Case studies of Advanced Construction and Demolition waste(CDW) Recycling initiatives and technologies In JAPAN

Affiliation	Hanshin Expressway Co., Ltd, Japan	
Location	Sankyo Sakai East bldg..5F 2-3-20 hanadacho minami-ku, Sakai, OOSAKA, Japan	
Position:	Construction Manager , Sakai Construction Department ,Construction Management Headquarters	
Name/Surname	Muneyuki Yamana	
e-mail	muneyuki-yamana@hanshin-exp.co.jp	
Title	**"Joint Project for Effective Reuse of the Soils" Effective utilization of shield tunnel construction sludge using tracing technology**	
Theme classification		Prevention
		Re-use
	○	Recycle
		Reduce Co2
		Legacy
		Business to overseas
		Etc.
Technology development stage	○	Practical use
		Scheduled to be put into practical use by 2020
		Scheduled to be put into practical use after 2020
Specific content	-"Joint Project for Effective Reuse of the Soils" implemented in Osaka, in which a couple of big construction projects, Hanshin Expressway Yamatogawa Line construction by shield tunneling and coastal reclamation, were integrally planned and managed to effectively utilize 0.95 million m3 of excavated soils (construction sludge) from the shield tunneling as reclamation material. -"Joint Project for Effective Reuse of the Soils" has been demonstrated to have many advantages such as effective use of resources, proper disposal of construction sludge, prolongation of life of final disposal site, reduction of CO2, reduction of project cost.	
Appeal point	-"Joint Project for Effective Reuse of the Soils" is a case example of advanced model for effective utilization of construction sludge making use of ITS, including improvement of traceability of industrial waste transportation, prevention of environmental pollution by illegal dumping, prolongation of life of public final disposal site, reduction of environmental burden, reduction of business cost, promotion of effective utilization of construction sludge in the future, leading to the establishment and sustainment of a recycling-oriented society in the future is expected.	

Effective utilization of shield tunnel construction sludge using tracing technology

Muneyuki Yamana[1*], Yasuo Tomizawa[2], Manabu Inagaki[3], Kazuma Mizuta[3], Katsumi Mizuno[4], Takeshi Katsumi[5], Toru Inui[5] and Masashi Kamon[6]

[1] *Hanshin Expressway Co., Ltd, Japan*
[2] *Hanshin Expressway Engineering Co., Ltd, Japan*
[3] *Environmental Management and Technology Center, Japan*
[4] *Osaka Bentonite Business cooperative, Japan*
[5] *Graduate School of Global Environmental Studies, Kyoto University, Japan*
[6] *Research Institute for Environmental Geotechnics, Japan*

ABSTRACT: This paper addresses "Joint Project for Effective Reuse of the Soils" implemented in Osaka, in which a couple of big construction projects, Hanshin Expressway Yamatogawa Line construction by shield tunneling and coastal reclamation, were integrally planned and managed to effectively utilize 0.95 million m^3 of excavated soils (construction sludge) from the shield tunneling as reclamation material. In this joint project, management of such a huge amount of soils transported between the highway construction site, the soil treatment facility, and the reclamation site was a key issue. For the transportation of this large quantity of shielded construction soil, we created a fully electronic manifest system by utilizing the ETC vehicle authentication function and GPS information. The newly developed ETC manifest system was used in order to issue and store manifests on the same day that the operation took place. This system has improved the traceability of transporting a large amount of generated soil, and ensured the transparency of construction sludge recycling, which led to significant savings in the creation of manifests.

