

Railways and the Environment

— Towards the Realization of Environmentally Conscious Railways —



Naoto MIFUNE
General Manager
Marketing and Business Development Division
Railway Technical Research Institute



Saburo ENDO
Chief examiner
Marketing and Business Development Division
Railway Technical Research Institute

1. Introduction

The relationship between the environment and railways features a range of diversified issues when viewed from different standpoints. It is no longer justifiable to regard railways only as a means of traffic and transport; focusing on the global environment in particular, railways obviously play an extremely important role. This paper gives a brief overview of the relationship between the environment and rail systems towards the realization of environmentally conscious railways based on a number of key issues, and summarizes the current points of issue for the environment and railways.

2. Environment

In today's society, the concept of "the environment" is often discussed with wide-ranging and ambiguous definitions. This paper defines the environment as the things that surround the activities of organizations (in this case, railway business promoters), including the atmosphere, water quality, land, resources, plants, animals, human beings and the relationships between these different factors (see the ISO 14001 standard for environmental management systems). Environmentally conscious railways are therefore those that consider not only the railway system itself or railway business promoters, but also the events and things surrounding railways and the people related to them.

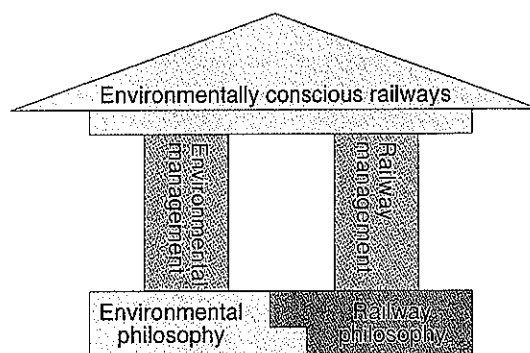


Fig. 1 Environmentally conscious railways supported by railway philosophy and environmental philosophy

3. Major sociological viewpoints for the environment and railways

3.1 Environmental philosophy and ethics

Discussions on the relationship between the environment and railways essentially involve philosophy and ideas as their basis or framework (Fig. 1). Sharing consciousness after boiling down philosophical discussions serves to clarify the points of issue and the directions to be followed. The definition of practical environmental ethics and corporate social responsibility (CSR) is made on the basis of such sharing of philosophical opinions (Table 1).

A number of fundamental questions arise here. What is the

Table 1 Major issues and viewpoints on environmentally conscious railways

Viewpoint		Major issues
Negative for the environment	Sociological viewpoint	Environmental philosophy and ethics, environmental culture, corporate social responsibility (CSR), ecological design, environmental management, environmental management system, environmental communications, environmental account, environmental reports, LOHAS etc.
	Nature-related viewpoint	Preservation of ecology, protection of wild animals and plants, preservation of views in cities and along streets, protection of production sites of the raw materials used for wooden sleepers and crushed stones, protection of water resources etc.
	Physical viewpoint	Noise, vibration, light, electromagnetic waves, dust, color, atmospheric temperature, humidity, atmospheric pressure, heat, wind etc.
	Chemical viewpoint	Harmful substances (PCB, asbestos, lead, cadmium, mercury etc.), greenhouse gases, exhaust gases (carcinogenic substances, heavy metals, VOCs etc.), soil contamination (track waysides, rolling stock base compounds), bad odors, recycling, resource saving, biodegradable substances, zero emissions, incombustible materials, dust from wear and resource exhaustion (e.g. petroleum) etc.
Positive for the environment	Others	Modal shift, intermodal transport, socially responsible investment (SRI), life cycle assessment (LCA), new energy (light, bio-energy, wind power, mini-hydraulic power, hydrogen etc.), transaction of CO ₂ exhaust rights, fuel cells, environmental taxes, eco-marks and environmental rankings
		Eco-tourism, LRT, the therapeutic effects of railways (found in railway sounds and when boarding trains), cultural railway assets and legacies (permanent tracks, station houses, tunnels), encouragement of volunteer activities (gardening in railway compounds), utilization of resources along routes (rain water, snow etc.), recycling of litter from passengers, methane fermentation of excrement, bio-mass and bio-energy, etc.

environment for railways? What should environmentally conscious railways be aiming at in terms of consideration for the environment? What is the culture of the railway environment towards this aim? Thorough discussion of railways from these viewpoints is required.

3.2 The concept of ecological design (Design for the Environment (DfE))

In-depth discussion on environmental philosophy serves to clarify the concepts of various designs (i.e. ecological designs) in consideration of the environment. The idea of ecological design not only helps to develop hardware such as rolling stock, station houses, permanent tracks, bridges, train operation diagrams and materials, but also provides universal design policies on business styles, techniques for passenger guidance and other software measures.

3.3 Environmental management

Sound management is obviously essential in order for a railway to be viable as a business entity. What and how should the stance on the environment be to contribute to the sound management of railways? If a railway wants to be recognized as an appropriate organization for environmental management, what portion of its organizational assets and profit, and to what extent, should it invest in its stance on the environment (Fig. 2)? Is it possible to quantify the value obtained from environmental investment in monetary terms from an economic viewpoint? Discussion of these fundamental issues has so far been lacking. Based on such discussions, their investigation is expected to highlight the importance of considering *environmental accounts* (i.e. the environmental balance of payments) and *green finance*.

3.4 Environmental communication

It is a prerequisite for environmentally conscious railways to appropriately and promptly release information on the environment. Such railways should also go a step further and have a mechanism for bilateral communication with stakeholders. What kind of mechanism should be in place to make the environmental management of the organization transparent to society, exclude arrogant management and allow objective evaluation by stakeholders? In railways where passengers and freight are transported every moment of every day, by what mechanism should society be able to check the appropriateness and validity of the organization's environmental judgment? Communication is an important area for environmentally conscious railways to prevent and reduce the potential risks to the environment.

