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FIELD EXCURSION TO ENHANCE COASTAL AND ENVIRONMENTAL ENGINEERING CAPACITIES OF ENGINNERS IN ADMINISTRATIVE POSITIONS

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ABSTRACT: The capacity building of coastal administrators is essential for sustainable coastal zone management. In order to enhance the ability of trainees in coastal and environmental engineering, the College of Land, Infrastructure, Transport and Tourism of the Japanese Government has carried out annual field excursions to Kujukuri Beach, a typical sandy beach in central Japan for comprehensively learning about real phenomena occurring on the beach and in the hinterland. This paper describes the excursion in 2011, in which 20 trainees participated. The importance of learning through the field excursions to coasts is discussed.

Keywords: Education, capacity building, field excursion, Kujukuri Beach, field observation.

INTRODUCTION

With rapid economic growth in Asian countries, environmental impacts, including beach erosion, have been expanding. To properly deal with these issues, it is essential to enhance the capacity of coastal engineers involved in public works. They must have a multi-disciplinary vision and outlook that takes in a widespread variety of coastal engineering fields. Many problems cannot be solved through the application of only a limited knowledge of physical aspects such as structural design; concepts related to the social sciences are also needed. Coastal engineers face very complicated issues that bring together various factors and multi-stakeholder consensus building. Since the amendment of Japan's Seacoast Act in 1999, many issues related to the environment and citizen participation in coastal management have come to the fore. The experience and lessons learned in Japan are thought to be useful for reference because the same issues are occurring in other Asian countries. In Japan, many researchers work hard on numerical simulations, whereas field engineers have little opportunity to learn about real coastal engineering, and thus come to rely on reports prepared by consultants. Thus, their ability to think independently has weakened, resulting in repetition of the same mistakes. Better education and better capacity building of coastal engineers are needed to solve this problem.

The College of Land, Infrastructure, Transport and Tourism carries out excursions to Kujukuri Beach in order to comprehensively teach trainees about the real phenomena of beach erosion, including issues involving the environment and communities in the nearby area, on the assumption that this will be useful for enhancing their coastal planning and management capacity. On the study beach, longshore sand transport has been blocked in many places by various structures, resulting in downcoast erosion. Thus, the inevitable nature of trade-offs involving development and environmental conservation must be recognized. The participants also discussed the effectiveness and importance of field observation *in situ*.

SITES AND METHOD

The aim of studies based on field excursions is to teach trainees in such a way that they can comprehensively acquire professional knowledge while observing the actual situation on a real coast. In this case the trainees were young engineers in the Ministry of Land, Infrastructure, Transport and Tourism (MLITT) and other Ministries together with engineers from the prefectural governments. This training program including field excursions to Kujukuri Beach started in 2003 and has been carried out every year since. This paper will introduce details of the program in 2011. Twenty trainees participated in this study; 10 from MLITT, 2 from other Ministries and 8 from prefectural governments. The program was held between June 20, 2011 and July 1, 2011, and the field excursion to Kujukuri Beach took place on June 22 and 23. On June 21, before the field excursion, the formation and evolution of Kujukuri Beach was discussed, and on the bus to the various sites visited, professors continuously talked about and discussed various topics with the trainees including specific coastal engineering and

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environmental issues relating to Kujukuri Beach. During the on-site visits, each trainee had an acoustic transmission receiver so that they could hear the professors' explanations without being bothered by wind and wave noise. In addition, they tried measuring and analyzing the formation of a scarp in an eroded area using a measuring stick and learned how to measure breaking wave height with the measuring stick. Also, they walked along the shoreline of the sandy beach and felt the soft sand layer where sand had been newly deposited on the foreshore, and investigated the grain size of beach materials. On this field trip, we visited 15 sites between Inubo Point at the north end and Taito f ishing port at the south end of Kujukuri Beach, which is in total 60 km long, as shown in Fig. 1. In this study, beach changes and coastal environmental aspects at Kimigahama Beach north of Inubo Point, beach erosion on the Node coast, tsunami damages at Hasunuma coast, and the damage of gently sloping revetment and the protection of endangered species at the Hitotsumatsu coast were discussed. Because this field trip was carried out three months after the Great Tsunami that occurred on March 11, 2011, the trainees had a chance to observe various types of damage along the coastline.

