Vitalizing Japan
with Vital Ports

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# The Development of Kobe Port

# Preface

Kobe Port was officially stipulated by the national government as a port on the first day of the Meiji Era, January 1, 1868. When the port was opened, there were no wharfs large enough to serve large vessels and inefficient offshore loading operations were unavoidable. As foreign trade increased, the time ripened for expansion of the port facilities, and in 1907 plans were finalized for the development of the port facilities as a national public works project, the First Stage Kobe Port Development Plan. As a result, the Shinko (New Harbor) piers No. 1-No. 4 were constructed as the first step in the development of the modern Kobe Port.

In the 70 years since 1934 and the establishment of the Kobe Port Construction Office, which was the forerunner to the present office, the Kobe Ports and Harbors Office, we have been engaged in the construction of a large number of facilities within the area under our jurisdiction, including Kobe Port. Especially in the last quarter century, we have; 1. Constructed physical distribution facilities in Kobe Port in response to the advent of the use of containers for harbor-based trade, 2. Conducted improvement works to the Amagasaki Locks, designed to protect the Amagasaki City district, which is at sea-level, from high tides, and 3. Conducted harbor facility reconstruction works, including those in Kobe Port, in areas that suffered damage due to the Great Hanshin-Awaji Earthquake in the southern part of Hyogo Prefecture.

In the future, the Kobe Ports and Harbors Office will continue to promote a variety of district development and harbor planning projects that will contribute to both the expansion of the national economy and the livelihood of the citizens, including the promotion of a Super Hub Port, countermeasures for large-scale earthquakes in the seas southeast or south of the district, and environment revival works in the Osaka Bay area.

Here in this volume, almost ten years after the Great Hanshin-Awaji Earthquake disaster, we have presented a concise review of the port development works we have conducted in the last 25 years.

## Kobe Port

Photo taken in March of 2004

## Amagasaki-Nishinomiya-Ashiya Port

Photo taken in March of 2004

## Himeji Port

Photo taken in March of 2002

## From the post-war period — until the construction of the Maya Wharf
(1959 —1967)

After reconstruction following the end of the Second World War, Japan entered a period of economic growth. This growth brought an increase in the volume of foreign trade entering Kobe Port and new facilities were constructed, the Shinko and Hyogo Wharves.

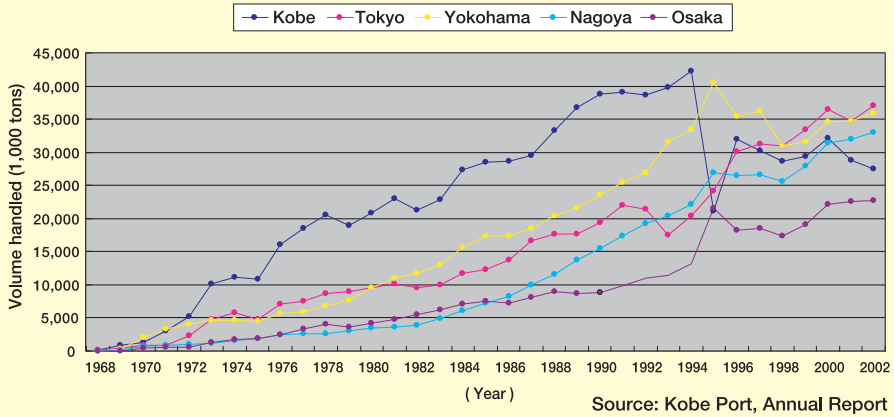
Along with the development of the Japanese economy, the ports also saw a steady increase in activity, and the amount of foreign trade volume seen in 1956 exceeded that recorded before the war. This led to a deficiency in the number of berthing facilities in the port. Accordingly, construction work was initiated in 1959 in the Maya Wharf district to provide mechanized, streamlined berthing facilities capable of handling the increase in vessel size and cargo volume. Designed primarily for exports, the eighteen berths of the four piers of the new 12-meter deep wharf were completed in 1967. In September of the same year, one of the first container ships seen in Japan entered Kobe Port, the Hawaiian Planter, commemorating the start of the container transportation age.

### Data No. 1

○ Transitions in container cargo volume

After the first container vessel entered Kobe Port in 1967, there was a sharp rise in the volume of marine container cargo transportation. In 1976, Kobe Port ranked 2nd worldwide for the amount of container cargo handled in the port, marking its transformation into a truly international port. Even though the damage caused by the Great Hanshin-Awaji Earthquake of 1995, in the southern part of Hyogo Prefecture, put a severe economic strain on the area, with a decrease in the volume of container cargo handled, the area is still one of the pivotal ports in Japan.