3.5 The ISO 14001 standard for environmental management systems

Approximately 20,000 entities in Japan have acquired third-party ISO 14001 certification for environmental management systems, accounting for about 20% of the world total. In the railway industry as well, several hundred business promoters and those engaged in related businesses have followed suit, presumably recording the highest number in corresponding industries throughout the world. As a business mechanism in consideration of the environment, it seems significant to formulate a system in accordance with the requirements of ISO 14001, which features open fulfillment checked by third-party organizations and the simultaneous release of the acquired certification to society. However, the ISO 14001 mechanism was designed for application across all industries as a greatest common factor, and includes discrepancies when used with the particularities of railways, and also has inadequacies from the viewpoint of the stance of environmentally conscious railways. It is the responsibility of railways in Japan, that have experienced

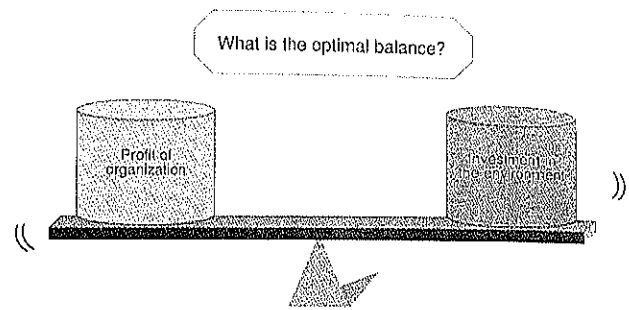


Fig. 2 Profit optimization of organizations and investment in the environment (environmentally managed organizations)

implementation of ISO 14001 with the largest number of certification holders in the world, to take the initiative in creating an environment management system for environmentally conscious railways that can function effectively in the different conditions represented by railway businesses.

From a sociological viewpoint, issues specific to railways, such as sustainable environmental development, education and reports on the environment and LOHAS should be considered.

4. Major nature-related viewpoints on the railway environment

The natural environment may have suffered somewhat as a result of the development and construction of railways, including the extension of railway lines and the building of station houses. What is the definition of environmentally conscious railways that fundamentally attach importance to the natural environment? What are railways in harmony with nature? It is necessary to discuss whether this issue can be considered in terms of observing the law only within the existing legal framework.

Nature-related viewpoints on environmentally conscious railways include concrete subjects such as the preservation of nature or protection of the ecological system, fauna and flora, views in cities and along streets, and the production sites of the raw materials used for wooden sleepers and crushed stones.

5. Major physical viewpoints on the railway environment

In what framework should the allowable range and degree of physical events input to and output from railway businesses be discussed? It is important to discuss the issues of evaluating accumulative events over time and those of evaluating factors that affect psychology. Is it possible to limit discussions to human beings alone, or is it also necessary to consider animals or plants? Can we help but evaluate these factors in terms of observing the law as in the case of the natural environment outlined above?

In concrete terms, physical considerations on environmentally conscious railways may include noise, vibration, light, electromagnetic waves, wind, dust, color, temperature, humidity and atmospheric pressure.

6. Major chemical viewpoints on the railway environment

In terms of environmental preservation, it is not necessarily possible to define a framework for the discussion of chemical substances that is applicable to railways.

There are a number of chemical substances that were initially regarded as safe but later avoided as being extremely harmful. These include PCB, asbestos, chlorofluorocarbons and other volatile organic compounds (VOCs), and other harmful

substances may also appear in the future. Refraining from the use of new chemical compounds would seem to be an effective idea, but is undesirable as it will retard the progress of technological development. In the application of newly emerged materials, therefore, it is advisable to discuss the practically conceivable outcomes from a chemical viewpoint.

There are a number of conceivable chemical viewpoints for environmentally conscious railways. These include the exclusion and purification of harmful substances (PCB, asbestos, lead, cadmium, mercury etc.), exhaust gases (greenhouse gases, carcinogenic substances, heavy metals etc.), soil contamination (track waysides, rolling stock base compounds etc.), bad odors, recycling, resource saving, biochemical (i.e. biodegradable) substances, zero emissions, incombustible materials, dehalogen materials, dust caused by wear and resource exhaustion (of crushed stones).

7. Other viewpoints on the railway environment

Issues related to the environment for environmentally conscious railways include green material distribution, modal shift, intermodal transport, socially responsible investment (SRI), life cycle assessment (LCA, LCCO₂), new energy (bio-energy, wind power, mini-hydraulic power, hydrogen etc.), bio-mass, the transaction of CO₂ exhaust rights, environmental (carbon) taxes, eco-marks and environmental rankings.

8. Positive aspects of railways for the environment

As well as the above issues that represent negative aspects for

the environment, environmentally conscious railways also contribute favorably in some ways. These include eco-tourism, LRT, the therapeutic effects of railways (found in railway sounds and when boarding trains), cultural railway assets and legacies (permanent tracks, station houses, tunnels), encouragement of volunteer activities (such as gardening in railway compounds and beautification activities in station houses), utilization of resources along routes (rain water, snow, forests), transport of harmful substances and waste materials, recycling of litter from passengers, methane fermentation of excrement, and bio-mass/bio-energy use in railway premises.

9. Conclusion

This paper summarizes the issues to be considered in discussing the relationship between the environment and railways with the goal of achieving environmentally conscious railways. Although not every conceivable issue is addressed, the reader is given some idea of the width and depth of the railway-related environment. Philosophical and sociological discussion on the environment is an area considered to be lacking with railways in Japan. Such discussion requires comprehensive debate and research, not only among environmental specialists but also by experts in the liberal arts, sciences and software/hardware technologies. The author hopes that this paper will be useful to those wishing to understand environmentally conscious railways or railways that consider the environment from a wide range of viewpoints.

