6.4.4 Financial Evaluation

(1) Method

1) General

The present financial analysis intends the financial evaluation of the planned investment in the Hanoi - Ho Chi Minh Railway Improvement Project to be managed by the VNR. The basic policies of the MS mainly focus on technical fields under the plan to consolidate the railway infrastructure in order to secure the higher safety and reliability of the railway transport system, destroyed by war and overdriven through years, and at the same time to promote transport efficiency by speeding up of trains, thus making railways play more important role in the national economy of Viet Nam. The VNR prepared the Development Strategy for the period between 2000 and 2020 in December, 1993 and an official meeting attended by all related ministries and agencies, etc. was held in March, 1994. The Prime Minister concluded the meeting by stating the basic development policies and several key issues for future improvement. The key points directly relating to financial management are listed below.

- Separate accounting for railway infrastructure and railway business operation: the VNR will specialise in railway business operation.
- Components of railway infrastructure: track, bridges, tunnels, signalling/ communication facilities and stations and their economic administrative accounting.
- Components of railway business operation: passenger transport, freight transport and railway industry (like other transport business modes, these will be organized, managed and accounted in accordance with the Business Operation Accounting System).
- The Ministry of Finance is entrusted with enacting regulations to conduct guidance and inspection of implementation. The guidance and inspection mechanism will be applied from January 1, 1994.
- Funds to be invested in business creation, operation and the renewal and modernisation of facilities should be generated by the railway sector itself, originating from operating profits, joint ventures and/or self-arranged loans. Outstanding financial losses for the period between fiscal 1988 and fiscal 1993 will be cleared off and the new accounting mechanism for business operation will become applicable in fiscal 1994. The Ministry of Finance will conduct a special

audit on the above outstanding losses and will make a final decision on the future of these losses in the 2nd quarter of fiscal 1994.

Note: Detailed information on the New Accounting Mechanism has not yet been obtained at the time of writing the present report.

As typically illustrated by the use of the old-fashioned statement of assets and liabilities based on the fixed allocation method, the financial and accounting structures of the VNR are rather incomplete and primitive, as are the general structure and contents of the financial statements. In fact, there is no clear distinction between own capital and borrowed capital. Values obtained from counterparts were utilized as far as possible in the analysis.

2) Pre-Conditions for Analysis: Relationship Between Hanoi - Ho Chi Minh Railway's Revenue and Expenditure and Its Investment Burden

Based on the government policies described in 1) above, the following statements can be made.

a) The entire planned investment for improvement of the Hanoi - Ho Chi Minh Railway will be met by the Infrastructure Account except that for rolling stock and workshops/depots. Accordingly, the VNR will only be responsible for the management of structures of which the improvement cost is met by the government and which are provided by the government for use by the VNR. In principle, the VNR will only be responsible for the maintenance cost of such structures.

b) As the rolling stock is a proper asset of the VNR, the VNR will be responsible for the rolling stock procurement and rehabilitation costs. Only that rolling stock to be used for the Hanoi - Ho Chi Minh Railway will be considered for the present improvement work. In short, the Transport Sector will procure the necessary quantity of new rolling stock from the Manufacturing Sector or overseas manufacturers. As in the case of the economic analysis, import tariffs will not be considered and the estimated prices in foreign currency will be directly treated as the market prices.

It is not always appropriate to account rehabilitation as new assets because repair work will be done on a whole range of out-of-order rolling stock for which book values are unclear, and for which service life after rehabilitation cannot be known for certain. However for this analysis, such rolling stock shall be treated as the equivalent of newly procured rolling stock with an assumed service life of 25 years. Rehabilitation costs however, are calculated as 70% of the cost of new rolling stock procurement.

c) Investment into workshops counts as investment into the Manufacturing (Industrial) Division, which is a separate accounting unit within the VNR, and its yield is the production of new rolling stock from the said Division. Such investment cost can be regarded as part of the consideration of goods and services the Manufacturing Division pays to the Transportation Division, however because investment into the Gia Lam Workshop can be considered indispensable to the operation of the Hanoi-Ho Chi Minh Railway and therefore vital to the Project, it has been included in the direct investment together with rolling stock but with service life set at 20 years.

(2) Revenue and Expenditure

1) Revenue from Train Fares

The method to estimate the revenue from train fares is based on the average train fare in fiscal 1993. The transportation volume in the target year is given by the demand forecast. The passenger fare increase rate is set at 2.02% for each hour of the shortened travelling time between Hanoi and Ho Chi Minh City, taking the current differences of the soft seat fares of different types of express trains into consideration. The resulting passenger fare increase rates of the different Alternatives are given below.

Alternative I (24 hours: shortened by 12 hours)	:	24.2% increase
Alternative II (30 hours: shortened by 6 hours)	:	12% increase
Alternative III (27 hours:shortened by 9 hours)	:	18.2% increase

(Limited express time in Alternative III is 25 hours, however because the times of inter-regional express and local trains are slower, the average train time becomes 27 hours).

No freight fare increase is considered.

The estimated revenues in the final target year (2010) of the different Alternatives are given below.

[Alternative I]

Passenger : total persons/km/day 17,258,476 = 6,299.34 million persons·km/year

unit fare 146.6 Dong × 1.242 = 182.1 Dong/person/km

annual revenue 182.1 Dong/person/km × 6,299.34 million persons·km/year = 1,147,103 million Dong (104.28 million US$)

Freight : total tons/km/day 7,670,136 = 2,799.60 million tons·km/year

unit fare 228.7 Dong/ton/km

annual revenue 228.7 Dong/tons/km × 2,799.60 million tons·km/year = 640,269 million Dong (58.21 million US$)

[Alternative II]

Passenger : total persons/km/day 10,808,728 = 3,945.19 million persons·km/year

unit fare 146.6 Dong × 1.12 = 164.24 Dong/person/km

annual revenue 164.2 Dong/person/km × 3,945.19 million persons·km/year = 647,800 million Dong (58.89 million US$)

Freight : total tons/km/day 6,146,742 = 2,243.56 million tons·km/year

unit fare 228.7 Dong/ton/km

annual revenue 228.7 Dong/ton/km × 2,243.56 million tons·km/year = 513,111 million Dong (46.65 million US$)

[Alternative III]

Passenger : total person/km/day 14,042,082 = 5,118.79 million person·km/year

unit fare 146.6 Dong × 1.182 = 173.3 Dong/person/km

annual revenue 173.3 Dong/person/km × 5,118.79 million person/km = 887,086 million Dong (80.64 million US$)

Freight : total ton/km/day 6,709.468 = 2,448.96 million ton/km/year

unit fare 228.7 Dong/ton/km

annual revenue 228.7 Dong/ton/km × 2,448.96 million ton/km = 560,076 million Dong (50.92 million US$)

2) Management and Operation Costs

The calculations of management and operation costs for each Alternative are as follows.

a) Setting of Base Units

Because detailed contents on personnel and material costs cannot be gathered from the financial statements and materials received from the VNR, rough mean values were taken from the data on actual performance in 1993 and estimated as standard values.

Personnel Costs

total: 167,485 million Dong (salaries and social welfare costs),
total personnel: 47,000 (35,250 if looking only at the transportation sector),
personnel cost per worker: 167,485 47,000 = 3.564 million Dong.

Material Costs

total: 221,311 million Dong (total of materials, fuel, power and other overhead costs),
transportation amount: 2.699 million person·ton·km (person·km and ton·km are simply added in the VNR),
material cost per person·ton·km: 221,311 ÷ 2,699 = 81.997 Dong/person·ton·km.

The estimated personnel and material costs in 2010 are shown below.

Material costs are calculated by multiplying the above base unit with the expected volume of business (increased management and operation costs that accompany investment are absorbed in the increased total).

Total personnel costs are calculated by first estimating the number of personnel required to operate the Hanoi-Ho Chi Minh Railway, with productivity as a factor, and multiplying that by the above personnel cost per worker.

b) Examination of Productivity

The following indicates a comparison in the productivity levels of the current VNR and Japan Railways (JR) in 1986.

VNR productivity (1993):

2,699 million person·ton·km ÷ 47,000 = 57,400 person·ton·km per worker.

JR productivity (1986): ....975,400 person·ton·km per worker.

Difference ratio: 57.4 / 975.4 = ... $\frac{1}{16.99}$

Assuming that the economic differences between Japan and Vietnam disappear in the future, say, in 45 - 50 years hence and that the productivity of the VNR and JR equalize at that time, the productivity of the VNR in 2010 can be estimated as 6.62 times its present value. 2010 productivity levels are then assumed in relation to the scale of investment for each Alternative.

Alternative I: productivity in 2010: 57.4 × 6.62 = 380,000 person·ton·km per worker,

Alternative II: multiply by 0.75 (ratio of investment in II compared to I): 380 × 0.75 ≒ 290,000 person·ton·km per worker,

Alternative III: multiply by 0.87 (ratio of investment in IIIcompared to I): 380 × 0.87 ≒ 330,000 person·ton/km per worker.

Compared with the productivity levels in other countries, the value of 380,000 - 290,000 person·ton·km per worker seems to be reasonable.

c) Calculation Results

[Personnel Plan]

	Transportation Volume (person·ton·km)	Productivity (person·ton·km)	Personnel (persons)
Alternative I	9,099 million	380,000	23,945
Alternative II	6,189 million	290,000	21,341
Alternative III	7,568 million	330,000	22,933

[Management and Operation Costs]

[Material Costs]

Alternative I	81,997 Dong/person·ton·km	× 9,099 million person·ton·km = 746,091 million Dong (67.83 million US$)
Alternative II	81,997 Dong/person·ton·km	× 6,189 million person·ton·km = 507,479 million Dong (46.13 million US$)
Alternative III	81,997 Dong/person·ton·km	× 7,568 million person·ton·km = 620,553 million Dong (56.41 million US$)

[Personnel Costs]

Alternative I	3.564 million Dong	× 23,945 = 85,340 million Dong (7.76 million US$)
Alternative II	3.564 million Dong	× 21,341 = 76,059 million Dong (6.91 million US$)
Alternative III	3.564 million Dong	× 22,933 = 81,733 million Dong (7.43 million US$)

d) Management and Operation Costs in Case of Without Investment

① In the case where no investment is made, it is estimated that repair costs will increase by 2.5 times the 1993 value in 2010, using American corporate analysis data.

	1993	2010	(1993 × 2.5)
Personnel Costs	167,485 million Dong	418,713 million Dong	
Material Costs	221,311	553,277	
Total	388,796	971,990	

② The increase in management and operation costs due to the increase in person·ton·km is as follows.

a. In 2010 without investment .... 2,800 million person·ton·km

b. In 1993 .... 2,699 "

.... a ÷ b = 1.0374

Personnel costs:

167,485 million Dong × 1.03742 = 173,753 million Dong
(an increase of 6,268 million Dong)

Material costs:

221,311 million Dong × 1.03742 = 229,593 million Dong
(an increase of 8,282 million Dong)

The increase in management and operation costs is therefore:

6,268 + 8,282 = 14,550 million Dong.

③ Management and Operation Costs in 2010 in Case of No Investment

Personnel costs:	418,713	+	6,268	= 424,981 million Dong
Material costs:	553,277	+	8,282	= 561,559 million Dong
	Total			986,540 million Dong

(Attached Table) Management and Operation Costs Overall Table

		1993	2010
Alternative I	Personnel Costs	167,485 million Dong (15.226 million US$)	85,340 million Dong (7.758 million US$)
	Material Costs	221,311 million Dong (20.119 million US$)	(746,091 million Dong (67.826 million US$)
	Total	388,796 million Dong (35.345 million US$)	831,431million Dong (75.584 million US$)
Alternative II	Personnel Costs	167,485 million Dong	76,059 million Dong (6.915 million US$)
	Material Costs	221,311 million Dong	507,479 million Dong (46.134 million US$)
	Total	388,796 million Dong	583,538 million Dong (53.049 million US$)
Alternative III	Personnel Costs	167,485 million Dong	81,733 million Dong (7.430 million US$)
	Material Costs	221,311 million Dong	620,553 million Dong (56.414 million US$)
	Total	388,796 million Dong	702,286 million Dong (63.844 million US$)

No Investment Case	Personnel Costs	167,485 million Dong	424,981 million Dong (38.635 million US$)
	Material Costs	221,311 million Dong	561,559 million Dong (51.051 million US$)
	Total	388,796 million Dong	986,540 million Dong (89.685 million US$)

3) Investment and Depreciation

In the VNR, the only assets for which service life and depreciation rates are set are almost exclusively rolling stock. For constructions such as bridges and track etc., no depreciation is considered and service life isn't prescribed, however an annual Big Repair Depreciation rate of 2-4% is applied. This is in reality a repair allowance and in fiscal 1993, this amounted to 22,000 million Dong while basic depreciation costs were 75,000 million Dong. However, even when both figures are combined, the depreciation rate for say 1992 comes to only 2.85% which makes it hard to accept that it is being strictly implemented.

Concerning the procured (and rehabilitated) engines, passenger cars and freight cars to be introduced to the Hanoi-Ho Chi Minh Railway under the Investment Plan, the VNR regulations set engine service life at 25 years and passenger and freight car service life at 30 years. In this analysis however, the service life of all rolling stock is set at a uniform 25 years to give a straight line depreciation of the initial investment over that period. Regarding investment into workshops and depots, the VNR does not set any specific provisions, however service life is assumed as 20 years, in accordance with practices in other countries.

The investment schedule is as follows.

[Rolling Stock] Procured and rehabilitated rolling stock total

million Dong

		Alternative I	Alternative II	Alternative III
Phase 1 1995-2000		1,640,760 (149.16 million $)	1,081,520 (98.32 million $)	1,204,280 (109.48 million $)
Draw down 6 years	(÷ 6)	273,460 (24.86 million $)	180,253 (16.39 million $)	200,713 (18.25 million $)
Annual depreciation	(÷ 25)	10,938	7,210	8,029
Phase 2 2001-2005		1,915,045 (174.095 million $)	1,457,005 (132.455 million $)	1,544,565 (140.415 million $)
Draw down 5 years	(÷ 5)	383,009 (34.82 million $)	291,401 (26.49 million $)	308,913 (28.08 million $)
Annual depreciation	(÷ 25)	15,320	11,656	12,357
Phase 3 2006-2010		1,928,245 (175.295 million $)	1,403,105 (127.555 million $)	1,511,015 (137.365 million $)
Draw down 5 years	(÷ 5)	385,649 (35.06 million $)	280,621 (25.11million $)	302.203 (27.47 million $)
Annual depreciation	(÷ 25)	15,426	11,225	12,088
Total		5,484.050 (498.55 million $)	3,941,630 (358.33 million $)	4,259,860 (387.26 million $)

[Workshop and Depots]

million Dong

		Alternative I	Alternative II	Alternative III
Stage 1 1995-2000		396,000 (36.0 million $)	374,000 (34.0 million $)	396,000 (30.0million $)
Draw down 6 years	(÷ 6)	66,000 (6.0 million $)	62,333 (5.67 million $)	66,000 (6.0 million $)
Annual depreciation	(÷ 20)	3,300	3,117	3,300
Stage 2 2001-2005		165,000 (15.0 million $)	110,000 (10.0 million $)	165,000 (15.0 million $)
Draw down 5 years	(÷ 5)	33,000 (3.0 million $)	22,000 (2.0 million $)	33,000 (3.0 million $)
Annual depreciation	(÷ 20)	1,650	1,100	1,650
Stage 3 2006-2010		154,000 (14.0 million $)	99,000 (9.0 million $)	154,000 (14.0 million $)
Draw down 5 years	(÷ 5)	30,800 (2.8 million $)	19,800 (1.8 million $)	30,800 (2.8 million $)
Annual depreciation	(÷ 20)	1,540	990	1,540
Total		715,000 (65.0 million $)	583,000 (53.0 million $)	715,000 (65.0 million $)

It is considered that investment will be carried out in uniform amounts each year for each phase.

In the economic analysis, benefits in Phase 1 are assumed to be nil and the benefit evaluation period is set as the 30 years following 2001. In the case of financial analysis however, because it is unnatural to assume that continuous investment over a six year period will not yield any benefits, and moreover, it is inconvenient in terms of depreciation cost processing, the evaluation period has been set as the 25 or 35 years following 1995.

4) Sales Tax

In its Development Strategy, the VNR states that will pay the government a sales tax of 8% of its transport business revenue to fulfil its obligation set out under the law. However, the recent tax paying performance of the VNR is as shown below.

Fiscal 1991 2.9%

Fiscal 1992 2.9%

Fiscal 1993 3.0%

Under the New Accounting Mechanism to be applied from January 1994, it is not yet clear as to what level will be set for the beneficial cost of government provided infrastructure. For present purposes however, it is assumed that the above mentioned 8% includes beneficial cost.

(3) Financial Evaluation

1) Cash Flow and FIRR

From Start of Investment	Alternative I	Alternative II	Alternative III
15 years	8.51%	6.84%	8.61%
25 years	10.09%	7.72%	9.87%
35 years	10.61%	8.15%	10.34%

2) Commentary

The above FIRR values for 25 to 35 years after the start of investment are certainly not low for a long distance railway in a developing country, if taken as simply surface values alone. However, if we take it into consideration that the Government has taken over the burden of all infrastructure investment, except for that into rolling stocks and workshops, the figures could not be described as satisfactory.

Of the three Alternatives shown above, II is clearly inferior compared to the others and is not an issue for present purposes. Alternatives I and III show similar values, however the investment burden regarding rolling stock in the latter is lighter, which means that the qualitative benefits of both cannot be considered on the same level. Rather, even if investment does increase (compared to I, the total investment and rolling stock investment values of Alternative III are 87% and 78% respectively), it is proper to recommend Alternative I because it pays ample attention to improvement of railway safety and reliability levels, which is after all the original aim of the Project.

However, because the FIRR, which is held to a maximum of around 10%, is considerably lower than current interest rates in Viet Nam (market short-term loan and long and medium-term interest rates are 25.2% PA and 20.4% PA respectively), it will be necessary for the enterpriser to actively utilise the capital Formation Loans (8.4% p.a.) which could be extended to social infrastructural construction works designated by the state, and/or any other support from low interest facilities of International Investment Finance Organisations.

At the same time, corporate restructuring of the VNR must be promoted in order to reinforce its productivity and profit making base. In order to achieve this, strong advice that includes examination of a business policy to raise the operating ratios of each of the three unions, and places emphasis on the close links of the railway to the local economy (bearing in mind the strong local nature of Vietnamese companies in general), is required above all else. Moreover, it is needless to say that, in order to establish the independent profit making ability of the VNR and develop the capabilities of the parties concerned, financial sponsorship by the government in the early stage of its restructuring is an indispensable factor.

6.4.5 Environmental Assessment

6.4.5.1 Environmental Items Related to Alternatives

The environmental items of each alternative on environmental examination are listed in Table 6.4.5-1.

For example, the maximum train speed or reduced arrival time is related to economic activity, noise or vibration, the rehabilitation and improvement of track facilities to noise or vibration.

Table 6.4.5-1 Environmental Items of Each Alternative on Environmental Examination

Major Policies	Alternative I		Alternative II		Alternative III		Related Environmental Items
Maximum train speed or shortest arrival time*1	MTS*1 110 km/h 80 km/h	SAT*1 24 h 40 h	MTS 80 km/h 80 km/h	SAT 30 h 43 h	MTS 110km/h 80 km/h	S.A.T. 25 h 41 h	At operation: Economy, train noise and vibration.
Rehabilitation and improvement of track facilities	Replacing with 43kg rails, improved RC sleepers. Long rails for sections where they can be laid.		Replacing with 43kg rails and using existing RC sleepers. Long rails for efficient sections on alignment.		Replacing with 43kg rails and RC sleepers. Long rails for sections where they can be laid and train speed is 80~110 km/h.		At construction: Waste, air or water pollution, noise and vibration. At operation: Train noise and vibration.
Rehabilitation and improvement of damage preventing facilities	Damage preventing facilities (slopes, rockfalls and flood submergence).		Almost same as Alternative I but smaller investment.		Same as Alternative I.		At construction: Hazards, noise and vibration At operation: Hazards
Rehabilitation and improvement of bridge and tunnel	Improvement of bridges and tunnels which have safety problems or restricts train speed.		Improvement of bridges and tunnels which have safety problems or at which train speed is not over than 40 km/h.		Same as Alternative I for about 1000 km and same as Alternative II for other sections.		At construction: Waste, air or water pollution, noise and vibration At operation: Landscape
Rehabilitation and improvement of rolling stocks	Introduction of new rolling stocks for limited express and local express.		Use of existing rolling stocks.		Introduction of new rolling stocks for limited express.		At operation: Public health, train noise and vibration

Table 6.4.5-1 (continued)

Major Policies	Alternative I	Alternative II	Alternative III	Related Environmental Items
Rehabilitation and improvement of workshops and depots	Pollutants treatment facilities at Gia Lam Workshop and Hanoi, Vinh, Danang, Nha Trang and Saigon Depot. Waste water treatment facilities at each workshop and depot.	Same as Alternative I excluding facility for new rolling stocks.	Same as Alternative I.	At construction: Waste, air or water pollution, noise and vibration At operation: Waste, water pollution
Others	Provision of plazas in front of major stations (Hanoi, Vinh, Hue, Danang, Nha Trang and Saigon)	Same as Alternative I.	Same as Alternative I.	At Construction: Air pollution, noise and vibration At operation: Landscape

Notes: As for *1, M.T.S.*1 and S.A.T.*1 show Maximum Train Speed and Shortest Arrival Time for limited express passenger (the upper) and direct freight (the lower), respectively.

6.4.5.2 Environmental Impacts by Each Alternative

The projected railway route of each alternative is basically same as the existing route. Therefore, the environmental impacts on resettlement or flora and fauna, e.g. will be almost same as the existing conditions after execution of each alternative.

The execution of each alternative will cause not only beneficial effects such as economic activation or sanitary improvement but adverse effects on the surrounding environment at construction and operation stages.

(1) Beneficial Effects by Each Alternative

Beneficial effects are expected both at construction and operation stages of each alternative.

1) At Construction Stage

Table 6.4.5-2 summarized beneficial effects. The increase in an employment opportunity is expected to activate regional economy at

Table 6.4.5-2 Beneficial Effects at Construction Stage

Items		Alternative I	Alternative II	Alternative III
(1) Social Environment	Economy	The increase in opportunity for employment will activate regional economy.	Same effect is expected as Alternative I, but the impact level is smallest among alternatives.	Same effect is expected as Alternative I, but the impact level is between Alternative I and II.

construction stage. The largest magnitude is expected in Alternative I, and is followed by Alternative III. And the smallest is in Alternative II.

2) At Operation Stage

The most beneficial effect in the rehabilitation and improvement of the existing railway is environmental improvement such as decrease of CO_2 gas and saving of energy consumption in contrast with road project.

The reduction rate of CO_2 gas generation and energy consumption of each alternative is estimated on the basis of the passenger density and the cargo density at 2010 of each alternative and without case (See "Chapter 7. Railway Demand Forecast "). Magnitude of this effect is shown in Table 6.4.5-3. Decrease in CO_2 gas generation and saving of energy consumption is expected approximately to be 8.1% and 7.5% respectively in Alternative I in comparison with those in the case without railway rehabilitation project. These are followed by 6.3% and 5.7% in Alternative III and the smallest is 4.9% and 4.0% in Alternative II.

Other beneficial effects are also shown in Table 6.4.5-3. Each alternative is expected to cause beneficial effects on economy, public health, hazards(safety) and water pollution at operation stage. The impact level is largest in Alternatives I and III and smallest in Alternative II.

