PARI

PARI Annual Report 2011

President's Message

Aiming at technologies to contribute to the world

The Port and Airport Research Institute (PARI), which was established in 1962 as the Port and Harbor Research Institute (PHRI) of the Ministry of Transport, has been conducting comprehensive research related to ports and airports including studies on coastal disaster mitigation, coastal environment, and utilization of the seas. The Institute was re-organized as an independent administrative agency, PARI, in accordance with the government reforms of 2001.

Since then PARI has been pursuing both innovative basic research and practical application research. We have been studying comprehensive countermeasures for liquefaction in coastal areas, strategic maintenance and management methods for port facilities, integrated management of coastal zone including tidal flat, and Blue Carbon (CO_2 mitigation by coastal systems). We have also established the Asia-Pacific Center for Coastal Disaster Research to conduct comprehensive studies on earthquakes, tsunamis, storm surges and storm waves and to enhance international research cooperation. We have recently constructed large-scale experimental facilities, an integrated wave basin for coastal disaster research to reproduce storm waves and currents, and a centrifuge facility for earthquake and tsunami experiments. PARI has been promoting research collaboration with 18 research institutes based on MOU and we have signed a MOU with the Network for Earthquake Engineering Simulation (NEES) for common use of the major research facilities of PARI and 14 U.S. universities and institutes.

The devastating Tohoku earthquake and tsunami which occurred on March 11 this year severely impacted the Tohoku and Kanto regions. We, especially as researchers related to coastal disaster prevention, have been profoundly moved by the tragic disaster. We would like to express our sincere sympathy to the victims and their families and friends. PARI is working hard to examine the disaster from its fields of expertise and to study the recovery and reconstruction of the coastal areas. The coastal disaster prevention strategy needs to be discussed, and studies on integrated mitigation measures have been started.

In April 2011, we launched the Third Mid-term Plan and the year 2012 will mark the 50th anniversary of PHRI and PARI. We continue to make every effort to achieve outstanding research activities as a leading global research institute. We appreciate your continuing help and encouragement.

高橋　重雄
Shigeo TAKAHASHI, Ph. D.
President, Port and Airport Research Institute (PARI)

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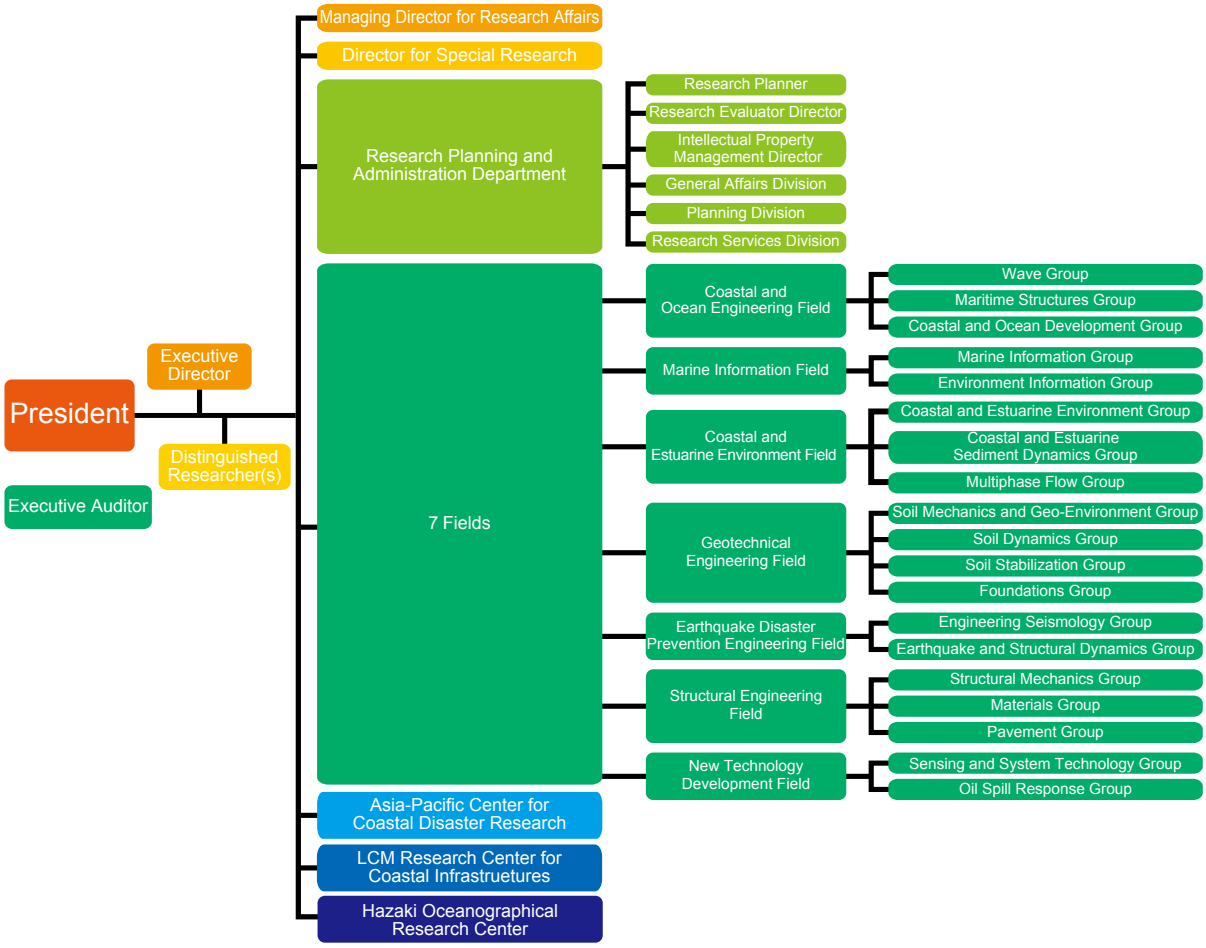
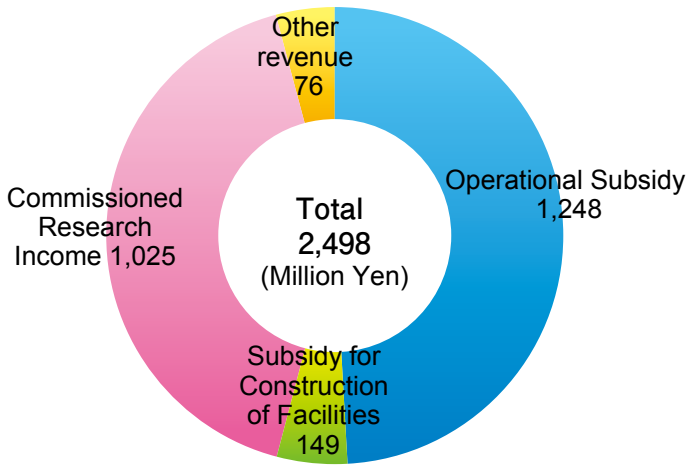
Organization Structure and Annual Budget(FY 2011)

Administrators, administrative staff and researchers (July 2011)			
Total	Administrators	Administrative staff	Researchers
101	4	18	79



FY 2011 Annual Budget



Management Strategy

Med-Term Objectives from FY 2011 to FY 2015

The Port and Airport Research Institute (PARI) contributes to facilitating smooth construction and maintenance of port and airport by conducting surveys, research, and development of technologies. PARI also aims at promoting the improvement of technologies for port and airport developments. PARI maintains, commonality, independence, and transparency in its administration, and also manages its operations in an efficient and effective manner, which is required for an independent administrative institution. Review of organizations and their operations, complying with the med-term objectives as well as the appropriate and effective conduction of its operations enable PARI to accurately carry out its mission, relating to a land, infrastructure and transport policy.

Focused Research Fields

1. Research on Infrastructure for Homeland Security
2. Research for the Creation of a Comfortable and Beautiful Homeland
3. Research on Infrastructure for a Vigorous Society and Economy

Med-Term Objectives from FY 2011 to FY 2015

Strategic Management

1.Formulation of a clear fundamental policy of research administration to promote a management strategy in PARI, administrative strategy meetings are conducted with the institutional executives and discussions at Board level with external experts.

2.Promotion of information sharing with related governmental agencies and external experts as well as personnel exchanges and closer cooperation with the agencies are conducted for a prompt and appropriate integration of social and governmental needs.

3.Development of an effective research environment for creative studies by discussions with administrative staff and researchers in PARI and reflects the management needs of researchers adequately.

Focused Research Themes

Considering social and governmental needs as well as the importance and urgency, research themes are focused regarding respective research fields indicated in the med-term objectives.

1. Research on Infrastructure for Homeland Security

(1) Research on Seismic Disaster Prevention and Mitigation

(2) Research on Tsunami Disaster Prevention and Mitigation

(3) Research on Prevention and Mitigation of Disasters Caused by High Wave and Storm Surge

2. Research for the Creation of a Comfortable and Beautiful Homeland

(1) Research on Improving Water and Sediment Quality in Enclosed Bay

(2) Research on Oil Spill and Rafts Response

(3) Research on Conservation and Formation of Sandy Beaches

3.Research on Infrastructure for a Vigorous Society and Economy

(1) Research on Upgrading Port and Airport Facilities

(2) Research on Strategic Maintenance for Port and Airport Facilities

(3) Research on Effective Use of Ocean Space and Renewable Energy Utilization

PARI's Aims as a Research Institution

PARI's mission is "to contribute to an efficient and smooth construction and maintenance of ports and airports by conducting a survey, research, and development of technologies, as well as to promote the improvement of technologies for port and airport developments. By doing so, PARI can encourage stability in everyday life and solid developments of the economy".

PARI has pursued a steady objective as "aiming at technologies to contribute to the world" and has achieved successful achievements. Following PARI's mission, its objective is set from the perspective of scientific developments and its research standards and achievements are not only highly appreciated but also practically useful both in the country and overseas. These goals are to be targeted in the future.

The followings are future goals of PARI as a research institution and show effective avenues to accomplish its steady objective.

1. "A global leading research institution"
To create innovation and to focus on fundamental studies.

2. "A research institution contributing to society"
To contribute to the society with the hallmark of the institution's superb technologies, and to focus on supporting public administration.

3. "The one and only research institution"
To focus on the idea of core competence and to share roles with non-governmental institutions.

4. "A research institution filled with individual researcher's independence and ingenuity"
To value each researcher's independence and ingenuity and to create innovation.

