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Sustainable Construction Practices during the Construction Stage

I. Sustainable Construction Practices during the Construction Stage in Japan

1. Efforts by the Japanese Government

This report outlines the efforts and results that have been implemented and achieved in both the public and private sectors in the Japanese construction industry. Fundamentally, the government has been creating new legal regulations and designation systems, while private companies have been strengthening their efforts based on those regulations and systems. Thus, we start by looking at the government's efforts from the three perspectives of resources, construction works, and zero emissions efforts.

1.1 Material Procurement

(1) Promoting Purchases of Eco-Friendly Goods and Services (EFGS)

To create a recycling-oriented society, efforts to supply recycled products must be accompanied by efforts on the demand side. Based on this idea, in May 2000, the Law Concerning the Promotion of Procurement of Eco-Friendly Goods and Services by the State and Other Entities (Law on Promoting Green Purchasing, LPGP) was enacted. This law promotes the priority procurement of EFGS (products and services that help reduce environmental impact) by the government and other public institutions, aims to facilitate a shift in demand by the dissemination of information regarding EFGS, and promotes the formulation of a society which can enjoy sustainable development with a lower environmental impact.

In February 2001, according to the LPGP, the Cabinet approved a Basic Policy on Promoting Green Purchasing, which established Designated Procurement Goods (DPG, types of goods such as EFGS which are promoted for priority procurement by the government and other public institutions) and the Way for Setting Procurement Targets (WSPT). Since then, revisions have been made to DPG and WSPT as needed, and construction companies have been managing their own green procurement systems while using those regulations and revisions as a source of reference. The specific examples are outlined in section 2.1 (3).

1.2 Construction Works

(1) Environmental Measures for Construction Works

In terms of its environmental measures for construction works, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) launched its Environment and Recycle Planning Office in July 2011, and it has been strengthening efforts in three areas: (1) guidance in and dissemination of technologies for environmental preservation related to the construction equipments; (2) planning, proposals, coordination, and guidance related to work methods for environmental preservation used in projects by Central Government Entities (CGE); and (3) planning, proposals, coordination and guidance related to surplus soil and other by-products of CGE's projects.

(2) Noise and Vibration Measures

Noise and vibrations generated by construction equipments (CEs) during construction works cannot be avoided, and numerous complaints from nearby residents continue to be lodged. The government is therefore advising construction companies to reduce noise and vibrations through the introduction of legal regulations and a designation system.

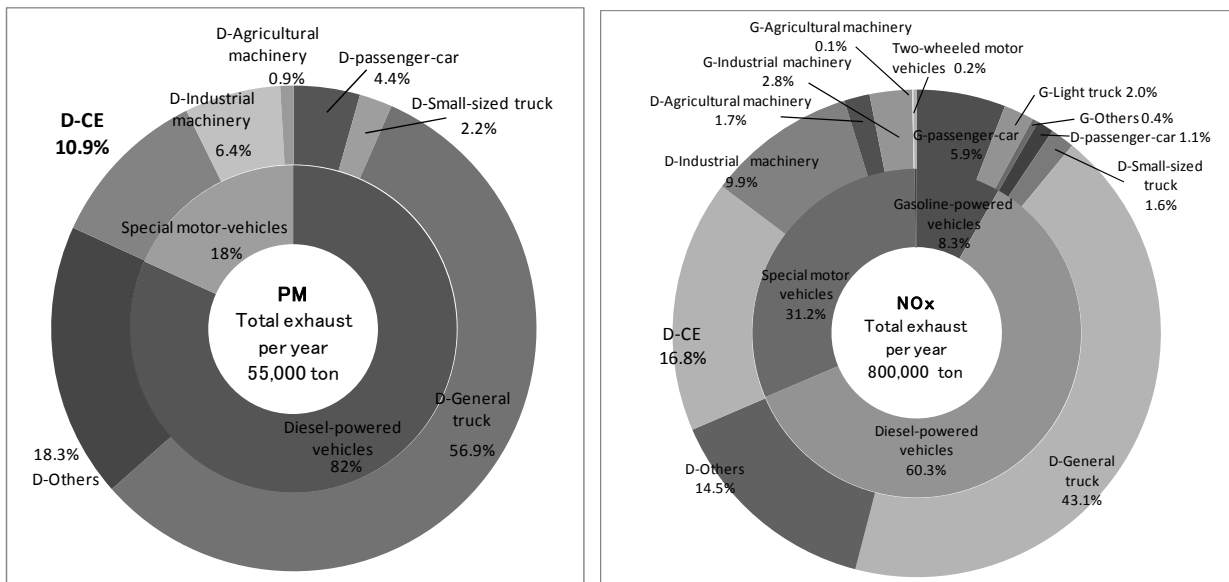
The legal regulations are as follows. The Noise Regulation Law and Vibration Regulation Law define designated construction works as works in which considerable noise and vibrations are generated during the construction works. When a company wants to engage in designated construction works in an area that has been designated for regulation of noise and vibrations by the governor (or mayor of a designated city), such company is required to give advance notice to each municipality by seven days prior to the commencement of the works.