Table 6.4.5-3 Beneficial Effects at Operation Stage

Items		Alternative I	Alternative II	Alternative III
Decrease of CO_2 gas generation and saving of energy consumption		CO_2 gas generation and saving of energy consumption will be decreased approximately by 8.1 and 7.5 % in comparison with the case without executing alternatives.	CO_2 gas generation and saving of energy consumption will be decreased approximately by 4.9 and 4.0 % in comparison with the case without executing alternatives.	CO_2 gas generation and saving of energy consumption will be decreased approximately by 6.3 and 5.7 % in comparison with the case without executing alternatives.
(1) Social Environment	Economy	The transportation of passengers and commodities will be activated than the existing condition due to the increased service level such as reduced arrival time, strengthening of track facility and the improvement of operation reliability. The impact level is largest among alternatives.	Same as Alternative I but the impact level is smallest among alternatives.	Same as Alternative I but the impact level is between Alternative I and II.
	Public Health	The sanitary condition will be improved than the existing level by the installation of pollutant treatment facility for new rolling stocks in Gia Lam Workshop, Hanoi, Vinh, Danang, Nha Trang and Saigon Depot.	The sanitary condition concerning rolling stocks will not be improved because of use of existing rolling stocks.	Same as Alternative I.
	Hazards (Safety)	The safety for hazards at track facilities will be increased than the existing condition by the construction of damage prevention facilities for slope, rockfalls and flood submergence.	Same as Alternative I but the impact on safety is smallest among alternatives.	Same as Alternative I.
(2) Pollution	Water Pollution	The water pollution will be improved than the existing condition by the installation of water treatment facilities such as oil separator or pH regulator in each workshop and depot.	Same as Alternative I.	Same as Alternative I.

(2) Adverse Effects by Each Alternative

Some adverse effects on environment are anticipated at construction and operation stages of each alternative.

1) At Construction Stage

The adverse effects are summarized in Table 6.4.5-4. Those are waste and hazards, air and/or water pollution, noise and vibration. The impact level is almost same between Alternative I and III and the smallest in Alternative II.

2) At Operation Stage

Table 6.4.5-5 listed the adverse effects by each Alternative.

At this stage, increase in noise and vibration level are expected in each alternative, and sanitary depression is also anticipated especially in Alternative II since in this plan, the existing rolling stocks will not be improved and be operated without evacuation tanks. The impact levels of other items are almost same in each alternative.

Table 6.4.5-4 Adverse Effects by Alternatives at Construction Stage

Items		Alternative I	Alternative II	Alternative III
(1) Social Environment	Waste	Waste dumps or construction wastes will be generated at construction stage by improving and rehabilitating the existing railway facilities.	Same as Alt. I. The quantity of generated wastes will be smallest.	Almost same as Alt. I.
	Hazards (Safety)	The unexpected hazards such as slope slide, rockfalls or leakage of underground water will be anticipated in construction of damage preventing facilities.	Same as Alt. I but the impact level is smallest among alternatives.	Almost same as Alt. I.
(2) Pollution	Air Pollution	Pollutant matters such as dust is anticipated by the construction vehicles.	Same as Alt. I but the impact level is smallest among alternatives.	Almost same as Alt. I.
	Water Pollution	Turbid water is anticipated in tunnel works.	Same as Alt. I but the impact level is smallest among alternatives.	Almost same as Alt. I.
	Noise and Vibration	Noise and vibration is anticipated by the construction equipment.	Same as Alt. I but the impact level is smallest among alternatives.	Almost same as Alt. I.

Table 6.4.5-5 Adverse Effects by Alternatives at Operation Stage

Items		Alternative I	Alternative II	Alternative III
(1) Social Environment	Traffic Facility	Traffic jams at level crossing remains as urban traffic problem.	Same as Alt. I.	Same as Alt. I.
	Public Health	Sanitary problems will remain due to use of existing rolling stocks, but the impact level will be smallest among alternatives.	Use of existing rolling stocks will cause sanitary impacts, and the impact level will be largest.	Sanitary problems will remain due to use of existing rolling stocks, but the impact level will be between Alt. I and II.
(2) Pollution	Noise and Vibration	Some effects on noise and vibration at passing of trains are anticipated especially in resident areas.	Same as Alt. I.	Same as Alt. I.

6.4.5.3 Environmental Examination

Environmental examination is conducted based on the field survey and an analysis of expected environmental impacts attributable to each alternative. In executing the rehabilitation and improvement project, there are anticipated no significant difference from the present conditions and no serious adverse effects are expected. Therefore, each alternative is acceptable in terms of environmental examination.

(1) Each alternative will cause not so serious adverse effects. This is because no environmental problems were recognized in the present conditions, and because each Alternative do not expand environmental influential areas in a process of rehabilitation and improvement.

(2) Railway projects can contribute to decrease CO_2 gas generation and to save energy consumption than road projects.

(3) The rehabilitation and improvement of existing railway facilities are expected to cause beneficial effects on regional economy by increasing an employment opportunity at construction stage. Besides, water pollution at the workshops and depots will be mitigated by installing waste water treatment facilities. Alternative I and III will contribute to mitigate sanitary problems to some extent

because of introduction of evacuation tanks for new rolling stocks. However, Alternative II adopts the existing rolling stocks, and thus the least improvement can be expected.

(4) However, some adverse effects such as bigger amount of waste or other pollution due to construction works and some effects on noise and vibration at operation stage will require counter-measures. These are explained in " section 6.4.5.4 Environmental Mitigating Measures".

6.4.5.4 Environmental Mitigating Measures

Some environmental mitigating measures will be required both at construction and operation stages. In feasibility study stage, the following measures should be studied with due attention.

(1) Environmental Impact Assessment (E.I.A.)

Environmental impact assessment (E.I.A.) is required for the definite plan at a feasibility study stage. This is a pre-requisite of the project execution and in this Study, E.I.A. is planned at the stage of feasibility study.

(2) Social Environment

1) Houses near the Railway Track

Railway track should be kept away from any intruders in order to guarantee safety operation of trains and inhabitants' lives. The safety of train's operation should be investigated carefully especially at the areas where higher frequency of train operation are planned.

2) Traffic Facility

High frequency of trains will further aggravate smooth traffic flow at the crossing with road, especially in large urban cities such as Hanoi and Ho Chi Minh City. Therefore, some counter-measures will be required. However, this is a matter of urban transport master plan, and levies this matter to a planned master plan of Hanoi City.

3) Public Health

It is ideal that the passenger coaches are equipped with evacuation tanks. As for the newly purchased coaches, it is sure that evacuation tanks will be facilitated. In addition, periodical cleaning or sprinkling of medicine is required in order to improve the sanitary conditions of passenger coaches and station facilities.

4) Waste

At construction stage, large volume of construction waste will be generated. Appropriate disposal manners should be planned and appropriate disposal areas should be selected.

(3) Natural Environment

1) Landscape

Designing and planning of landscapes harmonized with the surrounding landscape is required in designing bridges and station plazas especially in tourist resorts such as Hue.

(4) Pollution

1) Air Pollution

At construction stage, planning for appropriate route of construction vehicles, water sprinkling or covering of sheets over construction materials is required for mitigating measures for preventing generating dusts in resident areas.

2) Water Pollution

At construction stage, appropriate treatment for the turbid water in construction works is required in such works of the track and tunnel improvement works. At operation stage, reliable operation and management on treatment of waste water or pollutants is required in workshops and depots (Gia Lam Workshop, Hanoi Depot and Saigon Depot, etc.). Periodical monitoring is required for waste water and surface sediment both in the site and their surrounding areas.

3) Noise and Vibration

At construction stage, some mitigating measures of reducing noise and vibration are required. These measures are (1) selection of construction equipment with lower noise and vibration, and (2) appropriate construction schedule. These are important especially in resident areas such as Hanoi and Ho Chi Minh City.

At operation stage, each alternative adopts some measures to make train noise lower by weighting or lengthening of rails. However, additional mitigating measures such as periodical inspection, repairing and maintenance of track facilities are required.

6.4.6 Overall Evaluation

(1) Quantitative Evaluation

The most standard methods of quantitative evaluation are to use the national economy viewpoint indices of EIRR, CBR and NPV etc. to evaluate the Master Plan, and to use corporate financial viewpoint indices such as the FIRR etc. to evaluate the financial standing of the VNR which is the subject of the Master Plan.

EIRR gives Alternative I the best evaluation followed by III and II, whereas FIRR gives Alternative I and III the better evaluation than II which is the lowest. The Project aims to draw up a Master Plan for the rehabilitation and improvement of a north-south railway between Hanoi and Ho Chi Minh by the target date of 2010. As was described in 5.2.1, this will be a main railway line which will act as the backbone of Vietnam in supporting the nation's social and economic development. It is felt that evaluation of the Master Plan should be conducted from the national economic viewpoints. Moreover, it should be mentioned that the financial analysis assumes that the government will provide all of the VNR infrastructure investment, and thus financial evaluation does not take the state investment into consideration.

Another factor in the quantitative analysis is that the scale of investment should be realistic for Vietnam. The Master Plan for the restoration and modernization of VNR in 2010 must not be unrealistic and the scale of investment needs to be examined based upon the true potential of the scope of the Vietnamese economy and the scale of investment into the transport infrastructure.

Based upon ample consideration of the economic development of Vietnam by 2010 and the share of investment into the transport infrastructure and the railway system (see the Section 3.2), the JICA Study Team regards a figure of US$ 1,876 million to be a guide for the maximum amount of investment into Viet Nam railways by 2010. In terms of scale of investment, Alternative II is the most inexpensive followed by III and I, however it may be possible to regard all three as being realistic. In summing up the quantitative evaluation, considering that the Project is a national project and that each of the Alternatives is realistic in terms of scale of investment, Alternative I is recommended as the Master Plan due to having the highest EIRR or national economic evaluation index value.

(2) Qualitative Evaluation

The basic policy in compiling the Master Plan for the restoration and modernization of the Hanoi-Ho Chi Minh Railway was described in Chapter 6. The qualitative evaluation shown in Table 6.4.6-1 indicates the evaluation of each alternative in terms of the items contained in the basic policy. Regarding items (4)-(9) of the nine items, each alternative was found to be more or less the same. However in terms of item (1) or social impact and indirect benefits (development along the line, industrial effect, expansion of employment etc.), Alternative I, which entails the biggest investment, the fastest trains and the safest and most reliable train services, was judged to be the best.

In terms of item (2) or train service efficiency, safety and reliability too, Alternative I was judged to be best due to the fact that it eliminates all slow speed sections and includes the biggest investment into improvement of interlocking devices, disaster prevention measures and level crossing warning systems etc.

Alternative I was also judged to be the best in terms of item (3) or investment into developing railway characteristics because, of all the alternatives, it improves the railway characteristics of speed, safety and reliability etc. the most.

(3) Overall Evaluation and Selection of Optimum Plan

Based upon the above quantitative and qualitative evaluation, the JICA Study Team recommends Alternative I as the Master Plan for the Hanoi-Ho Chi Minh Railway in 2010.

(4) Other

A plan, that is similar in the content to Alternative III, to dig a tunnel through the Hai Van Pass was also examined. The tunnel digging would lead to an increase in investment, however in order to limit such an increase, 110 km/hr train operation sections would be decreased by 20 km and slow speed sections in 110 km/h operation sections would be increased in number by two compared with Alternative III.

Apart from this, all other items and improvement contents are the same as in Alternative III. The travelling time of limited express passenger trains between Hanoi and Ho Chi Minh is 25 hours and the service time of direct freight trains over the same route is 41 hours, both of which are the same as under Alternative III. The amount of investment is some US$ 35 million more than in Alternative III and the EIRR value is lower than the other Alternatives. The FIRR value is roughly the same as for Alternative III, however in terms of overall evaluation this plan receives a lower value than Alternative III.

Appendix 6.4.6-1 indicates travelling time reductions and countermeasure and improvement works costs for major areas of poor alignment such as Hai Van and Keness Passes. Such countermeasures should not be considered in terms of time reduction alone, but need to be examined amply from the viewpoint of increased transportation capability. In case the section of Hue and Da Nang happens to have a specific need to increase more the transport capacity, the cost/benefit analysis of digging a tunnel through Hai Van Path may become more advantageous than the analysis made here. The Master Plan is a long term plan having 2010 as its target year and as such will need to be reviewed after an appropriate term (maybe 5 years in consideration of economy in transition in Vietnam) in line with the state of economic development in Vietnam at that time. It is hoped that the alignment improvement areas will either be integrated into the Master Plan at the time of its review, or implemented after its completion in 2010, depending on the progress of economy and the need of increasing transport capacity.

Table 6.4.6-1 Overall Evaluation Table

Evaluation Item / Alternatives	I	II	III
A. Quantitative Item			
(1) EIRR	◎ (7.64)	○ (5.42)	○ (5.53)
(2) FIRR	◎ (10.61)	○ (8.15)	◎ (10.34)
(3) Realistic Investment Size (million US$)	○ (1630)	◎ (1227)	○ (1419)
B. Qualitative Item			
(1) Social impact, indirect benefit, environment	◎	Δ	○
(2) Efficient, reliable and safe train operation	◎	Δ	○
(3) Investment so as to make railway to display its advantageous characteristics	◎	Δ	○
(4) Formation of Integrated Transport System	○	○	○
(5) Investment on priority basis	○	○	○
(6) Stress on domestic technology	○	○	○
(7) Balanced improvement of railway system	○	○	○
(8) Compatibility with other development plans	○	○	○
(9) Compatibility with Master Plan in the Transport Development in the Northern Part in Vietnam by JICA	○	○	○
Total Evaluation	◎	Δ	○

Legend: ◎ Evaluated as best
○ Good / Evaluated as medium
Δ Evaluated as lowest

6.5 Revised Demand Forecast of Optimal Alternative

This section presents a revised demand forecast based on the latest traffic data for the optimal alternative; Alternative 1. This is because traffic situation has been drastically changed since latter half of 1993, and traffic survey of this Team provides useful data to up-date the demand forecast this time. This might be contribute to project the future traffic demand more accurately at the feasibility study stage.

6.5.1 Overview of Base Year Conditions

The overview on traffic demands in the base year 1994 is presented in this section.

(1) Traffic Modes

Passengers have a choice of traveling by rail, by road, or by air transportation. Inland waterway is also available, but it is not considered in this study because the network is not competitive with other modes. Total volume of trips made by travelers and commuters in Vietnam is estimated 191 million trips (excluding intra province trips) in the year 1994. This represents 2.7 trips per person in a year, reflecting small activities among provinces.

The most popular traffic modes among the travelers and commuters are bus and automobiles. The share of railway is about 5%. Share of air traffic is very small as shown in Fig. 6.5.1.

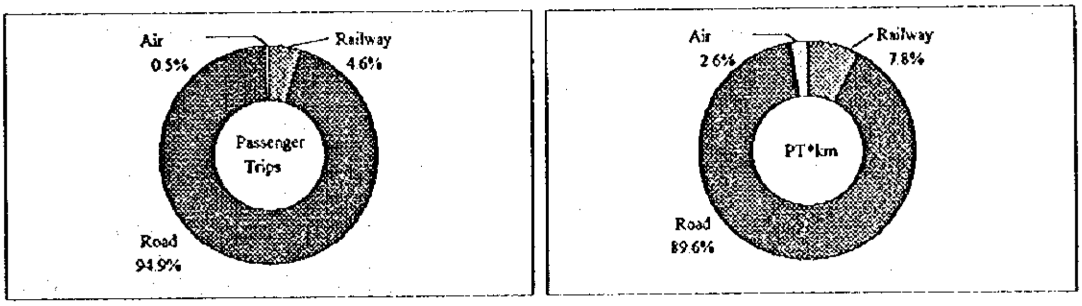
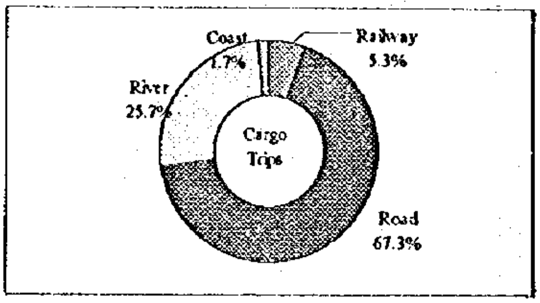
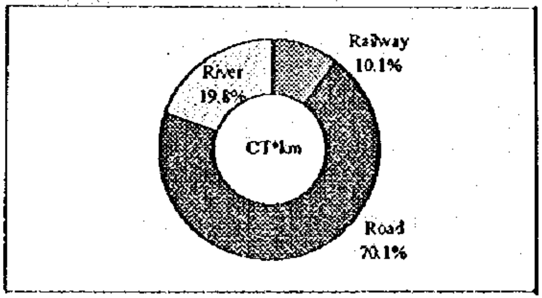


Fig. 6.5.1 Passengers analysis by transportation (1994)

Cargo is transported mostly by trucks. The share of truck freight is about 67% in the year 1994, which is relatively low compared to the percentage of passengers, because railway, inland waterway and coastal shipping are also available for cargo freights. The share of each mode are shows in Fig. 6.5.2. Total volume of cargo trips is 60.5 million tons.





*) The volume of CT*km by coastal shipping is unknown.

Fig. 6.5.2 Cargo Analysis by Transportation (1994)

(2) Railway Demand

The number of passengers using railway stations in the Hanoi zone marks the largest figure. It is approximately 1.6 million trips in the year 1994. The second largest is generated in the Ho Chi Minh zone. Total number of passengers were 8.8 million trips. This number has been consistent for a few years. The Hanoi - Ho Chi Minh line transported 5 million, which is 57% of the whole railway passengers in Vietnam. Along the Lao Cai line, the number of passenger was 2.2 million trips including connecting trips to/from other lines. The passengers at stations in Quang Ninh and Ha Bac zones was 0.6 million trips.

Total volume of cargo handled by railway was 3.2 million tons in the year 1994. The volume is almost the same as that in the year 1993 but it has been grown up since the year 1990. The share of the Hanoi - Ho Chi Minh line accounts for 60%, including cargoes that go to/from other lines.

Main cargo items by railway are cement along The Hanoi - Ho Chi Minh line, apatite along Lao Cai line and coal along Cai Lan line. Along The Hanoi - Ho Chi Minh line, cement is loaded at Thanh Hoa and goes to Hanoi and southern direction as far as Quang Ngai. Coal is transported from the northern area to Thanh Hoa or from Ninh Binh to Thanh Hoa. The trip distance of coal is not so long.

Table 6.5.1 Cargo Items by Railway (1994)

unit: ton/year

	All Vietnam		Hanoi-HCM Line		Lao Cai Line		Cai Lan Line	
	1994	Ratio	1994	Ratio	1994	Ratio	1994	Ratio
Coal	756,974	20.7%	305,468	13.9%	37,856	3.7%	493,948	82.1%
Gasoline, kerosene	72,306	2.0%	22,853	1.0%	24,243	2.4%	121	0.0%
Minerals	82,551	2.3%	9,177	0.4%	21,284	2.1%	52,115	8.7%
Machinery, Equipment	78,711	2.2%	26,281	1.2%	4,578	0.4%	769	0.1%
Apatite	504,902	13.8%	30,558	1.4%	504,446	48.9%	1,044	0.2%
Fertilizer	270,448	7.4%	233,997	10.6%	176,319	17.1%	2,946	0.5%
Chemical	64,482	1.8%	27,112	1.2%	34,617	3.4%	476	0.1%
Cement	775,355	21.2%	607,020	27.5%	99,466	9.6%	24,725	4.1%
Stone, Sand, Soil, Gravel	594,431	16.3%	532,690	24.2%	54,292	5.3%	14,987	2.5%
Lime, Brick, Tile	25,281	0.7%	17,760	0.8%	149	0.0%	113	0.0%
Wood, Wood furniture	134,388	3.7%	126,027	5.7%	5,364	0.5%	6,024	1.0%
Forest product	11,778	0.3%	11,552	0.5%	3,987	0.4%	769	0.1%
Other agricultural product	6,262	0.2%	3,399	0.2%	2,575	0.2%	441	0.1%
Rice, Corn	43,661	1.2%	41,245	1.9%	3,439	0.3%	642	0.1%
Salt	20,806	0.6%	5,178	0.2%	19,470	1.9%	0	0.0%
Foodstuff	80,304	2.2%	80,043	3.6%	353	0.0%	0	0.0%
Cotton, Silk fabric	1,587	0.0%	1,587	0.1%	0	0.0%	0	0.0%
Cotton yarn	13,270	0.4%	12,943	0.6%	171	0.0%	0	0.0%
Other commodity	45,479	1.2%	44,500	2.0%	11,513	1.1%	0	0.0%
Animals	74,326	2.0%	65,078	3.0%	27,434	2.7%	2,443	0.4%
Total	3,657,302	100.0%	2,204,468	100.0%	1,031,556	100.0%	601,563	100.0%

*) excluding intra province trips
*) generated/attracted trips to/from zones along each railway line
*) trips are double counted in the other lines
Source: VNR

(3) Traffic Demand of Other Modes

1) Road Transportation

Figure 6.5.3 shows the average daily traffic excluding motor cycle on the National Route No. 1. Rather heavy vehicular volumes are observed at the section between Hanoi - Thanh Hoa, around cities of Vinh, Da Nang, Qui Nhon and Ho Chi Minh. This traffic count data will be used for modifying the roadway passenger OD matrix developed in the Master Plan.

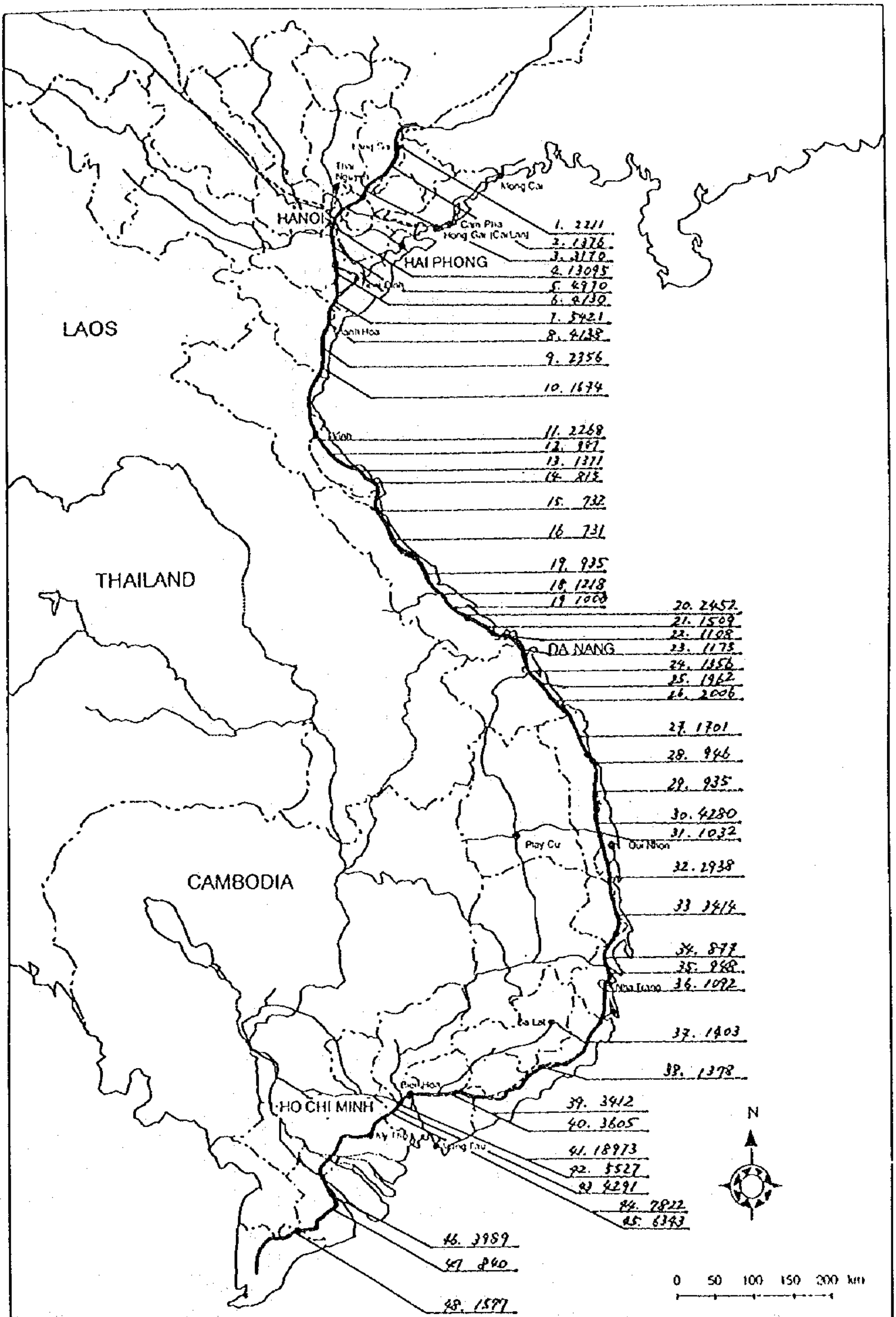
In order to confirm the volume and distribution pattern of dominant traffic generation zones, traffic count and roadside interview survey was conducted at the end of June, 1995 on the Hanoi cordon line.