Transitions in container cargo categorized by main port

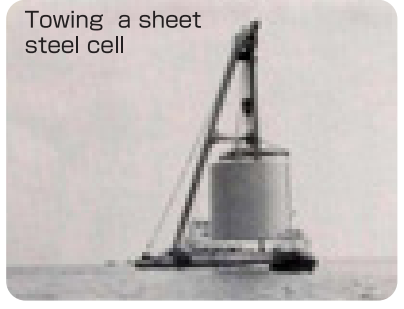



Source: Kobe Port, Annual Report

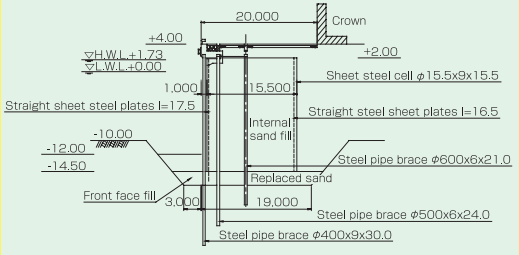
Maya Wharf near completion
(about 1967)

Along with the change from a primarily export-based wharf to an import-based facility, a need arose for a wide area at the wharf. Furthermore, there was a huge amount of rubble left from the damage caused by the Great Hanshin-Awaji Earthquake, and in order to achieve speedy restoration of the port after the disaster, this debris was used for landfill between the piers, resulting in the present configuration.

Present Maya Wharf




Maya Wharf Quay (12m deep) Cross-section Diagram




### Rapid operations employing the sheet steel cell method

As it was necessary to construct the wharf in the unprotected waters outside of the breakwater, the sheet steel cell method was employed in consideration of safety and ease of construction. This allowed us to meet the demands for the Maya Wharf and furthermore it reduced both the time required and the cost of the construction.

# The Arrival of the Container Era

## Port Island 1st Stage Construction
(1966—1981)

The need to construct a modern port appropriate for the full-fledged container era that arose with the increase in cargo volume during the years of economic expansion after the Second World War, and the demand for a new port and city environment led to the formation of the 2nd Five-year Port Development Plan (fiscal years 1965 - 1969). Based on this plan, construction was initiated in 1966 and continued for 15 years, resulting in the first man-made island of its kind worldwide, the marine metropolitan island known as Port Island (total area 436ha). In addition, a new unmanned urban transportation system, called the Port Liner, was constructed connecting Port Island with the central area of Kobe, Sannomiya, the first of its kind in Japan. During the Portpia '81 exposition held in 1981, about 16 million people employed the Port Liner, which served as the main transportation system for the event. On one day, the system carried a maximum of 250,000 people.

In order to meet the rapidly changing needs associated with the containerization movement, container berths 12m deep were constructed, and for ordinary cargo ships operating on a regular schedule, we constructed 15 berths with a 10m deep quay. Furthermore, as national construction works, the Kobe Ports and Harbors Office has constructed more than 3,040m of seawalls, in order to protect the function of the harbor and urban areas.

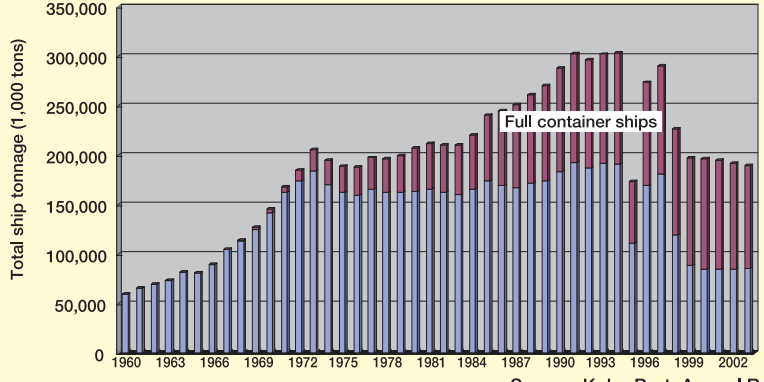
Accordingly, in 1980, 80.3% of the total container volume handled in the whole Kobe Port was handled on Port Island, amounting to 16.71 million tons of container cargo.

### Data No. 2

○ **Full container ships**

There are two types of container ships, full container ships, which carry only containers, and semi-container ships, which carry both regular cargo and containers. After the advent of container ships, the first full container ship entered Kobe Port in 1968 (the Japanese ship called the Hakone Maru, Nippon Yusen K.K., with a load capacity of 752 TEU). Thereafter, the number of container ships increased rapidly, and the percentage of full container ships entering Kobe has also continued to increase.