RESULTS OF FIELD OBSERVATIONS

Observation of the half-urbanized Kimigahama Beach

Kimigahama Beach, the first observation site, is a pocket beach 1.1 km in length located north of Inubo Point, as shown in Figs. 1 and 2. We first observed the formation of a scarp at the opening of an artificial reef constructed offshore. Here, trainees learned the method

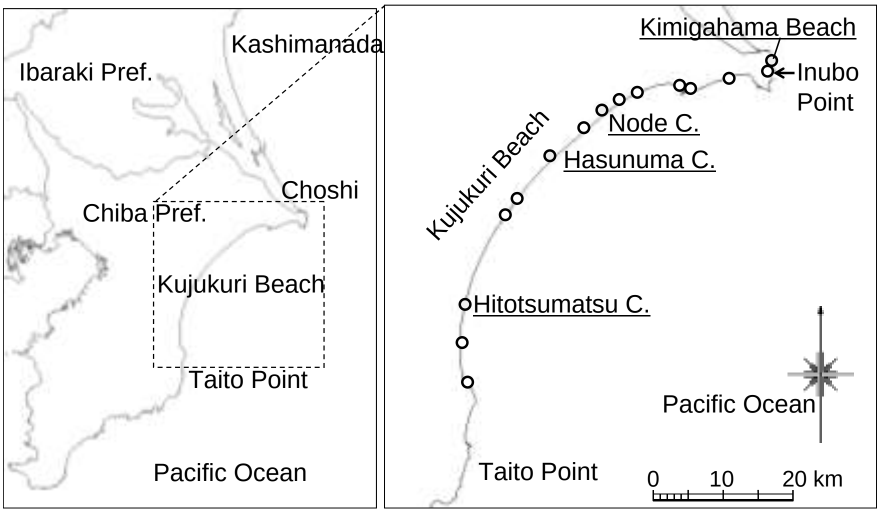

Fig. 1 Observation sites along Kujukuri Beach.

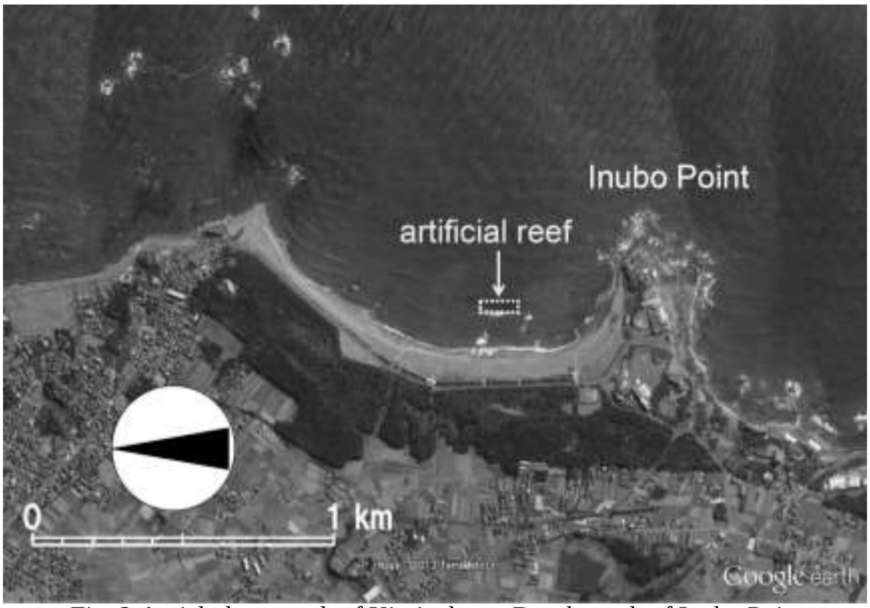

Fig. 2 Aerial photograph of Kimigahama Beach north of Inubo Point.

of using a measuring stick (Uda and Ishikawa, 2007) to take field pictures that can be effectively used in analysis, while also considering the formation pattern of the scarp and the angle of the sunlight. As seen in Fig. 2, the relative height of this scarp was 0.6 m as seen next to a trainee, and it decreased alongshore, implying that the scarp was formed due to the wave-sheltering effect of the artificial reef.

