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THE STUDY ON DEVELOPMENT PLAN FOR THE NEW DELHI RAILWAY STATION IN INDIA

FINAL REPORT

DECEMBER

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JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)

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PREFACE

In response to a request from the Government of India, the Government of Japan decided to conduct a study on the development plan for the New Delhi railway station and entrusted the study to the Japan International Cooperation Agency (JICA).

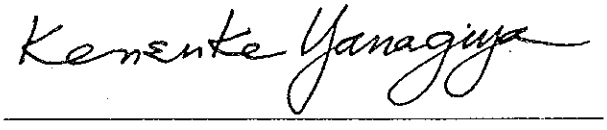
JICA sent to India a survey team headed by Mr. Hotsumi Harada, Japan Railway Technical Service three times, from December 1988 to March, 1989 from July to August and November in 1989. The team was composed of members from Japan Railway Technical Service and Tanichi Engineering Consultants, Inc.

The team held discussions with concerned officials of the Government of India, and conducted field surveys. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of India for their close cooperation extended to the team.

December, 1989



Kensuke Yanagiya
President
Japan International Cooperation Agency

December, 1989

Mr. Kensuke Yanagiya
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Sir,

LETTER OF TRANSMITTAL

We have the pleasure of submitting herewith the final report for the Study on Development Plan for the New Delhi Railway Station in India.

The Study was conducted during the period from December 1988 to December 1989, including the field studies carried out three times in India, i.e. from December, 1988 to March, 1989, from July to August and November, 1989.

The Study formulated the Modernization of the New Delhi Station of the Indian Railway, and analysed its techno-economical feasibility.

We hope that this Report will make a step to implement the project and contribute to upgrade the railway which serves as an essential infrastructure for the socio-economic development of India.

On behalf of the Study Team, which consists of the engineers of the Japan Railway Technical Service and the Tonichi Engineering Consultants

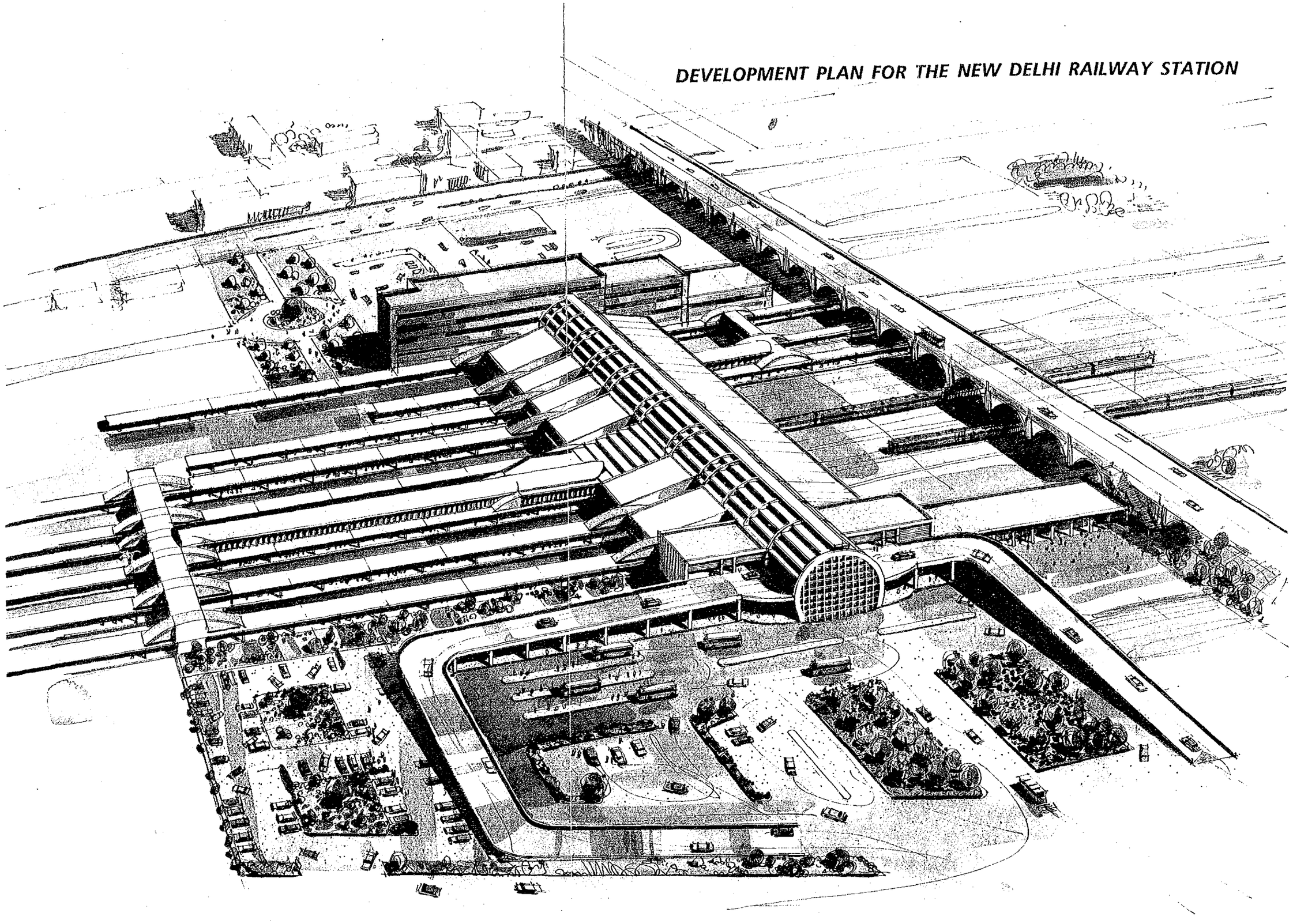
Inc., I wish to express my sincere gratitude, to the officials of your Agency, the Advisory Committee, the Embassy of Japan in India, as well as to all those concerned of the Government of India for the kind assistance and cooperation they extended to the Team.

Very truly yours,

M. Sugawara

Misao Sugawara, Dr. Eng.
President
Japan Railway Technical Service

DEVELOPMENT PLAN FOR THE NEW DELHI RAILWAY STATION



CONTENTS

Station Code List

Code	Station
ALJN	Aligarh
AMRO	Amroha
ANVR	Anand Vihar Halt
BZK	Bhaini Khurd
BPM	Bagpat Road
BGZ	Bahadurgarh
BWSN	Bijwasan
DLI	Delhi
DBSI	Dayabasti
DKZ	Delhi Kishanganj
DE	Delhi Queen's Road
DEE	Delhi Sarai Rohilla
DSA	Delhi Shahdara
DER	Dadri
DKDE	Dankaur
DEC	Delhi Cant
DSJ	Delhi Safdar Jang
<DAL>	Delhi Avoiding Line
FDB	Faridabad
GNB	Ghaziabad
GHH	Garhi Harsaru Jn.
GJL	Gajraula Jn.
<GAL>	Goods Avoiding Line
HPU	Hapur
HUK	Holambi Kalan
JHI	Jind Jn.
JHL	Jakhal Jn.
KIP	Khalipur
KKDE	Kurukshetra
LPNR	Lajpat Nagar
MB	Moradabad
MUD	Muradnagar
MTC	Meerut City
MTJ	Mathura
MDNR	Modinagar
NDLS	New Delhi
NZM	H.Nizamuddin
NDAZ	Naya Azadpur
NRW	Narwana Jn.
OKA	Okhla
PTNR	Patel Nagar
PWL	Palwal
PNP	Panipat Jn.
RE	Rewari
ROK	Rohtak
SBB	Sahibabad
SSB	Shakur Basti
SZN	Subzi Mandi
SRE	Saharanpur
SHDM	Shahbad Markanda
SMQL	Shamli
SNP	Sonipat
TKJ	Tilak Bridge
TKD	Tuglakabad
TPZ	Tapri
TDL	Tundla Jn.
UMB	Ambala Cant Jn.

CHAPTER 1 INTRODUCTION

CHAPTER 1 INTRODUCTION

1 - 1 Background of the Study

(1) The Indian Railways holds a service network of 61,976 route kilometres, the longest in Asia, and forms the vital artery for the development of the national economy. The traffic volume shows a continuous increase year after year. According to the Corporate Plan (1985), the passenger traffic is estimated to reach 376 billion passenger kilometres in the year 2000, the goods traffic, 398~416 billion ton-kilometres.

(2) The Indian Railways have been vigorously implementing the improvement plans of infrastructure and rolling stock. The plans have been supported by the Indian Government whose solid policy maintains that the railway mode should play the role of the long and middle distance surface transport of passengers and goods in this country. The plans include the replacement of rolling stock, renewal of tracks, construction of new lines.

(3) On the other hand, the plans also intend to improve the efficiency of the railway transport system. Namely, the plans encourage to electrify the lines/sections with busy traffic, to modernize the information system of the railway, to introduce electronic technology in the signalling systems, and to computerize the various fields of railway activities.

(4) As to the stations, the plans envisage to improve their work efficiency, amongst all, to raise their train handling capacity. Regarding the existing passenger terminals, it is planned not only to better their train handling capacity, but also the passenger service quality by improving the facilities such as passenger information booths, passages, luggages/parcels handling etc. It is also planned in large cities to construct new satellite terminals to complement the existing ones.

(5) The Delhi area, where the capital of the country is located, forms a core of the railway's national network. A large number of trains arrive and start here. The New Delhi Station has eleven platforms. They treat 140 trains per day. The capacity of the station is almost reaching its limit. The increasing passenger traffic overflows the limit, especially during the peak hours resulting in a congestion hard control. Want in facilities such as passenger information service suppress this congestion.

(6) Under these circumstances, the Government of India recognized the necessity of setting up the following two plans, and implementing them as early as possible:

- A plan which will raise the train handling capacity of the New Delhi Station, building more platforms, improving its track layout, and modernizing its passenger service facilities by double-decking the concourse, all the scheme being justified by an economic/financial evaluation.
  The plan will contribute ultimately to increase the total train handling capacity of the whole Delhi area.
- A plan (Master Plan) which would justify the New Delhi modernization project. For this purpose, an area larger than Delhi area will be delineated around New Delhi, where the future traffic flows and the train operation plans accommodating them will be reviewed. Reallocation of the functions of each existing terminal will be considered and, when necessary, construction of new satellite complementary terminal planned.

(7) Based on these needs, the Government of India requested the Government of Japan to conduct a study required to set up these plans.

1 - 2 . Objectives of the Study

The Scope of Work of the Study, agreed on April 13, 1988, between the Governments of India and of Japan, clarifies the objectives of the Study as stated below:

(1) to formulate Master Plan for the modernization of railway terminals in Delhi area.

(2) to conduct the feasibility study for the modernization plan on New Delhi Railway Station.

These objectives correspond with the requirements referred to in the preceding section(1-1(6)).

In the same scope of work, it was also agreed that "The target year of the Study shall be set (at) 2010 in formulation of plans", to achieve the consistency and integrity in transportation planning and facility planning.

1 - 3 Guidelines for the Study

The Study has been conducted under the guidelines described below. They are in line with the Scope of Work agreed between the two Governments, and they have been detailized by the discussions between the Team and the Nothern Railway.

(1) Geographical boundary of the Study

1) 200km radius circle

In order to evaluate a project, a simulation must be conducted of all the possible impacts it would give and it would be given, placing the project in an appropriate field of testing. It was for this purpose that the "Master Plan" study is conducted. For this purpose, the field is chosen in a circular area with the radius of 200 kilometres around New Delhi, since it is considered as an area within which the traffic flows involving New Delhi are more or less conclusive.

2) Outer and inner circles

The 200km radius circle area is devided into the inner circle area and outer circle area. The inner circle is identified with a jurisdiction of Northern Railway, the Delhi Area. It is for reasons of the affinity in traffic pattern observed in the area, and the convenience in information logistics. The outer circle area lies between the 200 km raduis circle and the inner circle.

3) More exactly, the two circles are defined as follows:

Delhi area (inner circle)

Railway lines/sections whose outer ends are demarcated by the stations enumerated below:

Ghaziabad, Tuglakabad, Bijwasan(MG), Shakur Basti, Holambi Kalan and Behta Hazipur.

Related area (outer circle)

Railway lines/sections connected with the Delhi area whose outer ends are demarcated by the stations enumerated below:

Tundla, Moradadad, Saharanpur, Ambala Cant, Jakal, Mathura and Rewari(MG)

(2) Time boundary of the Study

1) Target year

The target year of the Project is set at 2010. For a project of this nature and scale, 10 Years' period (target year 2000) is considered too short and 30 years (2020), too long.

2) Earlier Period and Later Period

The project period is divided into Earlier Period (from now to 2000) and Later Period (from 2000 to 2010). This classification is made according to the difference in nature of the investment planning for each period. The difference is referred to in the subsequent paragraph.

(3) Investment policy

1) Earlier Period

For the Earlier Period, the investment is planned to the

extent that it can be verified of its feasibility and cost effectiveness, within the Scope of Work and the geographical boundary of the Study. They are chosen from among the Action Plan of the Northern Railway, on the one hand and on the other, they are newly proposed by the Team in addition to the Action Plan.

2) Later Period

For the Later Period, the investments are tentatively proposed to meet with the increasing traffic volume predicted for the period. They include the construction of a new "Delhi Avoiding Line" costing Rs 4 billion, the quadrupling of tracks of Tundla lines costing Rs 2 billion, etc.

Their feasibility and cost effectiveness must be verified, amongst all, whether or not the train operability in the areas exterior to the 200km radius circle could be matching with the upgraded traffic capacity within the circle. But this can not be verified in this Study for the following reasons.

--- The objectives of these investments contain the elements de viated from that of the Project.

--- The geographical boundary of such study could be enlarged in such a manner as to cover the traffic flows not necessarily involving New Delhi.

The investment plans proposed for the Later Period should not be considered, therefore, as having been led out of a solid policy, but they are proposed as a concept presupposing that their cost effectiveness might be verified by separate studies.

(4) Economic/Financial Evaluation

As such, the economic and financial analysis of this Study is produced by the investment made in the Earlier Period.

1 - 4 Study Flow

Phase 1: Preoparatory works in Japan

Phase 2: Works in India (1)

a) Presentation of Inception Report

b) Study of social/economic framework and related development plans

c) Study of actual situations of transport by railway and other modes

d) Field study of railway facilities in Delhi area and in related lines/sections

e) Review of the preceding studies and existing improvement plans

Phase 3: Works in Japan (1)

a) Analysis of data collected in phase 2

b) Determination of socio-economic framework

c) Prediction of traffic demand

d) Formulation of a fundamental transportation plan.

e) Formulation of the Master Plan for the railway transport in areas around Delhi

f) Formulation of the basic plan of improving New Delhi Station facilities

g) Drafting Interim Report

Phase 4: Works in India (2)

a) Presentation of Interim Report and discussion

b) Supplemental field investigation

Phase 5: Works in Japan (2)

a) Detailization of the improvement plan of New Delhi Station

b) Economic/Financial analysis of the New Delhi Station modernization project

c) Implementation planning of the project

d) Comprehensive evaluation of the project

e) Drafting of Draft Final Report

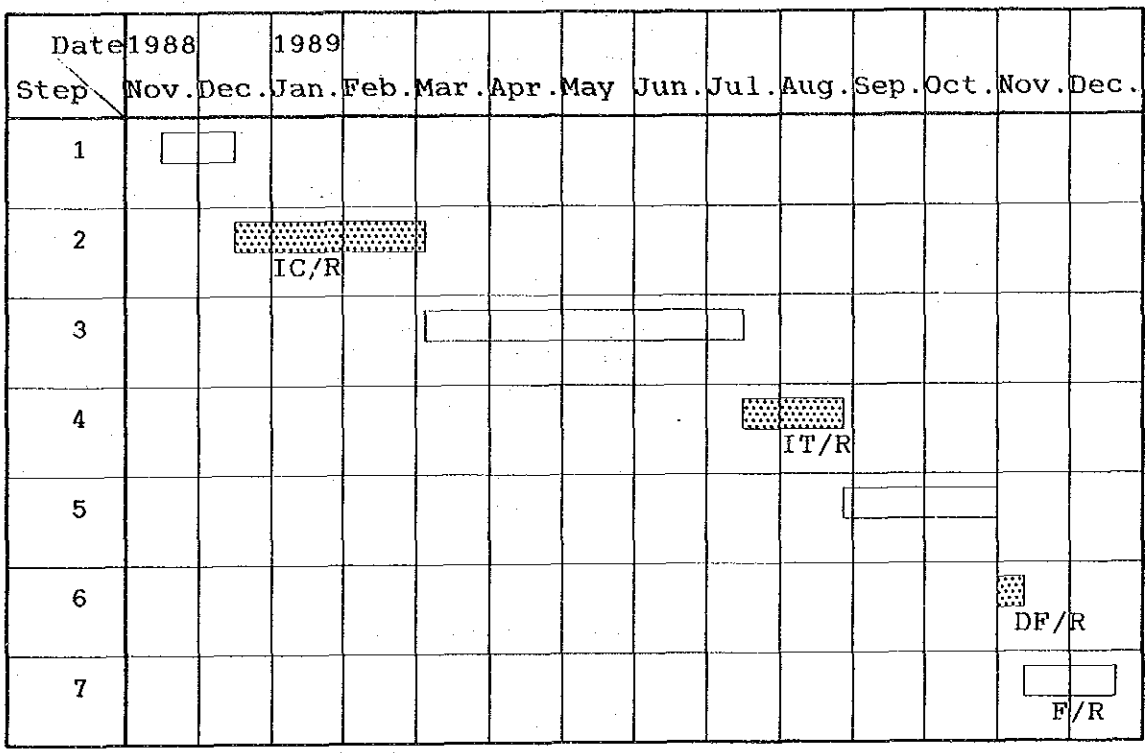
Phase 6: Works in India (3)

- Presentation of Draft Final Report and discussion

Phase 7: Works in Japan (3)

- Drafting and submission of Final Report

The study flow is schematized in Fig. 1-4-1 and 1-4-2.



:Submission of Report
IC/R :Inception Report
IT/R :Interim Report
DF/R :Draft Final Report
F/R :Final Report

Fig. 1.4.1 Study Schedule

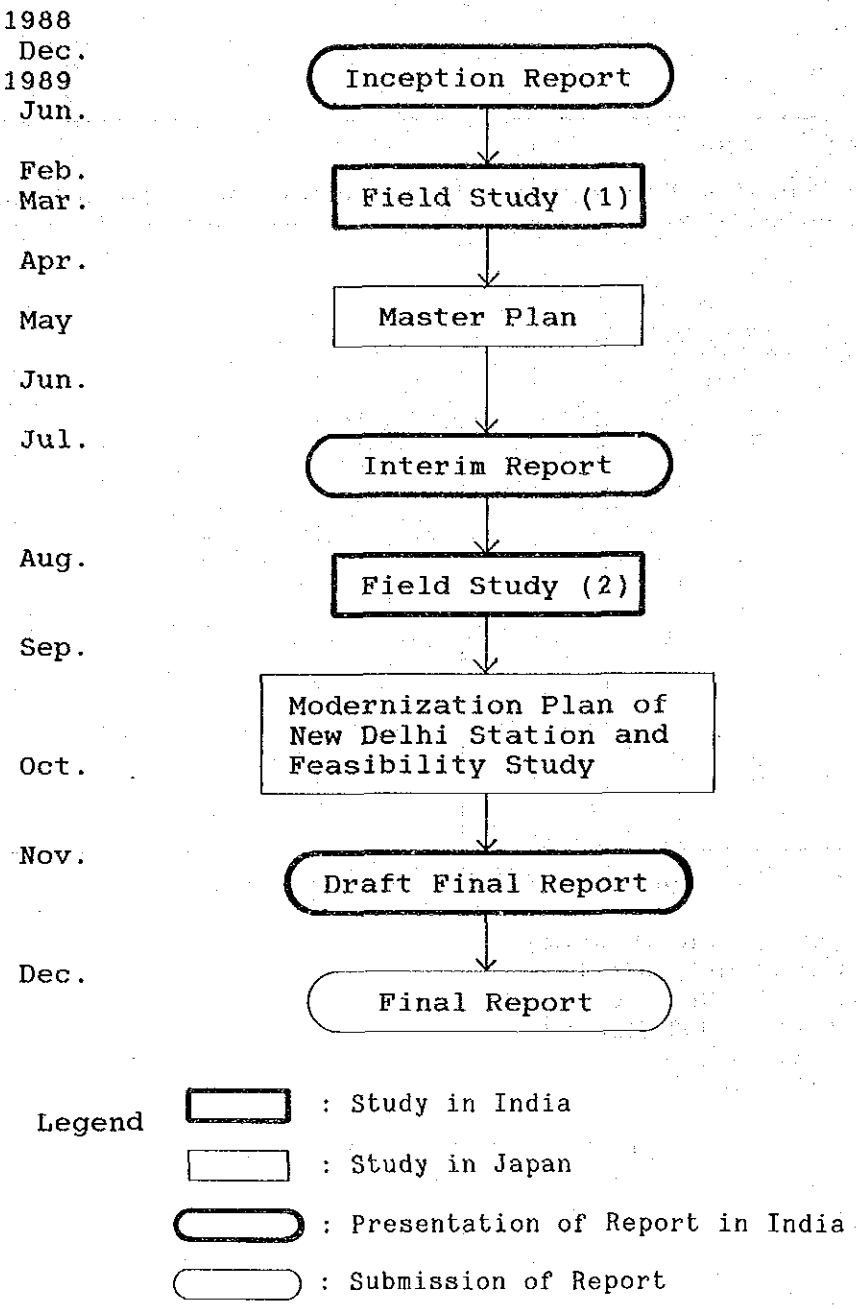


Fig. 1.4.2 Study Flow

1 - 5 Organization of the Study

1 - 5 - 1 Advisory Committee

Masayoshi DOBASHI Chairman	Directer, Cargo Transport Facilities Div., Cargo Transport Bureau, Ministry of Transport
Toshiro KOTAKE Traffic Demand/ Train Operation (Predecessor)	Senior officer for International Cooperation, International Cooperation Div., International Transport and Tourism Bureau, Ministry of Transport
Tomio ONUKI Traffic Demand/ Train Operation	Assistant Director, International Cooperation Div., International Transport and Tourism Bureau, Ministry of Transport
Shigeru KOJIMA Station Planning	Special Assistant Facilities Div., National Railway Restructuring Promotion Dep., Ministry of Transport
Yoshihiro AKIYAMA Passenger Facilities	Chief, Railway Planning Div., Tokyo Metropolitan Branch Office, Japan Railway Construction Public Corporation

Coordinator of JICA

Toshiichi MINATANI	First Development Survey Division, Social Development Cooperation Department JICA

1 - 5 - 2 Study Team

Hotsumi HARADA	Team leader
Hisashi SATO	Acting Leader/Station yard Planning
Hiroshi YAJIMA	Related development planning
Naoki TAKANASHI	Traffic demand forecast/Economic analysis
Makio KASAI	Transport planning
Harutoshi HAYASAKA	Construction planning
Yoichi OKAWA	Station yard design
Noboru KATO	Station architectural planning
Shigeo MATSUMOTO	Station architectural design
Kiichi TAKEMURA	Signalling/telecommunication planning
Koji YAMANO	Electric facilities design
Haruyuki FUJII	Station equipment design
Takuo NISHIKAWA	Financial analysis

1 - 5 - 3 Indian Counterparts and Related Organization

It is with a greatest appreciation that the Team has the pleasure of listing up here the names of the people of India, without whose cooperation this Study would have been impossible.