Total volume of traffic generation and attraction of Hanoi accounts for 74,000 in non-motorized-vehicle (NMV), 90,000 in motor cycle (MC), and 24,000 in motorized vehicles of more than four wheels (MV). More than 80 % of traffic is made by NMV and MC, while only 13 % of traffic is made by MV.

2) Air Transportation

Airlines carried 0.25 million passengers in 1993 according to the government statistics. Major airport to airport passenger OD matrix in the year 1993 was obtained. According to the matrix, the air transportation demand between Hanoi and Ho Chi Minh city was 180 thousand passengers in one way trip counts. The third large airport was Da Nang. The air fare is relatively cheap considering the time needed for traveling, but absolutely expensive as compared with average income level of the average Vietnamese people. Thus the majority of the passengers are people with high-income, and with official purpose. But in the future this mode will be more popular as GDP per capita increases, and become competitive traffic mode to land transport.

Air cargo was 1.4 thousand tons from Hanoi and 2 thousand tons from Ho Chi Minh city in the year 1993. The volume at these years is very small. The target demand by the government in the year 2010 is 3 thousand tons from Hanoi and 7.6 thousand tons from Ho Chi Minh city including international cargo. The small volume is not expected to increase so drastically by the year 2010, so it is decided to exclude air cargo from the modal split model in this study.



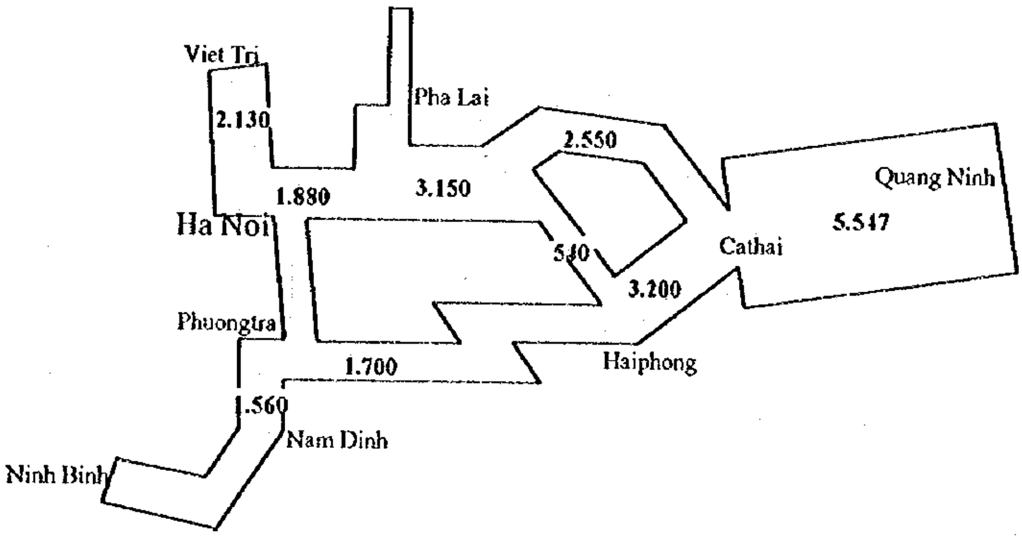
Source : Road Bureau, MOTC

Fig. 6. 5. 3 Average daily traffic volume on National route No.1

3) Inland Waterway

The Red river delta and the Mekong river delta form important network for cargo transportation. In the Red river delta, total volume of cargo is about 8.8 million tons and in the Mekong river delta it is 7.8 million tons in the year 1995 according to the estimation by Vietnam Inland Waterway Bureau. Major items of cargo are construction materials (4.2 million tons) and coal (4 million tons) in the Red river delta. In the Mekong river delta, they are agricultural products (3.5 million tons) and construction materials (2.5 million tons).

The transport system by inland waterways is competitive with railways only in the northern districts. The route between Hanoi and Hai Phong connects with Quang Ninh through the sea and the other direction reaches to Viet Tri. The details of cargo volume in each section are shown in Fig. 6.5.4.



Source: Vietnam Inland Waterway Bureau

Fig. 6.5.4 Cargo Flow in the Year 1995 (unit: 000 tons)

4) Coastal Shipping

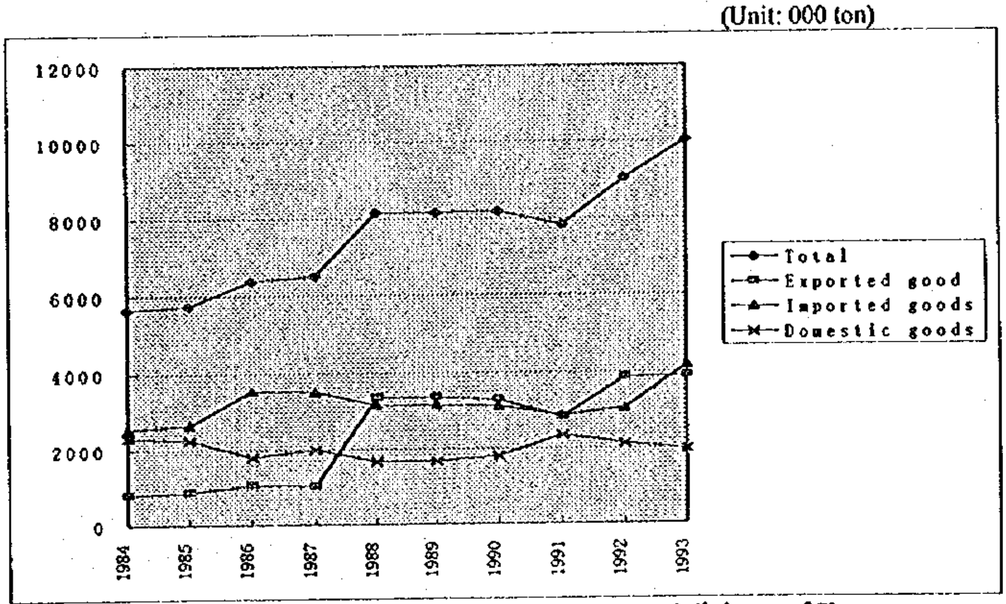
MOT statistics indicates that the total cargo volume of major coastal ports shows increase in recent years. Increases amount 10 million tons in the year 1993, and consists of export/import cargo. The volume of domestic cargo is consistently about 2 million tons.

On domestic cargo the analysis of the transport between railway and coastal shipping needs two kinds of data, the demand matrix from/to ports to/from inland and the cargo flows among ports. But these data are not available at present, so any traffic models with the demand of coastal shipping can not be prepared until those research will be completed in the future.

Nevertheless, export/import cargoes that build up the most of the cargo at major ports have to be transported from the port toward inland or vice versa by road, railway or inland waterway. So it will co-exist and not compete with other traffic modes.

The demand of traffic between the port and inland towns depends on the cargo volume which each port can handle. In this study the share of railway cargo was estimated based on the plan of Cai Lan port.

(Unit: 000 ton)



Source: Ministry of Transport

Fig. 6.5.5 Cargo Volume

(4) Major Result of the Traffic Survey

Questionnaire surveys were conducted in order to find the traffic characteristics of long distance passengers in Viet Nam as well as to collect the necessary data for developing discrete choice model for railway passengers. The survey forms are translated into Vietnamese and the trained survey staffs from the TEDI and the VRDI asked domestic passengers to answer the questions at various points; the Noi Bai airport, the three bus terminals in Hanoi, the three railway sections of the Hanoi - Ho Chi Minh line, the Hanoi - Lao Cai line and the Hanoi - Ha Long line. The survey was carried out from June 1995 to July 1995.

About half of the air passengers and 13.9 % of the Hanoi - Ho Chi Minh railway passengers have "official" purpose for their trips. Other transport modes except the air are mainly used by the passenger whose trip purpose is "self-business", which accounts for about 30 to 40 % of the total. Almost all the air passengers selected "time" for their dominant decision making factor. The significant share of railway passengers prefers the transport modes that guarantee the "Safety" and "Comfort," whilst the majority of bus passengers selected its mode because of its "Frequency" and "Time". The most frequent answer for the fare evaluation is voted for "Reasonable", which well exceed 50 % of total passengers by each mode except the Hanoi - Ho Chi Minh line passenger. There are variations in the railway passengers' responses for the travel time evaluation. Majority of the railway passengers on the Hanoi - Ho Chi Minh line and the Hanoi - Ha Long line voted for "Rather long." On the contrary the passengers on the Lao Cai line responded "Rather short".

6.5.2 Transport Modeling

This section sets forth the transport model.

(1) Trip Matrix Calibration

The base-year matrices developed in other relevant studies needs to be modified due to the recent rapid growth and development of the Viet Nam's economy.

1) The Base Year Person Trip Matrix Calibration

Three trip matrices, (1) those are the railway station to station OD matrix at the year 1992 obtained in the period of the Master Plan development phase, (2) the land transport (rail + road) matrix developed in the National Transport Sector Review in 1992, and (3) the major airport to airport matrix in 1993; will be calibrated into a comprehensive base-year person trip matrix. A flow chart of calibration process is presented in Figure 6.5.6. The number of passengers at railway stations is updated according to the VNR's statistics for the year 1994. The result of traffic survey carried out in this study is also utilized for calibration.

Administrative system has been changed since 1990, the traffic zone system and the zonal parameters are modified by using a macro economic indicator (i.e. population) as an adjusting factor.

Passenger travels made by river transport mode is excluded from this demand forecast study because the capacity of the river transport is very limited at present. For instance it is 1,000 persons/day at the Hon Gai, the Hanoi and the Nam Dinh river port, and 100 persons/day at the Viet Tri river port. It seems reasonable to assume that there is no competitive river transport systems used for the same trip purpose of the passengers on the selected priority sections of the Hanoi - Ho Chi Minh line and the Lao Cai - Ha Long line from the transport network point of view as well.

2) The Base Year Cargo Trip Matrix Calibration

Although the basic approach is the same as the procedure applied for the estimation of the passenger OD matrices, starting point of calibration is different.

The beginning point was set at the railway station to station OD matrix in 1994; the NTSR's land transport and inland waterway OD matrices in 1992. The inland waterway system in the Red River Delta is a good competitor for the East - West railway system (the Lao Cai - Cai Lan line). Therefore, in contrast with the person OD matrix, the inland waterway OD was included into a comprehensive base-year matrix of cargo.

Coastal shipping data is preferred as one of the component of the consolidated cargo OD matrix because major cargo transport of the North - South direction is made by shipping as well as railway and trucks. It, however, can not be included directly in the models because of data availability at present. But the volume and competition are considered after modeling, and explanation are given in section 6.5.6.

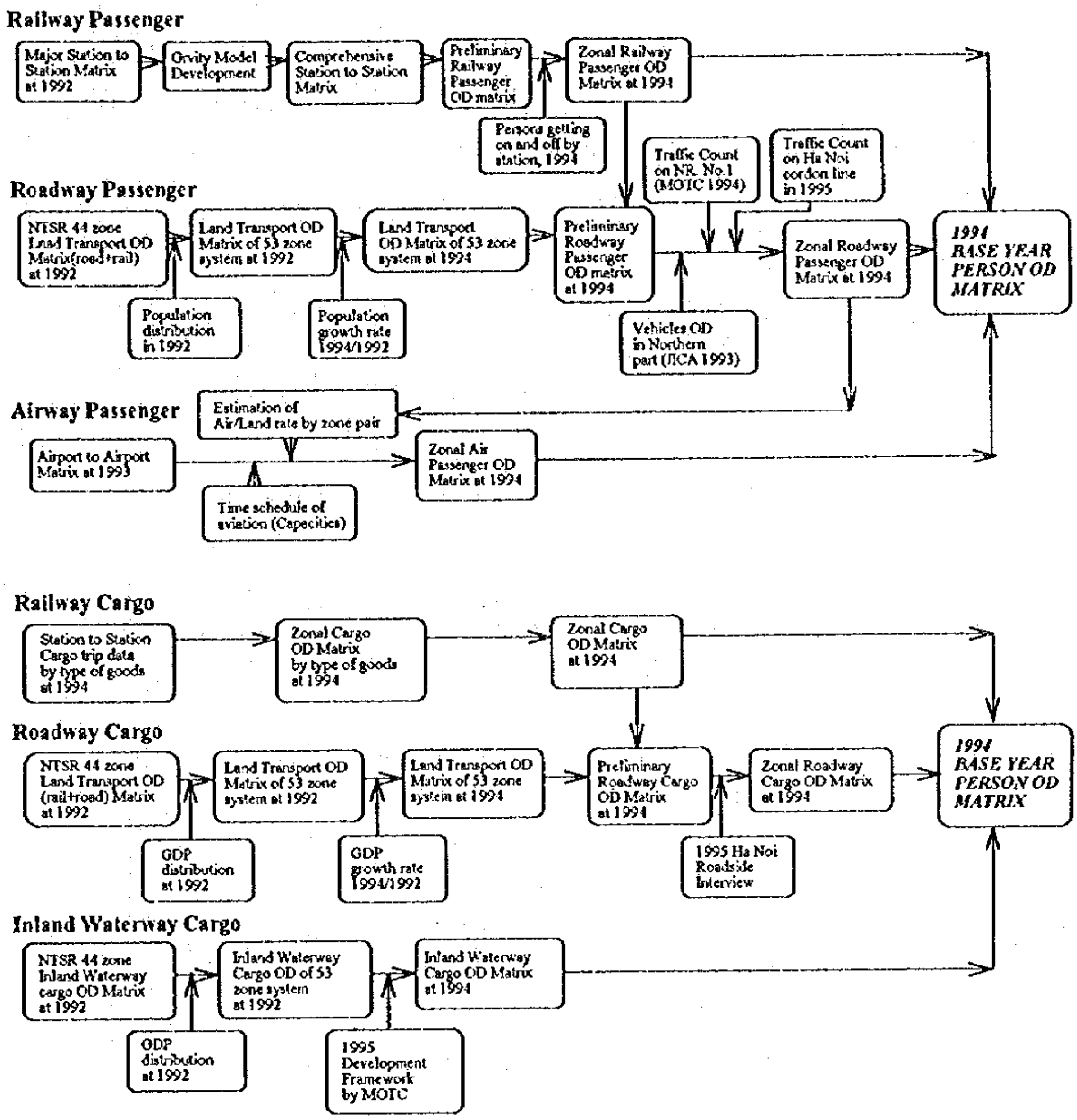


Fig. 6.5.6 Calibration Procedure of the Base Year OD Matrix

3) OD Matrices in Base Year 1994

Passenger trip OD table in the base year 1994 is calibrated as shown in Table 6.5.2. The total number of passenger trips excluding intra province trips was 191 million trips in all Viet Nam. This table is summed up by person trip OD tables of roadway, railway and airway that is adjusted in each.

Cargo trip OD table is shown in Table 6.5.3. Total volume was 59 million tons in all Viet Nam.

Table 6.5.2 Passenger Trips (Road+Railway+Air) in Year 1994

(unit: 000 persons)	1	2	3	4	5	6	7	Total
1 Northern Upland	5,430	16,784	203	53	23	71	5	22,570
2 Red River Delta	17,058	35,732	2,665	976	291	845	127	57,694
3 North Central	210	2,645	2,962	1,484	174	624	36	8,135
4 Central Coast	50	921	1,446	5,236	1,537	3,871	446	13,506
5 Central Highlands	22	282	167	1,538	68	1,434	73	3,582
6 Southeast	65	781	567	3,868	1,415	37,245	16,297	60,238
7 Mekong River Delta	4	113	34	438	72	16,265	8,596	25,524
Total	22,838	57,257	8,044	13,592	3,582	60,354	25,580	191,248

Table 6.5.3 Cargo Trips (Road+Railway+Inland waterway) in Year 1994

(unit: 000 tons)	1	2	3	4	5	6	7	Total
1 Northern Upland	4,429	11,68 6	1,077	283	11	117	2	17,605
2 Red River Delta	6,496	3,006	1,075	347	0	73	29	11,026
3 North Central	842	1,605	1,315	737	29	110	11	4,648
4 Central Coast	247	322	596	1,843	600	711	145	4,464
5 Central Highlands	10	0	29	607	1	187	68	902
6 Southeast	90	320	104	695	190	2,579	5,118	9,096
7 Mekong River Delta	3	35	12	154	71	6,342	4,217	10,834
Total	12,116	16,974	4,207	4,666	902	10,120	9,590	58,575

(2) Procedure

1) Flow Chart

Since it is likely that any trend based-transport demand forecasts can not reflect a drastic structural change in Vietnam, it is a key task to build a transport model which can trace the present travel pattern in the most fitted manner, and can be compatible with structural changes in the future. In this context, a conventional four - stage transport model is adopted. It is presented as a sequence of four sub models : 1) trip generation/attraction models as function of socio-economic variables, 2) trip distribution model, 3) modal split model and 4) trip assignment.

2) Estimated Time and Cost

Time and fare data of all traffic modes is necessary to simulate modal split model because this model has the difference value of time and fare in the formula. These data are researched and estimated in the following procedure.

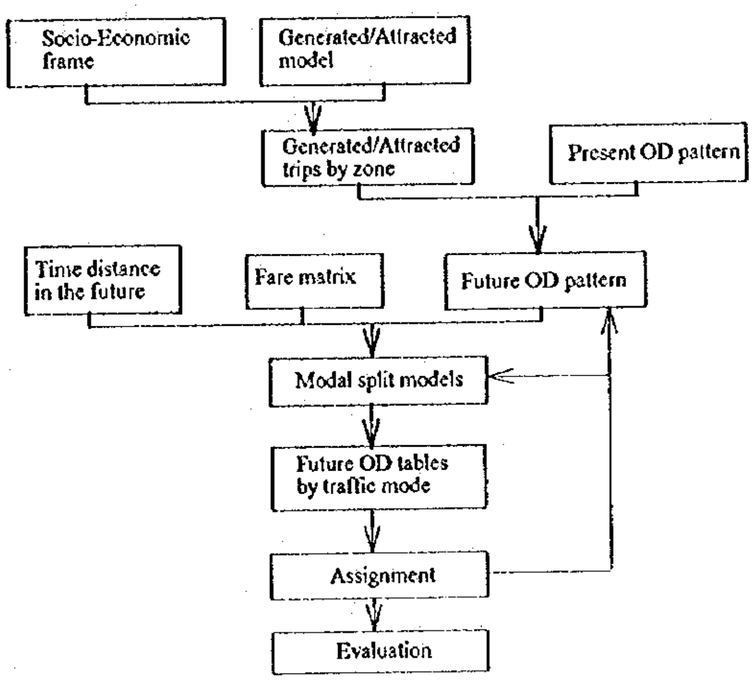


Fig. 6.5.7 Overall Flow Chart of Demand Forecast

Time distance matrix of road network is estimated from the average speed in each road that is surveyed by our trips and some hearing surveys at the bus terminals. Those of railway and air transport are compiled by using time tables. Time distances of inland waterway are calculated by the estimation of the average speed.

The fare matrix of railway is calculated by the fare system and the distance matrix. Because the fare of railway cargo differs by the category, the average fare is used to simulate modal split model. The result of our survey on the unit fare of bus is shown in Fig. 6.5.8. As the unit fare at the bus terminals decreases according to the distance, the fare model is estimated. The relations between ticket price and distance of air transportation are plotted in Fig. 6.5.9. From these plots the unit fare of air is calculated.

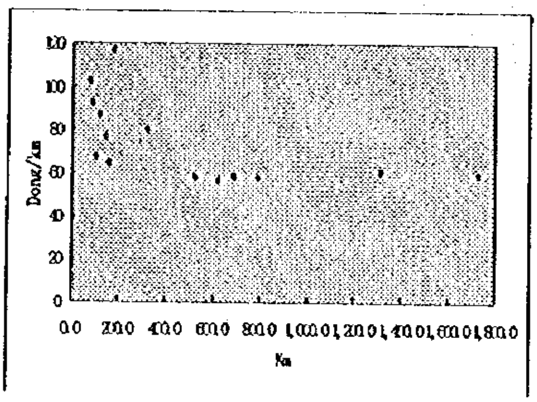


Fig. 6.5.8 Unit fare by Bus

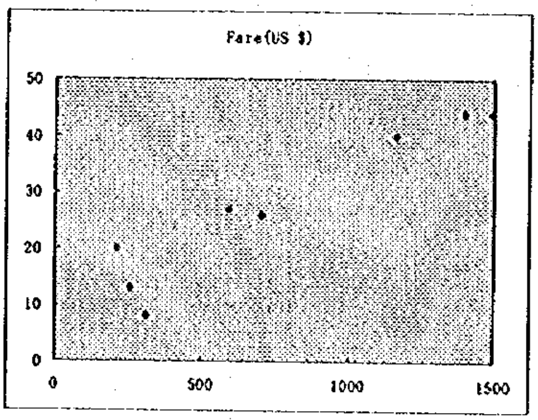


Fig. 6.5.9 Fare by Air

There are other survey data as shown in Table 6.5.4. These data are also used for supplementing the data that we could not survey. The following survey shows that the fare of truck is about three times of railway.

Table 6.5.4 Unit Fare by Modes

Items		1990	1991	1995
Passenger Trips (Dong/pass-km)	Bus			120
	Railway			140
	Inland waterway			70
Cargo Trips (Dong/ton-km)	Truck	296.0	370.0	600
	Railway	105.0	131.0	200
	Inland waterway	94.6	118.0	140
	Coastal shipping	60.0	75.0	

*) 1990,1991: MOC Report
1995 June, Vietnam Inland Waterway Bureau

(3) Modeling

1) Generated and Attracted Model

Person trips increase in proportion to the growth of population. Person trips also tend to increase as the GDP grows. This is because the socio-economic activities result in person trips. Correlation between generated/attracted passenger trips and socio-economic indices by zone are shown in Table 6.5.5. Trips correlate highly with density of population and GDP. The correlation factor of density of population is higher than that of population because of inter province trips.

Referring the correlation coefficients, regression functions based trip generation and attraction models are derived. The variables of the model are density of population, labor force, GDP and area for an adjustable factor. Although the assumption that number of generated trips is the same as number of attracted trips because all persons come back to the original departure place is reasonable, in this study we build up two models for generated and attracted trips. The outputs of two models were almost same. The correlation coefficient of each regression model is over 0.9.

Table 6.5.5 Correlation Coefficients with Person Trips and Socio-economic Indices

	Area(Km^2)	Population	Person/Sq-km	Labor Force	Labor Force Ratio	GDP	Per capita GDP
Generated Trips	-0.3580	0.5735	0.8256	0.6563	0.5042	0.8676	0.4989
Attracted Trips	-0.3586	0.5724	0.8251	0.6553	0.5048	0.8685	0.4999

Number of cargo freights generally depends on economic parameters because economic activities generate cargo freight demand. However, the correlation coefficients between generated trips of cargo and economic indices are not high at present. It is estimated that the reason of this weak correlation is attributable to the limitation in manufacturing capacity at some facilities and to the fact some types of cargoes are not closely related with whole economic activities in the district overall. In addition, some types of cargo have no freedom in selecting the transportation mode due to governmental restrictions. In the future, the correlation coefficient of cargo generation with socio-economic parameters will be higher as same as cargo attraction. The variables of regression models by transportation modes were selected in order to increase the coefficient. Total estimation is made of the summation of all transportation modes.

Table 6.5.6 Correlation Coefficients with Cargo Trips and Socio-Economic Indices

	Area(Km^2)	Population	Person/Sq-km	Labor Force	Labor Force Ratio	GDP	Per capita GDP
Generated Trips	-0.1840	0.3810	0.3579	0.4068	0.2768	0.4348	0.1824
Attracted Trips	-0.3071	0.6107	0.7074	0.6655	0.4443	0.6923	0.2528

2) Trip Distribution Model

In estimating trip distributions, there are two methods that are present pattern method and gravity model method. The gravity model method is suitable if the socio-economic character in each district will become a uniform condition in the future. But, our research suggests that Vietnam will preserve its local differentials until the year 2010, so it is judged that the present pattern method is more preferable. With this method, we obtained the estimated total future generation of trips as a sum to the matrix, and converge the current traffic distribution patterns to fit the sum. The calculations were performed by using the Fratar method.

