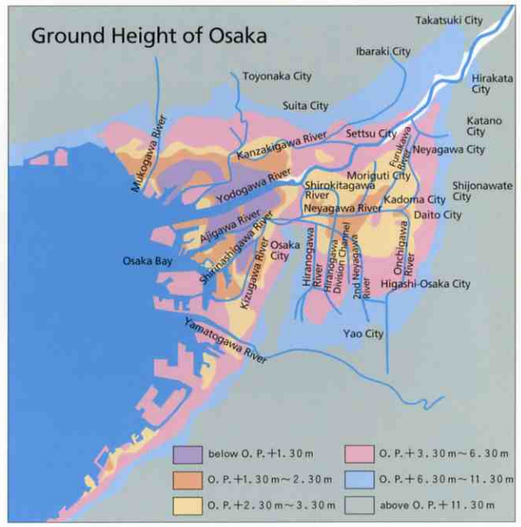
Osaka Prefectural Government

Measures to Control Tidal Waves in the Western Osaka Region

Rivers Office, Department of Public Works, Osaka Prefectural Government
Nishi Osaka Flood Control Office, Osaka Prefectural Government

The Low-ground Coastal Region of Western Osaka Region Needs to Take Anti-tidal Wave Measures

The Western Osaka Region with a population of 1.1 million is the center of commerce, industry, and culture. However, due to the 3-m-land subsidence that lowered the 21km² of this coastal area below the sea level, this area often suffered extensive damage from tidal waves in its proximity to the Osaka Bay.
Under the circumstances, the Osaka Prefectural Government have taken various measures to control tidal waves, including the construction of floodgates and embankment, with the current efforts focusing on the reinforcement of the embankments against earthquakes.



Typhoon-caused Tidal Waves can Inundate Coastal Areas

Due to geographical conditions, the phenomenon of tidal waves can occur easily in the Osaka Bay region. Typhoons move to the north while rotating counterclockwise, so when they pass to the west side of Osaka, this combination tends to result in tidal waves that pose the risk of causing serious disaster anywhere along the coast.

■Damage Caused by Typhoons that Struck Osaka

date	1934	1950	1961
name	Muroto	Jane	MurotoNo.2
atmospheric pressure (hp)	954.5	970.3	937.3
max. precipitation (mm/h)	—	19.8	—
total precipitation (mm)	22.3	64.7	42.8
max.wind velocity (m/sec)	42.0	28.1	33.3
max.tide level (O.P.+ m)	(4.20)	(3.85)	4.12
inundated area (m²)	4,921	5,625	3,100
inundated house above floor	166,720	45,406	59,198
inundated house below floor		35,058	67,782
damage total	166,720	80,464	126,980
casualties	17,898	21,465	2,165

( ) assumption

Minato Ward damaged by the tidal waves caused by Muroto Typhoon No.2 (1961)

Map of the Western Osaka Region

The Renovation of Facilities against Super-typhoon can cause Tidal Waves is Now Under Way

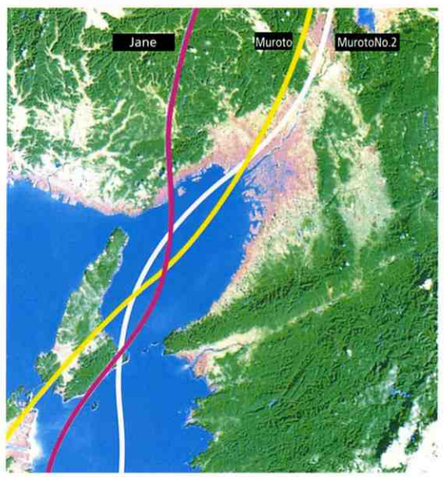
The Western Osaka region has taken various measures to minimize the damage caused by typhoon-generated tidal waves since it was hard hit by Jane Typhoon (1950) and Muroto Typhoon (1961). 1965 saw the renovation of the anti-tidal wave facilities against Isewan Typhoon-class typhoons, the greatest in history.
In 1970, three large arch-typed floodgates were constructed as the front-line barrier against tidal waves and in 1980 Kema Pumping Station was constructed to prevent the over flowing of rivers. Currently bridge elevation and embankment reinforcement against earthquakes are going on.