Railway Board

N.K. PARTHASARTHY	Advisor Planning
S.P. JAIN	Advisor Traffic/Transport
K.K. ARORA	Advisor Commercial
R.B. MATHUR	Advisor Mechanical
Y.V. ASWATHANARAYANA	Advisor Works
S.K. KHANNA	Executive Director (Coaching)
Y.M. GARG	Executive Director (Planning)
V.K. MITTAL	Director Perspective Planning (S&T)
R.P. GUPTA	Director Perspective Planning (CE)

Northern Railway

J. RAJGOPALACHARI	General Manager (Predecessor)
Y.P. ANAND	General Manager (Predecessor)
S.M. VAISH	General Manager
A.N. SHUKLA	Additional General Manager
M.K. RAO	Additional General Manager
N.K. SIKKA	Chief Administrative Officer (Construction)
S.K. SINGH	Chief Planning Officer
G.K. LALWANI	Chief Mechanical Engineer
D. SINGH	Chief Mechanical Engineer
M.P. BHUDIRAJA	Chief Engineer
N.P. VERMA	Chief Operating Superintendent
A. BHATNAGAR	Chief Operating Superintendent
K. KUMAR	Chief Commercial Superintendent
C.S. ANAND	Financial Advisor and Chief Accounts Officer
A.S. SANT	Chief Electrical Engineer
R.K. NAIR	Chief Signal and Telecommunication Engineer
S. MISRA	Chief Traffic Planning Officer
G.K. MALHOTRA	Chief Rolling Stock Engineer

ISH KUMAR	Chief Signal and Planning Engineer
N.K. GOEL	Chief Signal and Planning Engineer
P.K. MALIK	Chief Mechanical Engnieer (Planning)
C. PRASAD	Chief Signal and Telecommunication Engineer
S.S. SEN	Chief Signal and Telecommunication Engineer
S.R. SHAH	Chief Commercial Superintendent
R.K. SAREEN	Chief Electrical and Distribution Engineer
K. SINGH	Chief Marketing Superintendent
H.S. AGGARWAL	Cheif Marketing Superintendent
M.A. UMAR	Chief Engineer (Construction - Survey)
I.I.M.S. RANA	Chief Engineer (Construction - Survey)
L.C. MONGA	Chief Engineer (Planning & Design)
A. KRISHAN	Deputy Chief Engineer (Construction)
R. CHOPRA	Deputy Chief Engineer (Construction)
M.M. MITTAL	Senior Civil Engineer (Survey)
R. BHARGAVA	Deputy Chief Engineer & Secretary to G.M
S. BENERJEE	Deputy Finance Accounts - I
R. DUTT	Deputy Finance Accounts - II
N.N. VASUDEY	Chief Passenger Traffic Superintendent
R. KRISHNASWAMY	Senior Deputy General Manager
L.R. THAPAR	Deputy Chief Operating Superintendent

Delhi Division

V. KANWAR	Divisional Railway Manager
D.P. TRIPATHI	Additional Divisional Railway Manager
R.K. SARKAR	Additional Divisional Railway Manager
V. ASTHANA	Divisional Operating Superintendent (Planning)
L.R. THAPAR	Senior Divisional Operating Superintendent
S.C. GUPTA	Sr. Divisional Mechanical Engineer
S.K. BANSAL	Divisional Mechanical Engineer
I.J. MANN	Divisional Commercial Superintendent
L.M. SAHORE	Senior Divisional Electical Engineer
D. KRISHAN	Divisional Engineer (Co-Ordinating)
K.D. SHARMA	Deputy Chief Signal Engineer

Ministry of Finance

S. JOSHI	Directer in Dep. of Economic Affair (MOF)

CHAPTER 2 SOCIO-ECONOMIC FRAMEWORK AND DEMAND FORECAST

CHAPTER 2 SOCIO-ECONOMIC FRAMEWORK AND DEMAND FORECAST

2 - 1 Socio-Economic Conditions

(1) General Economic Situation in India

The Indian economy showed an average growth of 4% to 5% during 1980-86. In 1987, India was hit by one of the worst drought in her history. As a result, the rate of growth of gross national product was lowered to only 2.5%, whilst the rate of growth in the mining and manufacturing sectors reached a relatively high level of 7.7%. In 1988, however, a sharp increase in agricultural production, primarily of cereals, is estimated throughout the country, the economy has shown its sign of recovery. Also, outputs have been encouraged in the mining, manufacturing and hydraulic power generation sectors. A growth at a level of 8 to 9% is forecast.

(2) Seventh Five-Year Plan (1985-90)

Since the nation's independence, seven Five-Year Plans have been made in series up to the current Seventh Plan. These national programs give a significant impact on the framework to be set up in planning this railway project. The current (7th) Five-Year Plan is outlined below:

1) Targeted values and total investment

a) Economic growth: Annual increase of 5% in gross national product (GNP), whilst 8% is anticipated in industrial product, and 4% in agricultural product

b) Budgeted outlay during the term: 3,223,660 million Rupees (Rs)

c) Gross domestic saving (vs. gross domestic product GDP): Raising from 23.3% to 24.5%

d) Debt service ratio: within 20%

e) Deficit balance on trade account: 1.6% of GNP

f) Investment ratio (vs. GDP): Raising from 24.5% (in 1984) to 25.9%

g) Growth in export/import: 6.8% and 5.8% per year, respectively

h) Employment policy: Creating job opportunities for 40 million for

the new labor force of 39 million estimated through the period of the program, thus reducing the total number of unemployed by one million.

i) Priority is given to coal mining, electricity, energy and railways. In the industrial sector, particular stress is laid on the modernization of iron and steel and textile industries, and on the promotion of dry land cultivation and encouragement of rice crop in the Eastern Regions.

Table 2.1.1 Gross Investment during 7th Five-Year Plan
(Rs. crores at 1984-85 prices)

Sectors of Economy	Gross Investment			
	Public	Private	Total	Ratio(%)
1. Agriculture and allied	27,574	34,048	61,622	19.1
2. Mining, quarrying and manufacturing	42,455	62,172	104,627	32.5
3. Electricity	32,149	419	32,568	10.1
4. Railways	12,334	...	12,334	3.8
5. Other Transport	8,871	18,015	26,886	8.3
6. Communication	6,355	...	6,355	2.0
7. Other services	24,480	53,894	77,974	24.2
TOTAL	154,218	168,148	322,366	100.0

2) Tactical objective of transportation sector and demand target of railways.

a) Renewing obsolete facilities.

b) Modernizing the transport infrastructure by advanced engineering technologies.

c) Appropriately maintaining and repairing the exsisting useful facilities.

d) Maximizing the current transportation capacity through improvements in the technical, administrative and operational areas.

e) Earliest possible completion of the projects already undertaken.
f) Fostering energy saving measures.
g) Improving communications with remote villages and rural areas.
h) Reducing incidence on the sector by partially sharing it with other sectors through close coordination of the respective policies in the activity areas of industrial dispersion, equilibrated regional development and rational land use planning.
i) Planning the projects giving importance to an intersectoral consistency among mining/manufacturing, energy-related and transportation sectors.
j) Establishing an integrated complex transportation system by containerization.
k) Building up a firm financial structure of public enterprises through introduction of a pricing system based on cost evaluation.

Bearing in mind the tactical objectives summarized as above, the railway goods transportation demand is estimated at 340 million tons for 1989/90 (compared with 264 million tons achieved in 1983/84), of which 45% is accounted for coal for power generating plants.

With respect to the passenger transportation, an increase in volume at an annual average of 2% is anticipated during the term of the 7th Five-Year Plan. First priority of investment is given to the long-distance transportation, and then to easing traffic congestions in urban and suburban lines.

Investment costs of transport and railway sectors based on 7th Five-Year Plan are shown in Appendix 1-1 and 1-2.

(3) Outline of Union Territory of Delhi

The area under jurisdiction of Delhi Municipal Corporation has expanded to finally reach the constitution of the Union Territory of Delhi, an autonomous territory under the direct jurisdiction of the federal government.

〔2－1〕

The Union Territory of Delhi embraces a total area of 1,483 km², with a population of 6,220,406 (1981). It includes three civic administrations governed by Delhi Municipal Corpotation, New Delhi Municipal Committee and Delhi Cantonment Board, respectively. The remaining area is subdivided into two Tahsils, Delhi and Mehrauli, consisting of 214 inhabited and 17 uninhabited villages, 30 towns, including the above-mentioned three major civic administrations and 27 census towns.(see Appendix 1-3)

2 - 1 - 1 Population Framework

(1) Outline of Demographic Structure in India

According to the latest Census conducted in 1981, the population of India is 685,184,692. This indicates 25 percent increase during the decade 1971-81, and approximately twice as many as the population immediately after the independence in 1947.

The sharp increase in population is mainly attributable to the decrease in mortality due to improvement of public health, medical dissemination cares and socio-economic development. As birthrate is relatively constant while mortality has markedly decreased, the population will further increase steadily. It is anticipated that the population of India exceeds 800 million in 1990.

At the end of 1981, there are 12 cities which have a population over one million throughout the country. The urbanization rate, however, is still at a low level. The pace of the increase of urban population is slower than that of the total population. The ratio of urban/rural population shows a gentle curve of increase (see Appendix 1-4).

The population structure by age is represented by a pyramid (see Appendix 1-5). As can be seen in the figure, the population of younger age group shows a large expansion, and the pyramid itself is growing more and more with years. This indicates a population explosion that occurred after the 1920's due to a sharp decrease in mortality and the continued high birthrate.

A large reduction in mortality is substantiated by the lengthening of average life expectancy which was on the order of 20 years old in 1921, finally reaching 52.5 (male) and 52.1 (female) years old in the sample survey by dynamic statistics of population conducted during the period 1960-80. There has been no remarkable

decline in the birthrate on the other hand, thus causing the nation's population to increase steadily.

(2) Population Structure in the Union Territory of Delhi

In the 1981 Census, 6,220,406 persons were counted in the Union Territory of Delhi, comprising of 452,206 in rural areas and 5,768,200 in urban areas. The table below shows the area, population and population density of each district of the Union Territory.

	Area (km²)	Population	Population Density (Population/km²)
D.M.U.	360.55	4,884,234	13,547
N.D.M.C	42.74	273,036	6,388
Delhi Cantt	42.97	85,166	1,982
Others	145.59	525,764	3,611
Total urban population	591.9	5,768,200	9,745
Delhi Tahsil	541.5	275,064	508
Mehrauli Tahsil	337.8	177,142	524
Total rural population	891.1	452,206	507
Delhi Union Territory	1,483.0	6,220,406	4,194

Population in the Union Territory of Delhi in the 1981 Census shows 53% increase (2,154,708 persons) from the one in the 1971 Census. This represents average annual increase of over 4% during the decade 1971-81. A significant growth is observed in the urban area, which is attributable to the inflow of people from the neighbouring areas and to the recent urbanization of surrounding rural areas. (See Appendix 1-6)

	Population in 1971	Population in 1981	Population increase ratio for last decade
Urban	3,647,023	5,768,200	58.2%
Rural	418,675	452,206	8.0%
Total	4,065,698	6,220,406	53.0%

(3) Population Forecast

With regard to the forecast of the future population of India, estimations are given at intervals of 5 years up to 2010, the target year of this project.

A long-term forecast up to 2025 is also included in consideration of economic and financial analyses. The figures given in Table 2.1.2 are used as basic data for this purpose. In addition, the following reference materials are also used.

— Seventh Five-Year Plan (Planning Commission)
— Draft Regional Plan 2001 (National Capital Region)
— Population Projection for India 1951-1981 (Registrar General & Census Commission)
— Urban Growth in India 1951-1981 (Registrar General & Census Commission)
— Delhi Vikas Varta —— Delhi 2001 (Delhi Development Authority)

20 zones have been set up within the area that will be directly affected by this project (inner circle) and 6 zones out of the impact area (outer circle).

Table 2.1.2 Assumptions Underlying Population Projections 1981-2001

Period	Population at the end of the period (million) (as of 1st March)	General Fertility rate		Average expectation life at birth (years)		Birth rate	Death rate	Growth rate
	Total Urban	Decline compared to the previous quinquennium(%)	Absolute level	Males	Females			
1981-86	761	192	156	55.6	56.4	33.2	12.2	21.0
1986-91	837	230 13	136	58.1	59.1	29.7	10.7	19.0
1991-96	913	274 13	118	60.6	61.7	26.7	9.3	17.4
1996-2001	986	326 14	102	62.8	64.2	23.7	8.4	15.3

The result is summerized in Table 2.1.3. The population in 1990 is estimated, to be 820,792,000 which shows 20% increase from 1981. The population in 2000 is estimated to be 976,282,000 which increases 40% more than in 1981.

Concerning the population after the year 2000, it is estimated to grow to 1,043,470,000 by 2005 extrapolating a gradual declining tendency until the year 2000. It is estimated that the population will grow at an annual increase ratio of 1.0% after 2005.
As for the population in the inner circle, it showed a higher growth rate especially in Union Territory of Delhi. The population of the inner circle is estimated to increase to 56,197,000 by 1995, which is 1.4 times more than in 1981. Similarly, the population in 2010 is estimated at 75,217,000 which is 1.9 times more than in 1981.

Table 2.1.3 Population Forecast

Zone	State	District	Population (Unit ; thousand)							
			1981	1985	1990	1995	2000	2005	2010	2025
①	U.T. of Delhi	———	6,220	7,333	8,947	10,781	12,859	15,052	17,113	22,364
②	Uttar Pradesh	Ghaziabad	1,843	2,026	2,259	2,519	2,795	3,086	3,374	4,156
③	〃	Bulandshahr	2,358	2,593	2,891	3,223	3,576	3,948	4,317	5,317
④	Haryana	Faridabad	1,001	1,105	1,238	1,353	1,430	1,503	1,572	1,798
⑤	Uttar Pradesh	Aligarh	2,575	2,831	3,157	3,520	3,905	4,311	4,714	5,807
⑥	〃	Mathura	1,560	1,715	1,912	2,132	2,366	2,612	2,856	3,518
⑦	〃	Agra	2,853	3,137	3,497	3,900	4,327	4,777	5,223	6,434
⑧	〃	Moradabad	3,149	3,462	3,860	4,304	4,775	5,272	5,764	7,100
⑨	〃	Meerut	2,767	3,042	3,392	3,782	4,196	4,633	5,065	6,239
⑩	〃	Muzaffarnagar	2,274	2,500	2,788	3,108	3,448	3,807	4,162	5,127
⑪	〃	Saharanpur	2,674	2,940	3,278	3,655	4,055	4,477	4,895	6,030
⑫	Haryana	Sonipat	847	935	1,048	1,145	1,210	1,272	1,330	1,521
⑬	〃	Karnal	1,323	1,460	1,636	1,789	1,889	1,985	2,076	2,375
⑭	〃	Kurukshetra	1,130	1,247	1,398	1,528	1,614	1,696	1,774	2,029
⑮	〃	Ambala	1,409	1,555	1,743	1,905	2,012	2,115	2,212	2,531
⑯	〃	Rohtak	1,342	1,481	1,660	1,815	1,917	2,015	2,107	2,410
⑰	〃	Jindo	938	1,035	1,160	1,268	1,340	1,408	1,473	1,685
⑱	〃	Hisar	1,497	1,652	1,851	2,024	2,138	2,247	2,350	2,688
⑲	〃	Gurgaon	850	938	1,051	1,149	1,214	1,276	1,334	1,526
⑳	〃	Mahendragarh	959	1,059	1,186	1,297	1,370	1,440	1,506	1,723
Inner Circle Total			39,569	44,046	49,952	56,197	62,436	68,932	75,217	92,378
Year Growth Rate			—	2.72	2.55	2.38	2.13	2.00	1.75	1.38
㉑	Madhya Pradesh	Bopal	326,530	352,915	390,312	429,338	466,988	498,665	520,298	598,998
㉒	Bihar	Patna	177,261	192,099	210,641	228,940	246,390	261,532	274,873	319,119
㉓	Uttar Pradesh	Lucknow	61,250	67,266	75,072	83,252	91,557	99,120	105,211	122,147
㉔	Himachal Pradesh	Shimla	22,050	23,793	25,531	27,100	28,694	30,158	31,696	36,798
㉕	Punjab	Firozpur	6,166	6,653	7,139	2,578	8,024	8,433	8,863	10,290
㉖	Rajasthan	Jaipur	52,359	56,786	62,145	67,279	72,193	76,630	80,539	93,503
Outer Circle Total			645,616	699,512	770,840	843,487	913,846	974,538	1,021,480	1,180,855
Year Growth Rate			—	2.03	1.96	1.82	1.62	1.29	0.95	0.97
Grand Total (All India)			685,185	743,558	820,792	899,684	976,282	1,043,470	1,090,697	1,273,233
Year Growth Rate			—	2.07	1.98	1.82	1.61	1.34	1.00	1.00

2 - 1 - 2 Socio-Economic Framework

(1) Economic Active Population

According to the Census in 1981, a total of 245 million people are engaged in economic activities, the ratio of those active in economy to the total population is only 35.7%.

According to the 1981 Census, 68.7% of the total employed people (regular employment only) are engaged in the primary sector, i.e., agriculture, fishery, forestry and livestock industry. There are 92.50 million farmers and 55.50 million agricultural workers, accounting for 41.6% and 24.9% of the total employed population, respectively. Those who are engaged in the manufacturing industry do not exceed 11.3%.

In India, enterprises are classified into "organized" and "non-organized" sectors according to the number of employees. 90% of the economic active population belongs to the non-organized sector that covers agricultural workers and those who work in village factories and household industry. Out of 22.88 million employees in the organized sector, 15.48 million (67.7%) belong to the public sector.

(2) Economic Active Population in the Union Territory of Delhi

Out of the total population of 6,220,000 in the Union Territory of Delhi (1981), 1,986,000 (31.9%) are engaged in economic activities and 4,234,000 (68.1%) are unemployed. The number of the employed increased 773,000 during the decade 1971-81. However, the average growth rate of the employed persons was only 1.98% during this decade. This is largely due to rapid increase of population.

In 1981, employment ratio is 52.67% for male and 6.84% for female in the whole Union Territory. The low employment ratio of female is quite a contrast to the male employment ratio. It is also noted that 93.9% (1,865,000 persons) of the total employment

population in the Union Territory of Delhi are from urban area. From the viewpoint of industrial sector, as shown in Appendix 1-7, 60% of employment falls under the tertiary sector, 36% the secondary sector, and only less than 4% of employment population is engaged in the primary sector.

(3) Forecast of Economic Active Population

There was a growth of 23.40 million employed persons during the decade 1971-81. 39.8% of the growth is accounted for the increase in the service sector and 34.2%, agricultural workers, and those who are engaged in manufacturing industry account for only 5.4%. During the decade 1974-84, the growth of employment remained at an average rate of 2.2% whilst the volume of real value-added production in the manufacturing industry showed an average annual increase of 5%.

It was estimated that the unemployment as of 1971 amounted to 18.7 million (9 million of the wholly unemployed and 9.7 million of under-employed whose total working hours are less than 14 hours per week). Unemployment in rural areas accounted for 86.1% and that of urban areas for 13.9%.

The 7th Five-Year Plan sets the unemployment at 9.2 million persons as of 1985, and forecasts that this figure will not change considerably during its projection period.

"Analysis of Work Force in India (Occasional Paper No. 8 of 1988)" issued by the Registrar General & Census Commissioner provides a detailed population forecast in terms of economic activities. The data given in this paper has been used as reference in our forecasting.

The forecast results have been summarized in the similar ways as the population forecast given in Table 2.1.3, that is, at intervals of 5 years up to the target year of 2010. 20 zones have been set up within the area that will be directly affected by this survey (inner circles) and 6 zones out of the impact area (outer circles).

It is estimated that the national economic active population to 313,305,000 by 1955; 1.4 times more than in 1981 (222,517,000). Compared to the national total figure, the economic active population in the inner circle showed a higher growth rate. Namely, it is estimated to increase to 16,648,000 in 1995; 1.5 times more than in 1981 (11,282,000).

Forecast results are shown in Table 2.1.4.

Table 2.1.4 Economic Active Population Forecast

Zone	State	District	Main Workers (Unit ; thousand)							
			1981	1985	1990	1995	2000	2005	2010	2025
①	U.T. of Delhi	———	1,986	2,347	2,953	3,666	4,501	5,218	5,990	8,062
②	Uttar Pradesh	Ghaziabad	506	543	603	666	734	806	882	1,086
③	〃	Bulandshahr	610	654	727	803	845	928	1,015	1,250
④	Haryana	Faridabad	295	338	396	457	528	603	683	892
⑤	Uttar Pradesh	Aligarh	683	733	814	899	991	1,089	1,190	1,466
⑥	〃	Mathura	429	460	511	565	622	683	747	920
⑦	〃	Agra	783	840	933	1,031	1,136	1,248	1,365	1,681
⑧	〃	Moradabad	895	960	1,067	1,178	1,298	1,426	1,559	1,921
⑨	〃	Meerut	766	822	913	1,009	1,111	1,221	1,335	1,644
⑩	〃	Muzaffarnagar	648	695	772	853	940	1,033	1,129	1,391
⑪	〃	Saharanpur	781	838	931	1,028	1,133	1,245	1,361	1,677
⑫	Haryana	Sonipat	239	274	321	370	427	488	552	721
⑬	〃	Karnal	385	441	518	596	688	786	889	1,162
⑭	〃	Kurukshetra	324	372	436	502	579	662	748	978
⑮	〃	Ambala	409	469	550	634	731	835	945	1,235
⑯	〃	Rohtak	358	410	481	555	640	731	827	1,081
⑰	〃	Jindo	274	314	368	424	490	560	633	828
⑱	〃	Hisar	448	514	602	694	801	915	1,035	1,353
⑲	〃	Gurgaon	236	271	317	366	422	482	545	713
⑳	〃	Mahendragarh	227	260	305	352	406	464	525	686
Inner Circle Total			11,282	12,555	14,518	16,648	19,023	21,423	23,955	30,747
Year Growth Rate			—	2.71	2.95	2.77	2.70	2.41	2.24	1.68
㉑	Madhya Pradesh	Bopal	121,895	135,520	154,420	174,696	196,491	219,521	243,390	298,589
㉒	Bihar	Patna	46,535	50,966	57,439	63,854	70,915	78,296	85,811	105,709
㉓	Uttar Pradesh	Lucknow	18,236	19,562	21,736	24,010	26,457	29,068	31,780	39,149
㉔	Himachal Pradesh	Shimla	6,695	7,355	8,217	9,081	9,958	10,887	11,844	14,591
㉕	Punjab	Firozpur	1,889	2,075	2,318	2,562	2,810	3,072	3,342	4,117
㉖	Rajasthan	Jaipur	15,985	17,679	20,031	22,454	25,035	27,776	30,517	37,594
Outer Circle Total			211,235	233,157	264,161	296,657	331,666	368,620	406,684	499,749
Year Growth Rate			—	2.50	2.53	2.35	2.26	2.14	1.99	1.38
Grand Total (All India)			222,517	245,712	278,679	313,305	350,689	390,043	430,639	530,496
Year Growth Rate			—	2.51	2.55	2.37	2.28	2.15	2.00	1.40

(4) Gross Domestic Product (G.D.P.)

In 1970-71 the primary industries such as agriculture and fishery accounted for 48.5% of GDP in India, and the secondary sector (manufacturing industry) 20.7%. In 1985-86, however, the ratio of the primary sector has decreased to 36.9%. While the manufacturing industry showed only a negligible growth as it still remains at a level of 21.9%(see Appendix 1-8). The share of agriculture and its related sectors (such as irrigation) to G.D.P. will decrease from 36.9% in 1984-85 to 32.7% in 1989-90. The share of manufacturing industry (industrial sector) to G.D.P. will, on the other hand, increase from 18.1% in 1984-85 to 19.7% in 1989-90 according to the 7th Five-Year Plan.

The targeted average annual growth rates under the Plan are as follows:

G.D.P.	5.0%
Agriculture	4.0%
Manufacturing industry	8.0%
Export	6.8%
Import	5.8%

(5) G.D.P. in the Union Territory of Delhi (U.T.D.)

The Union Territory of Delhi is a large city next only to Calcutta and Bombay. Its G.D.P. in 1985 amounts to Rs. 13,500 million which is 2.2% of the national G.D.P. (Rs. 616,900 million). (both figure in 1970-71 prices). Thus G.D.P. of the U.T.D. is the largest among the cities in India. Moreover, the Union Territory is also ranked as the highest throughout the country with respect to the G.D.P. per capita, marking Rs. 1,837 (in 1985, in 1970-71 prices) which is more than twice the national average per capita G. D.P., Rs. 830. Its annual G.D.P. growth rate also exceeds 10% in 1986 and 1987.

(6) G.D.P. Forecast

While the primary sector still predominates in the G.D.P. of India.

the growth rate of the secondary and especially, tertiary sectors have been outstanding during these ten years.
This tendency will apparently continue in the future: while the share of agricultural sector will decrease, the tertiary sector will grow at a higher rate than that of secondary sector. Team's forecast for future G.D.P. is based on these past trends and also the data given in Table 2.1.5 and Table 2.1.6.

Table 2.1.5 Projected Sectoral Annual Rates of Growth in Terms of G.D.P. during 7th Five-Year Plan

Sector	1984/85 (GR. Rate)		1989/90 (GR. Rate)		1999/2000 1999/2000
1) Agriculture	36.9%	2.5%	32.7%	2.4%	25.5%
2) Mining & Manufacturing	18.1%	6.8%	19.7%	6.9%	23.6%
(a) Mining	3.5%	11.7%	4.7%	3.5%	3.8%
(b) Manufacturing	14.6%	5.5%	15.0%	7.8%	19.8%
3) Electricity, gas & water supply	2.0%	7.9%	2.3%	7.7%	2.9%
4) Construction	6.2%	4.8%	6.2%	4.9%	6.1%
5) Transport	5.6%	7.1%	6.2%	5.3%	6.4%
6) Services	31.2%	6.1%	32.9%	5.8%	35.5%
Total	100.0%	5.0%	100.0%	5.0%	100.0%

The following reference materials have been used as basic data for the purpose.