3) Modal Split Model

We have assumed that the distribution factors of traffic mode transfer is designated by the differences in time and fare. The following equation was used as the model. The equation is originally a model used by the Japan Highway Public Corporation to calculate the distribution factor of normal roads and highways, but is also applicable for other modeling of mode distribution.

$$P = \frac{100}{1 + \alpha(\frac{C}{T} / S)^{\beta} / T^{\gamma}}$$

P = Mode ratio of faster traffic mode (unit: %)
C = Difference of fare/cost
T = Time difference
S = Shift factor

This function demonstrates that transportation mode-change to faster transportation is accelerated when the fare/cost parameter difference is small, and the bigger the fare difference, the smaller the mode change. In the same way, when the fare/cost parameter is a fixed value, the mode-change is accelerated by the amount of time difference it can earn. The value "S" is the shift factor showing the need by society to more advanced traffic-modes. The value is approximately 1.3 per 5 years with regard the Japanese road to highway switch.

Person trip models have been generated by deducting the air transportation passengers from total person trips, and then separating the railway trips. The competitors of air transportation have selected the faster mode between road and rail.

With regard cargo transportation, truck deliveries were deducted from total cargo trips. In zone pairs where railways and inland waterways were available, the competition between railways and trucks were modeled, and then rail transportation has been separated. Model have been built by zone pairs where trucks and rail are both available and cases where inland waterways and trucks are available.

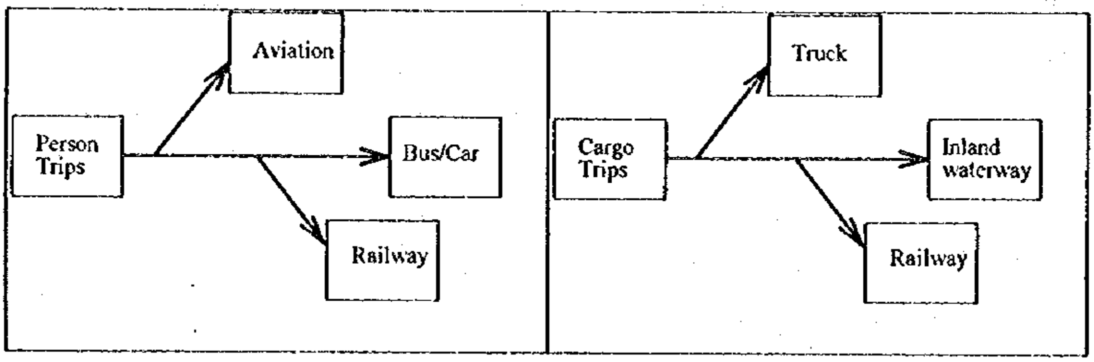


Fig. 6.5.10 Modal Split of Person Trips and Cargo Trips

Each coefficient of the modal split model formulas are shown in Table 6.5.7. Although these correlation factors are at sufficiently significant level, there are differences between the real ratios and the values by the model in some zones. So in assuming that the differences will gradually decrease toward the model within 20 years in the case of passenger trips and 30 years in the case of cargo trips, these ratios are adjusted.

Table 6.5.7 Coefficient of Modal Split Model Formula

	Traffic Mode	Competitor	α	β	γ	R
Passenger Trips	Aviation	Railway + Road	0.8067	1.0581	0.8152	0.69
	Railway	Road	1.0679	0.7216	0.5690	0.66
Cargo Trips	Road	Railway + River	0.0850	1.0741	1.7953	0.71
	Road	River	0.1748	0.7819	0.9063	0.45
	Railway	River	47.6014	0.3664	0.7150	0.71

(4) Forecast Conditions

The conditions for traffic demand forecast are designed by taking into the considerations the future network plan and the socio-economic framework. The future GDP and populations that give the generated/attracted trips, depends on the socio-economic framework. The road network is given based on the improvement plans of main national roads and the speed of each road are estimated to increase according to the plan. The network of inland waterway includes the future routes. The routes of aviation are set to two way between present routes. The fare of each mode are assumed to the same conditions.

The speed of railway are given by the plan of this study as shown in Table 6.5.8. The frequent service is discussed in the latter section.

Table 6.5.8 Speed of Passenger Train in Each Railway Line

Line	Section	Year 1994	Year 2000	Year 2005	Year 2010
Hanoi - Ho Chi Minh Line	Hanoi - Than Hoa	51.8	65.6	67.0	70.1
	Hue - Da Nang	37.9	41.2	44.3	51.6
	Muong Man - HCM	45.8	65.6	67.6	72.3
	Other section	49.3	50.6	57.8	74.5
Cai Lan Line		22.0	38.9	44.8	58.4
Lao Cai Line		30.0	32.6	33.8	36.7
Other lines		30.0	30.0	30.0	30.0

Table 6.5.9 Speed of Cargo Train in Each Railway Line

Line	Year 1994	Year 2000	Year 2005	Year 2010
Hanoi - Ho Chi Minh Line	29.8	37.1	38.8	42.6
Cai Lan Line	19.3	31.6	35.1	43.4
Lao Cai Line	17.0	20.6	21.1	22.2
Other lines	17.0	17.0	17.0	17.0

6.5.3 Future Demand Forecast of Railway Transport

(1) Overview of Future Demand

1) Passenger Traffic

The total amount of passenger traffic is estimated to be 384 million trips in the year 2,000 and 1,094 million trips in the year 2010. The growth rate behind these numbers are 12% from 1994 to 2000, 11% from 2000 to 2010. The higher growth rate in the earlier stage is caused by the rapid increase in population until the year 2000. The examination of trips per person reveals a higher rate after the year 2000. Tables 6.5.10 and 6.5.11 do not contain numbers of intra province trips. The estimation of passenger traffic shows that the trips are centered around Ho Chi Minh City, Hanoi, and Da Nang.

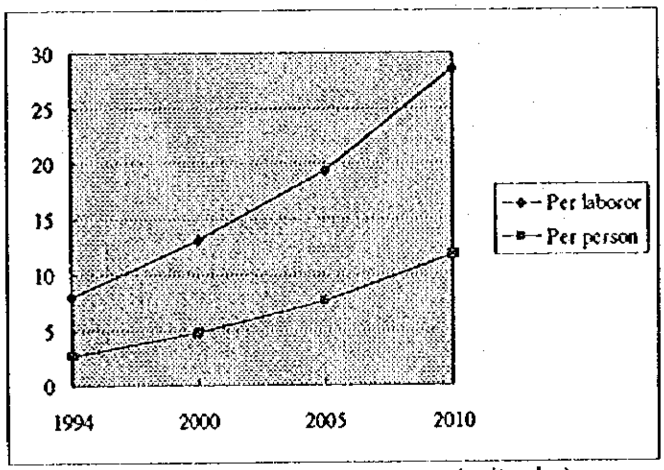
Table 6.5.10 Forecast of Passenger Trips in the Year 2000

(unit: 000 persons)	1	2	3	4	5	6	7	Total
1 Northern Upland	8,840	27,260	638	147	34	135	6	37,060
2 Red River Delta	27,478	61,111	5,984	1,833	374	1,338	252	98,369
3 North Central	654	5,922	6,646	3,997	280	1,347	93	18,939
4 Central Coast	138	1,778	3,939	10,476	2,515	7,735	784	27,364
5 Central Highlands	32	374	273	2,508	115	2,596	151	6,048
6 Southeast	123	1,278	1,303	7,726	2,563	91,238	34,190	138,422
7 Mekong River Delta	5	234	89	769	150	34,241	22,943	58,431
Total	37,271	97,958	18,871	27,455	6,031	138,630	58,419	384,634

Table 6.5.11 Forecast of Passenger Trips in the Year 2010

(unit: 000 tons)	1	2	3	4	5	6	7	Total
1 Northern Upland	24,620	69,619	2,493	491	148	310	10	97,690
2 Red River Delta	69,684	143,201	18,531	4,712	1,451	2,720	604	240,904
3 North Central	2,530	18,335	21,498	12,567	1,297	3,340	312	59,880
4 Central Coast	460	4,640	12,418	27,532	10,417	20,008	2,461	77,936
5 Central Highlands	137	1,470	1,273	10,354	809	9,597	606	24,246
6 Southeast	281	2,630	3,354	19,961	9,459	293,254	89,270	418,209
7 Mekong River Delta	9	568	300	2,403	600	89,554	81,839	175,272
Total	97,722	240,462	59,866	78,021	24,181	418,782	175,102	1,094,137

The average trip per person rate in 1994 is 2.7 trips, resulting a 1.5 times return-trips from other zones. By the year 2000, this number is expected to raise to 2 return-trips, and by the year 2010, 6 return-trips. With regard per laborer trip rate, there will be approximately 1 trip going out to other zones every month.



(unit: trips)

Fig. 6.5.11 Passenger Trips per Person

The traffic mode diversities are shown in Tables 6.5.12 (with) and 6.5.13 (without). Table 6.5.12 (with project) shows the growth based on the railway rehabilitation executed, showing increase in passengers from 8.8 million trips in 1994 to 12.4 million trips in the year 2000, and 23.1 trips in 2010. Table 6.5.13 (without project) shows the growth when the rehabilitation is not performed. There will be a slight increase because the total number of person trips will increase with the population, but the share of railway travelers will go down significantly. The rehabilitation and improvement of railway transportation will prevent the railway's share from going down rapidly.

The 1994 share of railway passenger trips is 4.6%, but advancements in air traffic and road conditions result in higher growth rates of these transportation, leaving the railway a subtle 2.1% share in the year 2010.

But these numbers are based on the current preference of transportation model. If railways can prove that railways are much more comfortable and convenient than using airplanes or buses, there is a possibility that the preference model itself may change. The quality of service is another key factor in increasing railway demand, in addition to time savings and cost saving factors that we have previously observed.

Table. 6.5.13 (without project) shows that demand for air travel will increase to 11 million trips. However the Vietnam Aviation Bureau only plans for expansion to 7 million trips, which means that demand overflows the supply. It is assumed that the excess passengers will convert to road traffic.

Table 6.5.12 Mode Share of Passenger Traffic (With Project)

		Year 1994	Year 2000	Year 2005	Year 2010
Passenger Trips	Total	191,247,726	384,634,395	659,719,208	1,094,136,576
	Railway	8,807,434	12,416,816	17,040,539	23,119,926
	Road	181,527,512	370,381,435	639,307,353	1,063,572,945
	Air	912,780	1,836,144	3,371,317	7,443,706
Ratio (%)	Total	100.0	100.0	100.0	100.0
	Railway	4.6	3.2	2.6	2.1
	Road	94.9	96.3	96.9	97.2
	Air	0.5	0.5	0.5	0.7

Table 6.5.13 Mode Share of Passenger Traffic (Without Project)

		Year 1994	Year 2000	Year 2005	Year 2010
Passenger Trips	Total	191,247,726	384,634,395	659,719,208	1,094,136,576
	Railway	8,807,434	9,894,442	11,064,520	11,222,673
	Road	181,527,512	372,839,234	644,780,172	1,072,297,377
	Air	912,780	1,900,719	3,874,517	10,616,527
Ratio	Total	100.0	100.0	100.0	100.0
	Railway	4.6	2.6	1.7	1.0
	Road	94.9	96.9	97.7	98.0
	Air	0.5	0.5	0.6	1.0

2) Cargo Transportation

The total amount of cargo transportation is 58 million tons for 1994, and estimates project 96.8 million tons for 2000, and 209.4 million tons for the year 2010. The growth rate behind these numbers are 8.7% from 1994 to 2000 and, 8.0% from 2000 to 2010. The larger growth rate in the earlier section reflects that the current traffic demands have not yet grown to the size appropriate for the economic activities of this country, and model shows a rapid growth to follow. Tables 6.5.14 and 6.5.15 do not include intra province trips. In comparison with passenger traffic data which showed a large amount of movement inside the large zones, cargo freight traffic shows large transactions and traffic flows between neighboring large zones. Cargo traffic also center around Ho Chi Minh City, Hanoi, and Da Nang.

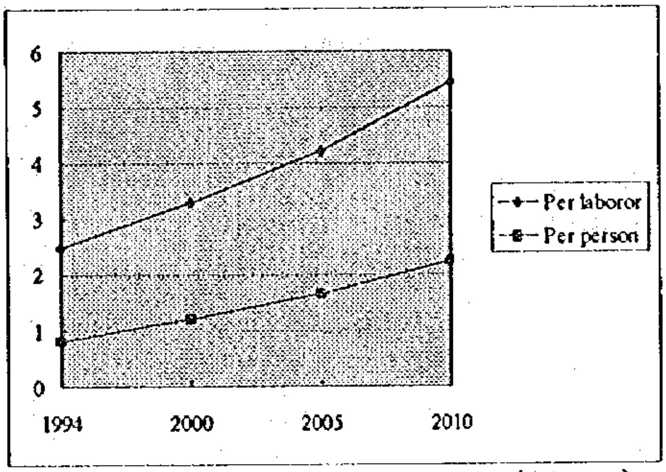
Table 6.5.14 Forecast of Cargo Trips in the Year 2000

(unit: 000 persons)	1	2	3	4	5	6	7	Total
1 Northern Upland	6,066	15,773	1,496	320	22	191	3	23,871
2 Red River Delta	9,881	4,910	1,695	444	0	138	31	17,099
3 North Central	1,402	2,591	2,332	1,180	54	244	15	7,818
4 Central Coast	436	573	1,107	2,784	882	1,476	178	7,436
5 Central Highlands	28	0	59	903	2	450	98	1,541
6 Southeast	227	804	280	1,504	475	6,490	11,052	20,833
7 Mekong River Delta	5	49	15	179	100	12,005	5,892	18,244
Total	18,046	24,700	6,984	7,314	1,535	20,994	17,271	96,843

Table 6.5.15 Forecast of Cargo Trips in the Year 2010

(unit: 000 tons)	1	2	3	4	5	6	7	Total
1 Northern Upland	10,795	28,313	2,711	438	58	354	7	42,676
2 Red River Delta	19,781	10,257	3,526	679	0	314	46	34,604
3 North Central	3,130	5,542	5,086	2,092	141	595	27	16,612
4 Central Coast	941	1,205	2,276	4,690	1,779	3,531	298	14,720
5 Central Highlands	100	1	171	1,815	7	1,414	219	3,726
6 Southeast	582	2,254	790	3,381	1,420	21,141	27,530	57,098
7 Mekong River Delta	15	100	22	277	223	28,278	11,019	39,934
Total	35,343	47,673	14,582	13,372	3,628	55,626	39,145	209,370

The number of cargo trips per person was 0.8 tons in the year 1994 and will be 1.2 tons in the year 2000 and 2.2 tons in the year 2010. The growth ratio is forecast to be sharply raised. As shown in Fig. 6.5.12, the ratio after the year 2000 is higher than that before the year 2000. Observing the data from another angle, the number is about 3 tons - 2 tons per GDP (US$1000). The per GDP ratio will decrease slightly, because the growth of GDP is very sharp.



(unit: ton)

Fig. 6.5.12 Cargo Trips per Person

The demand forecast of cargo trips by each traffic mode gets the results as shown in Table 6.5.16 (with project) in case of that the railways will be reformed according the plan in this study. Table 6.5.17 (without project) represents without improvement plan.

Total volume of cargo trips by railway will grow up to 4.7 million tons in the year 2000 and 14.8 million tons in the year 2010, from 3 million tons in the base year 1994 and the share will also increase in the case of improvements. However without improvements of railway, the volume will grow at a stagnating rate because the growth ratio of cargo demand is totally high but the share of railway cargo will gradually decrease.

The forecast volume of cargo by inland waterway in this study is higher than the forecast in the study of UNDP, but is smaller than the target volume according to Vietnam inland waterway bureau. This fluctuation depends on not only time/cost model but also management strategy.

Because characteristic item of cargo has the adequate mode by the size and the weight, each traffic mode for cargo transportation plays the role on the adequate items. But the competition in the future will become more keen on general cargo. Under these competitions the transportation mode only that supply suitable services in high quality to customers can survive and can remain the share. So the demand forecast might be reflected by the none economic factors.

Table 6.5.16 Mode Share of Cargo Trips (With Project)

		Year 1994	Year 2000	Year 2005	Year 2010
Cargo Trips	Total	58,575,307	96,843,098	143,394,707	209,369,882
	Railway	3,182,951	4,654,907	8,644,116	14,831,757
	Road	40,085,187	68,772,556	105,516,391	160,131,563
	River	15,307,170	23,415,635	29,234,200	34,406,562
Ratio (%)	Total	100.0	100.0	100.0	100.0
	Railway	5.4	4.8	6.0	7.1
	Road	68.4	71.0	73.6	76.5
	River	26.1	24.2	20.4	16.4

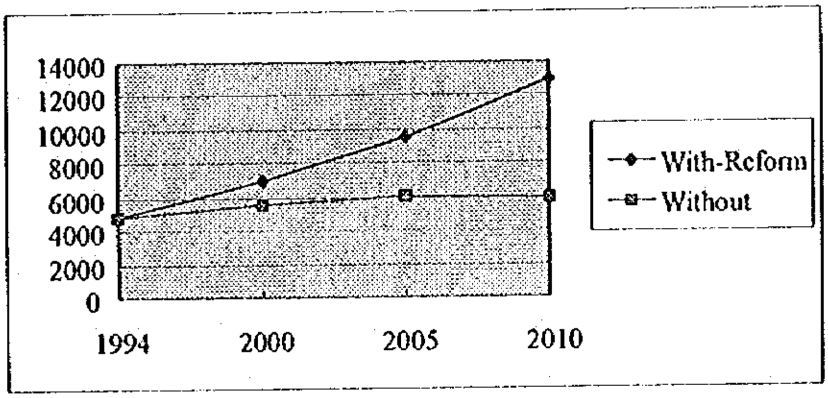
Table 6.5.17 Mode Share of Cargo Trips (Without Project)

		Year 1994	Year 2000	Year 2005	Year 2010
Cargo Trips	Total	58,575,307	96,843,098	143,394,707	209,369,882
	Railway	3,182,951	3,525,095	6,491,746	8,406,388
	Road	40,085,187	70,110,882	108,080,702	167,422,468
	River	15,307,170	23,207,121	28,822,259	33,541,026
Ratio (%)	Total	100.0	100.0	100.0	100.0
	Railway	5.4	3.6	4.5	4.0
	Road	68.4	72.4	75.4	80.0
	River	26.1	24.0	20.1	16.0

(2) Railway Transport of Hanoi-Ho Chi Minh City Line

1) Passenger Traffic

The growth ratio of passenger traffic along the Hanoi - Ho Chi Minh line will be 6 % with the rehabilitation of railway as proposed in this study, but the number of railway passengers will decrease gradually in the case of without improvements. The largest number of passengers are generated at Hanoi and Saigon, which are followed by Da Nang and Dong Hoi.

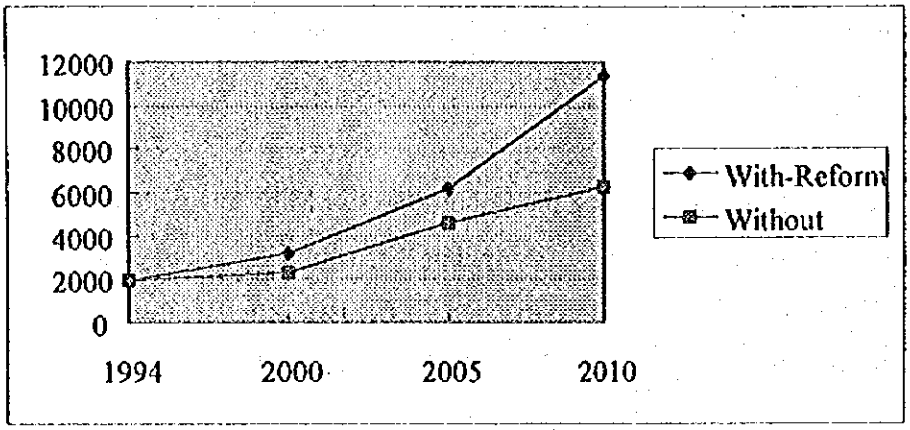


(unit: 000)

Fig. 6.5.13 Person Trips by Railway along Hanoi-Ho Chi Minh Line

2) Cargo Traffic

The growth of cargo traffic demand for railway is projected to increase at a rate of 8.7% up to the year 2000 and then at 13.5% after that in our forecast under the condition that the rehabilitation plan is executed. If not, the growth will continue in proportional to the total growth of cargo transportation demand, but will soon hit a ceiling where it cannot grow anymore. The zones that produce the most railway cargo freight are Thanh Hoa and Saigon, and the more concentrated areas are Hanoi and Thanh Hoa.



(unit: 000 tons)

Fig. 6.5.14 Cargo Trips by Railway along Hanoi-Ho Chi Minh Line

3) Other Conditions

a. Frequent Service

For the convenience of railway passengers, frequent services are planned for priority sections of the this route. Frequent services, resulting in going to railway stations at any time the passenger wants to and riding trains without waiting for a long time, will eliminate the trouble to check the timetable, contributing in increasing short-distance and mid-range passengers. The Jakarta Central Line in Indonesia has succeeded in attracting 16 to 29% more passengers by increasing the number of services by 13 to 17%. The growth in Indonesian GDP during the survey period was 7 to 8%, so subtracting the increase of train trips caused by GDP growth, we get a growth in demand between 8% to 20%, showing cultivation of potential demand.

A similar effect can be achieved in this route. Team's survey on the main transportation modes used from the departure point to the nearest railway station in this route, shows that busses are most frequently used, occupying 26%, followed by motorcycles covering 25%. The average time required by bus is 67 minutes. More potential passengers could be gained by increasing the frequency of train operation to a shorter interval than this average value, whilst higher service rates will be required to satisfy the demand of motor-cycles, people who come on foot (9%), by bicycles (6%), and taxi (1%).

Considering the effects in other regions where the potential demand is high, increasing the frequency of train operation, will directly result in the increase of passengers, and the rate of passenger increase will be in proportion with the rate of increase in service. However, the increase stops at the point where all the passengers are satisfied with the frequency of service. Team's survey points out that 15% of the people are feeling that there is not enough trains operated in this route. Judging from this fact, it is estimated that there will be a 15% increase in passengers in this region if frequent services can fully satisfy their demand on train operation.

b. Competition with Air Transportation

The current use of air traffic is basically by the government and corporate staff. Team's survey showed 52% of the passengers were on official use. It is expected that some more time is needed for individuals to travel on their own budget. This does not contradict to the fact that air transportation passengers will increase.

Even if Hanoi - Ho Chi Minh City was connected by rail in 24 hours, the time advantage will be on air transportation for people who can afford the fare. The difference in fare is so large that we consider the main competitors of long-distance travel is buses, and not airplanes. Survey results showed that average income level of aircraft passengers were 2 million Dong in comparison to the 1 million Dong income of the average train passenger. The social class is very different. For reasons to prefer trains for long distance travel is that such passengers have more time, have more luggage, or prefer the service offered by railway companies. When compared to mid-range flights, trains can become competitive depending on the time required to reach the airport, and the waiting time before flight departure.

These facts show that if railways keep rehabilitating there services, and maintain a certain level of satisfaction for the passenger, it would maintain its position against air transportation. If such efforts do not take place, the large income class will take air transportation while the others who cannot afford planes will use buses, and railway competitiveness will rapidly decrease.

c. **Competition with Coastal Shipping**

It is difficult to forecast in accurate manner the volume of coastal shipping corresponding to the North-South line, but the amount cargo traffic by domestic coastal shipping was estimated. The total volume of domestic cargo handling at ports accumulates to 1.93 million tons, so the trip amount will be half of the total. In contrast to this volume, the total amount of all cargo traffic for the year 1994 is 58.6 million tons, so it is concluded that coastal shipping traffic is approximately 1.7% of the total cargo traffic. Although we expect the amount of cargo through ports to increase, the forecast predicts about a 2.4% share in the year 2000. The total volume of cargo may increase from 2000 to 2010, but increase in land transportation volume will keep the share at the same rate.