Research Theme Structure in FY 2010

Strategic Research Theme Structure

Research Field	Research Theme	Research Sub-Theme	Priority Topics
Research on Infrastructure for Homeland Security	Research on Earthquake Disaster Prevention	Understanding of Earthquake Disaster Mechanism by Strong Ground Motion Observation Damage Monitoring	
		Improving Forecasting Accuracy of Strong Motion	Research on High Earthquake-Proof Port, Shore and Airport Facilities
		Ground Motion Forecasting and Countermeasures against Earthquakes	
		Structure Motion Forecasting and Countermeasures against Earthquakes	
	Research on Tsunami Disaster Prevention	Developing Forecasting Method of Tsunami Disasters	Research on Tsunami Disaster Resilience
		Developing Innovative Software Technology	
	Research on Storm Surge and Wave Disasters	Ocean Wave Reproduction by combination of Efficient Observation and Highly-Accurate Wave Estimation Method	Research on Highly-Accurate Maritime Observation for Stormy Wave Disaster and Global Environmental Change
		Improving accuracy of Estimating Wave Over-topping Flow and Forecasting Stormy Wave Disaster	
		Understanding Failure Phenomenon of Breakwaters and their Basement by Stormy Wave Disaster	
		Forecasting Effect of Global Warming on Storm Surge and Wave Disasters	Research on Highly-Accurate Maritime Observation for Stormy Wave Disaster and Global Environmental Change
		Other	
	Research on Human-Oriented Disasters in Coastal Zones	Research on Oil Spill Response	Research on Oil Spill Response in Coastal Zone
		Research on Port Security	
Research for the Creation of a Comfortable and Beautiful Homeland	Research on Improving Water and Sediment Quality in Enclosed Bays	Understanding Physical and Chemical Process in the Boundary of Sea Bottom Sediment	Research on Environmental Restoration of Semi-enclosed Environment and Carbon Dioxide Absorption by Coastal Ecosystems
		Monitoring Boundary Condition between Bay and Ocean	
	Research on Conservation and Restoration of Coastal Ecosystems	Relation between Benthic Environment and Soil Properties in Inter-tidal Flat	Research on Environmental Restoration of Semi-enclosed Environment and Carbon Dioxide Absorption by Coastal Ecosystems
		Environment-restoring Technology with Dredging	
	Research on Comprehensive Coastal Management	Beach Morphological Changes and Sediment Transport Properties	
		Numerical Simulation Model of Beach Morphological Changes	Research on Prediction of Beach Morphological Changes induced by Multiple Waves and Currents
		Development of Comprehensive Coastal Maintenance Management	
Research on Infrastructure for a Vigorous Society and Economy	Research on Integration of Infrastructure	Improving Performance Verification Method of Port Facilities	Research on International Harmonization of Performance Based Design Standards for Port Facilities
		Upgrading Technology of Port Facilities	
		Upgrading Technology of Airport Pavement	Research on Advanced Terminal Function to Promote Distribution Reform
		Other	
	Research on Life-Cycle Management of Infrastructure	Monitoring and Assessment Technology for Port Structure Maintenance	Research on Life-Cycle Management on Port, Shore and Airport Facilities
		Forecasting Degradation and Repairing Effect of Structures	
	Research on Automation of Underwater Work Procedures	Un-manned Monitoring Method of Steel Structures	Research and Development on Automatic Systems for Underwater Work
		Un-manned Underwater Working Technology	
	Research on Ocean Utilization and Environment-Friendly Infrastructure Technology	Technology Development of Utilizing Ocean Space	Research on Effective Utilization of Deep Sea Area
		Long-term Assessment of Waste Disposal Site in the Ocean	
		Reducing Environmental Burden through Recycling Technology	

Research Theme and Activities in FY 2010

1 Research on Earthquake Disaster Prevention

Background and Objectives

A large-scale earthquake disaster is predicted due to the Tokai, Tonankai and Nankai earthquakes. Technological developments for earthquake disaster prevention are required for port and airport facilities. Unsolved tasks include understanding the characteristics of long-period and long-duration seismic ground motion from huge subduction-zone earthquakes such as the Tokai earthquake. Ground motion characteristics are not fully understood due to varied local ground soil characteristics in the targeted areas. Verification methods of anti-seismic structure performance require improved accuracy. Improvement is also required in relation to seismic performance of newly built structures, and cost reduction in seismic measures must be improved. Enormous efforts have been made to stimulate technological capacity to address these issues.

Research topics

This research theme has four focal topics: (1) seismic ground motion observations and post-event damage surveys, (2) predicting seismic ground motion, (3) prediction of soil behavior during earthquakes, and (4) predictions of structural damage during earthquakes and its countermeasures.

Post-event damage surveys, continued observation of seismic strong ground motion to elucidate severe seismic ground motion, and monitoring to comprehend ground and structure behavior during seismic strong ground motions must be performed to obtain fundamental knowledge for earthquake disaster prevention.

Appropriate set-up of seismic ground motions for the design of port and airport facilities requires the proposals and practical utilizations of seismic source models, evaluation of nonlinear behavior of surface strata, and more accurate evaluation methods of strong ground motion.

Long-period and long-duration seismic ground motion are predicted during large-scale earthquakes, therefore reliability of predictions and countermeasures must be improved for combined behavior of soil and structure due to these ground motions.

Activities in FY 2010

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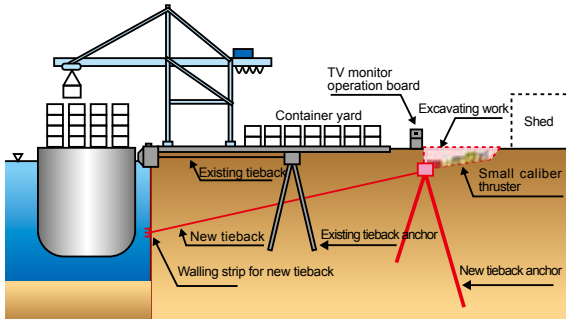
Constructions of a countermeasure against liquefaction at Niigata Airport

We have proposed a verification method of liquefaction regarding the characteristics of seismic waves based on experiments and analysis on liquefaction characteristics during long-period and long-duration earthquake ground motions.

Further, we have examined the application of grid-shaped solidification behind quay-walls as a countermeasure against large-scale earthquakes to identify its performance and proposed an applicable range.

We proposed a countermeasure of a double tiered method which improves the seismic performance of existing sheet pile quay walls without stopping cargo handling operations. Its effectiveness was confirmed with a verification of seismic performance and implemented at Sendai-Shiogama port.



Reinforcement of a double tieback method to utilize quay-walls

In addition to clarifying dynamic characteristics in the existing seismic isolation system container cranes, we have developed a device to equip the berth for containers against long-period and long-duration earthquake ground motions and also provided technical support aiming to produce an actual container crane equipped with the function.

In 2010, we conducted a damage investigation of the Chilean earthquake and tsunami to understand its destruction process from multiple damage of seismic motions and tsunamis. Thus, we developed and established the first facility of the Large-scale Geotechnical and Hydraulic Centrifuge apparatus in the world to cooperate with researchers on earthquake, tsunami, geotechnique and structure as well as initiate development in experiment technologies as a research tool.

Before (left) and after functioning (right) in the facility for the Large-scale Geotechnical and Hydraulic Centrifuge apparatus

2 Research on Tsunami Disaster Prevention

Background and Objectives

Tsunami is a Japanese word which can be divided into two words: tsu and nami. Tsu means harbor; and nami means wave. Tsunami in Japanese thus originally means a giant wave that causes enormous damage in a harbor. A study on tsunami disaster prevention has been an important research topic since the Port and Harbor Research Institute (PHRI) was established in 1962. After the 2004 Indian Ocean tsunami, the Tsunami Research Center (TRC) was founded to study next-generation tsunami disaster prevention, to prepare for tsunamis due to large-scale earthquakes in the Tokai, Tonankai, and Nankai regions, aiming at no casualties from tsunamis.

The center has been reorganized as the Asia-Pacific Center for Coastal Disaster Research (APaC-CDR) since FY 2010 and studies on preventing coastal disaster are progressing as an important matter.

Research topics

At APaC-CDR, prediction technologies for tsunami disasters and real-time tsunami forecasting technologies as well as technologies for reducing a tsunami's impact such as a new water gate have been developed.

(1) Development of disaster prediction technologies

Disaster prevention starts with public awareness of specific actual disaster situations. Thus, we are developing technologies to predict tsunami disasters and enable people to easily understand tsunamis. First, we conduct field surveys after large tsunami disasters around the world to understand tsunami disasters. We also conduct model experiments to investigate the mechanisms and processes of the disasters in a large-scale flume. Numerical computation programs are being developed to predict disasters. A dynamic tsunami hazard map is also produced from the calculation results for people to easily understand the hazard. Utilizing the calculation and visualization technologies, we have been working on development in planning methods for faster recovery from damages at ports and airports.

(2) Development of innovative non-structural countermeasures

Once an earthquake occurs, a tsunami warning is issued in response to predicting tsunamis based on the seismic epicenter and its magnitude. We are developing new technologies for predicting incident tsunamis to coasts on a real time based on measurement data of tsunamis offshore by GPS wave meters.

(3) Development of effective structural countermeasures

We are developing a new water gate for tsunamis to effectively reduce tsunami impact.

A new movable water gate for tsunamis is to be experimented at the site in FY 2011.

Activities in FY 2010

As to disaster caused by the Chilean earthquake tsunami on February 27, 2010, we sent our researchers to Chile as part of a joint field investigation team with the cooperation of other researchers in the earthquake study to clarify the fundamental characteristics of the coastal disaster by the earthquake and tsunami in Chile. For the Indonesian Mentawai earthquake and tsunami on October 25, 2010, we also sent a field investigation team there with the international cooperation of the Ministry of Marine and Fishery of Indonesia to clarify the fundamental characteristics of the disaster due to the tsunami. In the Great East Japan Earthquake on March 11, 2011, we conducted an urgent field investigation at each of the damaged ports, gathered information and analyzed the damage. In addition, we have gathered information on 10 tsunamis when tsunami warnings and watches were issued in Japan as well as overseas.

We deliberated on an analysis on destruction phenomena by tsunamis that was experimented on a large scale and on reproducing the disaster with calculation. Then we improved programs to reproduce destruction phenomena in further detail. We structured a combined system with an individual element method and reproduced how the walls are destroyed.

In order to improve evacuation, an actual evacuation was studied in the field investigation held in FY 2009 and FY 2010. We found securing an emergency evacuation shelter important based on the behavioral principle in the evacuation planning. Such a behavioral principle includes the fact that people initiate an evacuation only when they actually see tsunami or hear the sound of tsunami.

We conducted a tsunami disaster simulation at Shimizu port in cooperation with the Shimizu Port Office to specifically move forward with port administrators and people who utilize ports, working to develop planning methods to promptly recover from the damage caused by a tsunami disaster.

The real time prediction technology of tsunamis using tsunami data obtained by GPS wave meters has been extended to immediately estimate tsunami inundation areas. In addition, we have developed a technology to estimate inundation areas in approximately several minutes after measurement of the first tsunami peak by the GPY wave meters.