"Estimates of State Domestic Product" June,1988
"National Accounts Statistics" May, 1988
"Economic Survey 1987-1988"

According to the target values of the 7th Five-Year Plan, (Table 2. 1.5), the share of the manufacturing sector will be 19.8% in the year 2000 (14.6%, in 1984/85), and the service industry sector, 35. 5% (31.2% in 1984/85), while that of the agricultural sector will decline to 25.5% (36.9% in 1984/85).

Our forecast is summarized in Table 2.1.6. Similar to the population forecast given in Table 2.1.3, the results are given time-wise at intervals of 5 years up to 2010, and area-wise divided into 20 zones the inner circle and for 6 zones in the outer circle. As is observed in the Table 2.1.6, the G.D.P. of India of the year 19 95 is estimated at 100,491 Rs.crores (in 1970/71 prices), approximately 2.0 times more than that of 1981, and in the year 2010, 208,913 Rs.crores, 4.1 times more.

Taking the future population growth into consideration, G.D.P. per capita will be 1,117 Rs/person in the year 1995, 1.5 times more than that of 1980/81 (739 Rs/person) in 1970/71 prices and in the year 2010, 1,905 Rs/person, 2.6 times more.
Gross regional domestic product in U.T.D. is estimated to reach 4,561 Rs.crores in 2010, 4.6 times more than that attained in 1980/81 (992 Rs.crores), whereas G.D.P. per capita may not exceed 2,665 Rs/person, namely, 1.7 times as much as that in 1980/81 (1,595 Rs/person in 1970/71 prices), due to a rapid growth of population.
Gross regional domestic product in the inner circle, on the other hand, is estimated to reach 15,323 Rs.crores in the year 2010, 4.3 times as much as that in 1980/81. G.D.P. per capita is estimated to reach 2,037 Rs/person in the year 2010, twice as much as that in 1980/81.

Table 2.1.6 Gross Domestic Product Forecast

Zone	State	District	G. D. P (Unit ; Rs. Crores at 1970/71 Prices)							
			1981	1985	1990	1995	2000	2005	2010	2025
①	U.T. of Delhi	———	992	1,347	1,719	2,194	2,800	3,574	4,561	8,214
②	Uttar Pradesh	Ghaziabad	246	308	393	502	641	817	1,043	1,878
③	〃	Bulandshahr	163	205	262	334	426	544	694	1,250
④	Haryana	Faridabad	118	144	184	235	300	382	488	879
⑤	Uttar Pradesh	Aligarh	165	207	264	337	430	549	701	1,262
⑥	〃	Mathura	72	90	115	147	188	239	305	549
⑦	〃	Agra	131	165	211	269	343	438	559	1,007
⑧	〃	Moradabad	145	170	217	277	354	451	576	1,037
⑨	〃	Meerut	127	148	189	241	308	393	501	902
⑩	〃	Muzaffarnagar	104	119	152	194	247	316	403	726
⑪	〃	Saharanpur	123	143	183	233	297	379	484	872
⑫	Haryana	Sonipat	100	122	156	199	254	324	413	744
⑬	〃	Karnal	156	190	242	309	394	504	643	1,158
⑭	〃	Kurukshetra	133	162	207	264	337	430	549	989
⑮	〃	Ambala	166	202	258	329	420	536	684	1,232
⑯	〃	Rohtak	158	193	246	314	401	512	654	1,178
⑰	〃	Jindo	111	135	172	220	281	358	457	823
⑱	〃	Hisar	177	215	274	350	447	570	728	1,311
⑲	〃	Gurgaon	100	122	156	199	254	324	413	744
⑳	〃	Mahendragarh	113	138	176	225	287	366	467	841
Inner Circle Total			3,600	4,525	5,776	7,372	9,409	12,006	15,323	27,596
Year Growth Rate			—	4.8	5.0	5.0	5.0	5.0	5.0	4.0
㉑	Madhya Pradesh	Bopal	24,671	29,957	38,234	48,797	62,278	79,484	101,444	182,695
㉒	Bihar	Patna	11,337	13,336	17,020	21,722	27,724	35,384	45,160	81,330
㉓	Uttar Pradesh	Lucknow	3,606	4,506	5,751	7,340	9,368	11,956	15,259	27,480
㉔	Himachal Pradesh	Shimla	2,436	3,047	3,889	4,963	6,334	8,085	10,319	18,584
㉕	Punjab	Firozpur	951	1,224	1,562	1,994	2,545	3,248	4,145	7,465
㉖	Rajasthan	Jaipur	4,022	5,098	6,506	8,303	10,597	13,526	17,263	31,090
Outer Circle Total			47,023	57,168	72,962	93,119	118,846	151,683	193,590	348,644
Year Growth Rate			—	4.0	5.0	5.0	5.0	5.0	5.0	4.0
Grand Total (All India)			50,623	61,693	78,738	100,491	128,255	163,689	208,913	376,240
Year Growth Rate			—	4.0	5.0	5.0	5.0	5.0	5.0	4.0

2 - 1 - 3 Land Use and Related Development

(1) Land Use in the Urban Territory of Delhi

As shown in Appendix 1-3, the population density of Delhi Municipal Corporation (urban area)is outstandingly high (13,547 persons/km²). This means that the 3/4 of the total population in the Union Territory of Delhi concentrate here. The majority of household industry in Delhi concentrates in this densely built-up area, on the other hand, the modern manufactures are situated in the northern area of Delhi.

Commercial population also concentrates in the densely built-up area mentioned above. Informal sector is distributed in the complementary form in relation to manufacturing and business areas. Informal sector particularly concentrate in New Delhi, Delhi Cant., and in the southern suburbs of the Union Territory. This is apparently because main clients of informal sector are government agencies and their related offices. Informal sector employment also prevails in the north of Old Delhi where the University of Delhi and other administrative offices are located. Land utilization in the Union Territory of Delhi coincides with the distribution of the employment population. The central business district is situated in the centre of the Delhi urban area, around Delhi Station, and small-scale commercial areas are distributed in the north-western and eastern parts. The southern part of the Union Territory still remains underdeveloped compared with other parts; however, it is expected that this southern area can be placed under a new development project for future urbanization.

Industrial sector, except for household industry, predominates in the north, with heavy industries located close to the peripheral areas of Delhi.

The latest industrial location expands on the east of the old urban area across the Yamuna River, and on the west along the railways and roads for easier access.

The current situation of land use by purpose is shown in Table 2.1.7.

Table 2.1.7 Land Use Pattern of U.T.D. in 1987

Category	Area(ha)	Percent(%)
1. Forest	2,678	1.8
2. Land put to non-agricultural use	35,820	24.2
3. Barren land	11,438	7.7
4. Water bodies	329	0.2
5. Permanent pasture & other grazing Land	793	0.5
6. Land under misc. tree,crops & groves	1,137	0.8
7. Culturable waste	856	0.6
8. Cultivated land	95,249	64.2
Total	148,300	100.0

As is shown in the above table, the land use for housing, roads and railways ("2. Land put to non-agricultural use") currently accounts for 24.2% in the U.T.D. This will further increase as the area will become more active, by the urbanization, industrialization and by the improvement of traffic network.

(2) Related Development

1) Land Use and Related Laws and Regulations

Future land-use plans and related development plans in the Union Territory of Delhi are controlled by the following laws and regulations;

The Delhi Development Act, 1957.

The Slum Areas (Improvement and Clearance) Act, 1956.

The Urban Arts Commission Act, 1975.

The Delhi Road Transport Laws Act, 1971.

The Land Acquisition Act, 1894.
Urban Land (Ceiling and Regulation) Act, 1976.
Delhi Municipal Corporation Act, 1957.
The Punjab Municipalities Act, 1911.
The Cantonment Boards Act, 1924.

2) Transportation Plan

"Regional Plan 2001" prepared by National Capital Region Planning Board, authorized the construction of the following road network as shown in Appendix 1-9.

① Expressway plans
- Expressway between Delhi～Ghaziabad ～Meerut
- Expressway between Delhi～Gurgaon ～Behror
- Expressway between Delhi～Panipat
- Expressway between Faridabad～NOIDA ～Ghaziabad

② M-I Motorway plans
- M-1 Motorway between Delhi ～Hodal
- M-I Motorway between Rohtak～Hansi

③ M-II Motorway plans (proposed in National Capital Region of the Uttar Pradesh, Haryana and Rajasthan).

④ Sub-regional road network

3) Other Development Plans

"Delhi Vikas Varta — Delhi 2001" prepared by Delhi Development Authority (D.D.A.) describes the transportation improvement plans to ease traffic congestion by the following systems:
- Light Rail Transit (LRT)
- Tram
- Cycle track

These plans have not been authorized yet. The following plans are also prepared by D.D.A.

"2nd Entry to the New Delhi Station" - 1982
"Traffic and Mass Transportation System in Delhi"- 1986

These plans have also not been authorized yet.

Land use and related development plans are now being prepared by D.D.A. which focuses on Hazrat Nizamuddin, Holambi Kalan, Anand Vihar, Bijwasan and Tuglakabad where are important stations.

2 - 2 Current Situation of Railways in India

The Indian Railways owns a railway network of 61,976 km, which is the second longest in the world. Railways are one of the most important modes of transport in India. The Indian Railways provides, therefore, the basis for the national economic growth. It can be expected that railway transport will continue to play an important role in the predictable future, as well. However, the share of railways in transport shows a markedly declining trend, down to 24% in passenger traffic and 43% in goods traffic in 1985, compared with 74% and 88% in 1951, respectively. This significant downdrift is attributable to the limitations of its transport capacity. It is also due to the expansion of road networks.

From the financial viewpoint, goods accounts for 68.37% of the gross revenue receipts of the Indian Railways, and 25.85% from passenger transport.

2 - 2 - 1 Current Situation of Passenger Traffic

In the year 1986-87, a total of 3,850 million passengers are transported by Indian Railways, or 256,468 million passenger-kilometers in total. Average travelling distance per passenger was 71.6 km. As can be seen in Table 2.2.1, the number of passengers originating per annum has been 3300-3700 million for the past several years.

It is observed that since 1981 the passenger-kilometerage has increased stably at an annual rate of 3%. As for the non-suburban passenger services, the number of passengers in ordinary trains has remained practically unchanged since 1981, whilst the number of those who use upper class and express trains has shown a marked increase.

Table 2.2.1 Number of Passengers Originating
(Number of Passenger Journeys)

(In millions)

Year	Suburban (all classes)	Non-Suburban				Grand Total
		Upper	Second		Total Non-Suburban	
			Mail/Exp.	Ordy.	Total	
1950-51	412	25	52	795	847	872	1,284
1955-56	495	15	76	689	765	780	1,275
1960-61	680	15	96	803	899	914	1,594
1965-66	1,018	17	125	922	1,047	1,064	2,082
1970-71	1,219	16	155	1,041	1,196	1,212	2,431
1975-76	1,639	07	175	1,124	1,299	1,306	2,945
1980-81	2,000	11	260	1,342	1,602	1,613	3,613
1981-82	2,064	11	277	1,352	1,629	1,640	3,704
1982-83	2,029	12	276	1,338	1,614	1,626	3,655
1983-84	1,834	11	288	1,192	1,480	1,491	3,325
1984-85	1,884	11	288	1,150	1,438	1,449	3,333
1985-86	1,884	12	314	1,223	1,537	1,549	3,433
1986-87	1,970	13	326	1,271	1,597	1,610	3,580

Source:Year Book (1986-87)

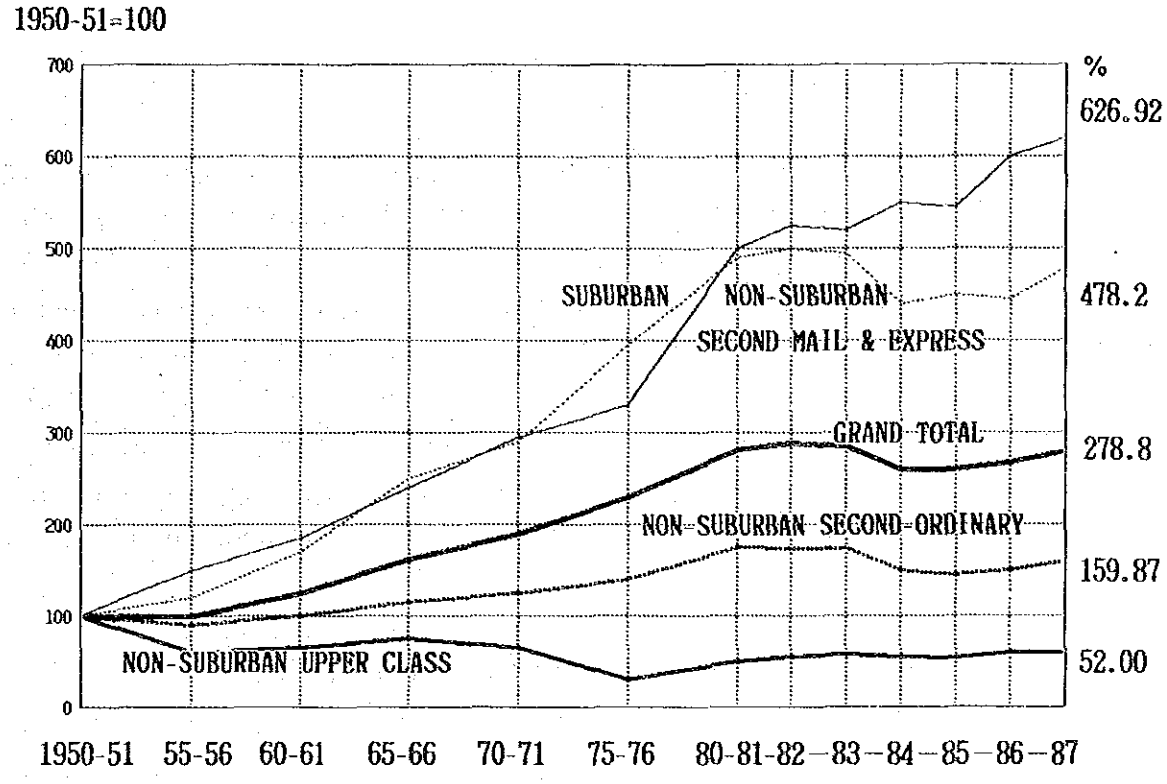


Fig. 2.2.1 Passengers Originating

Source : Year Book (1986-87)

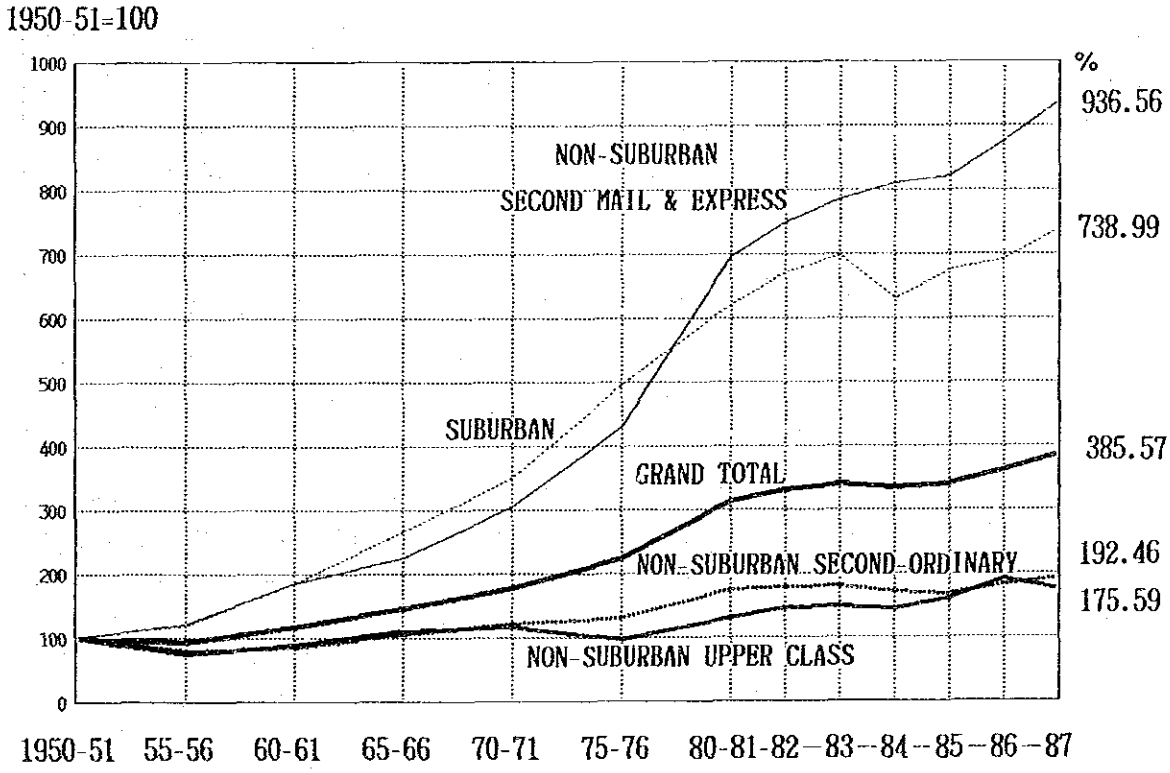


Fig. 2.2.2 Passenger Kilometrage

Source : Year Book (1986-87)

2 - 2 - 2 Current Situation of Goods Traffic

In the year 1986-87, the Indian Railways marked 277.8 million tonnes of goods traffic. The Indian Railways has strongly supported the foundation of the growing economy of the nation. Table 2.2.2 shows annual goods traffic carried by the Indian Railways. An annual growth of 4.7% for the past five years, observed in the table, conforms with the growth of national GDP. As is shown in Fig. 2.2.4, coal accounts for the largest volume (39.4%) of the goods transported by the railways, followed by other bulk commodities, such as iron ores, food grains and cement. These bulk commodities account for 90% of the total goods traffic.

Table 2.2.2 Revenue Earning Goods Traffic

Year	Tonnes (Million)	Index	Tonne kms. (Million)	Index	Lead kms.	Index
1950-51	73.2	100.0	37,565	100.0	513	100.0
1955-56	92.2	126.0	50,435	134.3	541	105.5
1960-61	119.8	163.7	72,333	192.6	603	117.6
1965-66	162.0	221.3	98,978	263.5	611	119.1
1970-71	167.9	229.4	110,696	294.7	659	128.5
1975-76	196.8	268.9	134,874	359.0	685	133.5
1980-81	195.9	267.6	147,652	393.1	754	147.0
1981-82	221.2	302.2	164,253	437.2	743	144.8
1982-83	228.8	312.6	167,781	446.6	733	142.9
1983-84	230.1	314.3	168,849	449.5	734	143.1
1984-85	236.4	322.9	172,632	459.6	730	142.3
1985-86	258.5	353.1	196,600	523.4	760	148.1
1986-87	277.8	379.5	214,096	569.9	771	150.3

Source:Year Book (1986-87)

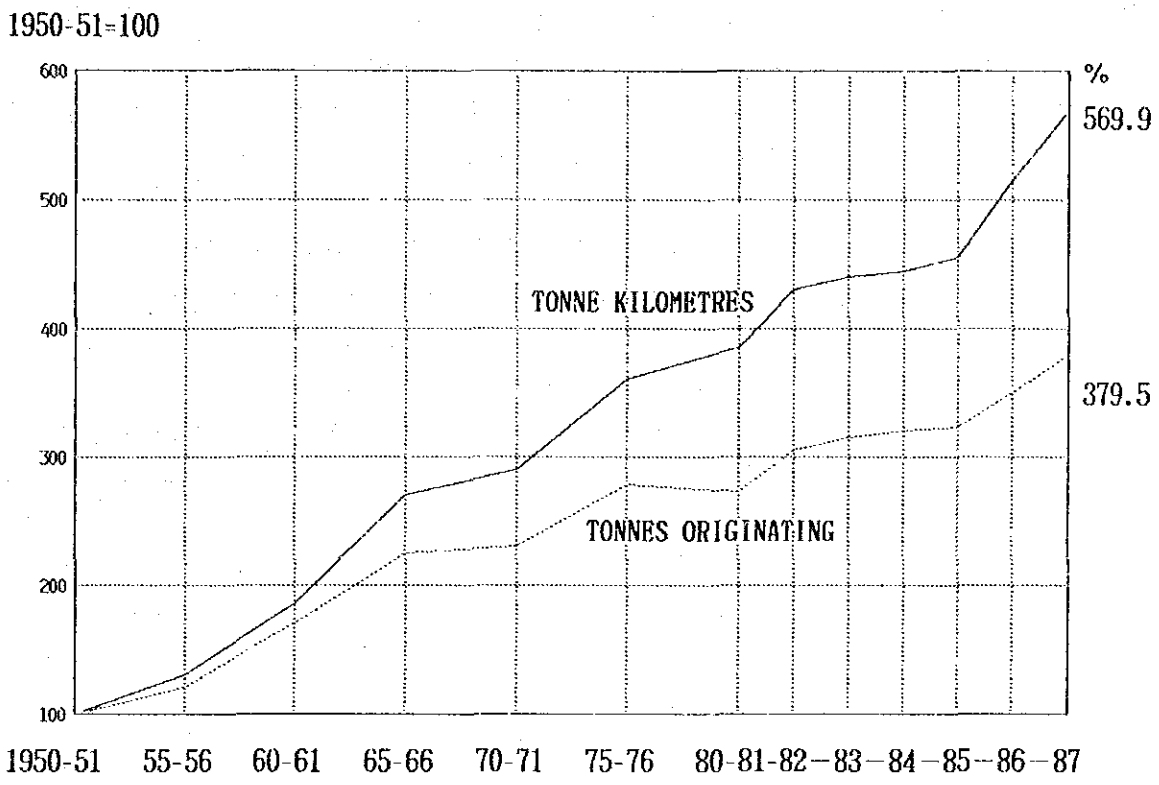


Fig. 2.2.3 Goods Traffic Trends (Revenue Earning Traffic)

Source : Year Book (1986-87)

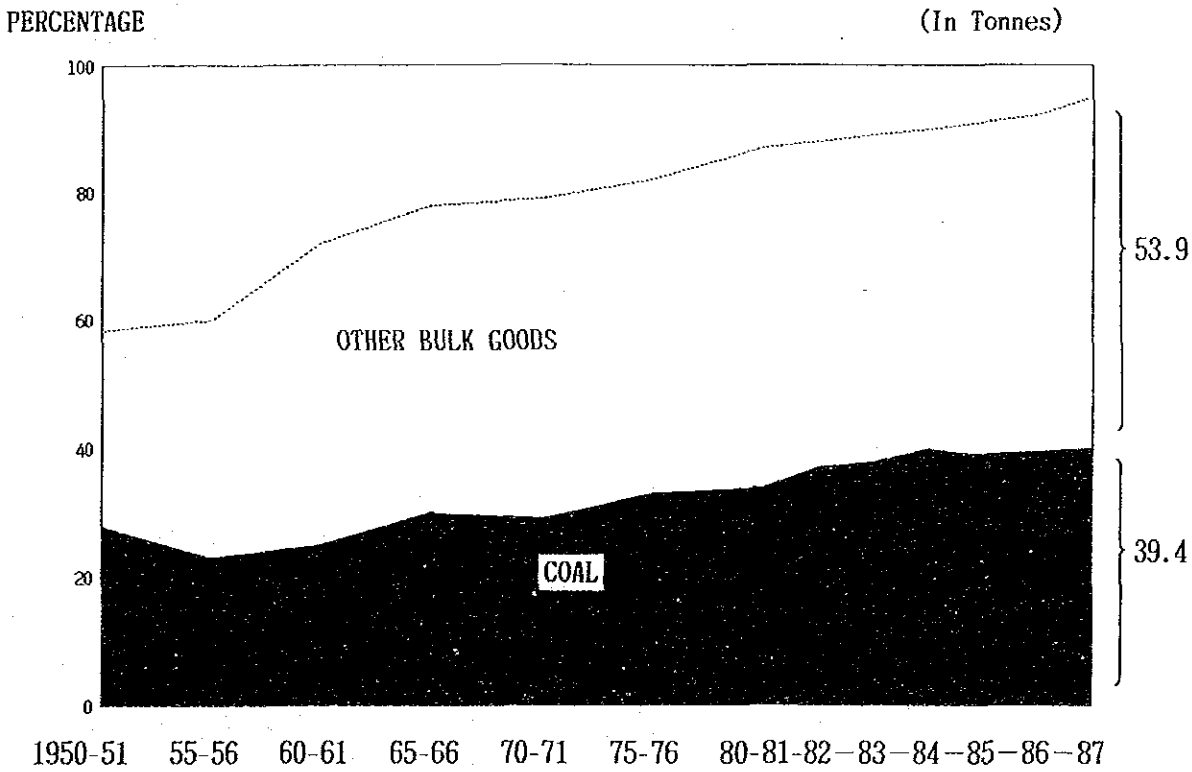


Fig. 2.2.4 Share of Bulk Commodities in Goods Traffic

Source : Year Book (1986-87)

Table 2.2.3 shows the goods handled by the Indian Railways in the Delhi Area. Bulk commodities, including coal, cement, POL and food grains, account for 70% of its total. It is also noticeable that other goods amount to a relatively large volume, ranking second.