Keywords: Excavated soil, Tracing technology, ETC manifest system

1. INTRODUCTION

A “Joint Project for Effective Reuse of the Soils” was implemented in order to reclaim and utilize the excavated soils generated through mud-pressure shield tunnel construction at the Hanshin Expressway Yamatogawa Line as reclamation material for the No. 6 Lumber Yard Development Project, which is managed by the Ports and Harbors Bureau, Osaka City. The transportation of these excavated soils was equivalent to load of 158,000 units of dump trucks with a capacity of 10 t (approximately 500 units per day). The soils generated through the shield tunnel excavation were required to be managed as “construction sludge,” which is categorized to "industrial waste" according to the local regulation. In Japan, the delivery of the industrial waste management slips (manifests) has been mandated, and entails a series of process control procedures, from the generation to the landfill of industrial waste. However, the management of manifests, at sites where a large amount of industrial waste is discharged, is burdensome because it entails the delivery and counting of slips by collection companies, collecting carriers, and processing companies, in addition to the obligation of storing the manifests for five years. Moreover, with regard to paper slip management, problems such as the omission of entries, alteration, spoofing, and loss have occurred. Therefore, in this project, to improve the traceability of industrial waste movement, and to prevent environmental contamination by illegal dumping, the ETC manifest system was introduced in operations such as generation, transportation, acceptance, and reclamation of generated soil, and in manifest management. Thereby, ensuring the transparency of the recycling process was attempted.

In this paper, an outline of "Joint Project for Effective Reuse of the Soils" is presented in Section 2. The ETC manifest system introduced in this project is outlined in Chapter 3. The operation management procedure wherein this system was used is outlined in Section 4. Finally, an overall summary of this study is provided in Section 5.

* Corresponding author
Tel.: +81 72 226 4738; fax: 81 72 233 5730, muneyuki-yamana@hanshin-exp.co.jp

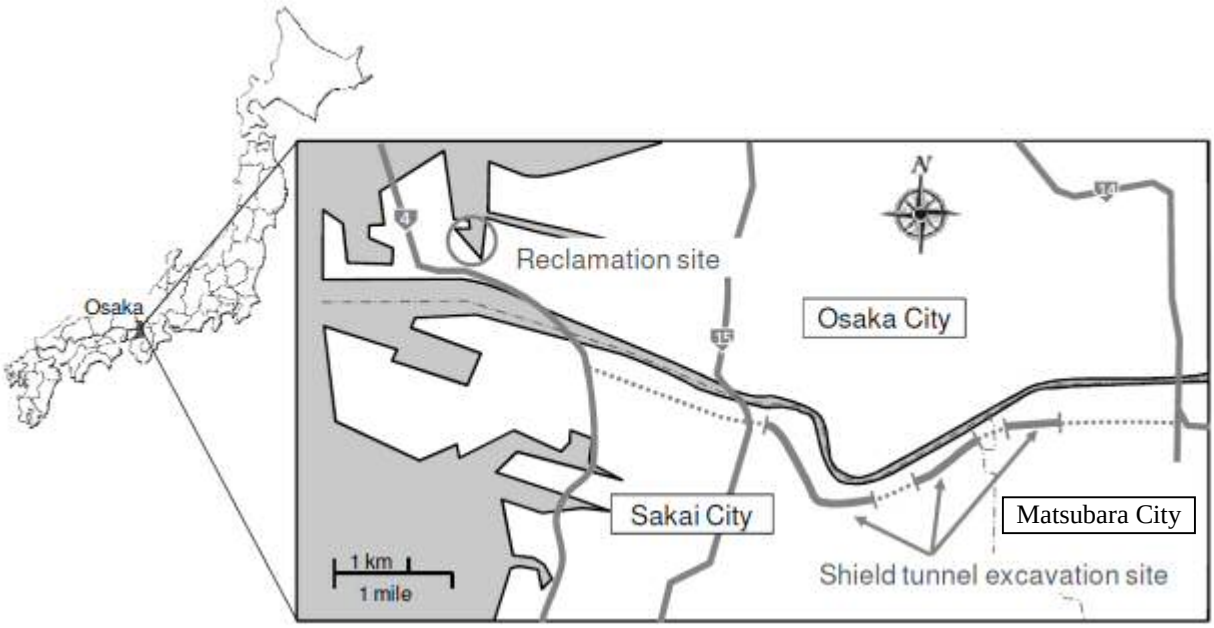

Figure 1. Project site locations [1)]