JREA誌は 会員皆様の機関誌です



JREA誌は鉄道技術者が全体的な共通の基盤に立って相互に意見をのべ、それによって技術の向上をはかり、お互いの親睦を深めようとする目的で発行されている会員みなさまの機関誌です。優秀な記事に対しては毎年JREA賞により表彰が行われます。また当協会は特許法第30条による学術団体に指定されていますので、本誌での発表には学会誌と同様に「発明の新規性喪失の例外」が適用されます。この場を利用して、あなたのご意見を広くアピールしませんか。

問合せ先

社団法人 日本鉄道技術協会
JREA誌担当部長 中島英雄
TEL NTT 03-5626-2322 JR 057-3904
FAX NTT 03-5626-2325 JR 057-3904

JR Kyushu Group's Environmental Initiatives



Tomonori UWABU
Deputy Manager
Strategy Management Department
Corporate Planning Headquarters
Kyushu Railway Company

To ensure the continued implementation of measures to protect the environment, JR Kyushu set up the Ecology Committee in March 1999, headed by the president of JR Kyushu. The Committee deliberates and makes environmental decisions, including formulation of basic policies. In its mid-term management plan, which started in FY 2004, the JR Kyushu Group set one of its principles as "making contributions to the community." This gave a clear action guideline to the Group's employees that each of them shall "strive to build a better global environment" and that the Group as a whole shall conduct environmental conservation activities. In keeping with this principle, the JR Kyushu Group is actively pursuing environmental conservation activities.

1. Overview of the Ecology Committee

(1) Basic Principle and Basic Policies

Pursuant to the basic principle that "the JR Kyushu Group will devote its fullest effort to tackle global environmental problems and to help build a safe and comfortable community," the JR Kyushu Group formulated the following policies :

- (i) To provide a clean and comfortable environment for railway facilities, including stations and rolling stocks, while cooperating with local communities ;
- (ii) To use energy efficiently and to actively reduce environment-polluting substances such as carbon dioxide, reduce waste, and recycle resources ; and
- (iii) To share environmental information so that each employee will act with an awareness for environmental conservation.

(2) System for Implementation

The Ecology Committee carries out company-wide environmental conservation activities in accordance with the basic principle and basic policies described above. The president of JR Kyushu serves as the Chairman of the Committee. The Committee's executive office is set up within JR Kyushu's Strategy Management Department. The Committee is comprised of four special subcommittees in charge of environmental management, energy management, environment-polluting substances management, and resource conservation and recycling. Together, they draw up implementation plans, set targets, compile performance reports, and implement activities to tackle a wide range of environmental issues. The following introduce the major activities carried out by the subcommittees :

(i) Subcommittee for Environmental Management

Public relations, ISO certification, and enhancement of company-wide environmental awareness

(ii) Subcommittee for Energy Management

Reduction of energy consumption and efficient energy use
(iii) Subcommittee for Managing Environment-polluting Substances

Reduction and proper management of environment-polluting substances

(iv) Subcommittee for Resource Conservation and Recycling

Reduction of waste, recycling, and green purchasing

(3) Numerical Targets

Using FY 1990 as the base year and FY 2010 as the target year, JR Kyushu set the following two numerical targets in 2004 to mitigate global warming : (1) Use energy-efficient rolling stock for 60% of the conventional train operations and (2) Reduce the unit consumption of energy, which is the energy a train requires for operating one kilometer, by 6%. In FY 2006, energy-efficient rolling stock accounted for 57.9% of the trains for conventional lines for the first time, making achievement of the first target imminent. Furthermore, the unit consumption of energy has been reduced by over 20%, showing that the target has been achieved.

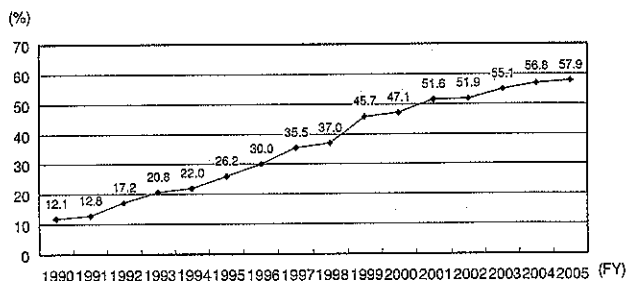


Fig. 1 Changes in the Use of Energy-efficient Rolling Stock

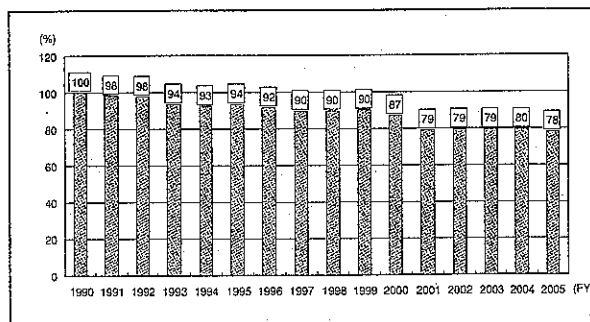


Fig. 2 Changes in the Unit Consumption of Energy Index (1990 = 100%)

(4) Ecology Committee in FY 2006

On May 30, 2006, the FY 2006 Ecology Committee held a meeting to present a report on the results of recent environmental policies and to deliberate future issues.

[Major Accomplishments]

- Acquired new ISO14001 certification : JR Kyushu Consultants Company was certified in March 2006
- Started treatment of PCB waste (May 2005)
- Removed all small incinerators at stations as a way to curb dioxins.
- Reduced raw refuse generated from the Amu Plaza Kagoshima at the Kagoshima-Chuo Station Building.

[Major Issues for the Future]

- Review the compilation of environmental report
- Hold JR Kyushu Group Ecology Committee meeting
- Energy conservation and waste measures for the new Hakata Station Building (slated for opening in Spring 2011)

2. Measures for Arresting Global Warming

Arresting global warming is a global issue. For its part, JR Kyushu is working on reducing energy consumption by using energy-efficient equipment and facilities such as energy-efficient rolling stocks and stations.

(1) Introduction of Energy-efficient Rolling Stock

Since its inauguration in 1987, JR Kyushu has introduced over 900 train cars. The new rolling stock is made with lightweight materials and/or equipped with energy-efficient equipment and engines. At the same time, the engines of existing diesel multiple units have also been replaced with fuel-efficient direct-injection engines. Through these measures, energy-efficient rolling stocks reached 57.9% of the fleet on conventional lines for the first time in FY 2006. Furthermore, 35 new cars (18 cars of the Series 813 suburban trains, 8 cars of the Series 817 suburban trains, and 9 cars of the Kiha 220 diesel multiple units) have been put into operation in FY 2006. Thus, energy-efficient rolling stocks are expected to make up 59.9% of the whole fleet by the end of FY 2006.

