REPUBLIC OF KOREA
KOREAN NATIONAL RAILROAD

FEASIBILITY REPORT
ON
CHUNG BUG LINE DOUBLING PROJECT
IN
REPUBLIC OF KOREA

November 1975

JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF KOREA
KOREAN NATIONAL RAILROAD

FEASIBILITY REPORT
ON
CHUNG BUG LINE DOUBLING PROJECT
IN
REPUBLIC OF KOREA

November 1975

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

In compliance with the request of the Government of the Republic of Korea, the Government of Japan has decided to make a feasibility study of the Chungbug Line Doubling Project of Korea as a part of Japan's overseas technical cooperation programmes, and this study was conducted by the Japan International Cooperation Agency (JICA).

JICA dispatched a survey team consisting of 9 experts, headed by Mr. Y. Mukasa, Deputy Director, Technical Development Department, Japan National Railways, to Korea from June 23rd to July 22nd 1975 to carry out the field investigation for its technical and economic feasibility. The results of the survey have been carefully reviewed, and then compiled into the report herewith presented.

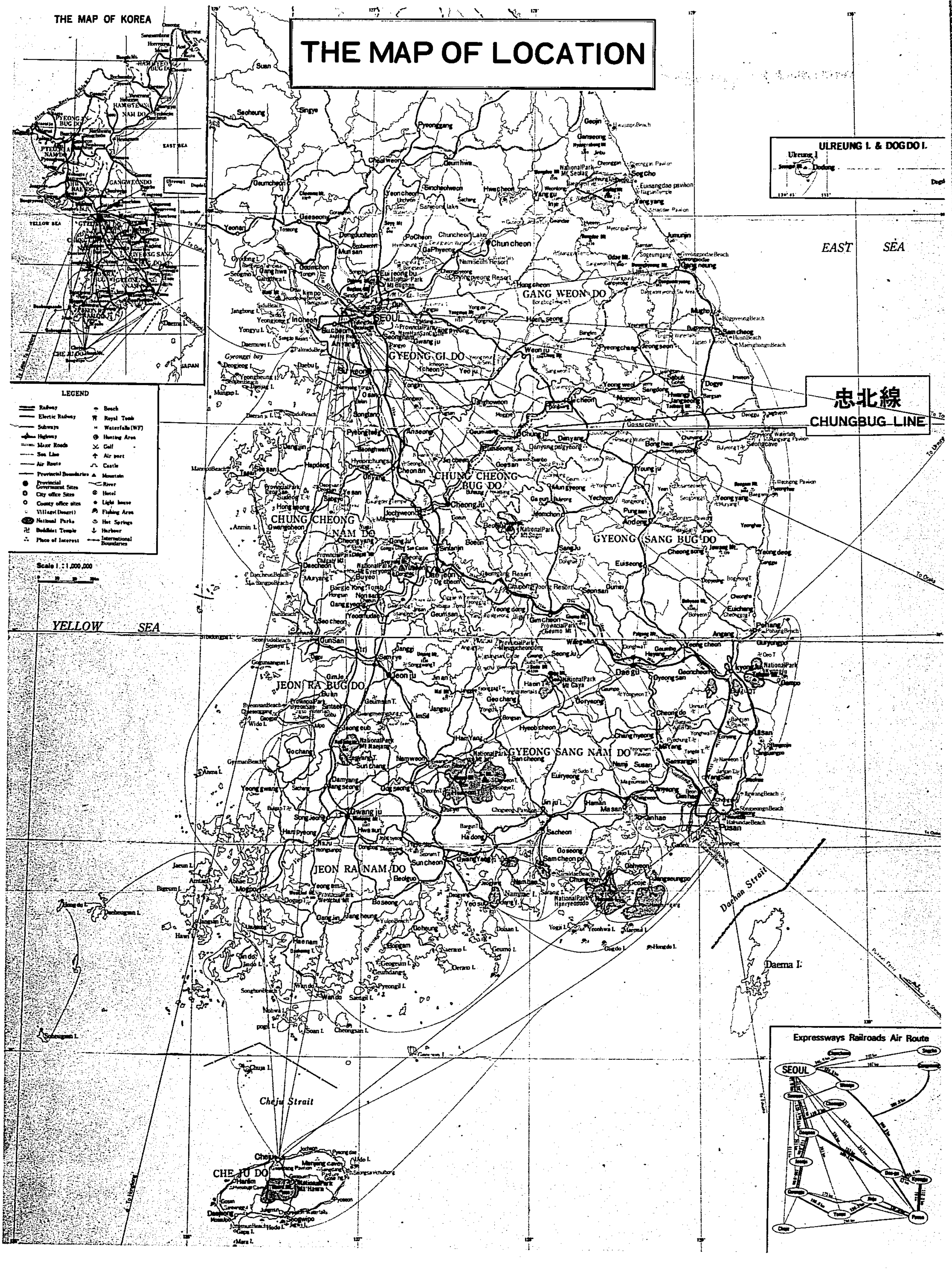
It is my great pleasure if the report would make a contribution to the improvement of railroad transportation in Korea with the effect of the stabilization of the supply of living necessities, and further if the friendly relations between our two countries which are happily existing so far would be greatly promoted through these actions.

On this occasion I wish to express my sincere gratitude to the authorities of the Government of the Republic of Korea, Korean National Railroad, and other authorities concerned for the kind cooperation extended to us while conducting the survey.

NOVEMBER, 1975,

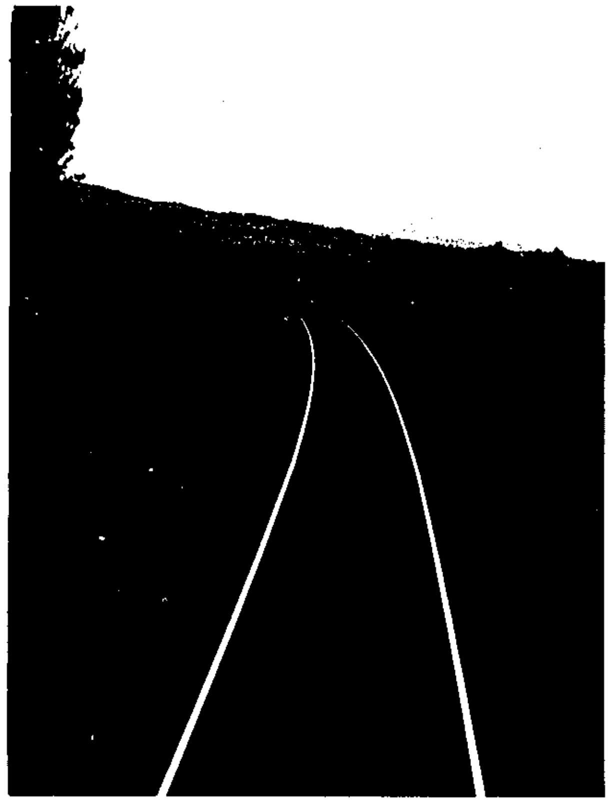
Shinsaku Hogen
President
Japan International Cooperation Agency
Tokyo, Japan

THE MAP OF LOCATION

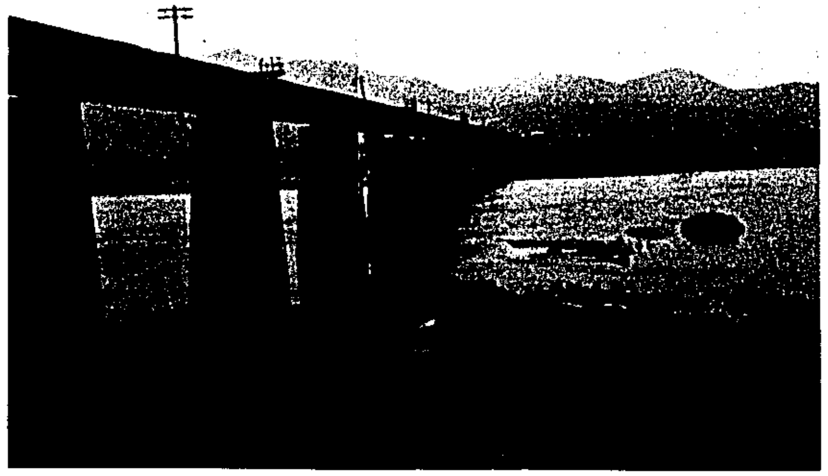


Mi Ho ~ Jeong Bong (Near 9.6 km Point)
(R = 400 m)

Bo Cheon ~ Sang Dang (Near 60.4 km Point)
Ma Song Tunnel (ℓ = 200 m)



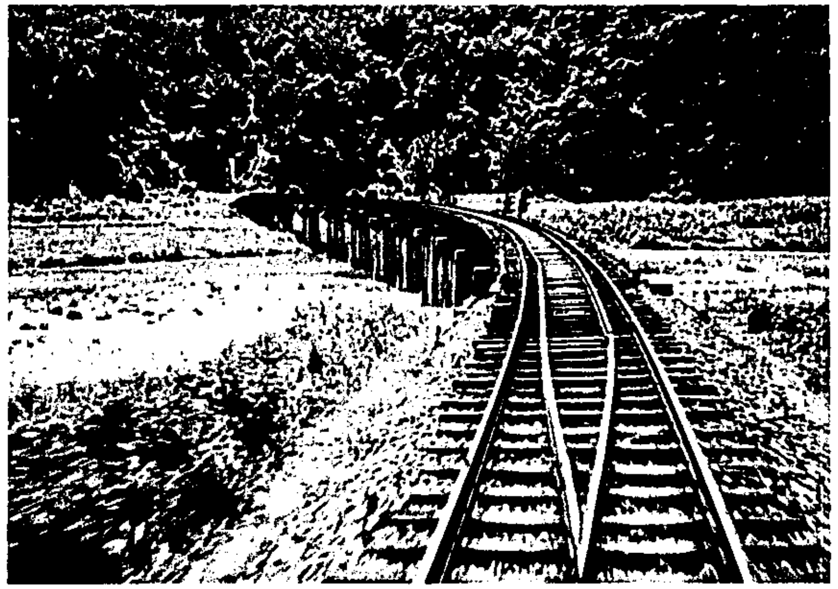
Jeung Pyeong ~ Do An
(Near 48 km Point) (R = 300 m)



Mog Haeng ~ Dong Ryang (Near 100.1 km Point)
Nam Ham Gang Bridge (ℓ = 426 m)

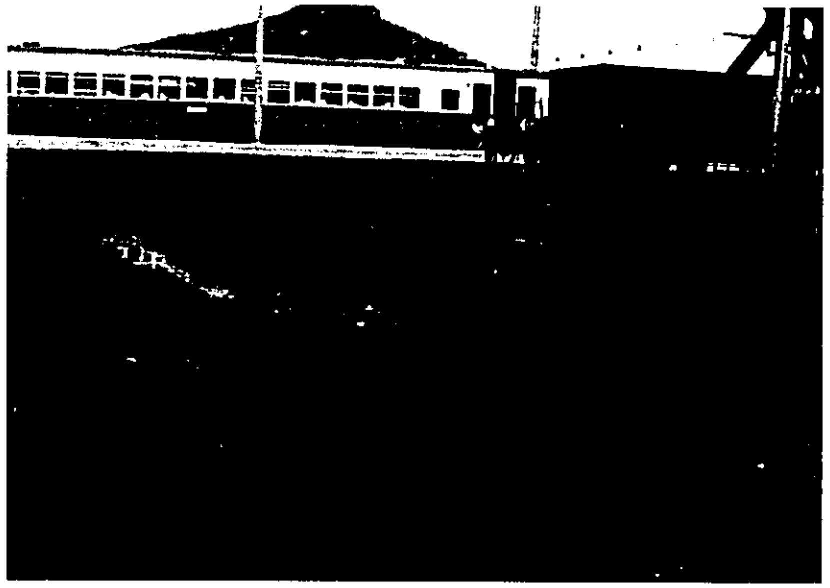
Near Dong Ryang Stn. (102 km Point)

Near 113 km Point of New Route

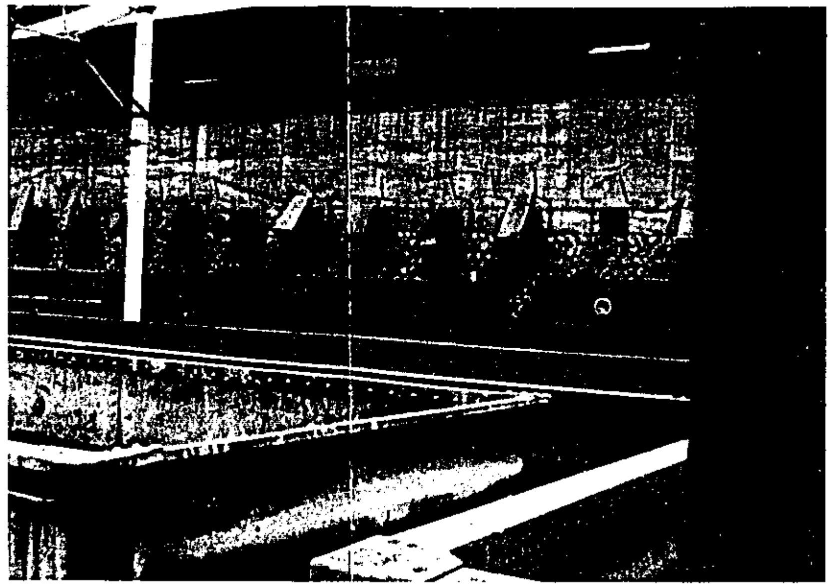


Jin So Cheon Bridge (R = 300 m)
(Sam Tan ~ Gong Jeon, 115 km Point)

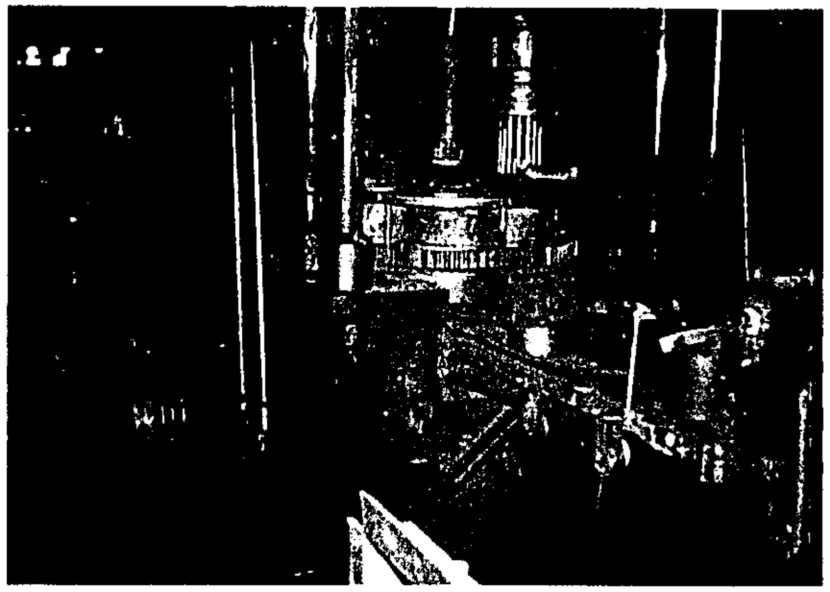
Near Hyeon Bag Tunnel of New Route



Coal Stock Yard at Mang U Stn.



Anthracite Loading Equipment at Mun Gog Stn.
of Tae Baeg Line



Briquet Factory at Mang U

CONTENTS

Summary and Recommendation

1. Object

At the request of the Government of Republic of Korea, the study has been made for feasibility of the track doubling project of Chung Bug Line, which effects a junction with both Geong Bu Line and Jung Ang Line in the central part of Korea.

2. Outline of Project

In Korea, anthracite and cement are for the most part produced in Tae Baeg and Yeong Dong districts, located in the north-eastern part of the country. These materials are transported in bulk by railway to the consuming areas; namely to Seoul via Jung Ang Line (up-track) and to the other places via Chung Bug Line.

The domestic demands for anthracite and cement are very strong among the people. With the sufficient production capacity for them at present, the available transport capacity comes to lag somewhat behind it. If the situation should be left as it is, it is apparant that the transportation of Jung Ang Line and Chung Bug Line is anticipated respectively to come to a standstill in about 3 years.

From such a point of view, the study has been made to consider the technical and economical feasibility of the most effective plan to strengthen the transport capacity via the optimum transport route for these two materials essential to the national living, giving the full scope of the work to cover the future demand.

3. Outline of Survey Result

3-1 Position of Korean National Railroad (KNR)

Korean National Railroad commands a vital position to provide the basic means of transportation throughout the country, discharging its function to the full extreme in compliance with the national requirement.

Particularly in the field of freight transport, KNR occupied the share of 52% in 1974, and is expected to take as high as a share of 46% in 1981 under the plan of Korean Government.

As to the freight items, KNR handles such basic materials as anthracite, cement, ore, petroleum, and also such living necessaries as rice, wheat and fertilizer. In 1974 it transported 9 billion tons-Km of these materials, and the understanding is made that it has established its mass transport method effectively as the industrial freight track serving through its nation-wide railway network. From a national-economic-development point of view, KNR is playing a very important role in extending throughout the country, and will stay in such a position for the future.

3-2 Anthracite and Cement for People's Living

Approximately 90% of anthracite are processed into briquets, which are one of the living necessaries in the Korean household for air-heating and cooking. In Korea the houses were built mostly in the structure to spend the severe winter seansons, equipped with the "hot floor", by which the room could be warmed up from beneath by fired briquests.

Although a remarkable increase has been seen in the consumption of petroleum in the recent years, it is chiefly confined in the industrial use; such as power generation, iron refinery, and cement production, etc. The oil consumption has not been so prevailed for the household use yet, because of its expensiveness and unavailability for use in the building structure.

Cement is widely used for the construction of roads, buildings and apartment-houses, and the demand for it strongly comes up from the "Sae-Maeul" movement, which is a spiritual drive for new village construction. The movement was launched in 1970, with the object of achieving the better environments and higher income. Taking a farming village for instance, it gives a special effort to its district community to improve the environments; reconstruction of houses, widening of village roads, and new construction of waterway, to aim at levelling up the standard of living in the village.
As a result, the demand for cement is strong, and will be so for the future, backed up with those constructions in more than 33,000 villages throughout the nation.

3-3 Railway Transport of Anthracite and Cement

Almost all the anthracite and cement plants have their industrial siding tracks in the yards; nearly 100% of delivery are made through such tracks.

In case that sea freight is needed, cement is transferred to a nearby port from the railway terminal to be transported by sea to the seaside industrial areas like Bu San, Ma San, Yeo Su, etc., where cement is consumed in bulk. Anthracite, only destined for Pusan, is sea-freighted.