Figure 3 shows the beach and its wide foreshore as seen from top of the seawall landward of the artificial reef. A large amount of sand has been deposited close to the top of the seawall forming a gentle slope, and fine windblown sand has been deposited on the walkway landward of the seawall. From this, the trainees realized that windblown sand was severe at this site because of the wide foreshore.

Fig. 2 Measuring of scarp height.

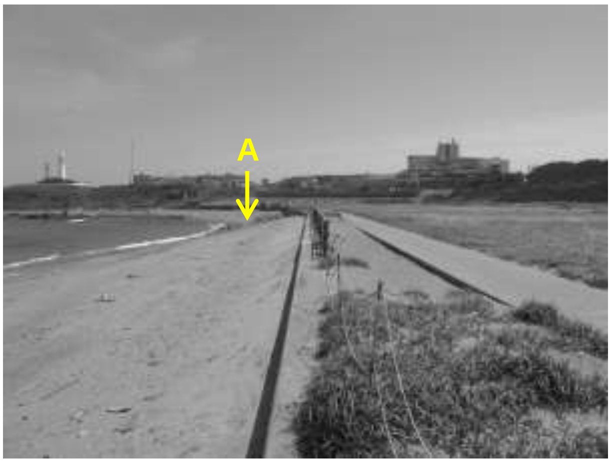

Fig. 3 Wide sandy beach with a gentle slope formed by the deposition of windblown sand.

Figure 4 shows the narrow beach near point A as indicated in Fig. 3, where a large number of concrete blocks have been installed along the foot of the seawall to prevent wave overtopping, in contrast to the excess accumulation of sand on the nearby beach shown in Fig. 3. Figure 5 shows the entire length of Kimigahama Beach taken from the top of Inubo Point. The wave breaking at point B was caused by the existence of an artificial reef. In addition, Fig. 6 gives a close look at the cuspate foreland formed behind the artificial reef. The trainees realized from the scene shown in Fig. 6 that the cuspate foreland had formed behind the artificial reef because of its wave-sheltering effect. This example clearly illustrated that the sand required for the formation of a cuspate foreland is transported in from both sides, resulting in erosion on both sides of the cuspate foreland. For trainees who are accustomed to considering the effects of shore protection structures two-dimensionally, this example was useful for understanding three-dimensional beach changes in the vicinity of the offshore

Fig. 4 Concrete blocks placed along the coastline to prevent wave overtopping.

Fig. 5 Overview of Kimigahama Beach.

Fig. 6 A large cuspate foreland formed behind an artificial reef.

Fig. 7 A wide concrete walkway.

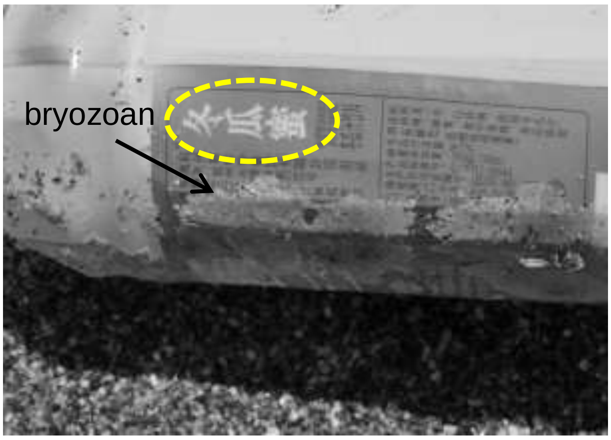

Fig. 8 PET bottle with a bryozoan densely attached.

breakwaters. They further understood that when an artificial reef is constructed in the middle of a pocket beach as in the case of Kimigahama Beach, sand accumulates in the lee of the structures while the beaches on both sides of them are eroded.