Development of a new tsunami water gate has been studied for an upright floating gate in cooperation with the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) and the private sector to research a (stability of seabed scour) and to deliberate the influences such a gate would provide for its surroundings in FY 2010. From January 26 to 27, 2011, we held the 7th International Workshop on Coastal Disaster Prevention at Shinagawa in Tokyo in cooperation with MLIT and the Coastal Development Institute of Technology (CDIT). Further, we accepted three researchers from Chile through MLIT's exchange program with research agencies in developing countries and instructed tsunami computation technologies as well as soft and hard countermeasures against tsunamis in Japan. Through these activities, we have been promoting international cooperation on tsunami disaster prevention in the Asia-Pacific region.

In addition, we hold public lectures on tsunami disaster prevention sponsored by the government and communities in Japan, participate in the committee, and provide support with countermeasure planning against tsunamis in various areas at home as well as overseas through JICA technical cooperation projects.

Research Theme and Activities in FY 2010

3 Research on Storm Surge and Wave Disasters

Background and Objectives

In recent years, human lives and properties in coastal areas have been severely damaged by extraordinarily huge hurricanes and typhoons worldwide, and hence effective countermeasures against coastal flooding are required.

The objective of this research theme is to qualitatively and quantitatively investigate the mechanism of coastal flooding and resulting damage through field measurements, laboratory experiments and numerical simulations to propose effective countermeasures.

Research topics

The following five topics are focused in this research theme.

(1) Offshore wave properties

For reducing damage induced by coastal flooding, a new system to effectively utilize offshore wave data obtained through the Nationwide Ocean Wave information network for Ports and Harbours, NOWPHAS, is investigated. Furthermore, a numerical simulation model for predicting offshore waves is developed.

(2) Prediction of damage caused by flooding

Models for estimating wave transformation and wave pressure developed by PARI are improved and applied to the overtopping problem, to which the models were not previously applicable. The validities are examined based on laboratory experimental data.

(3) Prediction of structure deformation

For predicting the deformations of breakwaters and seawalls caused by coastal flooding, a numerical simulation model considering interactions among seawater, soil and structure is developed. A new soil improvement method is proposed to reduce the risk of structure failure.

(4) Influence of global warming on flooding

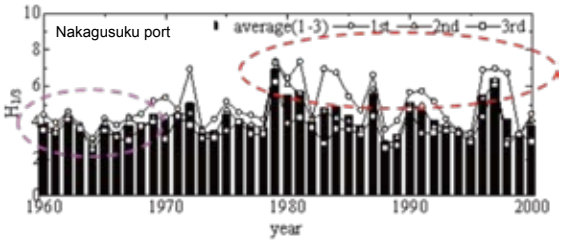
The influences of sea level rise and strengthened typhoons caused by global warming on the frequency and intensity of coastal flooding are numerically investigated.

(5) Database

Databases of water depths and numerical models are built and maintained.

Activities in FY 2010

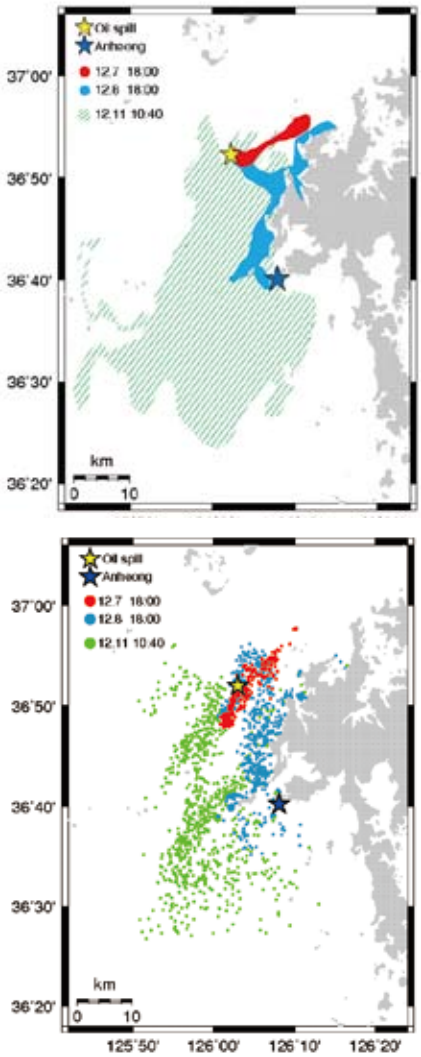
The third generation of a wave assessment model of WAM is applied to the estimated wave height calculation for the 40 years from 1960 to 2000. Based on the results, we have studied the emergence characteristics of the waves in the sea area around Japan. In Nakagusuku port, the annual average heights of the waves from the 1st to the 3rd had no big differences in the 1960s. However in the 1970s in some years, the 1st average height was outstanding compared to the 2nd and 3rd. Since the 1980s, a trend can be seen in which the 1st annual average height became tremendously larger and years with the outstanding 1st height emerged frequently.



The 1st (○), 2nd (Δ), and 3rd (□) distributions in the most significant wave height in Nakagusuku port
Changes in time of the annual 1st, 2nd, 3rd average wave height (bar graph)

In the development of oil spill simulation, a particle drifting model was proposed. Fay's equation, a conventional oil spreading model, was modified to fit the particle model by converting the time-dependent scale length into a repulsive velocity between oil particles.This modification enabled the model to address a continuous oil spill as well as a flush spill.

The particle model, combined with STOC-ML, was applied to an actual oil spill incident at Taean, South Korea. An excellent reproduction of the oil drift at the site was confirmed.



An observed range in the oil spill incident at Taean South Korea and a calculation result of its drift prediction

4 Research on Human-Oriented Disasters in Coastal Zones

Background and Objectives

Occurrence of an oil spill disaster makes widespread devastating damage inevitable as shown by the Nakhodka tanker accident. Furthermore, recovery efforts mainly depending on human power take extremely a longer time so that immediate recovery operations are highly demanded. Oil spill from a vessel and mixture with seawater causes its viscosity and specific density exponentially increase, and therefore vacuum suction needs enormous energy. In this way, it is difficult to transport spilled oil smoothly since it adheres firmly to the inside of pipes. To separate oil from contaminated seawater is quite difficult and takes a longer time to dispose of after recovery. Due to all the reasons mentioned above, it is hard to say effective countermeasures for oil recoveries have been established.

Meanwhile, there has been an increased demand for human-caused disaster measures including counterterrorism measures to ensure security since the terrorist attacks in the United States on September 11, 2001. In accordance with safety demands, though improvements in security at ports and harbors have been developed, counterterrorism measures under the sea lag behind land-based or ocean-surface measures.

In this research theme,Oil spill response R&D activities include:

-Development of high performance oil recovery devices such as a high-viscosity oil skimmer using steam-driven jet pump

-Oil spill drift forecast for effective oil recovery vessel operation

We have also worked with studies on developing technologies that would enable imaging of objects under the sea where optical cameras cannot be used due to turbidity.

Research topics

Due to the mixing with seawater, spilled oil from vessels becomes extremely highly viscous, which causes an impediment to recovery works. Thus, we have developed various equipments to automatically recover an oil slick, and will work on improving its efficiency in the future. Meantime, physicochemical methods of reducing viscosity are effective for oil disposal after recovery, so that we will continue to research on this matter. We will develop highly efficient vessel-based oil recovery equipment to adapt to the characteristics of the operating areas as well as to the MLIT vessels for environmental improvement. In order to contribute to efficient oil recovery, we will advance oil slick drift prediction technologies to keep tracking oil spills.

On the other hand, to improve security under the seawater where it is hard to discern with optical cameras, we will work on a development of detection technologies for unidentified objects under the sea such as acoustic technologies, which make it possible to image an unidentified small submarine.

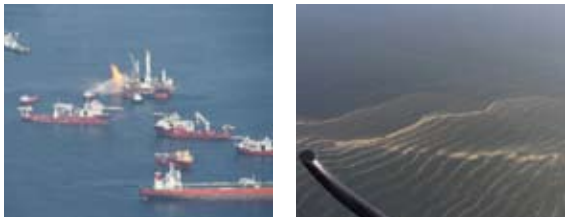
Activities in FY 2010

The following activities are held regarding measures for oil spills on the ocean surface.

We have implemented the following activities for countermeasures against oil spills on the ocean surface.

(1) Since FY 2009, we have continued to develop oil spill recovery equipment with an added dispersion method made for the oil recovery vessel Harima, owned by the Kinki Regional Bureau of MLIT.

(2) On April 20, 2010 when Deepwater Horizon, a semi-submerged oil drilling rig, exploded in the ocean, a huge amount of oil from the oil well gushed into the Gulf of Mexico and resulted in serious consequences on the Gulf as well as the coast. We sent our senior officers and researchers there to conduct a field investigation on the situation and to consider countermeasures against the damage.



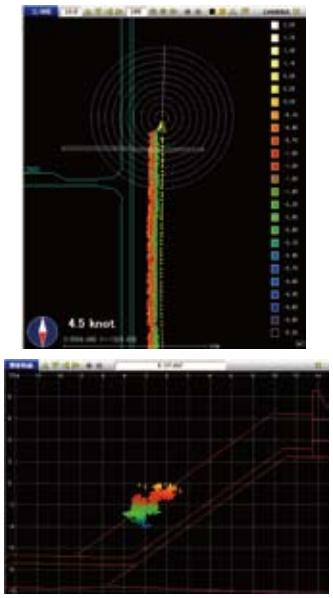
Investigation of the oil spill in the Gulf of Mexico (between July 11 and 18, 2010)
Left: Oil recovery work at the incident site
Right: Oil spill at the mouth of the Mississippi River

(3) As to a real time tracking oil spill device, we have improved automatic tracking buoys for oil spill drifting developed in the past years, and conducted field experiments offshore of Hiratsuka, Kanagawa Prefecture by collecting and sending information on marine phenomena on the sea surface, tracking artificial oil, and drifting a standard and the improved buoys and comparing their statuses.

(4) In order to improve the accuracy of the predictive simulation of oil spill drifts, we have established a basic model applicable for closed marine environments such as Tokyo Bay, and verified a drifting force due to wind force using a large scale test tank.

We conducted the following activities related to port security.

(1) We developed software for a device for capturing images and supporting measurements in turbid water. The software can analyze three dimensional data of the underwater portion of a structure using the measurement data and the correction sensor data (such as RTK-GPS, GPS-compass, and Clinometer) output by the device to display the geological data in synchronization with the real time map information. We conducted a sea experiment at the construction site of D-runway at Tokyo International Airport (Haneda Airport) to verify and evaluate the operation of the device and software. We also created an operation manual to implement the device.