The railway share in transport in 1974 marked 63% for anthracite, and 56% to 60% for cement; they explained that these materials should be transported by railway to attain the economy in distribution. Anthracite and cement are both mass-transport items, and distributed all over the country. What is more important is the reasonable rate of freightage accounted in the cost; all of which indicate that railway will assume its important position to transport these two materials for the future.

KNR has already started its scheme to strengthen the existing transport capacities of both Tae Baeg Line and Yeong Dong Line running through the production areas, responding with the expected increase in productivity. The scheme is to complete in 1977.

3-4 Position of Chung Bug Line in Transport Improvement Plan

From the producing areas to Seoul, the freight transport is made via the up-track of Jung Ang Line and to other destinations via either the down-track of Jung Ang Line or Chung Bug Line. Seoul is the biggest consuming area, which covers as much as 40% of the total national consumption, and will stay in such a position for the future. If the trend continues, Jung Ang Line and Chung Bug Line would come to a deadlock around 1978, for which some countermeasure must be taken to improve the present situation.

In the meantime, the future increase in demand in the special city of Seoul would probably arise in the south side of the Hang Gang River. The transport to the district would require the transit run through the city, if it were made via Jung Ang Line. The investigation turned out, however, that the present city traffic would not afford any more freight through the city with the limited traffic facilities and heavy passenger traffic by electric railcars, and that there would be no room available for the expansion of the coal stock yard nor a new land acquisition because of the urbanization developed around there.

Meanwhile, the track doubling work for Jung Ang Line will require an immense amount of investment and a long period of six or sevey years for construction.

Consequently it is apparant to be the most rational countermeasure that the transport to Seoul would be carried out in a dual system: One via Gyeong Bu Line through Chung Bug Line to the southern part of the Hang Gang River where comsumption will expand, and the other via Jung Ang Line to the northern part as done at present.

As to the population in the northern part of the Han Gang River, Korean government has already established the policy to restrict it, taking a strong administrative measure, so that slight would be the increase in demand, which could be covered by the allowance left in the present transport capacity of Jung Ang Line. On the other side, the passing freight tonnage would in turn go up sharply in Chung Bug Line; it would have to absorb almost all the increment in demand for freight to Seoul and various cities locating nation-sidely, in addition to the present transport volume.

The national avarage rate of the increase in railway transport volume accounted 9% or somewhere around it, while Chung Bug Line is anticipated in the plan to have two times as high a ratio as the national average of the increase in transport volume, showing 8.8 million tons in 1981 and 17.3 million tons in 1990 as a stretch, as compared to 1.7 million tons in 1974.

In short, Chung Bug Line should be originally strengthened in capacity to meet a increasing trend, but this time some drastic measure must be taken to absorb the extraordinary increase caused by the transferred freight transport from Jung Ang Line.

By effecting the diverted freight into Chung Bug Line, Jung Ang Line would have no immediate need to be improved its capacity, and at the same time no more burden would be imposed upon the current operation of electric railcars within the special city of Seoul.

3-5 Effective Track Doubling Plan and its Influence on Gyeong Bu Line

Various trial calculations have been carried out to probe upto what extent the traffic capacity could be strengthened if the betterment were accomplished for the present single-track line. As a result, not so much could not be expected for the effect to be enough in proportion to the investment amount, even if the highest level of improvement were proceeded with CTC and then electrification in the line.

Further strengthening of transport capacity should call for the doubling of track, when the once-completed CTC and electrification works would become useless at all to cause a total loss of the construction cost. If there were no problem for the acquisition of land, therefore, a rational plan should be drawn up to effect the doubling of track at the begining for the railway section that would confront a strong future demand. And, when the demand increases, the transport capacity will be intensified reasonably by an additional investment to rolling stock and ground equipment accordingly.

Chung Bug Line will be in character a one-way traffic of freight transport even when the doubling of track is completed; the up track will serve for the heavy-duty transport, while the down track to forward the deadhead trains only. The doubling plan was therefore mapped up so as that the up track should be constructed on the up-grade of 12.5 o/oo even at the maximum. The down track was designed to take in some part of the existing line which had an up-grade of 21 o/oo, taken consideration of the freight characteristics it bore.

In planning the transport from Chung Bug Line to Gyeong Bu Line, a small yard is to be constructed at O Song station, located next to the branch-off station of Jo Chi Weon, for the purpose of classifying work on the up and down tracks of Gyeong Bu Line, and at the same time a delta siding track is constructed in the yard in order to raise efficiency in traffic to Gyeong Bu Line.

As of the year of 1981, the train passage from Chung Bug Line to Gyeong Bu Line will account 12 ∿ 14 in the up track, and 8 ∿ 10 in the down track, which can mostly be accommodated by the existing carrying capacity.

As large future increment in traffic demand is anticipated in Gyeong Bu Line by itself, KNR has the plan, as a means for enlarging track capacity, for the more installation of block signal systems between the stations of the line. The plan is to complete in 1977, when the increase in train passage from Chung Bug Line will be absorbed not to affect upon Gyeong Bu Line.

About the plan of Bu Gog Freight Center, located at a branch-off from Bu Gog station of Gyeong Bu Line, that a stock yard is to set up for the anthracite destined for the southern side of the Han Gang River in Seoul, and that the unloading of cement is also handled there, the location of the Center is regarded as the best suitable for the purpose. As there is no problem but the acquisition of land, the construction plan should be promoted as soon as possible.

3-6 Outline of Construction Works

So far has been described the necessity for the double tracking of Chung Bug Line. Regarding the construction plan, our survey team has completed its study entering into details with the results of the field investigation, and covering the data of Korean construction plan already prepared by KNR's survey. As a result, we conclude that the plan is feasible enough for construction from a technical point of view.

(1) Total construction cost: 29.8 billion won
(29,800 million won)

(Unit: One million won)

Total Sum	Year					Equivalent to US Dollar
	1975	1976	1977	1978	1979	
29,800	1,000	5,000	10,800	11,100	1,900	About $60 million

(2) Procurement Sum by Year for Materials & Supplies to be Imported

(Unit: US$1,000.-)

Total Sum	Year				
	1975	1976	1977	1978	1979
8,700	0	0	8,700	0	0

(3) Breakdown of Materials & Supplies to be Imported

Item	Specification	Quantity	Unit Price	Sum	Remarks
Rail	50kgN	16,000(t)	350($)	5,600,000($)	1=25m
"	37kg	2,500	350	875,000	"
Log	(for Sleepers)	33,770m^3	65	2,195,000	
Instruments	(for Survey)			30,000	Transit, Level, etc.
Total				8,700,000	₩4.22 billion

(Nearly ₩485/$)

Rails are 50kgN for main tracks and 37kg for sidetracks respectively. They are not produced in Korea at present and to be purchased by foreign exchange.

Wooden sleepers will be used for the following reasons: (1) PC sleepers are twice as high in price as wooden ones, and (2) only used for about 30% of even the trunk lines in Korea at present.

The import of complete sleepers is banned in Korea, so the round logs for sleepers shall be imported from off-shore. The unit price of the foreign-exchange purchase items are $350 per ton for rial and $65 per cubic meters for round log, which are estimated in reference to the import price in 1974.

Survey instruments consist of 5 sets of Transists and Levels, of which price per set are estimated at $6,000.

All the costs are estimated as of April 1975.

3-7 Evaluation for Investment

Taken consideration of the character of this plan, the evaluation has been made from the standpoint of national economy, with which the total judgement was synthesized. The estimation was carried out on the basis of benefit-cost ratio, to which the calculation results from the internal rate of return were supplied. The time of horizon was set to cover 12 years from 1979 to 1990, when the track-doubling is completed, as commonly done for 10 - 15 years of this sort of project.

Sensitivity analysis was used to estimate the effect; in this method a probable future state was visioned, based on the actual figures given by the experiences with four factors such as freight rising rate, wage rising rate, commodity price rising rate, and transfer rate of cement transport from trucking. At the same time, certain levels were set up in close reference to the trend in the Korean whole-sale commodity price variations With the levels together with the four factors in various combinations, the analysis was conducted on the calculation results for the relativity among them.

The calculation result in benefit-cost ratio exceeded 1.2 to indicate a high possibility, while internal rate of return also exceeded 0.06 to show a good practicability, so the track-doubling plan of Chung Bug Line should be concluded to be feasible for construction.

By effecting the track-doubling, Chung Bug Line would reasonably absorb the transferred transport volume from Jung Ang Line, inclusive of its future trend, and eventually it will be capable of dealing with a large transport volume, which will grow by more than 20% per year and two times as much as national average.

4 Conclusion

Judging from the over-all study, it is concluded that the double-tracking project of Chung Bug Line is feasible for construction from a technical and economical point of view.

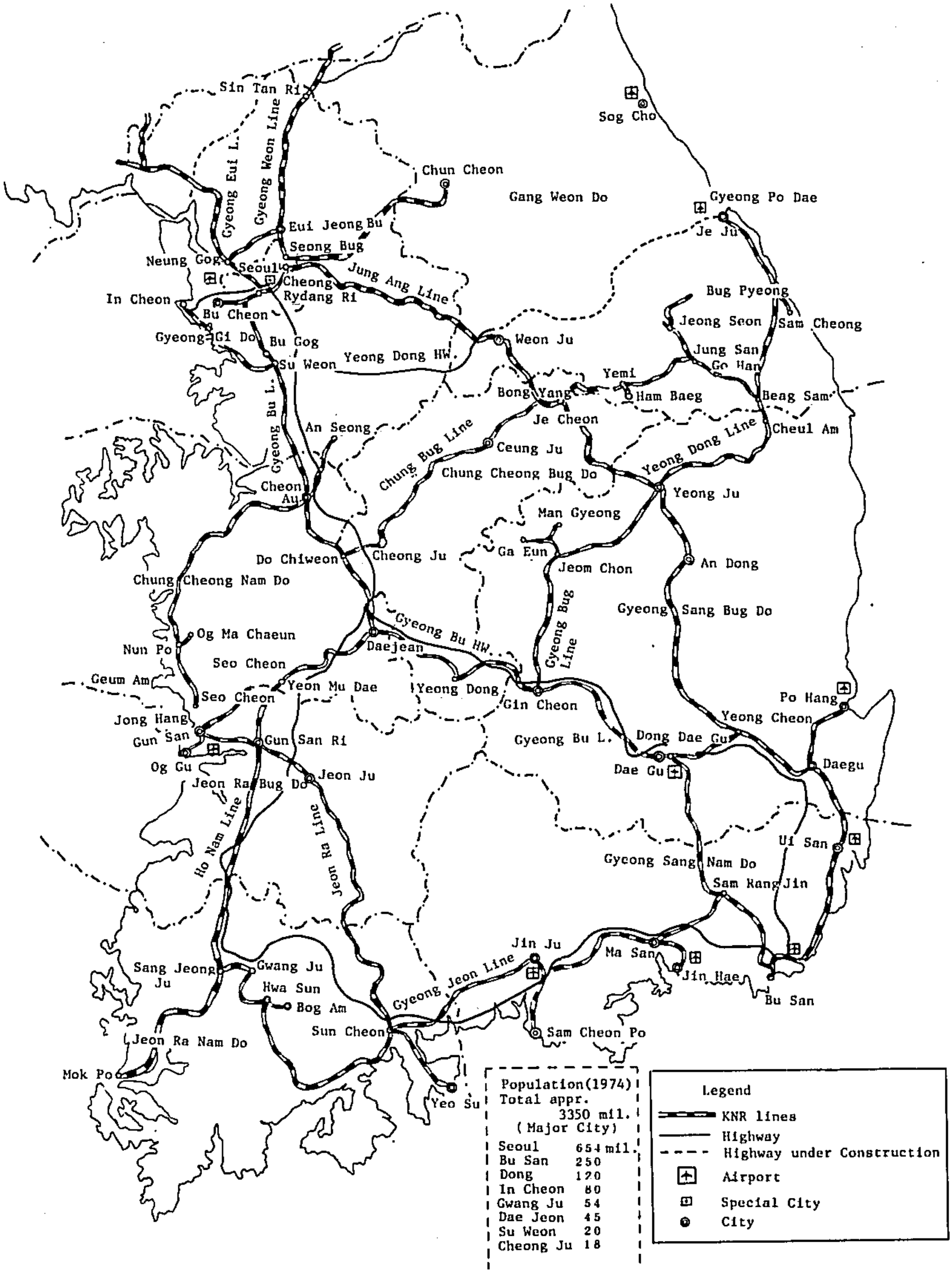
5. Problems to be solved in Future

Generally speaking, KNR's technical level is recognized to be so high, and its technology should be properly appreciated especially in the field of construction for the facts that it completed the long "Jeong Am Tunnel" in Tae Baeg Line and the track of as long as 500 km of a part of Chung Bug Line.

It is regretable, however, to note that the investment to KNR has been occasionally insufficient. For instance, the analysis of the train delay, which largely impedes traffic efficiency, discloses the shortage of accommodation capacity at main station yards, shortage of track capacity in the trunk lines, etc. Despite of a great deal of efforts made in the planning and adjusting of train operation, the existing facilities are definitely insufficient to keep up with the increasing demand for transport.

In the course of the 4th Five-year Economic Development Plan (1977 - 1981) to be promoted with its emphasis on social development, the investment in KNR, basic transport itself, should be treated as a matter of urgent importance. Especially Gyeong Bu Line is the nation's main artery, which if once disturbed would largely affect the social economy in Korea.
The railway section between Seoul and Su Weon is the most important to serve as interurban traffic line on its one side.

It is strongly recommended that an immediate review of Gyeong Bu Line should be made to plan out an optimum transport and to raise track capacity adequately coping with the possible future changes of situation, for it should facilitate the development of social economy of whole Korea.



Population(1974)
Total appr.
3350 mil.
(Major City)

Seoul	654 mil.
Bu San	250
Dong	120
In Cheon	80
Gwang Ju	54
Dae Jeon	45
Su Weon	20
Cheong Ju	18

Organization of Survey Team

I. The survey team consisted of the following members:

Leader	Yoshio Mukasa (General)	Deputy Director, Technical Development Dept., Japanese National Railways
Member	Noboru Machida (Railway Transport)	Deputy Director, Traffic Div., National Railway Dept. Railway Supervision Bureau, Ministry of Transport
Member	Hiromasa Ukawa(Railway Electricity)	Deputy Director, Safety Operation Div., National Railway Dept., Railway Supervision Bureau, Ministry of Transport
Member	Makio Kasai (Train Operation)	Assistant Chief, Planning Div., Train Operation Dept., Japanese National Railways
Member	Hideo Komatsu (Civil Engineering)	Assistant Chief, General Affairs Sect., Truck & Structure Dept., Tokyo Nishi Railway Division, Japanese National Railways
Member	Akira Muranaka (Economic Analysis)	Director, Systems Analysis Dept., The Japan Institute of Transportation Economics Inc.
Member	Seizo Hagiwara (Civil Engineering)	Senior Engineer, Railway Div., Pacific Consultant International
Member	Takeo Onozawa (Railway Electricity)	Senior Engineer, The Japan Electric Consulting Co., Ltd.
Member	Yoichi Seki (Coordination)	Staff, Social Development Cooperation Dept., Japan International Cooperation Agency

II. A team was organized for the purpose of explaining the final draft report to KNR with the following members:

Leader	Yoshio Mukasa
Member	Noboru Machida
Member	Hideo Komatsu
Member	Yoichi Seki

The team visited Korea for the period from October 1st to 7th 1975.

SCHEDULE OF SURVEY

The schedule of the survey team was made in brief as follows.

Date	Description
5/30	Orientation for the survey team.
6/11	Briefing of survey items. Questionnaire sent to Korean National Railroad (KNR) through Japanese Ministry of Foreign Affairs.
6/23	Lv. Tokyo, and ar. Seoul. Call on Japanese Embassy in Seoul, where conference was made.
6/24	Call on Korean Ministry of Transportation, where the survey members werw introduced to the Director General, higher officials and the counterpart in KNR.
6/25 ∿ 29	Discussions about the questionnaire with KNR counterpart.
6/30	Making of an interim draft report, presentation of which was made to KNR administrative staff. Request for Korean data. Preparations for the field survey.
7/1	Left for field survey. Survey of Gyeong Bu Line (Seoul - Dae Jeon), and Dae Jeon Yard for its expansion plan.
7/2	Survey of short-cut route from Jo Chi Weon station yard and Chung Bug Line to Gyeong Bu Line. Field study of railway improvement work on Chung Bug Line (Jo Chi Weon - Cheong Ju) and of yard improvement work on O Song and Sae Cheong Ju stations.
7/3	Field study of railway improvement work on Chung Bug Line (Cheong Ju - Bong Yang), and of yard improvement work on Mun Am, San Deung and Weon Bag stations.
7/4	Observation of Jung Ang Line (Bong Yang - Je Cheon - Yeang Ju). Field study of expansion plan of Je Cheon yard. Investigation of Je Cheon and Yeong Ju stations.

7/5 ∿ 6	Observation of both Tae Baeg and Yeong Dong Lines. Observation of anthracite and cement factories.
7/7	A Group: Survey of track doubling of Jung Ang Line (Je Cheon - Seoul). Ar. Seoul.
7/8 ∿ 10	A Group Investigation of surrounding areas of Seoul: Field study of Mang U and Cheong Ryang Ri yards along Jung Ang Line, Ri Mun and Su Saeg station yards, and the siding track of Mang U. Observation of briquet manufacturing factory. Field study of Yang San and Yeang Deung Po yards along Gyeong Bu Line, and of Gu Ru and Bu Gog station yards. Survey of the planned site of Bu Gog Freight Center. Observation of Seoul Back Shop.
7/7 ∿ 10	B Group Field study of new route of Chung Bug Line: New route area designated by grade improvement (near In Deung Tunnel, and up and down track separation zone between Gong Jeon and Bang Yang). New route area designated by city planning (Chung Ju city and Cheong Ju city). Ar. Seoul.
7/11 ∿12	Drafting of field survey report.
7/13 ∿20	Review and discussion about data presented by KNR. Meeting with KNR counterparts, Briefing for field study report. Meeting with Japanese Embassy officials.
7/21	Field study report submitted and expained to Director General of KNR. (Explanation to be made to Korean Ministry of Transportation later through KNR). Field study report submitted and explanined to Japanese Embassy.
7/22	Lv. Seoul, and ar. Tokyo.
7/23	Report to organizations concerned, on returning of the survey team.
7/28	Interim report submitted and explained to Japanese Ministries concerned.

I. Railway Service in the Republic of Korea

1-1 Passenger and freight service by rail

The present state of and the plans for the field of activity of each mode of transport, railway, road or motorcar transport, coastal shipping or airlines in Korea, according to the Korean Government report of 1973, are as follows:

1-1-1 Passenger traffic

The total traffic for 1974 would be 46,900 million passenger km, railways accounting 11,100 million passenger km or 24%, motorcar transport 35,200 million or 75%, and coastal shipping and airlines together accounting for only one percent.