The designation system works as follows. The use of low-noise CEs is generally required by the low-noise, low-vibration construction equipment designation system, and when construction works are performed using only designated CEs, the project is exempted from the application of the designated construction project regulations specified under the Noise Regulation Act.

(3) Emission Gas Measures

Article 16 of the Basic Environment Law establishes standards that should be maintained for the sake of protecting human health—specifically, those regarding environmental conditions related to air pollution¹. Estimates of total exhaust emission gas from Motor Vehicles (2005) indicate that emissions gas from construction equipments (CEs) account for about 10% of the total particulate matter (PM), and 17% of nitrogen oxides (NOx). There is a growing need to implement exhaust emission gas regulations in response to this situation.

Figure 1: Estimate of Total Exhaust Emission from Motor Vehicles (PM, NOx)



Source: Central Environment Council of Japan

¹ Article 16, Clause 1 of the Basic Environment Law: With regard to the environmental conditions related to air pollution, water pollution, soil contamination and noise, the Government shall respectively establish environmental quality Standards, the maintenance of which is desirable for the protection of human health and the conservation of the living environment.

The government is making efforts to reduce exhaust emission gas through the introduction of legal regulations and designation systems, as it is doing in the case of noise and vibration measures.

The designation systems were launched in 1992, based on the first standard values for emission gas. Today, CEs applicable for emission gas control are made based on the fourth revised standard values.

Legal regulations, meanwhile, were launched in 2006 with the enactment of the Act on Regulation, Etc. of Emissions from Non-road Special Motor Vehicles on May 25, 2005 (nicknamed the Off-Road Law).

The MLIT requires only the use of designated CEs in the projects by Central Government Entities (CGE), and it implements policies to increase construction company incentives to introduce designated CEs, such as financial system arrangements that allow designated CEs to be acquired at low interest rates and measures to award additional points for the use of such equipments in the technical tender for the projects by CGE.

Today, the use of designated CEs goes beyond the projects by CGE. More than 90% of prefectures and designated cities also require only the use of designated CEs, and the dissemination of designated CEs is thus expanding. For example, more than 70% of backhoes are applicable for emission gas control, and even more widespread use of designated CEs is expected in near future.

(4) Global Warming Measures

One of the major factors in global warming seems to be the increase in greenhouse gases, and Japanese CO₂ emissions account for about 5% of emissions worldwide. Japan is trying to reduce its CO₂ emissions in an effort to prevent further global warming, and the construction industry is no exception. To reduce CO₂ emissions generated from CEs, the MLIT is working to create manuals for energy-saving operation, to introduce a system of certification for fuel-efficient CEs to promote the dissemination of energy-saving CEs, and to introduce a system of certification for low-carbon CEs to promote the dissemination of hybrids CEs.