Improvement of the device for capturing images and supporting measurement in turbid water (November 29, 2010)
Top: Overlaying the captured data on the CAD drawing
Below: Displaying the measurement data at an arbitrary cross-section

5 Research on Improving Water and Sediment Qualities in Enclosed Bays

Background and Objectives

The water quality and ecosystem in an enclosed marine area are affected by terrestrial inputs and the marine atmospheric boundary layer. They also varying depending on tidal exchange with the open sea and material exchange processes at the sediment-water interface as well as at the sea surface. For example, exchange of water mass at the bay entrance and oxygen consumption processes by sediments play important roles in formation of hypoxia, which is a typical water quality deterioration phenomenon in semi-enclosed coastal seas. Therefore, understanding the processes across these boundaries is necessary.

Following the ratification of the 1996 London Convention Protocol to regulate waste dumping into the sea, there is a need for control methods for siltation and technologies to promote beneficial use of dredged material from ports and harbors. To do this, fundamental knowledge on the physico-chemical processes at and around sediment surface is indispensable to understand sediment movements as well as the fate and transport of chemicals. Such fundamental information will be utilized to assess adverse effects of chemicals on benthic fauna and to develop countermeasures for contaminated sediments.

Research topics

Exchange processes at the bay entrance have been investigated through continuous measurements of flow field at the cross section and surface water quality at the mouth of Tokyo and Ise Bays by using instruments mounted on ferries. Differences in the tidal water exchange system at the mouth of the bays and variations of water quality such as formation of hypoxic water in the inner part of the bays have been compared.

The Coastal Bottom Boundary Eco-hydro Dynamics Experimental Flume was developed in FY 2006 to investigate transport processes of fine sediment under external forces. Experiments with intact sediments collected in Tokyo and Ariake bays by using a special container device were conducted. Intensive field observations in the two bays as well as laboratory experimental results have been utilized to develop a mathematical model on the re-suspension processes. Prediction of movements of sediments with a broader particle size distribution on the seashore has also been investigated by a model analysis.

In a research on the material cycling processes inside the sediments, analytical models on the dynamics of dissolved oxygen and nutrients in the benthic boundary layers have been developed. Field surveys of chemicals and benthic fauna in port and harbor sediments have been conducted to understand the fate and transport of chemicals and to evaluate adverse effects of chemicals on living organisms. Such fundamental knowledge has been further utilized to develop a scheme for countermeasures against sediment pollution as well as to promote the beneficial use of dredged material.

Activities in FY 2010

Analysis of the monitoring data of flow fields collected by ferryboats at the cross section of the mouth of Tokyo and Ise Bays in FY 2010 revealed that variations of a mixing intensity at the bay entrances caused a different formation of hypoxic water mass in respective bays. Topographic changes off Haneda monitored with video cameras for a long period also showed that tidal flats geometries were gradually restored after large-scale flooding of the river.

The dominant bio-chemical process on the formation of hypoxic water mass in the bottom layers of an enclosed bay has been identified as the oxygen consumption process by sediments. Analytical models on dynamics of dissolved oxygen and phosphorus in sediments as well as in the benthic boundary layers were formulated. For hydraulically smooth surfaces, in which modeling had been traditionally advanced, and also for rough surfaces, modeling has been successfully reproduced, showing the microstructure of oxygen distribution and sedimentary oxygen consumption processes with reasonable accuracy. We successfully performed field observations of sediment physical transport processes in the benthic boundary layer, and advective transport of fluid mud with high turbidity was also detected above the sea floor, which might be responsible for the sediment focusing phenomena in Tokyo Bay. In respect to this phenomenon, we analyzed the dynamics of fluid mud with a one-dimensional model in FY 2010.

We proposed an analytical method to predict variations of currents, tides and drifting sands caused by constructed coastal structures, such as piers and submerged levees, as well as of a grain sizes in sediment qualities along with these changes to estimate the amount of drifting sands at specific ports. This type of model can be employed to predict changes in coastal topography and variations in size distributions of sediment under a wide range of condition.

Finally, we also analyzed chemical survey results, which are already known as toxic substances for the coastal environment, in seawater, sediments and benthic fauna as well as fish to reveal that the bio-concentrations in organisms of higher trophic level highly differentiate depending on chemicals.

In the current environment in which new materials are increasingly manufactured and used, a preventative perspective requires estimating the adverse effects of chemicals already regulated and highly persistent chemical substances that may be subject to future measures.

In this regard, we have initiated research to develop a method of screening these emerging chemicals and also conducted a survey on several selected substances in Tokyo Bay and the Port of Nagoya.

Monitored blue tide in Tokyo Bay (near Makuhari at the Port of Chiba)

6 Research on Conservation and Restoration of Coastal Ecosystems

Background and Objectives

The legal regulation system related to the coastal environment has recently shifted in line with the change in public concern. Bay Renaissance Projects have been established successively for Tokyo, Osaka, Ise, and Hiroshima Bays. The restoration goal of each bay seems to have shifted from that of a clean sea to that of a sea with high productivity and biodiversity. The idea is also introduced in the "Act for the Promotion of Nature Restoration" enacted in FY 2002, and the draft report on "6th Total Load Pollution Control" submitted in 2005. Among several restoration options, construction of tidal flats and seaweed/seagrass beds as well as restoration of borrow pits, are appointed as the main target of restoration technologies to realize a coastal water environment with high productivity and biodiversity.

In light of this background, research on technology for conservation and restoration of coastal ecosystems as well as basic scientific studies on the structures and functions of ecosystems should be promoted as a restoration goal. To evaluate the effectiveness of each technology and to select appropriate measures suitable for the purposes, development of an innovative ecological model for coastal waters is also needed.

The report published by UN Environment Program (UNEP) in 2009 demonstrates that coastal ecosystems vigorously absorb CO_2 and that conservation of coastal ecosystems such as seaweed/seagrass beds is extremely important to mitigate climate changes. The concept is focused with the term of "blue carbon". However, the quantification of CO_2 absorption by coastal ecosystems remains unclear and developing methodology to promote CO_2 absorption is indispensable.

Research topics

We have conducted preliminary research in a variety of ecosystems to understand the structures and functions. By examining coastal ecosystems of tidal flats and seaweed beds, we are promoting research to pursue technology developments, which will achieve a healthy coastal environment through the construction and restoration of tidal flats as well as seaweed/seagrass beds. We are evaluating the effects of filling borrow pits with dredged sediments, which is a new promising method of beneficial use of dredged materials for coastal water restoration. We are incorporating bio-geophysical approaches, which are a novel idea for tidal flat ecosystem studies. The feeding behavior and food source of higher trophic level organisms such as migrating birds have been studied, because such animals are good indices of biodiversity. Including all these results, a next generation model for coastal ecosystem is to be formulated. In addition, we will suggest measures to promote CO_2 absorption by coastal ecosystems through field observation to understand the effectiveness.

Activities in FY 2010

In FY 2010, we promoted research on the relation between several bio-geophysical parameters such as suction and benthos activity in tidal flats as a part of studies on design and construction technologies of tidal flats with geotechnical approaches. We also performed a lab experiment on various benthos as well as conducted a field survey on the relation between geophysical dynamics and biological activities/ distributions in natural tidal flats. We examined selection behavior and habitat distribution of multiple benthos in sediment environment as well.

Observations on the feeding behavior and food sources of sandpipers and plovers, which are the major migrating birds to tidal flats in Japan, were performed in FY 2010. Biofilms on the surface of sediments were identified as a major diet for various small shorebirds, providing us with novel evolutionary insight. In addition, fish gathering in tidal flats was also revealed to feed on biofilms.

We initiated a special research program to evaluate the performance of CO_2 absorption in coastal ecosystems in FY 2009. We selected Lake Furen in Hokkaido as a field site and conducted a large-scale field observation during summer and winter to quantify absorption by organisms and abiotic environments in FY 2010. We detected that inorganic carbon was sequestrated in the benthic system of the Lake Furen all year round.

Focused on improving effective water environment by supplying high-oxygen water that had been experimented in Nakaumi as one of the research projects on restoration of borrow pits other than filling, the relation between the continuous period of aeration and effective restraint of phosphorus release rate was analyzed in FY 2010.

Further, the technology of filling borrow pits with dredged sediments to be planned in Hakata Bay was compared with the aeration method.

A new ecosystem model including a bacteria loop in semi-enclosed coastal seas was developed and completed in FY 2010. The model was linked with a simple benthic one and was applied to Ise Bay to reproduce long-term water quality variations. The formation process of density stratification and hypoxia were simulated in Ise Bay, and the bacterial activities contributing to the organic production and the oxygen consumption in the water column were quantified.

Sea grasses accumulated on a beach, forming a "blue carbon" sequestration and a CO_2 absorption survey on a tidal flat

7 Research on Comprehensive Coastal Management

Background and Objectives

Since Japanese coastlines are suffering from erosion of approximately 160 ha/year, comprehensive coastal management is required to prevent massive beach erosion. The objectives of this research are to develop numerical models for predicting morphological changes in the nearshore region on the basis of results of field measurements and to propose effective coastal zone management systems.

Research topics

(1) Field measurement

On the basis of field data of waves, currents, sediment sizes and bathymetry obtained at Hazaki Oceanographical Research Station (HORS) on the Hazaki coast of Japan, beach profile changes during 15- to 20-year periods, and temporal and spatial changes of bathymetry and sediment size near the shoreline are investigated. Morphological responses to the construction of detached and submerged breakwaters on other coasts are also examined.

(2) Numerical model

In order to predict bathymetry and beach profile changes in the nearshore region during severe and mild wave conditions, one- to three-dimensional models are developed.

(3) Coastal management

An effective sand bypassing system for reducing erosion in beaches and sedimentation in channels and basins is tested at various sites. Furthermore, a probabilistic approach employing a numerical model for which the validity is confirmed by field data is utilized to maintain beaches with appropriate widths.

Activities in FY 2010

In this research we applied the multiple regression model to the shoreline position data observed at the Hazaki coast in Ibaraki prefecture for a period of 22 years, and investigated the effect of bar and tide level fluctuation on shoreline fluctuation and the possibility of introducing new parameters to the model for shoreline fluctuation. The results revealed that shoreline fluctuation is affected by offshore wave energy flux, shoreline position, shore-side bar height, offshore bar height, highest tide level and highest rising tide velocity. The results of the reproduction of the shoreline position of the model that includes the shore-side bar height, offshore bar height, highest tide level, and highest rising tide velocity (Chart 1, No.1) clearly showed a regression tendency around 1993 (the bar was undeveloped on the offshore side) and a progression tendency from around 1996 to 1998 (the bar had been developed on the offshore side), compared with the model that does not include the aforementioned parameters (Chart 1,No.2). Such a model that includes these parameters was never considered in past studies. The respective coefficients show that the amount of shoreline progression increases as the bar is more developed, and that the bar prevents erosion. They also indicate that as the highest tide level rises, the shoreline regression amount increases. This is interpreted to indicate a phenomenon in which energy flux that reaches near the shoreline decreases due to the wave breaking accompanying the development of the bar. Also, it suggests that wave breaking occurs less and the waves hitting near the shoreline become stronger at higher tide levels.