Figure 6 shows a large parking lot. In general, Japanese tourist and coastal administrators tend to believe that a parking lot as close as possible to the shoreline is appropriate for use. The parking lot shown in Fig. 6 exactly satisfies this condition. In the past in Japan, people parked their cars landward of the sand dunes and coastal vegetation, and after passing through these areas via a narrow access way, they were greeted by the sudden vista of a wide sandy beach. However such pleasure was lost with the construction of parking lots very close to the shoreline.

Furthermore, in many cases a wide concrete walkway is built on the backshore, as shown in Fig. 7. However, the backshore, which is considered useless land by some, forms an important buffer zone against wave action and windblown sand, and the impact of its loss extends to the entire sandy beach as well as to the coastal vegetation. Thus, trainees realized through this example that excess construction of artificial structures on the beach should be avoided in a coastal tourist resort.

With respect to a coastal environmental issue, we observed various kinds of drift litter on the foreshore. On a PET bottle washed up near the shoreline and shown in Fig. 8, we found Chinese-style characters, indicating that it was produced at a location in the coastal zone along the East China Sea coast in China. Figure 8 also shows a bryozoan, a type of sessile organisms with a calcium-made net-type body, densely attached to the PET bottle. From this example, trainees understood that this PET bottle had been transported by the *Kuroshio* current from the East China Sea, suggesting that the Pacific Ocean connects Japan's Pacific coast to foreign countries on the far side of the archipelago and further that issues related to drifting debris can occur internationally, implying that international cooperation is important to solve this issue.

Observation of Beach Erosion, Windblown Sand and Vegetation at the Node Coast

Along the Node coast located in northern Kujukuri Beach, as shown in Fig. 1, the beach has been severely eroded leaving no foreshore in front of the gently sloping revetment, and the seawall is directly exposed to waves. Although the seaward slope of the revetment had already been damaged before 2010, this damage was exacerbated by the effect of the 2011 Great Tsunami. Figure 9 shows the damaged revetment on this coast. Concrete blocks on the seaward slope were scattered and the foot of the revetment was exposed to waves. Furthermore, Fig. 10 shows the damaged revetment located near arrow C. The 0.5 m thick concrete revetment was completely breached as a result of the discharge of foundation gravel carried by the return currents.

Since the early 1990s, gently sloping revetments have been constructed along many coasts in Japan to create easy access to the shoreline. However, many of these revetments have been destroyed by the discharge of the foundation gravel (Uda, 2010). The trainees observed a clear example on this coast, and understood the mechanism of how a gently sloping revetment is damaged and the weakness of this structure.

The 2011 Great Tsunami also hit this coast on March 11, 2011, and evidence of the tsunami inundation was observed. Figure 11 shows the damage to the coastal forest which occurred when the tsunami flowed over the low-elevation sand dunes on this coast. Pine trees toppled and died owing to the tsunami inundation and the plastic debris such as PET bottles were scattered behind the dunes. This observation was of interest to the trainees because they could observe real tsunami damage first-hand.

On the Node coast, artificial headlands (HL) Nos. 9 and 10 were constructed as a measure to stem beach erosion and stabilize the shoreline. Figure 12 is an oblique aerial photograph of the coast taken on March 11, 2011 by Japan's Self-Defense Force. It shows that the beach width to the left (south) of HL No. 9 is narrow, whereas to the right (north) of HL No. 10 it is wide, implying that the direction of the predominant longshore sand transport is southward. We walked along the shoreline between HL Nos. 9 and 10, and observed various features. In this area, there is still a sandy beach left, although it has been gradually eroded. The trainees gained an understanding of the severity of beach erosion from observing the isolation of an agave tree (*Agavaceae sp*.) which originally grew on the sand dune but had been scoured out both by run-up waves and windblown sand, and in addition, also damaged by the tsunami. This tree is located at arrow D in Fig. 12 halfway between HL Nos. 9 and 10. Figures 13 and 14 are photographs of this tree taken on June 23, 2011, and June 18, 2010, respectively, both from the northwest side of the tree, showing that the tree's width was reduced by half in a single year due to erosion, from 2.2 m to 1.1 m.

