POLICIES AND IMPROVEMENT MEASURES OF ROAD ENVIRONMENT IN JAPAN

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abstract: This paper explains the current status of the road environment such as air pollution and noise in Japan and states measures being taken in Japan for improving the road environment. Further the Environment Policies for infrastructure construction lately announced by the Ministry of Construction are introduced.

1. INTRODUCTION

Japan has been experiencing rapid economic growth since 1960s. People and industries have gathered to urban areas at the same time. Transportation demand has also increased tremendously and a share of motor vehicles accounted for 60 per cent for passenger transportation and 52 per cent for freight transportation in 1993 (32 per cent and 26 per cent respectively in 1965). Car population also grew to 61.6 millions in 1993 from 7.2 millions in 1965. As a result, there has emerged traffic pollution such as air pollution, noise, vibration, etc. in roadside areas, in particular along arterial roads in the urban areas. The following chapters show the status of road environment in Japan, measures taken to alleviate road environment problems and the environmental policies lately announced by the Ministry of Construction in its jurisdiction.

2. STATUS OF ROAD ENVIRONMENT IN JAPAN

In this chapter the status of road environment in Japan is stated in respect of air pollution such as nitrogen dioxide (NO_2), suspended particulate matters (SPM), noise, etc.

2.1 Nitrogen Dioxide

There are 336 monitoring stations of NO_2 located in the roadside areas throughout the country in 1992. About 29 per cent of the stations did not meet the environmental quality standard, not more than 0.06 parts per million (ppm). They were mostly located in the metropolitan areas. Figure 1 shows the transition of annual average density of NO_2 monitored at the same 21 stations from 1971 to 1992. The density of NO_2 remains over the environmental quality standard because the traffic volume has increased so much although various improvement measures have been taken to reduce the NO_2 density.

2.2 Suspended Particulate Matters

There are also six stations monitoring SPM in the roadside areas from 1975 to 1992. The average value of the annual average densities of them has been remaining about 0.05 mg/m^3, not improving. In 1992 only 34 per cent of 182 monitoring stations near the roads met the environmental quality standard of SPM, the annual 98 per cent value of daily averages not more than 0.1 mg/m^3, while 58 per cent of 1,408 stations in other areas satisfied the standard.

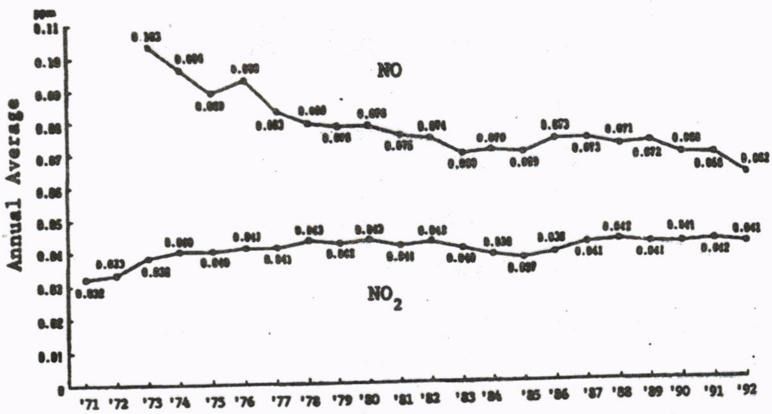


Figure 1 Annual Average Density of NO and NO2 at 21 Roadside Monitoring Stations

2.3 Other Pollutants

With regard to the sulfur dioxide, 77 of 78 monitoring stations in the roadside areas met the environmental quality standard, the annual 98 per cent value of daily averages not exceeding 0.04 ppm, in 1992 since petroleum with little sulfur has been used nowadays. A similar situation has been observed as to the carbon monoxide, of which the environmental quality standard is not more than 10 ppm in terms of the annual 98 per cent value of daily averages, since fuel combustion has been improved leading to perfect combustion due to improvements and good maintenance of vehicle engines.

