# KNOWLEDGE NOTE 1-4

## CLUSTER 1: Structural Measures

# Multifunctional Structures

GFDRR
Global Facility for Disaster Reduction and Recovery

THE WORLD BANK

Prepared by Junko Sagara, CTI Engineering

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# Multifunctional Structures

**Public facilities and infrastructure can be built in such a way as to reduce disaster risks and serve as disaster risk management facilities. Roads, expressways, and other public facilities helped reduce damage and loss in the Great East Japan Earthquake by providing protection against flooding, and by serving as evacuation routes and base stations for emergency operations. Organizations for disaster management and other public sector organizations should coordinate to ensure that their public works are multifunctional whenever possible; and cost-sharing mechanism should be developed to ensure that the financial burden is shared equitably.**

## FINDINGS

### EXPRESSWAYS SERVED AS DISASTER MANAGEMENT FACILITIES

Expressways and roads mitigated damage resulting from the Great East Japan Earthquake (GEJE). The East Sendai Expressway, a 24.8-kilometer toll road running through the Sendai Plain, about 4 kilometers off the coast and at an elevation of 7 to 10 meters, acted as a secondary barrier or dike and prevented tsunamis from penetrating further inland (figure 1). It also prevented debris from flowing into the inland urban areas. The embankment served as an evacuation shelter for nearby residents, and about 230 people escaped the tsunami by running up to the expressway.

Many expressways were built on high ground, providing routes for evacuation as well as for rescue operations. Many coastal towns and communities were isolated immediately after the disaster because roads were flooded or covered with debris. Expressways built on higher ground served to connect otherwise isolated towns and communities (figure 2).

The Sanriku Expressway, a 224-kilometer expressway that runs along the Pacific coast through the Miyagi and Iwate prefectures, is still under construction. About 51 percent of the expressway was open for public use when the area was hit by the GEJE; it helped save many lives.

FIGURE 1: **East Sendai Expressway**


*Source:* MLIT.

FIGURE 2: **The Sanriku Expressway was built with tsunamis in mind**


*Source:* MLIT.

Expressways constructed on higher ground were not damaged by the tsunami. In the aftermath of the GEJE, they provided an evacuation route for residents and enabled the self-defense forces and other emergency relief teams to get to the coastal municipalities that had been heavily affected. It also served as an important emergency route for transporting food, medical supplies, fuel, and other relief materials going to local disaster management bases and evacuation centers.

Miyako Road, a 4.8-kilometer section of the Sanriku Expressway, opened in March 2010. When the tsunami hit the area, about 60 residents managed to escape from the tsunami by climbing up the expressway embankment.

The Kamaishi–Yamada Road, a 23-kilometer section of the Sanriku Expressway that was opened only six days before the GEJE, served as a disaster management road. It was built to ease traffic congestion on Route 45, the main road connecting the coastal communities. Since Route 45 was prone to flooding from typhoons and tsunamis, the new road was expected to provide an alternative route if Route 45 were cut off in an emergency. In the Unosumai District of Kamaichi City, about 570 residents and school children escaped the tsunami. Because the road that led to the evacuation shelter had been destroyed, they climbed up to the Kamaishi-Yamada Road and managed to reach the evacuation shelter safely.

## SERVICE STATIONS AND PARKING AREAS ALONG HIGHWAYS SERVED AS DISASTER MANAGEMENT BASES

Roadside service stations, service areas, and parking areas along highways also helped in the disaster management effort, providing bases of operation for rescue teams and evacuation shelters for local residents (table 1). The roadside service stations and rest areas along roads and highways, called Michi-no-eki (road stations), are equipped with toilets, restau-

TABLE 1: **"Road stations" used in the aftermath of the GEJE**

| *Road stations* | *Location* | *Services during GEJE* |
|---|---|---|
| Sanbongi | Osaki, Miyagi | Open for 24 hours with power. Supplied food to evacuees. |
| Tsuyama | Tome, Miyagi | Used as a base for self-defense forces and rescue teams and as an evacuation center. |
| Fukushima-Touwa | Nihonmatsu, Fukushima | Provided food, water, and toilets for evacuees. Used by 1,500 evacuees. |
| Kita-no-sato | Kitakata, Fukushima | Provided water and food.<br><br>The hot-spring facility was made available to the affected residents. |
| Minamisouma | Minamisouma, Fukshima | Used as an evacuation center and emergency support base. |
| Hirata | Hirata, Fukushima | Provided power and water to evacuees and food to local hospitals and evacuation centers. |