(2) Adoption of Energy-efficient Equipment

Energy-efficient equipment is used when constructing new stations, new station buildings, and for linear operation. Specifically, lighting equipment that automatically adjusts illumination intensity to outdoor light is used for the Chikuh Line Kyudai-gakentoshi Station that opened on September 23, 2005. Cogeneration is used at the Kagoshima-Chuo Station Building and the JR Kyushu employee-training center. New escalators installed at stations use automatically start-and-stop mechanism to adjust operation time with service needs.

3. Measures for the Reduction of Waste and Environment-polluting Substances

Waste from stations and station buildings are collected in sorted categories in accordance with regulations set up by local governments and efforts are made to reduce waste. PCB (polychlorinated biphenyl) waste and environment-polluting substances from JR Kyushu's rolling stock workshop and other facilities are stored and disposed of properly pursuant to legal requirements. Efforts are also made to reduce these substances.

(1) Reduction of Raw Refuse and Other Wastes from Station Buildings

Waste reduction was a challenge for the Amu Plaza Kagoshima at the Kagoshima-Chuo Station Building as 300 to 400 tons of raw refuse and large quantities of carton boxes and

polystyrene foam are generated from the building annually. Thus, equipment to dehydrate and compress raw refuse, equipment to compress carton boxes, and equipment to dissolve and compress polystyrene foam were installed to reduce waste and to promote recycling (carton boxes and polystyrene foam). Furthermore, reduction of raw refuse and other wastes, and the use of compost are being considered for the new Hakata Station Building slated to open in tandem with the opening of the whole Kyushu Shinkansen Line in Spring 2011.

(2) Measure for PCB Waste

PCB waste from transformers and condensers owned by JR Kyushu was stored in the company's storage facilities pursuant to the law. When the Kita-Kyushu office (Wakamatsu-ku, Kita-Kyushu City, Fukuoka Prefecture) of the government-sponsored Japan Environmental Safety Corporation (JESCO) started the treatment of PCB in May 2005, JR Kyushu took the lead among JR companies to treat and disposed of PCB waste in its possession.

(3) Elimination of Small-scale Incinerators

Subsequent to the revision of the Waste Management and Public Cleansing Law in December 2002, the use of small-scale incinerators at stations was abolished. As a measure to tackle dioxins, the idled incinerators were removed (a total of 229 units). Special method was used to prevent the scattering of dioxins during removal.

(4) Measure to Tackle Asbestos

Asbestos was used in 167 cars of the rolling stocks made during the Japanese National Railways era. Normally, the asbestos is tightly sealed and there is no danger of scattering. Nevertheless, it is removed during general inspection or dismantlement of the rolling stocks.

4. Resources Conservation and Recycling Measures

Conservation of resources and recycling not only contribute to the protection of the environment but also help reduce cost. JR Kyushu is pursuing these measures proactively.

(1) Recycling Paper Resources

JR Kyushu recycles tickets collected at stations into toilet papers. In FY 2005, approximately 78 tons of tickets (including also forms used at stations) were recycled into 610,000 rolls of toilet papers, which are used in restrooms at stations, trains, and hotels (JR Hotel Yakushima, etc.) operated by the JR Kyushu Group companies.

(2) Recycling Water Resources

A huge volume of water is used to clean train cars and parts at Kokura Workshop (Kita-Kyushu City, Fukuoka Prefecture), JR Kyushu's biggest rolling stock maintenance workshop. The wastewater from the workshop is treated and then reused at the workshop. The recycled water is also sent to the Kokura Station Building at about 2 km away for reuse. These measures help conserve about 110,000 tons of water annually. In addition, wastewater from the public bathhouse "Gokuraku-yu" at Minami-Fukuoka, operated by a JR Kyushu Group company, is treated and reused to clean train cars in the neighboring Minami-Fukuoka Electric Car Depot (Fukuoka City, Fukuoka Prefecture), contributing to the conservation of approximately 6 tons of water annually.

For experiment purpose, specially structured cartridges are installed in urinals at the men's restrooms of three stations, transforming the urinals into "waterless toilets" that require no

flushing after use. "Water-saving type toilet," which adjusts the amount of water for flushing according to the length of time the user stays in the toilet, is also installed at two stations. Increasing the use of this type of water-saving toilets at other stations is being considered for the future.

(3) Green Purchasing

Automation products and other office supplies used by JR Kyushu and other JR Kyushu Group companies are procured through the "Product Network Purchasing System" of the JR Kyushu Group. Among the 9,000 and some items, about 3,700 items are so-called "eco-products" that are made with recycled materials. The "Product Network Catalog" clearly indicates which are the eco-products to make it easy for employees to procure them.

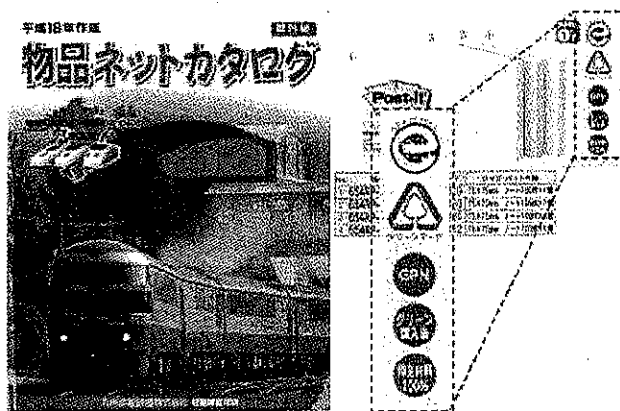


Fig. 3 Product Network Catalog

5. ISO 14001 certification

The Kokura Workshop was the first conventional train maintenance workshop among all JR companies that acquired

the ISO14001 certification, which is an international standard for environmental management system. Four other companies in the JR Kyushu Group have also been certified. JR Kyushu is working on acquiring more ISO14001 certification in the future.

