Research and Study Subcommittee for the Disposal and Utilization of Post-Earthquake Rubble

Subcommmittee 223
Chairman; Prof. Makoto Hisada（Tohoku University）
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Activity Report

In response to a JSCE call for proposals for priority projects to be undertaken in FY2012, the Concrete Committee of the Japan Society of Civil Engineers (JSCE) proposed an investigation of technology for effectively using the massive amount of waste resulting from the Great East Japan Earthquake disaster, and providing technical information for restoration activities in the disaster area. The proposal was accepted and, as a result, the Concrete Committee established a subcommittee for the "Research and Study Subcommittee for Disposal and Utilization of Post-Earthquake Rubble" (Committee 223). This report describes the results of the subcommittee's investigation of technology. The report covers three types of disaster waste: (1) concrete rubble, (2) tsunami-driven sand, and (3) incinerated rubble residue (incineration ash).

1. Current status of disaster waste resulting from the Great East Japan Earthquake
The estimated amounts of disaster waste generated in the three most severely affected prefectures are 5,250,000 tons in Iwate prefecture, 18,730,000 tons in Miyagi prefecture, and 3,610,000 tons in Fukushima prefecture (Figure 1). The governments of these prefectures intend to achieve full recovery by the 10th anniversary of the 2011 disaster.

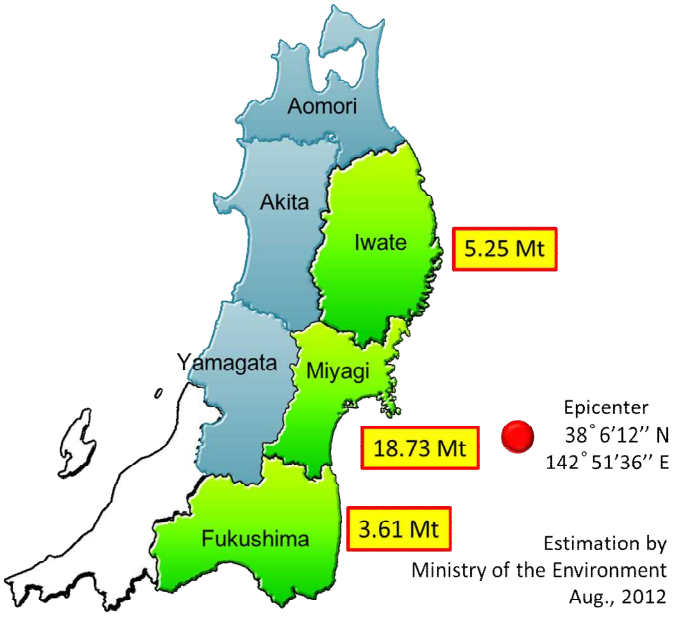

Figure 1. Estimated volume of earthquake debris in the three affected prefectures
(Compiled by the Ministry of the Environment (published August 31, 2012))

Iwate prefecture is using the Ofunato Plant of Taiheiyo Cement Corporation (in Ofunato City) and the Iwate Plant of Mitsubishi Materials Corporation (in Ichinoseki City) to manufacture cement that will be used for restoration and reconstruction work in the

affected areas. These cement plants make as much use as possible of the disaster waste that has been collected from all parts of Iwate Prefecture, classified and treated at secondary temporary storage sites, and delivered to the plants (Figure 2).

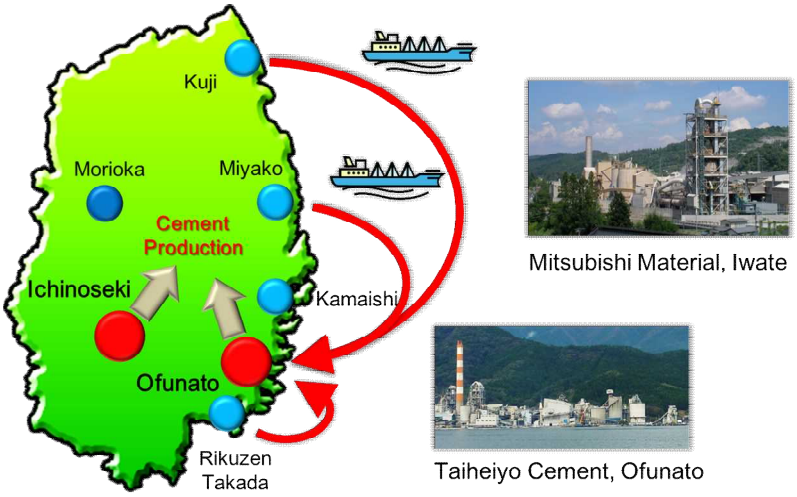

Figure 2. Framework for processing earthquake debris in Iwate Prefecture

In contrast, Miyagi prefecture has no cement plants or other facilities for converting disaster waste into raw materials and fuels. Instead, the prefecture has divided its coastal zone into four large blocks and constructed an incinerator in each block (Figure 3). Tasks ranging from the classification and treatment of disaster waste to its disposal have been contracted out to general contractors. Most of the waste had been treated by March 2014. The committee surveyed 10 treatment facilities in Miyagi prefecture and identified the types and amounts of disaster waste being treated, the structure of the facilities, the methods used for treatment and their characteristics, and the innovations and improvements developed at each of the facilities.