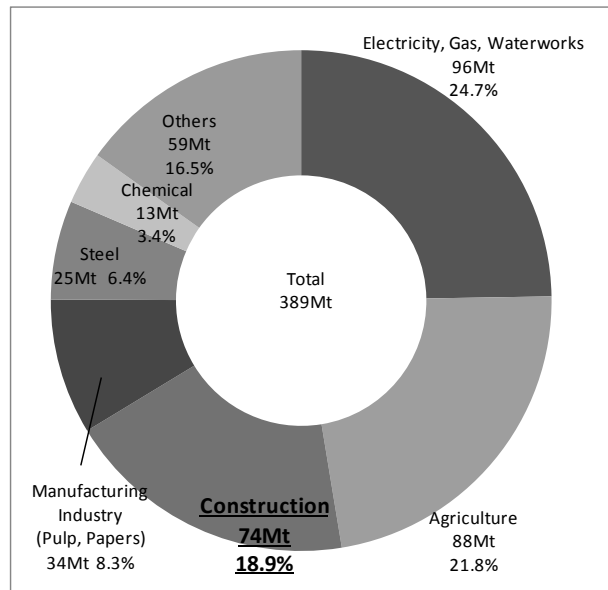
Through these efforts, the MLIT is striving to further reduce emissions in the construction sector, which were reported to be at 14 million tons in 1990.

1.3 Zero Emissions

(1) Construction Recycling

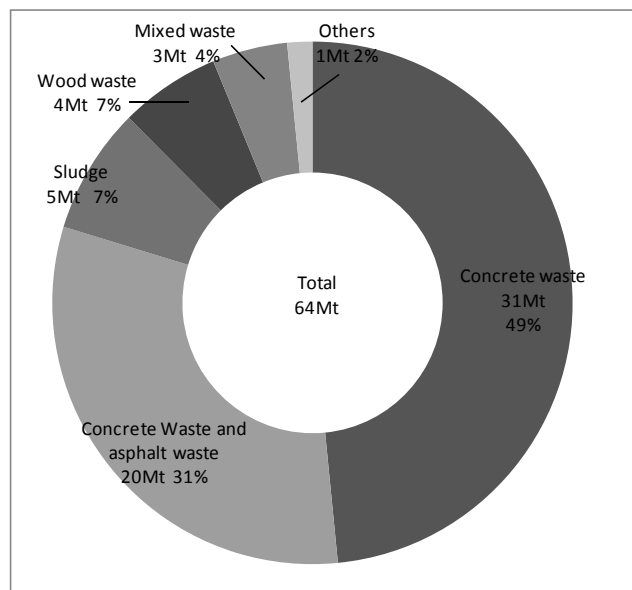
Construction works require the input of an extremely large amount of resources. Construction waste accounts for about 20% of Japan's total industrial waste output and about one-fourth of its final disposal volumes.

Figure2: Amount of by-products derived from Industry



Source: Ministry of the Environment “The condition of emission and disposal of Industrial Wastes, FY2009”

Figure3: Classified construction by-products volumes



Source: Ministry of Land, Infrastructure, Transport and Tourism “Survey of construction by-products FY2008”

While various laws are being established to promote the creation of a recycling-oriented society, in the construction industry, regulations are being applied through the Construction Material Recycling Law (CMRL), which requires to contractors to sort out and recycles wastes generated in demolition works of buildings that the specified construction materials, such as concrete (including pre-cast plates), asphalt/concrete and wood building materials are used or construction works using the specific construction materials.

Measures to promote construction recycling began with the 1992 formulation of rules for adhering to the principle of recycling, and these measures were instigated by the lack of effective uses for construction by-products, low excess capacity at final disposal sites, and the need to cut final disposal volumes through the promotion of recycling. Later, in conjunction with the enactment of the CMRL in 2002, the effects achieved through policies focused on regulatory methods began to improve considerably.

In 2008, as a result of the fact-finding survey of the CMRL and the formulation of the Construction Waste Recycle Strategic Program 2008 (CWRSP), even more progressive efforts were implemented. CWRSP was formulated for the purpose of promoting the 3Rs (Reduce, Reuse, Recycle) and was intended to apply to all construction works, whether performed by the State, local governments, or private sector.

2. Efforts by Private Construction Companies

Construction companies are implementing various efforts not only from the perspective of ensuring compliance with rules established by the government—that is, obeying laws and adapting to designation systems—but also from the perspective of fulfilling their social responsibility given their role as companies that are responsible for the development of the social infrastructure. As part of these efforts, companies are genuinely working to address environmental problems, and they have reached a certain level of success in achieving the major goal of engaging in “sustainable construction.” The sections below present efforts made by private construction companies from the three perspectives of resources, construction works, and zero emissions efforts.