2.4 Noise

There were 4,511 monitoring points of road traffic noise throughout the country in 1992. Figure 2 indicates the monitoring results. 87 per cent of the points did not meet the environmental quality standards of road traffic noise (see Table 1), and 31 per cent exceeds the request limits, over which the noise level causes requests for taking improvement measures to the prefectural security councils and/or the road administrators. The limits are stipulated 5-10 dB more than the environmental quality standards. The poor attainment is observed in the metropolitan areas and in the urban areas near the trunk roads.

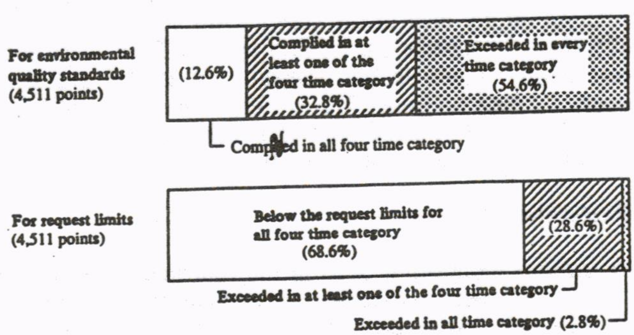


Figure 2 Compliance with Environmental Quality Standards and Request Limits

Table 1 Environmental Quality Standards for Road Traffic Noise

(in dB(A))

Category of area	Time Category		
	Daytime	Morning & evening	Night time
	Not more than	Not more than	Not more than
Type A areas facing two-lane road	55	50	45
Type A areas facing more than two-lane road	60	55	50
Type B areas facing not more two-lane road	65	60	55
Type B areas facing more than two-lane road	65	65	60

Notes: A Primarily residential areas
B Areas where a substantial number of residences are located among shops and factories.

3. IMPROVEMENT MEASURES OF ROAD ENVIRONMENT

3.1 Environmental Impact Assessment

Consideration of the environment is essential prior to determination of the highway projects so as to smoothly execute the projects successfully preventing environmental pollution and preserving the natural environment. Environmental impact assessment (EIA) is one of the leading procedures used for this purpose.

It was decided by the Cabinet meeting in 1984 to conduct united enforcement of EIA for projects to be executed by the Government and also in which the Government is involved through licensing or granting of permission. In accordance with the Cabinet decision, notifications entitled "Outline for the Enforcement of Environmental Impact Assessment Relating to Projects under the Jurisdiction of the Ministry of Construction" and "Technical Guidelines for the Environmental Impact Assessment of Highway Construction Projects under the Jurisdiction of the Ministry of Construction", were issued in 1985. Since then, EIAs relating to the highway projects have been carried out based on these notifications. The flow of the EIA procedures is indicated in Figure 3.

The following shows the projects and the environmental factors subject to the EIA.

Projects subject to EIA:

i) New construction and reconstruction of national expressways (excluding small-scale reconstruction such as the addition of an interchange);

ii) Construction of a national highway and a bypass for a national highway of four or more lanes, and widening of a national highway to add new lanes to four lanes (limited to sections exceeding 10 km in length); and

iii) Reconstruction or new construction of the Metropolitan Expressway, the Hanshin Expressway, and a designated city expressway with four or more lanes (excluding small-scale construction such as the addition of ramps).