Table 2.2.3 Delhi Area Goods Traffic in 1986-87

Commodity Group	Inward	Outward	Total
1. Coal	4,716,877	409	4,717,286
2. Other Goods	2,102,708	678,074	2,780,782
3. Cement	1,491,393	3,720	1,495,113
4. POL	1,024,345	7,644	1,031,989
5. Food Grains	997,096	407,916	1,405,012
6. Iron & Steel	475,856	0	475,856
7. Salt	187,115	13	187,128
8. Fertilizers	72,568	33,658	106,226
9. Limestone & Dolomite	18,361	157	18,518
10. Iron Ore	111	0	111
Grand Total	11,086,430	1,131,591	12,218,021

Source: Total Transport System Study

Table 2.2.4 shows the change of shares between railway mode and highway mode in 1978-79 and 1986-87. A sharp increase in tonnage by road transport from 34.1% to 48.1% is observed. On the other hand, the average lead in the railway transport is observed to have double that of the road transport.

Table 2.2.4 Modewise Inter-regional Commodity Flows

Mode of Transport	Tonnes (In million)		Tonnes kms(In billion)		Average Lead (kms)
		share (%)		share (%)	
Railway					
1978-79	185.0	65.6	149.6	80.6	810
1986-87	255.4	50.9	198.6	64.2	788
Highway					
1978-79	96.0	34.1	33.7	18.2	353
1986-87	240.7	48.0	101.6	32.8	422

Source : Total Transport System Study

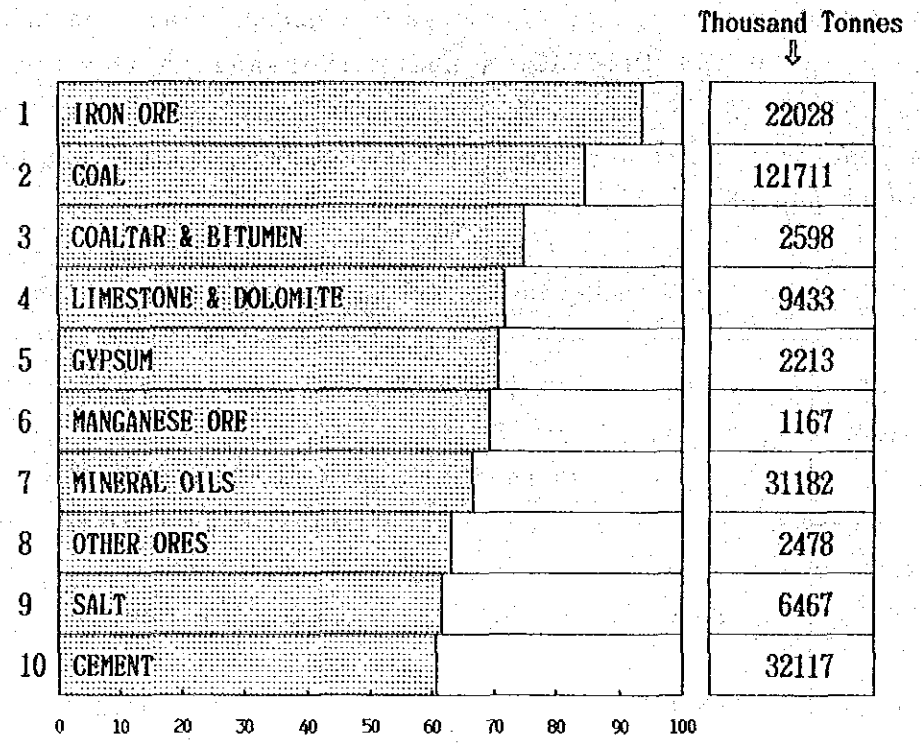
Illustrated in Fig. 2.2.5 are the railway-road shares in net tonnage for 10 major commodities. Railway accounts for a share over 60% of the total volume of bulk commodities, indicating its predominant position over road. This trend is considered to remain unchanged in future.

2 - 3 Demand Forecast

2 - 3 - 1 Forecasting Method

(1) Source data

The major mass transit modes of passengers in urban districts in



NOTE :—
Commodities are arranged according to their respective shares in net tonne on Railways & Highways

Fig. 2.2.5 Shares by Modes in Net Tonnes

Source : Total Transport System Study

the study area include railways, non-suburban shuttle buses and aircrafts. Taxi, sightseeing buses and private cars are excluded from the study as they refer to nonregular transport means.

As for goods, its major part consists of bulk commodities. Trains and trucks are considered as the main means of transport. Air freight is excluded from the study, because it deals with only a small quantity of passenger luggage and post.

Source data have been obtained from statistical offices of Indian Railway (IR), Northern Railway (NR), Delhi Transport Corporation (DTC), Ministry of Surface Transport (MST) and Indian Airlines (IA).

1) Passenger traffic

As to the passenger flows leaving Delhi Area outward for other areas, the statistical data were available from the Indian Railway's electronic data processing division. Analyzing these data, the current traffic distribution pattern for railway passengers was established. In addition, the NR Statistical Office provided the counts of passengers getting on and off at each station within the study area as well as the main passenger flow data.

These data were also used to adjust OD traffic volume.

2) Goods traffic

Goods flow survey was conducted in 1985 by the Planning Commission of India. This survey data provided the basis of this study. To adjust OD traffic volume, the data provided by the NR Statistical Office with respect to the outward/inward flows of goods in the Delhi Area, goods transport volume handled at the respective stations in the study area, and tonnages by main traffic flows were used.

3) Parcel traffic

The data of parcel traffic in the Delhi Area is based on the report issued by NR ("Work Study Report on Review of Strength of Staff in Parcel Offices at Delhi, New Delhi & H.Nizamuddin and Rationalization Parcel Traffic of New Delhi").

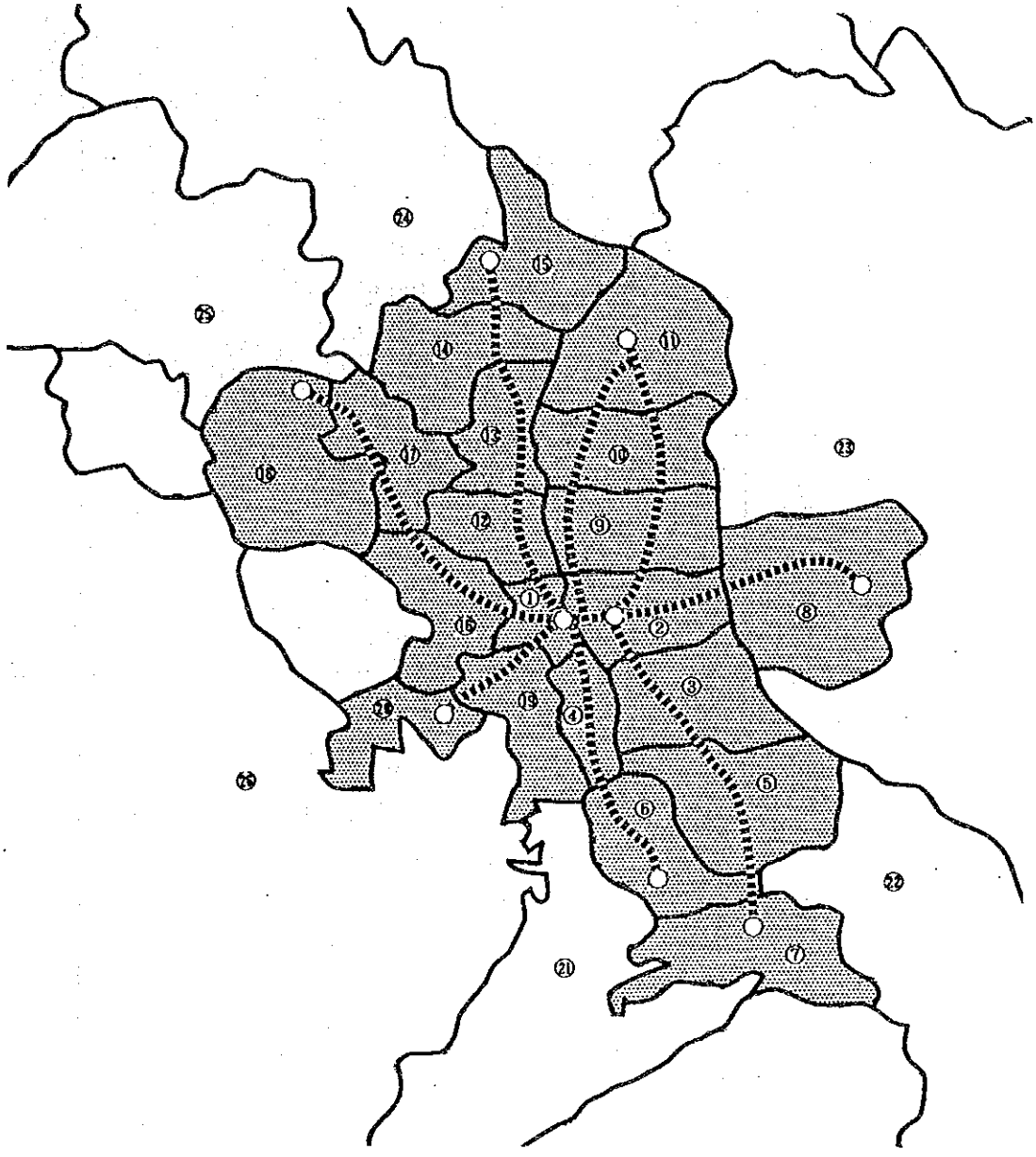
Additionally, statistical data concerning parcel handling provided by the NR Statistical Office was referenced.

(2) Zoning

An area with 200 km radius from New Delhi was considered to formulate a master plan under this study. The area was divided into twenty (20) zones based on the division of administrative districts.

The regions exterior to this 200km radius area were divided into six zones each of which lies along a main railway line extending from the outer circle (See Zones㉑ through㉖ in Fig. 2.3.1).

Traffic forecast was made for each of the inward/outward traffic flows between the adjacent two zones. Zoning map is illustrated in Fig. 2.3.1, with a breakdown of zones in Table 2.3.1. Stations handling daily average of more than 3,000 passengers originating or of more than 100 arrival goods wagons were counted as the main stations in the area.



Legend : Shaded Area Shows the Study Area

Fig. 2.3.1 Zoning Map

Table 2.3.1 Zoning for Traffic Demand Forecast

Zone	State	District
①	U.T.of Delhi	—
②	Uttar Pradesh	Ghaziabad
③	〃	Bulandshahr
④	Haryana	Faridabad
⑤	Uttar Pradesh	Aligarh
⑥	〃	Mathura
⑦	〃	Agra
⑧	〃	Moradabad
⑨	〃	Meerut
⑩	〃	Muzaffarnagar
⑪	〃	Saharanpur
⑫	Haryana	Sonipat
⑬	〃	Karnal
⑭	〃	Kurukshetra
⑮	〃	Ambala
⑯	〃	Rohtak
⑰	〃	Jind
⑱	〃	Hisar
⑲	〃	Gurgaon
⑳	〃	Mahendragarh
㉑	Madhya Pradesh	Bhopal
㉒	Bihar	Patna
㉓	Uttar Pradesh	Lucknow
㉔	Himachal Pradesh	Simla
㉕	Punjab	Firozpur
㉖	Rajasthan	Jaipur

(3) Forecast procedure

Four-step forecast method as shown in Fig(s).2.3.2 and 2.3.3 was used to estimate the future traffic demand under this study. This method includes the following four steps, namely: 1) establish a model formula based on the analysis of current

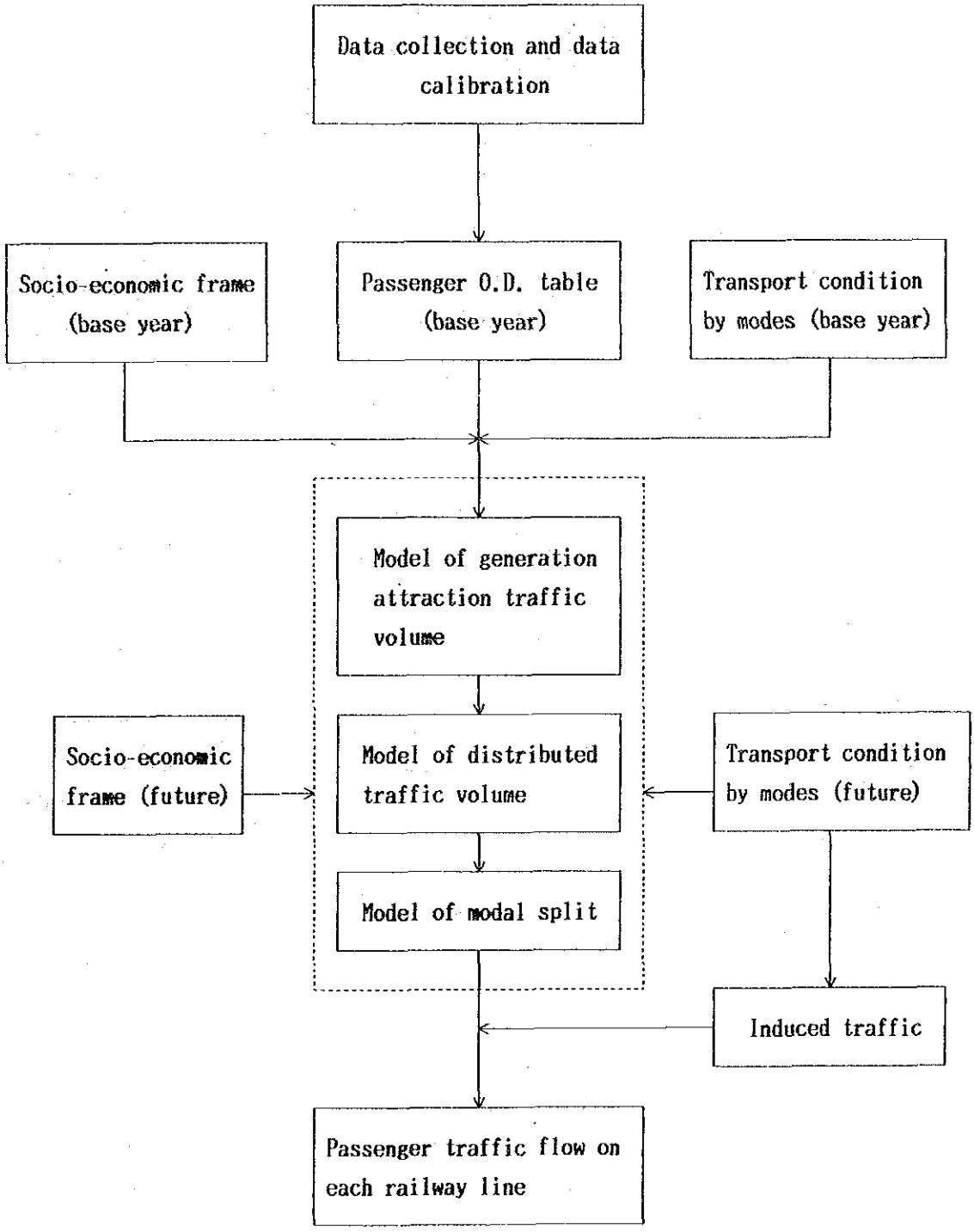


Fig. 2.3.2 Flow of Passenger Traffic Demand Forecast

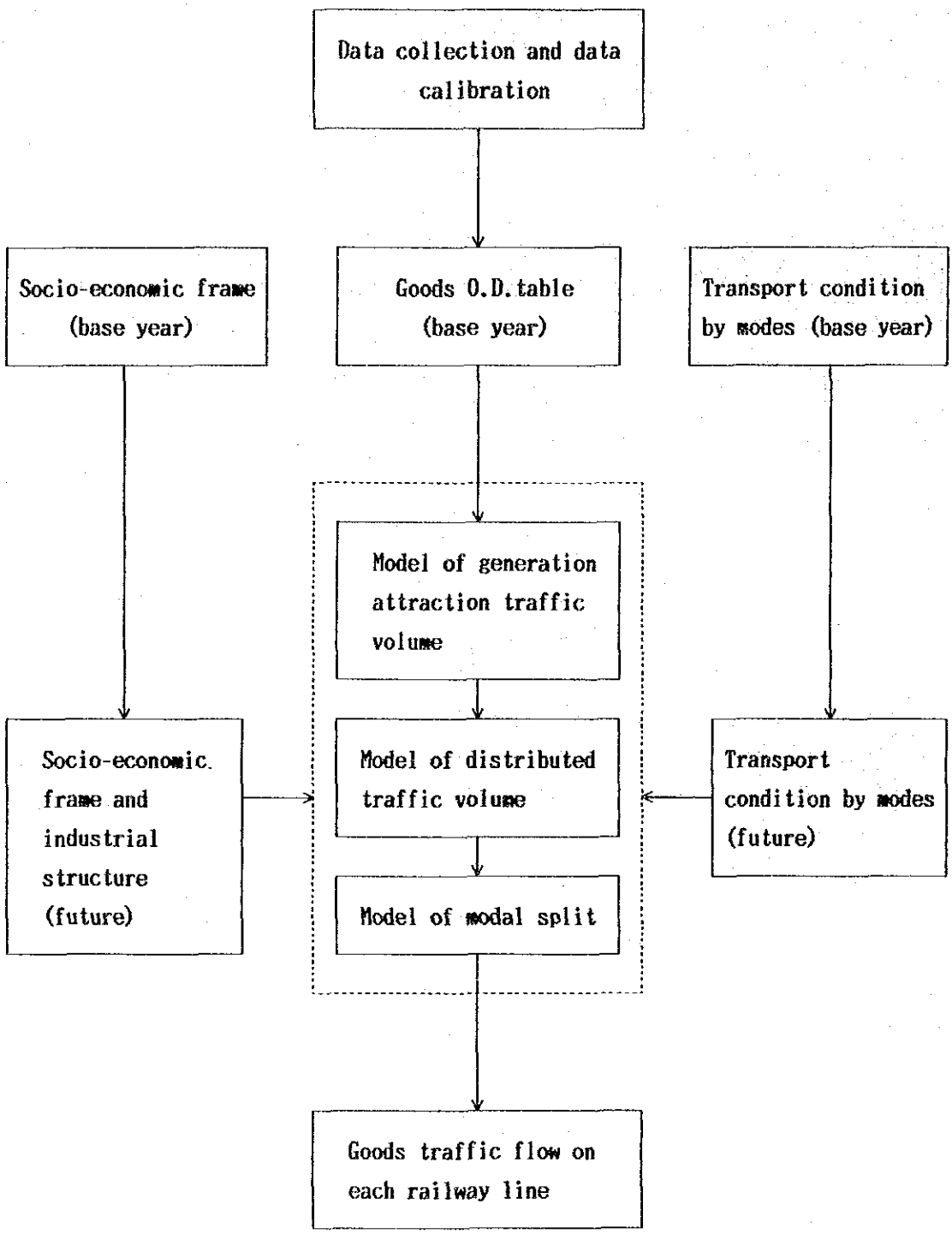


Fig. 2.3.3 Flow of Goods Traffic Demand Forecast

traffic conditions, 2) forecast the generation/attraction traffic, 3) forecast the distributed traffic volumes based on the estimated future socio-economic frame, and 4) forecast the traffic volume by the modal split determined by the estimated future traffic conditions, and by the service levels of each mode.

1) Generation/attraction traffic volume

a) Passenger traffic

The Functional Model Method was used to estimate the generation/attraction passenger traffic volume. To establish the model, a regression coefficient was defined by multiple regression analysis based on the selection of explanatory variables. For these variables, zonal night-time population and economic active population values were selected.

$$F_i = a_0 + a_1 P_i + a_2 E_i + a_3 GDP_i$$

$$G_j = b_0 + b_1 P_j + b_2 E_j + b_3 GDP_j$$

Where F_i , G_j : future generation/attraction traffic volume

P_i , P_j : night-time population in zones i and j

E_i , E_j : economic active population in zones i and j

GDP_i , GDP_j : GDP in zones i and j

b) Goods traffic

To forecast goods generation/attraction traffic volume, Basic Unit Method was used, by which the ratio of generation/attraction volume to GDP by major commodity in each zone was obtained as follows:

$$F_i = U_i \cdot Q_i$$

$$G_j = U_j \cdot Q_j$$

Where F_i , G_j : future generation/attraction traffic volume

U_i , U_j : growth rate of GDP in zones i and j

Q_i , Q_j : current generation/attraction traffic volume

2) Control total

The following method was used to calculate the gross traffic

volume associated with the survey area as time series analysis of passenger/goods flows does not work for this purpose.

a) Passenger traffic

The gross traffic volume to be surveyed can be divided into: i) trips utilizing the modes of transport within the area, and ii) trips utilizing the modes of transport out of the area.

Since the study area is a considerably large urbanized area, it can be assumed that the majority of the gross traffic volume consists of the trips 1) above. Based on this assumption, Trip Production Method was used for the purpose of this forecast. Using riding habit, i.e., average annual trip frequency per capita of urban population, as basic unit and also taking growth rate of other index (GDP) into consideration, future values were calculated.

b) Goods traffic

It is impractical to estimate the gross traffic volume in goods transport indiscriminately as it involves various types of inter-area traffics with diverse characteristics. Therefore, Trip Generation Method was used. There, zonal trip generation volume is directly forecast by omitting the trip production phase. The method allows reflection of influence of a real characteristics the respective commodity groups.

3) Distributed traffic volume

a) Passenger traffic

A Gravity Model formula as shown below was assumed based on the current traffic distribution pattern. Future population estimate was added to this model to create a future distribution pattern. Using this pattern and Frater Model, future distributed traffic volume was calculated.

$$T_{ij} = K \frac{(G_i \cdot A_j)^{\alpha}}{R_{ij} \cdot \beta}$$

T_{ij} : traffic volume between zones i and j
G_i : traffic generation in zone i
A_j : traffic attraction in zone j
R_{ij} : center-to-center distance (traffic line)
K, α, β : parameters

b) Goods traffic

The future distributed traffic volume for goods transport was calculated using Frater Model established based on the current distribution pattern (as of 1986).

$$T_{ij} = t_{ij} \cdot F_i \cdot G_j \left(\frac{L_i + L_j}{2} \right)$$

$$F_i = \frac{P_i}{P_{oi}} \qquad G_j = \frac{A_j}{A_{oj}}$$

$$L_i = \frac{P_i}{\sum_{j=1}^{n} (tij \cdot G_j)} \qquad L_j = \frac{A_j}{\sum_{i=1}^{n} (tij \cdot F_i)}$$

Where, T_{ij} : future traffic volume between zones i and j
t_{ij} : current traffic volume between zones i and j
P_i : future traffic generation in zone i
P_{oi} : current traffic generation in zone i
A_j : future traffic attraction in zone j
A_{oj} : current traffic attraction in zone j

4) Modal split

a) Passenger traffic

Modal share of each mode has not significantly changed these several years. It was assumed therefore that the basic share of each mode will vary only according to passenger travel time

and fare. The following model formula was established:

$$S\alpha = \frac{EXP\ (f\ \alpha)}{EXP\ (f\alpha) + EXP\ (f\beta)}$$

Where, $S\alpha$: share of transport mode α

$f\alpha = \alpha \times (T\alpha_{ij} + C\alpha_{ij}/W + K\alpha_{ij})$

$f\beta = \beta \times (T\beta_{ij} + C\beta_{ij}/W + K\beta_{ij})$

$T\alpha_{ij}$, $T\beta_{ij}$: time required by modes α and β for transport between zone i and j

$C\alpha_{ij}$, $C\beta_{ij}$: cost required by modes α and β for transport between zone i and j

w : time value

$K\alpha_{ij}$, $K\beta_{ij}$: specific factor by respective mode α and β

α, β : parameters

(these parameters were calculated by multiple regression analysis.)

b) Goods traffic

Currently, bulk commodities account for 90% of the total goods traffic volume by railway. It is not realistic to consider that the railway mode will be replaced by road for this kind of commodities in predictable future. Railway mode is definitively more advantageous than road mode, as far as the land transport cost of these commodities is concerned.

For other goods, railway mode has been losing its share being replaced by road mode. However, in view of the general nature of the use of this forecast result, and in view of the Indian Railways' efforts modernize of goods transport, such as containerization and Yard-Pass system, it was assumed in this study that its share within the study area would practically remain unchanged in the future.

5) Distribution traffic volume

Railway passenger/goods traffic volumes between zones were distributed throughout its network. Each distribution traffic volume was calculated using All-or-Nothing Method.