2.1 Material Procurement

(1) Cutting CO₂ emissions during the production and processing of structural materials

It is well known that electric furnace process reduce CO₂ emissions from the production of steel and reinforcing bars (re-bar), and many construction companies in Japan are striving to reduce CO₂ emissions by accepting steel and re-bar that is produced using electric furnaces. When it comes to the cement that is needed for making concrete, the use of type-B blast-furnace slag cement likewise reduces CO₂ emissions.

(2) Construction Methods That Require Fewer Resources

Every construction company, through efforts to improve the strength of its construction materials and to re-examine structures as a result of technological developments, is able to construct buildings that use fewer resources than in the past, with no structural problems. For example, the adoption of construction methods that have a low environmental impact reduces the amount of resource inputs needed and thus effectively reduces the CO₂ emissions generated in the production of those resources.

(3) Green Purchasing

Construction companies typically use a wide variety of materials in rather high volumes and thus can have both a direct and indirect impact on the environment through their purchasing decisions.

The Japanese construction industry has thus been making efforts to promote green purchasing, taking an active role in building and maintaining a sustainable society. Using as reference the government's Basic Policy on Promoting Green Purchasing (BPPGP), construction companies have been engaging in activities to promote green purchasing (contributing to the creation of a sustainable, recycling-oriented society by taking environmental impact into account and striving to give priority to office supplies and construction materials that have a lower environmental impact).

To thoroughly implement green purchasing, it is essential that each construction company enact its own internal green procurement standards and guidelines and work to achieve its goals in cooperation with its materials suppliers. It is also important for construction companies to make proposals to its contractees and designers, encouraging them during the design phase to use recyclable resources and construction materials and to use materials with a low environmental impact.

Within this context, Japanese construction companies are approaching procurement in accordance with the BPPGP and are striving to contribute to the creation of a sustainable society. By way of example, the guidelines formulated by various companies include stipulations regarding: (1) the promotion of efforts to save energy and resources; (2) reductions in CO₂ emissions; (3) the control of waste generation; (4) the promotion of recycling; (5) the controlled use of hazardous substances; and (6) the preservation of the surrounding environment and ecosystem.

2.2 Construction Works

(1) Promoting Green Construction methods

70% of the CO₂ emissions from construction projects are derived from the use of heavy construction equipments (CEs) or the use of automotive diesel oil. Given survey results indicating that a majority of CO₂ emissions is accounted for by cranes and hydraulic shovels, it is extremely important to promote efforts to improve the efficiency of these CEs.

By using high-performance CEs that are well suited to the site conditions and type of construction works being performed, and by striving to speed up and streamline construction works, it becomes possible to cut the amount of time CEs are being operated and thus to reduce CO₂ emissions.

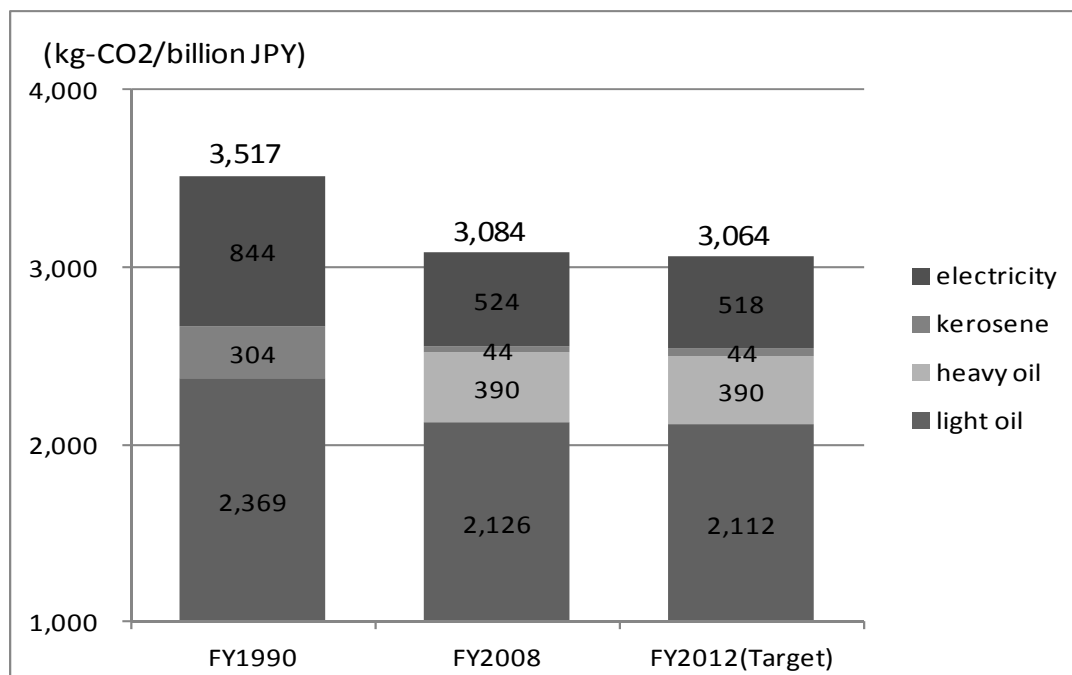
Efforts are also being made to work with manufacturers and partner companies to promote the development of hybrid heavy CEs and CEs that run on clean fuels. There are even some examples where heavy CEs that run on biodiesel fuels (BDF) are being used.

