

# RESEARCH&DEVELOPMENT

Operations

## Future-Oriented R&D



### 1 Research and Development Management Group

We believe it is the mission of Toa Corporation to respond to the demands of society, which change together with the times, and as a construction company, to continuously make appropriate contributions to society. At Toa, we thoroughly grasp the changes in the state of the market environment and carefully deliberate the direction of the research and development carried out at the Research and Development Center. Moreover, it is also necessary for us to broaden our focus on society and look abroad as well. With regard to the research and development results, activities in overseas markets are promoted through the International Technology Group, and the results from such activities are evaluated and feedback is given to be applied to subsequent research and development efforts.

### 2 International Technology Group

The International Technology Group undertakes efforts to put the technologies developed by each of the specialized technology groups to use in Toa Corporation's businesses overseas. Furthermore, in order to put the information gained through such businesses activities to effective use in research and development activities in the future, the Group collaborates with the other groups to promote the businesses.

### 3 Hydraulics and Environment Technology Group

This Group carries out research and development related to the hydraulics and environment of coastal zones and the ocean. In the field of hydraulics, the three techniques of hydraulic model experiments, field observations, and numerical simulation, are combined in carrying out research and development of technologies that will

contribute to disaster prevention in sea areas, as well as to seacoast preservation and harbor improvement. Furthermore, research and development is also carried out on technologies related to controlling the effects (water pollution, noise, vibration, etc.) that construction work may have on the surrounding environment; improving the water quality of lakes, marshes, and sea areas; and preserving and restoring the ecosystem.

### 4 Geo-Technical and Disaster Prevention Technology Group

Since establishing the Soils Laboratory in 1970, efforts have been carried out through the research and development of technologies to deal with issues covering a broad range of fields, from traditional soft ground-related technologies to ground stabilization, with the aim of "carrying out research and development that will be of use in the field." The results of these efforts have earned high marks and been put to use in

harbor construction work abroad, as well as in large-scale construction projects to build man-made islands for Kansai Airport, Chubu Airport, and Haneda Airport. There has been a particular focus recently on research and development related to "recycling the earth and sand generated by dredging or deposited by tsunami as well as reducing the volume of such materials" and "pile installation technologies."

### 5 Architectural Technology Group

The Architectural Technology Group focuses its research and development efforts in the fields of structure, materials, and the environment. Aiming to mitigate earthquake risk, development is being carried out on seismic resistance and base-isolation structure technologies, damper retrofitting technology for fitting damping devices in existing structures, as well as construction technologies for using various materials for the purpose of constructing high-quality concrete structures. Moreover, research is also being conducted on technologies to reduce noise and vibration generated when construction work is being carried out, as well as on various analytical techniques for such areas as structure-borne sound in buildings, environmental vibration, light environment, and energy conservation.

### 6 Materials and Renewal Technology Group

The Materials and Renewal Technology Group aims to propose optimal methods for getting the most out of the required capabilities of the structures throughout the life cycle of various structures, from new construction to repair, reinforcement, and renewal. Furthermore, it carries out research and development on construction materials and methods of execution that can be applied to steel and concrete structures. To accomplish this, efforts are undertaken in such areas as the development of new technologies for work execution and work execution management, the development of high-performance materials, the development of technologies for effectively utilizing industrial by-products, and the development of methods for predicting durability.

### Cutter Suction Dredger

-Dredging-



A dredging vessel which excavates sea bottom foundations using the cutter on the tip of the rudder, and dredges large quantities using its pumps. Dredged material is directly transported to the designated discharge areas through soil exhaust pipes. Our company has carried out continual improvement of dredging machinery since the company's founding in order to allow handling of dredging in a wide variety of soil qualities from soft mud to hard soil.

### Wide Grab Bucket Dredging Method

-High precision dredging-



A large-scale wide bucket used for effectively carrying out highly precise shallow layer dredging. This equipment is tightly sealed and has a high soil concentration ratio per grab and the trajectory of the bucket blades can be verified on a screen from the control room while carrying out highly precise shallow layer dredging.

### Multiple Angle Swinging Pile Driving Vessel and Crane Ship

-Pile Driver Ship-



The company has constructed the "Kakuryu" large scale multiple angle swinging pile driving vessel with a 600t hoisting capacity and superior work efficiency to accommodate the increasing trend towards scaling up of diameter of steel pipe piles for the larger scaling of port facilities both in Japan and overseas.

### Mangrove Transplanting

-mitigation-



In development in Singapore forest that was going to be eliminated was instead transplanted and recreated in accordance with local environmental conditions. The mangrove seeds were grown to saplings and then transplanted for a successful large scale production of an approximately 13 hectare mangrove forest.

\*Mitigation: A preservation act for reducing the affect of development projects on the environment.