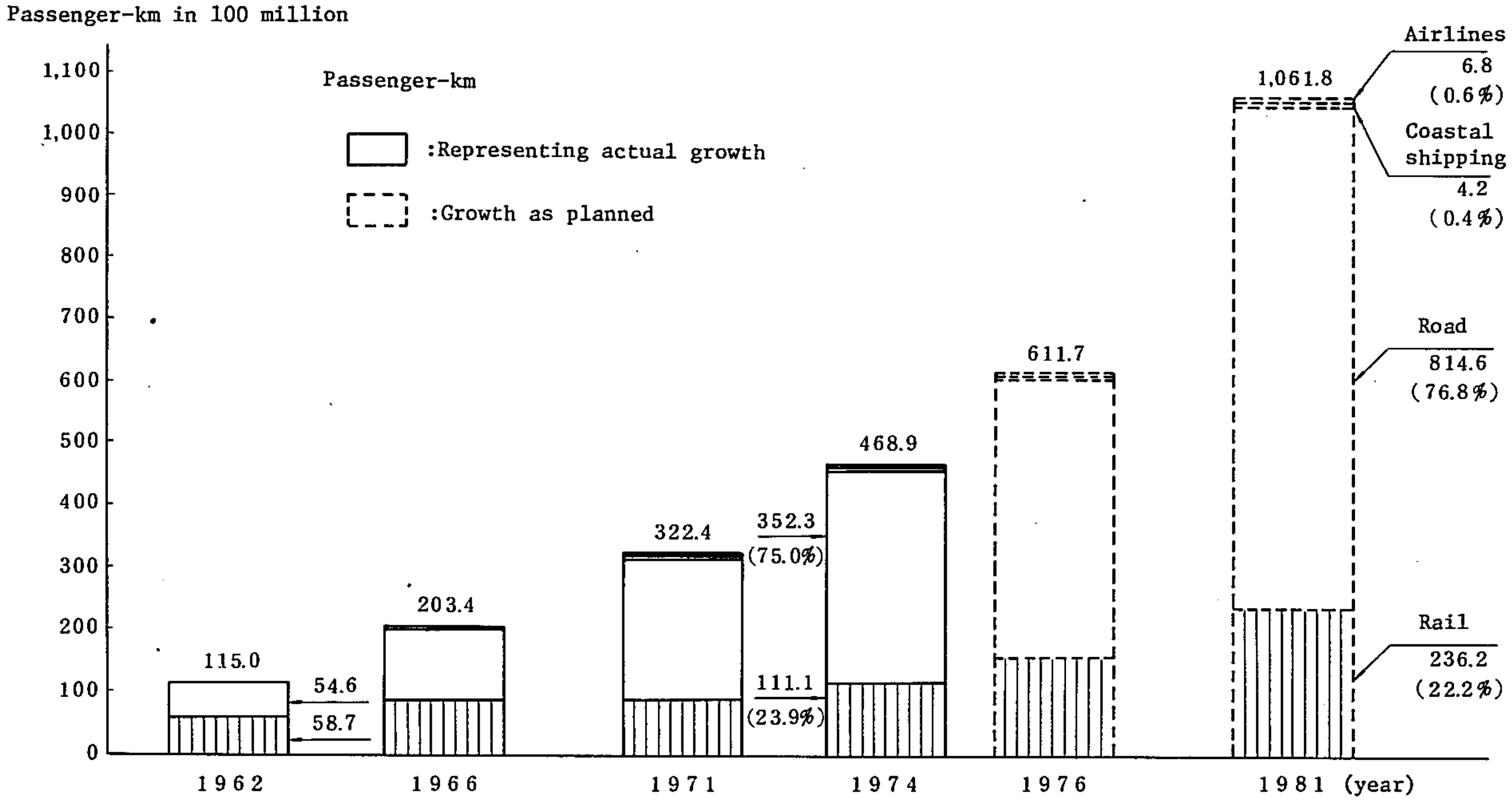
Comparing this with the 1962 figures, railways account for 51% and motorcar transport 48%, we find railways losing and motorcar transport gaining both in passengers carried and passenger km. In average ridership per person only a small change is noted in the meanwhile, 58 km both in 1962 and 1974 by rail and 8 km in 1962 and 9 km in 1974 by road service.

Under the plan the total traffic for 1981 is set at 106,100 million passenger km, with a yearly average growth rate marked at about 12% over 1974. The road traffic here is set at 81,400 million passenger km, or 77%, with the yearly average growth rate aimed at about 13% a rather big share for the road traffic. Against this, the railway traffic is planned to be 23,600 million passenger km, or 22%, with the yearly average growth rate set at 11%, lower than the average.

In the average transporting distance, 12.3 km is marked in the total traffic volume (against 10.8 km for 1974) with the 58km by rail for 1974 shortened to 36 km against the 8.5 km by road in 1974 raised to 10.2 km.

This goes to show that the commuter traffic, office workers and students, is expected to continue growing in larger cities and the bus service that is presently carrying on commuter service will sooner or later be stalemated and the high-speed mass transport by rail be looked up to as a mean of solution for the resulting road traffic jams. The average ridership per person then will go down as the consequence. The growth rate of passenger km is also planned to be low as is shown in Fig. 1.

Fig. 1-1 Passenger Traffic by Mode of Transport



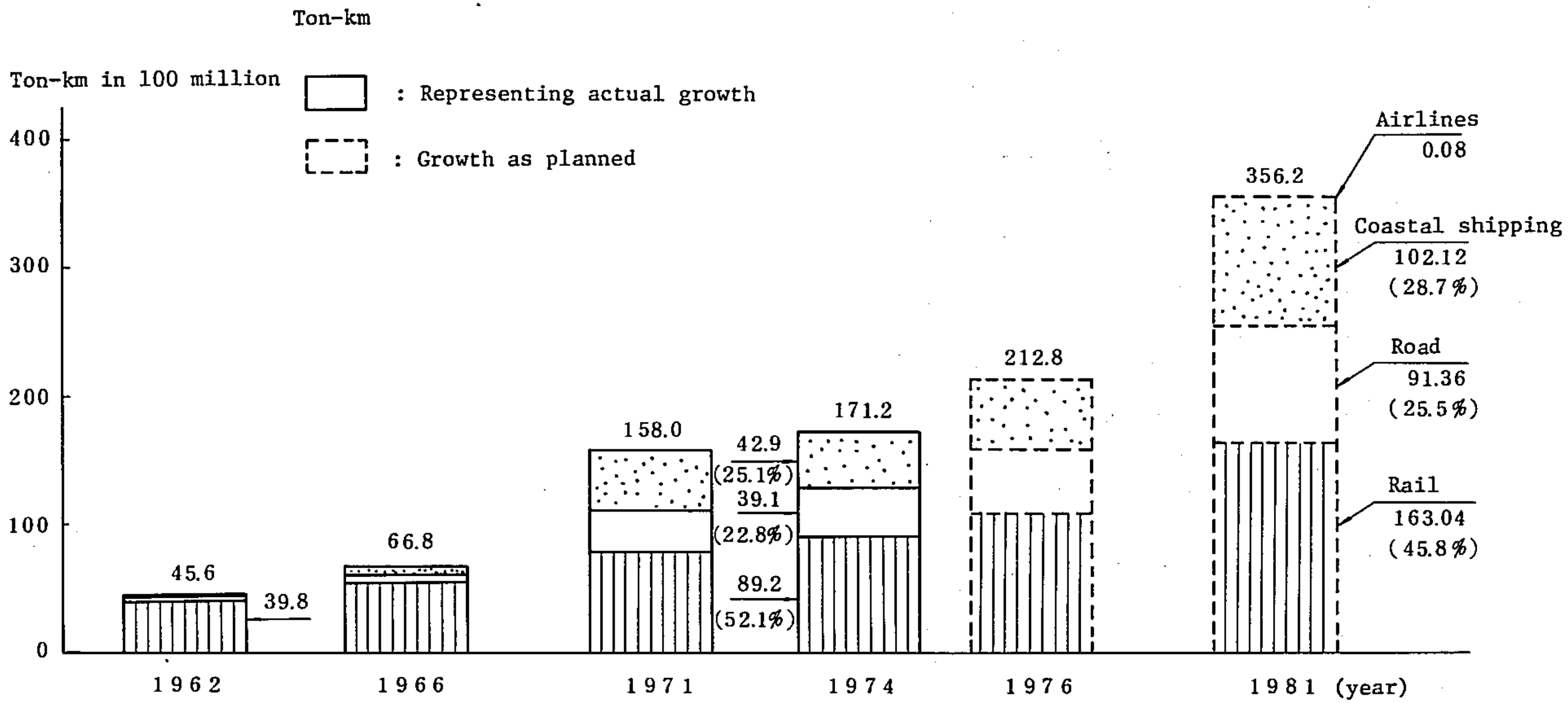
1-1-2 Freight traffic

The total freight traffic set in the plan for 1974 is 17,100 million ton-km, of which as much as 8,900 million, or 52.1%, by rail and 3,900 million, or 22.8%, by road. This, as compared with 87.2% by rail and 8.5% by road during 1962, is a notable increase by road and a decrease from 87.2% to 52.1% by rail.

Actually, however, the railway traffic continued to decline only up to 1970, for it has continued to account for about 50% since 1971. Coastal shipping accounted for 4,290 million ton-km, or 25%, in 1974, a remarkable growth from 200 million ton-km, or 4.3%, for 1962.

For 1981 the total freight traffic is set under the plan at 35,600 million ton-km, with an annual growth rate of about 11% over 1974. Of this, 16,300 million ton-km, or 46%, as compared with 52% for 1974 by rail at the low average yearly growth rate of 9%. The traffic by coastal shipping, on the other hand, is set at 10,200 million bon-km, or 28%, with the annual average growth rate set at as high as about 13%. The traffic by road is planned to be 9,100 million ton-km, or 28%, with the average annual growth rate set at 12%. The growth rate of rail traffic is thus assumed to be lower than that for any other mode of transport. (Fig. 1-2)

Fig. 1-2 Freight Traffic by Mode of Transport



This as compared with the traffic by mode of transport in Japan we have Table 1-1, let alone the scale of tonnages carried:

It is thus apparent that the railway in Japan is displaying its peculiar capability more markedly in passenger service, whereas that in Korea in freight service. When both the passenger and freight service combined, we find that the railway in Korea enjoys a greater share in traffic than that in Japan.

Table 1-1 Comparison of Traffic by Mode of Transport in Japan and Korea

(%)

Item / F.Y. / Mode of Transport	Passenger			Freight		
	Japan	Korea		Japan	Korea	
	1974	1974	1981	1974	1974	1981
Total traffic	100	100	100	100	100	100
By rail	46.8	23.7	22.3	14.0	52.1	45.8
By road	49.6	75.2	76.7	34.7	22.8	25.6
By coastal shipping	1.1	0.5	0.4	51.3	25.1	28.6
By airlines	2.5	0.6	0.6	-	-	-

Note: 1. The percentage by rail in Japan indicates the total value of traffic by JNR and private railways.

2. The numerical values for Japan from the "Handbook of Statistics on Land Transportation" compiled by the Japanese Ministry of Transport.

1-2 Railway's share in transportation of anthracite and cement

1-2-1 Anthracite

Production of anthracite which amounted to 15.5 million tons in 1974 is planned to be upped to 24 million tons in 1981. All the anthracite output in 1974 was for domestic consumption. That is, production meant consumption, and, as the consequence, transport service lagged behind the demand.

On the total 24 million, 8.5 million is hauled by more than two modes of transport to the consuming areas.

The anthracite produced in the Tae Bueg-Yeong Dong District in the northeastern part of Korea is shipped out either from the terminal freight line track or the plant yard industrial track in the producing district. That is to say, almost 100% of the coal shipped out from the mines depend upon rail for transportation. Of this, 5 to 10% are loaded on coal boats at the nearby ports to be transported to the pusan area. The rest is hauled on by rail to the consuming areas, where it is stored in the briquest manufactories equipped with industrial tracks. To the briquest manufactories in some towns and villages it is distributed from the rail terminal coal yard by trucking service. Transportation of anthracite thus depends largely on rail and efficiency in it is largely enhanced by use of industrial track.

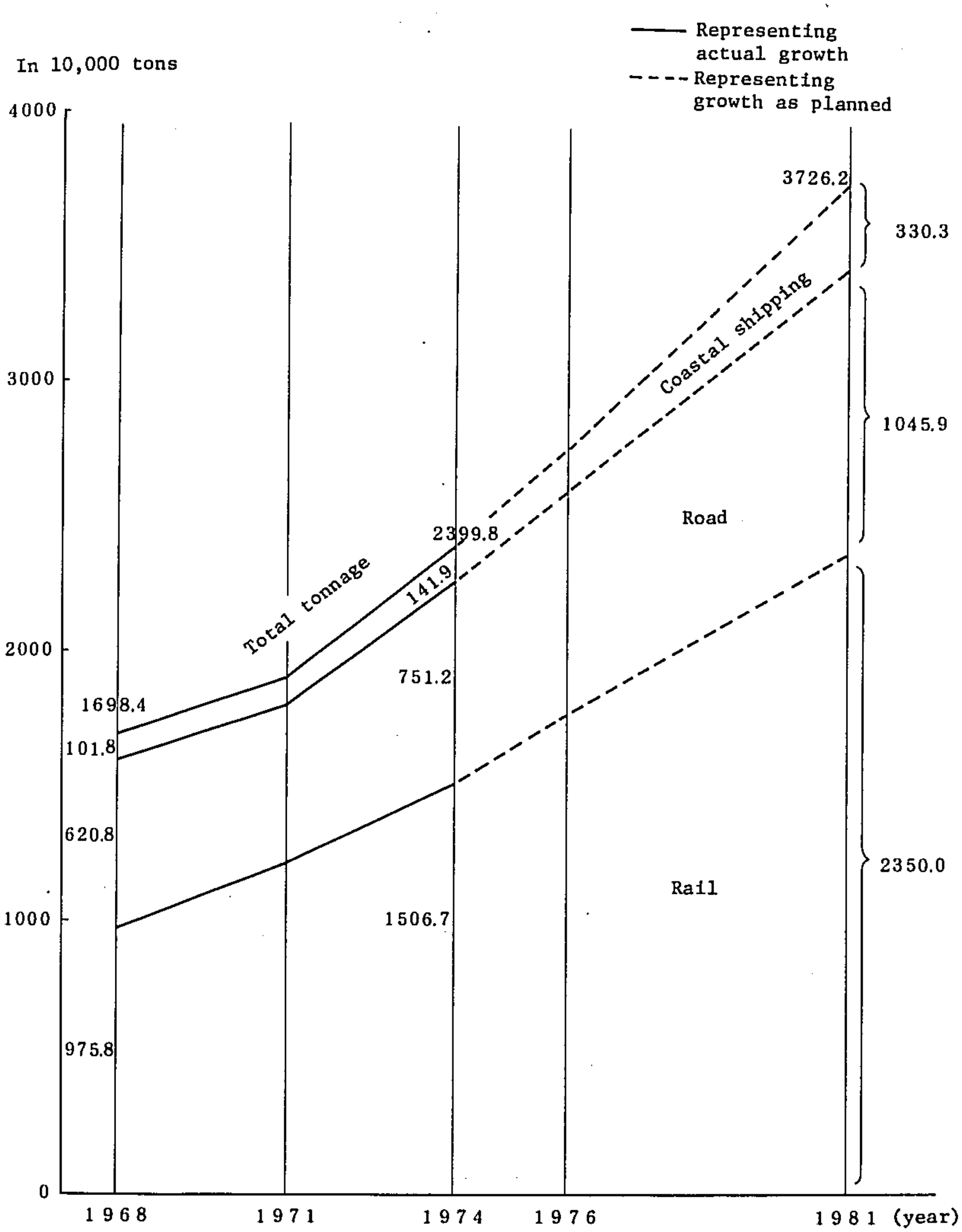
The tonnages of anthracite carried by various modes of transport are shown in Table 1-2 and Fig. 1-3 to follow. As is seen in these the hauling by rail is set at 63% in 1981 as in 1974, 15 million tons tons. With the yearly average growth rate of 6.6% estimated the rail hauling is planned to reach some 23.5 million tons in 1981. Though the hauling by coastal shipping is set low at 6 to 9%, the annual average growth rate is estimated to reach as high as 12.8%. Here the hauling is mostly for the Gyeong Song Nam district, including pusan. During 1974 the hauling by coastal shipping to these consuming district reached 70%. For 1981 100% hauling by coastal shipping is planned.

Table 1-2 Anthracite Hauling by Mode of Transport

(In 10,000 tons)

F.Y. / Mode of transport	1974	1981	Yearly average growth rate (%)
Total tonnage	2399.8 (100)	3726.2 (100)	6.5
By rail	1506.7 (63)	2350.0 (63)	6.6
By road	7512 (31)	1045.9 (28)	4.8
By coastal shipping	141.9 (6)	330 (9)	12.8

Fig. 1-3 Anthracite Hauling by Mode of Transport



By quarterly hauling the railway actually accounted for about 24 to 27%. Now that anthracite storage facilities in the rail terminals are already built up, normalization of transport service for higher efficiency during autumn and winter is planned.

To the rail freight service, anthracite is an essential item. In 1974 the hauling by rail reached 3,400 million ton-km. For 1981 a raise up to 5,300 million ton-km is planned. The hauling corresponds to 38% of the total ton-km carried by rail in 1974 and 33% in 1981, the largest single item for rail transport.

Cement ranks next to anthracite. Both combined, the tonnage reaches as much as 50% of the total hauling by rail both in 1974 and 1981.