FIGURE 4: **Self-defense force at a roadside station**

*Source:* MLIT.

rants, and shops and are also intended to promote local tourism and business. These facilities are developed jointly by the Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) in cooperation with local municipalities. In April 2012, there were 987 such stations nationwide. During the GEJE road stations were turned into disaster management bases equipped with electric power. They were available to the public around the clock when the neighboring area experienced power failures (figure 4).

FIGURE 5: **Evacuation stairway at the Omoto Elementary School**


*Source:* MLIT.

In Minami Sanriku City, sports facilities near a highway exit were used as a disaster management center, evacuation shelter, drop-off site for emergency supplies, and operating base for the local government, medical institutions, police, and volunteer workers. The local government even moved its office to the site, because its official building had been destroyed by the tsunami.

### EVACUATION STAIRS TO EXPRESSWAYS SAVED SCHOOL CHILDREN

When Iwaizumi Town in the Iwate Prefecture was severely hit by the massive tsunami, an evacuation stairway constructed at the Omoto Elementary School two years before saved the lives of 88 children (figure 5). Because there was no escape route from the school, since it was surrounded by steep cliffs, some of the children, during a tsunami evacuation drill, suggested how improvements might be made. In response to their suggestions and those of local residents, a MLIT field office completed the approximately 30-meter evacuation stairway with 130 steps along Route 45, which runs right behind the school.

## LESSONS

Embankment structures used to raise the elevation of highways and expressways can effectively prevent penetration of tsunami water and debris further inland. They can also be used as disaster management facilities (box 1).

Roads, highways, and expressways provided safe evacuation sites and escape routes because they were designed with earthquakes and tsunamis in mind. It pays to take disaster reduction into account when designing transport and other infrastructure.

Public facilities such as roadside stations and highway parking areas were used by various teams and organizations as base stations for rescue and emergency operations. They were

BOX 1: **Evacuation stairs to the East Sendai Expressway**

Recognizing that the embankment of the East Sendai Expressway had served acted as an effective evacuation site for local residents, evacuation stairs were temporarily installed at five locations along the embankment in May 2011. They are intended to facilitate evacuation in case of a tsunami.

*Source:* MLIT.

also used as evacuation centers because they were equipped with electricity, food, and water supplies.

## RECOMMENDATIONS FOR DEVELOPING COUNTRIES

Infrastructure and public facilities such as roads, highways, and railways can be used as disaster management facilities in the event of floods, tsunamis, mudflows, and landslides. Facilities that are multifunctional are a particularly cost-effective approach to disaster management.

**Integrate various facilities into planning for disaster risk management.** DRM plans should include a range of public facilities. For example, playgrounds and parking areas can become rescue team bases or spaces for transition shelters. Expressway embankments can become evacuation sites in the event of cyclones, floods, and tsunamis.

**Develop cost-sharing mechanisms.** Cost-sharing mechanisms should be established between DRM organizations and public works organizations. The latter cannot be expected to bear all the DRM-related costs of a project, since those costs affect the project's financial feasibility. In Japan the cost of adding height to an expressway is shared by the DRM organizations (KN 2-3-1).

**Coordinate with other sectors.** Coordination with other sectors, such as transportation, is required to develop multifunctional facilities. Platforms to coordinate planning, construction, and operation and maintenance should be established. In Japan prefectural governors designate the multifunctional facilities, allowing concerned organizations to initiate coordination under a new tsunami DRM law (KN 1-3).

**Consider negative effects.** High structures such as bridges and highways may have negative effects, such as water logging. They may isolate or separate communities and impose obstacles to the passage of people and animals. These effects should be assessed, and countermeasures or diversion channels and routes developed. In Japan, permission from DRM organizations is required before highways and bridges can be built.

## KEY REFERENCES


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