**Full container ship tonnage compared with the total ship tonnage**

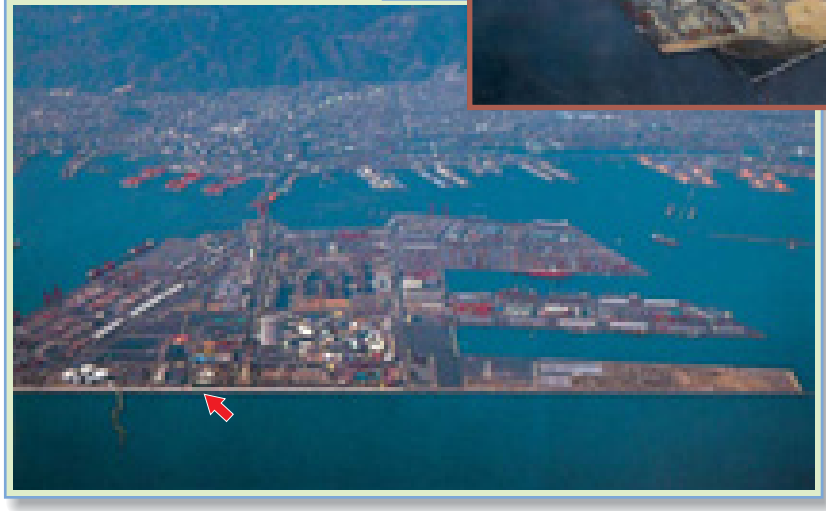



Source: Kobe Port, Annual Report

Land scheduled for use in the Port Island project, about 1967

Port Island with land reclamation underway

Port Island, about 1981

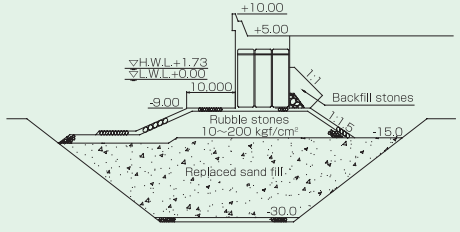


### The seawall protecting Port Island

At that time, there were a large number of construction projects being conducted in the waters offshore, beyond the existing seawall, and accordingly, we put a high priority not only on the protection of moored construction facilities, but also on the protection of shore-based landfill operations from wind-driven waves. Rapid construction measures were thus necessary, to ensure protection during the actual construction.

In the short period of a little more than three years, we constructed and fixed 287 caissons in place.

Port Island 1st stage seawall
Cross-section Diagram



# Port Facilities Capable of Meeting Diverse Needs

## Rokko Island Facilities
(1972—1992)

Six years behind the schedule for Port Island, the 4th Five-year Port Development Plan (1971 - 1975) was initiated in 1972, in order to construct the marine culture city Rokko Island (total area 595ha). This plan was designed to meet the demands created by the trend towards large vessels, and the multifarious changes in the physical distribution systems, through the provision of modern port facilities. At the same time, the plan called for the construction of an integrated marine metropolitan city providing various functions, such as residential areas, offices, business centers, education facilities, and cultural facilities capable of responding to changes created by the trend to an advanced information-based society and internationalization.

The rapid change to large-scale vessels, the advent of container shipping and specialization led to the construction of a container terminal with a total of 39 berths with quays 7.5-14m deep, including 12 berths at a quay with a depth of 10-12m, which covered about 50% of the total 12km circumference. In addition, as a national works project under our direct jurisdiction, we also constructed a breakwater, No. 7, with a length of 4,180m.

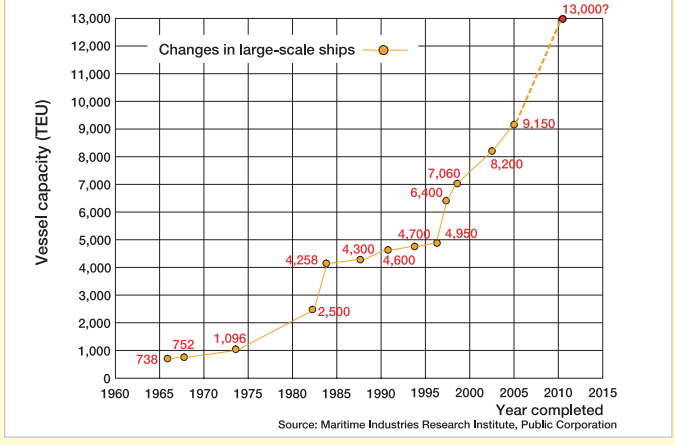
## Data No. 3

### ○ The change to large-scale container ships

First of its kind worldwide, in 1966, Sealand Corporation initiated the use of international marine container shipping on shipping lines in the North Atlantic Ocean. At that time, the container ships employed used 35ft containers, and they could only carry 226 containers. In 1968, the first Japanese container vessel appeared, the Hakone Maru, which could carry 752 TEU (TEU indicates the load capacity based on the conversion of 20ft containers), operating on shipping lines between Japan and the west coast of the United States. Then, by the 1970s, ships were capable of carrying 2,000 TEU.

This tend towards large-scale container ships continued at a rapid pace, and in the 1980s we saw the advent of the Panamax container ships (the largest vessels that could transit the Panama Canal). By 1988, Super-Panamax container ships that could carry more than 4,000 TEU appeared (larger than the largest vessels that could transit the Panama Canal). In the latter part of the 1990s, ships appeared that could carry 6,000 TEU, and this class of ship had a total length of more than 300 meters, with a draft of 13-14m. In the future, we can expect that this trend will continue even further.