2 - 3 - 2 Premises for Demand Forecast

(1) Railways

It was assumed that there would be no limitation in transport capacity. The current scheduled speed was determined at the average values calculated from the train operation schedules in the time table. Then, it was assumed that this scheduled speed would be improved in future for the following three lines : Delhi/New Delhi-Tundla, Delhi/New Delhi-Ambala and Delhi/New Delhi-Mathura. It was also assumed that the future ratio between the numbers of passenger and goods trains would not see a large fluctuation from the current one. As to the fares and rates, it was assumed that the level will be raised proportionally to GDP, while the charging system will be practically the same as at present.

(2) Roads

The road transport capacity, the operating frequency of buses and the traffic volume of trucks will be upgraded as the demand increases. The future road network is described in Chapter 2-1-3,(2),2), but, these expressways are mainly intended to eliminate road congestion in suburban area of Delhi. No definite inter-city expressways plans are being implemented. It was assumed therfore. that inter-city expressways would not be constructed. It was also assumed that the passenger fare/goods tariff systems would not see practical change compared with the present, but their levels would be raised propotional to GDP.

(3) Forecasting period

2009 is the end year of the forecast period. For interim years 1994, 1999 and 204, the growths were interpolated upon calculation.

2 - 3 - 3 Results of Demand Forecast

The result of traffic demand forecast are shown in Tables 2.3.2 through 2.36 and Fig. 2.3.4 through 2.3.7. It should be noted that these results have been obtained from the calculation based on some macro-models. And these models had been made for each line (not for each station), because they are the Master Plan use.

A separate detailed forecast study will be necessary to establish micro-models for estimating the passengers/goods handling volume at each individual station.

(1) Passenger traffic

Table 2.3.2 and Table 2.3.3 show the main passenger traffic flow in terms of passenger-kilometrage and number of passengers respectively. It can be seen from these tables that there will be a significant growth of passenger traffic in the directions Mathura and Calcutta.

Table 2.3.2 Passenger-km

(In Million Passenger-km/day)

Year \ For	MTJ	TDL	MB	MTC SRE	SMQL SRE	UMB	JHL	RE	Total
1986 ~ 1987	8.3	9.3	2.6	2.1	1.0	4.5	3.8	2.2	33.8
1999 ~ 2000	15.7	17.3	4.7	3.8	1.8	8.5	5.9	3.2	60.9
2009 ~ 2010	25.5	28.3	7.6	6.3	3.0	13.8	9.5	5.3	99.3

Table 2.3.3 Railway Passengers Flow at Main Sections

(In Thousand Passengers/day)

Year	For	MTJ	TDL	MB	MTC SRE	SMQL SRE	UMB	JHL	RE
1986 ~ 1987	Inward	37.6	23.0	9.9	9.9	6.5	18.3	15.5	14.2
	Outward	37.6	23.0	9.9	9.9	6.5	18.3	15.5	14.2
1999 ~ 2000	Inward	67.8	44.2	16.2	16.4	10.0	34.0	22.3	21.3
	Outward	67.8	44.2	16.2	16.4	10.0	34.0	22.3	21.3
2009 ~ 2010	Inward	110.7	72.1	27.0	27.3	16.7	55.1	36.3	34.6
	Outward	110.7	72.1	27.0	27.3	16.7	55.1	36.3	34.6

(2) Goods traffic

Table 2.3.4 and Table 2.3.5 show the main goods traffic flows in terms of ton-kilometrage and tonnage respectively. It is observed that there will be a significant growth of goods traffic, again, in directions Mathura and Calcutta. Coal and POL are their main commodities, indicating that bulk commodities will still depend on railway mode two decades later (2009).

A marked growth of other goods by railway transportation is also noted, which will necessarily require the containerization.

(3) Parcel traffic

A progressive transfer of railway parcels to road transport is anticipated, and a relatively low growth is forecast.

90% of the total parcels originating in Delhi area will be handled at Delhi and New Delhi stations. Their containerization is a must.

Table 2.3.4 Tonne-km

(In Million Tonne-km/day)

Year \ For	MTJ	TDL	MB	MTC SRE	SMQL SRE	UMB	JHL	RE	Total
1986 ⟩ 1987	8.0	13.0	0.5	2.8	0.8	4.2	3.3	0.7	33.3
1999 ⟩ 2000	18.3	30.6	1.2	6.3	1.5	9.5	7.1	1.6	76.1
2009 ⟩ 2010	27.6	45.9	1.8	9.5	2.2	14.3	10.6	2.5	114.4

Table 2.3.5 Railway Goods Flow at Main Sections

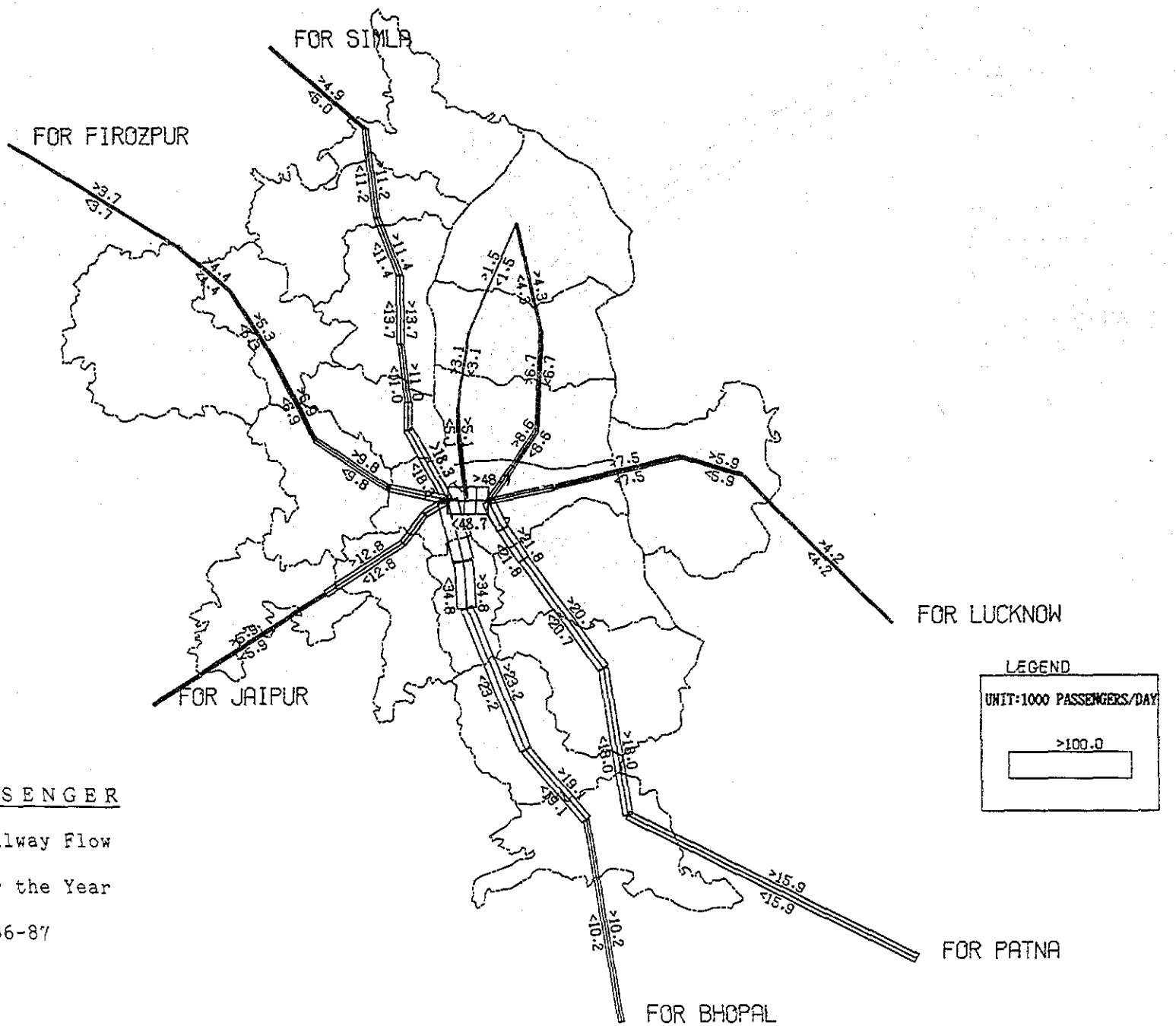
(In Thousand Tonnes/day)

Year	For	MTJ	TDL	MB	MTC SRE	SMQL SRE	UMB	JHL	RE
1986 ⟩ 1987	Inward	38.0	44.5	1.3	9.2	4.2	7.7	8.8	6.1
	Outward	16.0	19.2	2.7	11.1	0.8	16.0	8.8	2.4
1999 ⟩ 2000	Inward	93.8	116.3	2.4	16.1	7.2	13.4	15.3	14.4
	Outward	30.0	33.9	6.3	28.1	1.9	40.7	22.8	5.5
2009 ⟩ 2010	Inward	141.8	173.6	3.8	24.3	10.7	19.9	22.7	22.0
	Outward	44.7	51.3	9.6	42.3	2.9	61.2	34.2	8.4

Table 2.3.6 Delhi Area Parcel Traffic (Outward)

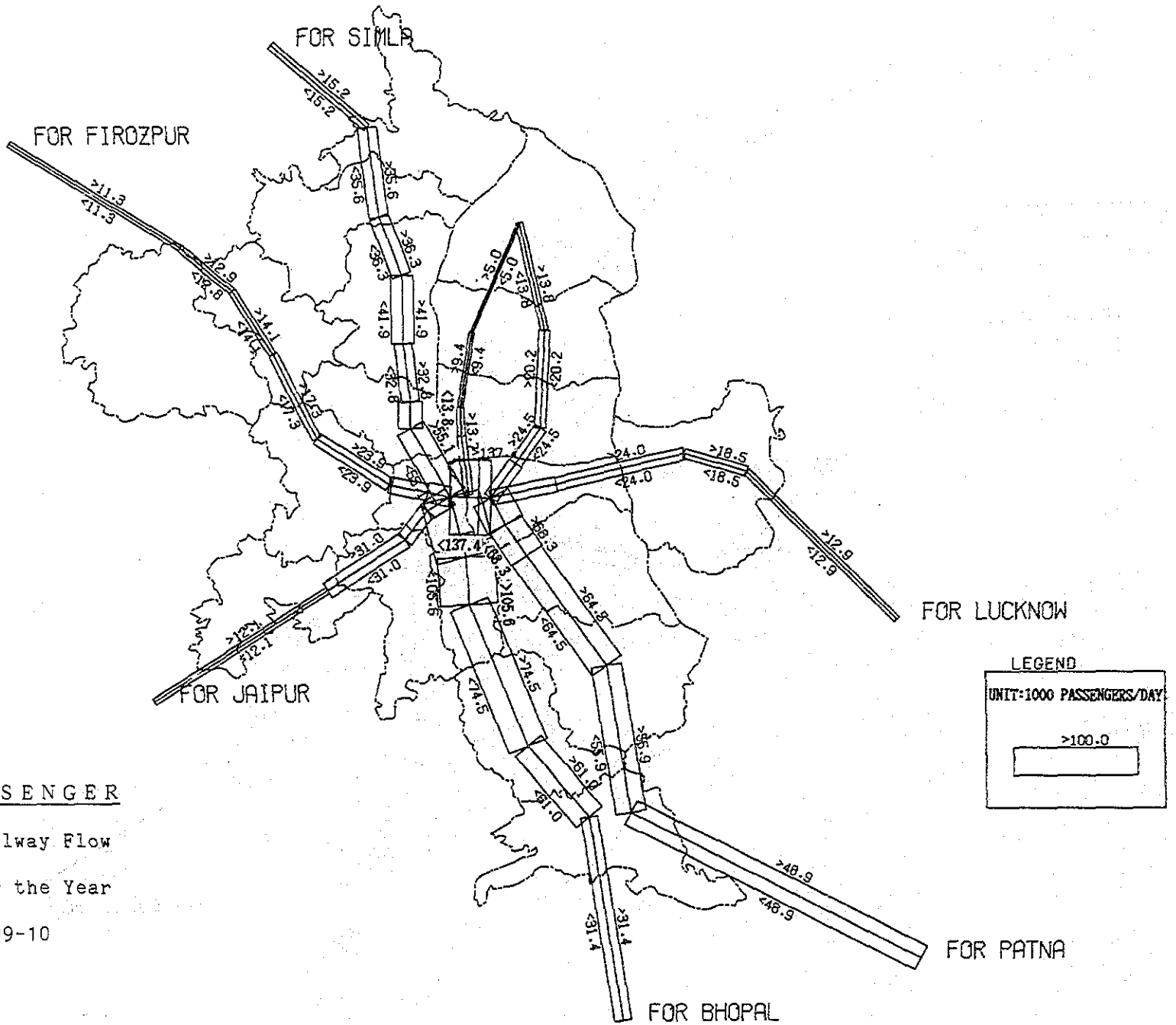
(In Quintals)

Name of Station	1987～1988	1994～1995	1999～2000	2004～2005	2009～2010
Shakurbasti	9	10.7	12.1	12.9	13.7
Delhi Kishanganj	45	53.5	60.5	64.4	68.5
New Delhi	2,597	3,087.8	3,493.0	3,716.3	3,955.2
Delhi	4,914	5,842.7	6,609.3	7,031.9	7,484.0
Subzimandi	51	60.6	68.6	73.0	77.7
Delhi Shahdara	245	291.3	329.5	350.6	373.1
Sahibabad	7	8.3	9.4	10.0	10.7
Ghaziabad	49	58.3	65.9	70.1	74.6
Hazrat Nizamuddin	295	350.8	396.8	422.1	449.3
Tuglakabad	1	1.2	1.3	1.4	1.5
Naya Azadpur	4	4.8	5.4	5.7	6.1
Total (Growth Ratio)	8,217	9,770.0 (1.189)	11,051.8 (1.345)	11,758.4 (1.431)	12,514.4 (1.523)



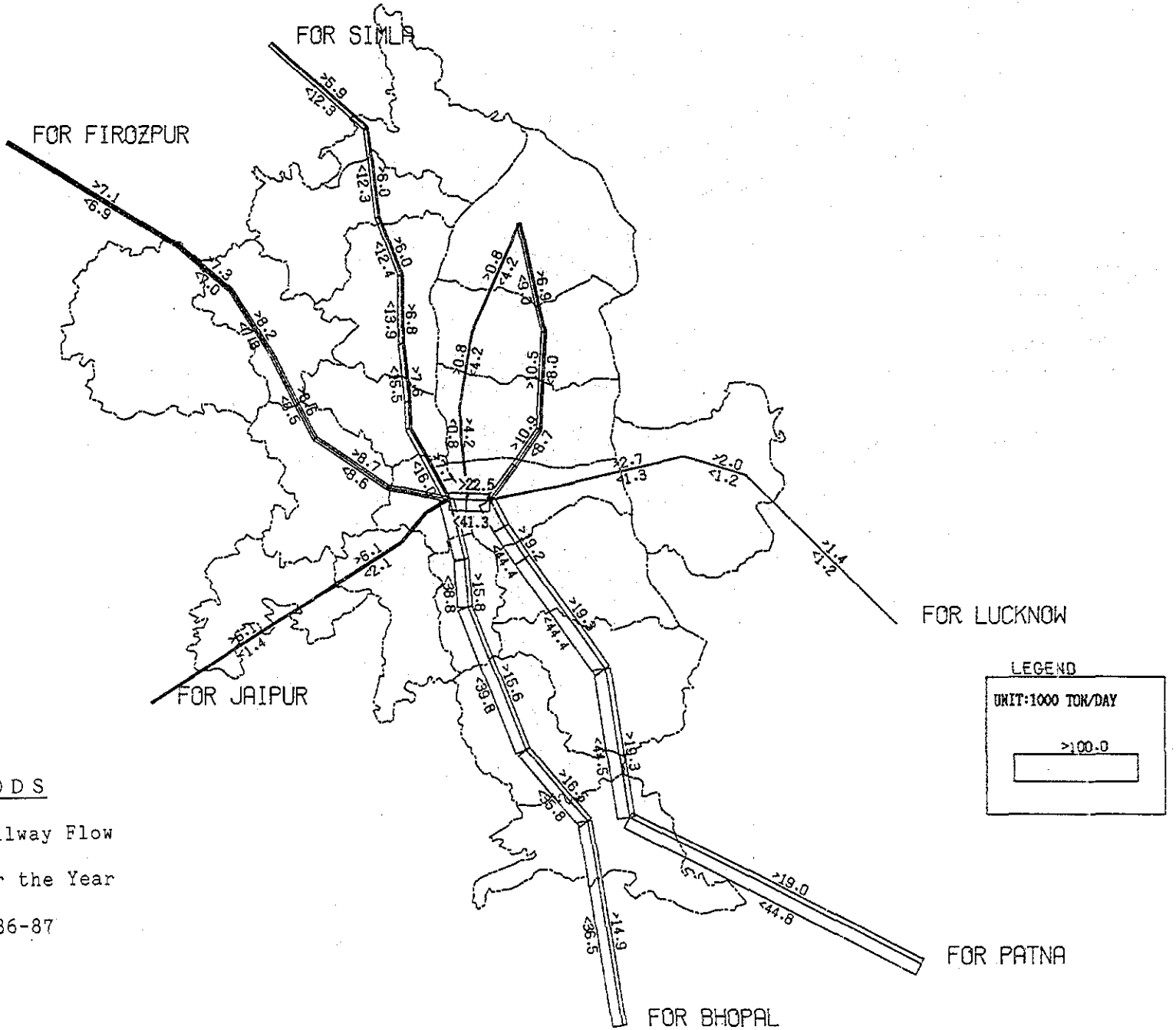
PASSENGER

Fig. 2.3.4 Railway Flow for the Year 1986-87



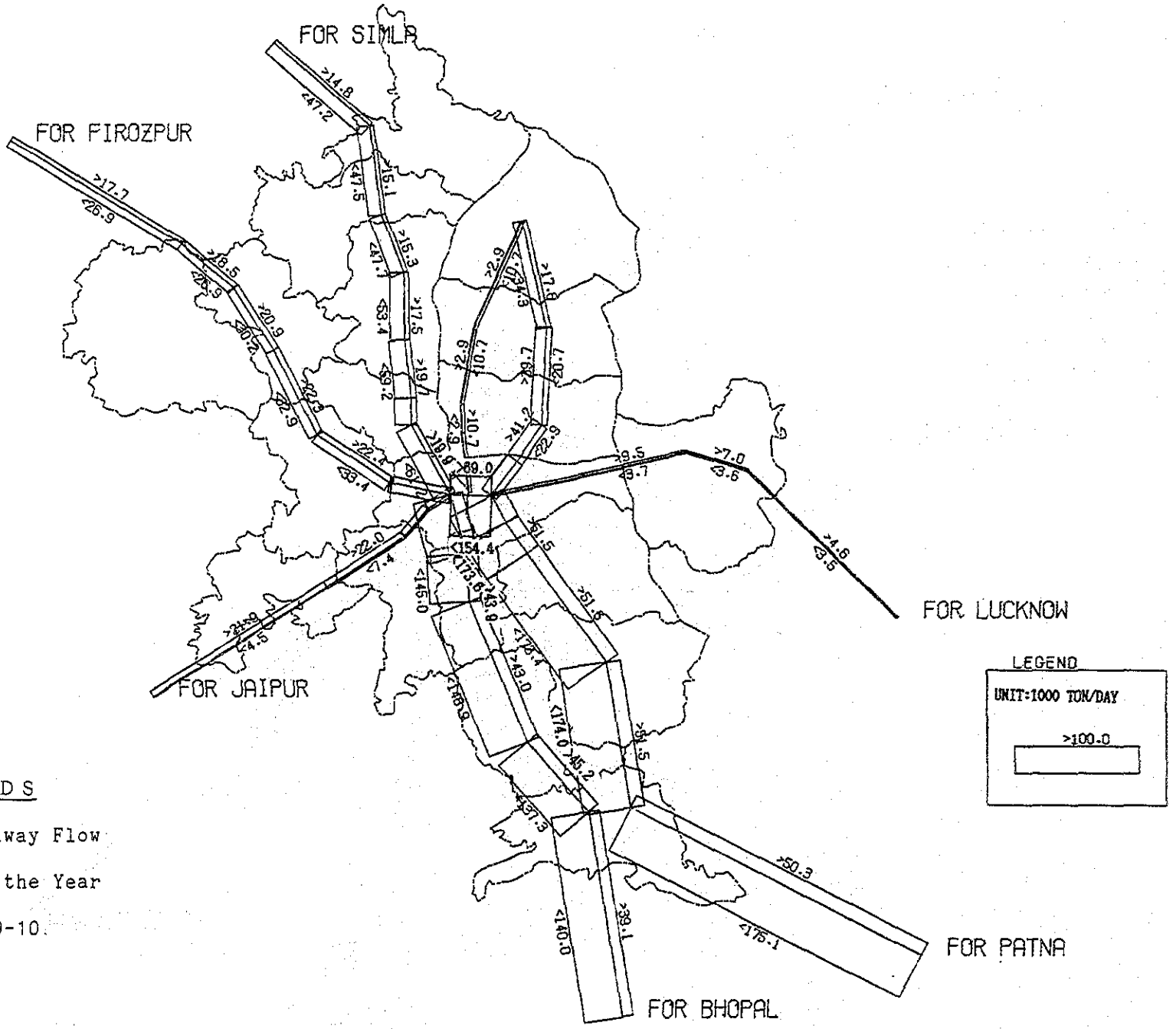
PASSENGER

Fig. 2.3.5 Railway Flow for the Year 2009-10



GOODS

Fig. 2.3.6 Railway Flow for the Year 1986-87



GOODS

Fig. 2.3.7 Railway Flow for the Year 2009-10.

2 - 4 Planned Traffic Volume

Fig(s). 2.4.1 and 2.4.2 show the estimated railway passenger and goods traffic demand. It, however, will not be unrealistic to plan such traffic, because the track capacity is limited at present.
Considering the traffic demand and the transport capacity of the relevant railways sections, a realistic traffic was planned and shown in Fig(s). 2.4.3 and 2.4.4.

(1) Case "With the Project"

The planned traffic volume will be temporarily short of demand in 1995. But, as a whole, it could be commensurate with the passenger and goods demand up to 2004.

After 2005, however, large part of the demand will gradually have to divert to other transport modes.

(2) Case "Without the Project"

After 1991, the transport capacity will become a limiting factor and no traffic increase can be expected.

The shortage of the transport capacity will be estimated 21.6 million passenger-km/day for passenger demand and 29.2 million tonne-km/day for goods demand in 2005.