(1) Kokura Workshop

The Kokura Workshop acquired the ISO14001 certification on April 21, 2000, the first among the train maintenance workshops for conventional lines of all JR companies. Since the registration area for the certification included all activities within the workshop's perimeters, JR Kyushu and JR Group companies including KSK Co., Ltd. and JR Kyushu Shoji Co., Ltd., as well as the Japan Freight Railway Company Kokura Rolling Stock workshop were certified jointly. On April 21, 2006, the companies advanced to ISO14001 : 2004.

(2) JR Kyushu Group Companies

To date, the following Group companies have acquired ISO14001 certification :

Company Name	Date of Certification
KSK Co., Ltd.	April 2000
JR Kyushu Maintenance Co., Ltd.	March 2003
Kyutetsu Corporation	March 2004
JR Kyushu Consultants Company	March 2006

6. Conclusion

In line with its basic principle and basic policies, the JR Kyushu Group will continue to contribute to the conservation of global environment through various activities carried out by the Ecology Committee. At the same time, JR Kyushu will learn from other companies their progressive and innovative approaches to optimize the eco-friendly appeal of railways.

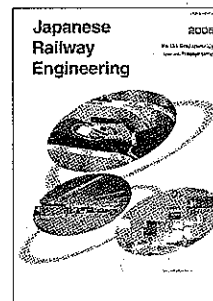
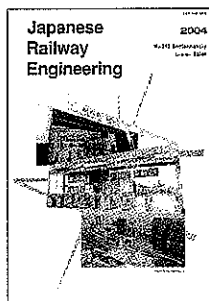
広告募集中!!

貴社の技術を海外へ紹介してみませんか?

約120にも及ぶ国々に配布しているJRE誌は、世界でも有数の専門技術誌として非常に高く評価されています。各国の交通機関や研究機関、学術関係者からの照会もあり、技術の国際交流に大いに役立っています。

広告料金 (消費税別)

	カラーA4判	白黒A4判
会 員	¥150,000	¥100,000
会員外	¥200,000	¥150,000



問合せ先

社団法人 日本鉄道技術協会
JRE誌担当部長 早川昌之
TEL NTT 03-5626-2323 JR 057-3904
FAX NTT 03-5626-2325 JR 057-3904

Execution of Environmental Protection Measures at Motosumiyoshi Station of Toyoko Line



Tomomine MORI
Project Team
Facility Engineering & Construction Division
Railway Business Unit
Tpkyu Corporation

Motosumiyoshi Station of Tokyu Toyoko Line was rebuilt as a bridge station building with execution of the quadruple tracking project for the Toyoko Line. Paralleling the new construction of the station building, various environmental protection measures such as ① photovoltaic power system, ② gardening in the station premises and ③ rainwater utilization system were accomplished with the objective of shaping Motosumiyoshi Station as a model of railway stations with consideration of environmental protection.

1. Position of Motosumiyoshi Station

Motosumiyoshi Station of Tokyu Toyoko Line is located in Kawasaki City of Kanagawa Prefecture and used by some 58,000 passengers a day (Fig. 1).

With execution of the Toyoko Line quadruple tracking project, this station was renovated from the ground-level station with 2 island platforms - 4 tracks to a bridge station with 2 island platforms - 6 tracks.

Completion of the whole Toyoko Line quadruple tracking project is scheduled for Fiscal Year 2007, and it will become

possible to offer a run-thru service on Meguro Line and secure a new route linking Toyoko Line in the directions of Yokohama · Kawasaki and center of the Metropolis city, thus attaining substantial quadruple tracking of Toyoko Line. This will radically relieve the heavy traffic on Toyoko Line.

Among the quadruple tracking projects, Toyoko Line part between Musashi-Kosugi ~ Hiyoshi was switched from the