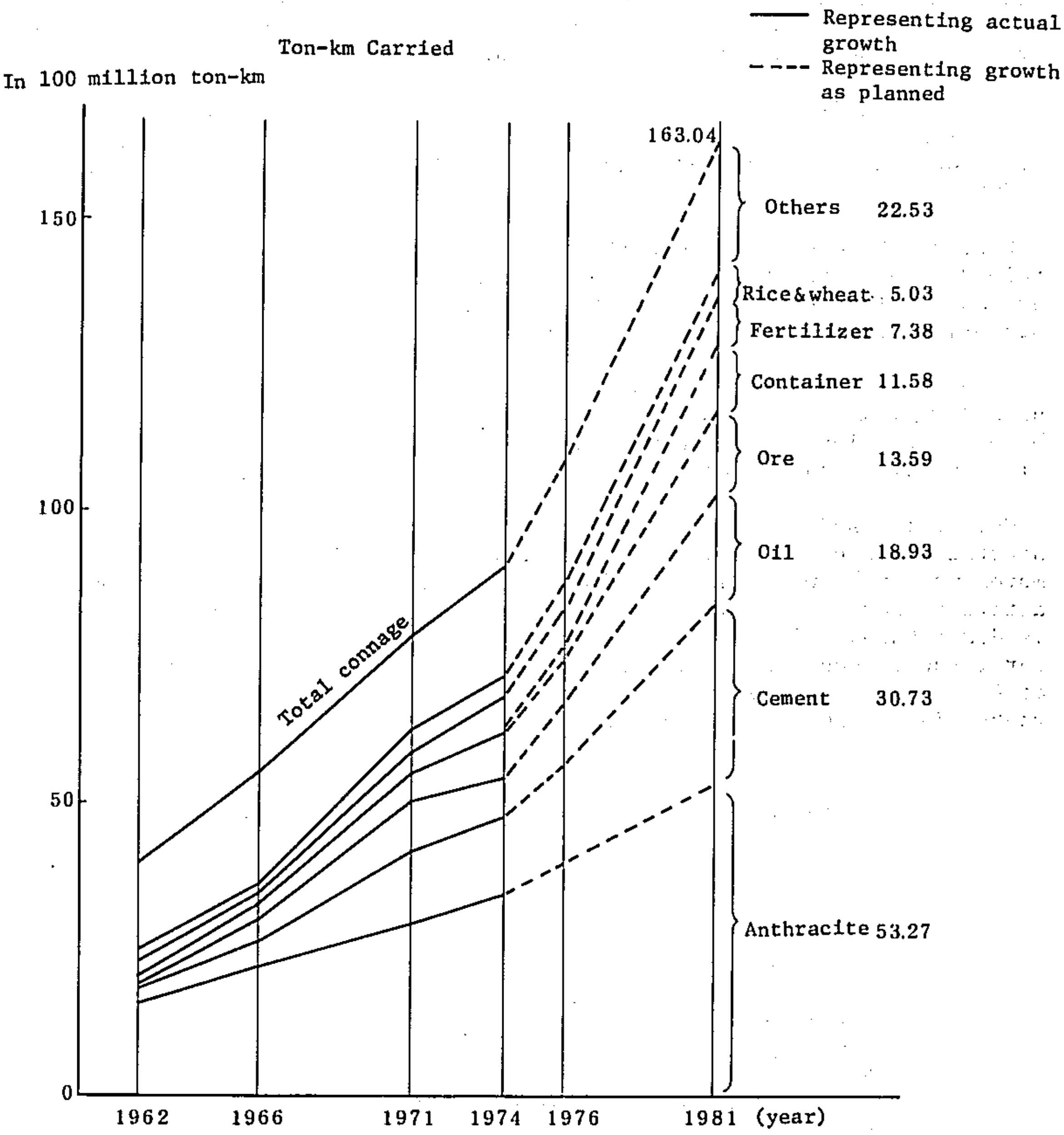
A marked increase in kerosene transportation is noted. This item, however, is mainly for use in electric power generation and iron and steel and cement production. As Korean households are not accumtomed to the use of it for cooking and heating, it is proper and reasonable in the light of the economic growth of the nation that the yearly average growth rage of 6.6% is set as the target in the plan.

Table 1-3 Rail Freight Tonnage by Item

(In 10,000 tons)

F.Y. Item	1974	1981	Annual average growth rate (%)
Total tonnage	90.05 (100)	163.04 (100)	8.9
Anthracite	34.08 (37.9)	53.27 (32.7)	6.6
Cement	13.36 (14.8)	30.73 (18.9)	12.6
Oil	6.49 (7.2)	18.93 (11.6)	16.5
Ore	7.51 (8.3)	13.59 (8.3)	8.8
Container	0.86 (1.0)	11.58 (7.1)	45.2
Fertilizer	5.25 (5.8)	7.38 (4.5)	5.0
Rice & wheat	3.34 (3.7)	5.03 (3.1)	6.0
Others	19.16 (21.3)	22.53 (13.8)	3.2

Fig. 1-4 Rail Freight Tonnage by Item



1-2-2 Cement

Cement was to be produced to the tune of 9,300,000 tons in 1974, of which 7,500,000 tons was for domestic use and 1,800,000 tons for export. For 1981 the production is planned to be raised to 27 million tons with a larger growth rate set than that for anthracite production.

Produced as is anthracite in the Taihaku-Reito District in the northeastern part of Korea, all the hauling of cement begins with the railway, as there are industrical tracks and loading facilities set up in all the cement plant yards.

Part of the cement for export and domestic consumption hauled by rail is reloaded on ships at ports. Those plants making direct shipments by boat are mostly located close to ports and the majority of the plants in the hinterland depend upon rail for consignments to the consuming areas.

Shipments by boat are destined to seaside industrial zones, such as Po Hang Ui San Ma San and Yeo Su,where cement is consumed in bulk. Shipments by boat are planned to occupy 18% of all the shipments planned for 1981 (11% in 1974) and the growth rate is set high in the plan.

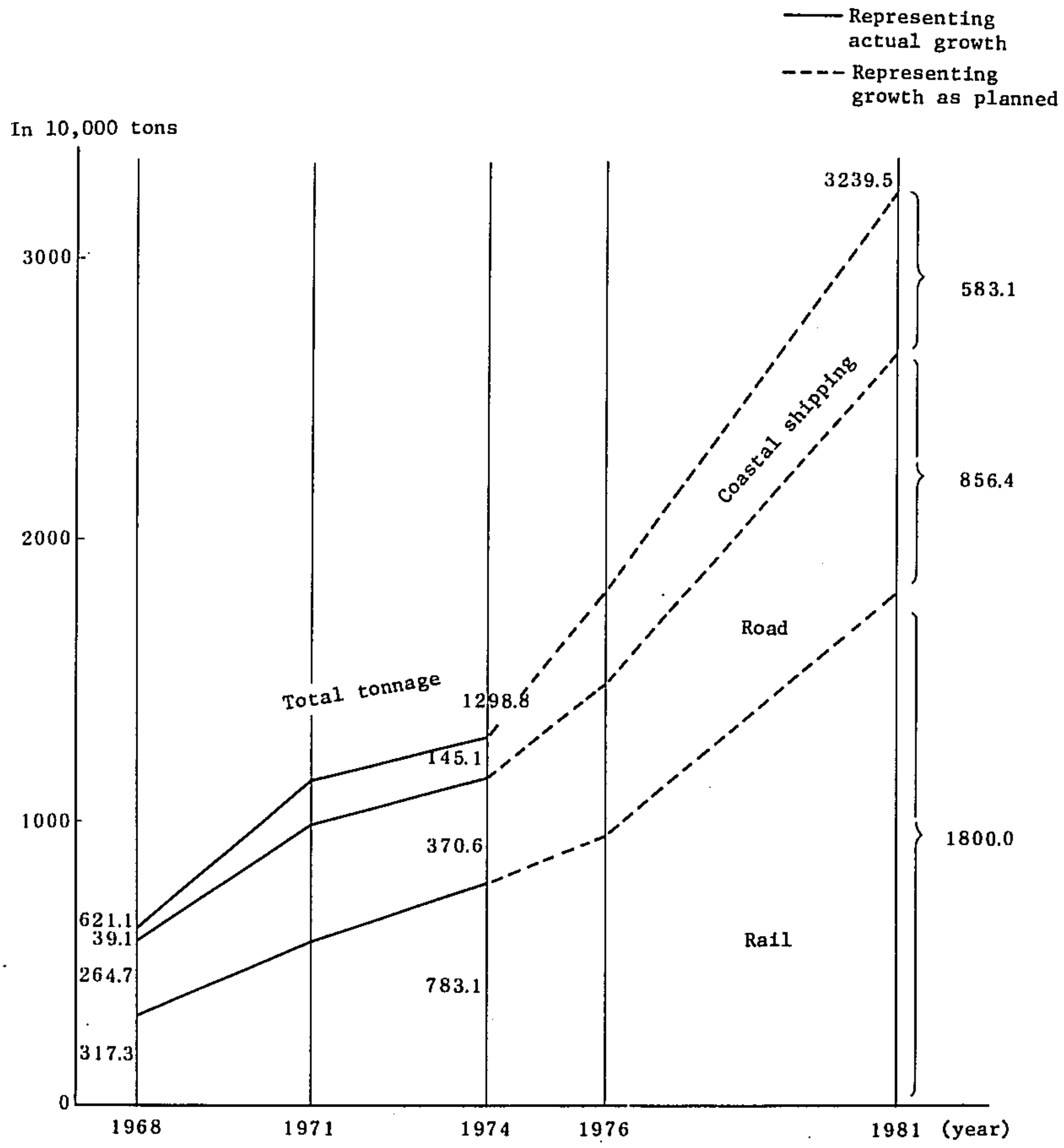
Cement is used largely for the construction of office buildings and apartment houses in Seoul and other principal cities. There besides is a movement for "new village construction" called the "Sae-Mauel" campaign being actively carried on, and for this, cement is strongly demanded. Cement thus is distributed all over the country by the railway network. (So are motorcars, too.) Consequently, railway share in cement transportation was set at 60% in 1974 and 65% is aimed at for 1981. Along with anthracite, cement ranks high in importance to railway.

Table 1-4 Cement Tonnage by Mode of Transport

(In 10,000 tons)

F.Y. / Mode of transport	1974	1981	Annual average growth rate (%)
Total tonnage	1298.8 (100)	3239.5 (100)	13.9
By rail	783.1 (60)	1800.0 (56)	12.6
By road	370.6 (29)	856.4 (26)	12.7
By coastal shipping	145.1 (11)	583.1 (18)	22.0

Fig. 1-5 Cement Tonnage by Mode of Transport



1-3 Importance of anthracite and cement in national living

Anthracite and cement indispensable to daily life in Korea. Just as rice and wheat are, these are daily neceessities.

About 90% of anthracite is processed into briquests for use in heating the rooms, Hot Floor, during the cold season, as well as in cooking throughout all seasons.

Prior to the oil shock when the national economy was growing rapidly, kerosene burners came into popular use for a while, but now that the people are economy-minded there is a strong demand again for briquests, for which the productive capacity is high. And the transport capacity is seen lagging behind the demand.

Briquests are made of anthracite power hardened by machine. The market price is less than 17 yen each, exmill. A household of five members uses in an average two pieces (each retailed at less than 20 yen) a day during summer and eight pieces a day in winter. So cheape is this fuel.

Although consumption of kerosene and the like tends to increase, oil is used mainly in power generation and iron, steel and cement production. Because of the price and the peculiar structure of Korean houses using the "ondoru" type heater, it is said that the people will not get accustomed to oil as fuel for heating and cooking.

Cement, on the other hand, is used in construction of office buildings and apartment houses, as well as in developing industrial complexes and in creating "new villages" under the Sae-Mauel movement.

The Sae-Mauel movement is a campaign for the creation of new villages with the living environment improved and the villagers' income levelled up. Demand for cement is strong particularly in rural areas where efforts are being exerted to improve house roofs, reconstruct kitchens, widen the roads and set up service water ditches. With the environment thus fundamentally improved, the productive capacity of rural districts will go up and the villagers' income levelled up. The movement is being carried on with some 33,000 villages throughout the country serving as units. The strong demand for cement is expected to continue.

How to transport anthracite, cement and other essentials cheaply and securely, therefore, is essential in stabilizing the people's livelihood as well as in levelling up the living standard in the rural districts.

1-4 Summary

Railway service in Korea is well developed throught the country, capable of serving the country as the basic means of transport. Especially in the field of freight transport, its share amounted to as much as 52%, outranking coastal shipping, road and other means of transport.

The freight transport plan of the Korean Government shows an estimated growth of total freight traffic up to 35,600 million ton-km, as compared with 17,100 million ton-km for 1974, at the yearly growth rate set at 11% by 1981 when the Fourth Five-year Plan for Economic Development comes to its completion.

For the railway the yearly growth rate is set low at 9% in this plan. Even then its share in 1981 comes up to 16,300 million ton-km, or 46%, nearly half of the total traffic. This means a two-fold increase over 8,900 million ton-km in 1974.

The principla rail freight items are anthracite and cement and these two items together comprise half of the total hauling of freight by rail, 53% in 1974 and 52% in 1981. Other main items are ore, oil, fertilizer, rice, wheat and containerized miscellaneous goods, which also are essential in the industrial and economic development of the nation.

The railway's shares in the transportation of anthracite and cement are extremely high, 63% and 60 to 56%, respectively. The railway plays an important role in the distribution process of these items as well, and it is not exaggerating to say that the railway alone among other means of transport is capable of transporting these vital items.

Approximately 90% of anthracite are processed into briquests for household use, heating and cooking. These are inexpensive fuel daily used in national living.

The demand for oil products continues strong. However, these are mainly for industrial use. For heating and cooking in ordinary households they are too expensive. The dwellings in Korea being of the "ondoru" type structure, besides, the people in general are not accustomed to oil products as fuel.

Strongly in demand also is cement for use in developing seaside industrial zones and in constructing office buildings and apartment houses. It also is used country-wide in improving living environment in connection with the "Sae-Mauel movement being extensively carried on.

The Sae-Mauel movement is a "new village creation" movement aspiring for the improvement of environment and the growth of villagers' income through "self-support, cooperation and diligence." In farming villages, for instance, cement is plentifully used to improve house roofs, reconstruct kitchens, enlarge road breadth and build up ditches for the amelioration of living environment. This will lead to strengthen the productive capacity of farming villages and level up the villagers' living standard.

As the new village creation movement for over 33,000 villages in the country is expected to be vigorously carried on, cement will be demanded all the more strongly.

The railway in Korea thus has itself well-established as the basic means of transport in the country. Especially in the field of freight service, it had a large share of 52% in 1974, and the share planned for the railway in 1981 is set at 46%. The freight items it transports are all basic commodities, indispensable to national life, such as anthracite, cement, ore, oil, rice, wheat and fertilizer, which were carried to the tune of 9,000 million ton-km during 1974. It may as well be said that Korea has a railway system already firmly established for bulk transport with industrial tracks efficiently put to work, and, with its closely-knit country-wide network, it indeed is playing a feature role in the development of national economy. So it will continue to act up to its role.

II. Measures for the Better Way of Transporting Anthracite and Cement

2-1 Plans for producing and supplying anthracite and cement

In the Fourth Five-year (1977 to 1981) Plan for Economic Development of the Korean Government, the plans for the supply and demand of anthracite and cement are drawn up as follows:

2-1-1 Anthracite

(1) Production plan

In 1974 15.5 million tons of anthracite was produced. Beginning in 1977 the plan calls for production of 19 million tons in that year and for an increase in production by some 1.3 million tons every year thereafter until the production reaches 24 million tons in 1981, an increase of 8.5 million tons, or 55%, over 1974. For 1977 29.5 million tons is set for transportation under the plan and the transporting capacity is to be raised for additional 2 million tons each year. (Table 2-1)

Table 2-1 Anthracite Production, Actual & As Planned, and Modes of Transport for the Hauling

		'67	'68	'69	'70	'71	'72	'73	'74	'75	'76	'77	'78	'79	'80	'81
Production		12,436	10,242	10,273	12,394	12,785	12,403	13,571	15,500	17,000	18,000	19,000	20,300	21,500	22,800	24,000
Transportation	Total	16,884 (100.00)	16,984 (100.0)	16,033 (100.0)	18,476 (100.0)	19,101 (100.0)	16,718 (100.0)	19,833 (100.0)	23,998 (100.0)	25,688 (100.0)	27,447 (100.0)	29,463 (100.0)	31,659 (100.0)	33,861 (100.0)	35,609 (100.0)	37,262 (100.0)
	By rail	11,274 (66.7)	9,758 (57.5)	10,418 (65.0)	12,070 (65.3)	12,123 (63.5)	11,318 (67.7)	13,635 (68.7)	15,067 (62.8)	16,600 (64.6)	17,600 (64.1)	18,600 (63.1)	19,900 (62.9)	21,100 (62.3)	22,300 (62.6)	23,500 (63.1)
	By road	4,179 (24.8)	6,208 (36.6)	4,700 (29.3)	5,037 (27.3)	5,827 (30.5)	4,570 (27.3)	5,320 (26.8)	7,512 (31.3)	7,588 (29.5)	8,247 (30.0)	8,707 (29.6)	9,207 (29.1)	9,768 (28.8)	10,204 (28.7)	10,459 (28.1)
	By coastal shipping	1,431 (8.5)	1,018 (5.9)	915 (5.7)	1,369 (7.4)	1,151 (6.0)	830 (5.0)	878 (4.5)	1,419 (5.9)	1,500 (5.9)	1,600 (5.9)	2,156 (7.3)	2,552 (8.0)	2,992 (8.9)	3,105 (8.7)	3,303 (8.8)

Note: 1. Figures in 1,000 tons

2. Figures from the plan drawn by the Commerce & Industry Dept. & Traffic Dept. (1974)

Anthracite is produced mainly in the Tae Baeg and Yeong Dong District in the northeastern part of Korea. Here 11.5 million tons was produced, or 74% of the total production in the whole country. The Ham Chong Ga Eun and Mum Gyeong district along the Gyeang Bug Line ranked next with 2.3 million, or 14%, followed by the Daisen District along the Chokosen Line with 960,000 tons, or 6% and the Hwa Sun district along the Gyeong Jean Line with 750,000 tons, or 5%.

Production increase called for under the plan is 8.5 million tons in 1981 over 1971, of which 5.75 million, or 68%, in the Tae Baeg and Yeang Dong district. (Table 2-2)

Table 2-2 Plan for Anthracite Production by District

(In 1,000 tons)

		'74		'81		'81 - '74	
Taihaku-Reito District		11,474	74.0	17,220	71.8	5,746	67.6
Others	Keihoku District	2,235	14.4	3,140	13.1	905	10.6
	Keizen District	754	4.9	1,110	4.6	356	4.2
	Choko District	963	6.2	2,290	9.5	1,327	15.6
	Keihu District	74	0.5	240	1.0	166	2.0
	Total	4,026	26.0	6,780	28.2	2,754	34.2
Grand Total		15,500	100.0 %	24,000	100.0 %	8,500	100.0 %

(2) Supplying plan

Of the anthracite production, 90% is for household use, processed into briquest and supplied to ordinary households.

Anthracite for household use amounted to 14.21 million tons in 1974. An annual increase of about 1 million tons considered, supply of 21.08 million tons is set in the plan for 1981.

Anthracite for industrial use amounted to 1.37 million tons in 1974, mainly for use in drying tobacco and generating electric power. An increase up to 2.5 million tons in supply is expected for 1981. (Table 2-8)

Under the supplying plan by district, the largest quantities are for the Special City of Seoul and the Gyeang Gi Do District -- 7.56 million tons, or 53%, in 1974. In 1981 the supply to this district will increase by 3.57 million tons to reach 11.13 million, or 53% of all the anthracite supplied to the nation.