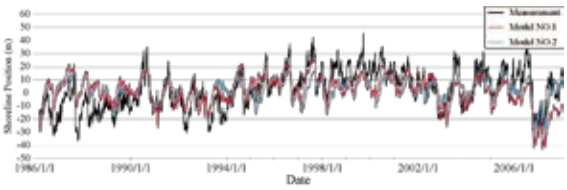


Chart 1. Results of reproduction using the measurements of shoreline positions and the shoreline fluctuation model (1986 to 2007)

To study the correlation between the geomorphological changes of the foreshore near the shoreline and the geomorphological changes in the offshore bar formation region, and the relation between these geomorphological changes and external forces, we studied the correlations among the below-mentioned variables by using long-term data obtained at Hazaki Oceanographical Research Station. The variables among which we studied the correlations with are the bar movement vate Ψ_1/dt, shoreline position y_s, shoreline position fluctuation vate dy_s/dt, offshore wave energy flux E_f and the annual average of PDO (Pacific Decadal Oscillation) index. As for the correlation between the geomorphological changes of the foreshore near the shoreline and the geomorphological changes in the offshore bar formation region, the correlation coefficient between the bar movement vate Ψ_1/dt and the shoreline position y_s was 0.31, but the two showed no correlation at a significance level of 5% (Chart 2). Similarly, no correlation was noted between the bar movement vate and the shoreline position fluctuation vate dys/dt, or between the shoreline position and the shoreline position fluctuation vate. Regarding the correlation between the geomorphological changes and external force, the shoreline position fluctuation vate had a negative correlation with offshore wave energy flux at a significance level of 1%. The long-term fluctuation of shoreline position, which is the integral value of shoreline position fluctuation vate, had a higher correlation coefficient with the PDO index than wave energy flux, and showed a negative correlation with the PDO index at a significance level of 5%.

	y_s	dy_s/dt	E_f	PDO
$d\psi_1/dt$	0.31	0.13	-0.19	-0.02
y_s		0	-0.32	-0.43
dy_s/dt			-0.56	0
E_f				-0.07

Chart 2. Correlation coefficients among respective variables

8

Research on Infrastructure Integration

Background and Objectives

Ports and airports function as freight transport complexes and recovery hubs for disasters, so efficient maintenance and improvement are required for port and airport facilities. However, recent circumstances due to the economic downturn and aging society have resulted in significant financial constraints. To properly maintain and develop social capital efficiently and effectively, we strongly need to apply a new design and building method for longer-life facilities through appropriate maintenance and management, as well as reduced life cycle costs for structures. Design methods of numerous structures have recently shifted to performance-based designs; developing and improving evaluation methods for structure performance is urgently needed.

Research topics

The following four topics were focused on in this research theme.

(1) Developments and improvements of performance verification technologies in port facilities

Effects on structures from long-period ocean waves; material characteristics such as soil, steel, and concrete; mechanism of deformability and failure behavior of structures and soil; interactions of waves and structures; and developments and improvements of performance-based design methods.

(2) Technology development of functional improvement of port facilities

Long-term durability of soil and structures; and decision-making for cargo handling availability at offshore ports.

(3) Technology development of functional improvement of airport pavement

Deformation prediction for airport pavement; improved method for de-bonding detection of asphalt concrete pavement; and upgraded design and quality control of overlay pavement.

(4) Computer program development applicable to practical design

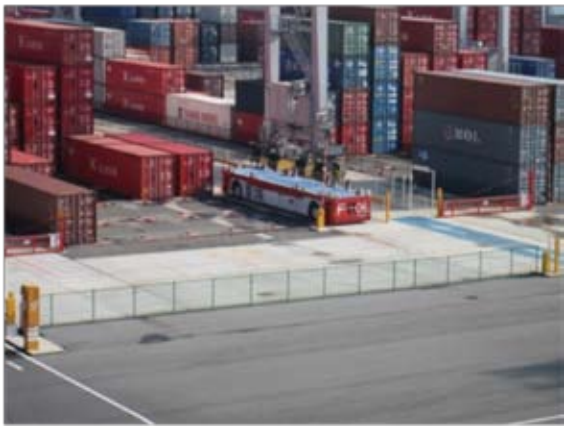
Activities in FY 2010

To maintain port and airport facilities efficiently and effectively, we mainly focused on research contributing to improving the performance-based design methods that have been introduced in 'Technical Standards and Commentaries for Port and Harbour Facilities In Japan'. Also the development of new buildings and installation methods for port and airport facilities was implemented.

Regarding performance verification technology in port facilities, we implemented research on accidental wave loads by long-period swells, long-term durability of concrete and steel, and examinations of performance verification methods of reinforced concrete by impact load. We also conducted studies on prediction methods of differential settlement and on the stability of group column type improved ground using solidified geomaterial.

In terms of technology development of functional improvement of port facilities, we launched research to evaluate high-standard container terminals and develop methods for deepening the water off quays, which mainly handle bulk cargos. We also conducted studies regarding rationalizing the anti-corrosion design of steel structures used at ports and harbors.

In relation to technology development of functional improvement of airport pavement, we studied the development of high durability asphalt concrete materials and technology for shortening the period of pavement overlaying.



We studied the simulation of interactive logic of adequate cargo handling at container terminals (terminal operations).

A method to reduce the ground temperature was researched.

Research Theme and Activities in FY 2010

9 Research on Life-Cycle Management of Infrastructure

Background and Objectives

There has been demand to secure the functions and performance of existing port and airport infrastructure above the required level, and to promote their beneficial use. Thus a management system consisting of inspection, diagnosis, evaluation, prediction and countermeasure techniques should be developed to realize life cycle management (LCM) of the infrastructure. In this research, a series of research projects are implemented to establish and achieve the systematization of life cycle management, including durability enhancement of materials, prediction of structural performance degradation, countermeasures and repair techniques.

Research topics

The following three topics were focused on in this research theme:

(1) Integrating inspection and diagnostic techniques

Improving the kinematic performance of the inspection (vehicle) was examined for integration and labor-saving of inspection and diagnosis of structures and materials in marine environments.New diagnostic techniques were investigated for inspecting structures and materials where many accumulated inspection results from real structures are analyzed through the probabilistic approach.

(2) Investigation of deterioration mechanism and its prediction

Deterioration mechanisms of materials constituting structures were investigated to establish prediction models of deterioration for each material. Also, the relationship between the recycling and life cycle of the materials was clarified to establish prediction and countermeasure techniques from material viewpoints. Deterioration process prediction under several exposure environments was also experimentally examined.

(3) Evaluation of structural performance degradation and quantification of repair effect

The evaluation models on structural performance degradation and performance recovery by repair were investigated by examining the mechanisms of structural performance degradation due to material deterioration.The evaluation scheme to quantify repair effects was examined by incorporating the NPV and LCC concepts for evaluation of the maintenance scenarios induced by the LCM system.

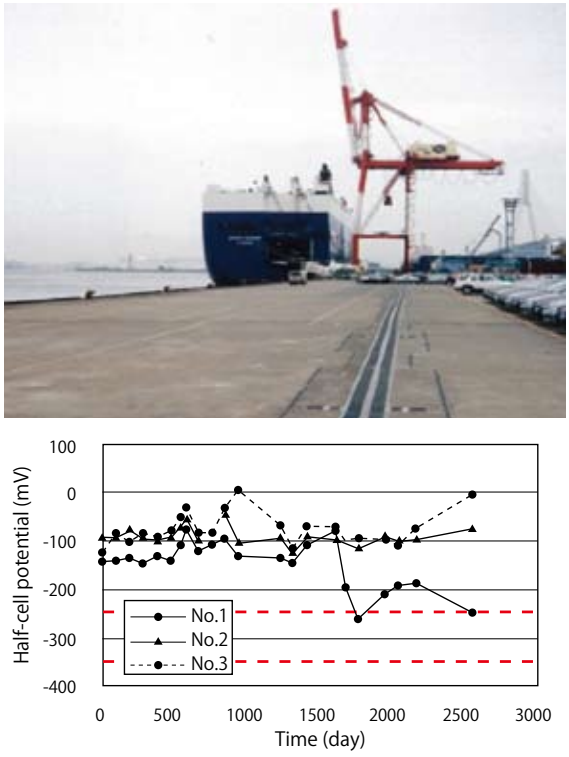
Activities in FY 2010

In order to secure a performance higher than demanded for the existing structures and to use stocks effectively and for long periods, it is indispensable to establish an LCM system that integrates the techniques of inspection and diagnosis of structures, evaluation and prediction of structural performance, and repair and reinforcement. Especially in the current Mid-term Plan period, we focused on the study to practically apply the LCM system to berthing facilities.

To achieve practical application of the LCM system, our study in FY 2010 focused on: 1) enhancing the techniques of inspection and diagnosis, 2) predicting the performance degradation of structures and quantifying the effect of repair.

To achieve Objective 1 above, we considered whether and how nondestructive testing techniques can be utilized to perform highly accurate investigation, diagnosis and monitoring of port and harbour structures. Especially, we studied how to evaluate corrosion of reinforcing steel in concrete using nondestructive testing techniques. We monitored half-cell potentials of reinforcing steel in concrete at a pier superstructure as shown in the figure below and succeeded in nondestructively detecting steel corrosion. We also studied a new technology that allows noncontact measurement of stress distribution in structural members.

To achieve Objective 2 above, we estimated how a maintenance scenario that adopts structural details considering maintenance simplification and implements preventive maintenance is economical, based on the LCC trial calculation using the already-established LCM system for pier structures. To aim at expanding the application range of the established LCM system, we studied to develop the LCM system for sheet-pile-type and gravity-type quay walls.



Monitoring of half-cell potentials of reinforcing steels in concrete of superstructure of pier

Moreover, we held the "International Seminar on Strategic Maintenance of Port Facilities" (Kuala Lumpur, Malaysia, February 2011) to promote and utilize the LCM technology in ASEAN countries. We created “Guidelines on Strategic Maintenance for Port Structures” as an outcome of the ASEAN-Japan Transport Partnership Projects and published the guidelines on our website. The guidelines provide the basic concept that should be followed when maintenance manuals for port structures are prepared in ASEAN countries and can be used as reference materials when port structures are inspected, diagnosed, repaired and reinforced in the countries.

10

Research on Unmanned Underwater Construction and Survey

Background and Objectives

The major part of underwater construction work in ports and at airports is currently implemented by divers' manual labor. In contrast to onshore work, visual information is mostly limited due to unclear seawater or muddiness caused by the construction work itself. In addition, impact from waves and tidal currents significantly constrains the safety and efficiency of under water operations. The aging and shortage of divers in the future is also of significant concern in the light of the decreasing younger working population, which is threatening the underwater construction work industry. Since April 2007 when the Basic Act on Ocean Policy was enacted, public interest in marine issues has increased. The marine activities of oil recovery as environmental improvement, development and maintenance of shipping channels, and of mooring GPS-mounted buoys have been nationally applied. The ocean surrounding Japan, however, is a deepwater and large-wave area, so that manned operations in this area are limited.