Figure 2. No.6 Lumber Yard (before the project)

2. JOINT PROJECT FOR EFFECTIVE REUSE OF THE SOILS

Most of the length of the 9.7 km Hanshin Expressway Yamatogawa Line is an underground structure, and approximately 40% of it was constructed by the mud pressure shield tunnel excavation method. Since the soil produced by this method is typically regarded as industrial waste (construction sludge) in Japan, it is commonly carried out to a site where it is finally disposed. However, this results in excessive disposal cost. In this project, recycling treatment (reforming treatment by neutral solidification and classification washing treatment) was applied to a large amount of construction sludge amounting to approximately 950,000 m^3, which

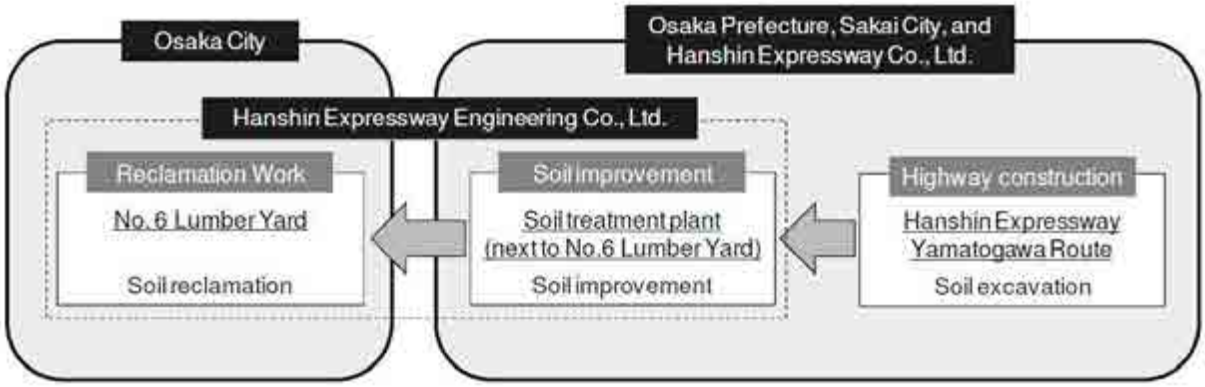

Figure 3. Scheme of joint project [1)]

was discharged from multiple shield tunnel construction sites, and used effectively as sea level reclamation material in the No. 6 Lumber Yard Development Project of the Ports and Harbors Bureau, Osaka City. Such joint management of different projects was attempted for the first time in Japan. Coastal reclamation was conducted in order to fill an area of 8.3 ha, which was previously used as an old lumber yard and is expected to make good use of the space. The excavated soils were subjected to soil improvement in order to be used as reclamation material ($>$400 kN/m^2 in cone index, and 6.0 - 9.0 in pH). A gypsum-based stabilizing agent was applied in order to maintain the pH of the improved soil lower than 9.0.

As a result, this will not only enable the proper and effective utilization of construction sludge at a low recycling rate, which is considered as a geotechnical engineering problem in Japan, but it will also extend the life of the final disposal site and reduce the emissions of CO_2 and cost of disposal. Additionally, many other advantages have been demonstrated [2)].

3. DEVELOPMENT AND SUPERIORITY OF ETC ELECTRONIC MANIFEST SYSTEM

As a new manifest registration mechanism to improve the traceability of industrial waste movement and to prevent environmental contamination by illegal dumping, the radio communication of the electronic toll collection system (ETC) was used in the ETC electronic manifest system. This system has been recently developed in order to generate