The next largest supplied is 2.38 million tons, or 11%, to the Bu San District in 1981, followed by 2.35 million, or 11%, to the Gyeang Bug district, 1.44 million, or 7%, to the Jean Nam district and 1.08 million, or 5%, to the Chung Nam district. (Table 2-3, Fig. 2-4)

Table 2-3 Anthracite Supplying Plan by District
(for household use)

(In 1,000 tons)

	'74		'81		'81 - '74	
Special City of Seoul district	7,558	53.2	11,133	52.8	3,575	52.1
Gyeang Gi Do district	1,644	11.6	2,375	11.3	731	10.7
Gyeang Bu district	1,562	11.0	2,354	11.2	792	11.5
Jeam Nam district	941	6.6	1,435	6.8	494	7.2
Chung Nam district	701	4.9	1,075	5.1	374	5.4
Other	14,214	100.0 %	21,077	100.0 %	6,863	100.0 %

2-1-2 Cement

(1) Production plan

Cement production in 1974 was 9.28 million tons. The production plan calls for 19.66 million in the first year of 1977 and, with an increase of 2 million each year thereafter, for 27.06 million in 1981--a growth of 17.78 million, or 192%, over 1974. For transportation 20.55 million is set for 1977 and an annual increase of 3 million thereafter is marked. (Table 2-4)

Table 2-4 Cement Actually Produced & As Planned for Production and Transportation by Mode of Transport

		'68	'69	'70	'71	'72	'73	'74	'75	'76	'77	'78	'79	'80	'81	Remark
Production		3,574	4,865	5,822	6,872	7,630	8,290	9,280	11,260	16,860	19,660	22,060	25,060	27,060	27,060	
Transportation	Total	6,211 (100.0)	8,071 (100.0)	9,980 (100.0)	11,516 (100.0)	10,988 (100.0)	12,908 (100.0)	12,988 (100.0)	15,575 (100.0)	18,102 (100.0)	20,547 (100.0)	23,183 (100.0)	26,105 (100.0)	29,343 (100.0)	32,395 (100.0)	
	By rail	3,173 (51.1)	4,358 (54.0)	4,858 (48.7)	5,780 (50.2)	5,986 (54.4)	7,546 (58.5)	7,831 (60.3)	9,200 (59.0)	9,540 (52.7)	11,650 (56.7)	13,910 (60.0)	15,430 (59.1)	16,640 (56.7)	18,000 (55.6)	
	By road	2,647 (42.6)	2,572 (31.9)	3,239 (37.5)	4,160 (36.1)	3,650 (33.2)	3,901 (30.2)	3,706 (28.5)	4,713 (30.3)	5,304 (29.3)	5,198 (25.3)	5,100 (22.0)	5,976 (22.9)	7,421 (25.3)	8,564 (26.4)	
	By coastal shipping	391 (6.3)	1,141 (14.1)	1,383 (13.8)	1,576 (13.7)	1,352 (12.4)	1,461 (11.3)	1,451 (11.2)	1,662 (10.7)	3,258 (18.0)	3,699 *18.0)	4,173 (18.0)	4,699 (18.0)	5,282 (18.0)	5,831 (18.0)	

Note: 1. Figures in 1,000 tons

2. Figures from the plan drawn up by the Commerce & Industry Dept. and the Traffic Dept. (1974)

Cement is mainly produced, as anthracite is, in the Tae Baeg Yeang Dong District in the northeastern part of Korea. Production here amounted to 8.14 million tons in 1974, or 88% of the total production.

Ranked next is in and around on the Ho Nam Line with 0.66 million, or 7%, and Mun Gyeong Area along the Mun Gyeong Line with 0.48 million, or 5%.

In 1981 the production is planned to be raised up to 17.78 million tons over 1977, and most of this in the Tae Baeg Yeang Dong district. (Table 2-5)

Table 2-5 Cement Production Plan by District

(In 1,000 tons)

	'74		'81		'81 - '74	
Tae Baeg Yeang Dong district	8,140	87.7	19,920	73.6	11,780	66.2
Ho Nam district	660	7.1	660	2.4	0	-
Mun Gyeang district	480	5.2	480	1.8	0	-
Others	0	-	6,000	22.2	6,000	33.8
Total	9,280	100.0	27,060	100.0	17,780	100.0

(2) Supplying plan

The demand for cement in 1974 was 7.5 million tons for domestic consumption and 1.8 million for export. Most of the cement for domestic consumption is used for the construction of office buildings and apartment houses in the major cities. Largely used also as the outcome of the Semaura movement in rural districts, in the building of dwellings, roads, bridges and in the repairing of rivers and streams. The distribution of consuming districts is about the same as that of anthracite.

Under the supplying plan by district the City of Seoul and Gyeong Gi Do district was to produce 3.03 million tons, or 41% of the national production.

In 1981 the demand in this District is set at 4.71 million tons, or 27% of the national demand. This goes to show a notable indrease in demand elsewhere.

In 1974 the exports amounted to 1.8 million tons, or 19% of the total production. In 1981 this is expected to be raised to 9.6 million tons, or 35% of the national production.

2-2 Disputable points of the existing rail line route

2-2-1 Jung Aug Line up-train track constituting bottleneck

At present anthracite and cement produced in the Tae Baeg-Yeong Dong district are transported to the Special City of Seoul and its vicinity where 50 to 40% of national consumption is accredited with, and this by the up-freight trains on the Jung Aug Line. The rest by the up-trains on the Chung Bug Line and the down-trains on the Jung Aug Line.

The freight by up-trains on the Jung Aug Line is for the Special City of Seoul and its satellite cities of In Chean Su Wean and others on the southern side of the Han Gang River to the southeast of Seoul. The main items are anthracite and cement, and out of the total passing tonnage of 11 million tons in 1974, these two items together constituted 7 million (64%) and 3 million (27%), respectively, or as much as 91%. (Table 2-6)

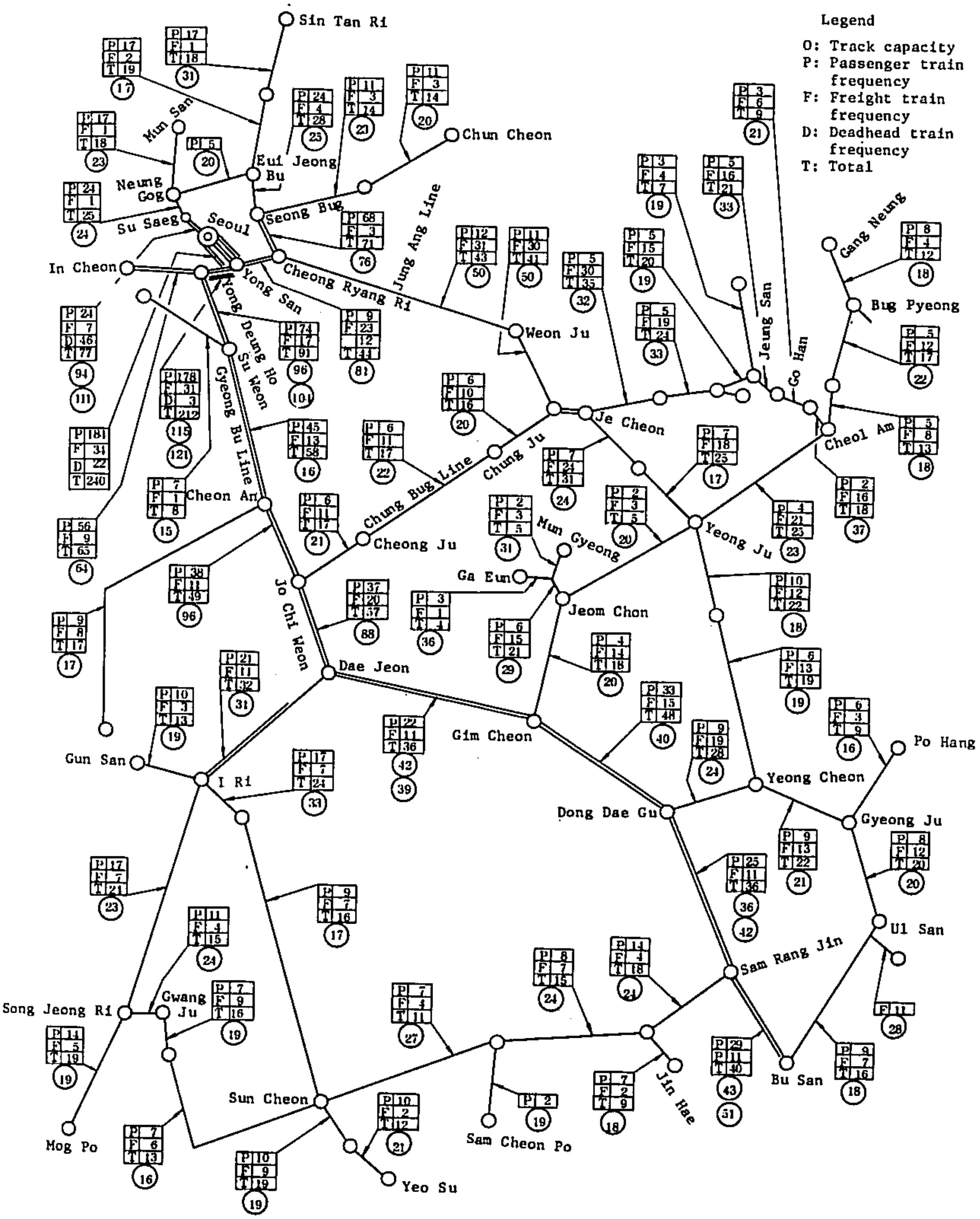
Table 2-6 Passing Tonnages of Main Freight Items in 1974

(In 1,000 tons)

Line / Item	Jung Aug Line up-trains		Jung Aug Line up trains		Chung Bug Line up-train	
	Cheang Ryang Ri-Bang Yang		Yeang Ju - Yeang Chean		Cheang Rhang Ri Jo Chi Weon	
Anthracite	6,982	63.6	1,598	39.1	476	28.0
Cement	2,982	27.2	1,074	26.3	818	48.1
Ores	365	3.4	722	17.6	83	4.9
Others	636	5.8	696	17.0	323	19.0
Total	10,965	100.0	4,090	100.0	1,700	100.0

The Jung Aug Line (155 km between Cheang Ryang Ri and Je Cheon) has already undergone improvements time and again and is now a high-level single-track line of semi-secondary line track structure, electrified with alternating current, its signals automated, operating CTC. In all 43 trains are operated per day, (31 freight and 12 passenger trains), and this is almost up to the limit for a single-track line of 45 to 50 trains per day. As it is, the line will soon be incapacitated in meeting the increasing demand expected. (Fig. 2-1)

Fig. 2-1 Track Capacity & Train Frequency by Line & Section (June, 1975)



In strengthening the Jung Aug Line, additional tracks for some of its sections will no longer suffice. The whole line of 15.5 km will have to be bolstered with a line of additional track, A.C. electrified for CTC operation.

This additional track laying including the construction of tunnels to the total length of 15 km and that of bridges to 5 km needs the cost of 75,000 million wons, or 45,000 million yen, and a period of 6 years. And it will not be completed in time by 1978-79 when the transport capacity of the Jung-Aug Line is expected to reach its limit.

2-2-2 Bottleneck in transportation within the special City of Seoul

About half of the anthracite reaching the City of Seoul and its satellite cities is unloaded on the industrial tracks of I Mon and Mang U Stations for storing in the briquet manufactories, where it is made into briquests for distribution among the households in the City of Seoul.

About half of cement also is unloaded in the eastern part of Seoul, at Chang Dang, Seong Bug and Seo Big Go Stations. (Fig. 2-2) This is because of the level railway crossings within special city of Seoul, constituting a bottleneck in transport service and incapacitating both the freight trains and the passenger trains to operate in the same time zones. (Fig. 2-3)

Fig. 2-2 Arriving Tonnages of Anthracite, Cement & Oils (In 1974 in Metropolitan Seoul & Its Satellite Cities -- Main Stations Only)

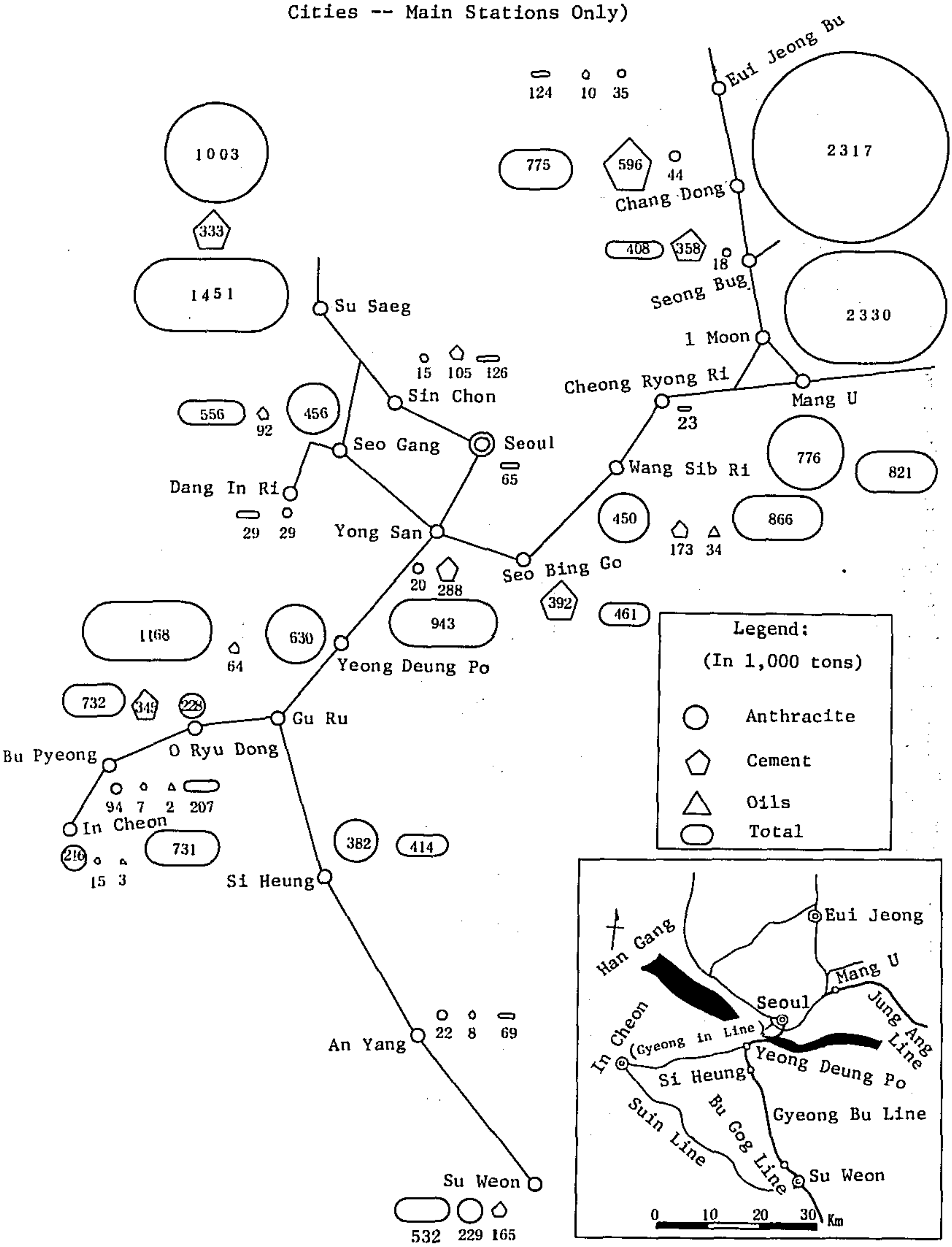
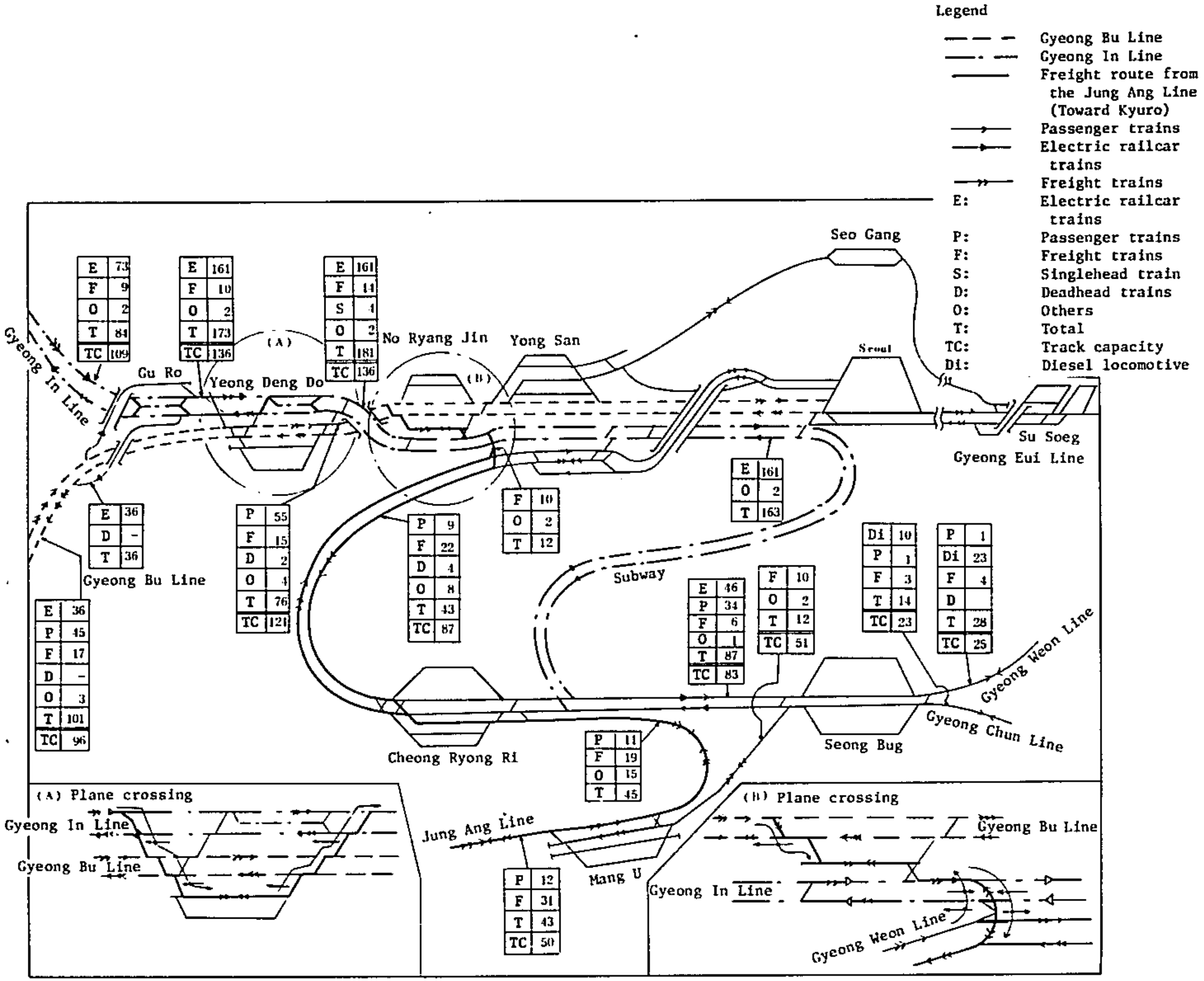


Fig. 2-3 Train Frequency & Track Capacity with Level Crossings by Line in the Seoul District



In scheduling freight trains from the eastern side of Special city of Seoul to the southwestern district, the operating time zone is restrained a great deal by the hitches resulting from the passenger train operation and the level crossings.