The items transported via domestic coastal shipping is relatively limited. Items that have a possibility of conflicting with rail transportation is cement and coal. In the year 2000, the forecast predicts that 1,125 thousand tons of cement will be shipped from Cai Lan port, 106 thousand tons through Quy Nhon port, and 900 thousand tons will be shipped from Saigon port. Cement accounts for 28% of the total cargo freight on the North-South line, and will cause a large loss of demand if shifted to coastal shipping. The same forecast predicts 130 thousand tons of coal to be shipped from the Da Nang port, and 34 thousand tons from the Quy Nhon port, by the year 2000. This is also an important item consisting 14% of the total freight in the North-South line. However these predictions does not mean a total loss from a viewpoint that it generates cargo traffic from production points to the ports, and from the ports to the consumers. Coastal shipping have an advantage of low-cost mass transportation of goods, but land transportation have an advantage at providing service for detailed demands. Analysis in our current data shows that there are not very much long-distance trips from North to South for cement and coal. This shows a possibility of railways coexisting with coastal shipping, fulfilling different roles, which may stay the same in the future.

However, the fact that 40% of the cargo traffic being dominated by cement and coal must be considered from a administration point of view, taking in count that these are the items that meets the most competition with coastal shipping. If these two item switch from railway to coastal shipping, there will be a great reduction in long distance freights except the deliveries to and from the ports. Strategic decisions are required to decide whether to compete with these transportation with a special pricing, or to maintain the service by delivering direct from production sites to varying consumers, in a timely manner.

For other items in the list, rail traffic and coastal cargo will cover different needs.

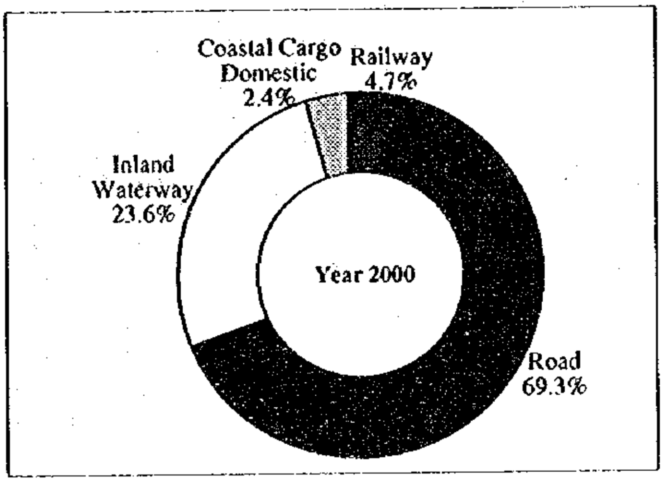


Fig. 6.5.15 Share of Cargo Trips(ton) in Viet Nam

6.5.4 Revised Demand Forecast

In this section we discuss the revised demand forecast under the above considerations.

The revised factor on passenger trips is frequent service. However the analysis of the survey in June 1995 could not get the sufficient result for developing discrete choice model on service factors.

We also revised the competition model of cargo trips. The current model already incorporates the road transportation and the inland waterways, so the problem to be added is the competition rates with coastal shipping.

Table 6.5.18 shows the contents of railway cargo freight in 1994. Cement and coal are the items that face competition with coastal shipping, but the trips for these goods are relatively short-distance, intra-region demands. Studies in other countries show that long-distance trips

Table 6.5.18 Trip Length of Railway Cargo and the Modal Split to Coastal Shipping

Item	Share of Item	Trip Length and Share by the Distance	
Cement	27.5	100-346km(82%)/100-175km(74%)	About 10% of these items will be transported by ship.
Coal	13.9	less 175km(92%)	
Stone/Gravel/Sand	24.2	less 260km(76%)/80-425km(87%)	
Wood/ Furniture	5.7	220-530km(67%)	
Fertilizer	10.6	500-1726km(75%)	These trips have long distance.
Food Stuff	3.6	1460-1726km(85%)	Coastal shipping is strong for long trips.
Mineral/Salt/Apatite		less 600km	The role of railway will be the same.
Others		12% of all cargo (over 600km)	This part also will be transported. by ship.
Total			30%

have a trend to shift to coastal shipping. For example, cargo freights in Southern Bangkok show that rail and coastal shipping each own half of the total demand, and in Japan, the volume of long-distance railway cargo and coastal shipping became equal in 1960, then shifted to shipping.

Considering the above facts, it is judged a 10% amount of long-distance cargo will shift into shipping for cement, coal, stone, wood. As for the fertilizers and foodstuff, long distance freights (75%-80%) are predicted to shift to shipping. For other products, it is predicted all trips exceeding 600 kilometers will shift to coastal shipping.

Summing up these factors, we forecast that 30% of railway cargo will shift to coastal shipping. However, the economic growth rate suggests that it will take more than 10 years for all the ports and ships to be prepared, and for shipping to be competent with the land opponents. We have decided not to modify our estimate for the year 2000, but modified the figure at the year 2010 with a view that there will be a 30% decline in railway cargo demands for the year 2010.

CHAPTER 7 DETAILS OF SELECTED MASTER PLAN ALTERNATIVE

7.1 Marketing

7.1.1 Marketing System

The VNR's current railway service marketing and operation system must be fundamentally reviewed and strengthened with the implementation of a series of modernisation measures to upgrade the system to meet the challenges facing the railway service in the 21st century as well as the requirements of passengers and consignors. This subject is described also in the UNDP report. The promotion of the following measures appears essential to achieve the improvement targets together with measures to rationalise the surplus manpower at stations and to strengthen the nationwide railway management function of the Head Office.

(1) Passenger Services

1) Establishment of Basic Passenger Services

The establishment of basic passenger services, including the publication and sale of nationwide train timetables, improvement of the station facilities and environment and public relations activities on railway transportation, is urgently required. The efficient use of manpower can be achieved by diverting surplus station staff to the travel centres to be newly introduced and to new positions to improve the station environment, etc.

2) Modernisation of Passenger Train Marketing System

In addition to introducing new PCs and rehabilitating existing PCs, the passenger train service should be upgraded through improvement of the passenger accommodation, stepping-up of PC cleaning and shortening of the travelling times.

The introduction of a passenger information system together with improvement of the railway communication network is particularly required and should be followed by an improved fare system and a quick and accurate ticket sales system (including return tickets and reserved seat tickets). The establishment of these systems will further reduce the actual travelling times for passengers who will enjoy shorter travelling times by faster trains.

3) Promotion of Tourism and Related Businesses

The Hanoi - Ho Chi Minh route is an important route for not only domestic passengers but also for foreign tourists. The development and utilisation of tourism resources along the route, followed by the development of public relations activities to attract tourists, are highly desirable. Moreover, tourism-related businesses should be promoted along the route in cooperation with local enterprises and authorities, etc.

The need for tourism promotion also underlines the need for a passenger information system which will help to establish convenient links with private local bus services operating from stations.

(2) Freight Services

As in the case of passenger services, freight services should be improved by the publication of freight train timetables and the promotion of the following measures.

1) Shorter Travelling Times

The improved train speeds (by means of the standard use of high-powered locomotives and a slight reduction of the haulage capacity, etc.) should be augmented by the introduction of more through freight trains to shorten the freight travelling times in general to provide better services for consignors.

2) Modernisation of Freight Information Service

As in the case of the passenger information service, the freight information service should cover the entire railway network in Viet Nam. It should be designed to ensure swift and accurate freight services based on the FC and cargo database of the central control office with the assistance of the sub-systems of the Union offices and terminal systems of the main yards. This system is essential for an increased level of container operation in the future.

3) Unification/Withdrawal of Small-Scale Cargo Handling Stations and Promotion of Multi-Mode Transportation

Given the characteristics of railway transportation, a road transportation system should be developed for the transportation of cargo from those stations of which the daily cargo handling volume is less than one FC equivalent to nearby main stations to improve the freight transportation efficiency and to rationalise the manpower at stations.

With regard to such wagon-load cargo as express cargo, the introduction of a designated train system and other measures will enable the efficient promotion of multi-mode transportation.

4) Speeding-Up of Yard Operation at Cargo Stations

In addition to faster train speeds, the speeding-up of yard operation at not only terminal stations (departure and arrival stations) but also at intermediate stations where part of the FCs may be disconnected or new FCs added is essential for the swift transportation of cargo.

Measures to achieve such speeding-up include the introduction of the Class 1 electric relay interlocking system for main stations (the signals and points, etc. are electrically operated under the uniform control of the signals office) for speedy and safer yard operation. The establishment of the freight information system described in b) above will then increase the speed and reliability of freight transportation along the entire route and should resulted in increased revenues.

These measures should also prove effective to improve the freight transportation efficiency (shortening of the FC return period) which will in turn enable a reduction of the number of FCs.

7.1.2 Fare System

As described in Section 5.3.2, the current fare system is particularly difficult for passengers to understand. While the tariff based on specific trains, classes and destinations appears helpful at first glance, the system is used unfriendly at the time of purchasing a ticket in accordance with a specific travel plan because of the many restrictions, including the impossibility of changing the class depending on certain segments of a trip.

The standard fare is the basic train fare and guarantees that the passenger will reach the original destination even if the train is changed at an intermediate station. The express fare, sleeping berth fare and first class fare, etc. are charged for the use of special facilities and are combined with the standard fare to make up a specific fare for each passenger. From the passenger viewpoint, it would be more convenient if these special fares could be separately paid in order to permit a change of class or change of an ordinary seat to a sleeping berth, etc. The practice of charging a special fare in response to the actual requirements would also permit passengers to accurately and easily calculate the total train fare in advance. The special and standard fare tariffs should be included on the train timetable sold to the public together with descriptions of the train services.

It would be particularly convenient for foreign tourists to be able to purchase return tickets, seat reservation tickets and round-trip tickets, etc. at major stations. In addition, a radical review of the fare system should include the introduction of group reduction tickets, etc. to promote the use of passenger trains.

Railway passenger transportation could also be vitalised by the issue of multi-mode tickets which include sightseeing bus fares. An example of such a ticket is the Bay of Ha Long Sightseeing Round-Trip Ticket. The introduction of a passenger information system will allow the quick purchase of these tickets at travel centres or major stations, improving passenger services and increasing revenues.

In regard to freight fares, the present system is fairly adequate as such well considered special fares as discounts for cargo for export are offered. There are, however, certain issues to be examined in the future, including a new fare system for multi-mode transportation involving road haulage and alteration of the present system in view of the use of privately owned containers on freight trains and the introduction of a designated train system for freight transportation.

7.2 Transportation Plan

7.2.1 Transportation Plan Planning Principles

For every mode of transportation, including the railway, the final product is an operation diagramme. It is the ultimate task of a railway operator to ensure accurate, safe and speedy daily transportation in accordance with a publicised train operation schedule. These requirements are the focal point for the work to prepare an improvement plan for the Hanoi - Ho Chi Minh Railway which is the major trunk line operated by the VNR. Improvement of this railway line is expected to enhance its role as a pillar for economic development in Viet Nam and also as a convenient and reliable mode of transportation to meet the needs of such users as local residents and foreign tourists, etc.

Give the above-described required roles of the Hanoi - Ho Chi Minh Railway in the future, efforts should be made to speed up the operation by means of speeding up the trains as much as possible in accordance with the improvement and rehabilitation of the railway infrastructure in order to fully exploit the advantages of train transportation. The targets for train operation should, therefore, be increased train frequency and higher travelling speeds for all trains in addition to the improved reliability of transportation services.

Reliable transportation services should be achieved by the introduction of an appropriate operation and maintenance system vis-a-vis the characteristics of the route and the current conditions and future prospects of transportation services, followed by strengthening of the transportation management system and modernisation of the dispatching facilities.

7.2.2 Basic Planning Conditions

A viable transportation plan should be prepared based on the following conditions, taking the principles described in Section 7.2.1 into consideration.

(1) Subject Railway Lines

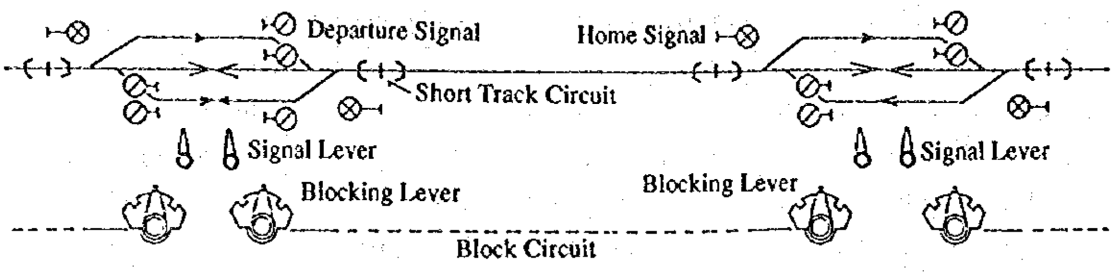
The subject lines of the transportation plan in question are the 1,726.2 km line between Hanoi and Ho Chi Minh City and 3 branch lines.

(2) Operational Safety System

An operational safety system, an essential component of train operation, will be planned to improve the safety of train operation and to allow the future modernisation of the system, taking the existing conditions of such railway infrastructure as track and bridges, etc., the transportation demand and operation systems of other lines and neighbouring countries into proper consideration.

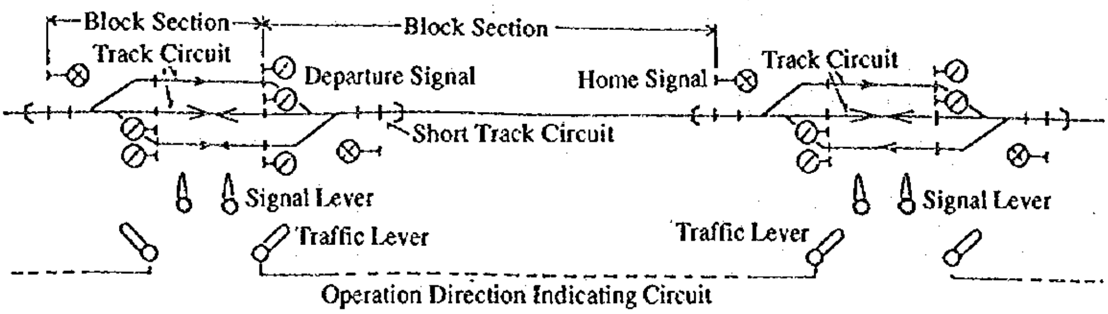
1) Block System

The block system to be planned will be the token-less block system, the installation of which is currently in progress. The token-less block system is popularly used for single track sections and is similar to the special automatic block system, which should be the system for the next stage of development, in terms of safety, mechanism and operational procedure, allowing easy upgrading in the future. The employment of the more advanced special automatic block system in the future is desirable in accordance with the introduction of the centralised traffic control (CTC) system for the entire network. The token-less block system and special automatic block system are illustrated in Fig. 7.2-1 and Fig. 7.2-2 respectively.



Note: Home signal with 3 colourlight display: Ⓡ = Stop, Ⓨ = Caution, Ⓖ = Go
(YY display for entry to a subsidiary main track.)
Departure signal with 2 colourlight display: Ⓡ = Stop, Ⓖ = Go

Fig. 7.2-1 Token-Less Block System



Note: Home signal with 3 colourlight display: Ⓡ = Stop, Ⓨ = Caution, Ⓖ = Go
(YY display for entry to a subsidiary main track.)
Departure signal with 2 colourlight display: Ⓡ = Stop, Ⓖ = Go

Fig. 7.2-2 Special Automatic Block System

2) Signalling System

The current 2 dual display system mainly using mechanical signals will be upgraded to the electrical 3 colourlight display system which is very similar to the signalling system under the automatic block system and which will be able to operate under the special automatic block system without modification. Furthermore, an approaching signal is installed at a nacessary station, with consideration of such factors as the distance needed for the home signal identification. Fig. 7.2-3 shows the new integrated signalling system following improvement of the current sytsem.

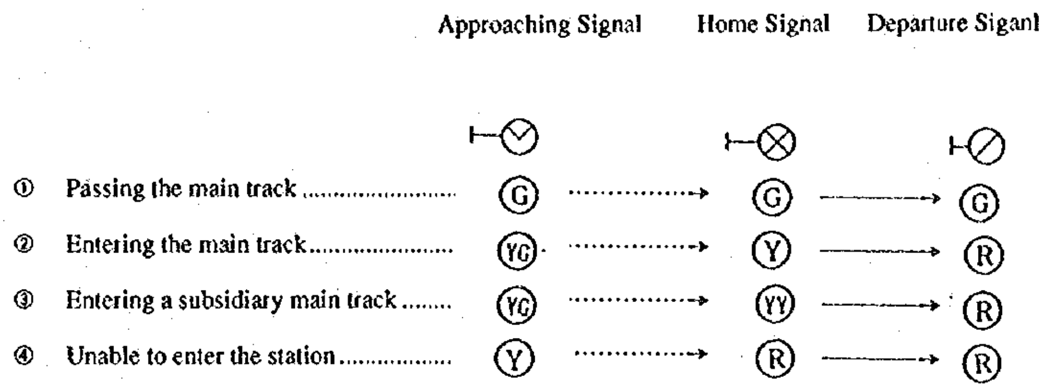


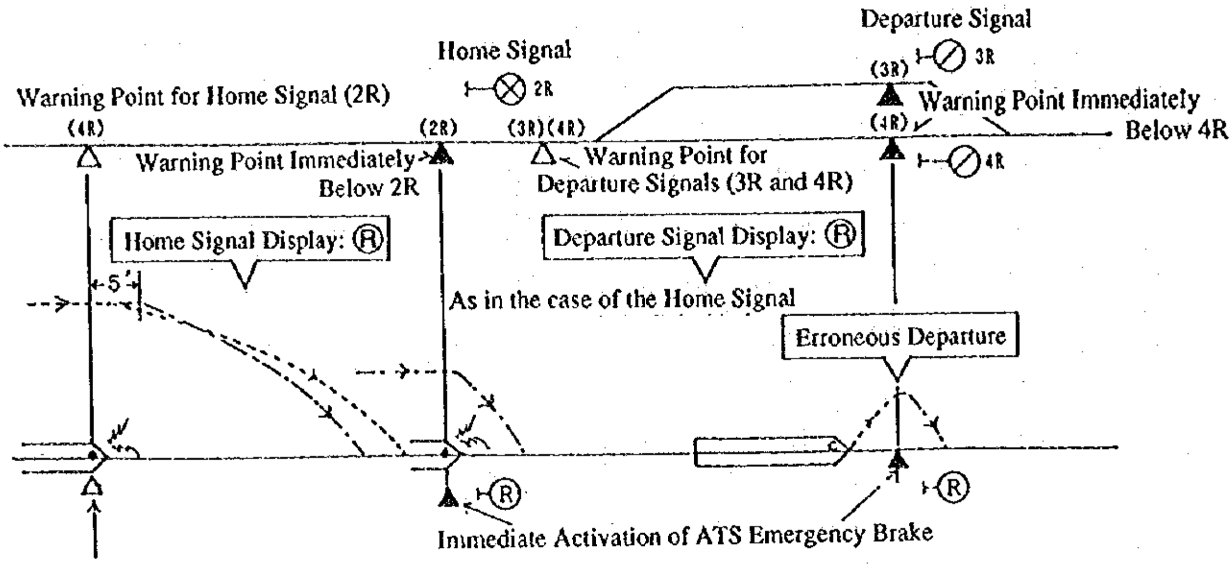
Fig. 7.2-3 Unified Signalling System

3) Interlocking System

The Class 1 electrical relay interlocking system (centrally controlled system) will be installed at stations with a heavy yard work volume relating to train services while the Class 2 relay interlocking system should be installed at all other stations. The special automatic block system will be introduced between Thanh Khe Station and Da Nang Station to speed up train handling at the latter and the Thanh Khe Station will be remotely controlled by the Da Nang Station.

4) Miscellaneous

At present, all communication with a train in operation relies on acknowledge-ment by the train's engineer and a mistake in the communication process can lead to a major accident. The ATS (automatic train stop) system will be introduced to prevent accidents resulting from human error as this system will significantly improve the safety of train operation. The prospective ATS system is illustrated in Fig. 7.2-4.



• Signal Confirmed ⇒ ordinary operation possible
• Signal Not Confirmed ⇒ emergency brake activated after 5 seconds to stop the train

Notes 1) ATS Functions
The ATS communication unit on the train constantly transmits signals at 105 KHz.
△ Warning Point : For the R display, the frequency is changed to 130 KHz to issue the warning. The train driver can confirm the signal display and over-ride the warning.
▲ Warning Point : For the R display, the frequency is changed to 123 KHz to issue the warning and to immediately activate the emergency brake to stop the train.
2) "Signal Confirmation" : The train driver can press the signal confirmation button to keep the train running.
"Warning Display" : The red signal is lit and the alarm bell rings.

Fig. 7.2-4 Functions of ATS System

(3) Train Types

The maximum speeds by train types under the Optimum Alternative are shown in Table 7.2-1.

Table 7.2-1 Maximum Speeds by Train Types

Train Type		Section	Max. Speed	Remarks
Passenger	Limited Express	Hanoi - Ho Chi Minh	110 km/hr	New cars (push-pull)
	Express	between major stations	110 km/hr	New cars (push-pull)
	Local	between major stations	75 km/hr	Existing cars (D12Es)
Freight	Direct	Giap Bat-Song Than	80 km/hr	Pulled by D18E
	Inter-Regional	between major freight terminals	80 km/hr	Pulled by D18E
	Local	between major freight terminals	70 km/hr	Pulled by 2 D12Es

Note: By 2000 (first phase), express (inter-regional) trains running between Hanoi and Da Nang City will use existing PCs and will be pulled by D18E.

(4) Operation Staff

In principle, a passenger train will be operated by 2 engineers and one guard. A limited express or (inter-regional) express train will have a guard on board each PC and service personnel. A freight train will be operated by 2 engineers basically.

(5) Rolling Stock and Its Performance

New fixed composition trains (push-pull) will be introduced to serve as limited express and (inter-regional) express trains. Other trains will use the existing rolling stock as much as possible except locomotives where efforts will be made to introduce the standard use of D18Es and D12Es. D18Es will be used for direct and inter-regional freight trains and D12Es will basically be used for local passenger trains and local freight trains. D11Hs and other locomotives will also be used to serve local trains as long as they are operational. Local freight trains will be pulled by 2 D12Es.

The planned rolling stock performance will be based on the performance guidelines described in 7.5 - Rolling Stock and Its Maintenance. The train acceleration curves are shown in Appendix 7.2.1.

(6) Seat-Load Factor and Cargo-Load Factor

1) Seat-Load Factor

The seat-load factor for the upgraded Hanoi - Ho Chi Minh Railway is planned based on the conditions of the route in terms of transportation demand fluctuations. Given the fact that the route is largely used for medium and long distance transportation, the current conditions of the Hanoi - Ho Chi Minh Railway described in Section 5.2 will also be taken into consideration to establish a realistic seat-load factor.

① All seats on limited express trains and (inter-regional) express trains will be reserved seats and the planned seat-load factor will be 80 - 85%. The issue of unreserved express tickets will be taken into consideration.

② The planned seat-load factor for local passenger trains will be 80 - 100%.

The transportation fluctuation rate will be assumed to be approximately 130% and excess seat requirements during busy seasons will be met by additional trains.

2) Cargo-Load Factor

The planned cargo-load factor for freight trans is 85% based on the past and present average factors.

3) FC Return Period

The average return period for FCs has been shortening every year and the following periods will be adopted based on the past performance and shortened travelling times of freight trains and increased frequency of direct freight trains in the future.

Year	:	2000	2005	2010
Return Period	:	8 days	7.5 days	7 days

4) Empty Car Ratio of Freight Trains

At present, all direct freight trains are said to be loaded. However, an empty car ratio of 30% is assumed for future freight operation.

(7) Track Conditions

The track conditions, including the maximum allowable train speed by track grade which is the basis for train operation planning, are as described in 7.3 - Railway Infrastructure.

Every effort will be made to ensure an operation speed of 80 km/hr at those sections where no special speed limit is imposed, as in the case of bridges, even if these sections are not subject to track improvement during the first phase.