**Transitions in large-scale container ships**

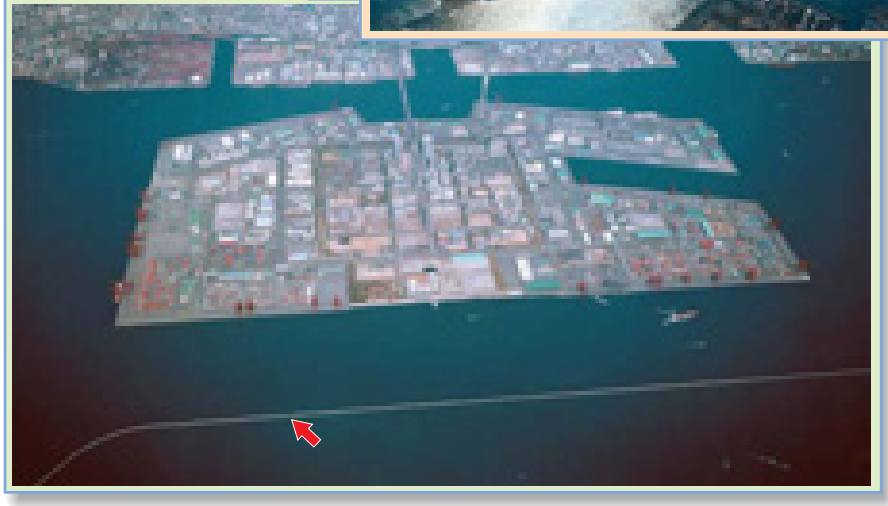



Source: Maritime Industries Research Institute, Public Corporation

Land scheduled for use in the Rokko Island project, about 1971

Rokko Island with land reclamation underway

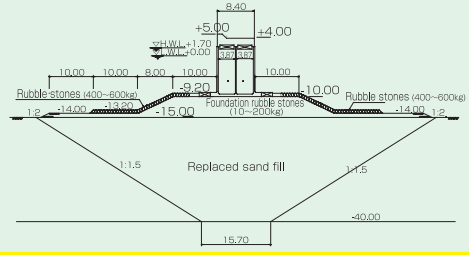
Rokko Island, at present



### The long breakwater, 4,180m

Because the soil base at the construction site at a depth of 15 to 40 meters was clay, it was necessary to conduct soil bed improvement works at both high and low levels. Accordingly, the construction included bed excavation and sand replacement, using a compound embankment gravitation method. The bed excavation involved the use of large grab-bucket dredging boats (8m³ –10m³), and at the height of the construction period there were 20 boat groups at work. Over the four years of the construction period, about 6 million square meters of soil were dredged.

**Breakwater No. 7 Cross-section Diagram**



# Restoration after Large-scale Disasters

## Restoration after the Great Hanshin Earthquake
1995 - 1996

At 5:46 AM on January 17, 1995, Hyogo Prefecture was struck by a large-scale earthquake, with the epicenter located in the northern part of Awaji Island. Except for a few earthquake resistant berths, the Great Hanshin-Awaji Earthquake caused widespread destruction throughout the Kobe Port area, literally paralyzing the functional capability of the port. Normally, Kobe Port accounts for about 30% of the nationwide container cargo trade, and the loss of the port functions affected not only the economic activity in the Kobe area, but also that nationwide, with ripples affecting the whole Asian district. In order to hold the economic effects to a minimum, it was necessary to restore the functional capability of the port as soon as possible.

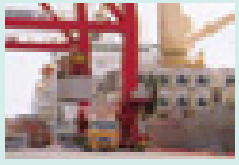
As the earthquake damage was extensive throughout the Kobe Port area, the national government conducted restoration works on government property under our direct jurisdiction. Over a period of two years, we conducted restoration works on a total of about 35.4km of mooring facilities and about 14.8km of seawalls and breakwaters.

### ① Maya Wharf

Sunken apron

The first container ship to moor at Maya Wharf after the disaster.

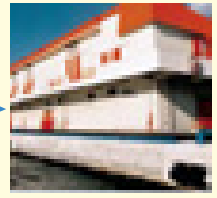
Maya Wharf was restored using a caisson-type gravity construction method and pier construction employing steel pipe piles.



### ② Shinko Pier

Piers that suffered little damage were used to receive urgent supplies.

A damaged loading wharf leaning out to sea.



Care was taken to maintain the historic scenery of the old districts that had been the face of the port since it was opened. Granite was employed in the superstructure works.

Superstructure works using granite were conducted to restore buildings.

### ③ Naka Pier and Wharf

A damaged loading wharf leaning out to sea.

Immediately after the disaster, railway lines and roads were cut off, and ships became the only viable means of transportation.