When we went up the sand dune behind this tree, we found that a blowout had been formed on top of the dune, as shown in Fig. 15, and near this site a steep slope with a 1/2 angle of repose of fine sand was found along the sand dune/coastal forest boundary, and pine trees had been buried by sand, as shown in Fig. 16. From these observations, the trainees learned about the effects of windblown sand and the value of coastal forests in preventing them.

In this area, the trainees also observed the interaction between the deposition of windblown sand and the

Fig. 9 Damaged seawall on the Node coast.

Fig. 10 Enlarged photograph of the damaged seawall.

Fig. 11 Dead trees behind sand dunes killed by tsunami inundation and tsunami-transported debris.

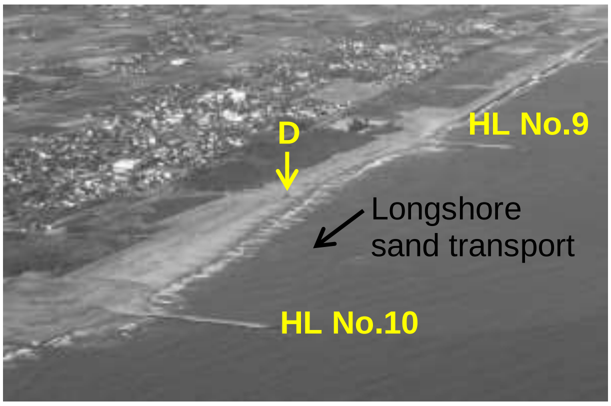

Fig. 12 Oblique aerial photograph of Node coast taken on March 11, 2011.

growth of vegetation. Figure 17 shows an example of sand being trapped by vegetation on the sand surface. While sand mounds can develop when windblown sand is trapped by vegetation, their habitat can also develop when the scale of the mound increases to a point which is appropriate for their growth, resulting in an increased number of plants. This picture shows a good contrast: the color of windblown sand deposited around the vegetation is white because it is dry, whereas the ground behind it is black because it is wet. Furthermore wind blowing over the sand surface was disturbed by the leaves of *Carex kobomugi*, as shown in Fig. 18, resulting in the reduction of wind velocity and deposition of sand. Observing this, the trainees understood that the effects of windblown sand are also significant on Kujyukuri Beach.

Fig. 13 Tree (*Agavaceae*) photographed on June 23, 2011.

Fig. 14 Tree (*Agavaceae*) photographed on June 18, 2010.

Fig. 15 Blowout formed on top of a sand dune.

Fig. 16 Landward slope of a sand dune with a 1/2 slope of angle of repose.

Fig. 17 An example of sand trapped by vegetation on the sand surface.

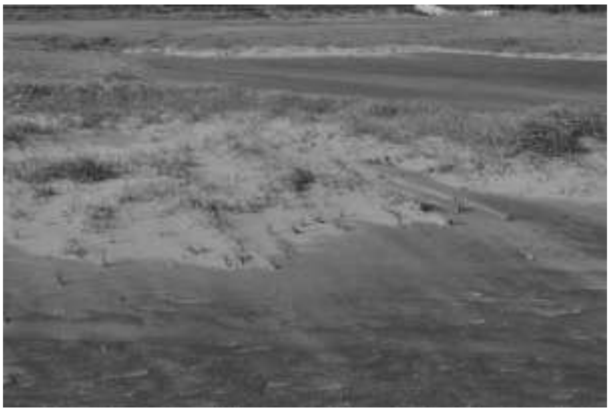

Fig. 18 Mound formed by the interaction between vegetation and wind.

Observation of Tsunami Damage on the Hasunuma coast

On the Hasunuma coast located in the central part of Kujukuri Beach, as shown in Fig. 1, a wide coastal forest extends landward of the sand dunes. This coastal forest has long been used for recreation, and an access way extended straight from the inland area to the coastline through the forest. The tsunami was concentrated in this straight access way keeping its intensity. Figure 19 shows the damage to the landward slope of the sand dune by the tsunami overflow at the seaward entrance of this access way. The pine trees on the sand dunes were felled by the strong tsunami flow, and the coastal forest behind the sand dune was inundated.