7.2.3 Train Operation Plan

The train operation plan will be prepared on the basis of the operation diagram, taking the basic planning principles of the transportation plan and various conditions of the operation components into proper consideration.

The train travelling times for the improved routes will be calculated on the basis of the operation diagram. The emergency braking distance for trains, which is the basis for safe train operation, is planned to be "upto 800m".

There is a special need to speed up local passenger and freight trains as their relatively slow speeds are a major cause of the low track capacity. Efforts should be made to adopt a standard haulage capacity so that these local trains can travel at a speed of at least 25 - 30 km/hr in sloping sections.

The composition and haulage capacity of each type of train are shown in Table 7.2-2.

Table 7.2-2 Haulage Capacity of Different Trains

Train Type	Composition	Haulage Capacity (tons)	Passengers: persons Freight: net tons
Limited Express	Push-Pull (10 PCs)	350	446
Express Passenger	Push-Pull (10 PCs)	350	516
Local Passenger	D12E + 6 PCs	260	400
Direct Freight	D18E + 17 FCs	600	330
Inter-Regional Freight	D18E + 17/22 FCs	600 - 800	330 - 410
Local Freight	D18E x 2 + 13-21 FCs	600 - 750	330 - 410

7.2.4 Transportation Plan

The transportation capacity of each type of passenger and freight train will be determined based on the figures shown in the O-D Table in Section 6.4.2 - Railway Demand Forecast and the train operation plan described in Section 7.2.3.

(1) Train Operating Plan

The train operating plan will be decided in view of providing the best customer services to meet customer requirements. The departure times for inter-regional express passenger trains will be set during the daytime as much as possible. As for the local passenger service, since the distance between adjacent stations on this section is fairly long (about 10 km), it is necessary to promote closer cooperation with local buses in order to sufficiently meet the demand of residents along the route. In this connection, at least 2 trains in each direction will be introduced for the local passenger service. The travelling times of the key trains between Hanoi and Ho Chi Minh City are shown in Table 7.2-3 and Table 7.2-4. The travelling time between Hanoi and Ho Chi Minh City by a limited express passenger train will be reduced to 24 hours owing to the eradication of slow speed sections and the operation of maximum speed 110 km/h.

(2) Number of Trains, Train-km and Car-km by Improvement Stage

The number of trains to be operated, train-km and car-km by improvement stage (target year) are given in Fig. 7.2-5 and Table 7.2-5 (also see Appendix 7.2.2) taking the estimated transportation demand into consideration.

(3) Calculation of Required Rolling Stock Volume

The calculation results of the required rolling stock volume based on the train operation plan by improvement stage (target year) are given in Table 7.2-6.

Table 7.2-3 Train Travelling Times Under Optimum Alternative: Limited Express (Push-Pull with 10 PCs)

Station	Distance (km)	2000 Travelling Time (110 km/hr)	2000 Stoppage Time	2005 Travelling Time	2005 Stoppage Time	2010 Travelling Time	2010 Stoppage Time
1 Hanoi	0						
8 P.Ly	55.9						
12 Nam Dinh	86.8						
15 N.Binh	114.6						
19 B.Son		6h05'		5h20'		4h15'	
22 T.Hoa	175.2						
24 M.Khoi	196.9						
29 H.Mai	245.4						
35 Vinh	319.0		5'		5'		5'
43 H.Pho	386.8						
48 D.Le	436.3	4h35'		3h50'		3h05'	
51 L.Son	467.1						
56 Dong Hoi	521.8		5'		5'		5'
59 M.Duc	550.9						
61 My Trach	565.1	3h25'		2h05'		2h	
66 Dong Ha	622.2						
73 Hue	688.3		5'		5'		5'
78 L.Co	755.4	3h10'		2h50'		2h00'	
84 Da Nang	791.4		20'		20'		20'
86 N.Son	813.6						
96 Q.Ngai	927.9	5h25'		5h00'		3h55'	
102 S.Huynh	990.8						
110 Dieu Tri	1,095.0		5'		5'		5'
117 Tuy Hoa	1,197.5	3h10'		2h40'		2h45'	
128 Nha Trang	1,314.9		5'		5'		5'
134 T.Cham	1,407.6	3h15'		2h55'		2h45'	
144 Muong Man	1,551.2		5'		5'		5'
152 B.Chanh	1,639.8						
156 Ho Nai	1,688.0	2h35'		2h30'		2h25'	
159 Song Than	1,710.6						
163 Saigon	1,726.2						
		31h40'	(50)	27h10'	(50)	23h10'	(50)
Total Travelling Time		32h30'		28h		24h	
Time Allowance		approx. 30 min.		approx. 20 min.		approx. 40 min.	

Note: Maximum Travelling Speed: 110 km/hr

Table 7.2-4 Train Travelling Times Under Optimum Alternative: Direct Freight Train (D18E; 600 tons)

Station	Distance (km)	2000 Travelling Time	2000 Stoppage Time	2005 Travelling Time	2005 Stoppage Time	2010 Travelling Time	2010 Stoppage Time
1 Hanoi	0						
2 Giap Bat	5.2						
		1h30		1h30		1h20	
12 Nam Dinh	86.8		30		30		30
		40		40		30	
15 N.Binh	114.6		30		30		30
		40		40		30	
19 B.Son	141.5		30		30		30
22 T.Hoa	176.2		-		-		-
		3h30		3h10		2h50	
24 M.Khoi	196.9		-		-		-
29 H.Mai	245.4		-		-		-
35 Vinh	319.0		30'		30'		30'
43 H.Pho	386.8		-		-		-
48 D.Le	436.3	4h40	-	4h10	-	3h40	-
51 L.Son	467.1		-		-		-
56 Dong Hoi	521.8		30		30		30
59 M.Duc	550.9		-		-		-
		2h20		1h40		1h30	
61 My Trach	565.1		-		-		-
66 Dong Ha	622.2		30		30		30
		1h30		1h20		1h10	
73 Hue	688.3		30		30		30
78 L.Co	755.4	3h10	-	3h00	-	2h30	-
84 Da Nang	791.4		30'		30'		30'
86 N.Son	813.6		-		-		-
96 Q.Ngai	927.9	5h50	-	5h30	-	4h30	-
100 Duc Pho	967.7						
110 Dieu Tri	1,095.0		30		30		30
117 Tuy Hoa	1,197.5	3h50	-	3h20	-	3h20	-
128 Nha Trang	1,314.9		30'		30'		30'
		1h30		1h30		1h30	
134 Th. Cham	1,407.6		30		30		30
		2h20		2h10		2h10	
144 Muong Man	1,551.2		30		30		30
152 B.Chanh	1,639.8		-		-		-
		2h50		2h50		2h50	
157 Bien Hoa	1,697.5		-		-		-
159 Song Than	1,710.6						
		31h20'	6h	31h	6h	28h20'	6h
163 Saigon	1,726.2	46h		43h		40h	

Note: Maximum Travelling Speed: 80 km/hr. The time allowance to accommodate unexpected delays in travelling is approximately 2 hours 30 minutes for each stage.

(2000)

Alternative	Train Type	Station / Distance (km)	1 Hanoi (0km) – 2 G.Ba	2 G.Ba 5.2 – 3 Y.Di.	3 Y.Di. 8.9 – 6 P.Xu.	6 P.Xu. 33.3 – 12 K.D.	12 K.D. 86.8 – 15 K.B.	15 K.B. 114.6 – 22 T.Ho.	22 T.Ho. 175.2 – 35 Vinh	35 Vinh 319.0 – 43 H.Pho	43 H.Pho 386.8 – 56 D.Hoi	56 D.Hoi 521.8 – 66 Dong Ha	66 Dong Ha 622.2 – 73 Hue	73 Hue 688.3 – 84 D.Na.	84 D.Na. 791.4 – 96 Q.X	96 Q.X 927.9 – 110 D.Tri	110 D.Tri 1095.5 – 117 T.Hoa	117 T.Hoa 1197.5 – 128 N.Tra.	128 N.Tra. 1314.9 – 144 K.Xan	144 K.Xan 1551.2 – 157 B.Hoa	157 B.Hoa 1697.6 – 163 S.Than	163 S.Than 1710.6 – 163 Saigon 1726.2	Total (km) 1726.2
		Distance (km)	5.2	3.7	24.4	53.5	27.8	60.6	143.8	67.8	135.0	100.4	66.1	103.1	136.5	167.6	102.0	117.4	236.3	146.3	13.1	16.6	
I	Passenger (L.Exp., I.Exp., Local P.)	Total	7	14	14	11	11	11	9	9	9	10	10	11	9	9	9	9	9	11	14	14	
	Freight (T.F.T., I.F.T., Exc.F.T.)	Total	0	8	10	10	8	8	6	6	6	5	5	6	5	6	5	5	6	6	5	0	
	G. Total		7	22	24	21	19	19	15	15	15	15	15	17	14	14	14	14	14	16	19	14	

(2005)

Alternative	Train Type	Station / Distance (km)	1 Hanoi (0km) – 2 G.Ba	2 G.Ba 5.2 – 3 Y.Di.	3 Y.Di. 8.9 – 6 P.Xu.	6 P.Xu. 33.3 – 12 K.D.	12 K.D. 86.8 – 15 K.B.	15 K.B. 114.6 – 22 T.Ho.	22 T.Ho. 175.2 – 35 Vinh	35 Vinh 319.0 – 43 H.Pho	43 H.Pho 386.8 – 56 D.Hoi	56 D.Hoi 521.8 – 66 Dong Ha	66 Dong Ha 622.2 – 73 Hue	73 Hue 688.3 – 84 D.Na.	84 D.Na. 791.4 – 96 Q.X	96 Q.X 927.9 – 110 D.Tri	110 D.Tri 1095.5 – 117 T.Hoa	117 T.Hoa 1197.5 – 128 N.Tra.	128 N.Tra. 1314.9 – 144 K.Xan	144 K.Xan 1551.2 – 157 B.Hoa	157 B.Hoa 1697.5 – 163 S.Than	163 S.Than 1710.6 – 163 Saigon 1726.2	Total (km) 1726.2
		Distance (km)	5.2	3.7	24.4	53.5	27.8	60.6	143.8	67.8	135.0	100.4	66.1	103.1	136.5	167.6	102.0	117.4	236.3	146.3	13.1	16.6	
I	Passenger (L.Exp., I.Exp., Local P.)	Total	7	14	14	11	11	11	11	10	10	10	10	14	11	11	10	10	11	12	15	15	
	Freight (T.F.T., I.F.T., Exc.F.T.)	Total	0	9	11	11	14	12	9	9	8	8	7	6	7	7	7	7	7	7	7	0	
	G. Total		7	23	25	22	25	23	20	19	18	18	17	20	18	18	17	17	18	19	22	15	

(2010)

Alternative	Train Type	Station / Distance (km)	1 Hanoi (0km) – 2 G.Ba	2 G.Ba 5.2 – 3 Y.Di.	3 Y.Di. 8.9 – 6 P.Xu.	6 P.Xu. 33.3 – 12 K.D.	12 K.D. 86.8 – 15 K.B.	15 K.B. 114.6 – 22 T.Ho.	22 T.Ho. 175.2 – 35 Vinh	35 Vinh 319.0 – 43 H.Pho	43 H.Pho 386.8 – 56 D.Hoi	56 D.Hoi 521.8 – 66 Dong Ha	66 Dong Ha 622.2 – 73 Hue	73 Hue 688.3 – 84 D.Na.	84 D.Na. 791.4 – 96 Q.X	96 Q.X 927.9 – 110 D.Tri	110 D.Tri 1095.5 – 117 T.Hoa	117 T.Hoa 1197.6 – 128 N.Tra.	128 N.Tra. 1314.9 – 144 K.Xan	144 K.Xan 1551.2 – 157 B.Hoa	157 B.Hoa 1697.5 – 163 S.Than	163 S.Than 1710.6 – 163 Saigon 1726.2	Total (km) 1726.2
		Distance (km)	5.2	3.7	24.4	53.5	27.8	60.6	143.8	67.8	135.0	100.4	66.1	103.1	136.5	167.6	102.0	117.4	236.3	146.3	13.1	15.6	
I	Passenger (L.Exp., I.Exp., Local P.)	Total	11	16	16	15	14	13	13	13	12	12	12	16	14	13	13	13	13	14	16	16	
	Freight (T.F.T., I.F.T., Exc.F.T.)	Total	0	10	12	12	14	14	9	9	8	8	7	8	7	7	7	7	8	9	10	0	
	G. Total		11	26	28	27	28	27	22	22	20	20	19	24	21	20	20	20	21	23	26	16	

L.Exp. : Limited Express Train. I.Exp. : Inter Regional Express Train. Local P. : Local Passenger Train.
T.F.T. : Through Freight Train. I.F.T. : Inter Regional Freight Train. Exc.F.T. : Exclusive Freight Train.

Fig. 7.2-5 Train Operation Plan by Improvement Stage

Table 7.2-5 Estimated Train-km Car-km by Improvement Stage

(Unit: km)

Train Type / Year		2000				2005				2010			
		Train-km	Car-km			Train-km	Car-km			Train-km	Car-km		
			Trains	F Cs	Locmotive		Trains	F Cs	Locmotive		Trains	F Cs	Locmotive
P.T.	L. Exp.	17,270	158,890	-	28,210	17,270	172,700	-	34,540	20,710	207,100	-	41,420
	I. Exp.	11,810	84,040	-	18,250	14,790	147,900	-	25,780	15,410	154,100	-	30,820
	Local P.T.	4,530	22,490	-		6,280	35,440	-	6,280	9,950	59,700	-	9,950
	Total	33,610	265,420	-	39,540	38,340	356,040	-	66,660	46,470	420,900	-	82,190
F.T.	T. F. T.	10,360	-	364,290	15,970	10,360	-	501,580	11,180	13,810	-	589,290	13,810
	I. F. T.	7,810	-		11,550	12,250	-		15,770	12,980	-		19,380
	Exc.F.T.	1,510	-		1,510	1,750	-		1,750	2,100	-		2,100
	Total	19,680	-		29,030	24,360	-		28,700	28,890	-		35,290
G. Total		53,290	265,420	364,290	68,570	62,700	356,040	501,580	95,360	75,360	420,90	589,290	117,480

Note L.Exp : Limited Express Train. I.Exp. : Inter Regional Express Train. Local P.T.: Local Passenger Train.
T.F.T : Through Freight Train. I.F.T. : Inter Regional Freight Train. Exc.F.T. : Exclusive Freight Train.

Table 7.2-6 Required Rolling Stock Numbers by Impr ovement Stage

(Unit: cars)

Train Type		2000					2005					2010				
		New No.of Trains	D18E	D12E	PC	FC	New No.of Trains	D18E	D12E	PC	FC	New No.of Trains	D18E	D12E	PC	FC
P.T.	L. Exp.	5			180	-	17	-	-	-	-	18	-	-	-	-
	I. Exp.	-	17	75	204	-	10	11	26	240	-	26	-	-	-	-
	Local P.T.	-			90	-	-	-	24	130	-	-	-	37	220	-
	Total	5	17	75	474	-	27	11	50	370	-	44	-	37	220	-
F.T.	T. F. T.	-			-	-	-			-	-	-			-	-
	I. F. T.	-	32	46	-	-	-	61	20	-	-	-	72	28	-	-
	Exc.F.T.	-			-	-	-			-	-	-			-	-
	Total	-	32	46	-	2,400	-	61	20	-	3,600	-	72	28	-	5,500
G. Total		5	49	121	474	2,400	27	72	70	370	3,600	44	72	65	220	5,500

Note D12E : Includes D4H, etc.

7.2.5 Facility Improvement Necessitated by Train Operation Plan

In addition to the upgrading of such infrastructure as the roadbed and bridges, etc., the following improvements are required to ensure the planned maximum travelling speeds and number of trains to be operated.

(1) Construction of New Interchange Stations

A new interchange station should be introduced at those sections shown in Table 7.2-7 in order to increase the track capacity. It is apparent from this table that the demand for an increased number of trains in 2000 can be met by increasing the train speed without constructing new interchange stations. With the increased train speeds, however, the track capacity will be unable to accommodate the planned increase of train services in 2005, necessitating close analysis with a view to constructing new interchange stations.

(2) Upgrading of Roadbed and Bridges, etc.

Upgrading of the roadbed and bridges, etc. will be conducted section by section and the travelling speed will be increased at those sections where the upgrading work has been completed. With the increased use of direct freight trains, part of the Song Than Freight Terminal should be improved (construction of additional freight track, etc.)

Table 7.2-7 New Interchange Stations Construction Plan

	Section	Track Capacity			Number of Trains		
		1995	2000	2010	1995	2000	2010
1	Nam Dinh 86.8 km – Nui Goi 100.8 km	41	50	56	22	38	56
2	Nghia Trang 161.0 km – Thanh Hoa 175.2 km	33	46	51	18 ~	38	54
3*	Tan Ap 408.7 km – Kim Lu 426.0 km	20	24	35	16 ~	30	40
4*	Thua Luu 741.6 km – Lang Co 755.4 km	30	32	37	22	34	48
5*	Hai Van Bac 760.7 km – Hai Van Nam 771.6 km	22	22	34	22	34	48
6	Ka Rom 1,381.3 km – Thap Cham 1,407.6 km	25	32	36	18	28	42
7	Ca Na 1,436.3 km – Vinh Hoa 1,453.7 km	32	37	43	18	28	42
8	Muong Man 1,551.2 km – Suoi Van 1,567.7 km	33	42	48	18	32	46
9	Suoi Van 1,567.7 km – Song Phan 1,582.9 km	35	44	45	18	32	46
10	Dau Giay 1,661.3 km – Trang Bom 1,677.5 km	26	47	47	18	32	46

*: Projects to be completed in 2000.

7.3 Railway Infrastructure

7.3.1 Basic Concept of Improvement Work

Analysis of the subject items of the railway infrastructure improvement work under the Optimum Alternative is conducted on the basis of the following premises.

① The present analysis is part of a master plan study or feasibility study and more concrete details will be analysed at the pre-detailed design or detailed design stage.

② Specific requests made by the Viet Namese side will undergo a sympathetic review which will also take the current social and economic conditions in Viet Nam into consideration and will be included in the improvement plan as much as possible.

③ Given the importance of railway services, both the qualitative and quantitative aspects of railway transportation will be fundamentally reviewed, including safety, speeding-up and increased service frequency, so that the modernisation work will create new railway infrastructure capable of supporting national development in the future.

④ As railway technologies in Viet Nam must be upgraded in the future, the transfer of technology from Japan will be made with the purpose of contributing to the continuous progress of the technological level of the railway in Viet Nam.

⑤ Proper attention will be paid to environmental protection during the construction work.

⑥ In view of the basic policies for Alternative 1 described in Chapter 6, the railway infrastructure (track, bridges, tunnels and stations, etc.) will be improved where-ever there is a safety risk for train operation in order to achieve a target travelling time between Hanoi and Ho Chi Minh of 24 hours by limited express trains (110 km/hr) by the year 2010.

7.3.2 Construction Gauge, Design Load and Tunnel Section

(1) Construction Gauge in Future

It may be considered that the construction gauge to be applied in the future will reduce the present width of the lower section by 10 cm or so. This reduction will be advantageous to secure a safety clearance for structures, particularly tunnels.

The construction gauge in Japan is determined by allowing a certain clearance beyond the rolling stock gauge, taking the clearance of rolling stock etc. into consideration. The actual degree of this clearance is determined by taking the horizontal movement of the wheel set, the horizontal movement of the body vis-a-vis the wheel set, the horizontal sway of the body's shoulder section caused by the tilted body due to rolling, the sway of the body end due to yawing and sway increment due to track tolerance into consideration. The construction gauge, rolling stock gauge and clearance beyond the rolling stock gauge employed by Viet Nam and its neighbouring countries are shown in Table 7.3.2-1. The construction gauge and rolling stock gauge of ordinary Japanese railway lines (track gauge: 1,067 mm) are shown in Fig. 7.3.2-2 for reference purposes.

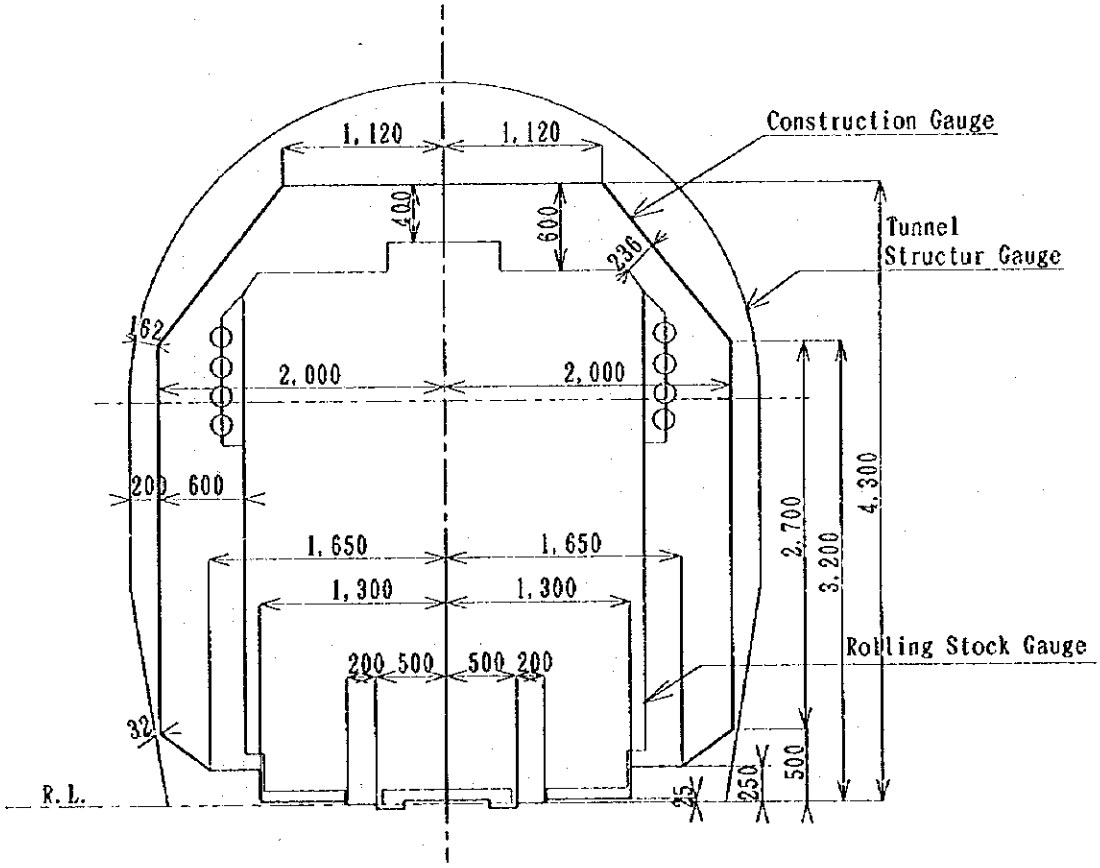


Fig. 7.3.2-1 Construction Gauge
(1,000 mm gauge)

Table 7.3.2-1 Construction Gauge, Rolling Stock Gauge and Clearance Beyond Rolling Stock Gauge

Country	Track Gauge (mm)	Construction Gauge (Width) (mm) (A)	Rolling Stock Gauge (Width) (mm) (B)	Clearance Beyond Rolling Stock Gauge (mm) (A) - (B)	Maximum Train Speed (km/hr)
Vietnam	1,000	4,000	upper half 3,100	900 1,200	70
Thailand	1,000	3,500	2,820	680	95
Malaysia	1,000	4,200	3,290	910	80
Japan	1,067	3,800	3,000	800	130
Indonesia	1,067	3,900	2,990	910	90

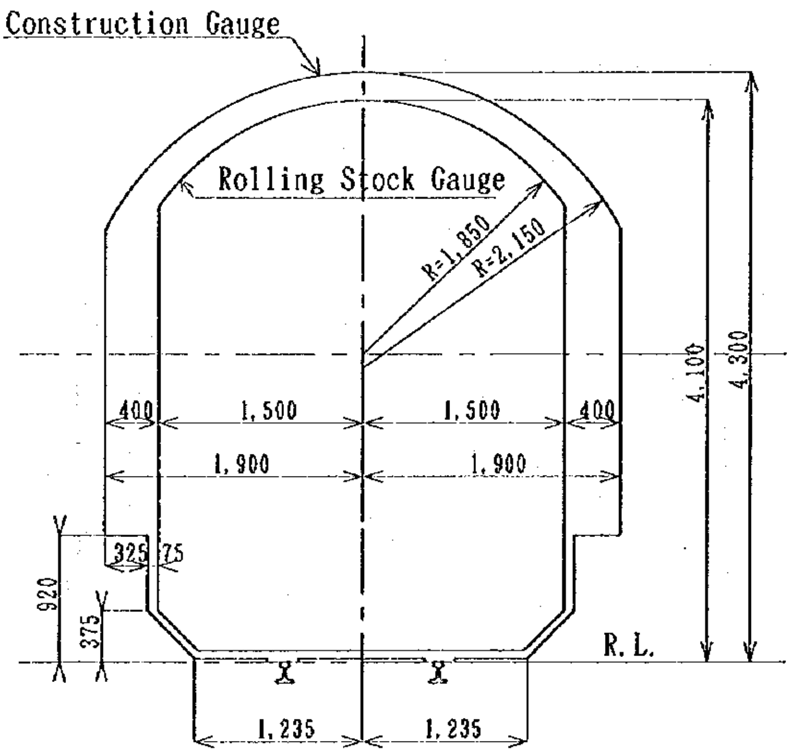


Fig. 7.3.2-2 Construction Gauge and Rolling Stock Gauge of Ordinary Japanese Railway Lines

(2) Design Loads

The current design loads (as of April, 1994) in Viet Nam is explained in 5.3.4-(1)-3) - Train Load. Given the fact that bridges are used for a long period of time, their design load is determined based on the use of double locomotives to allow for increased train speeds and an increased transportation volume during their period of service. The design load for bridges with a track gauge of 1,000 mm is shown again here in Fig. 7.3.2-3.