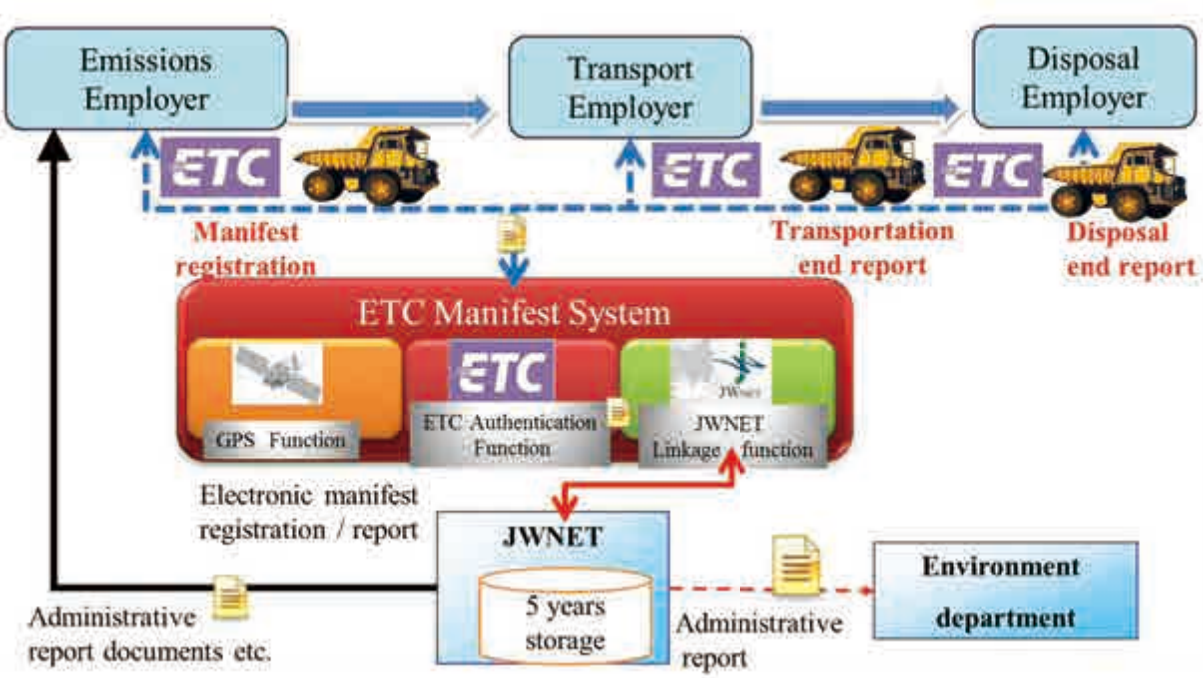

Figure 4. ETC (electronic toll collection) manifest system

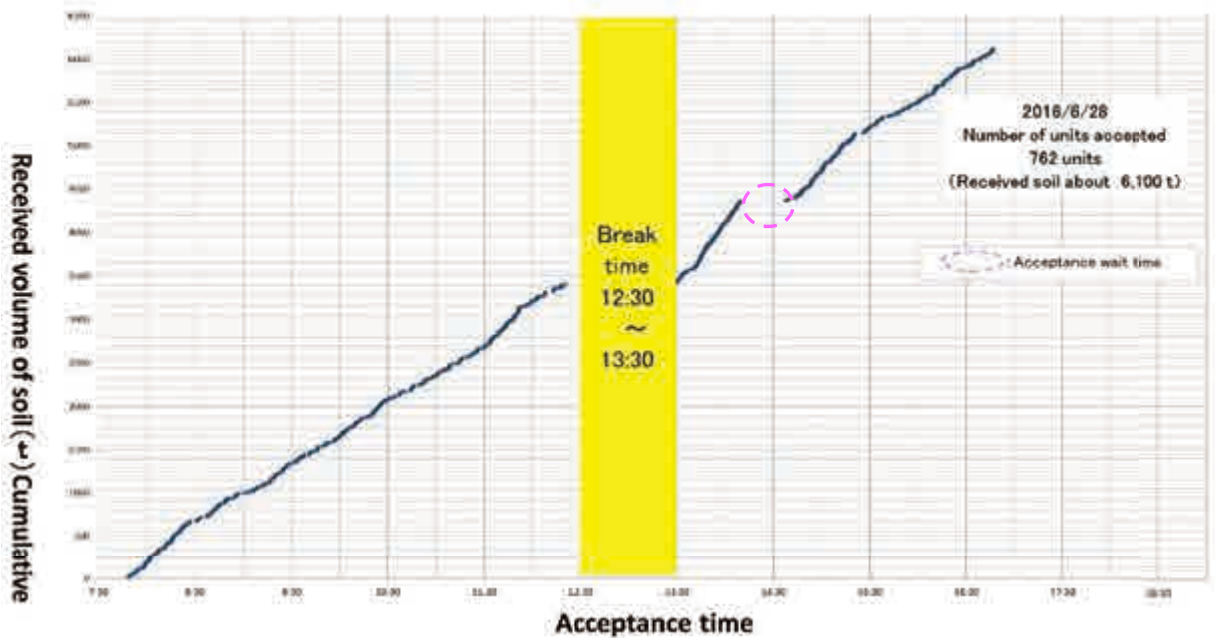

Figure 5. Operation control chart by ETC manifest system (number of maximum acceptance days)

electronic manifests (Figure 4). These electronic manifests were generated by the ETC certification of the transported soils generated through shield tunnel excavations entrance and exit records at each site. The system managed the electronic manifest in cooperation with JWNET, which is the abbreviation of "Japan Waste Network" and the electronic manifest system prescribed by the Japanese waste disposal legislation. Additionally, with regard to the transportation of the soils discharged from shield tunnel excavation, the management of transportation routes is instructed, standing by and detouring at times of congestion, ensuring that emergencies are communicated by the onboard global positioning system (GPS), and generally aimed for an overall appropriate and smooth work flow [3]. By the introduction of this system, the following advantages were gained:

(1) The load measurement (from the truck scale boarding to the weighing, ETC vehicle certification, etc.) lasted for approximately 10 seconds. Therefore, it was possible to reduce the vehicle waiting time in the vicinity of the on-site gate by 500 transport vehicles per day and a significant shortening was achieved.

(2) With regard to emission projects, education for drivers requires only simple practical training, and there is no need to input the operation by a personal computer or similar means. Therefore, the efficiency of making electronic manifests was increased, and very few operation errors by human was occurred.

(3) Since only registered vehicles are authenticated by ETC, it was possible to prevent the intrusion of unauthorized vehicles and conduct operation management in real-time. Therefore, it was possible to identify the target vehicles and the locations where a vehicle broke down or a traffic accident occurred. Additionally, the surrounding traffic congestion situation was assessed effectively, and also in real-time, which made it possible to respond to emergency situations promptly and ensure the reliability of operation control. As a result, delays in the progress of the project were prevented.

4. OPERATION MANAGEMENT USING ETC ELECTRONIC MANIFEST SYSTEM

The graphs shown in Figs. 5 to 7 visualize the operation management data collected by the ETC manifest system during the three days period of accepting the excavated soils. The amount of soil received on each day can be seen in the figure which vertical axis represents cumulative amount of soil received in the recycling treatment facility. The measurement time is shown on the horizontal axis. In principle, the facility started accepting the soil every morning at 8:00. At this site, the soil was transported by the same transport vehicle over six to seven round trips from the multiple shield tunnel construction sites to the recycling treatment facility, which was approximately 6 to 9 km away. The soil was sent to the reclamation site by a belt conveyor or similar, and the construction of the embankment was carried out.