Project

●Goal
To renovate the existing anti-tidal wave facilities against the worst case of Typhoons: Isewan Typhoon(1959)-class taking the route of Muroto Typhoon

●Estimated Height of Tidal Waves
O.P.+5.2m (=O.P.+2.2 m +3.00 m)
O.P.+2.2m : mean full tide level during the typhoon season
3.00m : tide deviation(unusual upsurge of tide caused by strong wind and low atmospheric pressure)

The Course of the Typhoon That Brought Tidal Waves



Floodgate System

Floodgates and Pumping Stations to Prevent Inundation

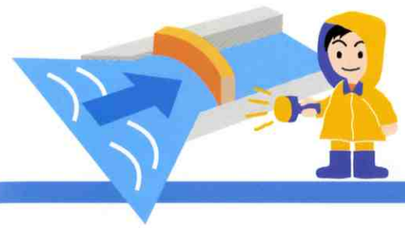
In Bridge-rich areas where the costly bridge elevation seriously affects the city functions, floodgates and pumping stations are constructed to control tidal waves and the overflow of rivers respectively.

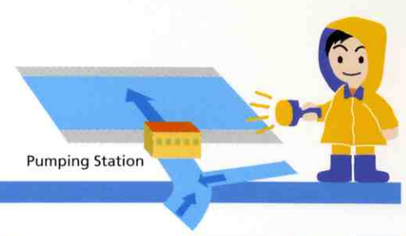
Floodgates

name	type	span length (m)	gate sill level (O.P.m)	gate top level at closing (O.P.m)	time for opening and closing
Ajigawa Floodgate Shirinashigawa Floodgate Kizugawa Floodgate	Arch-typed Gate (Swing Gate)	57.0×1 (15.0×1)	O.P.-4.50 (O.P.-4.00)	O.P.+7.40	30min. (10min.)
Shorenjigawa Floodgate	Double Roller Gate	14.0×1	O.P.-3.00	O.P.+7.50	30min.
Rokkenyagawa Floodgate	Double Roller Gate (Single Roller Gate)	14.0×1 (8.5×2)	O.P.-3.00	O.P.+7.30	30min. (30min.)
Sangenya Floodgate	Double Roller Gate	14.6×1	O.P.-2.80	O.P.+7.40	20min.
Dekijima Floodgate	Double Roller Gate	10.0×1	O.P.-2.67	O.P.+8.60	20min.
Old Inagawa Floodgate	Single Roller Gate	9.0×2	O.P.-0.80	O.P.+6.70	20min.
Sumiyoshigawa Floodgate	Single Roller Gate	8.0×1	O.P.-2.00	O.P.+5.65	10min.

Pumping Stations

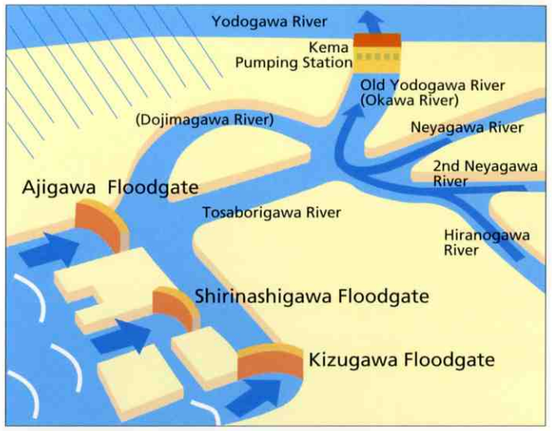
name	pump capacity (m^3/s)	type	impeller diameter(mm)	number	head (m)
Kema	330	adjustable vane vertical axial	4,000	6	4.13
Old Inagawa	40	vertical axial	2,000	4	3.10
Takami	19	vertical axial (Two adjustable vanes)	1,650	4	1.90