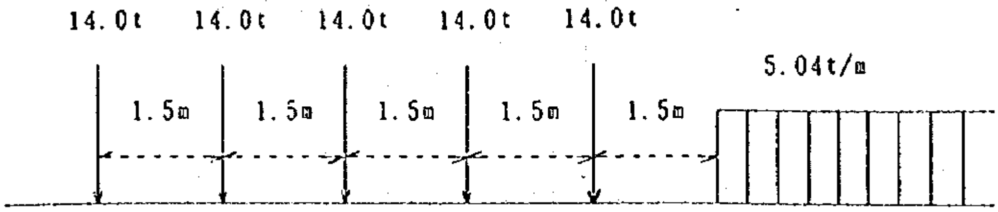
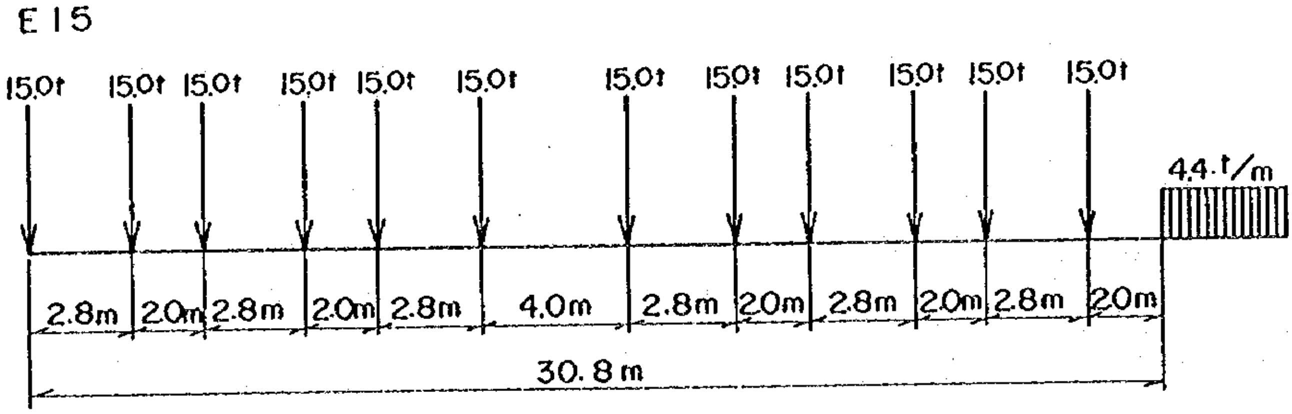


Fig. 7.3.2-3 Design Load for Bridges

The design train load for ordinary railway lines in Japan (track gauge: 1,067 mm) is EA-17 in principle although EA-15 can be used for non-electrified sections regardless of the track grade. This EA-15 design load is shown in Fig. 7.3.2-4 for reference purposes.



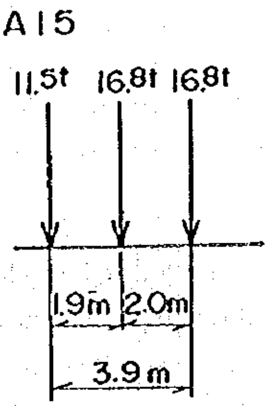


Fig. 7.3.2-4 Design Load for Railway Bridges in Japan (Non-Electrified Sections)

(3) Tunnel Section

The tunnel section to be adopted is the same as the present tunnel section shown in Fig. 5.3.4-6. A Japanese example of a tunnel section for a non-electrified section (track-gauge: 1,067 mm) is shown in Fig. 7.3.2-5.

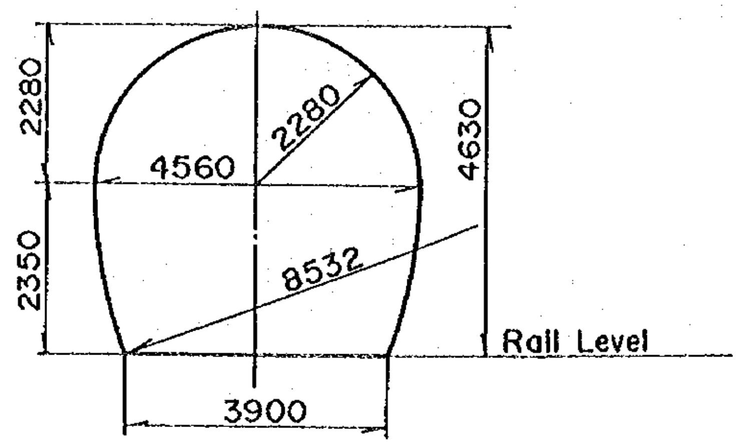


Fig. 7.3.2-5 Tunnel Section in Japan (Non-Electrified Section)

7.3.3 Bridge Improvement

(1) Basic Concept of Bridge Improvement

The planning of bridge improvement is based on the following basic premises.

1) Efforts will be made to solve the current problems discussed earlier through the fundamental improvement of bridges to permit faster and safe train operation.

2) The concrete work will include replacement of the super-structure, reinforcement of the substructure or improvement of all bridge components of some 630 bridges with a total length of approximately 19.6 km.

3) The elevation of those bridges which are 20m in length or more and which are liable to submersion due to flooding will be raised as part of the improvement work. The elevation of bridges which are less than 20m in length and located between Vinh and Thuan Ly where flooding frequently occurs will also be raised as part of the improvement work.

4) In the case of those combined road and railway bridges subject to improvement, their future separation into a road bridge and railway bridge will be considered.

5) As the substructure of many of the existing bridges will be retained, the superstructure material will, in principle, be the same as the present material. Welded girders will be used where possible to minimise the work cost, including the subsequent maintenance cost.

6) Prestressed concrete girders will be used where conditions are suitable for those bridges of which the substructure will be renewed as part of the efforts to transfer bridge technologies.

7) The maximum train interval during the work period will be assumed to be 4 hours under normal conditions.

8) The 9 bridges of which the improvement is under consideration by the SAPROF will be removed from the scope of improvement under the Optimum Alternative.

(2) Improvement Plan

Three bridge improvement methods are identified under the Optimum Alternative based on the visual inspection of 56 bridges (8% of the total) and relevant data obtained. The subject bridges for improvement are compiled in Table 7.3.3-1.

Table 7.3.3-1 Subject Bridges for Improvement

	Bridge Length: 20m or More		Bridge Length: Less than 20m		Total	
	No. of Bridges	Aggregate Length (km)	No. of Bridges	Aggregate Length (km)	No. of Bridges	Aggregate Length (km)
Hanoi - Vinh	27	1.4	74	0.6	101	2.0
Vinh - Hue	53	3.6	179	1.2	232	4.8
Hue - Da Nang	31	1.7	72	0.5	103	2.2
Da Nang - Dieu Tri	90	6.2	12	0.2	102	6.4
Dieu Tri - Nha Trang	36	2.0	5	0.1	41	2.1
Nha Trang - Ho Chi Minh	44	2.0	4	0.1	48	2.1
Total	281	16.9	346	2.7	627	19.6

Bridge improvement can largely be conducted in 2 different ways, i.e. "hot line work" with a bridge being improved or even rebuilt without stopping train operation using the bridge in question and "separate line work" with trains using the existing track or temporary track while a new bridge is under construction upstream or downstream of the existing bridge. Hot line work will basically be adopted for the present plan purposes while separate line work will be adopted for those bridges for which both the super-structure and substructure require complete reconstruction.

(3) Improvement Work

1) Classification of Improvement Work

There are 306 bridges of 20m in length or more and 380 bridges of less than 20m in length between Hanoi and Ho Chi Minh City. These bridges are largely divided into steel bridges and RC bridges in terms of the main structural material. The steel bridges are not uniform, however, and require different improvement work. Consequently the following 3 types of improvement work have been decided.

① Replacement of super-structure

② Replacement of super-structure and reinforcement of substructure

③ Replacement of both super-structure and substructure

Type 1 work applies to those bridges where the infrastructure is solid but where the present super-structure requires complete renewal due to its inability to withstand the planned train speed of 110 km/hr. Type 2 work applies to those bridges where the substructure with minor defects can be sufficiently reinforced without changing it but where the super-structure requires complete renewal. Type 3 work applies to those bridges which require complete rebuilding due to the many defects of both the super-structure and substructure.

Taking the prospective construction cost and other elements into consideration, Type 1 and Type 2 work will, in principle, be conducted as hot line work while Type 3 work will be conducted as separate line work.

2) Bridge Classification by Type and Span

In addition to the 3 types of work described in 1) above, the type of bridge to be constructed and its cost will also depend on the type of girders and length of the span. Therefore, the following categories are introduced to classify bridges by the girder type and span length.

a) Steel bridge with a span of 40m or more

b) Steel bridge with a span of 20m or more but less than 40m

c) Steel bridge with a span of less than 20m

d) RC bridge with a span of between 10m and 20m

e) RC bridge with a span of less than 10m

(4) Contents of Improvement Work

1) Classification of Subject Bridges for Improvement

The total number of bridges subject to improvement is 627, accounting for 91% of the total number of bridges (686), while the aggregate length of these 627 bridges of 19,517 m accounts for 81% of the total bridge length as shown in Table 7.3.3-2.

Table 7.3.3-2 Subject Bridges for Improvement

Type of Work	Bridge Type	Span Length (m)	Number	Aggregate Length (m)
1. Renewal of Super-Structure	a. Steel	40 or more	17	1,451
	b. Steel	20 - 40	35	1,055
	c. Steel	less than 20	191	2,059
	d. RC	10 - 20	31	1,364
	e. RC	less than 10	178	1,505
2. Renewal of Super-Structure and Reinforcement of Substructure	a. Steel	40 or more	28	3,150
	b. Steel	20 - 40	31	1,230
	c. Steel	less than 20	14	381
	d. RC	10 - 20	29	1,161
	e. RC	less than 10	7	161
3. New Bridge on Separate Line (Withdrawal of Old Line)	a. Steel	40m or more	25	3,777
	b. Steel	20 - 40	20	1,241
	c. Steel	less than 20	4	100
	d. RC	10 - 20	5	251
	e. RC	less than 10	1	24
4. Approaches		(300m each side)	41 sites	
5. Stone Bridge Repair			11	607
Total			627	19,517

2) Sections Vulnerable to Flooding

For the 57.256 km section between Vinh and Thuan Ly which is the most frequently flooded with extensive damage, new bridges will be constructed on new line and the banking will be made high to avoid submersion. In the case of other sections, totalling approximately 103 km in length, which are also vulnerable to flooding, the elevation of the bridges will be raised as part of the improvement work. As it will be difficult to raise the girders by 1 - 2m as on-line work, the new bridges will be constructed as separate line work to replace those bridges of 20m in length or more which are located in vulnerable sections. In addition, separate line work will be adopted for the rebuilding of those bridges where raising of the girders is found necessary on the basis of the study findings on the natural conditions. The construction of a new bridge will require a banked approach of 300m in length on both sides of the bridge and this land must be acquired and prepared by the VNR. Raising of the girders will not be considered this time for bridges of less than 20m and this raising work may be conducted as part of future rebanking work.

(5) Cost Calculation

In principle, such materials as steel girders and others will be imported from abroad for fabrication in Viet Nam. Similarly, reinforcing bars, steel materials for temporary structures and large machinery, etc. will also be imported while cement, aggregate and timber, etc. will be domestically procured. The guidance of engineers of industrialised countries will be sought for design, girder fabrication and construction management, etc. requiring the latest technologies/techniques. All other engineers and workers will be Viet Namese nationals.

(6) Phased Improvement Work

The actual bridge improvement work will be conducted in phases as shown in Table 7.3.3-3.

Table 7.3.3-3 Bridge Phased Improvement Plan

Phase	Improvement Work	No. of Bridges	Aggregate Length (km)
I	- Improvement of bridges of 20m in length or more with a speed limit of less than 30 km/hr.	26	3.5
	- Improvement of bridges of 20m in length or more with a speed limit of 30 km/hr or more, in track improvement section.	50	2.1
	- Improvement of bridges of less than 20m in length with a speed limit of less than 50 km/hr.	68	0.6
	- Improvement of bridges of less than 20m in length with a speed limit of 50 km/hr or more, in track improvement section.	6	0.1
	Sub-Total	150	6.3
II	- Improvement of bridges of 20m in length or more with a speed limit of 30 km/hr or more, in track improvement section.	83	4.7
	- Improvement of bridges of less than 20m in length with a speed limit of 50 km/hr or more, in track improvement section.	164	1.0
	Sub-Total	247	5.7
III	- Improvement of bridges of 20m in length or more with a speed limit of 30 km/hr or more, in track improvement section.	122	6.6
	- Improvement of bridges of less than 20m in length with a speed limit of 50 km/hr or more, in track improvement section.	108	0.9
	Sub-Total	230	7.5
Total		627	19.5

7.3.4 Tunnel Improvement

(1) Basic Concept of Tunnel Improvement

1) As in the case of bridge improvement, fundamental improvement work is planned to solve all existing problems in order to ensure safe and faster train operation in the future.

2) The actual improvement work will be conducted for 27 tunnels with a total length of 8.4 km to improve deteriorated sections.

3) Because of the inadequacy of the data collected so far, possible measures to prevent tunnel flooding caused by river flooding in the rainy season are not considered.

4) The chipping work to remove the old, deteriorated tunnel lining will be mechanised in view of this being hard work in limited space and the likely deterioration of the working environment due to dust produced by chipping.

5) The planned train interval while the improvement work is in progress will be upto 4 hours as in the case of the bridge improvement work.

(2) Improvement Plan

1) The improvement plan will adopt the following 3 types of repair/reinforcement work based on a visual survey at approximately half of the subject tunnels and data obtained. The number of tunnels subject to improvement is given in Table 7.3.4-1.

Type 1
- Sites of soft ground and a relatively large soil pressure
- Sites where the lining is much deteriorated or deformed
- Sites where the tunnel width is not more than 4.1m and requires widening

Type 2
- Sites of firm ground but with a deteriorated lining
- Sites where the tunnel width is not more than 4.2m and requires widening

Type 3
- Tunnel sections without lining

Table 7.3.4-1 Subject Tunnels for Improvement

Section	No. of Tunnels	Aggregate Length (m)
Hanoi - Vinh	0	0
Vinh - Hue	5	693
Hue - Da Nang	9	3,277
Da Nang - Dieu Tri	2	448
Dieu Tri - Nha Trang	11	3,987
Nha Trang - Ho Chi Minh	0	0
Total	27	8,405

2) Typical Cross-Section

A typical cross-section of the existing tunnels on the Hanoi - Ho Chi Minh Railway is shown in Fig. 7.3.4-1.

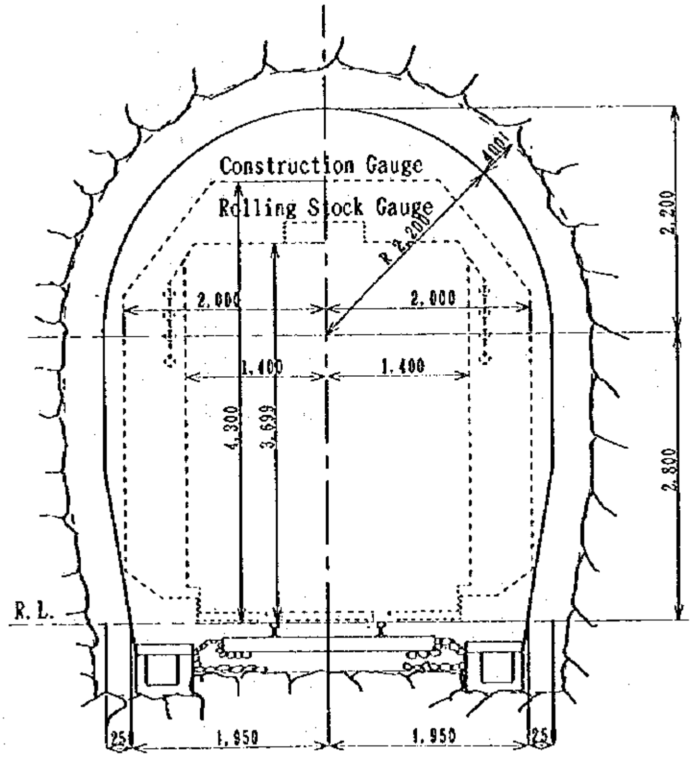


Fig. 7.3.4-1 Typical Tunnel Cross-Section

3) Improvement Work

a) Type 1

① Chipping of concrete lining (t = 15 cm)
② Erection of supporting steel (H - 100, interval 1.0m)
③ Lining with wire mesh
④ Spraying of concrete (t = 15 cm)
⑤ Placing of rock bolts (Ø 25 mm, L = 4m, 7 bolts/section)
⑥ Backfilling of crown with aerated mortar

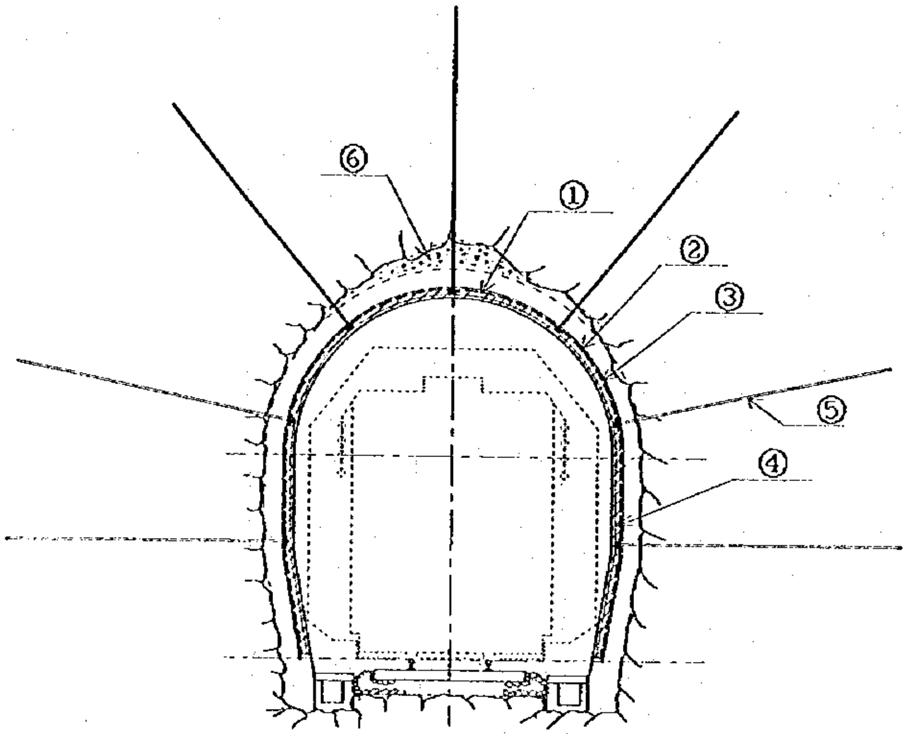


Fig. 7.3.4-2 Type 1 Tunnel Improvement Work

b) Type 2

① Chipping of concrete lining (t = 5 cm)
② Lining with wire mesh
③ Spraying of concrete (t = 5 cm)
④ Placing of rock bolts (Ø 25 mm, L = 3m, 5 bolts/section)
⑤ Backfilling of crown with aerated mortar

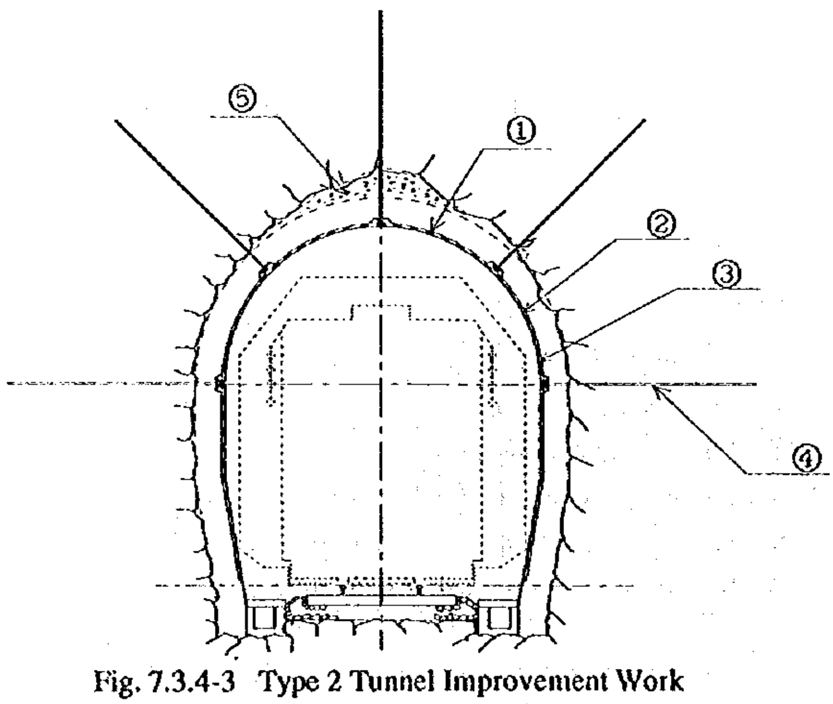


Fig. 7.3.4-3 Type 2 Tunnel Improvement Work

c) Type 3

① Surface cleaning by jet water

② Placing of anchor bolts (Ø 16 mm, L = 0.3m, 20 bolts/section)

③ Lining with wire mesh

④ Spraying of concrete (t = 15 cm)

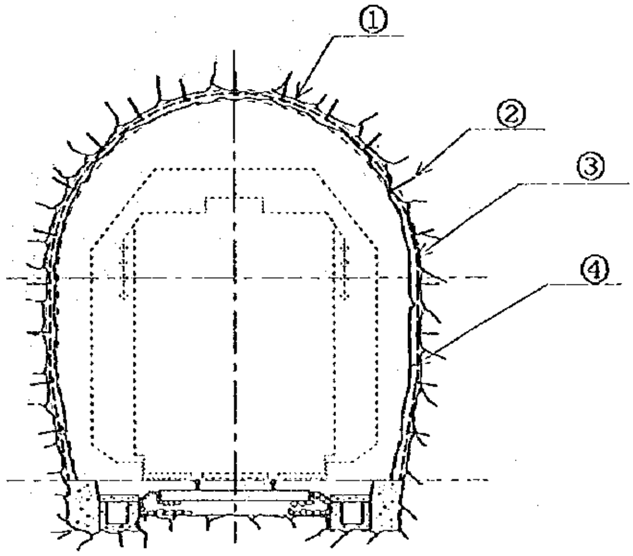


Fig. 7.3.4-4 Type 3 Tunnel Improvement Method

4) Improvement Work and Tunnel Cross-Section

The key question in tunnel repair and reinforcement is how much distance can be established between the train and tunnel lining. In Viet Nam, the official rolling stock gauge width, construction gauge width and structural width for tunnels are 3.1m, 4.0m and 4.4m respectively. In reality, however, the structural width is only met by 2 tunnels (No. 11 and No. 27) out of 27 tunnels and the structural width of the remaining 25 tunnels is between 3.8m and 4.3m. Narrowing of the original width of 4.4m due to tunnel deformation would pose a serious problem. However, the fact that the structural width tends to be narrower than the required standard width at tunnels with solid ground suggests that the structural width was narrow at the time of original construction. As described in the section on the construction gauge, a construction gauge of the lower section of 3.8m is proposed under the present improvement plan and, accordingly, the tunnel width will only be widened by means of chipping the side walls of the tunnels of which the structural width is currently less than 4.2m.