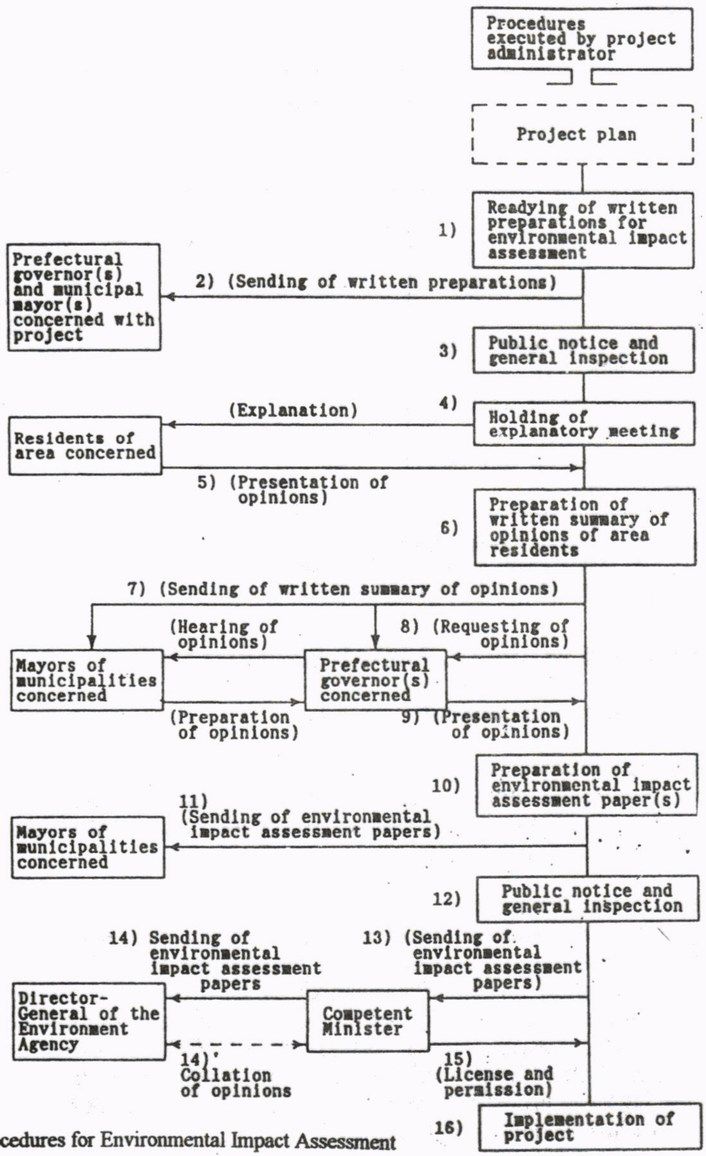


Figure 3 Procedures for Environmental Impact Assessment

Environmental factors subject to survey, prediction and assessment:

i) Factors related to pollution control
- a) Air pollution (CO and NO_2)
- b) Water pollution
- c) Noise
- d) Vibration
- e) Land subsidence

ii) Factors related to conservation of the natural environment
- f) Topography and geology
- g) Fauna
- h) Flora
- i) Landscape

3.2 Individual Measures

a. Improvement Measures for Gas Emission of Vehicles

Regarding the air pollution, the basic measures are the source control. While manufacturing improvements of automobiles are presently going on, there are also the development and dissemination of low pollution vehicles.

i) Gasoline Engine

Nitrogen oxides (NOx) in the exhaust gas is a product of reaction between nitrogen and oxygen in the air during high temperature combustion. The temperature of combustion is a very important factor. One way to reduce the emission of NOx is the Exhaust Gas Recirculation (EGR) technology that recirculates exhaust gas into intake air in order to lower the combustion temperature and slow down the speed of combustion. The technology has been found to be quite effective in decreasing NOx. This is because the exhaust gas includes large amount of inactive CO_2 and H_2O.

The catalyzer method is another effective means for reducing pollutants in the exhaust gas. The ternary catalyzer almost thoroughly removes three elements of the exhaust gas, CO, HC and NOx. The electric fuel injection system supports this method by maintaining the narrow range of air-fuel ratio, which makes a certain mixture ratio of the three elements, under which the resolution of the elements takes place.

ii) Diesel Engine

If we look at the combustion in the engine, Ox is mostly produced at a time of high temperature combustion immediately after fuel injection. Provided the combustion temperature is lowered and the fuel injection timing is delayed, the emission of NOx can be reduced. These are major means being utilized for the reduction of pollutants by the diesel engines.