Considering the recent severe fiscal situation and the appropriate maintenance of deteriorated port structures, repair work is expected to increase. The development of unmanned technologies for underwater operations is essential following the enactment of Basic Act on Ocean Policy.

Research topics

We have been developing non-contact thickness measurement techniques, which do not require removing the marine organisms attached to the structures, for performing indispensable measurement of board thickness to examine deterioration in steel structures in port areas.

We will also develop unmanned examination systems for mooring devices for GPS-mounted buoys set at a depth of around 200 meters.

Development of chain-net recovery equipment, which enables safe recovery of wave-dissipating blocks from under the sea without any divers, is expected to be conducted.

We will achieve multifunctional safe underwater operations by developing operation manipulators based on the system innovated over the past years for underwater backhoe manipulator techniques.

Activities in FY 2010

Based on the results of studies conducted up until the previous fiscal year, we know how to apply chain-net recovery equipment to the relocation of large-size blocks that exceed 50 tons.

We solicited private sectors for joint research of noncontact measuring equipment for steel structures that utilizes ultrasonic waves to allow such equipment to be highly applicable to sites and to be more practical. We started joint study on developing tools that are applicable to various structures and investigating guidelines for handling obtained data to be utilized for structure maintenance and management.

Examination systems for mooring devices for GPS-mounted buoys were used for actual work procedure examinations in the sea off the coast of Kamaishi, Iwate Prefecture. Through the actual experiments, the effectiveness in the sea was evaluated and verified.

Regarding the remote control system for underwater backhoes, two of our researchers visited South Korea to lecture about the achievements of the study at the Korea Ocean Research and Development Institute (KORDI) as well as to exchange opinions with local researchers. After that, Korean researchers visited Japan to conduct further opinion exchange.

Opinion exchange regarding underwater backhoes

Interactive meeting between KORDI staff and PARI executives

Research Theme and Activities in FY 2010

11 Research on Ocean Utilization and Environment-Friendly Infrastructure Technology

Background and Objectives

Effectively using ocean space is crucial for Japan as a maritime country. Technological development to effectively utilize the huge ocean space is indispensable for the economy of the future. Since more severe waves and wind due to frequent typhoons must be considered, however, technological development is needed to overcome such severe natural conditions.

Research topics

Potential waste disposal sites are available only in shallow sea areas that are inevitably close to mega-cities due to land space being significantly limited by the geographical features of Japan. Therefore, developing evaluation technology of long-term stability of waste disposal sites is required to secure the ocean environment from the risk of large-scale spills. Developing recycling technology is also essential for safe and secure human life.

To reduce human-oriented adverse environmental impact on the ocean, recycling technology must be developed, especially for the dredged and disposed material in the coastal area.

The following three topics are focused on in this research theme:

(1) Research on effectively using ocean space.

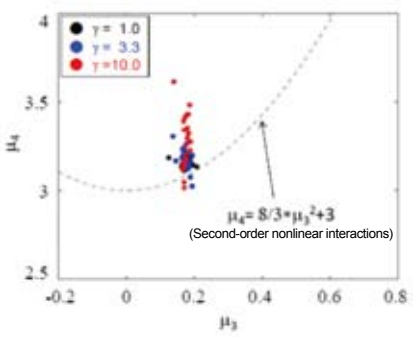
(2) Research on evaluating the long-term stability of waste disposal sites in the sea.

(3) Research on mitigating adverse environmental impact.

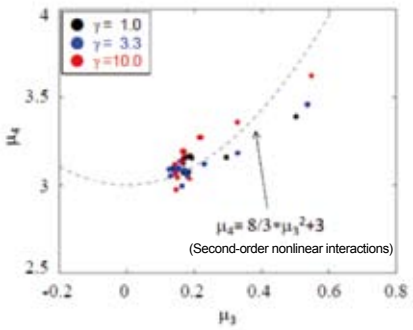
Activities in FY 2010

In researching the properties of extreme waves, we performed cross-sectional experiments on swells that were propagated from offshore to the shoreline, considering that swells with a period of over 14 seconds that act on an offshore platform constructed on a continental shelf, shallower than 200m, are shallow water waves. Especially, previous research has shown that the spectrum of swells with a long period has large kurtosis and directional spreading and that freak waves are generated easily in a deep water region. We therefore studied the behavior and observed specifications of waves in a shallow water region and a very shallow water region and found that second-order nonlinear interactions due to wave shoaling dominated in a shallow water region, shallower than kh=1.36, and that skewness μ3 and kurtosis μ4 increased with a specific relationship.

(Figures a and b).



(a) Constant depth (deep water region)



(b) Sloping depth with constant gradient

Relationship between skewness μ3 and kurtosis μ4

In the research on quality control techniques for water-proof quay walls at a waste disposal site in the sea, we studied data processing technology to use construction control information for quality control information. About water-proof quay walls at a waste disposal site in the sea, we studied the correlation between a change in concrete casting speed, current of a vibro-hammer and insulation resistance of monitoring wires (reflects damage to rubber) in water-proof rubber. In the research on reusing recycled geomaterial in dredged soil, we changed the conditions to perform experiments on cement solidified soil containing no bubbles.

Water-proof quay wall at a waste disposal site in the sea

Fundamental and Exploratory Research

Fundamental Research in FY 2010

1	Analyze and collate observations and records of strong motions at port and airport areas
2	Earthquake disaster investigations
3	Develop verification set-up methods of ground motions appropriate for facilities with considerable extension
4	Work on soil dynamic characteristics in the vicinity of fracture stress conditions
5	The evaluation and improvement of seismic capacity of existing port and shore facilities
6	Establishing experimental technologies for interaction among water / ground / structures in a centrifugal field
7	Observations and examinations on meteorological and hydrographic conditions at Ashika Island, as well as preparation for materials and statistic reports by an integrated processed analysis on data from observations of nationwide coastal waves, tsunami, tidal levels and wind conditions
8	Suggestions for controlling methods of new persistent chemicals accumulating in the inner bay
9	Work with numerical indices on stability and soundness of coastal nature foundation
10	Full-time continuous monitoring of the environment of the closed inner bay and statistical analysis of the results
11	Preparing diagnosis charts for the living environment of living creatures by developing geotechnical approaches on the tidal flat
12	Research and experiments on the feeding habitat of higher order organisms in coastal ecosystems
13	Research and experiments on enhancing CO_2 uptake of coastal ecosystems
14	Observations and analyses on terrain variation and sediment transport at a littoral region such as the Hazaki ocean research center
15	Evaluation on long-period durability of cement, steel, and other materials through exposure tests
16	Suggestions for a prediction method of differential settlement to maintain and manage landfill
17	Efficiency of corrosion control procedures and designs in port structures
18	Research on reusing recycled geomaterial in dredged soil

Exploratory Research in FY 2010

1	Developing contact inspection and diagnosis methods to detect deterioration and degradation of steel structures of port facilities
2	Developing a new measurement method for residual mass of sacrificial anode
3	The mechanism of evacuation behavior using brain activity
4	Multi-time monitoring on port structures using optical measurements

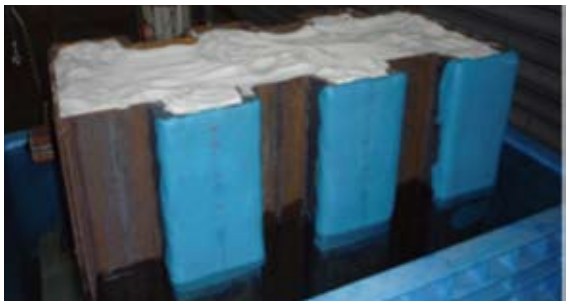
Examples of Exploratory Research

Developing contact inspection and diagnosis methods for deterioration/degradation of steel structures of port facilities

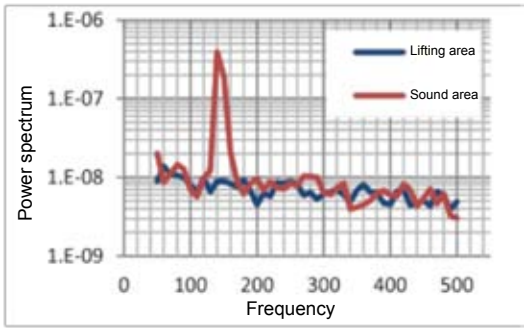
Inspection and diagnosis are vital to adequately maintain port structures. However, most current inspection methods, especially for steel sheet piles and steel pipe piles, are insufficient; more efficient and simplified inspection methods are urgently needed. For this reason, we have developed technology for a simplified inspection and diagnosis method that efficiently detects degraded portions of steel materials.

We evaluate the change in elastic wave characteristics based on the presence or absence of degradation of steel materials and anti-corrosion coating, and studied the best possible detection method for types of degradation. In addition, an inspection method using infrared images is considered as a more simplified way to detect such degradation.

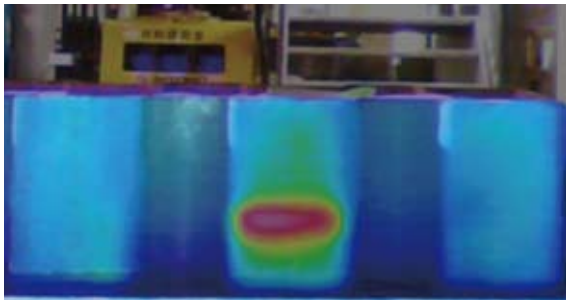
Determining whether steel materials or anti-corrosion coating have degraded or not from viewing the input waveform of a hit from an impact hammer is difficult. Understanding the response waveform of target parts by an acoustic emission sensor is easier. Moreover, anti-corrosion coating can easily be detected by lifting an area with infrared images, which is an effective inspection method for corrosion.