(3) Contents of Improvement Work

The present tunnel improvement plan has been prepared by determining various types of improvement work based on the field survey findings and survey maps on tunnel deformation and other information collected in Viet Nam and also by deciding the type of improvement work to be conducted for each tunnel section and the scope of work for each site. The actual implementation of improvement work should be preceded by a detailed plan specifying the type of improvement work for each work section which takes the current conditions of each tunnel into consideration.

Table 7.3.4-2 Tunnel Improvement Work and Work Volume

Item	Type of Improvement	Aggregate Length (m)
Tunnel Improvement	Type 1	4,293
	Type 2	1,664
	Type 3	1,944
Protection of Tunnel Entrance Area		10 sites

(4) Maintenance

Each tunnel currently has a safety observation look-out men. A new regime will be introduced whereby these look-out men keep observation records on the deformation of predetermined vulnerable sites at the tunnels to which they are assigned. They will be required to notify nearby stations of any acceleration of deformation when exceeding the notification level to ensure safe train operation.

(5) Phased Improvement Targets

Table 7.3.4-3 shows the phased improvement plan of the tunnel improvement work.

Table 7.3.4-3 Phased Improvement Plan

Phase	Improvement Work	Number of Tunnels	Aggregate Length (km)
I	Improvement of all tunnels with a speed limit of less than 30 km/hr.	10	2.8
II	Improvement of tunnels in the track improvement sections with a speed limit of 30 km/hr or more	10	3.6
III	Improvement of tunnels outside of the track improvement sections with a speed limit of 30 km/hr or more	7	2.0
Total		27	8.4

7.3.5 Other Civil Engineering Structures

(1) Prevention of Track Submersion

The construction of new track on high banking and new bridges, etc. for the sections listed in Table 7.3.5-1 is planned.

The sections are selected as highest priority ones from submerged sections 160km in length referring to the TEDI report and the study report of natural conditions (Appendix 2.1-1)

Table 7.3.5-1 Subject Sections for Track Submersion Prevention Work

Section		Length	Remarks
From	To		
329 km 650m	372 km 606m	42 km 956m	Vinh (319.0) - Chu Le (380.6)
420 km 350m	426 km 900m	6 km 550m	Tan Ap (408.7) - Kim Lu (426.0)
429 km 050m	436 km 800m	7 km 750m	Kim Lu (426.0) - Dong Le (436.3)
Total		57 km 256m	

(2) Slope Improvement

Slope improvement work will be conducted at those sections which pose a safety problem vis-a-vis train operation. At disaster sites caused by torrential rain, grating work will, in principle, be conducted while stone pitching work and/or slope trimming will be conducted for other slopes. An earth-retaining structure will be erected if necessary to ensure a wide work base. The construction/improvement of drainage facilities will also be conducted.

(3) Protection of Falling Rock

A rock-retaining wall will be constructed and/or a protective shielding will be conducted at those sites where rock falls are anticipated and where the subject section is short and can accommodate a protective structure. A falling rock protective system will be introduced at other sections. The subject sections are shown in Table 7.3.5-2.

Table 7.3.5-2 Subject Sections for Falling Rock Protection Work

Section		Length	Remarks
From	To		
749 km 650m	775 km 150m	25 km 500m	Thua Luu (741.6) Kim Lien (776.9)
984 km 000m	996 km 500m	12 km 500m	Thuy Thach (977.1) - Tam Quan (1,004.3)
1,134 km 500m	1,135 km 500m	1 km 000m	Van Canh (1,123.6) - Phuoc Lanh (1,139.3)
1,217 km 300m	1,224 km 800m	7 km 500m	Phu Hiep (1,209.6) - Dai Lanh (1,232.2)
1,437 km 800m	1,438 km 200m	0 km 400m	Ca Na (1,436.3) - Vinh Hoa (1,453.7)

(4) Drainage and Other Facilities

Drainage ditches will be constructed for those sections which are vulnerable to flooding by the torrential rain, posing a safety hazard for train operation. Depending on the actual site conditions, a larger cross-section than standard may be used to accommodate cesspools, traverse drainage ditches and vertical drains. At sections near stations with dense housing, drainage facilities will be constructed for environmental purposes. Such existing civil engineering structures as earth-retaining walls and slope protection work, etc. will be replaced or reinforced if found to be severely deteriorated to the extent of posing a safety risk for train operation.

7.3.6 Track and Level Crossings

The track and level crossings will be improved in each phase as described in 6.4.1 to achieve safety and reliability. Improvement work priority is given to those sections using 27 kg/m rails or 30 kg/m rails, those with specific maintenance problems the same as the UNDP report and those of which improvement will drastically reduce the train travelling time. Table 7.3.6-1 shows the subject sections for phased improvement.

(1) Rails

- 27 kg/m rails and 30 kg/m rails will be replaced by 43 kg/m rails (25m rails).
- The current length of 12.5m of the 43 kg/m rails will be extended by 25m by the on-site welding of 2 rails.
- Where possible, long rails will be introduced (including at those bridges of which R is more than 600m and the length is less than 25m). The tentative length of these long rails is set at approximately 1,000m. Although it is possible to extend the rail length to several kilometres, the introduction of such super long rails should be preceded by the accumulation of experience in long rail maintenance.

(2) Turnouts

All the existing turnouts on the main track of the Hanoi - Ho Chi Minh Railway will be replaced. The new turnouts will be either ordinary turnouts ($V \leq 70$ km/hr), improved crossing type turnouts ($V \leq 80$ km/hr) or Manganese crossing type high speed turnouts ($V > 80$ km/hr) depending on the expected speed of the train passing through the straight side of the turnout.

Table 7.3.6-1 Sections Subject to Phased Improvement Plan

Stations				Distance		Aggregate Length (km)	Improvement Phase		
From		To		From	To		I	II	III
1	Ha Noi	4	Thuong Tin	0.0	17.4	17.4			◎
4	Thuong Tin	5	Cho Tia	17.4	25.5	8.1		◎	
5	Cho Tia	8	Phu Ly	25.5	55.9	30.4			◎
8	Phu Ly	10	Cau Ho	55.9	72.9	17.0		◎	
10	Cau Ho	13	Nui Goi	72.9	100.8	27.9			◎
13	Nui Goi	15	Ninh Binh	100.8	114.6	13.8		◎	
15	Ninh Binh	22	Thanh Hoa	114.6	175.2	60.6			◎
22	Thanh Hoa	26	Van Trai	175.2	219.0	43.8		◎	
26	Van Trai	30	Cau Giat	219.0	261.0	42.0			◎
30	Cau Giat	33	My Ly	261.0	291.6	30.6		◎	
33	My Ly	34	Quan Hanh	291.6	308.2	16.6			◎
34	Quan Hanh	38	Duc Lac	308.2	344.8	36.6		◎	
38	Duc Lac	43	Huong Pho	344.8	386.8	42.0			◎
43	Huong Pho	45	La Khe	386.8	404.4	17.6		◎	
45	La Khe	53	Ngan Son	404.4	488.8	84.4			◎
53	Ngan Son	69	My Chanh	488.8	651.7	162.9		◎	
69	My Chanh	71	Hien Sy	651.7	669.8	18.1			◎
71	Hien Sy	73	Hue	669.8	688.3	18.5		◎	
73	Hue	76	Cau Hai	688.3	729.4	41.1			◎
76	Cau Hai	77	Thua Luu	729.4	741.6	12.2		◎	
77	Thua Luu	82	Kim Lien	741.6	776.9	35.3			◎
82	Kim Lien	84	Da Nang	776.9	791.4	14.5		◎	
84	Da Nang	90	Tam Ky	791.4	864.7	73.3			◎
90	Tam Ky	91	Diem Pho	864.7	879.5	14.8		◎	
91	Diem Pho	95	Dai Loc	879.5	919.5	40.0			◎
95	Dai Loc	97	Hoa Vinh T	919.5	940.4	20.9		◎	
97	Hoa Vinh T	98	Mo Duc	940.4	948.9	8.5			◎
98	Mo Duc	100	Duc Pho	948.9	967.7	18.8		◎	
100	Duc Pho	103	Tam Quan	967.7	1,004.3	36.6			◎
103	Tam Quan	106	Phu My	1,004.3	1,049.4	45.1	◎		
106	Phu My	108	Phu Cat	1,049.4	1,070.9	21.5		◎	
108	Phu Cat	110	Dieu Tri	1,070.9	1,095.5	24.6			◎
110	Dieu Tri	115	Chi Thanh	1,095.5	1,170.4	74.9	◎		
115	Chi Thanh	116	Hoa Da	1170.0	1,183.9	13.9		◎	
116	Hoa Da	119	Phu Hiep	1,183.9	1,209.6	25.7	◎		
119	Phu Hien	121	Dai Lanh	1,209.6	1,232.2	22.6		◎	
121	Dai Lanh	129	Cay Cay	1,232.2	1,329.1	96.9	◎		
129	Cay Cay	130	Hoa Tan	1,329.1	1,340.5	11.4		◎	
130	Hoa Tan	131	Suoi Cat	1,340.5	1,351.4	10.9	◎		
131	Suoi Cat	132	Nga Ba	1,351.4	1,363.8	12.4		◎	
132	Nga Ba	136	Ca Na	1,363.8	1,436.3	72.5	◎		
136	Ca Na	138	Song Long	1,436.3	1,465.5	29.2			◎
138	Song Long	139	Song Mao	1,465.5	1,484.5	19.0		◎	
139	Song Mao	145	Suoi Van	1,484.5	1,567.7	83.2	◎		
145	Suoi Van	149	Gia Huynh	1,567.7	1,613.5	45.8			◎
149	Gia Huynh	162	Go Vap	1,613.5	1,722.1	108.6	◎		
162	Go Vap	163	Sai Gon	1,722.1	1,726.5	4.4		◎	

(3) Sleepers

- The existing wooden and iron sleepers in those sections where the curve radius is 600m or more will be replaced by improved concrete sleepers with the laying density increased from 1,440 sleepers/km to 1,660 sleepers/km.
- The existing concrete sleepers will be replaced by improved concrete sleepers with the laying density increased from 1,440 sleepers/km to 1,660 sleepers/km.
- With the introduction of improved type sleepers, the fasteners will be improved. The tentative improved type sleepers and improved fasteners are illustrated in Fig. 7.3.6-1 and Fig. 7.3.6-2 respectively.
- The laying density for wooden sleepers in those sections where the curve radius is less than 600m will be increased from 1,660 sleepers/km to 1,720 sleepers/km.

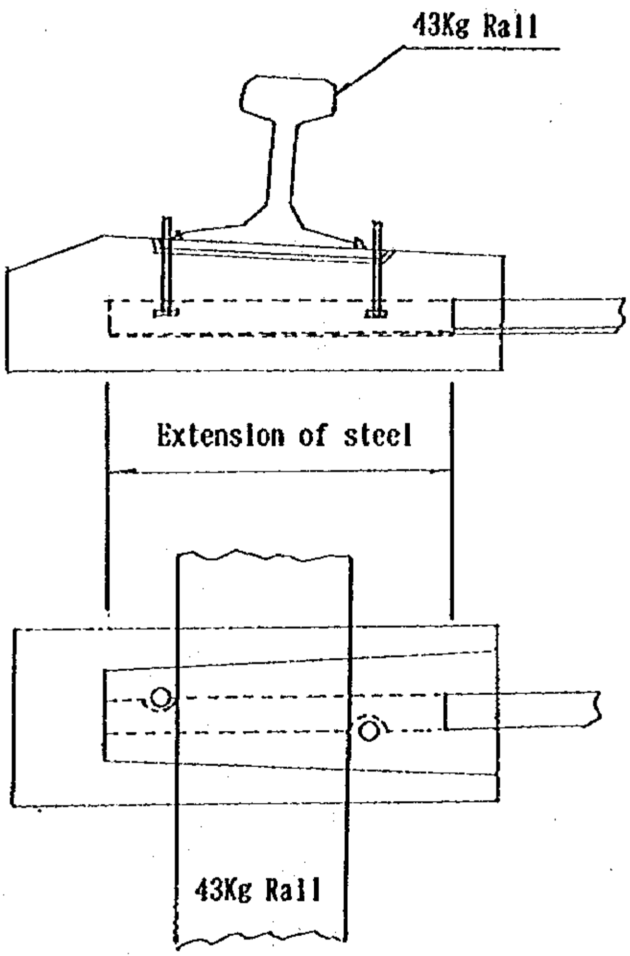


Fig. 7.3.6-1 Improved RC Sleepers

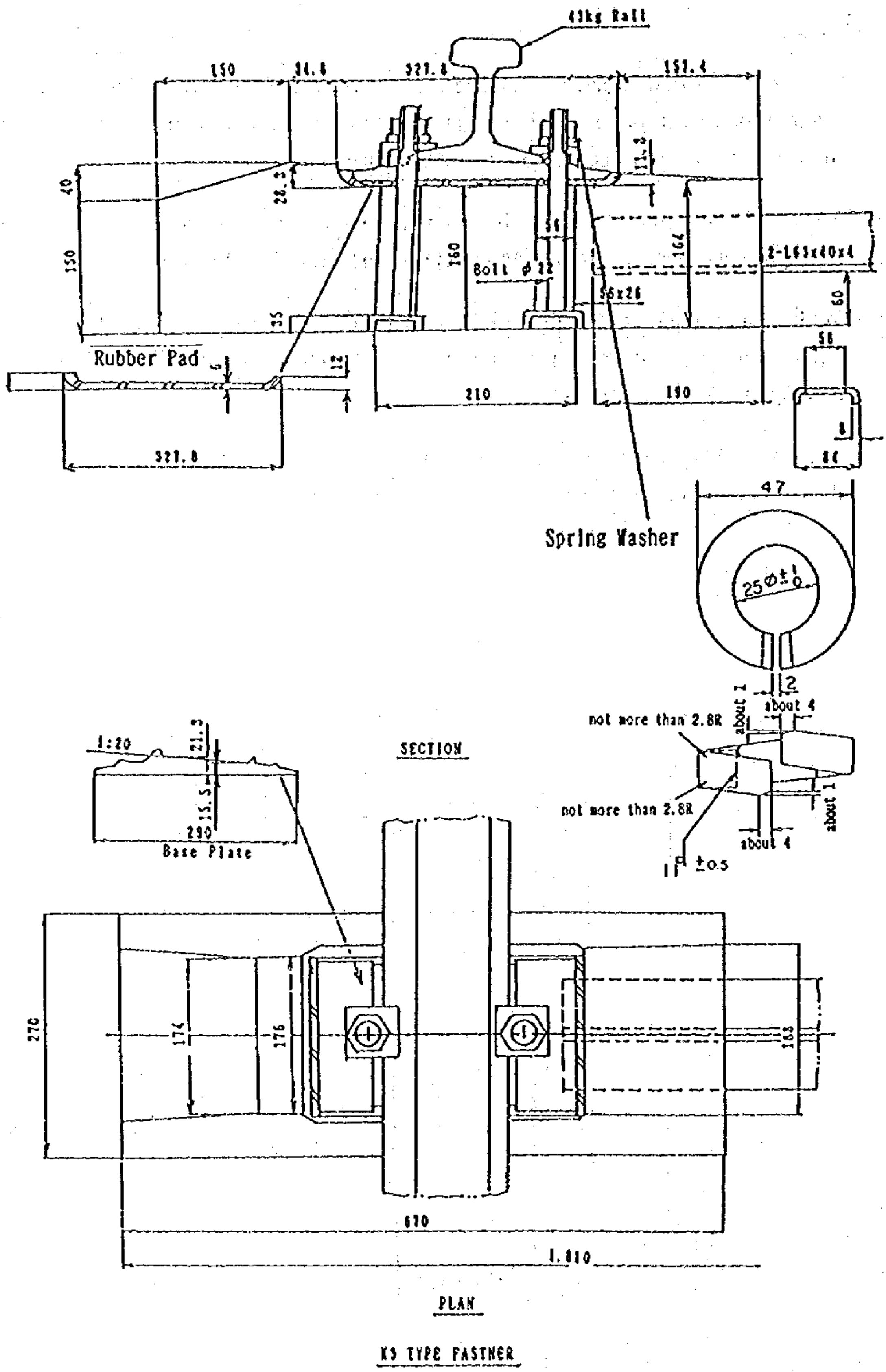


Fig. 7.3.6-2 Improved Fasteners

(4) Ballast

The planned minimum ballast thickness is 25 cm and additional ballast will be used at those sections where shoulder ballast etc. is lacking even if the existing ballast thickness is 25 cm or more.

(5) Roadbed

The roadbed of those sections which pose problems in terms of train operation and maintenance work will be improved. The subject sections are listed in Table 7.3.6-2. Depending on the actual conditions at each section, the improvement work will involve grouting with auger agitation and/or roadbed replacement.

Table 7.3.6-2 Subject Sections for Roadbed Improvement

Section		Length	Remarks
From	To		
142 km 400m	142 km 500m	0 km 100m	Bin Son (141.5) - Do Len (152.3)
146 km 000m	146 km 300m	0 km 300m	
153 km 000m	156 km 000m	3 km 300m	Do Len (152.3) - Nghia Trang (161.0)
331 km 337m	331 km 437m	0 km 100m	Yen Due (330.0) - Cho Thuong (337.5)
441 km 250m	441 km 300m	0 km 050m	Dong Le (436.3) - Ngoc Lam (449.6)
441 km 500m	441 km 600m	0 km 100m	
762 km 484m	762 km 570m	0 km 100m	Hai Van Bac (760.7) - Dinh Deo (766.0)
779 km 000m	820 km 200m	41 km 200m	Kim Lien (776.9) - Tra Kieu (824.8)
989 km 500m	989 km 800m	0 km 300m	Thuy Thach (977.1) - Sa Huynh (990.8)
991 km 920m	992 km 300m	0 km 380m	Sa Huynh (990.8) - Tam Quan (1,004.3)
993 km 500m	996 km 500m	3 km 000m	

(6) Curve, Cant and Transition Curve

It is important for railway engineers to understand how to determine the cant deficiency. Moreover, the current speed limit at curved sections of the Hanoi - Ho Chi Minh Railway should be reassesed. The cant can be determined in any of the following manners.

① Vis-a-vis the maximum train speed to emphasise passenger comfort

② Vis-a-vis the minimum train speed for sections where freight services are the mainstay of railway operation in view of the maintenance work amount

③ Vis-a-vis the average train speed

In the case of ② and ③ above, the cant deficiency is the difference between the value of the cant of each case and the value of the cant determined vis-a-vis the maximum train speed.

As the length of the transition curve is determined by the cant value, a large improvement budget may be necessary to secure the desirable transition curve required by the topographical and alignment conditions of a particular railway section. New rolling stock will be introduced for trains travelling at maximum speed to ensure passenger comfort. The cant value will accordingly be set against the average speed of trains passing a specific curve and the cant deficiency will be checked under this setting.

The maximum cant deficiency is identified as being 60 mm. The permissible train speed at different curved sections is shown in Table 7.3.6-3 and the calculation method is explained in Appendix 7.3-3.

Table 7.3.6-3 Permission Train Speed at Curved Sections ($V = 3.64\sqrt{R}$)

Curve Radius (m)	Maximum Speed (km/hr)	Remarks
R = 200	50	
250	60	
300	65	
350	70	
400	75	
450	80	
500	80	
550	85	
600	90	
650	95	
700	95	
750	100	
800	105	
850	105	
900	110	

The existing cant and transition curve length will be changed if necessary following changes of the train speed at curved sections.

The curve radius which starts at the 207 km 884m point and which greatly slows down the train speed will be increased from the present 300m to 600m.

(7) Level Crossings and Other Sites

- In line with the roadbed/track improvement work, all the level crossings will be paved with asphalt and safety fencing will be erected along the track near level crossings to prevent the public from entering onto the railway track.
- Similar safety fencing will be erected where such fencing is deemed necessary to prevent the public from entering onto the railway track.

7.3.7 Stations

- A new interchange station will be constructed in 10 sections shown in Table 7.3.7-1 where the planned number of trains will exceed the track capacity simply to allow trains to pass each other.
- Based on the rolling stock operation plan, additional storage track will be introduced at certain stations.
- In order to improve passenger services, the improvement of station square, the arrangement of car park and bicycle place will be carried out at 6 stations, i.e. Hanoi, Vinh, Hue, Da Nang, Nha Trang and Ho Chi Minh. An example of a station square is given in Appendix 7.3-4.

Table 7.3.7-1 Planned Construction of New Interchange Stations to Allow Trains to Pass Each Other

Sections	Kilometre	Distance (km)	Planned Site for Pass-By Only Station
Nam Dinh – Nui Goi	86.8 – 100.8	14.0	93.0 – 93.6
Nghia Trang – Thanh Hoa	161.0 – 175.2	14.2	170.4 – 170.9
Tan Ap – Kim Lu	408.7 – 426.0	17.3	414.7 – 415.2
Thua Luu – Lang Co	741.6 – 755.4	13.8	747.9 – 748.5
Hai Van Bac – Hai Van Nam	760.7 – 771.6	10.9	764.9 – 765.8
Ca Rom – Thap Cham	1,381.3 – 1,407.6	26.3	1,395.8 – 1,396.4
Ca Na – Vinh Hoa	1,436.3 – 1,453.7	17.4	1,445.2 – 1,445.8
Muong Man – Suoi Van	1,551.2 – 1,567.7	16.5	1,557.6 – 1,558.2
Suoi Van – Song Phan	1,567.7 – 1,582.9	15.2	1,575.7 – 1,576.3
Dau Giay – Trang Bom	1,661.3 – 1,677.5	16.2	1,671.4 – 1,672.0

7.3.8 Maintenance System

- One new high speed track-measuring car will be introduced.
- Two new MTTs will be introduced for each Union.
- One new set of ballast production facilities, capable of the quality control of ballast size and other functions, will be introduced for each Union.
- New track maintenance equipment and tools (tie tampers, rail loading machine, rail carrier and rail saw, etc.) will be procured. Similar equipment and tools will be procured for the training centers together with other maintenance equipment and tools, including rail welders, used for the improvement work.
- No new manufacturing facilities for the improved 2 block concrete sleepers will be considered in view of the fact that the present facilities can be improved to produce the improved sleepers discussed in 7.3.6-3.

The UNDP report describes as follows:

The investments to track maintenance are considered essential and costs do not have to be justified. The investiments to rail welding equipments, tamping machines etc. are required to ensure VNR ability to compete with other modes and costs have to be justified.

7.4 Electrical Facilities

7.4.1 Power Supply and Distribution Facilities

With regard to the power supply and distribution facilities which are the basis of any plan to improve or expand the railway signalling and communication functions, the existing plan envisages the extension of the distribution line to all station areas between Hanoi and Saigon by 1996. A service line to each station should be installed as soon as possible to provide every station with adequate power supply. The new distribution lines and power receiving facilities will be constructed based on the following basic principles.

- All distribution lines and power receiving facilities will serve both signalling and communication facilities.
- The Hanoi, Da Nang and Saigon Stations will have an independent high voltage distribution line and power receiving facilities.
- High voltage power will be supplied to those stations with 5 or more tracks while low voltage power will be supplied to those stations with upto 4 tracks.