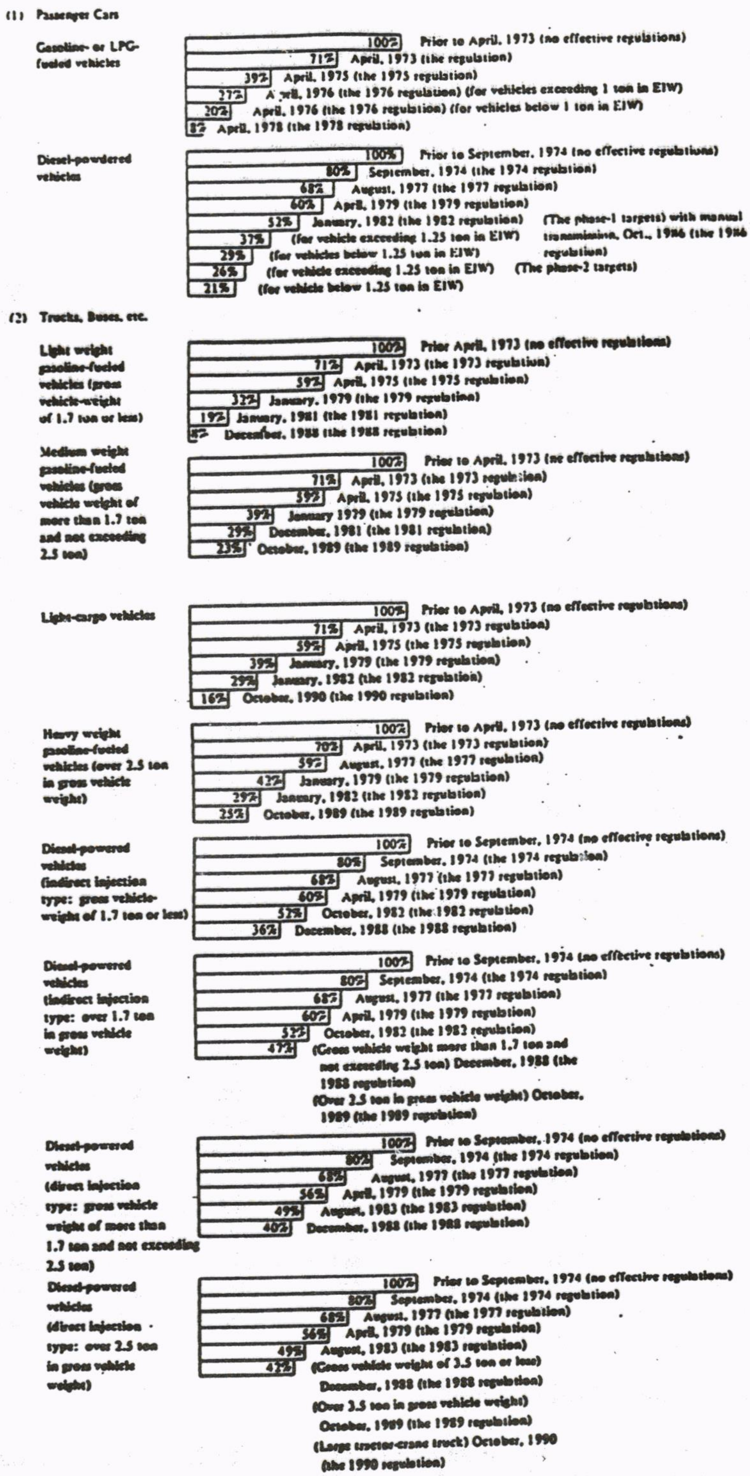
The catalyzer used for the gasoline engine, however, is not effective for the diesel vehicles since soot is contained in the exhaust gas. Even if the soot is excluded, NOx is still difficult to remove because the fuel-air ratio is lower than that of gasoline engine.