To do away with these restrains, the freight line has to be separated from the passenger line and grade separation undertaken, though it will take a considerably large amount of funds and some time to effect the improvement.

Mang U Station located in the midst of the consuming area is at present operating at full capacity handling 450 cars, and there is no room here for expansion. There also is no room around Seoul for construction of a new marshalling yard for the Jung Aug Line.

2-3 Chung Bug Line, the most appropriate route to serve the purpose

2-3-1 Main consuming districts to show up

The Korean Government in its plan for the increase in demand has 16 million tons for 1981, but the oil shock complled it to modify the plan for an increase of 50% raising the total to 24 million tons. The break-down of the total for distribution by district is determined as follows. (Table 2-7 & 2-8, Fig. 2-4)

The distribution to main district are:

Special city of Seoul, 9.95 million tons;	35% to the south of the Hano Gang by up-freight trains on the Gyeang Bug Line
Bu San, 2.38 million tons;	Down-train on the Jung Aug Line and coastal shipping
Dang Gu, 1.74 million tons;	Down-train on the Gyeang Bu Line or down - freight trains on the Jung Aug Line
In Cheon, 0.62 million tons;	Seoul satellite cities, up-freight trains on the Gyeong Bu Line
Gwang Ju 0.79 million tons;	Down-trains on the Gyeang Bu Line, down-freight trains on the Ho Nam Line
Dea Jeon 0.73 million tons;	Down-freight trains on the Gyeang Bu Line
Su Weon, 03 million tons;	Seoul satellite cities, up-freight trains on the Gyeong Bu Line
Cheong Ju, 0.23 million tons;	Freight in the districts served by the Chung Bug Line

Table 2-7 Anthracite Production Plan by District

(In 1,000 tons)

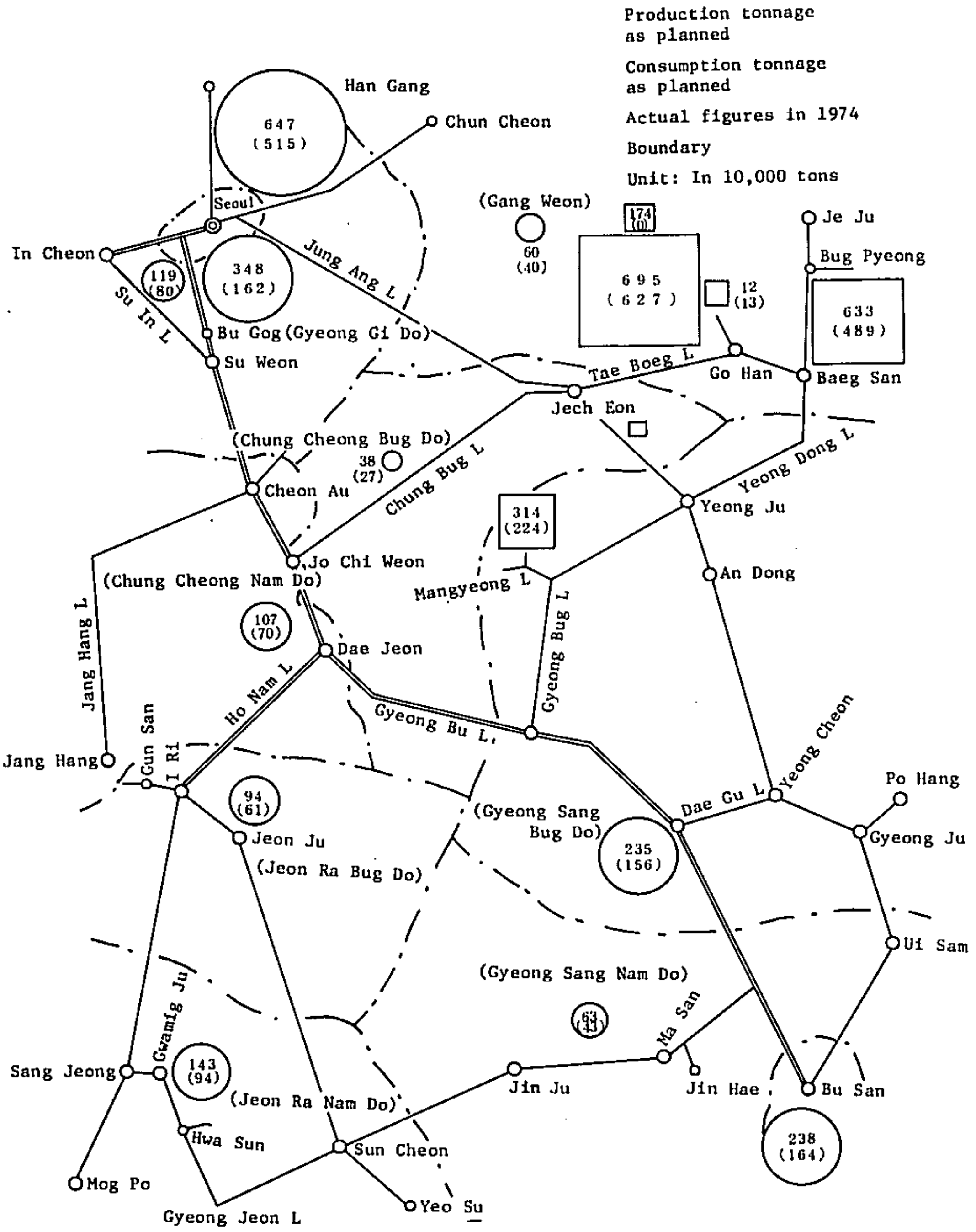
F.Y. / By district	'74	'75	'76	'77	'78	'79	'80	'81	Remark
Tae Baeg Line	6,274	6,530	6,694	6,812	6,929	7,031	7,021	6,943	Mun Gog Hwang Ji Go Han Yeo Ryang Sa Bug Ham Baeg
Jeong Seon Line	130	310	489	630	740	860	1,100	1,260	Jeong Seon
Yeong Dong Line	4,894	5,210	5,476	5,778	5,911	6,119	6,269	6,327	Cheol Am Do Gye Gang Neung
Jung Aug Line	176	310	420	470	570	660	860	950	Dan Yang
Pyeong Chang Line	-	-	30	100	480	800	1,120	1,740	Pyeong Chang line)
Sub-total	11,474 (74.0)	12,369 (72.7)	13,100 (72.8)	13,790 (72.6)	14,630 (72.1)	15,470 (71.6)	16,370 (71.8)	17,220 (71.8)	
Gyeong Bug Line	2,235	2,450	2,540	2,630	2,730	2,860	2,980	3,140	Ham Chang Ga Eun Mun Gyeong
Gyeong Bu Line	74	110	170	210	240	240	240	240	Og Cheon
Gyeong Jeon Line	754	840	860	920	1,030	1,090	1,110	1,110	Hwa Sun
Jang Hang Line	963	1,240	1,330	1,450	1,670	1,940	2,100	2,290	Dae Cheon
Sub-total	4,026 (26.0)	4,640 (27.3)	4,900 (27.2)	5,210 (27.4)	5,670 (27.9)	6,130 (28.4)	6,430 (28.2)	6 780 (28.2)	
Total	15,500 (100.0)	17,000 (100.0)	18,000 (100.0)	19,000 (100.0)	20,300 (100.0)	21,600 (100.0)	22,800 (100.0)	24,000 (100.0)	
Rail transport	15,067	16,600	17,600	18,600	19,900	21,100	22,300	23,500	

Table 2-8 Anthracite Supplying Plan by District

(In 1,000 tons)

F.Y. / By district	'74	'75	'76	'77	'78	'79	'80	'81	Remark
Special City of Seoul	6,761 (46.3)	7,201 (42.7)	7,668 (42.9)	8,111 (42.5)	8,615 (43.0)	9,107 (42.1)	9,665 (42.7)	9,945 (42.2)	
Gyeong Gi Do	797	856	918	974	1,021	1,066	1,114	1,188	In Cheon Su Weon Eui Jeong Bu etc.
Chung Bug	270	273	294	313	327	342	357	382	Cheong Ju Chung Ju etc.
Chung Nam	701	775	830	882	925	967	1,010	1,075	Dae Jeon Cheon Au etc.
Jeon Bug	612	663	710	753	786	827	886	941	Jeon Ju Gun San I Ri etc.
Jeon Nam	941	1,021	1,091	1,158	1,235	1,288	1,349	1,435	Gwang Ju Mog Po,Yeo Su Sun Cheon etc.
Gyeong Bug	1,562	1,696	1,818	1,929	2,024	2,116	2,211	2,354	Dae Gu,Po Hang Gyeong Ju Gim Cheon An Dong etc.
Gyeong Nam	433	471	523	559	564	583	579	628	Ma San,Jin Ju Chung Mu Jin Hae Sam Cheon Po Ui San
Gang Weon	404	437	468	496	522	543	568	596	Cheun Cheon Weon Ju Gang Neung Sog Cho etc.
Je Ju	88	77	104	111	116	121	147	158	Je Ju etc.
Bu San	1,644	1,773	1,870	1,984	2,061	2,154	2,231	2,375	
Sub-total	14,214	15,243	16,294	17,270	18,196	19,114	20,137	21,077	
For industrial use	1,370	1,619	1,600	1,793	1,851	2,500	2,500	2,500	
Total	15,514 (100.0)	16,862 (100.0)	17,894 (100.0)	19,063 (100.0)	20,047 (100.0)	21,614 (100.0)	22,628 (100.0)	23,587 (100.0)	

Fig. 2-4 Plan for Anthracite Production & Consumption in 1981



Besides for export, cement is demanded for domestic consumption in constructing office buildings and apartment houses in large cities, and apartment house houses, roads, bridges and riparian works that are extensively being carried on in rural areas in connection with the Sae-Mauel movement.

2-3-2 Population growth to the east of the Han Gang River

The population in the Special city of Seoul is rapidly growing.
For this reason the state and the Matropolitan Seoul municipality have been taking every administrative measure for city planning, endeavoring to induce the city population to move away from the city to the south of the Han Gang River, offering tax exemptions as attraction. (Table 2-9)

Table 2-9 Tax Exemptions Offered in Promotion of Metropolitan Redevelopment (Yeong Deung District of Seoul, south of the Han Gang River)

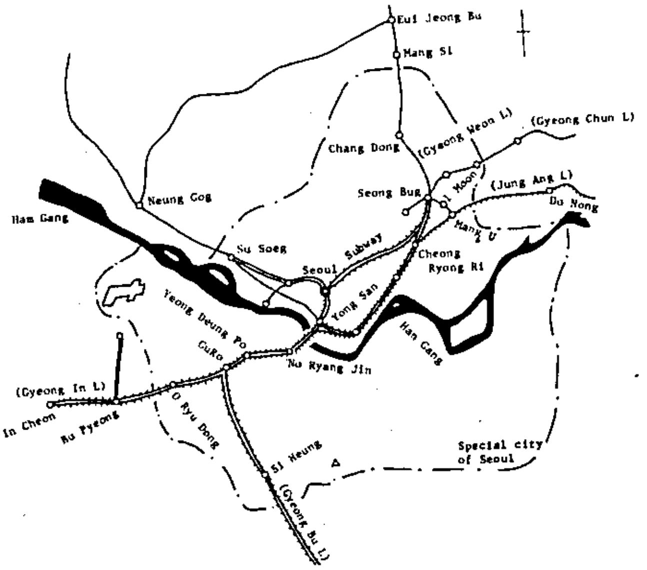
Kind of tax for exemption:	
Income tax on transfer	Land: 50% of the standard for taxation Buildings, etc.: 30% of the standard for taxation
Special surcharge on corporation	25% of the standard for taxation
Property tax	Dwellings: 30% of 5 million won price 0.5% of the excess
	Land: 0.3% of the price below 100 tsubo 0.5% of the excess
Registration tax	Farm: 3/1000 of the price Others: 8/1000 of the price
Acquision tax	1% of the standard for acquision tax in province 2% of the standard for acquision tax in Seoul and Pusan
City planning tax	2/1000 of the house, land or ship value as the standard for taxation, the excess over 31,000 of the value for the standard tax exempted
License tax	Six classes: 9,000 for class 1 up to 1,200 wons for class 6, paid in lump when license is given
Amount exempted	Total amount
Period	From Dec. 30, 1972 to Dec. 31, 1978

The Metropolitan Seoul population as of at the end of 1974 was 6.54 million. Of this, 24% (1.57 million) on the south side of the Han Gang River. The growth rate over the preceding year was high, 7% as compared with the city-wide average growth rate of 4%. In 1981 35%, or 2.65 million, of the 7.65 million in the whole city is envisaged under the policy to live here and this raised to 50% of the whole city population in 1990. Population growth on the north side of the Kanko River is planned to be supressed. (Table 2-10)

Table 2-10 Population Growth in Special City of Seoul by District

(In 10,000 persons)

District / As at the end of F.Y.		Northern side of the Han Gang River	Southern side of the Han Gang River	Remark
1970	533 (100.0)	413 (77.4)	120 (22.6)	Tax exemptions for
1971	585 (100.0)	454 (77.5)	131 (22.5)	
1972	607 (100.0)	468 (77.0)	139 (23.0)	
1973	629 (100.0)	482 (76.7)	147 (23.3)	Tax exemptions for residents on the southern side of the Han Gang River
1974	654 (100.0)	497 (75.9)	157 (24.1)	
1981	765 (100.0)	500 (65.4)	265 (34.6)	As planned
1990	(100.0)	(50.0)	(50.0)	As planned



Thus the increase in the supply of anthracite and cement to Metropolitan Seoul will be mostly to the southern side of the Han Gang River.

2-3-3 Transportation to be Doe Jean,Ho Nan District

Anthracite and cement are consumed nearly in propotion to the sizes of district population. They will be transported to the Dae Jean district on the Gyeang Line and to Chung Cheang Nam Do, Jean Ra Bug Do and Jeon Ra Nam Do districts on the Ho Nam Line where the demand will continue to be strong. Those from the main producing area, the Tae Baeg-Yeang Dong district, will be transported via the Chung Bug Line.

2-3-4 Make-up of the optimum transport route

In transporting anthracite and cement produced in the Jae Baeg Yeang Dong district to Special City of Seoul and its satellite cities, the largest consuming area, the most appropriate transporting route will be to use the hung Bug Line that directly links the producing district in the shortest distance with the Gyeong Bu Line along which about 60% of the Korean population reside. For the increase in traffic is mostly to the southern side of the Hang Gang River, as stated previously, and the freight traffic is largely hampered by the voluminous passenger traffic between Cheang Ryong Ri and Gu Ro in Seoul. The way from the producing area of Tae Baeg-Yeang Dang district is thus the shortest distance via the Chung Bug Line to the Dea Jeon district on the Gyeang Bu Line and the regions along the Ho Nam Line, Consumption of anthracite after all is proportionate to the inhabitants.

Thus, for the transportion to the southern side of Han Gang River and the Gyeang In district the best approach is to use the up-train track of the Gyeang Bu Line by way of the Chung Bug Line, using the Bu Gag Freight Yard on the Gyeong Freight Yard on the Gyeong Bu Line, presently under consideration, as the base.

For the northern side of Han Gang River in Metropolitan Seoul the Jung Aug Line will do as at the present.

2-4 Transporting plan by year and by line

Judging from the anthracite and cement producing and supplying plans by year and by district, these principal freight products will be increased in production mainly in the Jae Baeg-Yeang Dang district in the notheastern part of Korea and most of them transported to Special City of Seoul and its vicinity.

Thus in drawing up the anthracite and cement transport plans, the destinations center around these districts and weight in the planning is put on the district south of the Han Gang River.

2-4-1 Present state of transport service to the Special City of Seoul and its satellite cities

The freight passing tonnages by item on the main rail lines in 1974 are as shown in Fig. 2-5.

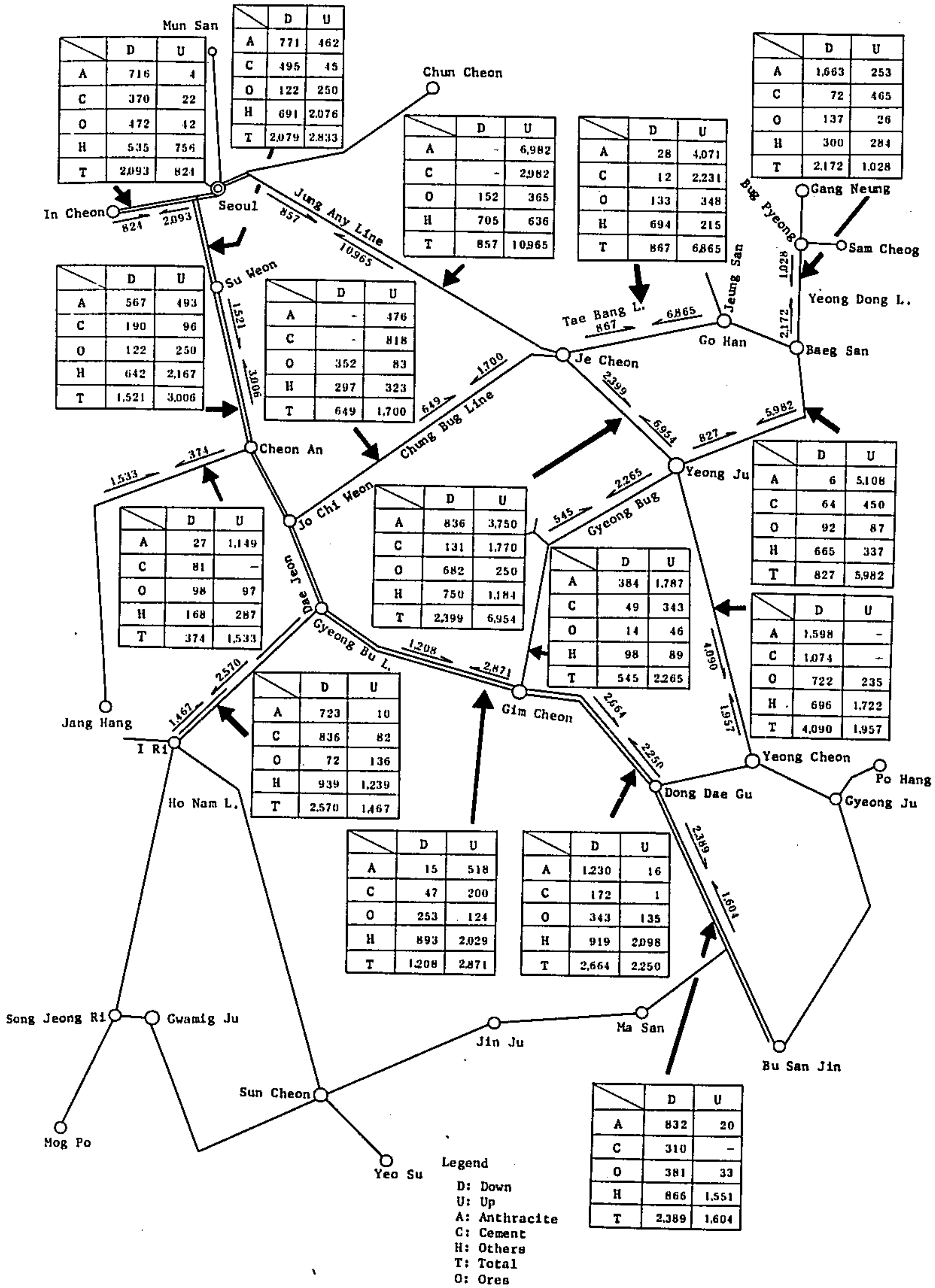
Anthracite is transported to Special City of Seoul and its satellite cities to the amount of about 7 million tons (93.3%) from the Tae Baeg-Yeong Dong district by up-train of the Jung Aug Line and to the amount of about -5 million tons (6.7%) from the districts along the Jang Hang and Gyeong Bug Lines by up-train of the Gyeong Bu Line. That is, to the total of 7.5 million tons.