Note: The case "With the Project" is the case where the New Delhi Station is modernized and the related sections within 200 km radius circle connected with the Delhi Area are improved.
The case "Without the Project" is the case where no such railway improvement would be made.
(Refer to Chapter 7 "Economic Analysis")

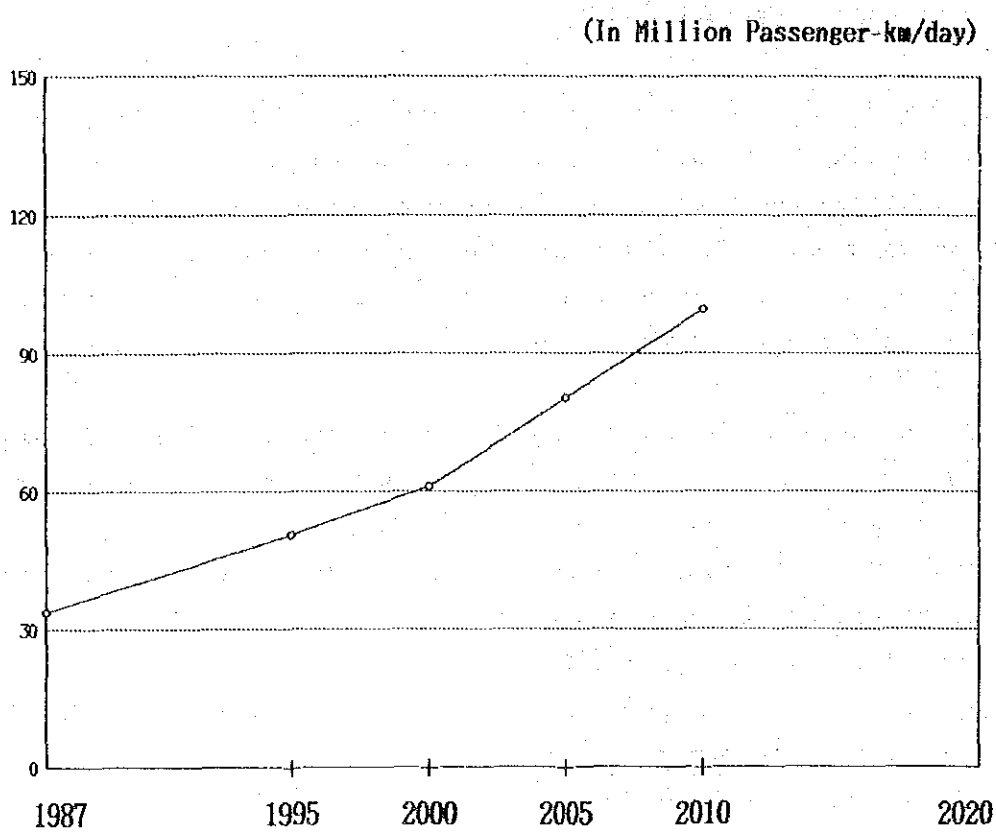


Fig. 2.4.1 Estimated Railway Passenger Traffic Demand

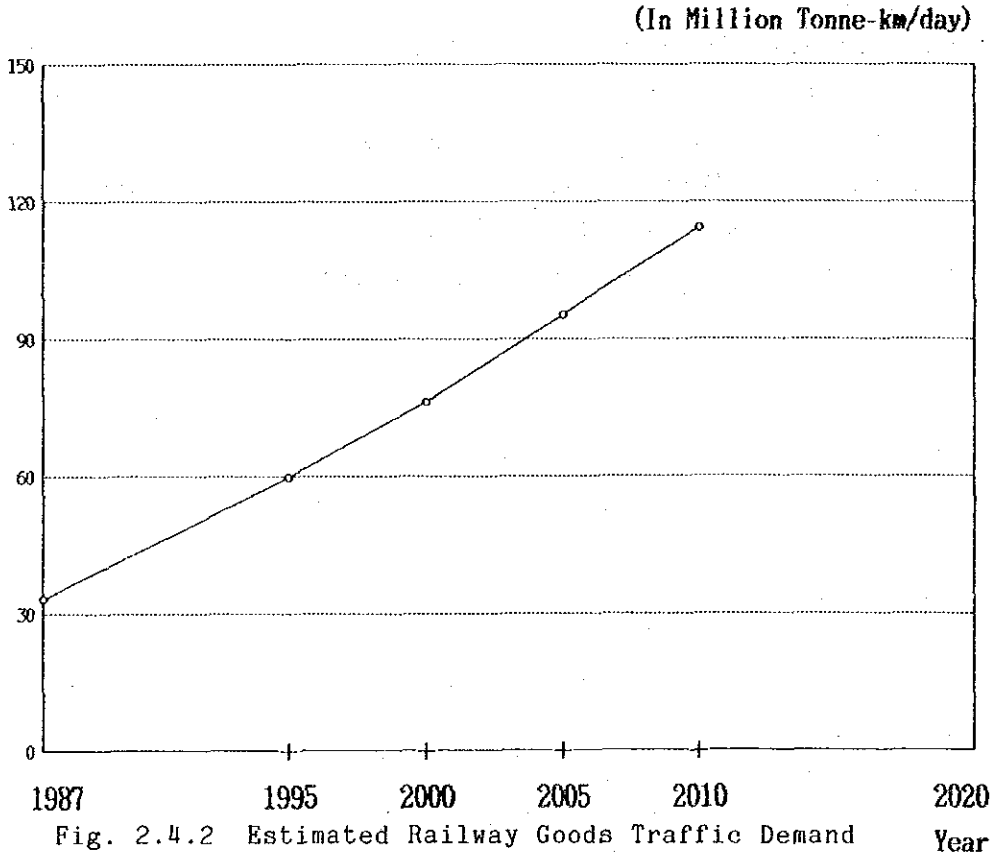


Fig. 2.4.2 Estimated Railway Goods Traffic Demand

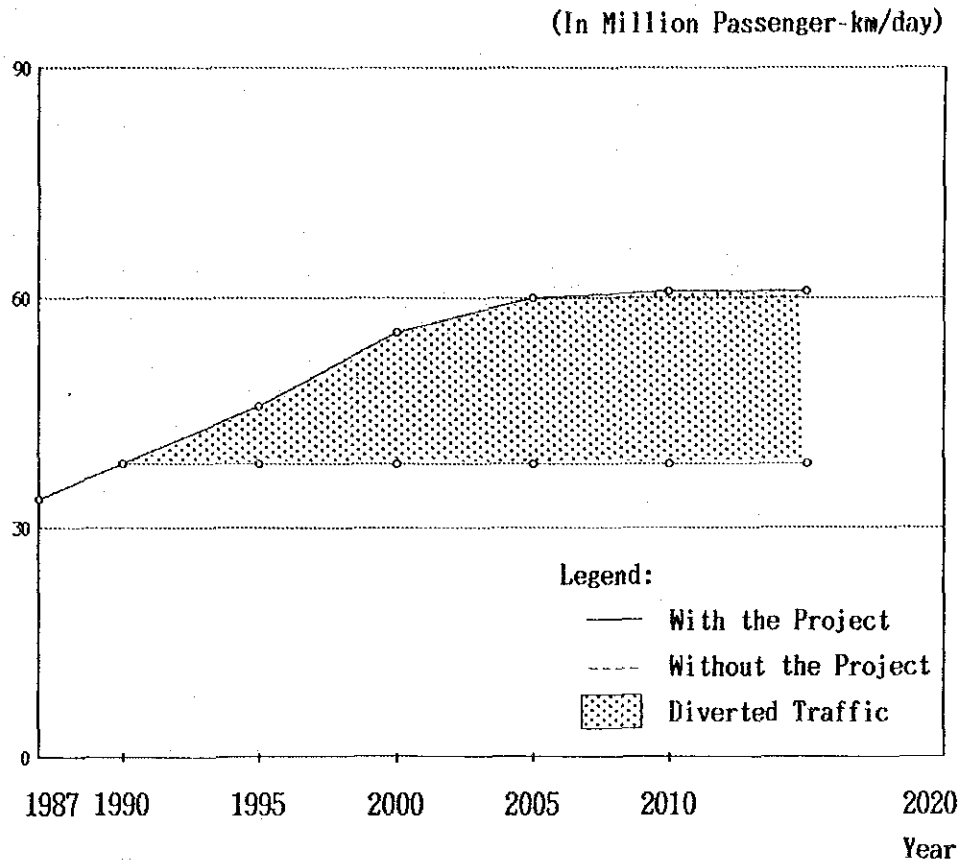


Fig. 2.4.3 Planned Railway Passenger Traffic Volume

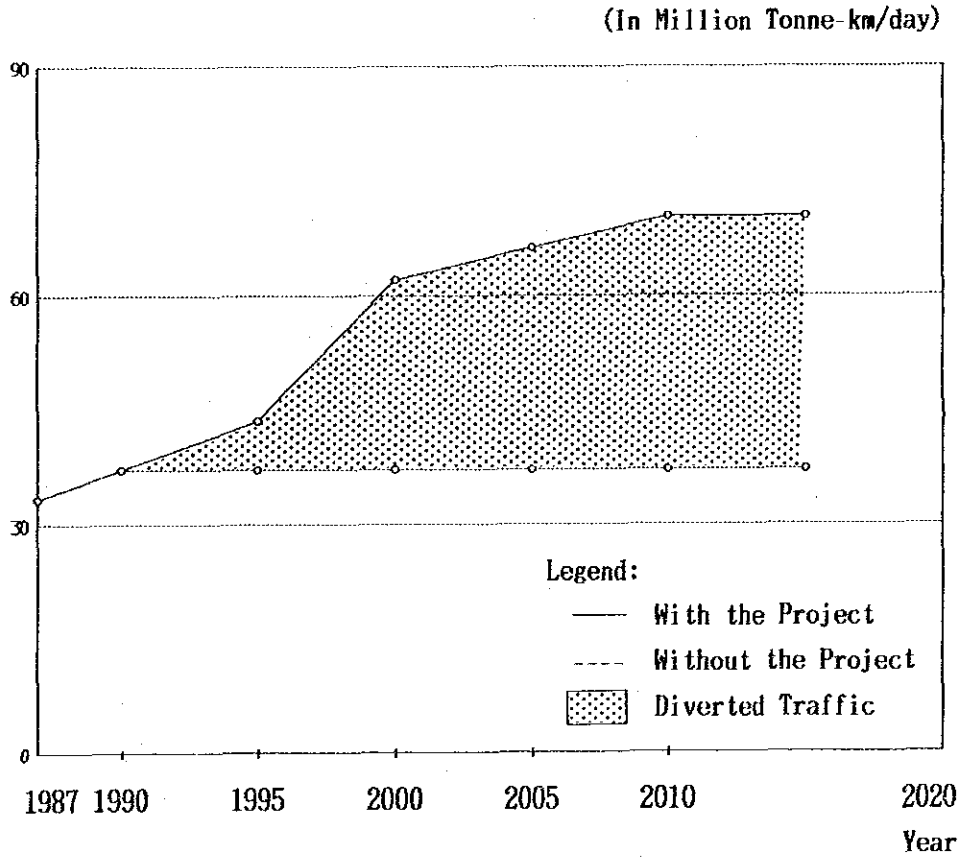


Fig. 2.4.4 Planned Railway Goods Traffic Volume

CHAPTER 3 BASIC TRANSPORTATION PLANNING

CHAPTER 3 BASIC TRANSPORTATION PLANNING

3 - 0 Aims

This chapter aims to clarify three things:

(1) How many trains can be operated in the 200 km radius area around New Delhi (outer area), and ultimately, how many of them can be operated in the Delhi area (inner area), each in the years from present up to 2010?

(2) How many of trains can be treated at Delhi Main and New Delhi, especially at New Delhi after its improvement? and

(3) How many trains of what directions will overflow the improved New Delhi and what should be planned to deal with them, in a later period of the Project?

In working out answers to these questions, the number of operable trains is counted considering the line capacity of the network involved in (1) and, considering the terminal capacity in (2) above. These capacities are evaluated at the improved level of the Action Plan and of the additional plans proposed by the Team for the earlier period of the Project. In working out answers to the question (3) above, the number of operable trains is counted, presupposing that a New Delhi avoiding line would be constructed and track quadrupling of the involved sections could be made, thus, the line capacity being drastically upgraded (See 3-1).

3 - 1 Transportation Planning Policy

The planning term is divided into two periods: the Earlier Period (from now to 1999-2000), and the Later Period (from 1999-2000 to 2009-2010).

(1) Earlier Period (1989-2000)

For this period, the train operation is planned according to the line capacity level which will be improved by:

1) Action Plan of the Northern Railway covering the years up to 1994-95, and

2) Additional plans of the Team (See Chapter 4) covering the years up to 1999-2000.

The Team limited itself to those plans for improvements whose cost-effectiveness can be ascertained within the area of 200 km radius around New Delhi. They are the track additions in some single line sections, the automatization of signals in busiest sections and the grade separation of a few surface crossings etc., all intended to pinpointedly eliminate the bottlenecks envisaged in the trains operation for years up to 2000.

(2) Later Period (2000-2010)

For this period, where the traffic is estimated to continuously increase, the train operation is planned presupposing that the line capacity would be drastically upgraded. This upgrading will include the quadrupling of tracks in the outer circles, the construction of a new route avoiding Delhi area and the construction of some satellite terminals in the periphery of the inner circle.

Even a larger investment will have to be concurrently made in the areas exterior to the 200 kilometre radius circle, to enable the operation of the required number of trains matching with those within the circle. But no verification was possible in this study, no alternatives could be studied. The plans for the Later Period are therefore conceptual.

3 - 2 Preconditions for Transportation Planning

3 - 2 - 1 Network

In order to best estimate the number of trains to be operated in Delhi area, and to best determine the roles of terminals in it, a Master Plan which covers a larger area must be set up. Supposing that Delhi area is an inner circle, the Master Plan delineates another circle exterior to it (outer circle) of an approximately 200 km radius with its centre at New Delhi, and estimates the number of trains in future within this outer circle. Then the number of trains operated in the inner circle i.e., the Delhi area is estimated. It consists of trains getting into/coming out of Delhi area from/to the outer circle.
The term "related lines" or "related sections" in this and subsequent chapters signifies the lines or sections existing in the outer circle.

3 - 2 - 2 Line Capacity, Required Number of Trains and Required Formations of a Train

(1) Line Capacity

In conformity with the Indian Railways' plans, the line capacity of the related lines are estimated in this study identifying them in principle with the Northern Railway's "Line Capacity and Utilization (1986-87)" and the "Action Plan (1994-95)".
In formulating the Master Plan, the number of trains operable of a line or of a section is assumed as shown below. In determining the number, the actual results of operation in Indian Railways are taken into account.

1) In a double tracked section ;
   a. When the signalling system is Automatic Block System : 75 ~ 100 trains/day
   b. When the signalling system is Tokenless System : 40 ~ 45 trains/day.

2) In a single tracked section ;

a. Automatic Block System : 22 trains/day

b. Tokenless System : 22 trains/day

c. Tablet System : 20 trains/day

(2) Future Line Capacity

The transportation improvement of the related sections was planned according to their future line capacity. The future line capacity was estimated at the improved status. Some of them are already envisaged in the Action Plan. Others were newly planned by the Team. (The contents of the Team's Plan of improvements will be described in Chapter 4).

The resultant transportation improvement plans are shown below.

1) Delhi area

Section	Charted line capacity	Planned line capacity	Year	Improvement items
◎ B.G	.			
NDLS-TKJ	96	100	94-95	
		150	94-95	Track quadrupling at the entrance of New Delhi
TKJ-SBB	45	75	94-95	
		150	99-00	Track quadrupling, grade separation
SBB-GZB	90	180	94-95	Track quadrupling (1989)
DLI-SBB	75	75	94-95	
(A)Panel-	10	10	94-95	
(B)Panel		45	99-00	grade separation (track doubling)
TKJ-NZM	67	70	94-95	
(M/L)		10	94-95	New construction of passage line
		(80)		
NZM=TKD	57	60	94-95	

(M/L)		75	94-95	
TKJ-NZM	40	40	94-95	
(GAL)		75	99-00	Track quadrupling of TKJ-SBB, grade separation
NZM-OKA	35	45	94-95	
(GAL)		75	99-00	
OKA-TKD	40	55	94-95	
(DAL/GAl)		75	94-95	Improvement (See Chap. 4)
NZM-LPNR	25	25	94-95	
		45	94-95	Improvement (See Chap. 4)
OKA-LPNR	25	45	94-95	Improvement of turnouts
LPNR-PTNR	50	75	94-95	
PTNR-DBSI	38	40	94-95	
PTNR-Rampura	30	35	94-95	
		75	94-95	Grade separation at Rampura
SSB-Rampura	38	55	94-95	
		75	94-95	Grade separation at Rampura
Rampura-DBSI	38	45	94-95	
		75	94-95	Grade separation at Rampura
{SI-DKZ	38	45	94-95	
		75	94-95	Grade separation at Rampura
NDAZ-Rampura	15	22	94-95	
		45	94-95	Track doubling, grade separation at Rampura
		75	04-05	Automatic Block
DLI-SZM	15	15	94-95	
DLI-DKZ	26	26	94-95	
NDLS-SZM	12	12	94-95	
NDLS-DKZ	20	20	94-95	
(M/L)				
NDLS-DKZ	8	12	94-95	

◎ M・G

DE -DEE	33	35	94-95	
		75	99-00	Eliminate surface crossing of B.G.Tracks
DEE-GHH	33	35	94-95	
		75	99-00	Automatic Block
CHH-KIP	27	35	94-95	Track doubling (1991)
		75	99-00	Automatic Block
KPI- RE	33	35	94-95	
		75	99-00	Automatic Block

2) Related sections

GZB-TDL	49	64	94-95	Improvement (See Chap. 4)
		100	99-00	Improvement (DLI-CNB) (See Chap. 4)
GZB-KRJ		122	09-10	Track tripling
KRJ-TDL		150	09-10	Track quadrupling
GZB-HPU	22	22	94-95	
		45	09-10	Track doubling
HPU-GJL	22	22	94-95	
GJL- MB	20	22	94-95	
		—		
GZB-MUD	37	37	94-95	
		—		
MUD-MTC	27	27	94-95	
(UP)		45	04-05	Track doubling
MUD-MTC	19	19	94-95	
(DN)		45	04-05	Track doubling
MTC-TPZ	27	27	94-95	
(UP)		—		
MTC-TPZ	19	19	94-95	
(DN)		—		
TPZ-SRE	37	37	94-95	

DSA-TPZ	9	9	94-95	
(UP)		—		
DSA-TPZ	22	22	94-95	
(DN)		—		
NDAZ-	37	45	94-95	
BZK		75	99-00	Automatic Block
BZK-				
KKDE	20	45	94-95	Track doubling (1989)
		75	99-00	Automatic Block
KKDE-				
SHDM	21	45	94-95	Track doubling (1989)
		75	99-00	Automatic Block
SHDM-				
UMB	33	45	94-95	
		75	99-00	Automatic Block
SSB-ROK	38	45	94-95	
		75	04-05	Automatic Block
ROK-JHI	22	23	94-95	
		45	99-00	Track doubling
JHI-NRN	22	23	94-95	
		45	99-00	Track doubling
NRW-JHL	21	23	94-95	
		45	99-00	Track doubling
TKD-PWL	54	62	94-95	
		150	09-10	Track quadrupling
PWL-MTJ	54	54	94-95	
		75	99-00	Automatic Block
		150	09-10	Quadrupling

(3) Required Number of Trains and Required Train Consist

Required Number of Trains can be obtained by the formula:A/B,

where : A=Sectional traffic volume (persons/day)

as given by the traffic prediction. The prediction regards the principal sections of the related lines.

B=Number of persons which can be carried by a train.

This formula is applied, however, for the years after 1994-95 (Ref. subsequent (4)).

Note.1 The number of "light engines" and "departmentals" are assumed to stay at the same level as their actual numbers (1987-88).

Note.2 When the required number of trains exceeds the line capacity (as identified in the (1) above), the excess is ignored and the number of trains to be operated is determined within the line capacity.

(4) "Working Time Table (Nov.1, 1988)" and "Action Plan"

In determining the number of trains to be operated and the number of cars in a train-consist, the "Working Time Table (Nov.1, 1988)" and "Action Plan" of the Northern Railway are respected up to 1994-95. Therefore, the A/B formula is applied for years after 1994/95.

1) Passenger trains

a. Long Express trains (operable at 160 kph)

It was assumed that a Long Express train consists of 22 cars and a train load is 1,380 persons. When the predicted traffic of a train does not suffice 1,380 persons, it is planned to carry them by a Mail/Express train.

b. Mail/Express trains

It is assumed that, up to 1994-95, the number of a Mail/Express trains to be operated and the number of cars of one train would be as described in the Working Time Table (Nov. 1, 1988), and would be as planned in the Action Plan. After 1994-95, they are increased according to the predicted traffic demand considering the line capacity of the section concerned.

c. Local Passenger trains

It is assumed that up to 1994-95, the number of Local Passenger trains to be operated would be as planned in the Working Time Table (Nov.1, 1988), and would be increased as planned in the Action Plan. As to the number of cars of one train, it is increased appropriately up to 1994-95, within the framework of 18 to 22 cars as envisaged in the Action Plan. After 1994-95, the number of trains to be operated and the number of cars of one train are increased in accordance with the line capacity and the traffic demand of the sections concerned.

2) Goods trains

The required number of trains is obtained by formula: C/D.

Where:C=the predicted traffic volume (tons/day)

D=Tons carried by a goods train, which was estimated from the "Density Chart" (Northern Railway 1986-87).

3) Other trains

The number of "light engines" and "departmentals" are assumed to stay at their actual numbers in 1987-88.

3 - 3 Transportation Planning (Earlier Period)

Based on the preconditions given in the preceding paragraph 3-2, a transportation planning is made for each of the section of the related lines . For this purpose it is necessary to make clear the difference in numbers of the trains, between those operable and those required. The numbers of trains operable are given section-wise in Appendix 3-6. In the subsequent 3-3-2, the numbers of trains required to be operated to meet the demand are given also section-wise. They are modified realistically according to the planning needs.

3 - 3 - 1 Planning Policy

The transportation plan for each section of the related lines was formulated based on a philosophy described as below:

(1) The required number of trains for each section is calculated according to the predicted traffic demand. The result is considered as the number of trains to be operated in the section.

(2) But, in and after the year when the calculated result exceeds the number of trains operable restricted by the line capacity of the relevant section, the excess is ignored and the said number of trains operable is considered as the number of trains to be operarated in the section.

(3) Within Delhi area (inner circle), there are seven short sections around Delhi and New Delhi. The number of trains to be operated in these sections is determined in conjunction with those of the relevant sections in the outer circle. If in the outer circle the trains cannot be increased because of their line capacity, the train increase in the inner circle will not prove effective, even if it is possible within there. The same applies in the reverse case.

Therefore it is assumed that the line capacity of the sections in the outer circle would restrict the number of trains operable in the inner circle sections and vice versa.

The transportation plan for each section of the related lines are given hereunder:

Abbreviations:

○ "Requirement/Operability"

"Requirement" here means the required number of trains in the section to meet the predicted trafic demand. "Operability", the number of trains operable considering the line capacity

of the section.

- "Status"
  The role the section plays in the railway transportation, and the status of the installations, line capacity, etc.
- "Existing Plans"
  Indian Railway's plans for improving the section, which are authorized and/or on-going.
- "Evaluation"
  The Team's view on the future traffic capacity of the section.

3 - 3 - 2 Number of Train Required and Planned

3 - 3 - 2 - 1 Section: Ghaziabad-Tundla

(1) Requirement and Operability

See Table 3.3.2-1

Note :

" P " Number of passenger trains

" G " Number of goods trains

" M " Number of "light engines" or "departmental"

" T " Total number of trains

"Req." Number of trains required to be operated in view of the predicted traffic demand.

"Pln." Number of trains planned to be operated with the existing infrastructure or with the improved infrastructure planned by Indian Railway.

Figures show the number of trains per day, one direction. As to the goods trains, comparing the up-trains and down-trains, the larger number is given.

Figures in parentheses denote the number of trains operable within the line capacity.

Table 3.3.2-1 Secton : Ghaziabad-Tundla

Year	Station	GZB		DER		DKDE		ALJN		TDL
	Train	Req	Pln	Req	Pln	Req	Pln	Req	Pln	
1988-	P		21		21		20		21	
Nov	G		24		24		24		24	
	M		2		2		2		2	
	T		47		47		46		47	
1994-	P	28	26	28	26	26	24	23	24	
1995	G	48	36	48	36	48	36	48	36	
	M	2	2	2	2	2	2	2	2	
	T	79	64	78	64	76	62	73	62	
1999-	P	36	36	34	34	32	32	28	28	
2000	G	62	62	62	62	62	62	62	62	
	M	2	2	2	2	2	2	2	2	
	T	100	100	98	98	96	96	92	92	
2004-	P	47		44		41		36		
2005	G	78		78		78		78		
	M	2		2		2		2		
	T	127		124		121		116		
2009-	P	59		56		52		46		
2010	G	93		93		93		93		
	M	2		2		2		2		
	T	154		151		147		141		
1988- NOV.		<49>		<49>		<51>		<54>		
1994- 95		<64>		<64>		<64>		<64>		
1999-2000		<100>		<100>		<100>		<100>		

Note : 1. Figures in parentheses < > show Line Capacity.

2. Figures in square [ ] denote the maximum number of trains operable restricted by the line capacity of the section in a certain year. The number of trains to be operated in the same section in the subsequent years will therefore stay at the same figure, their description is omitted.

(2) Status

This section forms a main railway connection between Delhi area and Calcutta. The whole section is double-tracked and electrified. The line capacity is 50 trains a day, and in fact, there are about 50 trains operated in the section.

(3) Existing Plan

The line capacity is planned to be improved from 50 to 64 in 1994-95. (Action Plan:)

—— Mail/Express

2 trains are planned to increase their days of operation. Regarding the train-consist, 3 trains are planned to be lengthened to 26 cars and 6 trains, to 22. One more train between Delhi area and Calcutta will be added to the present schedule. These improvements will increase by 35% the passenger transport capacity in terms of average number of passengers carried per day.

—— Local Passenger

Two more trains and one more loco-hauled train are planned to be added to the present schedule between Delhi area and Aligarh (130 km from Delhi), 6 more trains between Delhi area to Ghaziabad (20 km from Delhi). 3 loco-hauled passenger trains are planned to be replaced by EMU trains.

(4) Evaluation

From the viewpoint of goods transport, the predicted traffic demand cannot be met with in 1994-95 even if the line capacity is augmented from 50 to 64. Early improvement of it to 100 is required. When it is improved to 100, the predicted traffic demand can be satisfied up to 1999-2000.

Without this line capacity improvement, the number of trains capable of being added to the present schedule will be, between Ghaziabad and Dadri, 10 Mail/Expresses (including one Long Express), 5 Local Passenger trains and 38 goods trains, each approximately.

3 - 3 - 2 - 2 Section: Ghaziabad-Moradabad

(1) Requirement and Operability

See Table 3.3.2-2.

(2) Status

This section is single-tracked, not electrified, the line capacity is 22 trains a day, and 14 trains are operated.

(3) Existing Plans

According to the Action Plan, 4 of the present 6 Mail/Expresses will be lengthened in train formation (one train to 26 car-, 3 trains to 22 car-consist).

(4) Evaluation

The predicted traffic demand will exceed the line capacity in 1999-2000, even if the train formation is lengthened.