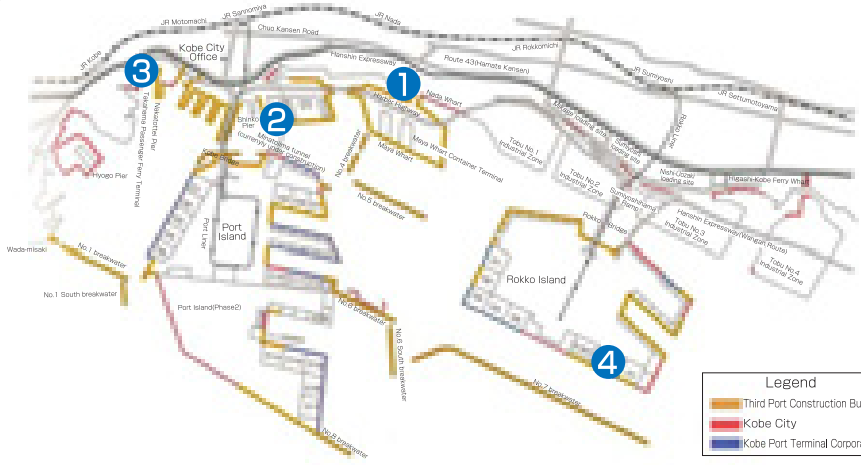
Naka Pier was quickly restored employing a jacket-type pier construction method.

### ④ Rokko Island

A damaged gantry crane

In order to restore container cargo handling capability as quickly as possible, we constructed an emergency container berth, and completed it within the short period of six months.

The restored container berths RC-6 and RC-7

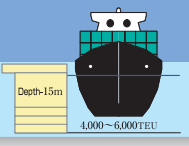



Distribution Map of Kobe Port Restoration Construction Works

### The jacket construction method was employed to shorten the construction time period.

Steel pipes and H-type girders were used to construct a framework (the wharf walls), and steel pipe piles were driven to secure the framework. This method allowed for a reduction in the construction period required, even in narrow spaces.

This shows the jacket being fixed in place.




## Port Island 2nd Stage Construction
(From 1986)

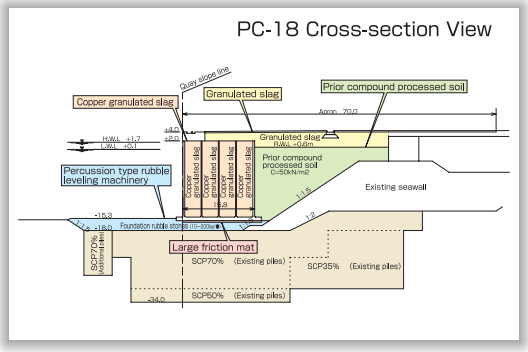
The 7th Five-year Port Development Plan (1986 - 1990) stipulated the initiation of the Port Island 2nd Stage Construction Project, which was designed to provide port and metropolitan facilities integrated with Port Island (1st Stage Construction) and capable of meeting the needs of the modern age, including those arising from the trends for internationalization and an information-based society.

The Port Island 2nd Stage Construction Project (total area 390ha) was initiated in 1987, resulting in the completion of the first 15m deep container berths (PC-14 and PC-15) in Japan in April of 1996. Thereafter, we completed construction of earthquake resistant 15m deep wharves, PC-13, PC-16 and PC-17, and the high-standard container terminal PC-18. The completion of these projects signaled the expansion of the functional capability of the port as a base for distribution in the western part of Japan, and also expansion of domestic feeder berths, which function to promote a modal shift in the distribution field.

Among these projects, as national works under our direct jurisdiction, we have constructed five berths, including two berths at a depth of 15 meters, and 1,546 meters of seawalls. We are now promoting the widening of shipping lanes and the construction of breakwater facilities.

### High-standard container terminal PC-18


A container terminal capable of servicing large-scale ships




### Responding to international distribution trends through shortening construction time requirements

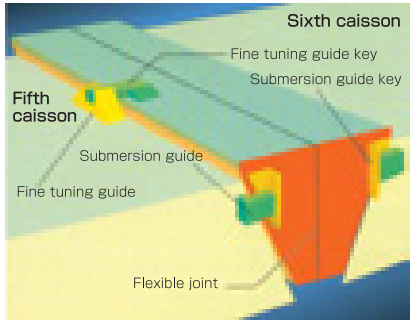
The use of percussion type rubble leveling machinery and underwater crawler type rubble leveling machinery increased the safety margin during construction and provided for highly accurate construction. In addition these methods shortened the time required for construction. Furthermore, the use of copper granulated slag in the caisson material made it possible to construct a slim caisson, in a short period of time. As a result, we constructed a high-standard container terminal with quays capable of handling 5,500 TEU class ships with a draft of 15m in the short period of a mere two years.