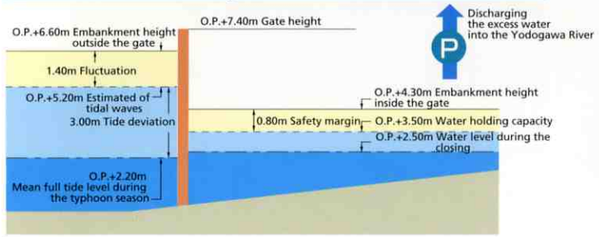


■Floodgates in Old Yodogawa River

Three large arch-typed floodgates were constructed to facilitate the passing of cargo ships that frequently move on the three major tributaries of the Old Yodogawa River.
However, since the closing of those floodgates can cause the rivers to overflow, the Kema Pumping Station was constructed to discharge the excess water at the rate of 330m^3/sec.. This facility can also serve to prevent the flooding of the Neyagawa River Watershed.



The Outline of Floodgate



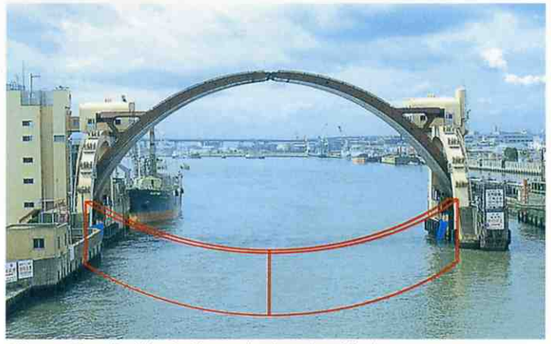
●Planned Height of the Embankment outside the Floodgate
O.P.+6.60m (=O.P.+5.20m+1.40m)
The estimated level of tidal waves is O.P.+5.20m with a fluctuation of 1.40m.

●Planned Height of the Embankment inside the Floodgate
O.P.+4.30m (=O.P.+3.50m+0.80m)
The estimated level of water during the closing of the gate is O.P.+3.50m plus a margin of 0.80m for safety reasons.

Floodgate operation record

August 22–23, 1975; typhoon No.6
September 29–October 1, 1979; typhoon No.16
September 29–30, 1994; typhoon No.26
July 26–27, 1997; typhoon No.9

Arch-typed floodgate



Ajigawa River (Red line indicates the closed position)

Kema Pumping Station

Embankment System

Embankment against Tidal Waves and Overflowing Rivers

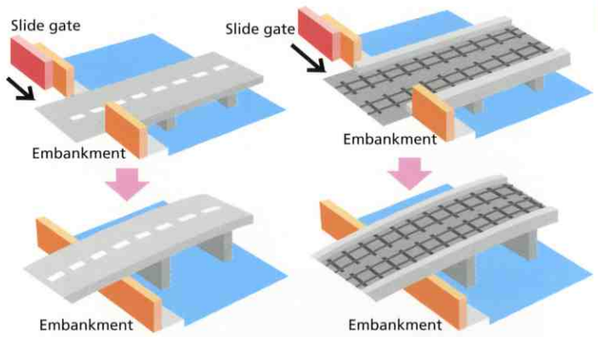
Unlike the Western Osaka region, the area along the Kanzakigawa River is protected mainly by embankment.

■Embankment along the Kanzaki River

The Kanzakigawa riverside is protected by embankment since the Kanzakigawa is a fast-running river over which relatively small numbers of bridges were built.

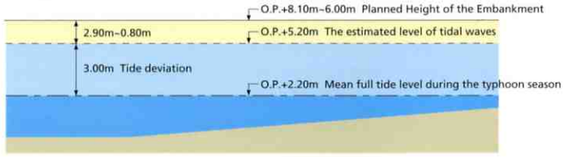
■Bridge Elevation

When it is difficult to elevate bridges, slide gates are constructed to control the overflowing of the Kanzakigawa River and when possible, both embankment and bridge elevation are carried out.