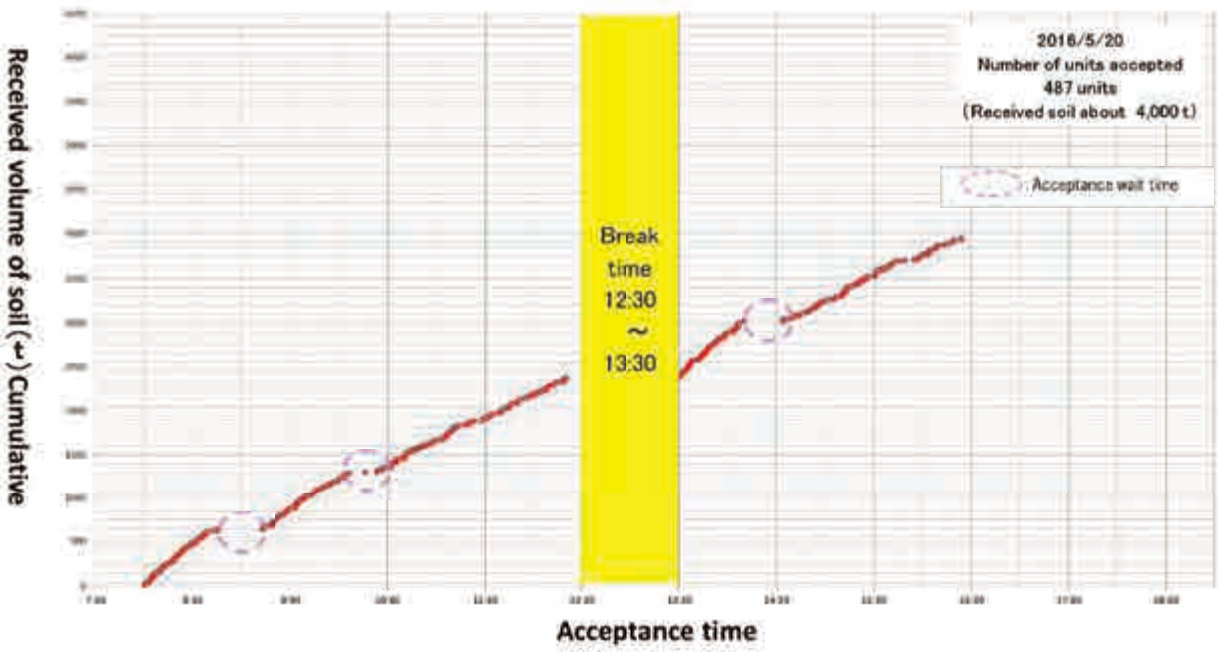

Figure 6. Operation control chart by ETC manifest system (examples of average acceptance days)