### Port Island at present


### The interior of Minatojima Tunnel

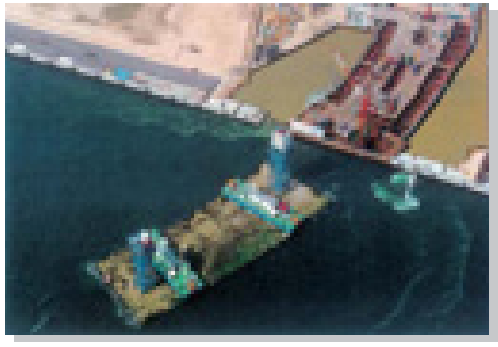
### Minatojima Tunnel

In July of 1999, Minatojima Tunnel was put into service, connecting the Shinko Higashi Wharf with Port Island. Minatojima Tunnel was constructed employing an immersed tunnel method on the seabed. It was constructed to respond to the increase in traffic expected with the advent of the high-standard container terminal being constructed in the 2nd stage Port Island construction project and also to ensure access during disasters. New techniques were employed in the construction of the tunnel, such as the full sandwich method and the use of high fluidity concrete, and in fiscal year 1999, the project was honored by winning the Technical Award from both the Society of Civil Engineers and the Kansai Branch of the Society of Civil Engineers.




### Last joint (V-block method)

At the last tunnel joint, a v-block, wedge-shaped reinforced concrete block with a composite construction was employed, taking advantage of both water pressure and the weight of the block itself to secure the joint and complete the construction.



The submersible caissons were constructed on a dock and towed to the submersion point, where they were immersed in the proper location.

# The Lock Gate Protecting the Land at Sea Level

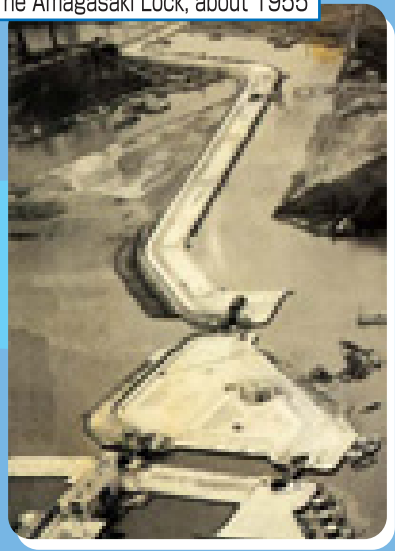
## The Amagasaki Locks

It has been said that most of the urban district in Amagasaki City is at sea level, and as the city is located at the rear of the Osaka Bay area, it has been hit hard by high tides many times in the past, causing extensive damage. Thus a seawall was constructed to protect the city from high tides. Furthermore, in support of the industrial activity at the idustrial center in the Amagasaki port area, a lock gate system, the Amagasaki Locks, was constructed as a first line of defense against high tides.

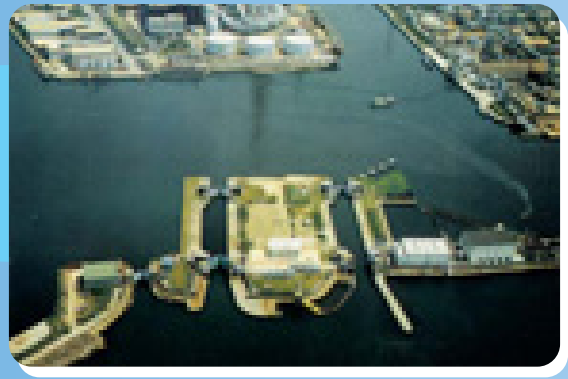
In order to meet the demands created by the trend towards large-scale vessels, make repairs for aging equipment, and provide earthquake resistant facilities, new construction work on the locks was promoted, and in 1994 the 2nd Amagasaki Lock was put into service. In 2002, the new 1st Amagasaki Lock was opened, so construction has been completed now. This high tide countermeasure project, taken under contract from Hyogo Prefecture, will be fully completed with the completion of the Amagasaki Locks Control Center by the end of fiscal year 2004.

A view of the whole Amagasaki area

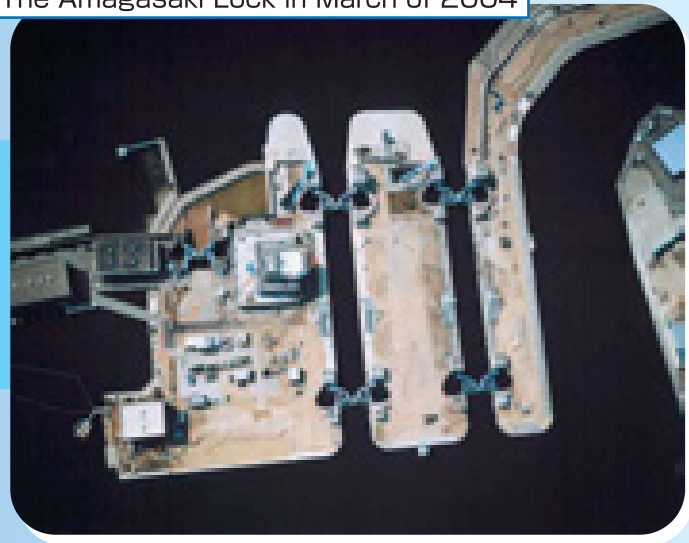
The Amagasaki Lock, about 1955



The Amagasaki Lock, about 1979



The Amagasaki Lock in March of 2004



### Construction of the Amagasaki Lock

In Amagasaki City, which has a long history of damage due to high tides and rough water, construction of the original Amagasaki Lock was completed in fiscal year 1954 to provide support and protection for the daily activities of the citizens of the area.