Steel sheet pile specimen



Response waveform of anticorrosion coating



Detection of lifting area of anti-corrosion coating using infrared images

Published Research Papers

Number of Refereed Papers in FY 2010

Year	Number of Papers (in Japanese)	Number of Papers (in English)	Total	Ratio of Papers in Japanese to English
FY 2010	69	66	135	48.9%

Papers Published in the "Report of PARI" in FY 2010

No.	Title	Author(s)	Month / Year
49-2 (1)	Experimental study on ground stability improved by the SCP method using solidified granular material	Hidenori TAKAHASHI,Yoshiyuki MORIKAWA	June 2010
49-2 (2)	Examining Field Application of the Solidification Acceleration Method of Granulated Blast Furnace Slag	Yoshiaki KIKUCHI,Shoji OKA,Taka-aki MIZUTANI	June 2010
49-2 (3)	One-Dimensional Model for Undertow and Longshore Current Velocities in the Surf Zone	Yoshiaki KURIYAMA	June 2010
49-2 (4)	Numerical Simulation of Cyclic Seaward Bar Migration	Yoshiaki KURIYAMA	June 2010
49-2 (5)	Prediction of Cross-Shore Distribution of Longshore Sediment Transport Rate in and outside the Surf Zone	Yoshiaki KURIYAMA	June 2010
49-2 (6)	Fine sediment transport process during a storm event induced by a typhoon in Tokyo Bay	Yasuyuki NAKAGAWA,Ryuichi ARIJI	June 2010
49-2 (7)	Hysteresis loop model for estimating coastal water temperatures: Using the buoy monitoring data in Mikawa Bay, Japan	Hong Yeon CHO・Kojiro SUZUKI Yoshiyuki NAKAMURA	June 2010
49-3 (1)	Assessment of shear velocity determinations from referring to DO microprofiles	Tetsunori INOUE,Ronnie N. GLUD Henrik STAHL,Andrew HUME	September 2010
49-3 (2)	Seed dispersal supporting areal expansion of seagrass meadows	Shinya HOSOKAWA,Masahiro NAKAOKA, Eiichi MIYOSHI,Tomohiro KUWAE	September 2010
49-3 (3)	Block Removal Using Holding Device with a Chain Net and its Modeling	Hitoshi NOGUCHI	September 2010
49-3 (4)	Liquefaction prediction method considering seismic motion wave forms	Hiroyuki YAMAZAKI,Syoichi EMOTO	September 2010
49-3 (5)	Rupture process of recent crustal earthquakes in Japan estimated by waveform inversion	Atsushi NOZU	September 2010
49-3 (6)	MASW technology and intertidal flat stratigraphy evaluation	Yoichi WATABE,Shinji SASSA,Tomohiro KUWAE, Sunbo YAN,Masanori TANAKA	September 2010
49-4 (1)	The GPS buoy network and shallow-water transformation of the 2010 Chilean Tsunami on the Japanese coast	Hiroyasu KAWAI,Makoto SATO, Toshihiko NAGAI,Koji KAWAGUCHI	December 2010
50-1 (1)	Effect of Surface Improvement Layer on Internal Stability of Group Column Type Deep Mixing Improved Ground under Embankment Loading	Masaki KITAZUME	March 2011

Papers Published in the "Technical Note of PARI" in FY 2010

No.	Title	Author(s)	Month / Year
No.1213	Model Experiments and Numerical Simulation on Tsunami Impact on a Moored Ship	Haruo YONEYAMA,Keiichi OHGAKI,Muneo TSUDA, Akio KURIHARA,Tetsuya HIRAISHI,Toshio AONO	June 2010
No.1214	Site amplification factor for strong-motion sites in Northern Hokkaido, Japan: Based on spectral inversion technique	Atsushi NOZU,Takahiro SUGANO	June 2010
No.1215	International comparison on port development project financial sources for optimum Life-Cycle Management	Masahiko FURUICHI	June 2010
No.1216	Structural behavior of reinforced concrete slabs subjected to repeated impact loads	Mitsuyasu IWANAMI,Taku MATSUBAYASHI,Yuichiro KAWABATA	June 2010
No.1217	Repair and strengthening of port steel structures using carbon fiber reinforced polymer	Ema KATO,Akihiro TATEISHI, Mitsuyasu IWANAMI,Hiroshi YOKOTA,Akira KOBAYASHI	June 2010
No.1218	Experiments on Wave Overtopping Rate and Wave Pressure on Seawalls from Long Period Swells	Hiroaki KASHIMA,Katsuya HIRAYAMA	September 2010
No.1219	Management of hazardous chemicals in port and harbor sediments	Ryoji NAITO	December 2010
No.1220	Soil Densification Design Method as Liquefaction Countermeasures	Hiroyuki YAMAZAKI	December 2010
No.1221	Removal of Objects from Seabed Using a Holding Device with a Chain and Its Modeling	Hitoshi NOGUCHI	December 2010
No.1222	Research on Tele-operated Support System of Underwater Excavator	Taketsugu HIRABAYASHI	December 2010
No.1223	Annual Report on Strong-Motion Earthquake Records in Japanese Ports (2009).	Atsushi NOZU,Jun WAKAI	December 2010
No.1224	Joint Survey for 2010 Chilean Earthquake and Tsunami Disaster in Ports and Coasts	Shigeo TAKAHASHI,Takahiro SUGANO,Takashi TOMITA Taro ARIKAWA,Daisuke TATSUMI,Hiroaki KASHIMA, Susumu MURATA,Yoshihiro MATSUOKA,Tomoaki NAKAMURA	December 2010
No.1225	Probabilistic Approach for Structural Performance Evaluation of Port RC Structure	Ema KATO,Yuichiro KAWABATA,Mitsuyasu IWANAMI	December 2010
No.1226	Annual Report on Nationwide Ocean Wave Information Network for Ports and Harbors (NOWPHAS 2009)	Hiroyasu KAWAI,Makoto SATOH, Koji KAWAGUCHI,Katsumi SEKI	March 2011
No.1227	Shake Table Test in 1g Gravitational Field and Effective Stress Analysis for Dynamic Deformation Characteristics of Breakwater Foundation	Yosuke OHYA,Masahiro TAKENOBU, Takahiro SUGANO,Eiji KOHAMA	March 2011
No.1228	Estimation of Tsunami Source and Numerical Simulation for 2010 Chilean Tsunami	Daisuke TATSUMI,Takashi TOMITA	March 2011
No.1229	Experimental Study on Energy Dissipation at Rubble Mound Breakwater	Katsumi SEKI,Taro ARIKAWA, Masahiro MIZUTANI,Katsuya HIRAYAMA	March 2011
No.1230	Fundamental Study on Durability of Hat-Type Steel-Sheet-Pile Protected by Heavy Duty Coating	Yoshikazu AKIRA,Toru YAMAJI,Mitsuyasu IWANAMI Noriyoshi HARADA,Nobuki YOSHIZAKI,Masatsugu MURASE Isao SAITO,Takayuki KAMIMURA,Takuya KITAMURA	March 2011

Public Relations

Lecture Meetings for the General Public

A total of 13 lecture meetings was held for the general public in FY 2010 (two in Tokyo, one each in the cities of Yokosuka, Sapporo, Sendai, Yokohama, Niigata, Nagoya, Kobe, Hiroshima, Takamatsu, Fukuoka and Naha).

Among them, twelve lecture meetings were certified as CPD programs, by which credits of continuing professional development (CPD) implemented by the Japan Society of Civil Engineers could be earned.

Lecture meeting for the general public in Sendai (September 15, 2010)

Lecture meeting for the general public in Nagoya (November 4, 2010)

Open House

Open house was conducted twice in summer and fall in FY 2010, orienting children on school vacation and their families to obtain some experience at the research institution in summer, as well as high school students and those older to learn about the most recent studies and achievements in the fall. In addition to the open house program, a total of 1,709 people visited the institution in FY 2009.

Especially during the summer open house, we demonstrated tests and held exhibitions such as the world's largest artificial tsunami, liquefaction reproduction, and underwater work robot. We also implemented events including a stamp rally for promoting the interest of children and their parents in the institute tour, providing opportunities to touch living creatures on a dry beach by hand.

Summer open house (July 31, 2010)

Fall open house (November 25, 2010)

Outreach Activities Through "Disaster College for Kids"

Outreach Activities through "Yokosuka Children University for Disaster Prevention"

In FY 2010 we participated in the "Yokosuka Children University for Disaster Prevention," a summertime disaster-prevention educational activity for elementary school students in Yokosuka city. The research institute accepted three groups of elementary school students (a total of 209 persons) and provided disaster-prevention education.

Disaster prevention class at the Children University for Disaster Prevention (August 10, 2010)

Media Appearance

We actively participated in TV programs and press interviews. In fiscal 2010, the programs that introduced the research institute's research activities were broadcast 30 times.

Especially from immediately after the Pacific coast of Tohoku Earthquake on March 11, 2011, we frequently received inquiries and requests for interviews from many TV stations and newspaper publishers, and we responded to each attentively. In a special news report on the day following the earthquake, which was on the morning of the 12th, the Director General of the Asia-Pacific Center for Coastal Disaster Research explained the damage mechanism due to the tsunami and the state of the affected areas.

NHKBS-hi-
"Einstein's Eyes"
(June 6, 2010)

Fuji TV
"FNN Special News Report"
(March 12, 2011)

NHK Sogo
"Ohayo Nippon
(Good Morning Japan)"
(March 29, 2011)

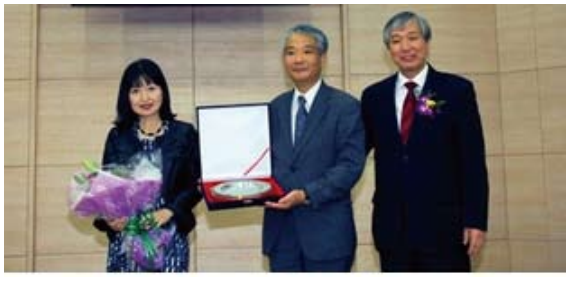
Fuji TV
"FNN Super News"
(March 31, 2011)