To achieve the more efficient operations of trucks and hydraulic shovels, some companies are conducting lessons on fuel-saving operating tips. They are also adding drive management systems that have eco-drive evaluation functions to their vehicles and are thus working to reduce CO₂ emissions by monitoring driving practices.

Reducing surplus soil shipment volumes and shipping distances makes it possible to improve the fuel efficiency of trucks and to reduce the distances they travel, ultimately cutting CO₂ emissions.

Survey results indicate that through these types of efforts, the CO₂ emissions in FY2008 were reduced by 12.3% as compared with FY1990.

Figure4: CO₂ emissions factor on construction industry



Source: Japan Federation of Construction Contractors “Environmental voluntary action plan of Construction Industry 4th edition (revised) (2010)”

(2) Saving Electricity

Given the impact of the Great East Japan Earthquake that struck in March 2011, the government established a target of cutting electricity use by 15% across the board, compared to 2010. In response, the major construction companies have taken various measures to achieve the goal.

Specifically, their efforts have included summer breaks for construction sites on a rotating basis, adjusting the summertime work hours, and the active use of generators. Some major construction companies have established bulletin boards showing the electricity use at their workplaces based on the idea that making it possible for people to visualize their electricity use will help remind them to conserve electricity.

As a result of these efforts, in 2011 some of the major construction companies actually exceeded the goals set by the government by a wide margin (30%).

Last year, emergency energy-saving measures were implemented, but this year, companies are looking into more long-term responses to energy conservation and are now implementing such measures. For example, some have added the enforcement of rules to perform work only during non-peak hours and a review of the procedures for using construction equipments that consumes a lot of electricity. They are also considering other efforts such as trying to use large cranes in the early morning hours and importing fuel.

If such measures are not actually implemented at construction sites, these visions will come to little more than pie-in-the-sky dreams, but the know-how of safety patrols, which have been developed through Japan's safety-first campaign, are now being applied to electricity conservation. For example, a construction manager walks around construction sites and makes inspections to determine if there are any irregularities. If a problem is found, he records the situation using a digital camera, discusses the matter in the meeting, and strives to prevent a recurrence. Such efforts raise the awareness of

workers and ensure that various measures are being diligently performed.

2.3 Zero Emissions Efforts

(1) Industry Trends

As was mentioned in section 1.3, while the government was promoting construction recycling to achieve its zero emissions goals, the Japanese construction industry has followed the trend and began its own zero emissions goals since around 2000. Efforts were made at many construction sites, particularly by general contractors, to control the amount of waste generated and to cut disposal volumes. The range of efforts taken by each company varied, but they had several elements in common: (1) reduce, (2) reuse, and (3) recycle (the 3Rs). To achieve a recycling-oriented society, construction companies are working to reduce and recycle construction by-products.

Reduction efforts include processing and pre-cutting construction materials in the factory in order to reduce wastes. Items that can be reused are reused. Companies are cutting way back on packaging, and when possible, they are delivering materials to construction sites without packaging. The modularization of interior parts has been implemented, along with the use of precast concrete floor panels, thus making every effort to ensure that no new by-products are created at construction sites.