Thereafter, the 2nd Amagasaki Lock was completed in fiscal year 1964, and these locks have protected the citizens living in the area as well as the expansion of the local industries for the past 40 years and more.

### Improvement works on the Amagasaki Lock

In order to deal with aging and adding earthquake resistant features to the original Amagasaki Locks, improvement works were initiated in fiscal year 1986. The new 2nd Amagasaki Lock, and the new 1st Amagasaki Lock were completed, respectively, in 1994 and 2002. We are now constructing the Amagasaki Locks Control Center, with completion scheduled for the end of fiscal year 2004.

# Providing Support for Industries in the District

## Himeji Port

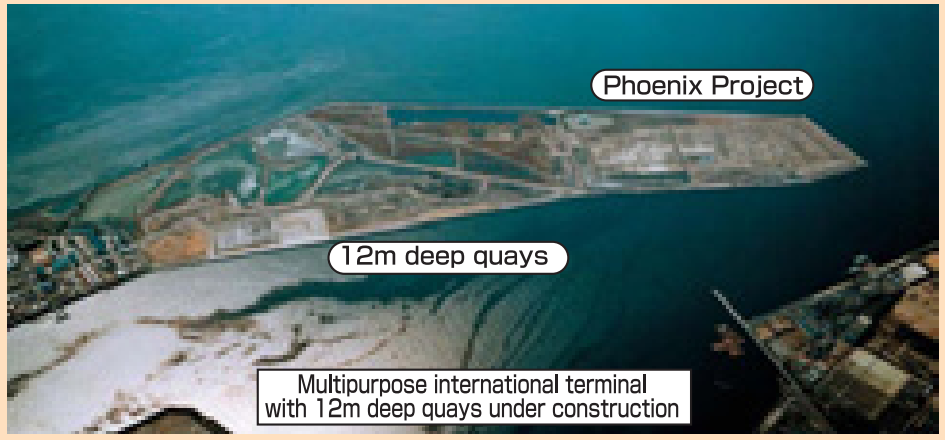
Himeji Port provides support for the three cities and eight towns in the Harima district urban base, centered around Himeji City. In order to respond to social changes and variations in the economic situation, as well as to upgrade the port facilities with advanced technology, creating a port integrated with the urban areas around the port, we are constantly involved with port improvement works. As a national works project, works were initiated in fiscal year 1994 in the Hirohata district to construct a 14m deep multipurpose international terminal.

### Hirohata district


## Amagasaki-Nishinomiya-Ashiya Port

Efforts were concentrated on the development of the industrial district in Amagasaki, and many industries established marine facilities in the area, making it a unique industrial center in the Hanshin industrial belt. In order to provide support for the vitality of this district, and in conjunction with the Phoenix Project, in the area offshore from Higashi Kaigan-cho, we are promoting the construction of a multipurpose international terminal (2 berths with 12m deep quays) as a national works project under our direct jurisdiction.

### Offshore of the eastern coast of Amagasaki




## Data No. 4

◆ Main changes in construction works

| Operation period | Fiscal years - 1960 | Fiscal years 1961 - 1964 | Fiscal years 1965 - 1967 | Fiscal years 1968 - 1970 | Fiscal years 1971 - 1975 | Fiscal years 1976 - 1980 | Fiscal years 1981 - 1985 | Fiscal years 1986 - 1990 | Fiscal years 1991 - 1995 | 1996 - 2002 | 2003 - |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | After WWII - | 1st 5-year Port Development Plan | 2nd 5-year Port Development Plan | 3rd 5-year Port Development Plan | 4th 5-year Port Development Plan | 5th 5-year Port Development Plan | 6th 5-year Port Development Plan | 7th 5-year Port Development Plan | 8th 5-year Port Development Plan | 9th 5-year Port Development Plan | Plan for the concentration of public capital |
| Hyogo Pier | | 1963 | | | | | | | | | |
| Shinko Pier | 1958 | | | | | | | | | | |
| Maya Wharf | 1959 | | 1967 | | | | | | | | |
| Port Island | | | 1966 | | | | 1981 | | | | |
| Rokko Island | | | | | 1972 | | | | 1992 | | |
| Port Island (2nd Stage) | | | | | | | | 1986 | | | |
| Rokko Island Minami | | | | | | | | | | | |
| Kobe Airport | | | | | | | | | | 1999 | |
| Himeji Port | 1959 | | 1966 | | | | | | 1993 | | |
| Amagasaki-Nishinomiya-Ashiya Port | | | | | | | | 1986 | | | |
| Period background | Entered the fast economic expansion period | Formation of a marine industrial district | Advancement of urban concentration | | First oil shock | 2nd oil shock | Enter a stable economic period | Economic bubble burst | Great Hanshin-Awaji Earthquake | Restoration completed in about 2 years | |
| | Sudden increase in the amount of cargo | Expansion in the heavy and chemical industries (Coal, petroleum, steel, etc.) | Increase in foreign and domestic containers, and ferry lines | | Increase in demand for marine recreation | | Increase in awareness of environment issues | | Sudden decrease in the amount of cargo handled due to extensive damage caused by the earthquake | Recovery to 80% of the cargo handled before the earthquake disaster | |