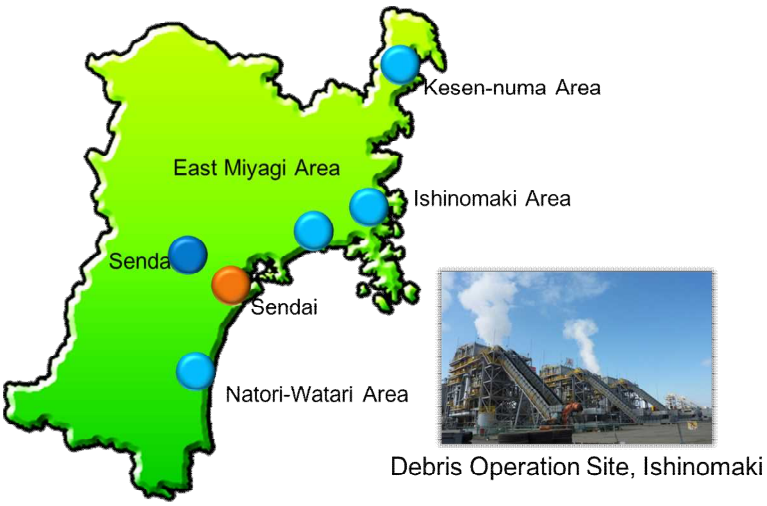

Figure 3. Framework for processing earthquake debris in Miyagi Prefecture

Unfortunately, disaster waste treatment and disposal work in Fukushima prefecture appears to be progressing quite slowly. This is because conditions at many of the evacuation areas near Tokyo Electric Power Company's Fukushima Daiichi Nuclear Power Station remain unchanged since the disaster occurred. To date, less than 70% of disaster waste has been treated.

The waste generated by this disaster consists of many types of materials. Among these, concrete rubble and tsunami-driven sand are incombustible and have a large mass. This makes them unsuitable for "treatment throughout the nation" (as encouraged by the Japanese government), as it would require transportation to municipalities far away from the disaster area. Moreover, after on-site incineration, the remaining residue (ash) should go to final disposal, which also does not fit into the nationwide treatment framework. For these reasons, effective on-site use or disposal of these types of wastes is strongly urged.

2. Review of technologies for utilizing disaster waste

The areas affected by the disaster have a strong desire to make use of the waste. Existing conventional technologies can effectively use the waste for construction work. New methods of utilizing the waste also have been developed. The committee reviewed these technologies in order to assess their applications to current and future restoration work.

(1) Concrete rubble

A variety of methods for classifying, treating, and re-using concrete rubble have been proposed. These methods are described here along with case studies.

To satisfy JIS (Japanese Industrial Standards) for aggregate quality, the reclamation of aggregate from concrete rubble requires advanced methods of classification and cleaning, as well as the removal of hazardous materials. The possibility that the rubble contains reactive components or asbestos also must be considered. Within these limitations, however, technologies have been proposed for using reclaimed material for specific purposes in specific situations. These include precast concrete that uses recycled aggregate obtained from concrete rubble (Figure 4), pre- or post-packed concrete that can use concrete rubble with large particle sizes as aggregate (Figure 5), and CSG (Cemented Sand and Gravel), a method that permits a certain amount of fine particles and unclassifiable residuals (Figure 6). These technologies are expected to accelerate efforts to treat and reuse disaster waste.

Figure 4. Precast concrete with recycled aggregate made from concrete rubble (Kitatsuji et al.)