iii) Exhaust Regulations

The regulations on the automotive exhaust gases are enforced by engine model in respect of the four matters, CO, HC, NOx and soot (the soot for diesel vehicles only). Since the influence of vehicle weight is significant for gasoline cargo vehicles, regulation values differ according to the vehicle weight. Density regulations are adopted for the diesel vehicles by combustion chamber model. For passenger vehicles, of which contribution is confined only to CO and HC emission, the emission has been drastically reduced by the enforcement of the 1975 regulations. Regulations on NOx have been gradually strengthened since 1973 and further reduction of about 10 per cent has been achieved by the 1978 regulations. For the cargo vehicles the 1988 to 1990 regulations led to 15 to 60 per cent reduction in NOx of gasoline vehicles and 10 to 20 per cent reduction in NOx of diesel vehicles. Figure 4 shows the regulations on NOx emission thus far.

b. Development of Low Pollution Vehicles

As mentioned above, in combination with improvements of gasoline and diesel engines, the development and dissemination of low pollution vehicles are also important to improve the gas emission of vehicles. Table 2 is a summary of comparison of various cars, including low pollution vehicles using substitute fuels for gasoline and diesel oil, under development/research throughout the world. Only a few kinds of them are in practical use



Note: EIW is the abbreviation for equivalent inertia weight.

Figure 4 Effects of Regulation on Automobile Exhaust (Average Values of NOx Permission)

Table 2 Comparison of Various Vehicles

		Environmental Impacts a)			Crusing Distance c)	Features / Issues	Current Status	Practical Use
		CO_2 b)	NOx	Soot				
Gasoline Vehicles		C	C	C	1	Well-balanced performance		C
Diesel Vehicles		B	E(DI)d) D(IDI)	E	1.2	Low CO2 emission Need to cut NOx, soot emisson		C
Electric Vehicles		A	A	A	0.1~0.15	Need to develop battery of high performance	Milk delivery cars in U.K. Garbage collecting cars in Yokohama	D~E
Methanol Vehicles	Otto Type	C e)	C	C	0.5	Substitute fuel for petroleum Need to improve ignition under low temperature		D
	Diesel Type	A~C e)	D	C	0.6	Possible to cut NOx, soot emission Need to cut emission of formaldehyde Need to improve engine durability		
Natural Gas Vehicles		B	C	C	0.15~0.25	Exhaust gas as clean as gasoline engine Need to improve fuel supply system	Hundred thousands of units in practical use in areas producing natural gas	D
Hybrid Vehicles	Diesel + Electric	B	D	D	1.3	Possible to reduce NOx, soot emission Need to develop battery of high performance	At stage of experiment / concept design	C
	Diesel + Accumulated Oil Pressure	B	D	D	1.3	Possible to reduce NOx, soot emission Need to develop container for high pressure		C
Hydrogen Vehicles		A~D f)	C	A	0.17~0.25	Need to develop solar storage technology	At stage of research	E
Solar Cars		A	A	A	–	Need to develop solar battery of high performance	Hundreds of units in use in Switzerland	E

a) In comparison with gasoline vehicles (A ← good - poor → E).
b) From fuel production to consumption.
c) In comparison under the same fuel tank volume.
d) DI:Direct Injection, IDI:Indirect Injection.
e) Methanol produced from natural gas.
f) A:Solar power, D:Hydrogen produced from natural gas.

due to high cost and insufficient performance compared to the existing cars and most types of the low pollution vehicles are still to be developed further.

c. Road Structure Measures

Although road structures are determined considering topography, ground stability, land use in roadside areas, etc., they have a strong influence on noise propagation in the roadside areas. Noise level distribution is shown for some road structures such as flat, cut, fill and elevated sections in Figure 5. For specific spots which need further noise reduction, roads can be imagined as covered canal structures, shelter or semi-shelter structures (shelter structures which have air openings on top). However, in using these types of structures, it is important to take into consideration ventilation of exhaust gases and construction cost.