Appearance of container ships

Promotion of containerization

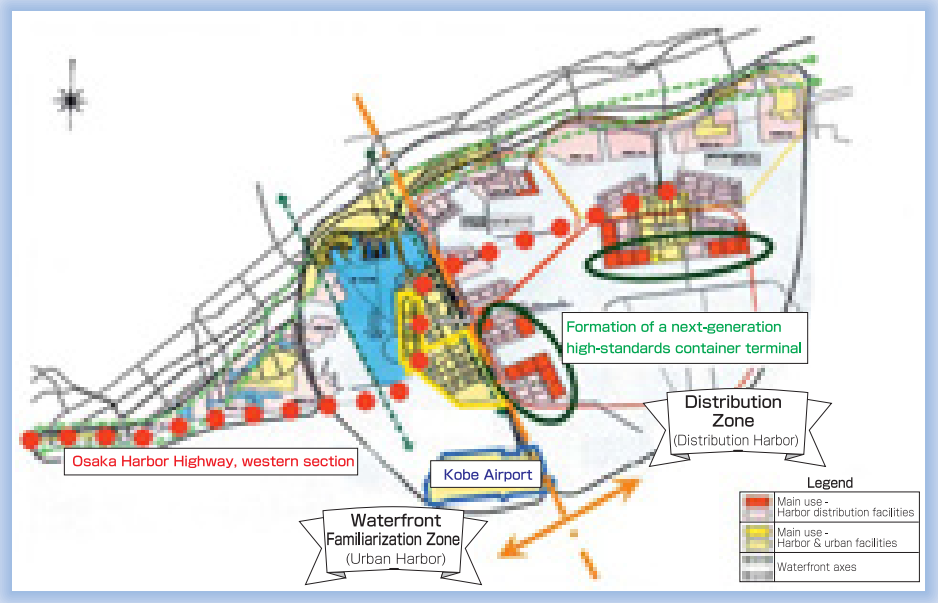
Change from export to import economic type

# On to the Future

Kobe Port and Harbor Office has conducted sufficient construction to establish a position as a modern international distribution base, well represented by the container terminals on Port Island and Rokko Island. In order to provide for a variety of distribution needs in the future, we will construct facilities capable of providing highly-advanced services in the distribution field, such as the Kobe Port International Distribution Center. In addition, the theme we will follow throughout this development is "A User-friendly Port," and in order to realize to this ideal, we are promoting construction with integrated hardware and software development.

In addition, the Kobe International Airport is under construction now and scheduled to be opened for service in fiscal year 2005. With the completion of this facility, it is expected that Kobe Port will play an even greater role as an integrated distribution base for marine, land and air transportation and a center for the exchange of people, cargo and information in the years to come.

- **The challenge of a Super Hub Port**
  Along with Osaka Port, Kobe Port is working to achieve an integrated "Hanshin Port," in order to form a Super Hub Port. Through unification of forms and procedures, the reduction of total transportation costs, the construction of large-scale deep water quays (16m deep), and improved access to the port facilities, we are aiming for the realization of an increase in the amount of cargo handled and the prestigious position of a foreign hub port featuring low cost, speed and service.
- **District planning featuring safety and peace of mind**
  We are aiming for peace of mind and the construction of a "Safe and Pleasant Port" though the construction of seawalls and breakwater facilities to protect the port facilities and urban zone against high tides and tsunamis due to typhoons or earthquakes in the seas to the southeast or the south. We are also engaged in raising the port security system to international standards to protect against international criminal activity and terrorism.
- **Increasing the efficacy of distribution and the vitalization of industry through port reorganization**
  We are consolidating and reorganizing the port in order to achieve efficient transportation, and furthermore, we provide support for the special economic zones in order to vitalize the new industrial environment.
- **The creation of an pleasant living environment in harmony with the urban district**
  Taking advantage of the special characteristics of Kobe as a port city, we are promoting the construction of cheerful, bustling waterfront zones integrated with the urban district.




Conceptual image of Kobe Port in the future