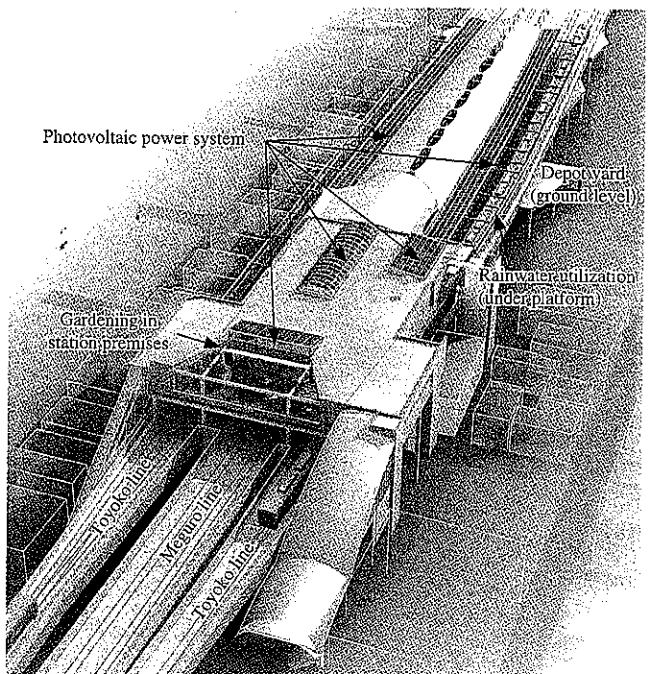


Fig. 2 Image of entire station building

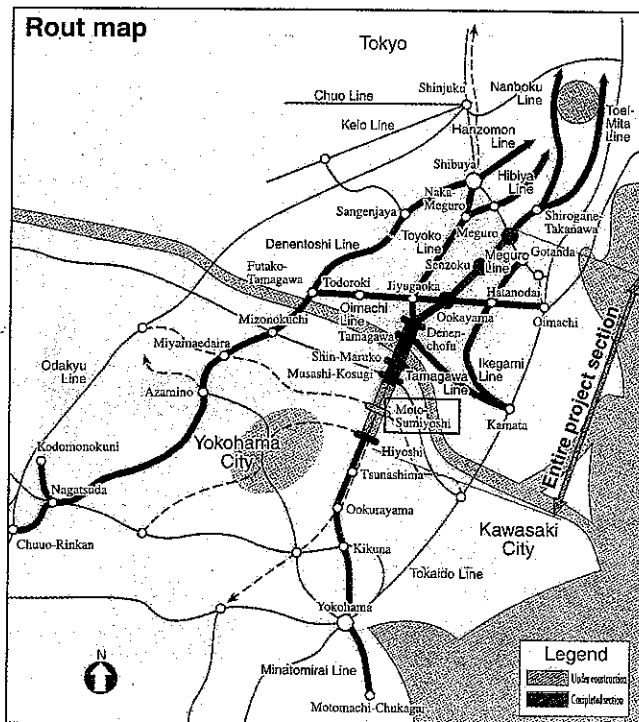


Fig. 1 Route map

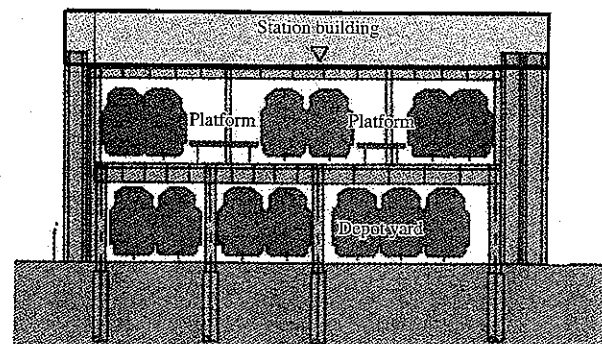


Fig. 3 Station building profile

ground level track to an elevated one toward end-September last year, and at the same time, Motosumiyoshi Station also came into service as a bridge station building.

The newly constructed station building is located about 150 m apart from the previous location toward Yokohama and designed to have the station building built above the depot yard and the commercial lines. The ticket gate floor is about 14 m high, which corresponds to the height of the 5th floor of ordinary buildings.

2. Introduction of environmental protection measures

For corporations, environmental protection is one of their social responsibilities. Tokyu Corporation is no exception to this, and the Railway Department of the Corporation is particularly concerned with reducing the operation power and directing its efforts toward reducing power consumption as it contributes to CO₂ reduction in a variety of aspects. As a part of this tackling, it was determined to accomplish the environmental protection measures to effectively use the natural energy in the station building.

In performing the environmental protection projects, Motosumiyoshi Station was selected for the reasons, mainly in the following two points.

The first point was that Motosumiyoshi Station building was a newly constructed one, and it was possible to draw up the plan with consideration given to the environmental protection measures from the designing stage. It may also be mentioned as another reason that the construction of the new station building has a higher PR effect when completed, because use of all the

station facilities can be started simultaneously as compared with the case of ordinary station renovation where partial use is started with progress of the work.

The second point was that there was no high rises in the periphery, which allowed effective use of the natural energies such as the sunlight.

3. Various environmental protection measures

Under a catch phrase [The station will be reborn as an eco-station with power of light · water · green], Motosumiyoshi Station has adopted three environmental protection measures, i.e. [Photovoltaic power system], [Gardening in station premises] and [Rainwater utilization system].

As for each method of executing these measures, studies were made not only on their installation, but also for the purpose of demonstrating the corporate attitude toward tackling the environmental issues in a more understandable manner and of promoting the passenger service with emphasis laid on [harmonization of the structural design with the environmental protection measures].

The concrete methods are described hereunder.

(1) Photovoltaic power system

In studying the photovoltaic power generation, it was determined to adopt the permeable (day-lighting) type structural member integrated panel which had been installed in Minami-Machida Station on Tokyu Line with a view to reducing lighting load during the daytime and harmonizing the appearance and structural design.

The panels are installed on the platform shed and the concourse roof as substitutes for the roofing materials. Power output capacities are some 100kW in the shed part and some 40kW in the concourse, a total of some 140kW, and the present photovoltaic power system is capable of providing some 15% of the total power demand in the whole station building. It is the first attempt for railway to install the permeable (day-lighting) type structural member integrated panel throughout the length of the platform shed. (Photo 1)

This project has been contracted out as a joint study with NEDO (New Energy and Industrial Technology Development Organization) on the structural member integrated system in the field test projects of the new photovoltaic power technologies by NEDO with a 50% grant for the photovoltaic power system project.

① Brief description of photovoltaic power system

The photovoltaic cell module is of such construction that a single crystal cell having a high conversion efficiency per unit area is laminated with reinforced glass and permeable back sheet and designed in proper sizes to match the structural member pitches. The power conditioners which convert the DC power generated by the photovoltaic cell module to system AC power are provided by dividing the up and down track platforms and in configurations of 2—50kW units for the platforms and 1—40kW unit for the concourse to prepare for their malfunction. The AC converted power is system-interconnected to the high voltage ordinary