The number of trains capable of being added to the present schedule will be 3 Mail/Expresses, and one Local Passenger train.

Table 3.3.2-2 Section : Ghaziabad-Moradabad

Year	Station	GZB		HPU		GJL		AMRO		MB	
	Train	Req	Pln	Req	Pln	Req	Pln	Req	Pln		
1988-NOV	P		11		11		11		11		
	G		3		3		3		3		
	M		-		-		-		-		
	T		14		14		14		14		
1994-1995	P	16	11	10	11	9	11	9	11		
	G	5	5	5	5	4	4	4	4		
	M	-	-	-	-	-	-	-	-		
	T	21	16	15	16	13	15	13	15		
1999-2000	P	17	15	12	14	10	14	10	14		
	G	7	7	6	6	5	5	5	5		
	M	-	-	-	-	-	-	-	-		
	T	24	22	18	20	15	19	15	19		
2004-2005	P	25		15		12		12			
	G	8		8		6		6			
	M	-	-	-	-	-	-	-	-		
	T	33		23		18		18			
2009-2010	P	31		19		15		15			
	G	10		10		8		8			
	M	-	-	-	-	-	-	-	-		
	T	41		29		23		23			
1988-NOV		<22>		<22>		<20>		<22>			
1994-1995		<22>		<22>		<22>		<22>			

3 - 3 - 2 - 3 Seotion: Ghaziabad - Saharanpur

(1) Requirement and Operability

See Table 3.3.2-3.

(2) Status

This section is single-tracked, except at the subsection Ghaziabad - Murad Nagar(38 km) and at Tapri-Saharanpur (7 km) where they are double-tracked. The section is non-electrified.

The line capacity is 37 trains a day at double-tracked sections. At the single-tracked section, it is 27 up-trains and 19 down-trains. In fact, there are 24 up-trains and 19 down-trains operated. There remains only little room in the line capacity at the single-tracked section.

(3) Existing Plans

Action plan envisages that 2 of the present 6 Mail/Expresses will be lengthened in train formation (one train to 26 car-, another to 22 car-consist), 2 Local Passenger trains will be added to the present schedule, between Delhi area and Meerut City (90 km from Delhi).

(4) Evaluation

The traffic demand will reach the line capacity in 1994-95, even if additional cars are coupled to the trains. The trains which can be added to the present schedule are 2 Local Passenger trains.

Table 3.3.2-3 Section : Ghaziabad-Saharanpur

Year	Station	GZB		MDNR		MTC		MOZ		SRE	
	Train	Req	Pln	Req	Pln	Req	Pln	Req	Pln	Req	Pln
1988-	P		11		11		11		11		11
NOV	G		12		11		11		11		10
	M		2		2		3		2		2
	T		25		24		25		23		
1994-	P	13	13	13	13	11	11	7	11		
1995	G	23	12	23	12	22	12	21	11		
	M	2	2	2	2	3	3	2	2		
	T	38	27	38	27	36	26	30	24		
1999-	P	15		15		13		8			
2000	G	29		29		29		29			
	M	2		2		3		2			
	T	46		46		44		38			
2004-	P	22		20		16		10			
2005	G	37		37		36		34			
	M	2		2		3		2			
	T	61		59		55		46			
2009-	P	26		24		20		14			
2010	G	44		45		43		41			
	M	2		2		3		2			
	T	72		71		66		57			
1988-NOV		<UP37, DN37>		<UP27, DN19>		<UP27, DN19>		<UP27, DN19>			

3 - 3 - 2 - 4 Section: Delhi Shahdara — Shamli — Saharanpur

(1) Requirement and Operability

See Table 3.3.2-4.

(2) Status

This section is single-tracked except at the subsection Tapri Saharanpur (7 km) where it is double-tracked, non electrified.The line capacity is 9 up-trains and 22 down-trains a day. Actually, there are 9 up-trains and 17 down-trains operated.

(3) Existing Plans

No mention is made in the Action Plan to increasing of Mail/Expresses (one per day at present) or Local Passenger service (6 at preset).

(4) Evaluation

For the time being, it will be able to cope with the increase in demand, by lengthening the train consist, as the present formation is 10 to 12 cars per train, and there is still room for making them longer.

Table 3.3.2-4 Section : Delhi Shahdara-Shamli-Saharanpur

Year	Station	DSA		BPM		SMQL		SRE	TPZ	SRE
	Train	Req	Pln	Req	Pln	Req	Pln		Req	Pln
1988-	P		7		7		7			17
NOV	G		9		8		6			13
	M		1		1		1			3
	T		17		16		14			33
1994-	P	8	7	8	7	3	7		10	17
1995	G	13	13	12	8	9	9		22	16
	M	1	1	1	1	1	1		3	3
	T	22	21	21	16	13	17		35	36
1999-	P	9	8	8	8	3	8		11	17
2000	G	16	13	15	8	11	9		29	16
	M	1	1	1	1	1	1		3	3
	T	26	22	24	17	15	18		43	36
2004-	P	12		10		4			14	
2005	G	20		18		13			36	
	M	1		1		1			3	
	T	33		29		18			53	
2009-	P	15		13		5			19	
2010	G	24		22		16			43	
	M	1		1		1			3	
	T	40		36		22			65	
1988-NOV		<UP9, DN22>		<UP9, DN22>		<UP9, DN22>			<37>	

3 - 3 - 2 - 5 Section: Naya Azadpur ——Ambala Cant Jn.

(1) Requirement and Operability

See Table 3.3.2-5.

(2) Status

The entire section has recently been double-tracked (March 1987). The line capacity is 37. Trains operated are 25-32. The section has the Delhi Avoiding Line (a single-tracked by-pass route for goods trains), between Rampura signalling yard and Naya Azadpur.

(3) Existing Plans

The traffic of this section is comparatively busy. In Action Plan, 3 of the 10 Mail/ Expresses are planned to be lengthened to 26 car-consist, 2 trains to 22 car-consist. One train is planned to increase its days of operation (5 days) 3 more Local Passenger trains are planned to be added to the present schedule, between Delhi area and Panipat (86 km from Delhi).

(4) Evaluation

At present, the trains operated in this section consist of 10 to 16 cars. There is still room for lengthening the trains. Moreover, the introduction of an Automatic Block System in this section will augment the line capacity up to 75 trains a day. With these measures, this section will meet with the predicted traffic demand up to year 1999-2000.

The number of trains which can be added to the present schedule up till 1999-2000 is 3 Mail/ Expresses and 4 Local Passenger trains.As it was predicted that the ridership of a Long Express would be around 270 passengers a day, the Team did not consider providing the service in this section.

Table 3.3.2-5 Section : Naya Azadpur-Ambala Cant Jn.

Year	Station	NDAZ		SPN		PNP		KKDR		UMB	Rampura	NDAZ
	Train	Req	Pln	Req	Pln	Req	Pln	Req	Pln		Req	Pln
1988-	P		19		19		16		15			-
NOV	G		11		11		10		9			12
	M		2		2		1		1			2
	T		32		32		27		25			14
1994-	P	23	22	19	22	12	16	11	15			-
1995	G	21	21	21	21	19	19	17	17		21	21
	M	2	2	2	2	1	1	1	1		2	2
	T	46	45	42	45	32	36	29	33		23	23
1999-	P	27	26	21	26	16	19	14	18		-	-
2000	G	28	28	27	28	24	24	22	22		29	37
	M	2	2	2	2	1	1	1	1		2	2
	T	57	56*	50	56	41	44	37	41		31	39
2004-	P	35	26	27	26	20	19	19	18		-	-
2005	G	35	35	34	34	30	30	27	27		36	37
	M	2	2	2	2	1	1	1	1		2	2
	T	72	63*	63	62	51	50	47	46		38	39
2009-	P	43	26	35	26	25	19	22	18		-	-
2010	G	42	42	41	41	37	37	32	27		43	37
	M	2	2	2	2	1	1	1	1		2	2
	T	87	70*	78	69	63	57	55	46		45	39
1988-NOV		<37>		<37>		<37>		<33>			<15>	
1994-1995		<45>		<45>		<45>		<45>			<45>	
1999-2000		<75>		<75>		<75>		<75>			《75(04-05)》	

* Note : The line capacity NDAZ-SPN will be improved to 75 in 1999-2000, but the number of passenger trains operable will be limited at 26 due to the line capacity NDLS-DLI-NDAZ. Therefore the values "T" stays below 75.

3 - 3 - 2 - 6 Section: Shakur Basti — Jakhal

(1) Requirement and Operability

See Table 3.3.2-6.

(2) Status

The sub-section: Delhi — Rohtak (50 km) is double-tracked. The rest of the section is single-tracked. The line capacity is 38 in the double-tracked portion, and 22 in the single-tracked portion. 27 trains are now operated. There is room for train increase in the double-tracked portion, but not much in the single-tracked portion.

(3) Existing Plans

Action Plan envisages to operate 3 more Local Passenger trains between Delhi and Rohtak, and lengthen the train-consist in 2 of the present 5 trains to 22 cars.

(4) Evaluation

The traffic prediction tells that the uptrend will be remarkable between Rohtak and Narwana, the single-tracked section. Doubling of tracks in this secion will have to be done step by step. Automatic Block System will have to be introduced in the section Delhi and Rohtak. The number of cars of a train will have to be increased for Local Passenger trains.

The number of trains which can be augmented in this section will be one more Mail/Express and 3 more Local Passenger trains between Shakur Basti and Rohtak.

Table 3.3.2-6 Section : Shakur Basti-Jakhal

Year	Station	SSB		BGZ		ROK		JHI		NRW		JHL	
	Train	Req	Pln	Req	Pln	Req	Pln	Req	Pln	Req	Pln	Req	Pln
1988-	P		14		14		9		9				7
NOV	G		11		11		11		10				9
	M		2		2		1		1				1
	T		27		27		21		20				17
1994-	P	17	17	14	17	10	9	9	9			6	7
1995	G	21	21	22	21	21	13	20	13			17	15
	M	2	2	2	2	1	1	1	1			1	1
	T	40	40	38	40	32	23	30	23			24	23
1999-	P	17	18	14	18	12	10	10	10			7	8
2000	G	29	29	28	28	28	28	26	26			23	23
	M	2	2	2	2	1	1	1	1			1	1
	T	48	49	44	48	41	39	37	37			31	32
2004-	P	22	20	18	20	15	13	13	12			9	10
2005	G	36	36	35	35	35	31	32	32			28	28
	M	2	2	2	2	1	1	1	1			1	1
	T	60	58	55	57	51	45	46	45			38	39
2009-	P	28	20	22	20	19		15				11	
2010	G	43	43	42	42	41		38				34	
	M	2	2	2	2	1		1				1	
	T	73	65	66	64	61		54				46	
1988-NOV		<38>		<38>		<22>		<22>		<21>			
1994-1995		<45>		<45>		<23>		<23>		<23>			
1999-2000		<75>		<75>		<45>		<45>		<45>			

3 - 3 - 2 - 7 Section: Tuglakabad — Mathura

(1) Requirement and Operability

See Table 3.3.2-7.

(2) Status

All the section is double-tracked and electrified. Part of it is triple-tracked. The section plays the role of a main line connecting Delhi area with Bombay. The line capacity is 54. Trains operated are 62 between Palwal and Mathura. The limit of the line capacity has already been reached.

(3) Existing Plans

In Action Plan, an addtional Mail/Express service is planned for Delhi area-Bombay. 2 trains will be lengthened to 26 car- and 9 trains to 22 car-consist. Operation days will be increased for one train. As for Local Passenger trains, 4 additional services are planned between Delhi area and Palwal. As the line capacity limit will be reached in 1994-95, the increase in number of cars of a Local Passenger train to 22 is also planned.

(4) Evaluation

Considering the capacities of the lines in Delhi area, it should be planned that the triple-tracked sub-sections be quadrupled and. furthermore, the signalling system of the sub-section Palwal Mathura be improved to Automatic Block System.

Table 3.3.2-7 Section : Tuglakabad-Mathura

Year	Station	TKD		FDB		PWL		MTJ
	Train	Req	Pln	Req	Pln	Req	Pln	
1988-	P		33		33		24	
NOV	G		27		28		29	
	M		1		1		1	
	T		61		62		54	
1994-	P	45	38	44	37	32	25	
1995	G	53	27	54	28	55	29	
	M	1	1	1	1	1	1	
	T	99	66	99	66	88	55	
1999-	P	55		53		40		
2000	G	68		70		72		
	M	1		1		1		
	T	124		124		113		
2004-	P	73		71		53		
2005	G	86		88		90		
	M	1		1		1		
	T	160		160		144		
2009-	P	90		87		66		
2010	G	103		106		109		
	M	1		1		1		
	T	194		194		176		
1988-NOV		<54>		<54>		<54>		
1994-1995		<62>		<62>		<54>		
2009-2010		<150>		<150>		<75>		

3 - 3 - 2 - 8 Sections within Delhi Area

The "required number of trains" in the sections within Delhi area consists of trains needed to cover the traffic coming into this area from the outer circle and the traffic getting out of this area into the outer circle. They are shown in the columns "Req." of this and subsequent Tables 3.3.2-8, 9 and 10.

Then, the number of "trains operable" within this area was studied if it could meet the requirement. Considering was the effective equilibrium between the number of trains in the outer circle and inner circles, as was referred to in 3-3-1(3). The criteria are the line capacity, signalling or other train operation installations and the train handling capacity of the related terminals. These elements were identified with the improved status where there is Indian Railway's plan of improvement. Where there is no improvement plan of Indian Railways and when the Team considered necessary, these elements were identified with the improved status according to the Team's plan of improvements (Ref. Chapter 4). As the result, the numbers of trains required and operable with the existing or improved infrastructure were clarified (they are shown in the columns "Pln" of the same Tables).

The sections within Delhi area are divided into three, namely:Section Delhi/New Delhi-Ghaziabad, Section: Delhi/New Delhi-Naya Azadpur (& Shakur Basti) and Section: Tilak Bridge-Tuglakabad(& Delta Links).

3 - 3 - 2 - 9 Section: Delhi/New Delhi —— Ghaziabad

(1) Requirement and Operability

See Table 3.3.2-8.

(2) Status

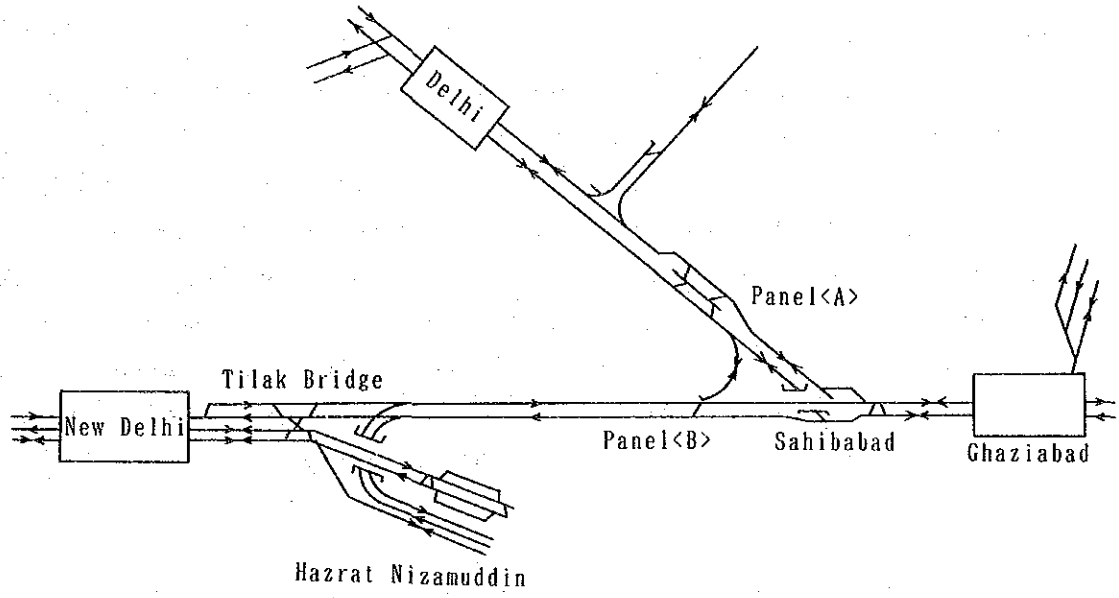


Fig. 3.3.2-1 Conceptual Route Map of Delhi/NDLS ~ GZB

In this section, trains are operated linking Delhi/New Delhi/Ghaziabad with Tundla, Moradabad, Saharanpur and Tuglakabad. Between Delhi/New Delhi and Ghaziabad EMU train are operated.
The line capacity between Sahibabad and Tilak Bridge (H. Nizamuddin) is restricted by the two surface crossings of railway tracks, and the limit of the line capacity is already reached.
The line capacity of the quadruple-tracked sub-section between New-Delhi and Tilak Bridge is also restricted to 96. This is because the four tracks are narrowed to three tracks at the entry to New-Delhi. It is also restricted by the slow speed operation of the trains.

(3) Existing Plans

The sub-section: Sahibadad-Ghaziabad (7 km) will be quadrupled by the Spring 1990. This will largely contribute to the increase of the line capacity.

(4) Evaluation

As was observed in paragraphs 3-3-2-1 through 3-3-2-7 above, the limit of the line capacity will be reached in all the lines/sections exterior to Delhi area by 1999-2000. But the fact tells that the number of trains operated could exceed the line capacity in some cases. Between New Delhi and Sahibabad, although the train increase will be difficult and various measures will have to be taken, it was considered practical to assume that the number of trains operable in this sub-section could be raised to 75 per day, as is envisaged in the Action Plan.

(5) Planning

The line capacity improvements described in 3-2-2 (2).1). were assumed to be completed as planned. In allocating the train arrivals and departures to New Delhi Station or to Delhi station, the actual ratio at present was respected. The ratio will be readjusted in the subsequent step (3-5-2) determining the terminal's capacity.

Table 3.3.2-8 Sections : Delhi/New Delhi-Ghaziabad

Year	Statio	DLI		DSA		SBB/NDLS		TKJ		<GAL>		<B>Panel		SBB		GZB
	Train	Req	Pln	Req	Pln	Req	Pln	Req	Pln	Req	Pln	Req	Pln	Req	Pln	
1988-	P		38		31		59		21		21		21		52	
NOV	G		6		7		11		3		31		26		33	
	M		8		7		22		15		15		14		21	
	T		52		45		92		39		67		61		106	
1994-	P	46	46	39	39	73	73	26	26	26	26	26	26	65	65	
1995	G	7	7	7	7	18	4	5	2	56	34	52	28	52	35	
	M	8	8	7	7	22	22	15	15	15	15	14	14	21	21	
	T	61	61	53	53	113	99	46	43	97	75	92	68	138	121	
1999-	P	57	53	48	46	90	80	35	33	35	33	35	33	83	79	
2000	G	7	7	7	7	23	4	7	2	73	69	68	61	68	68	
	M	8	8	7	7	22	22	15	15	15	15	14	14	21	21	
	T	72	69	62	60	135	106	57	50	123	117	117	108	172	168	
2004-	P	75		63		119		46		46		46		109		
2005	G	7		7		29		8		91		85		85		
	M	8		7		22		15		15		14		21		
	T	90		77		170		69		152		145		215		
2009-	P	92		77		146		56		56		56		133		
2010	G	7		7		35		10		109		102		102		
	M	8		7		22		15		15		14		21		
	T	107		91		203		81		180		172		256		
1988-NOV		<75>		<75>		<96>		<45>		<45>		<45>		<90>		
1994-1995						<150>		<75>		<75>		<75>		<180>		
1999-2000										<150>		<150>				

Note: Goods handling at New Delhi is shifted to Holambi Kalan in 1994-95.

3 - 3 - 2 - 10 Section: Delhi/New Delhi— Naya Azadpur (Shakur Basti)

(1) Requirement and Operability

See Table 3-3-2-9.

(2) Status

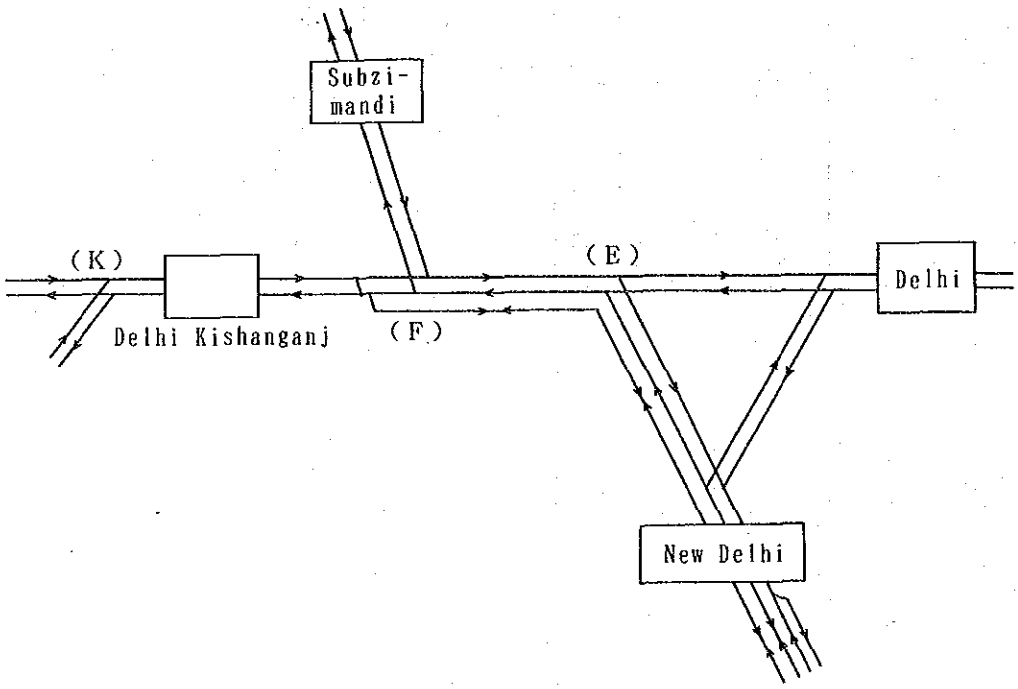


Fig. 3.3.2-2 Conceptual route map of Delhi/NDLS ~ DKZ (SZM)

In this section, trains are operated linking Delhi/New Delhi with Ambala Cantt and Jakhal. This section forms a part of the Ring Line and EMU train are operated.

(3) Evaluation

As to the goods transport, it is considered possible to meet the traffic demand up to 1999-2000. Because, if the route : Rampura

—Naya Azadpur is strengthened by the track doubling and by the grad crossing between DBSI-SSB and PTNR-NDAZ routes at Rampura Signalling Yard, the line capacity would be increased between Rampura and Shakur Basti.

When the goods handling at New Delhi Station is moved to Holambi Kalan, the goods trains will have to use this route. Considering the tonnage handled at New-Delhi now, this route will be capable of accepting these trains.

(4) Planning

It is to be noted that the two routes (viz. the route: Delhi/New-Delhi-Subzimandi and the route: Delhi/New Delhi-Kishanganj) share, in part, a track at the sub-section (E) - (F) of the Fig.3.3.2-2. In this planning, for the purpose of the best utilization of the line capacity of the said sub-section, a reallocation of train handling works was made between Delhi and New Delhi. Namely, Delhi will be allocated more trains bound for Ambala, and New Delhi will be allocated more trains bound for Shakur Basti, each compared with the present.