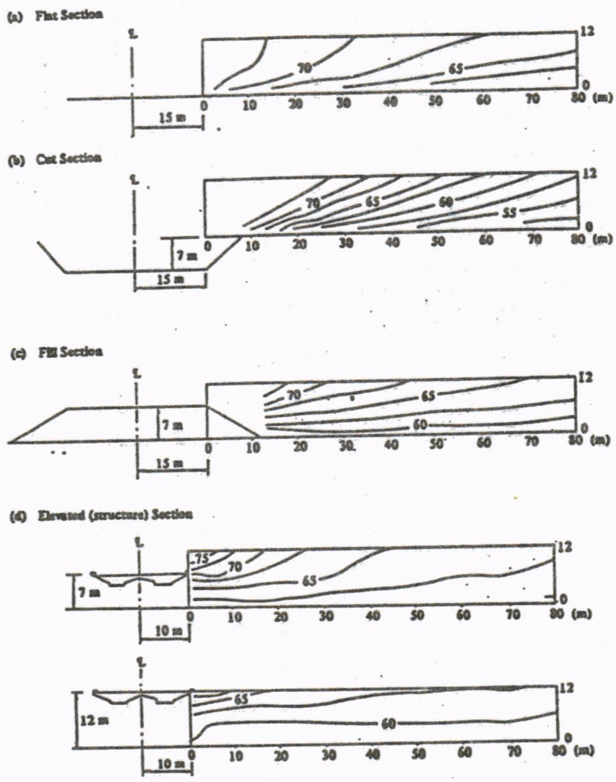


Figure 5 Noise Propagation in Various Road Sections (Unit: dB)
(Four lane roads; Traffic volume: 1,600/h/lane; Traffic speed: 60 km/h; Ratio of heavy vehicles: 15 %)

d. Noise Barriers

The noise barriers produce positive effects in noise reduction and further they are easily established as far as access to roads is controlled. There are two kinds of noise barriers, a reflection type and an absorption type. In case that the reflected sound matters on the opposite side of the barrier, the absorption type should be used. If the height of the barrier increases to obtain more noise reduction, it may cause problems in sunlight and scenery obstructions, and in the foundation of the barrier. In order to avoid such problems, a sound absorbing device can be installed on the top of the barrier with less height of the ordinary barrier to reduce diffracted sound more than the ordinary one (see Figure 6). Transparent panels for the barrier and greening of the barriers can improve the sunlight and scenery problems.

e. Porous Asphalt Pavement

About two million m ^{2} of porous asphalt pavement has been constructed so far in Japan. The porous asphalt pavement has a noise reduction effect by 3-5 dB compared with the ordinary asphalt pavement. Figure 7 shows difference of noise power levels of heavy duty vehicles by pavement type and by running speed of the vehicles. The noise power level of the porous pavement with pore ratio of 20 per cent and with thickness of 5 cm is about 110 dB at the speed of 80 km/h, about 3 dB lower than that of the ordinary pavement. There, however, is an issue that the effect does not last long. It usually continues only a few years because the pores of the pavement get clogged up due to structural destruction of a surface course and accumulation of dirt.

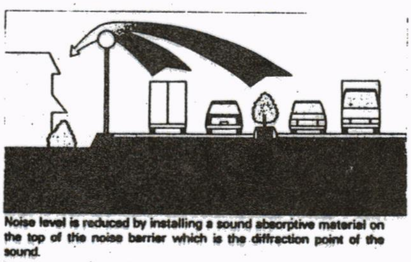


Figure 6 New Type Noise Barrier

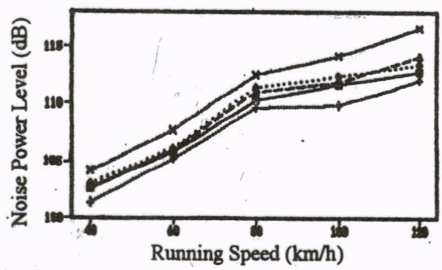


Figure7 Noise Power Levels of Heavy Truck by Pavement Type
× Ordinary Pavement
△ Porous Pavement (Pore Ratio 15%, Thickness 5cm)
□ Porous Pavement (Pore Ratio 20%, Thickness 5cm)
\+ Porous Pavement (Pore Ratio 20%, Thickness 10cm)
◇ Porous Pavement (Pore Ratio 25%, Thickness 5cm)