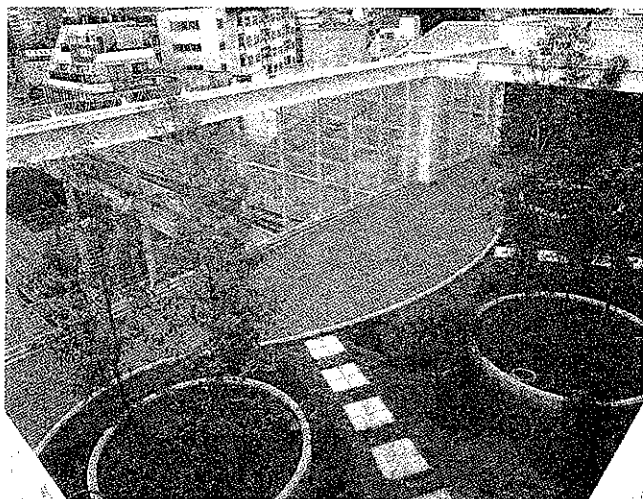


Fig. 4 Gardening in station premises

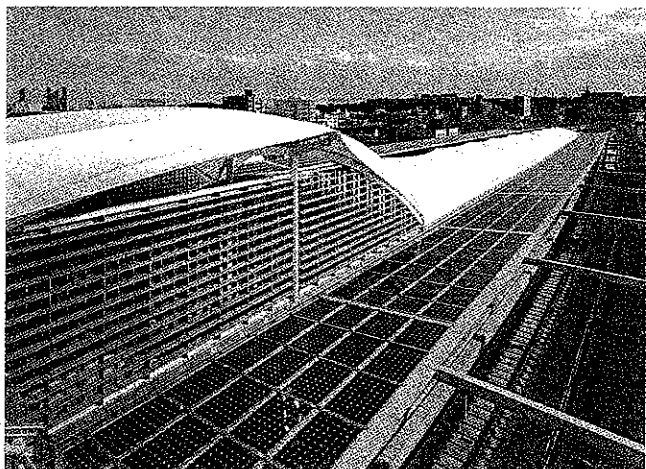


Fig. 5 External view of platform

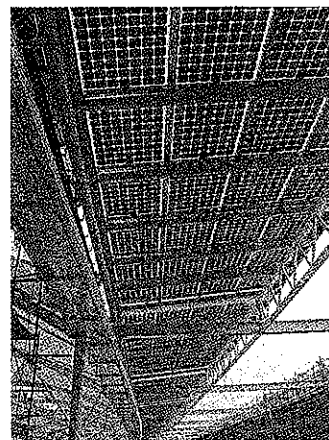


Photo 1 Internal view of platform part

distribution line and distributed to other load devices in the station.

For providing the passengers with information, our company is pursuing development of a system capable of publicizing the degree of the corporate contribution to the environment in our daily life by indicating the power generation on the large display panel installed in the concourse. The company is also envisaging to display on this large display panel the weather forecast, business advertisements, using the existing local cable network besides the information on the photovoltaic power generation.

② Comparison with known technologies

Since the known structural member integrated type panel is of such construction that the photovoltaic cell panel body is sandwiched between laminated wire glass, it has some defect in its workability due to increase in weight of the products and also presents a problem in cost efficiency. The platform shed part subject to the field of application as discussed in this paper has realized adoption of the permeable (day-lighting) type panel without increasing the product weight by changing the back sheet material of the conventional panel with the permeable (day-lighting) type. Also, the panel as a whole has about 15% permeability and is built to the specifications securing a predetermined luminous intensity in the daytime while taking counter measures against the heat on the platforms in summer.

③ Other features

(a) Top light of station building

The top light of the station building is made of double structures with wire glass installed on the lower surface (interior side) of the photovoltaic cell panel to secure its fire resistance as required.

(b) Visual effect of interior view

With use of the permeable type module, this system allows the sunlight to pass through the gaps of the cells for reducing the illumination load and the existence of the photovoltaic power system to be recognized from its silhouette in the daytime (Photo 2). On the other hand, the interior illumination is reflected upon the milky-white film attached to the back of the module (back of the wire glass in the case of the station building) in the evening, creating an interior view as if indirectly illuminated, thus different interior views can be seen day and night.

(c) Electric wiring arrangement

Since the station is designed on the basis of white color to preserve a sense of cleanliness and openness, the cables and junction boxes (current collector panels) which are indispensable for the photovoltaic power system are arranged in the least conspicuous way. The cables for collecting the power generated by the modules are housed in the aluminum sash to show their neat arrangement.

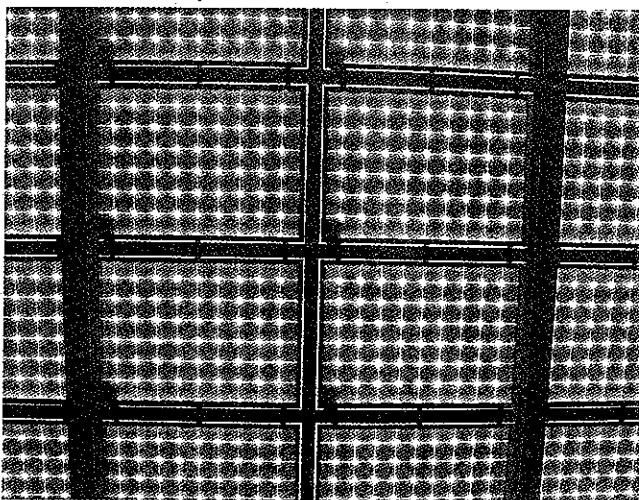


Photo 2 Internal view of station building

④ CO₂ reduction effect

It is expected that the photovoltaic power system installed in this project will produce about 121,000kWh power in a year with an effect of reducing about 73 tons of CO₂ in term of weight.

(2) Gardening in the station premises

The concourse is situated at a height of 14m from the ground level. In order to offer a place where those visiting the premises can gather and relax themselves without consciousness of this height, it was decided to arrange a green area in front of the ticket gates in the concourse. For vegetation in the green area, mainly *Quercus myrsinaefolia* and *Corous florida* are chosen as inner plants, around which boxwood and *Ophiopogon japonicus* of plant cover are arranged, and the depth of the soil layer is determined to be 300mm in consideration of the maximum load-carrying capacity. In the case of the soil layer with a depth of 300mm, quantity of water contained in the soil is limited, consequently it will become short of water unless adequate watering is performed, and there is a great possibility of interfering the growth of the plants. While in many cases electrically controlled watering means are installed, a gardening system which is capable of adequately watering without use of electricity (Terrapond System) has been adopted in view of coexistence with the environment which this station is aiming at.

Following describes the advantages of the Terrapond Method :

① Brief description of the Terrapond Method.