Table 3.3.2.9 Section : Dehli/New Delhi-Naya Azadpur (& Shakur Busti)

Year	Station	NDLS	(E)		(F)		(K)		Pampura		SSB		DLI	(E)		(F)
	Train	Req	Pln	Req	Pln	Req	Pln	Req	Pln	Req	Pln		Req	Pln	Req	Pln
1988-	P		10		10		21		16		16			11		11
NOV	G		4		4		6		5		12			4		4
	M		7		7		9		11		20			5		5
	T		21		21		36		32		48			20		20
1994-	P		13		13		26		19		19			13		13
1995	G		4		4		6		5		15			4		4
	M		7		7		9		11		20			5		5
	T		24		24		41		35		54			22		22
1999-	P	14	14	14	14	27	27	20	20	20	20		13	13	13	13
2000	G	4	4	4	4	6	6	5	5	33	33		4	4	4	4
	M	7	7	7	7	9	9	11	11	20	20		5	5	5	5
	T	25	25	25	25	42	42	36	36	73	73		22	22	22	22
2004-	P	18	16	18	16	33	29	24	22	24	22		15		15	
2005	G	4	4	4	4	6	6	5	5	41	33		4		4	
	M	7	7	7	7	9	9	11	11	20	20		5		5	
	T	29	[27]	29	27	48	44	40	40	85	[75]		24		24	
2009-	P	20		20		39		30		30			19		19	
2010	G	4		4		6		5		50			4		4	
	M	7		7		9		11		20			5		5	
	T	31		31		54		46		100			28		28	
1988-NOV		<20>	<8>	<20>	<8>	<38>		<38>		<38>			<26>			
1994-1995						<75>		<75>		<75>						

Year	Station	DLI	(E)		(F)	NDAZ			NDLS	(D)		(E)		(F)
	Train	Req	Pln	Req	Pln	Req	Pln		Req	Pln	Req	Pln	Req	Pln
1988-	P		7		7		19			12		12		12
NOV	G		-		-		2			2		2		2
	M		1		1		2			1		1		1
	T		8		8		23			15		15		15
1994-	P		10		10		22			12		12		12
1995	G		-		-	4	4		4	2	4	2	4	2
	M	1	1	1	1	2	2		1	1	1	1	1	1
	T		11		11		26			[15]		15		15
1999-	P	14	14	14	14	27	26		13		13		13	
2000	G	-	-	-	-	5	2		5		5		5	
	M	1	1	1	1	2	2		1		1		1	
	T	15	[15]	15	15	34	30		19		19		19	
2004-	P	22		22		35			13		13		13	
2005	G	-		-		5			5		5		5	
	M	1		1		2			1		1		1	
	T	23		23		42			19		19		19	
2009-	P	30		30		43			13		13		13	
2010	G	-		-		6			6		6		6	
	M	1		1		2			1		1		1	
	T	31		31		51			20		20		20	
1988-NOV		<15>		<15>		<37(27)>			<12>		<12>		<12>	

3 - 3 - 2 - 11 Section: Tilak Bridge — Tuglakabad and GAL,DAL

(1) Requirement and Operability

See Table 3.3.10.

(2) Status

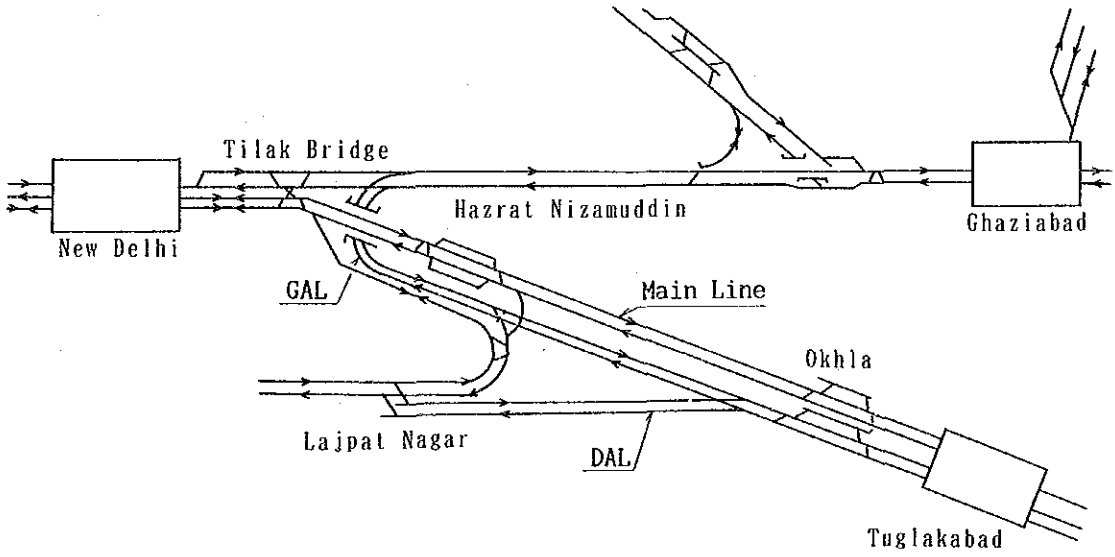


Fig. 3.3.2-3 Conceptual Route Map of TKJ~TKD and Delta Lines

In this section, trains are operated linking Delhi/New Delhi with Mathura. Goods trains routes are complicated. The line capacity is small because all these bifurcations are made by Surface crossings.

(3) Evalution

The line capacity of the main line between Tilak Bridge and Tuglakabad can be augmented by constructing a passing line at the

sub-section Tuglakabad-Nizamuddin. By this it will become possible to dead-head about ten passenger trains per day from New Delhi to Nizamuddin. But the sub-section's line capacity will reach its limit in 1994-95.

While the capacities of delta link sections (GAL and DAL) themselves will be good enough with the present infrastructure, because there will not be too much increase in goods trains from Mathura direction (due to the restricted line capacity between Tuglakabad and Mathura).

Table 3.3.2-10 Section : Tilak Bridge-Tuglakabad (& Delta Links)

Year	Station	(M/L)TKJ		NZM		OKA		TKD		(GAL)TKJ		NZM		OKA		TKD	
	Train	Req	Pln	Req	Pln	Req	Pln			Req	Pln	Req	Pln	Req	Pln	Req	Pln
1988-	P		38		33		33				-		-		-		
NOV	G		9		4		4				28		19		35		
	M		18		13		13				9		9		14		
	T		65		50		50				37		28		49		
1994-	P	45	45	45	38	45	38				-		-		-		
1995	G	18	9	5	5	5	0			50	32	33	24	56	42		
	M	18	18	13	13	13	13			9	9	9	9	14	14		
	T	81	72	63	56	63	51			59	41	42	33	70	56		
1999-	P	56		56		56					-		-		-		
2000	G	24		7		7				65	67	42	39	81	59		
	M	18		13		13				9	9	9	9	14	14		
	T	98		76		76				74	76	51	48	95	73		
2004-	P	73		73		73					-		-				
2005	G	26		7		7				81		53		103			
	M	18		13		13				9		9		14			
	T	117		93		93				90		62		117			
2009-	P	90		90		90					-		-		-		
2010	G	28		7		7				97		64		124			
	M	18		13		13				9		9		14			
	T	136		110		110				106		73		136			
1988-NOV		<67>		<57>		<57>				<40>		<35>		<40>			
1994-1995		<70>	<10>	<75>		<75>				<45>		<45>		<75>			
1999-2000										<75>		<75>					

Year	Station	NZM		LPNR		OKA		LPNR		DSJ		RTNR		DKZ		PTNR	Pampura
	Train	Req	Pln			Req	Pln			Req	Pln	Req	Pln	Req	Pln	Req	Pln
1988-	P		5				-				5		5		5		-
NOV	G		9				15				24		24		4		24
	M		3				5				8		8		5		11
	T		17				20				37		37		14		35
1994-	P	7	7				-			7	7	7	7	7	7		-
1995	G	16	16			30	18			47	35	47	35	10	10	51	34
	M	3	3			5	5			8	8	8	8	5	5	11	11
	T	26	26			35	27			62	49	62	49	22	22	62	45
1999-	P	7	7				-			7	7	7	7	7	7		-
2000	G	23	23			39	28			62	43	62	43	10	10	66	64
	M	3	3			5	5			8	8	8	8	5	5	11	11
	T	33	42			44	33			77	75	77	75	22	22	77	75
2004-	P	7								7		7		7			-
2005	G	28				49				77		77		10		83	
	M	3				5				8		8		5		11	
	T	38				54				92		92		22		94	
2009-	P	7								7		7		7			-
2010	G	35				57				92		92		10		99	
	M	3				5				8		8		5		11	
	T	45				62				107		107		22		110	
1988-NOV		<25>				<25>				<50>		<50>		<38>		<30>	
1994-1995		<45>				<45>				<75>		<75>		<40>		<75>	

3 - 3 - 2 - 12 Section: Delhi Queen's Road (Delhi) — Rewari(M.G)

(1) Requirement and Operability

See Table 3.3.2-11.

(2) Status

This section is double-tracked except at the sub-section: Garhi Harsaru-Khalipur (30 km) where it is single-tracked. There are two Surface crossings with B.G. tracks between Delhi and Delhi Sarai Rohila. They cause serious restrictions to the smooth operation of trains.

(3) Existing Plans

Action Plan envisages that 3 out of present 11 Mail/Expresses will increase the days of operation, and other 8 trains will lengthen their train-consists. A Local Passengers train will be added to the present schedule between Delhi and Rewari.

(4) Evaluation

The line capacity will be largely improved, if the surface crossing with B.G. tracks is eliminated, and if the Automatic Block System is introduced. Doubling of track at Garhi Harsarn-Khalipur (planned to be completed by 1991) will also enhance the line capacity. The operation of additional goods train will be restricted because the line capacity of this section will reach to the limit in 1994-95. It will therefore be able to meet the predicted traffic demand up to 2009-2010, if the Automatic Block System is introduced in the section by 1999-2000.

Table 3.3.2-11 Section : Delhi Sarai Rohilla－Rewari

Year	Station	(PTNR) DEE		(BWSN) PM		GGN		RE
	Train	Req	Pln	Req	Pln	Req	Pln	
1988-	P		20		19		16	
NOV	G		9		9		7	
	M		1		1		1	
	T		30		29		24	
1994-	P	24	22	22	21	22	18	
1995	G	16	13	16	13	16	13	
	M	1	1	1	1	1	1	
	T	41	36	39	35	39	32	
1999-	P	27	27	25	26	25	28	
2000	G	20	2	20	20	20	20	
	M	1	1	1	1	1	1	
	T	48	30	46	47	46	49	
2004-	P	35	35	32	34	33	38	
2005	G	26	3	26	26	26	26	
	M	1	1	1	1	1	1	
	T	62	39	59	61	60	65	
2009-	P	44	44	40	43	40	47	
2010	G	31	4	31	31	31	31	
	M	1	1	1	1	1	1	
	T	76	49	72	75	72	79	
1988-NOV		<33>		<33>		<27><33>		
1994- 95		<35>		<35>		<35>		
1999-2000		<75>		<75>		<75>		

Note: M.G. passenger facilities at Delhi is shifted to Patel Nagar, goods to Bijwasan by 1999-2000.

3 - 3 - 2 - 13 Numbers of Trains to be handled at Delhi and New Delhi

To recapitulate the foregoing Paragraphs 3-3-2-1 through 3-3-2-7, the impacts of the sections around Delhi area given on Delhi and New-Delhi stations, in terms of number of trains they send to these two stations are briefed in Table 3.3.12. This will provide the basis for evaluating the terminals' capacity in Delhi area. This being made, the appropriate number of trains to be handled at these stations will be readjusted.

Table 3.3.2-12 Number of Trains to be Treated in Delhi and New Delhi Stations

Station	Year	For GZB	For TKD	For DLI or DSA	For NDAZ	For SSB	Number of originating/terminating trains	Total
New Delhi	1988 Nov.	15 6 21	20 18 38	5 14 19	8 4 12	4 6 10	(26)	52 48 100
	1994 ~ 1995	17 9 26	21 24 45	5 17 22	8 4 12	4 9 13		55 63 118
	1999 ~ 2000	23 10 33	21 24 45	5 17 22	8 4 12	5 9 14		62 64 126
Delhi	1988 Nov.	13 18 31	5 13 18	1 6 7	2 5 7	1 10 11	(25)	22 52 74(77)
	1994 ~ 1995	13 26 39	5 16 21	1 6 7	3 8 11	1 12 13		23 68 91(94)
	1999 ~ 2000	18 28 46	5 16 21	2 6 8	5 9 14	1 12 13		31 71 102(105)
Total	1988 Nov.	28 24 52	25 31 56	6 20 26	11 9 19	5 16 21		74 100 174(177)
	1994 ~ 1995	30 35 65	26 40 66	6 23 29	11 12 23	5 21 26		78 131 209(212)
	1999 ~ 2000	41 38 79	26 40 66	7 23 30	13 13 26	6 21 27		93 135 228(231)

Note : 15 ----- Mail/Express
6 ----- Local Passenger
21 ----- Total

74 (77) ----- including 1 holiday speci
2 parcel trains

3 - 4 Transportation Planning (Later Period)

3 - 4 - 1 Planning Policy

The total line capacity of the lines/sections located within 200km radius circle around New Delhi, is considered to reach its limit by the year around 2000---even if piecemeal improvements are made by then, section by section, to the network's bottleneck points. In order to fully comply with the estimated traffic demand that will arise after 2000, a renovative nature of infrastructure improvement will be needed. But it will require a tremendous amount of investment and difficult works, especially in the urbanized Delhi area (which often seems to be almost prohibitive), if all the trains are meant to be operated. It is more practical to consider making all the goods trains bypass Delhi area. as is already planned by Northern Railways, except those trains directly originating/terminating at Delhi area.

3 - 4 - 2 Requirements and Plan of Train Operation

(1) Requirements and Plan of Train Operation

When all the goods trains should detour Delhi area, except those directly originating/terminating there, what would be like the required number of trains to be operated in the principal sections of the outer/inner circle networks? What would be like the required changes in the line capacity of the sections involved with the detour? These are the themes of this paragraph.

1) Outer circle

The number of goods trains is reviewed which are to be operated in the principal sections of the outer circle network. The review is made according to the demand forecast, and respecting the train operation policy of avoiding Delhi area. As the result, compared with the figures for the Earlier Period, the number of the goods trains will be modified in the Later Period as shown in Fig.3.4.2-1, when the detour is enforced.

The sections where some capacity improvements will become necessary by the detouring policy will be as follows:

Ghaziabad ～ Tundla
Tuglakabad ～ Mathura
Ghaziabad ～ Hapur
Muradnagar ～ Meerut City

Depending on the selection of the bypassing routes some more sections may have to be included in the above list.

2) Inner circle (Delhi area)

The same review is made as to the principal sections of the inner circle network and, as the result, the number of trains is modified as shown in Fig.3.4.2-2.

The sections where some capacity improvements will become necessary even after all the goods train are detoured, will be as follows:

Ghaziabad	～	Sahibabad
Delhi	～	Sahibabad
New Delhi	～	Tilak Bridge
Tilak Bridge	～	Tuglakabad (M/L)
Delhi/New Delhi	～	Shakur Basti/Naya Azadpur

(2) Train Operation Plan

Train operation plan is formulated presupposing that the capacity improvement will be made in the following manner:

i . In the outer circle, the capacity improvement will be performd as required.

ii . In the inner circle, where urbanization is remarkable, capaciy improvement will be limited to those listed in the paragraph 3.2.2(2),1).

iii . The above-mentioned restrictions in Delhi area will make some trains impossible being operated. They will be dealt with at Ghaziabad, Tuglakabad, Holambi Kalan and other peripheric terminals. The same with the trains overflowing Delhi Main and New Delhi. The improvements of these peripheric terminals will therefore be made as required.

iv . No improvement will be planned as to the access to these terminals, since it is considered as prematured.

As the result, it is found out that;

i . In Section GZB--SBB

The section will have the line capacity of 180 trains per day (See 3-2-2(2),1)) on completion of the track quadrupling works now going on. The required number of trains will be 213 (of which 59 are goods trains (See Fig.3.4.2-2)). Accordingly, 33 trains will be suspended.

ii . In Section TKD--NDLS

The existing line capacity of the section NDLS--TKJ is 150 and that of the section NZM--TKD is 75 (See 3-2-2(2),1)). The required numbers of trains are 173 and 103 (See Fig.3.4.2-2), respectively. Accordingly 23 and 28 trains will be suspended, respectively.

iii . In Section DLI/NDLS--SSB/NDAZ

The existing capacity (triple tracks) is 85. The required trains, 105. Accordingly 20 suspended (See 3.2.2(2),1) and Fig.3.4.2-2).

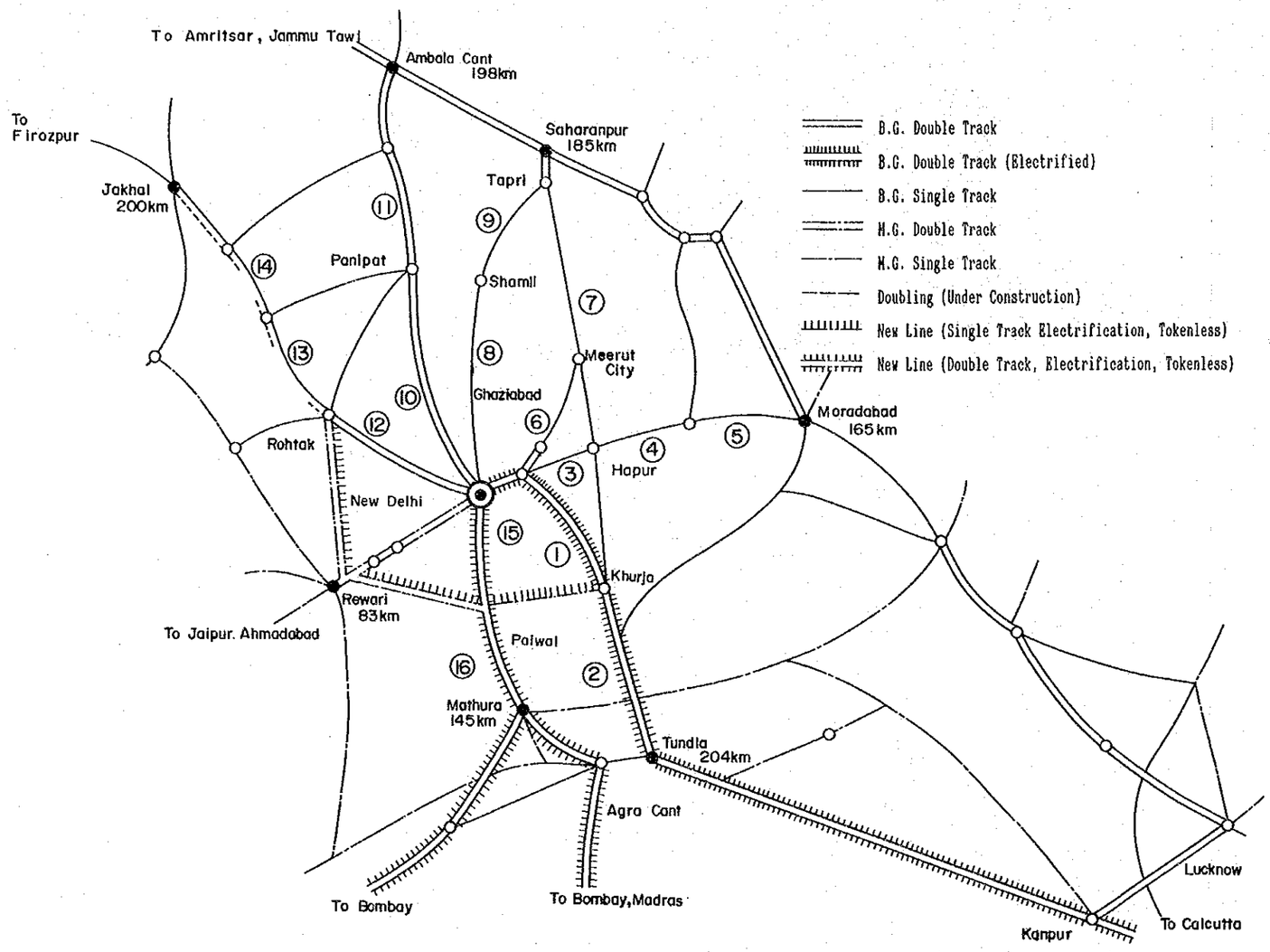
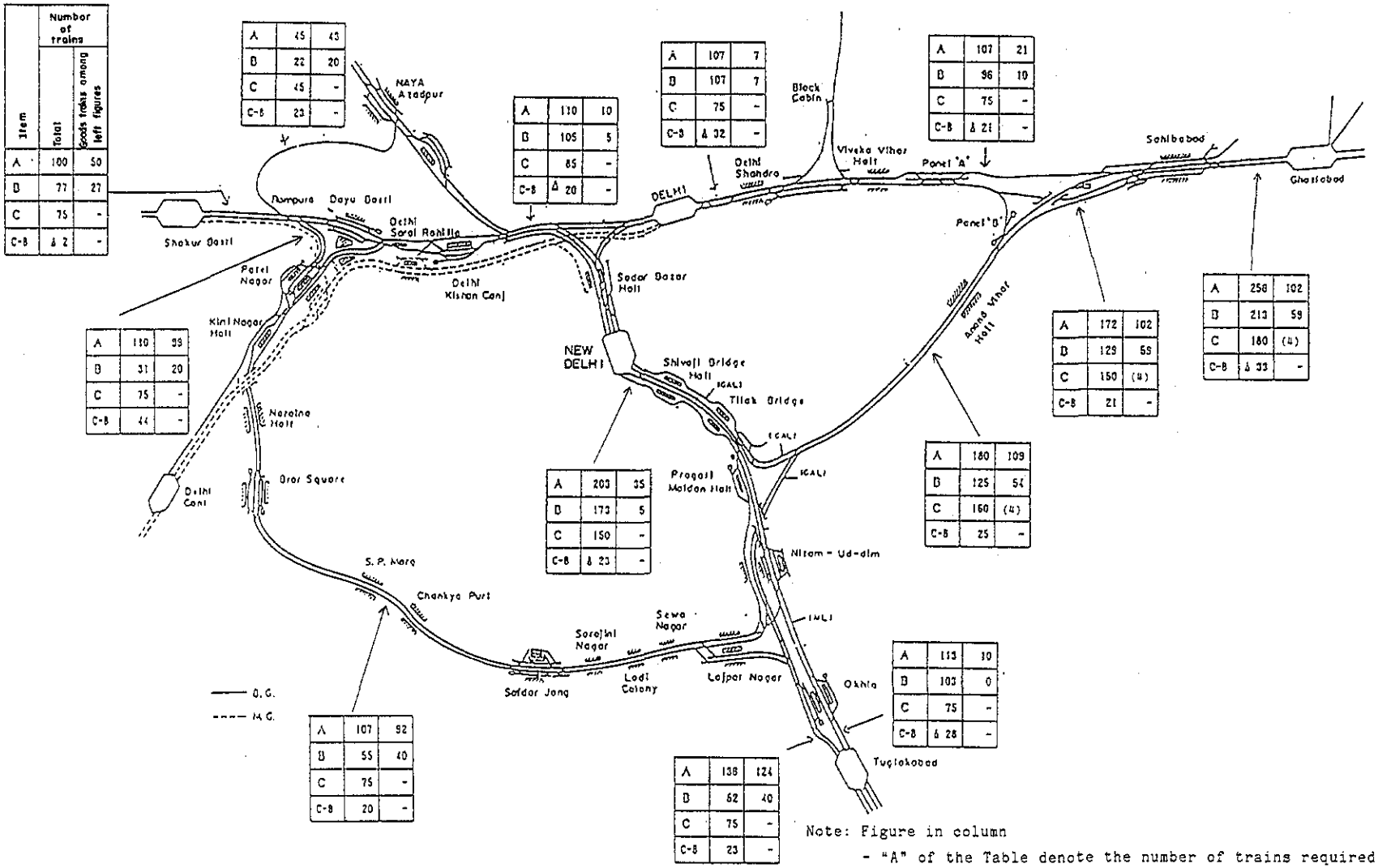


Fig. 3.4.2-1 Number of Trains Required and Operable (Outer Circle)
-- when Delhi Area bypassed

Section	Items	Number of trains		Section	Items	Number of trains	
		Total	Goods trains among left figures			Total	Goods trains among left figures
1	A	154	93	9	A	22	16
	B	111	50		B	8	2
	C	100	—		C	UP 9	—
						DN2 2	
	C − B	△11			C − B	14	
2	A	141	93	10	A	87	42
	B	*98	*50		B	43	3
	C	100	—		C	75	—
	C − B	* 2			C − B	37	
3	A	41	10	11	A	63	37
	B	32	1		B	29	3
	C	22	—		C	75	—
	C − B	△10			C − B	46	
4	A	29	10	12	A	73	43
	B	20	1		B	34	4
	C	22	—		C	75	—
	C − B	2			C − B	41	
5	A	23	8	13	A	61	41
	B	16	1		B	23	3
	C	22	—		C	45	—
	C − B	6			C − B	22	
6	A	72	44	14	A	54	38
	B	31	3		B	19	3
	C	UP27	—		C	45	—
		DN19					
	C − B	△ 4			C − B	26	
7	A	66	43	15	A	194	106
	B	26	3		B	135	47
	C	UP27	—		C	150	—
		DN19					
	C − B	1			C − B	15	
8	A	40	24	16	A	176	109
	B	18	2		B	*112	*45
	C	UP 9	—		C	75	—
		DN2 2				△	
	C − B	4			C − B	*37	

Note: Figure in column
- "A" of the Table denote the number of trains required in view of the estimated demand in 2009-10.
- "B", the number of trains required, when all the goods trains bypass Delhi area except those directly originating/terminating at Delhi area
- "C", the line capacity in 1999-2000.
- "*", the number of trains which may be subject to changes depending on rutes selected.



Note: Figure in column
- "A" of the Table denote the number of trains required in view of the estimated demand in 2009-10.
- "B", the number of trains required, when all the goods trains bypass Delhi area except those directly originating/ terminating at Delhi area
- "C", the line capacity in 1999-2000.
-(4) quadrupled line

Fig. 3.4.2-2 Number of Trains Required and Operable (Delhi Area) -- when Delhi Area bypassed (Later Period)