Cement is transported to the tune of 3.1 million tons in all, about 3 million (97%) from the Tae Baeg-Yeang Dong district by up-train of the Jung Aug Line and 0.1 million (3%) by up-train of the Keifu Line. Transportation of cement is thus mostly by up-train of the Chuo Line.

By up-train of the Chuhoku Line about 0.5 million tons of anthracite and about 0.8 million tons of cement are hauled, but these are mainly for the Chung Bug Line regions and the districts of the Gyeong Bu and Ho Nam Lines.

Fig. 2-5 Passing Tonnages by Line and by Item

(As of 1974, in 1,000 tons)



	D	U
A	716	4
C	370	22
O	472	42
H	535	756
T	2,093	824

	D	U
A	771	462
C	495	45
O	122	250
H	691	2,076
T	2,079	2,833

	D	U
A	-	6,982
C	-	2,982
O	152	365
H	705	636
T	857	10,965

	D	U
A	28	4,071
C	12	2,231
O	133	348
H	694	215
T	867	6,865

	D	U
A	1,663	253
C	72	465
O	137	26
H	300	284
T	2,172	1,028

	D	U
A	567	493
C	190	96
O	122	250
H	642	2,167
T	1,521	3,006

	D	U
A	-	476
C	-	818
O	352	83
H	297	323
T	649	1,700

	D	U
A	836	3,750
C	131	1,770
O	682	250
H	750	1,184
T	2,399	6,954

	D	U
A	6	5,108
C	64	450
O	92	87
H	665	337
T	827	5,982

	D	U
A	384	1,787
C	49	343
O	14	46
H	98	89
T	545	2,265

	D	U
A	27	1,149
C	81	–
O	98	97
H	168	287
T	374	1,533

	D	U
A	1,598	-
C	1,074	-
O	722	235
H	696	1,722
T	4,090	1,957

	D	U
A	723	10
C	836	82
O	72	136
H	939	1,239
T	2,570	1,467

	D	U
A	15	518
C	47	200
O	253	124
H	893	2,029
T	1,208	2,871

	D	U
A	1,230	16
C	172	1
O	343	135
H	919	2,098
T	2,664	2,250

	D	U
A	832	20
C	310	–
O	381	33
H	866	1,551
T	2,389	1,604

Legend

D: Down
U: Up
A: Anthracite
C: Cement
H: Others
T: Total
O: Ores

2-4-2 Fluctuations in the passing tonnages of anthracite and cement

Anthracite is consumed 2 to 3 fold in autumn and winter than in the spring and summer seasons. As far as rail transport is concerned, however, the passing tonnage remains almost the same throughout the four seasons, as the storing facilities at the terminals are now adequately built up. The quarterly average of 25% is almost maintained, the highest reaching 27% during October to December and the lowest 24% during April to June.

As the demand for cement is strongest during April to September, further improvement of the fluctuation rates in transport thus is not possible for anthracite, it appears. (Table 2-11)

Table 2-11 Railway Hauling of Anthracite & Cement by Season

Anthracite

F.Y. / Season	'70	'71	'72	'73	'74	Remark
Jan-Mar	3,035 (25.2)	2,956 (24.4)	2,810 (24.8)	3,194 (23.4)	3,617 (24.0)	
Apr-Jun	3,021 (25.0)	2,912 (24.0)	2,986 (26.4)	3,245 (23.8)	3,555 (23.6)	
Jul-Sep	2,813 (23.3)	2,923 (24.1)	*2,050 (18.1)	3,487 (25.6)	3,772 (25.0)	*Adversely affected by flood
Oct-Dec	3,200 (26.5)	3,332 (27.5)	3,472 (30.7)	3,709 (27.2)	4,123 (27.4)	
Total	12,069 (100.0)	12,123 (100.0)	11,318 (100.0)	13,635 (100.0)	15,067 (100.0)	

Cement

F.Y. / Season	'70	'71	'72	'73	'74	Remark
Jan-Mar	875 (18.0)	1,073 (18.0)	1,009 (16.9)	1,727 (22.9)	1,749 (22.3)	
Apr-Jun	1,426 (29.4)	1,507 (26.1)	1,545 (25.8)	2,102 (27.9)	2,077 (26.5)	
Jul-Sept	1,365 (28.1)	1,696 (29.3)	1,562 (26.1)	1,902 (25.2)	1,971 (25.2)	
Oct-Dec	1,192 (24.5)	1,505 (26.0)	1,870 (31.2)	1,815 (24.0)	2,034 (26.0)	
Total	4,858 (100.0)	5,781 (100.0)	5,986 (100.0)	7,546 (100.0)	7,831 (100.0)	

Remark: Unit in 1,000 tons
Figures in parantheses, %

2-4-3 Transport plan centering around the Jung Aug, Chung Bug Lines

(1) Route as envisaged in the transport plan

For the reasons stated so far the transporting route from the anthracite and cement producing area, Tae Baeg Yeang Dang district, to Special City of Seoul and its satellite cities are envisaged as follows:

1) The transporting route to the district to the north of the Han Gang River constituting part of Special City of Seoul and its satellite cities is the approach thereto by up-train of the Jung Aug Line.

2) The transporting route to the district to the south of the Han Gang River constituting part of the Metropolitan and its satellite cities, as well as to the Cheon Au, Dae Jeon along the Gyeong Bu Line and the districts along the Ho Nam Line, is the approach thereto by up-train of the Chung Bug Line.

(2) Estimation of future demand by district and traffic by line

The anthracite and cement supplying plans are as explained previously. Based on these plans, the track capacity of the Jung Aug Line, the time to complete the Bu Gog Freight Center and its scale, and the time to turn the Su In Line into wider gauge track as well as to double-track the Chung Bug Line all taken into consideration, the transporting route will be reset as described under (1) above for the hauling of anthracite and cement from the Tae Baeg Yeang Dong district with the following steps taken:

1) After 1978 all the hauling to the In Chean and Su Weon district by up-train of the Gyeong Line.

2) To the district to the south of the Han Gang River constituting part of Special city of Seoul and its satellite cities,50% of the tonnage demand by the Chung Bug Line from 1979, in which its double-tracking is slated for completion, until 1981. From 1985 all the hauling by up-train of the Gyeong Bu Line.

The passing tonnages by up-train of the Chung Bug Line, by year, thus will be as shown in Table 2.12.

Table 2-12

(In 1,000 tons)

District \ F. Y.		1978	1979	1980	1981	1985	1990
In Cheon	Anthracite	534	557	583	621	729	870
	Cement	71	76	81	85	102	123
	Others	450	500	550	600	600	800
	Sub-total	1,055	1,133	1,214	1,306	1,431	1,793
Su Weon	Anthracite	261	274	285	303	359	429
	Cement	390	420	450	481	579	700
	Sub-total	651	694	735	784	938	1,129
Southern part of Seoul	Anthracite	-	1,300	1,400	1,500	3,400	4,000
	Cement	-	700	900	1,000	2,600	3,620
	Sub-total	-	2,000	2,300	2,500	6,000	7,620
Total	Anthracite	795	2,131	2,268	2,424	4,488	5,299
	Cement	461	1,196	1,431	1,566	3,281	4,443
	Others	450	500	550	600	600	800
	Total	1,706	3,827	4,249	4,590	8,369	10,542

(3) Transport capacity of the Jung Ang Line

The Jung Ang Line is operated at the train frequency of 43 trains (12 passenger and 21 freight trains), almost to the limit of a single-track capacity of 50 trains.

No higher track capacity can be expected of the Jung Gug Line operated as it is with single track, even when further improvement were conceived and effected.

With the existing facilities as they are at present, its transport capacity will be as follows by our trial calculation:

1) Leaving the number of 12 passenger trains as it is on the Jung Ang Line and using the remaining 38 trains as freight trains, we have:

(50 trains - 12 trains) x 40 cars x 30 tons x 365 days x 0.9 (transport coefficient) + 1.2 (fluctuation rate) = 12,483,000 tons

2) Using the passenger transport demand (the maximum passenger traffic one way) on the Jung Ang Line in 1981 to be 3,900,000 persons as assumed by the Korean National Rail road and scheduling the number of passenger trains needed for this traffic and using the remaining scheduleable trains as freight trains, we have:

◎ The number of passenger trains

o When trains are scheduled for the trainsporting unit as is at present--

$$\text{Transporting unit} = \frac{\text{2,850,000 persons}}{\text{12 trains}} = \text{237,500 persons/per train}$$

$$\text{No. of trains} = \frac{\text{3,900,000 persons}}{\text{237,500 persons}} = \text{17 trains}$$

o When based on the transport coefficiency as planned by the Railroad--

$$\text{No. of trains} = \frac{\text{3,900,000 persons}}{\text{10 cars x 70 persons x 365 days x 0.65(transport coefficient)}} = \text{24 trains}$$

◎ Trial calculation on the freight transporting capacity

o When the transporting unit by passenger train is assumed to be the same as at present--

(50 trains - 17 trains) x 40 cars x 30 tons x 365 days x 0.9 ÷ 1.2 - 10,840,500 tons

o When the transporting unit by passenger train is assumed to be by 10-car consist, with 70 passengers on, and the transportation coefficient to be 0.65--

(50 trains - 24 trains) x 40 cars x 30 tons x 365days x 0.9÷ 1.2 = 8,541,000 tons

These trial calculations lead us to conclude that the transport capacity of the freight trains on the Jung Ang Line will be 8,541,000 to 12,483,000 tons in 1981 and that it is proper, to be on the safe side, to set it at about 12,000,000 tons.

(4) Freight passing tonnages on the Jung Aug and the Chung Bug Lines

The passing tonnages of main freight items by year and by line, when the transportation plan is implemented stage by stage as explained above, will be as shown in Table 2-13 and Fig. 2-6, according to the assumption made by the Railroad.

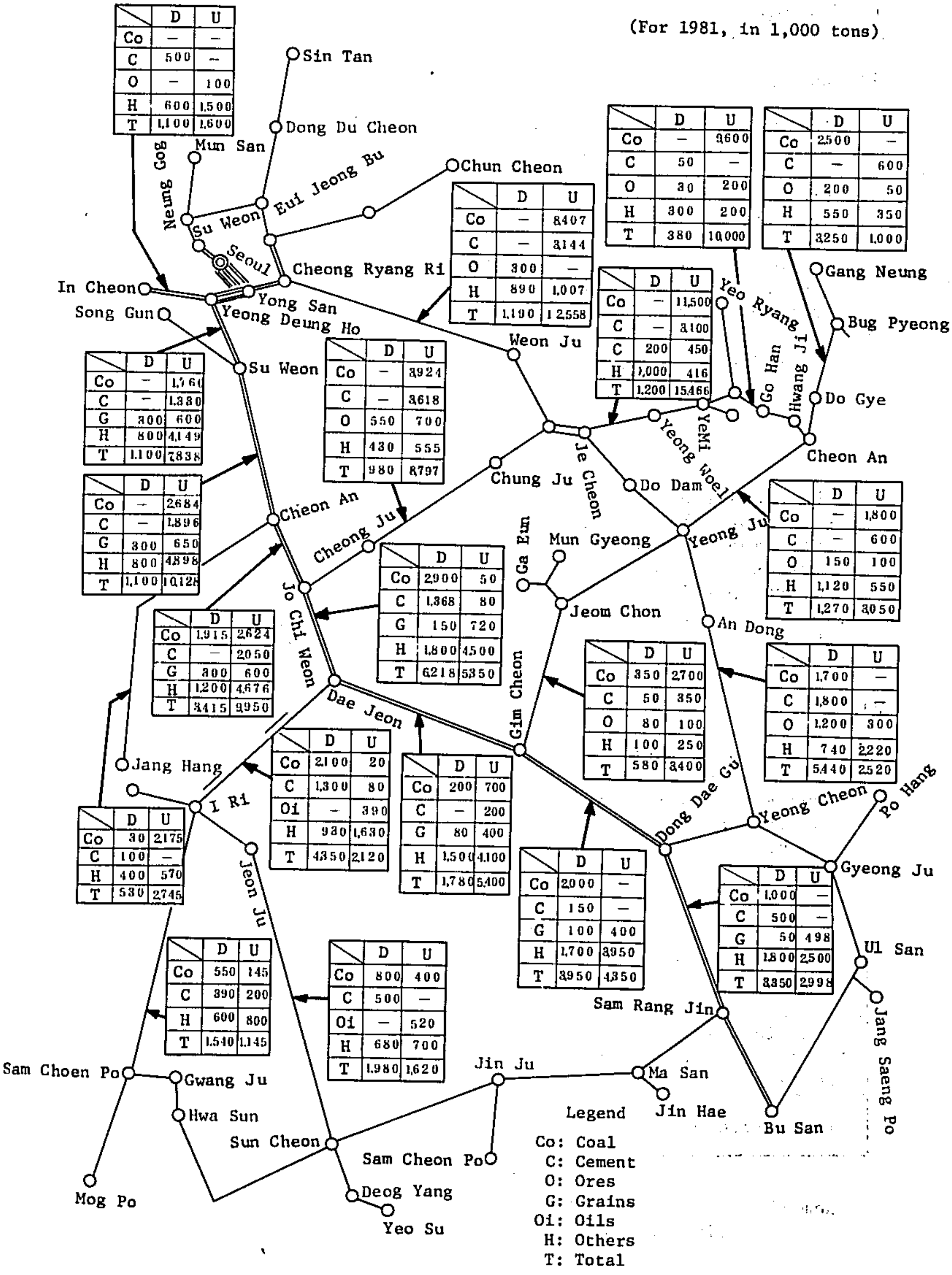
Table 2-13 Actual & Assumed Passing Tonnages of Main Freight Items by Year and by Tail Line

(In 1,000 tons)

Line		F.Y.	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Jung Aug Line	Cheang Ryang Ri - Bang Yang (Up-trains)	Anthracite	5,271	6,492	6,982	7,702	8,005	8,745	8,513	7,634	8,204	8,407
		Cement	1,897	2,880	2,982	3,288	3,525	3,762	3,538	3,040	3,042	3,144
		Others	842	864	1,001	1,071	1,146	1,226	862	904	952	1,007
		Total	8,010	10,236	10,965	12,061	12,676	13,733	12,913	11,578	12,198	12,558
	Bang Yang- Je Chean (Up-trains)	Anthracite	5,711	7,078	7,623	8,402	8,855	9,745	10,408	11,105	11,852	12,331
		Cement	3,088	3,960	3,805	4,608	4,967	5,326	5,685	6,044	6,403	6,762
		Others	1,127	1,517	1,288	1,378	1,474	1,577	1,688	1,806	1,932	2,068
		Total	9,926	12,555	12,716	14,388	15,296	16,647	17,781	18,955	20,187	21,161
Chung Bug Line	Bang Yang - Jo Chi Weon (Up-trains)	Anthracite	347	468	476	700	850	1,000	1,895	3,481	3,648	3,924
			-	-	-	-	-	-	(795)	(2,131)	(2,268)	(2,424)
		Cement	1,129	1,077	818	1,320	1,442	1,564	2,147	3,004	3,369	3,618
			-	-	-	-	-	-	(461)	(1,196)	(1,431)	(1,566)
		Others	330	369	406	440	470	500	985	1,072	1,163	1,255
			-	-	-	-	-	-	(450)	(500)	(550)	(600)
		Total	1,806	1,914	1,700	2,460	2,762	3,064	5,027	7,557	8,172	8,797
			-	-	-	-	-	-	(1,706)	(3,827)	(4,249)	(4,590)

Remark: Figures in parentheses indicate the breakdown of freight on the up track of Chung Bug Line destined for In Cheon, Su Weon and the district south of the Han Gang River constituting part of Metropolitan Seoul.