The Terrapond Method is comprised of :

- I. Concave-shape space formed by walls and floor surface
- II. Soil support and water supply structural members
- III. Soil

The soil support and water supply structural members are laid inside the concave-shape space to form a rainwater storage layer and the gap layer. (Fig. 6) Soil is put on the soil support and water supply structural members to form a soil layer. The water supply structural member is filled with soil having high water supply property by capillarity of the soil, which causes water to rise up to the soil layer to water the plant in the soil layer. Storing of water into the water storage layer is accomplished in such a way that rainwater penetrating through the soil layer flows into the water storage layer.

② Features of the Terrapond Method

(a) Watering by capillarity without power

Because of watering by capillarity of the soil and without power, it is possible to save time for watering and to reduce the maintenance cost of watering hoses and timer.

(b) Watering with stored rainwater

For watering with stored rainwater, it is necessary to keep the water storage layer filled with rainwater at all times. It has been confirmed by the field test conducted over one year that the storage layer was always filled with water under the average weather conditions and posed no problem in watering. It is considered that the soil covering the upper water storage layer prevents evaporation from the storage layer as compared with the case where the upper part is open.

It also allows plants to grow even in places shielded from rain such as under the elevated railway tracks if rainwater falling upon the elevated tracks are led to the storage layer built by the Terrapond Method through adequate means such as rail gutter.

(c) Rainfall runoff control

For the localized torrential rainfall that has increasingly been experienced in urban district in recent years, the gap layer built by the Terrapond Method plays a role of temporarily storing heavy rainfall. It controls rainfall runoff volume to the urban river catchment and the Earth's surface, thus contributing to lessening the urban-type water damage.

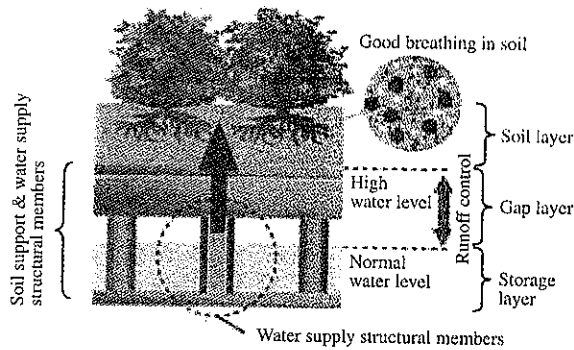


Fig. 6 Configuration of Terrapond method

(Terrapond Method : patent pending)

(3) Rainwater utilization system

Number of reports on embodiments of rainwater utilization systems are available, but few examples used in facilities like toilets in station buildings where a large volume of city water is used and where high water conservation effect by use of rainwater can be expected.

Motosumiyoshi Station Building adopts the rainwater utilization system with the aim for effective use of water resource and reduction of the sewage load. It should also be noted that about 19m³ of water are used in a day for toilet cleaning, and therefore high water conservation effect can be expected by use of rainwater.

Tokyu Corporation plans to store the rainwater from the platform shed in the rainwater storage tank (about 50m³) and re-use it as toilet cleaning water after filtering through the filter with the aim at attaining about 25% city water substitution a year.

Although use of rainwater has not yet come into widespread, it is being recognized as an established system. While this

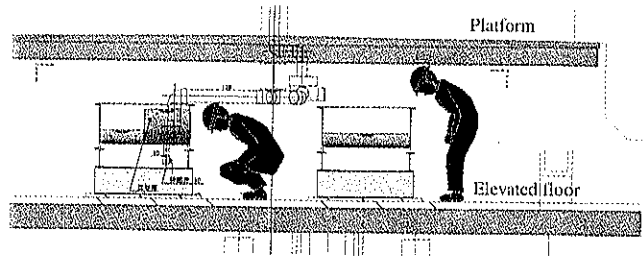


Fig. 7 Rainwater storage tank profile

planned system itself has no distinctive feature, it may be characterized by location of the installed rainwater storage tank. Differing from the ordinary structures, it is a matter of great concern where a large capacity rainwater storage tank is to be installed in the case of railway facilities. Although a site under the elevated tank or the surroundings can be proposed for its installation, it is considered promising to install the storage tank under the platform from the viewpoint of effective use of the railway site. In working up this plan, it was determined to install the rainwater storage tank under the platform after due consideration of securing the maintenance space. (Fig. 7)

In addition to the rainwater storage tank, it was determined to install a water supply pump for the toilet cleaning water system on the platform floor level rather than the ground floor level which allowed the transport power to be reduced.

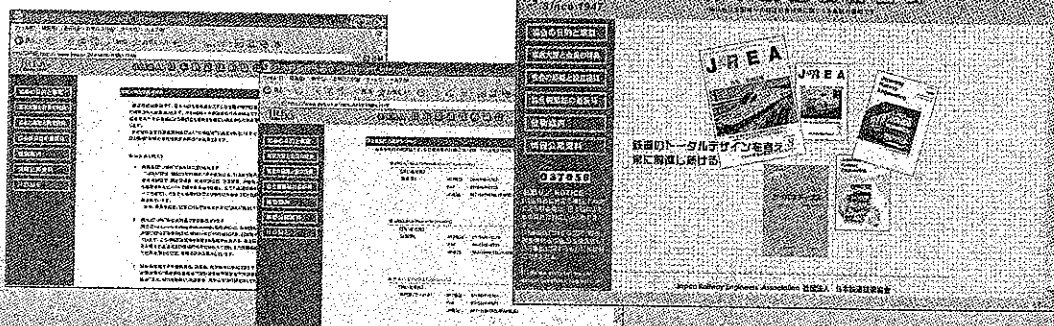
4. In conclusion

The plan introduced in this paper relates to a new station building with the harmonious coexistence of structural design and environmental protection measures, and the author believes that our corporate attitude toward tackling the environmental issue has fully been described.

Tokyu Corporation would like to actively introduce these environmental protection measures also in other stations for which renovation work is being planned on the basis of the customers' opinions and the performance of this project.

JREAのホームページをご活用ください。

<http://www.jrea.or.jp>



上記のアドレスでアクセスしてください。

JREA事業概要、機関誌最新号の内容紹介、行事開催の案内等が確認できます。