Samondogawa River (Route No.2 before bridge elevation)

The Outline of Embankment



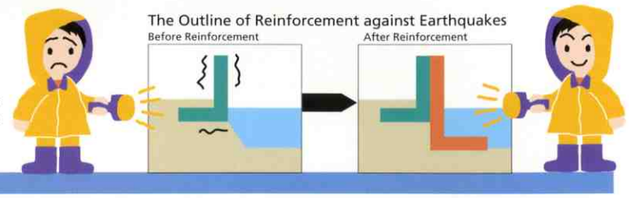
- Planned Height of the Embankment at an estuary
  O.P.+8.10m (=O.P.+5.20m+2.90m)
  The estimated level of tidal waves is O.P.+5.20m with a fluctuation of 2.90m.
  ⟆
  from the Mikuni Bridge to the Obuki Bridge
  O.P.+6.00m (=O.P.+5.20m+0.80m)
  The estimated level of tidal waves is O.P.+5.20m with a fluctuation of 0.80m.

Record of closing National Route 2 slide gates
(Kanzakigawa river, Samondogawa river)

August 22, 1975; typhoon No.6
September 30, 1979; typhoon No.16
September 4, 1993; typhoon No.13
September 29, 1994; typhoon No.26
August 14, 1996; typhoon No.12
June 28, 1997; typhoon No.8
July 26, 1997; typhoon No.9
June 30, 1999; downpour at start of rainy season

Kanzakigawa River (Hanshin Line after bridge elevation)

Embankment Reinforcement against Earthquakes



The reinforcement of riverbanks have been carried out to prevent inundation caused by earthquakes.

Tidal wave protection projects have made the rivers in western Osaka safer against tidal waves. However, embankments have repeatedly been built up to deal with previous settling, and it is impossible to declare that these embankments are sufficiently safe against earthquakes. Should an embankment be destroyed by an earthquake, there would be a risk of severe damage due to the resultant flooding. Hence from 1977, projects have been conducted to strengthen embankments against earthquakes measuring 5 (strong) on the Japanese scale. Since 1996, as a result of the earthquake in Southern Hyogo Prefecture, earthquake resistance has been studied further, and projects are being implemented to raise earthquake resistance to those measuring 6 (strong–violent) on the Japanese scale.
Especially in the Nakanoshima districts, new embankments are under construction to enhance the scenic beauty of the riverside by harmonizing the embankments with stone-structure design of Osaka Castle and Nakanoshima promenade.

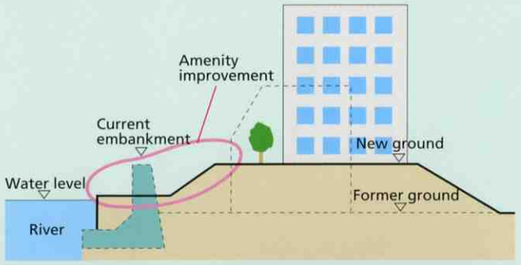
Tosaborigawa River

Tosaborigawa River

Superembankment

The Enhancement of the Riverside Safety and Amenity as Part of Urban Development

Superembankment is now under construction on the low-ground riverside to enhance its safety and amenity as part of urban development. The site for approximately 20-mile-long Superembankment is the riversides of the Ajigawa, Kizugawa, and Shirinashigawa River. In 1994, projects began on the Kizugawa and Shirinashigawa Rivers to coincide with the development of Osaka Dome, and these were completed in 1996. Currently, work is underway on the Ajigawa and Shorenjigawa Rivers (associated with redevelopment focused on USJ) and the Dojimagawa River (associated with development of the old Osaka University Hospital site).



The outline of Superembankment

In the vicinity of Osaka Dome (Construction complete)

Area around USJ (Under construction)

A boat crossing the Old Yodogawa River (Okawa River)

Osaka Prefectural Government

Rivers Office, Department of Public Works, Osaka Prefectural Government
2-1-22, Otemae, Chuo-ku, Osaka 540-0008 Tel: 06-6941-0351/+81-6-6941-0351
Nishi Osaka Flood Control Office, Osaka Prefectural Government
2-1-64, Enokoshima, Nishi-ku, Osaka 550-0006 Tel: 06-6541-7771/+81-6-6541-7771
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