f. Buffer Zone

In order to maintain the good living environment along roads, some part of road width has to be allocated to environmental buffer zones. They separate vehicles further from noise receivers in the roadside areas to provide the distance attenuation of traffic noise. The buffer zones usually comprise the green belts, service roads, pedestrian and bicycle paths, and noise barriers/embankments. Typical buffer zones can be seen at the Tokyo outer ring road (see Figure 8).

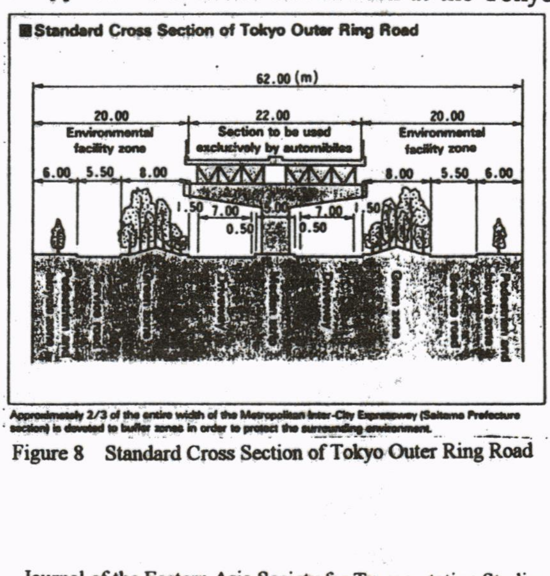


Figure 8 Standard Cross Section of Tokyo Outer Ring Road

g. Sound Proofing of Residential Houses

Subsidization for the sound-proofing of residential houses is being conducted under "Notification on the Subsidizing for Sound-proofing of Residential Houses in the Vicinity of Expressways" issued in 1976 by the Ministry of Construction and under the Roadside Law (see **3.3 h.**). This scheme is applied to residential houses near the expressways or the arterial roads designated under the Law provided the noise level at the outside of the houses exceeds 65 dB. Installation of sound-proof sashes and walls, air-conditioners and ventilating fans is to be carried out for such houses. Table 3 indicates an effect of the sound-proofing of houses.

Table 3 Noise Reduction by Sound-proofing of Houses

Structure	Before sound-proofing			After sound-proofing			Effect of sound-proofing
	Outdoor	Indoor (window closed)	Level diff.	Outdoor	Indoor (window closed)	Level diff.	
Wooden house	68	47	21	69	40	29	8
RC house	68	45	23	68	37	31	8

h. Land Use Adjustment in Roadside Areas

Appropriate land use should be taken in the roadside areas to materialize harmony of the areas and the roads in case of the arterial roads in particular. The land use of such areas needs to be adjusted to a commercial/industrial use. The Roadside Law has such objectives as promotion of this land use adjustment. Various measures for improvement of the roadside environment are stipulated in the Law as follows:

i) interest-free loan for purchase of roadside land by the local governments;

ii) subsidy for construction of buffer buildings and preparation of land for the buildings;

iii) subsidy for sound-proof works of residential houses; and

iv) regulations on structures of buildings.