Outstanding Research Activities

Awards in FY 2010

No.	Name	Award	Institution	Month/Year
1	Tomohiro KUWAE	Education, Culture, Sports, Science and Technology Minister Young Scientist Award	Ministry of Education, Culture, Sports, Science and Technology	April 2010
2	Shigeo TAKAHASHI	Japan Society of Civil Engineers Outstanding Research Performance Award	Japan Society of Civil Engineers (JSCE)	May 2010
3	Yuichiro KAWABATA	Japan Society of Civil Engineers Yoshida Research Encouragement Award	Japan Society of Civil Engineers (JSCE)	May 2010
4	Takashi TOMITA	Japan Society of Civil Engineers International Activity Encouragement Award	Japan Society of Civil Engineers (JSCE)	May 2010
5	Publication "TSUNAMI" (English and Indonesian versions)	Japan Society of Civil Engineers Publishing Culture Award	Japan Society of Civil Engineers (JSCE)	May 2010
6	Mitsuyasu IWANAMI Ema KATO Hiroshi YOKOTA	The Ports & Harbors Association of Japan Best Paper Award	Japan Society of Civil Engineers	May 2010
7	Taku MATSUBAYASHI	Japan Concrete Institute Encouragement Award	Japan Concrete Institute	May 2010
8	Yoshikazu AKIRA	Japan Concrete Institute Encouragement Award	Japan Concrete Institute	May 2010
9	Tetsuya SHIRAISHI Sayuri MATSUMOTO Natsuki YOSHIZUMI Kageyoshi KATAKURA	Marine Acoustics Society of Japan Outstanding Performance Award	(NPO) Marine Acoustics Society of Japan	May 2010
10	Tetsuya SHIRAISHI Natsuki YOSHIZUMI	The 12th Outstanding Construction Engineering Development Award	Japan Institute of Construction Engineering (JICE) Coastal Development Institute of Technology (CDIT)	July 2010
11	Taketsugu HIRABAYASHI	The Virtual Reality Society of Japan Outstanding Paper Award	(NPO) The Virtual Reality Society of Japan	September 2010
12	Shigeo TAKAHASHI	Techno-Ocean Award	Techno-Ocean Network	October 2010
13	Taketsugu HIRABAYASHI	Excellence Award, Poster Session Division, Construction Engineering Research Conference, Ministry of Land, Infrastructure, Transport and Tourism	Ministry of Land, Infrastructure, Transport and Tourism	October 2010
14	Toshihiko NAGAI	Korea Ocean Research & Development Institute Plaque of Merit	Korea Ocean Research & Development Institute	October 2010
15	Yuichiro KAWABATA	Japan Society of Civil Engineers Annual Meeting, the 65th Annual Scientific Lecture Meeting Outstanding Lecturer Award	Japan Society of Civil Engineers (JSCE)	November 2010
16	Yoshikazu AKIRA	Japan Society of Civil Engineers Annual Meeting, the 65th Annual Scientific Lecture Meeting Outstanding Lecturer Award	Japan Society of Civil Engineers (JSCE)	November 2010
17	Taka-aki MIZUTANI	Japan Society of Civil Engineers Annual Meeting, the 65th Annual Scientific Lecture Meeting Outstanding Lecturer Award	Japan Society of Civil Engineers (JSCE)	November 2010
18	So HIRAI	The 7th Japanese Geotechnical Society Kanto Branch Presentation Meeting, Outstanding Presenter Award	The Japanese Geotechnical Society	November 2010
19	Mitsuyasu IWANAMI Ema KATO Yuichiro KAWABATA	Best Paper Award	2nd International Conference on Durability of Concrete Structures	November 2010
20	Sayuri MATSUMOTO Natsuki YOSHIZUMI	Hydrographic Technology Encouragement Award	Japan Hydrographic Association	February 2011

TECHNO-OCEAN AWARD(October 15, 2010)



Korea Ocean Research & Development Institute Plaque of Merit (October 29, 2010)

Research Topics

PARI's Response to the 2011 Great East Japan Earthquake

(1) PARI's response immediately after the earthquake

The Tohoku Region Pacific Coast Earthquake, which occurred around 14:46 on March 11, 2011, recorded the largest magnitude in Japan's history of seismological observation – 9.0. The earthquake caused huge tsunamis mainly from the Tohoku region to the Kanto region on the Pacific Ocean side; many people died or became missing. The ports and airports in these regions were also severely damaged due to flooding by tsunamis, and the clashing and scattering of debris such as destroyed houses, cars, boats, ships and lumber.

PARI immediately established the disaster countermeasures office, and promptly sent investigation teams to ports and airports in the Tohoku region and Ibaraki prefecture, upon request from the Ministry of Land, Infrastructure, Transport and Tourism. These teams investigated the damage due to the earthquake and tsunamis regarding the ports, airports and their surroundings, and examined how they could be restored. Furthermore, we conducted joint research with related societies including the Japan Society of Civil Engineers, Japan Association for Earthquake Engineering and American Society of Civil Engineers (ASCE). By the end of June 2011, a total of 61 researchers were sent to the ports and airports in the disaster-stricken areas.

State of investigation of the run-up height by a range finder

sendai shiogama port

(2) Report and publication of the research results

We published the results of the local research as needed on PARI's homepage as a flash report. Also, we organized the research results, published reports, and officially announced them in magazines, lecture meetings, etc.

- Publication of the Port and Airport Research Institute's information (April 28, 2011)

Made a flash report of the research on the damage from the earthquake and tsunamis to the ports, coasts, and airports in the 2011 Great East Japan Earthquake.

Distributed pamphlets, and presented information on the PARI's homepage

- Conducted the port, airport and fishery harbor technology lecture meeting in Tokyo (May 11, 2011).

We conducted a lecture meeting regarding the results of the research on the damage from the earthquake disaster for researchers and the general public (about 1,000 attendants).

- Examples of the lectures conducted in Japan

Conducted many lecture meetings around Japan, such as:

"Lecture meeting at the Japan Institute for Port Policy Studies of the Ports and Harbours Association of Japan"

"Ise Bay tsunami disaster prevention symposium"

- Examples of lectures conducted abroad

"Busan general assembly of the International Association of Ports and Harbors (IAPH)"

"American Society of Civil Engineers (ASCE)"

Port, airport, fishery harbor technology lecture meeting (May 2011)

Report by Acting-President Fujita at IAPH general assembly (May 2011)

(3) Participation in technical committees, etc., as members

We participated, as committee members, in conferences (expert examination committee of the Central Disaster Prevention Council and others) established with the purpose of elucidating the damage mechanism from the recent disaster and studying future disaster prevention measures.

Also, we received many requests for interviews on earthquakes and tsunamis, and our researchers gave explanations on TV shows and in other media.

(Refer to P. 18 "Media Appearances")

Research Topics

Major Topics in FY 2009

I. Hosting / Co-hosting of International Conferences, etc.

The Port and Airport Research Institute (PARI) promotes widely ranging exchanges with researchers both in Japan and abroad, and collaboration with research agencies both in Japan and abroad, through hosting, co-hosting, actively participating in international conferences, etc., and promoting research overseas. Examples of international conferences, etc., hosted or co-hosted by PARI in fiscal 2010 are as follows:

(1) International Symposium on Recent and Future Technologies in Coastal Development (December 14 to 16, 2010: Yokohama city)

In recent years, large-scale projects in which international hub ports/harbours and international hub airports are built in coastal regions have been actively implemented both in Japan and abroad. Japan has also promoted and carried out large-scale projects such as the Kansai International Airport and the Tokyo International Airport (Haneda Airport). Therefore, we conducted a symposium in cooperation with the Kanto Regional Development Bureau of the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) to review past coastal region development projects and the technology development that supported them, and to discuss the latest trends and future directions of technology development.

Many students and young engineers in the private sector also attended this symposium, providing an opportunity to educate young engineers and engineering students and to improve technology through academic discussion.

International Symposium on Recent and Future Technologies in Coastal Development

(2) The 7th International Workshop on Coastal Disaster Prevention (January 26, 27, 2011：Tokyo)

We conducted this conference in cooperation with MLIT and the Coastal Development Institute of Technology. The conference was attended by researchers, engineers, and administration personnel, etc. from 11 countries: America, Italy, Indonesia, Australia, Sri Lanka, Taiwan, Chile, Turkey, Japan, Fiji and Mexico.

In this workshop, attendees discussed how to respond to tsunami disasters that may occur in the future, including restoration after disasters, aiming to improve tsunami disaster prevention capabilities in the world, through introducing past efforts in Japan and other countries to prevent and recover from disasters. In addition, personnel in charge of disaster prevention in national and local governments presented their work on disaster prevention.

International Workshop on Coastal Disaster Prevention

(3) International seminar on the strategic maintenance and management of harbour and port facilities

On February 22, 2011, in Kuala Lumpur, Malaysia, we conducted an international seminar on the strategic maintenance and management of harbour and port facilities in collaboration with the Port Technology Group. The group engages in activities under 21 Japan-ASEAN transport collaboration programs, which MLIT has implemented since 2002. The seminar was held jointly with MLIT, the Ocean Policy Research Foundation and Malaysia's Ministry of Transport.

With attendance by a total of 54 persons including researchers and engineers from Malaysia, Japan and eight ASEAN countries, opinions were actively exchanged at the seminar. PARI plays an important role in this seminar; four researchers from the institute presented their research.

II. Implementation of Administrative Support

PARI conducts funded research on technical issues faced by national and local governments, sending researchers to technical committees that they establish. PARI has worked to solve technical issues in implementing public projects.

For the re-expansion project for Tokyo International Airport (Haneda Airport), we established a project team within PARI and have worked in cooperation with its implementing agency, the Kanto Regional Development Bureau of MLIT. Toward its implementation, we clarified points of concern in its design, as well as technical issues and their solutions.

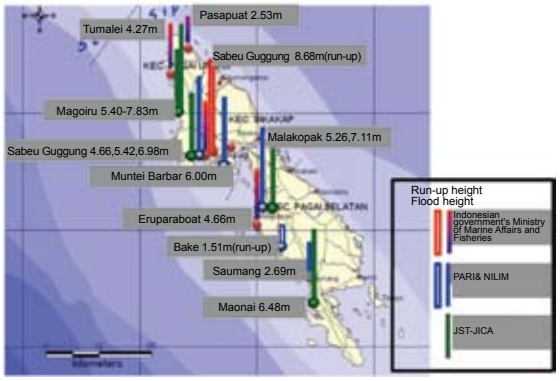
As for the re-expansion project for Haneda Airport, for which PARI provided full support, runway D began operating in October 2010. We will continue to provide technical support for the proper long-term maintenance and management of the airport.

Provided by Tokyo International (Haneda) Airport: JV, Runway D, Haneda re-expansion

III Local Research/Technical Support in the Event of an Earthquake/Tsunami Overseas

PARI researched the 2011 Tohoku Region Pacific Coast Earthquake and also sent researchers to overseas areas that have suffered from earthquakes and tsunamis.

Aiming to investigate the tsunamis and resulting damage on the Southern Sumatra Island (Mentawai) Indonesia Earthquake (M 7.7), which occurred on October 25, 2010 and caused over 500 deaths or missing people, we sent research officers from PARI to the affected area. We also conducted joint research with the Indonesian government's Ministry of Marine Affairs and Fisheries, and the JST-JICA team, which consists of the Japan Science and Technology Agency (JST) and the Japan International Cooperation Agency (JICA) (November 5 to 7, 2010). In this research, we examined the height of the tsunamis by surveying their traces on the South Pagai and North Pagai Islands. We also interviewed residents to determine how the tsunamis hit the areas and how people evacuated.



Height of tsunami traces based on local research

IV Conclusion of Research Cooperation Agreements with Research Agencies

PARI has increasingly collaborated with research agencies both in Japan and abroad, aiming to improve the quality and efficiency of research. We have already concluded cooperation agreements with 17 agencies.

Based on the agreements, we implemented activities such as interactions among researchers, joint research, lecture meetings, and exchange of scholarly information and research publications in common fields between PARI and other research agencies.

In FY 2010, we concluded the following research cooperation agreements:

In July 2010, we concluded a research cooperation agreement with the Network for Earthquake Engineering Simulation (NEES) of the U.S., in order to promote joint research using NEES's 14 earthquake- and tsunami-related research facilities and PARI's three facilities.

Concluded a research cooperation agreement with NEES

Port and Airport Research Institute (PARI)

−Aiming at technologies to contribute to the world−

Independent Administrative Institution

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