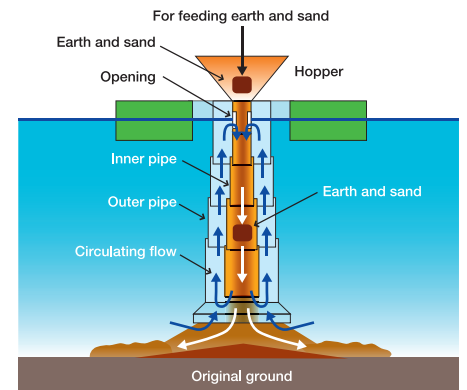
### Cement Deep Mixing Method

-Foundation Improvement -



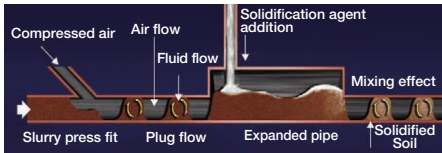
A Cement Deep Mixing method. This method hardens soft foundations by mixing soft soil with a stabilization agent in-situ using a rotating mixing shaft with blades. The method is suitable for providing stable strength quickly in both onshore and offshore works and for various purposes such as massive constructions, narrow space construction and treatment of contaminated soil.

### Double Pipe Tremie Method



The Double Tremie Method is used for dumping sand into the sea. Because circulation flow from the inner tube to the outer tube is induced by dumping sand, the occurrence of turbidity is reduced more than it is with an ordinary single tremie method.

### Plug Magic Method



TOA developed an engineering method called the "Plug Magic Method." This method enables soft dredged soil to be solidified efficiently for reuse as a filling material. This method requires no mixer, reducing the operating cost by as much as 10 to 15%. It is also an environmentally-friendly method that enables in-pipe transportation of soft mud from the dredging site to the reclamation site. Plug flow occurs when compressed air is mixed into soft mud in a pneumatic pipeline. This method kneads soft mud and solidification material in the pneumatic pipeline, utilizing the characteristics of plug flow. It has a maximum solidification capacity of 1,000m<sup>2</sup>/h.

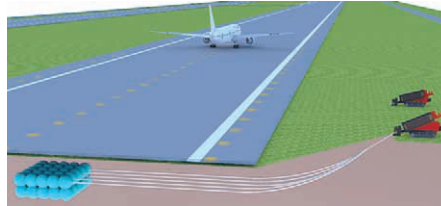
### Seismic Isolation Method

- Seismic isolation technology for protecting people and building from earthquakes -



A construction method where layered rubber is inserted in between the building and foundation and by separating the foundation from the building, the sharp movements of an earthquake are changed into slower, more gradual movements. This maintains the safety of the people inside the building and protects the building and equipment from damage.

### Balloon Grouting Method



Depiction of work being carried out on an airport runway (liquefaction countermeasure)

The Balloon Grouting Method is a chemical grouting method used to avoid liquefaction underneath existing structures and leakage of back-fill material behind existing wharfs. This method uses low pressure-injected chemicals into boreholes (96mm diameter) to strengthen foundations.

This operation can be carried out without damaging existing facilities and disturbing their operational activities. As the equipment is relatively compact, this method is particularly useful where space is restricted.

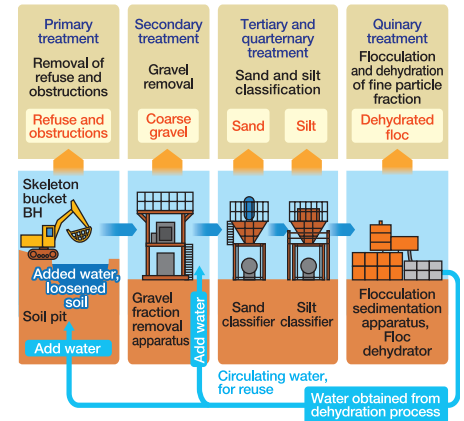
### FRP Protective Permanent Form Method -Salt Damage Deterioration Restoration-



A restoration method for concrete port structures suffering from salt damage. Highly rigid FRP\* panels are used as a framework when restoring the deteriorated parts, and the panels are left in place after completion of the work to prevent penetration of external chloride ions, making for a durable structure.

\*FRP: Fiber Reinforced Plastics

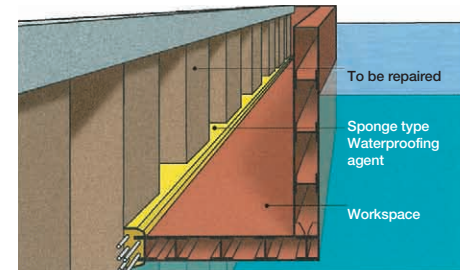
### Soil Separator Multi Method



The Soil Separator Multi Method is an upgraded technique for soil classification of dredged material or tsunami deposits, including trash and rubble, and is an upgrade of the conventional Soil Separator Method. This method covers not only classification of the sand and gravel but also classification of silt material through water treatment process. In addition, it enables recycling and reduction of the water used in the water treatment process. The method won Best Prize in the 15th Infrastructure Technology Development Award.

### Dokodemo(Anywhere and Everywhere) Dry Method

-Maintenance of Underwater Work Spaces-



A technology for creating workspaces around waterside structures. A sponge type water proofing material is installed in the joints between the main structures and work structures which are then connected to create an air filled space in water. The technology provides superior waterproofing and strength properties and can handle even structures with very complex shapes allowing for repair and reinforcement construction to be carried out earlier.