Figure 5. Wave-dissipating blocks made using the pre-packed method with seawater and concrete rubble of large particle size (Katano et al., Report by Obayashi Corporation Technical Research Institute)

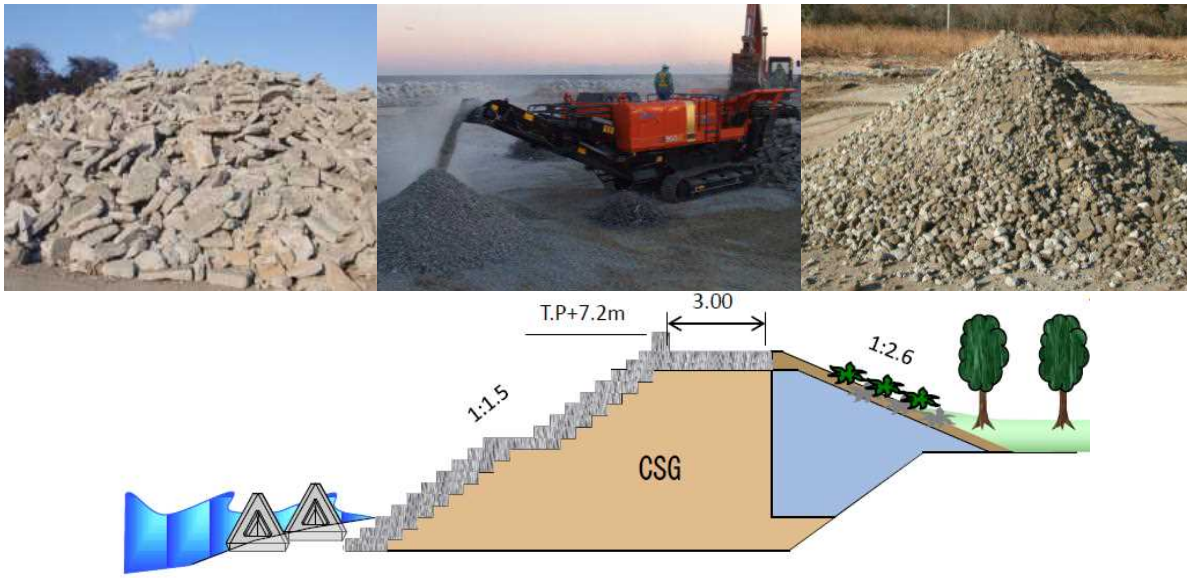

Figure 6. Sea embankment constructed with CSG (Cemented Sand and Gravel) method (from http://www.pref.fukushima.lg.jp/uploaded/attachment/49625.pdf)

(2) Tsunami-driven sand and incineration ash

The physical and chemical properties of tsunami-driven sand have been clarified. Moreover, methods have been described for utilizing this material after stabilizing its quality through mixing with landfill materials, embankment fill, or other materials.

(3) Treatment in cement kilns

As mentioned earlier, disaster waste in Iwate prefecture is being treated and used in cement plants. Generally in Japan, up to 470 kg of waste and by-products are consumed in the production of one ton of cement. Following this disaster, some combustible material was incinerated in cement kilns and some was converted into a raw material for cement. Clay and sand extracted during this process were utilized in earthworks.

3. Issues relating to waste utilization

The committee's investigation revealed a number of issues relating to the proper treatment and effective use of disaster waste.

(1) Matching of technologies

To accelerate the treatment and effective use of disaster waste, thereby promoting earlier recovery, it is essential to properly match the needs of the disaster areas with the seed technologies of industry and academia. This can be done, for example, through consortiums or similar organizations set up by municipal governments in the disaster area and industries and universities that have suitable technologies. The consortiums would link together those who share the same restoration objective, thereby facilitating restoration efforts.

(2) Location of treatment

The conversion of disaster waste into resources entails transporting the waste from temporary storage sites to work sites that can use it. Costs are associated with transportation, so an important issue is cost competitiveness with natural aggregate and sand.

(3) Timing of treatment

In principle, disaster waste treatment sites are expected to complete the treatment of waste by March 2014. Restoration work, however, will continue for the next five to ten years. In other words, the treatment sites will likely be closed well before the restoration work is completed. As a result, treated disaster waste will have to be stored somewhere until there is demand for it as a construction material.

(4) Quality of reclaimed material

The disaster waste is being stored in the disaster area in the expectation that it will be treated and reused. This material may present minor quality issues when assessed by the quality standards used in normal times. With certain advances in technology, however, it may exhibit equivalent performance. Standards such as JIS generally are established to allow easy implementation in a broad range of possible applications. However, if a careful examination of the treated disaster waste shows that it is suitable for limited applications, then the reclaimed material can be effectively utilized.

(5) Treatment schema

Effective use of treated disaster waste requires the governments of the municipalities where the waste originated and where treatment is contracted to establish a schema for the entire process from treatment to utilization. Moreover, a supervisory system is needed for departments having different responsibilities within each municipal government.

4. Conclusion

A number of major earthquakes are predicted for Japan in the future, including the Tonankai Earthquake and the Tokyo Inland Earthquake. The total amount of waste resulting from the Tonankai Earthquake has been estimated to be up to ten times that of the Great East Japan Earthquake. Given the scale of the waste problem, methodologies for the treatment, disposal, and effective use of disaster rubble must be prepared in advance. The committee hopes that the results of this investigation will offer guidance to those making such preparations.