These measures are incorporated in a roadside-improvement plan, which is decided as an urban plan, for the arterial roads designated under the Law. As of the end of 1993, five road sections totalling 83.5 km were designated by the Law and the roadside improvement plans for those of 63.3 km have been established.

i. Harmony with Natural Environment (Eco-road Projects)

Japan has a diversified natural environment with the four seasons. It is important for us to conserve our natural environment while we enjoy it. We must be sure to pass it in good condition to the next generation. Highway projects in areas where a rich natural environment existed were previously executed mainly taking into account the conservation of important animals and vegetation, and the harmony of the highways and scenic views. Now, however, people demand not only the conservation of precious species in the natural environment but also the creation of harmony between highway improvements and the entire ecosystem, including commonly seen flora and fauna. We must, therefore, conduct accurate environmental impact assessments prior to future highway-improvement projects. At the same time we must respond appropriately to these demands, achieving the harmony of each highway and the natural environment from the following viewpoints.

i) We will implement detailed research regarding the natural environment, and work to accumulate data on it to devise highway plans that harmonize with it. We must simultaneously select routes that will enable the conservation of the richness of nature, and must adopt a structure and form for each highway to avoid major changes in the topography and vegetation.

ii) We must take the lead in the appropriate utilization of highways in harmony with nature in areas where is a particularly lush and valuable natural environment, such as national parks. This can be done by improving the parking areas near the base positions in such areas, to have users transfer from their vehicles to buses, etc.

iii) We will disseminate "eco-roads" with structures that have been designed with thorough consideration of ecosystems. This can be accomplished in such ways as the posting of signs saying, "Caution : animals," and by the establishment of highway-crossing structures solely for animal trails. This will prevent the partition of animal habitats.

iv) We will restore the surfaces of cuts and embankments generated in the course of highway construction projects, as closely as possible to their natural condition. This will be effected by replanting trees and by making particular use of the vegetation (potential natural vegetation) that is most harmonious with the natural conditions such as the soil, local climate and the existing stock of local vegetation.

v) We will create an optimal environment for the growth of vegetation and for a use as an animal habitat. This is possible by designating the species of trees to be planted, considering the existing condition of the natural environment in the area where the highway improvement project is to be carried out.

4. ENVIRONMENT POLICIES FOR INFRASTRUCTURE CONSTRUCTION

The Ministry of Construction announced the Environment Policies for Infrastructure Construction under its jurisdiction in January 1994. The Policies are based on the recommendations of the committee for the rich environment set up in the Ministry and the concepts of the basic environment law enacted in November 1993. The outline of the Policies is summarized as follows.

4.1 Basic Concepts of the Policies

We should recognize that the creation and conservation of environment are proper missions of the construction administration. This means that the environment is an internal/built-in target of the construction administration. These basic concepts should be reflected as below in the course of infrastructure construction for well-balanced national land development.

i) To create beautiful and cultural environment full of green trees, affluent water and open space and encouraging human communications, taking into account local features, and to hand over such environment to the future generations;

ii) To preserve rich natural environment as much as possible and to minimize impacts on the environment in the course of infrastructure construction through mitigation measures considering less consumption of resources/energy and recycling of resources; and

iii) To contribute to the global environment issues such as the global climate change, destruction of ozone layer and deforestation of tropical rain forests, and to promote international cooperation in the environment field taking advantage of our environment-related experiences.

4.2 Road-related Issues/Measures under the Policies

Road-related environmental issues and measures under the Policies are detailed as below:

i) Scenery designs need to be considered more for road facilities including green belts, communication plazas, etc. so that people can feel relaxed and communicate each other.

ii) Roads need to be constructed as environmental space from a viewpoint of easiness of walking, provision of open space, etc.

iii) Historical roads should be restored, preserved and inherited to the future generations.

iv) Road alignments and structures should be considered so as to be in harmony with the natural environment on a basis of survey results of the local natural environment including fauna, flora, topographical features, etc. (see **3.3 i.** for details)

v) Environmental measures should be taken for road transportation from viewpoints of less energy consumption and the protection of roadside environment.

vi) Regional road environment programs are to be formulated, stipulating basic directions as stated above, targets and measures to attain the targets, and to be executed.