Recycling efforts have to be made through a common awareness of their importance by everyone at the company, from the general contractor's employees to the most incidental workers on the project.

To ensure that all companies have a shared awareness of the importance of recycling, it has recommended discussions be held at the daily meetings at each work site in order to cultivate a common awareness of the zero emissions goal. At waste disposal locations, efforts should be made to ensure that waste is sorted by type and that each company has its own dumpsters. Making it possible for workers to easily and visually sort waste will ensure that more waste is sorted properly.

Items that can be recycled should be identified as such and channeled for recycling in advance. The goal is to send zero waste to landfills.

(2) Introduction of Electronic Manifests

Companies are promoting the introduction of electronic manifests (an online system for keeping logs that confirm that waste processing has been handled appropriately) as a means of properly processing industrial waste. They are now being used by more than 80% of companies, and their use is expected to become even more widespread in near future.

II. Conclusion

In Japan, construction waste accounts for the vast majority of industrial waste that is illegally dumped, and the construction of new waste-processing facilities is becoming extremely difficult.

Recycling materials into new construction materials is the most direct solution for cutting down on industrial waste.

Thus the Construction Material Recycling Law was enacted in 2002. In addition to calling for the establishment of recycling goals, the creation of a registration system for demolition companies, and the appropriate payment of additional costs related to deconstruction for recycling, it also obligates companies to engage in deconstruction and recycling. Meanwhile, the Law on Promoting Green Purchasing encourages the use of construction materials made from recycled materials.

As a result, over the past 10 years or so, nearly all of the concrete and asphalt waste produced (98%) has been recycled into aggregate for the creation of new concrete through a process of fine pulverization. However, only about 50% of surplus soil and construction sludge is recycled, and more than 70% of the mixed waste that is generated when homes are demolished is treated as waste without being recycled. Thus, greater efforts are needed to reduce and recycle construction sludge and mixed waste.

Some measures can be implemented prior to recycling. To control the generation of construction waste in advance, it is important to make efforts to extend the life (longevity) of structures like bridges and tunnels by ensuring that they are properly maintained, and to promote the use of long-life materials in residential buildings (single-family homes in Japan are generally made of wood).

In terms of policies related to construction equipments (CEs), ongoing environmental measures to deal with nitrogen oxides (NO_x) and suspended particulate matter (SPM) are being promoted, as are measures to combat global warming, such as CO₂ reduction policies. The share of Japan's total CO₂ emissions (about 1.2 billion tons) accounted for by the construction industry is less than 1%, but it is nonetheless estimated to be more than 10 million tons. To improve the fuel efficiency of CEs, efforts have been made to create manuals with tips for energy-saving use (2003) and to launch a system of certifying energy-saving CEs (2007). However, given the government's goal of reducing emissions by 25% (versus 14 million tons in 1990) by 2020, the industry has been taking even more steps in recent years to promote the dissemination of hybrid CEs that combine electric energy with diesel engines.

Meanwhile, there has been growing interest in the sustainability of water resources around the world. Thus, efforts are also being made to develop water-conservation technologies that will be useful for construction projects in areas where clean water is a particularly precious resource.

Generally speaking, saline matter is not appropriate for reinforced concrete structures, but some companies have developed technologies for using seawater to make concrete that is very fine and offers high levels of strength and durability. These technologies are expected to be used in areas of the Middle East, where water resources are particularly valuable, and they are also likely to be useful in efforts to recycle salt-containing rubble that was inundated by the tsunami generated by the Great

East Japan Earthquake. Today, joint research is being promoted among the government and some companies to facilitate the dissemination of the use of these technologies at actual construction sites.

This report has discussed environmental sustainability by focusing on three separate components: (1) the resources that are used in construction works; (2) the CO₂-reducing, energy-saving, and resource-saving measures implemented in the course of construction works; and (3) the reduction of waste generated in the construction process. As the scope of human economic activities expands, its negative aspects, such as environmental degradation, waste problems, and global warming are all becoming more serious issues. Even greater efforts must be made to address these problems if we are to ensure sustainability.