infrastructure.

(3) Site grading, technical assistance in planning factory buildings, water treatment plants, and the like, as well as construction of these facilities for tenant companies.

Industrial parks are developed and constructed following the steps which are very similar to those used in the construction of steel mills. In this sense, total engineering including civil engineering, construction, care for the environment, and the like fostered through the experience gained in the construction of various steel mills designed and built by Kawasaki Steel were fully utilized in the development of this industrial park. In addition, Kawasaki Steel was able to respond to the various technical requirements of the tenant companies.

The Laguna Technopark was successfully completed and realized in spite of the fact that the project had been affected by various changes in local political conditions and by natural disasters occurred in the Philippines such as the Luzon earthquake on July 16, 1990 and the eruption of Mt. Pinatubo in June 1991 during the process of park development.

The authors believe that the completion of this industrial park will be a strong incentive to encourage investment in the Philippines, which in turn will contribute to the further development of the Philippine economy. They would be most pleased if this project would serve as a model for the development of other industrial parks in the future.

Reference

1) Japan Industrial Location Center: Kogyo Ricchi Gentani Chosa Hokokusho (1989)