The rail shown in Fig. 20 is a small locomotive built for children, which runs across the coastal forest park. The concrete facility shown in Fig. 20 is a side wall built to stabilize the side slope of a low sand dune. The tsunami currents flowed over this structure and at its landward end a one meter deep scour hole was formed, as shown in Fig. 21. The trainees understood that one of the tsunami impacts was serious scouring such as that which took place at the end of this impermeable structure. In addition, it can also be noted from this picture that the ground water level is very high just 0.6 m below the ground surface, which restricts the growth of trees in this coastal forest. The trainees realized the difficulty in planting trees in lowland area such as the Hasunuma coast.

Fig. 19 Damage to the landward slope of a sand dune by the tsunami overflow.

Fig. 20 Track for a small locomotive for children in the coastal park.

Fig. 21 One meter deep scour hole at the end of a concrete structure.

Protection of both the Beach and an Endangered Species at Hitotsu-matsu coast

The Hitotsu-matsu coast is located near the end of Kujukuri Beach, as shown in Fig. 1, and the beach has recently been eroded. As a countermeasure, gabions have been placed along the coast, as shown in Fig. 22. In the past, the sandy beach extended along the shore with no structures, but now the coastline is protected by these gabions. However, even with this protection, subsidence and damage to the gabions are occurring every year, requiring further measures. Although these gabions were deployed as an urgent measure against beach erosion

Fig. 22 Gabions placed along the coastline.

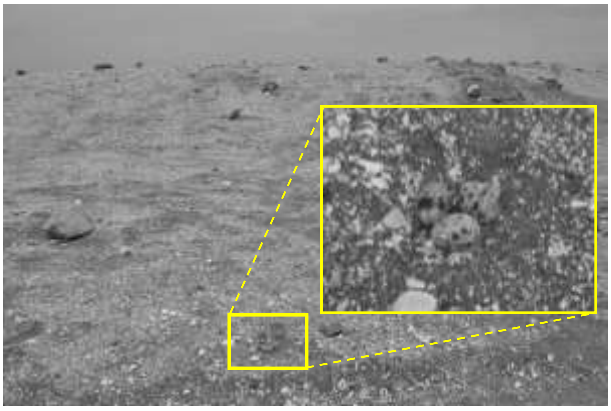
Fig. 23 Nesting sites of Little Tern *Sterna albifrons*.

because of their inexpensive initial cost, they are easily destroyed by scouring and are not resistant to wave force and thus suffer from inferior durability. Despite these weak points, this method was adopted, and the trainees understood how it really functions *in situ*.

In the vicinity of this site, the nesting sites of Little Tern *Sterna albifrons* were unexpectedly found, as shown in Fig. 23. This species is classified as endangered species (VU on the Red List of Japan's Ministry of the Environment) and its protection is an international obligation. For the nesting site, an open space composed of sand and gravel without coastal vegetation is needed. To protect this species, the open space must be slightly disturbed to prevent growth of the coastal vegetation. Dredged materials had been placed in this area for beach nourishment, and this nesting condition was automatically satisfied. The pattern of the egg shells is similar to that of the mixture of sand and shells, and this prevents their discovery by predators. The trainees gained an understanding of Little Tern nesting site requirements useful for the conservation of this species on coasts that they have an obligation to protect.

CONCLUSION

Despite the shortness of the excursion to Kujukuri Beach, the trainees carried out various observations relevant to coastal protection, the coastal environment and other topics. During the field excursion, the trainees understood that coastal conservation should not be considered only from a viewpoint dominated by sector-by-sector thinking but must also be considered from the viewpoint of comprehensive management, and they learned the importance of overall thinking about coastal matters. Also during this field excursion, trainees could observe damage from the 2011 Great Tsunami that occurred on March 11, 2011. They had continued with classroom lessons for ten days, so that they were pleased to have an outdoor excursion, which enhanced their interests on the real coast. Finally, all the trainees concluded that they enjoyed field observation. National and local government technical officials in departments related to coastal administration should take the wide-view and understanding the wide range of issues pertinent to their decision making. The method of the present study is considered useful in promoting this kind of awareness.

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