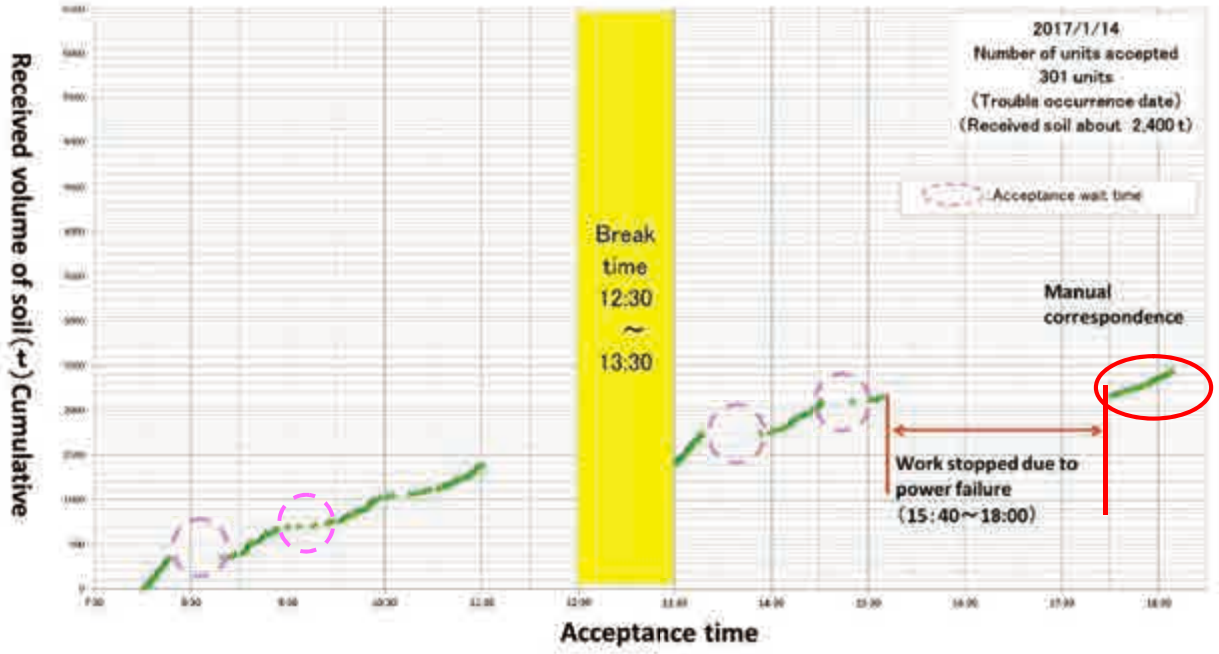

Figure 7. Operation control chart by ETC manifest system (examples of problematic days)

Figure 5 shows the day (June 28, 2016) on which 762 units were accepted. This was the largest amount of accepted units during this project. Total of 118 dump trucks prepared at two sites transported the material reciprocally and approximately 6,100 tons of the excavated soils were received. Transportation and acceptance were carried out efficiently, with the exception of a small waiting time for acceptance at approximately 14:10-14:30. However, it was some delay in process after acceptance of soil (recycling process, to reclamation), it did not affect the acceptance process and was able to accept the scheduled quantity of the excavated soils. Since the transportation vehicles gather early in the morning and afternoon from multiple sites, by shifting the start time and break time of one site, the waiting time of the transport vehicles around the facility was avoided.

Figure 6 shows one of a daily operation control chart when approximately 500 units as an average were accepted. A total of 109 units were arranged at the site and carried out transport back and forth.

Thereby, approximately 4,000 tons were accepted. Although there was a waiting time for acceptance at approximately 9:00, 10:15, and 14:00, it is thought that the standard number of receiving units was able to proceed to the next step of the process without difficulty.

Moreover, Fig. 7 shows an example of a day when trouble occurred. On that day, there was a power failure during the round-trip transportation with 43 vehicles arranged with a small number of 301 received cars, and we were only able to accept the scheduled amount of approximately 2,400 tons. The power outage occurred after 15:40, and acceptance was carried out by manual certification/weighing instead of electronic certification. The system was updated after the power was restored, which demonstrates the flexibly of the system to respond to the occurrence of problems. In this particular situation, the post-acceptance process was postponed for the next day.

In this way, by visualizing the weight data of the dump trucks and the time measured by the ETC electronic manifest system, it was possible to properly coordinate the transit vehicles and to efficiently manage the daily quantity of soil by accepting it in a reliable manner. The process and progress management of the entire project can also be useful.

5. SUMMARY

The newly developed ETC manifest system that was implemented in "Joint Project for Effective Reuse of the Soils" is introduced in this paper. This system makes effective use of the soils generated through shield tunnel excavation generated from highway projects and used as a reclamation material by land development businesses.

This system can be used as a technology to support transparency during the proper disposal of construction waste at mass emission sites. This system has many advantages, such as clarifying the responsibilities of each business operator, improving the efficiency of transportation management work, reducing labor, etc. Moreover, this system was evaluated and adopted in the management of vehicle operations during the East Japan great earthquake disaster. The ETC antenna was preliminarily installed in Gareki, which is located in the city of Kamaishi, in Iwate prefecture. The entrance and exit of the transport vehicles was recorded and the weighing control of the loads was carried out.

In this way, the system could be used in the large-area shielded tunnel construction of railways and roads, with a size of several millions of m^3, in the utilization of large-scale disaster waste as recyclable material, and in large-scale construction work in developing countries, for example. It is expected that the proper and effective utilization of construction waste will expand further and lead to the emergence of a recycling-oriented society in the future.

6. REFERENCES

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