Fig. 2-6 Freight Passing Tonnages by Line and by Item (Assumed)



(For 1981, in 1,000 tons)

	D	U
Co	–	–
C	500	–
O	–	100
H	600	1,500
T	1,100	1,600

	D	U
Co	–	9600
C	50	–
O	30	200
H	300	200
T	380	10,000

	D	U
Co	2,500	–
C	–	600
O	200	50
H	550	350
T	3250	1,000

	D	U
Co	–	8,407
C	–	3,144
O	300	–
H	890	1,007
T	1,190	12,558

	D	U
Co	–	11,500
C	–	3,100
C	200	450
H	1,000	416
T	1,200	15,466

	D	U
Co	–	1,760
C	–	1,380
G	300	600
H	800	4,149
T	1,100	7,838

	D	U
Co	–	3924
C	–	3,618
O	550	700
H	430	555
T	980	8,797

	D	U
Co	–	2,684
C	–	1,896
G	300	650
H	800	4,898
T	1,100	10,128

	D	U
Co	2,900	50
C	1,368	80
G	150	720
H	1,800	4500
T	6218	5350

	D	U
Co	–	1,800
C	–	600
O	150	100
H	1,120	550
T	1,270	3,050

	D	U
Co	1,915	2,624
C	–	2050
G	300	600
H	1,200	4,676
T	3,415	9,950

	D	U
Co	350	2,700
C	50	350
O	80	100
H	100	250
T	580	3,400

	D	U
Co	1,700	–
C	1,800	–
O	1,200	300
H	740	2,220
T	5,440	2,520

	D	U
Co	2,100	20
C	1,300	80
Oi	–	390
H	930	1,630
T	4,350	2,120

	D	U
Co	200	700
C	–	200
G	80	400
H	1,500	4,100
T	1,780	5,400

	D	U
Co	30	2,175
C	100	–
H	400	570
T	530	2,745

	D	U
Co	2,000	–
C	150	–
G	100	400
H	1,700	3,950
T	3,950	4,350

	D	U
Co	1,000	–
C	500	–
G	50	498
H	1,800	2,500
T	3,350	2,998

	D	U
Co	550	145
C	390	200
H	600	800
T	1,540	1,145

	D	U
Co	800	400
C	500	–
Oi	–	520
H	680	700
T	1,980	1,620

(5) Influence on the Chung Bug & Gyeang Bu Line

The Chung Bug and the Gyeang Bu Lines will be affected as follows when the transportation plan as described above is implemented:

1) Chung Bug Line

The service facilities and the transport capacity of the Chung Bug Line will be described later on. But in 1974, for the track capacity for 20 trains (between Dae Jean and Bang Yang its train frequency was 16 trains (6 passenger and 10 freight trains). It still has a capacity for 4 more trains.

Leave the number of scheduled trains as it is and use the remaining operative 4 trains as freight trains, and we have the freight transport capacity (the passing tonnage) as follows:

(20 trains - 6 trains) x 27 cars x 30 tons x 365 days x 0.7 = 2,897,370 tons

Traction invariable : 27 cars
Loading tonnage per car : 30 tons
Transport coefficient : 0.7

The assumption on the traffic volume on the Chung Bug Line goes to show that this freight transporting capacity is large enough to meet the demand almost up to 1977 (3,064,000 tons). However, let alone the increase in demand likely to result from the afore-mentioned change in transporting route to the southern side of the Han Gang River making part of Special City of Seoul and its satellite cities, it is obvious that the capacity would not be sufficient thereafter and something would have to be done to strengthen it.

2) Gyeong Line

When transportation from the anthracite and cement producing area, the Tae Baeg Yong Dong district, to the district south of the Han Gang River forming part of Metropolitan Seoul and its satellite cities, is carried on via the Chung Bug Line, the frequency of up-trains on the Gyeong Bu Line will presumably be as follows: (Table 2-14)

Table 2-14

F.Y.	1978	1979	1980	1981	1985	1990
Traffic(Passing tonnage in 1,000 tons)	1,706	3,827	4,249	4,590	8,369	10,542
Train frequency	5 (6)	10 (12)	11 (13)	12 (14)	22 (26)	27 (32)

Remark: Figures in parentheses indicate the train frequency at the fluctuation rate of 1.2.

o Method of caluculating the train frequency

$$\text{Train frequency} = \frac{\text{Traffic volume x (Fluctuation rate)}}{\text{No. of cars for traction x average tonnage loaded per car x 365 days x transport coefficient}}$$

$$= \frac{\text{Traffic volume x (1.2)}}{\text{40 cars x 30 tons x 365 days x 0.9}}$$

In 1981 the frequency of up-trains on the Gyeong Bu Line is estimated to be 12 to 14 trains.

The Seoul-Dae Jean Section of the Gyeong Bu Line, on the other hand, is a double track, automatic block section. The transport demand here is 91 up-trains for the track capacity of 104 trains between Gu Ro and Su Weon and 58 trains between Su Seon and Jo Chi Weon for the track capacity of 91 trains.

The Korean National Railroad is planning to raise the track capacity for 160 trains by 1977 between Seoul and Su Weon and 120 trains between Su Weon and Jo Chu Weon with additional blocking signal installed in between stations. This will be enough to deal with the additional trains coming up from the Chung Bug Line.

From the long-range view, however, we may say that the Gyeong Bu Line is the main traffic artery in Korea with a large natural increase expected of both in passenger and freight traffic. In planning for the enlargement of the track capacity of the Gyeong Bu Line, therefore, it behooves to take into consideration additional trains coming up from the Chung Bug Line.

2-5 Summary

Anthracite is mostly turned into briquests for heating in cold seasons and cooking meals. Cement is used in constructing office buildings and apartment houses as well as in building up waterways, roads and bridges, as well as in building and remodeling dwelling houses under the Sae-Mauel campaign being vigorously and extensively carried on throughout the country. These are consumed almost proportionately to the growth of population.

Metropolitan Seoul together with its satellite cities consumes 50% of anthracite and 40% of cement consumed in the country. From now on demand is expected to increase in the district south of the Han Gang River and the Supply line to the district will be by the Gyeong Bu Line.

For the increase in transport demand in Dae Jeon along the Gyeong Bu Line and in the districts along the Ho Nam Line, some effective way of strengthening the transporting route will have to be considered.

Taking all together in consideration, it is obvious that the strengthening of the transport capacity of the Chung Bug Line, which links directly in the shortest distance the Gyeong Bu Line along which with the Tae Baeg Line serving the anthracite and cement producing districts, will be so effective in outcome as killing two birds with one stone.

III. Measures for the Strengthening of the Chung Bug Line Capacity

3-1 Traffic and the plan for the future

3-1-1 Region served by the Chung Bug Line

(1) Population along the line

The region served by the Chung Bug Line between Jo Chi Weon and Ban Yang has a population numbering 1,213,818 (as at the end of 1973), corresponding to 3.7% of the total national population (33,157,211).

The population, the number of households and population density by administrative district and the number of persons per household are as shown in Table 3-1.

Table 3-1 Population & Number of Households per Administrative District within the Region Served by Stations along the Chung Bug Line (as at the end of 1973)

County and city	Population			No. of Households			Population Density (per km^2)	No. of Persons per Household
	Total	Male	Female	Total	Agricultural	Others		
Yeon Gi	105,687	54,013	51,674	18,465	12,247	6 218	293.5	5.72
Cheong Weon	203,323	103,827	99,496	33,889	29,012	4,877	226.1	6.11
Cheong Weon Cheong Ju	167,018	83,604	83,414	31,292	3,145	28,147	2,571.1	5.34
" Gyon San	147,379	75,349	72,030	24,703	19,330	5,373	162.1	5.97
" Jin Cheon	78,820	40,240	38,580	13,583	10,641	2,942	191.7	5.80
" Eum Seong	114,903	58,430	56,473	18,970	15,308	3,662	222.0	6.06
" Jung Weon	134,163	68,799	65,364	22,370	18,957	3,413	151.1	6.00
" Ghung Ju	96,471	48,714	47,757	17,961	3,982	13,779	1,078.6	5.37
" Je Cheon	166,054	84,625	81,429	28,523	16,261	12,262	188.9	5.82
Total	1,213,818	617,601	596,217	209,756	128,883	80,873	241.9	5.79

(References) ◎ Annual Statistics Reports on Chung Bug, Chung Nam and other counties and cities (Each for 1974)

◎ Literature by the Korean Railway Engineering Cooperation Association

The annual population growth rate within the region during 1969 and 1973 was low, 0.45%, as compared with that of 1.73% for the national average growth.

Within the region the population growth rates were rather high in the Cities of Ghung Ju and Cheong Ju. Attributable for this was the population concentration in these cities regulting from urbanization taking place and building up of industrial complexes and factories and plants. (Table 3-2)

Table 3-2 Changes in Population by Administrative Districts within the Region Served by Stations

Year County and City	Population					Growth Rate(%)	
	1968	1970	1971	1972	1973	'69-'73	'72-'73
Yeon Gi	106,496	103,163	101,403	102,030	105,787	-0.17	3.58
Cheong Weon	211,982	204,215	203,120	204,657	203,323	-1.02	-0.65
Cheong Weon Cheong Ju	133,189	143,744	154,561	159,287	167,018	5.84	4.85
" Gyon San	152,988	145,397	145,367	146,854	147,379	-0.70	0.36
" Jin Cheon	81,501	78,244	77,431	78,794	78,820	-0.81	0.03
" Eum Seong	117,919	112,810	112,826	114,432	114,903	-0.37	0.41
" Jung Weon	142,769	133,754	132,034	134,683	134,163	-1.50	-0.39
" Chung Ju	84,326	87,727	91,681	94,541	96,471	3.43	2.04
" Je Cheon	161,408	162,392	163,147	165,345	166,054	0.71	0.43
Total	1,192,578	1,171,646	1,181,570	1,200,623	1,213,818	0.45	1.10

(References) ◎ Korean Year Book (Economic Planning Board), Chung Bug Statistics Year Report, Chung Nam Statistics Year Report and Statistics Year Report on Each City and Country

◎ Literature by the Korean Railway Engineering Cooperation Association

(2) Industry

Agricultural in the main, as much as 65% of the population in the region served by the rail line is engaged in farming. Mining products include iron, talc, as well as graphite, tungsten, zinc and silica.

For manufacturing mainly in Chung Ju are fertilizer plants and in Cheong Ju tobacco plants.

(3) Tourism resources

The districts along the Chung Bug Line abound in tourism Hesorces. Main attractions are Bu Mo San in Seo Cheong Ju, Sog Ri San Cheong Ju and Beob Ju Sa Temples in Cheong Ju, the Mi Ho Cheon in Jeong Ha, Shoi Ensui in Nae Su and Tan Geun Dae, Su An Bo Hotspring, Jung Ang Tower, Tan Geum Dae, Chung Youl Sa, Mun Gyeong, Jo Ryeong etc. in Cheong Ju.

(4) Roads

In the road network along the Chung Bug Line are National Highway No. 36 running almost along the Chung Bug Line from on to Cheong Ju, Jeung Pyeong Eum Seong, Chung Ju and Je Cheon and National Highway No. 19 running therefrom to the east side of that highway.

Centering around these Highways No. 36 and No.19 are other national and local highways to link the principal cities within the region.

The Gyeong Bu Expressway running south and northward almost in between Jo Chi Weon and Cheong Ju was opened to traffic in 1970, and it has been contributing a great deal in the economic development of that locality.

3-1-2 Present state of traffic and the plan for the future

(1) Passenger

1) Trafic

On the Chung Bug Line 6 passenger trains were scheduled as of 1974. The number of passengers carried on the line has been largely diminishing since 1966, and that of season ticket passengers shrank notably of all to one tenth of that in 1974. Ordinary passengers, however, began to mount somewhat since the lowest year in 1970. In passenger km a recovery up to 1966 level is seen. An annual increase rate of 7% is seen in the traffic estimation made by the Korean National Railroad, as is shown in Table 3-3.

Table 3-3

	Year	1966	1967	1968	1969	1970	1971	1972	1973	1974
Passengers Carried (in 1,000)	Season-ticket Holders	1,240	1,089	1,012	836	730	669	210	134	119
	Ordinary Passengers	2,488	2,319	2,188	1,482	1,156	1,238	1,469	1,483	1,751
	Total	3,728	3,408	2,600	2,318	1,886	1,897	1,679	1,617	1,770
	Ratio (%)	210.6	192.5	146.9	131.0	106.6	107.2	94.9	91.4	100.0
Passenger Km (in 1,000)	Season-ticket Holders	23,009	92,282	19,232	15,647	15,667	13,685	5,082	3,026	2,783
	Ordinary Passengers	96,030	88,260	75,368	74,029	62,337	69,900	92,506	96,509	111,136
	Total	119,039	110,542	94,600	89,670	78,605	83,585	97,588	99,535	113,979
	Ratio (%)	109.4	97.0	83.0	78.7	69.0	73.3	85.6	87.3	100.0

	Year	1975	1976	1977	1978	1979	1980	1981	1985	1990
Passengers Carried (in 1,000)	Season-ticket Holders	113	109	105	100	100	100	100	100	100
	Ordinary Passengers	1,781	1,905	2,033	2,163	2,291	2,421	2,557	3,138	3,378
	Total	1,994	2,014	2,134	2,263	2,391	2,521	2,697	3,238	4,078
	Ratio (%)	107.0	113.8	120.8	127.9	135.1	142.4	150.1	182.9	230.4
Passenger Km (in 1,000)	Season-ticket Holders	2,600	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500
	Ordinary Passengers	119,313	127,665	136,218	114,935	153,486	162,235	171,320	210,230	266,527
	Total	121,913	130,165	138,718	147k435	155,986	164,735	173,320	212,730	269,027
	Ratio (%)	107.0	114.2	121.7	129.4	136.9	144.5	152.5	186.6	236.0

Table 3-4 Number of Transit Passengers, Actual & Assumed

Year	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1980	1980	1981
Transit Passengers (in 10,000)	502	467	465	479	483	567	605	643	682	770	759	798	838
Ratio (%)	88.5	82.4	82.0	84.5	85.2	100.0	106.7	113.4	120.3	127.0	133.9	140.7	147.8

2) Number of trains

Calculating the number of trains needed at the standard consist of 6 cars to each train, we have:

Table 3-5

Year	1974	1975	1976	1977	1978	1979	1980	1981
No. of Trains	6	6	7	7	7	8	8	8

(2) Freight

1) Traffic volume

Presently in 1974 10 freight trains are scheduled on the Chung Bug Line. Consignments are gaining gradually both in tonnage and ton-km.

The traffic volume as estimated by the Korean National Railroad is shown in Table 3-6 and 3-7.

Table 3-6

Year		1966	1967	1968	1969	1970	1971	1972	1973	1974
Tonnage shipped out (in 1,000)	Tonnage	426	521	624	595	544	467	478	679	853
	Ratio (%)	49.9	61.1	73.2	69.8	63.8	54.7	56.0	79.6	100.0
Ton-km (in 1,000)	Ton-km	156,240	160,153	171,677	233,941	315,468	337,662	249,040	269,466	255,004
	Ratio (%)	61.3	62.8	67.3	91.7	123.7	132.4	97.7	105.7	100.0

Year		1975	1976	1977	1978	1979	1980	1981	1985	1990
Tonnage shipped out (in 1,000)	Tonnage	391	939	985	1,434	1,095	1,139	1,195	1,451	1,850
	Ratio (%)	104.9	110.1	115.5	121.2	127.2	133.5	140.1	170.1	216.9
Ton-km (in 1,000)	Ton-km	369,000	414,300	459,600	498,150	545,500	588,450	944,550	1,589,250	2,516,700
	Ratio (%)	144.7	162.5	180.2	195.3	213.5	230.8	370.4	613.2	986.9

Table 3-7 Passing Tonnage, Actual & Assumed(up train trafic between Bang Yang and Jo Chi Weon)

Year	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1985	1990
Passing Tonnage (in 1,000)	1,806	1,914	1,700	2,460	2,762	3,064	5,027	7,557	8,172	8,797	13,695	17,268
Ratio (%)	706.2	112.6	100.0	144.7	162.5	180.2	295.7	444.5	480.7	617.5	799.7	1,015.8

2) Number of trains

Estimation of the number of trains needed is based on the tractive load per train. Taking it to be 27 cars as at the present on the grade of 20 o/oo and assuming it to be 40 cars on the grade of 12.5 o/oo after the additional track is laid, we have the number of trains needed as shown below:

Table 3-8

Year	1974	1975	1976	1977	1978	1979	1980	1981	1985	1990
Grade as at present (A)	10	12	14	15	24	37	40	43	66	84
Grade at 12.5 o/oo (B)	-	-	-	-	-	23	25	27	41	53

The number of trains required is calculated as follows:

$$N = \frac{\text{Passing tonnage x fluctuation rate}}{\text{Traction invariables x Average loading tonnage per car x 365 days x Transportation coefficient}}$$

Note: Traction invariables: In case of (A), 27 cars
In case of (B), 40 cars

Average loading tonnage per car: 30 tons

Transportation coefficient: In case of (A), 0.7
In case of (B), 0.9

Fluctuation rate: In case of (A), 1.0
In case of (B), 1.2

(3) The time the Chung Bug Line coming to a standstill

From the assumption on the train frequency as calculated above for the Cung Bug Line, it may be said that its track capacity for 20 trains will come to its limit in 1976, necessitating some means of strengthening its transport capacity with the facilities built up.

Table 3-9

Year	1974	1975	1976	1977	1978	1979	1980	1981
Passenger	6	6	7	7	7	8	8	8
Freight	10	12	14	15	24	37	40	43
Total (B)	16	18	21	22	31	45	48	51
Track Capacity (A)	20	20	20	20	20	20	20	20
(A) - (B)	4	2	Δ 1	Δ 2	Δ11	Δ25	Δ28	Δ31

3-2 Various measures for the improvement of the existing line

3-2-1 Various measures for improvement

Conceivable for the improvement of the transport capacity of the Chung Bug Line are:

(1) Enlarge the tractive force per train by coupling on an additional locomotive

(2) Shorten the train handling time and enlarge the track capacity by turning the present tablet block system into the single-track automatic signalling system

(3) Enlarge the track capacity by setting up stations for trains to pass each other in a section where the track capacity is low

(4) Improve the track (grades, curves and the effective length of the track), raise the tractive load and speed up train operation to strengthen the transport capacity

(5) Enlarge the transport capacity by using the two measures, (2) and (4), combined

   1) Use of the single-track automatic signal system and construction of stations for trains passing each other

   2) Use of the single-track automatic signal system and track improvement

(6) Speed up of train operation by electrification and a heavier tractive load to strengthen the transport capacity

(7) Double-tracking for higher track capacity.

Scrutinizing these measures we find the results to be explained later on. However, when we consider the propriety in meeting the transport demand, the amount of funds to be invested on the facilities , the most desired is the way of attaining the end by double-tracking. (Table 3-10)

3-2-2 Descriptions of tentative achievements by the various measures

(1) Enlarge the tractive force per train by coupling on an additional locomotive

Conceivable for this are the following means:

o- Double-header traction throughout all the sections

o- Double-header traction only in the steep gradient sections of 20 o/oo and traction by only one locomotive in the rest of the sections

o- Double-header traction only in the steep gradient sections of 20 o/oo and traction by only one locomotive in all the rest of the sections. However, with the 16 o/oo grade sections turned into

12.5 o/oo sections, so as to have the double-header traction display its capacity more effectively.

The level-up of the transport capacity, the amount of money needed for investment, the difficult points involved and the probable year capable of meeting the transport demand, resulting from these measures are as follows:

1) In case of double-header traction throughout all the sections

The tractive load of each train in the steepest grades will be raised from the present 27 cars to 54 cars. This means a two-fold increase of the transport capacity. However, as the train length will be twice as long, a longer track effective length and improvement of the facilities in the yards concerned, such as at Je Cheon, Jo Chi Weon, etc. will be required. Extension projects on the effective length alone will cost approximately 4.6 billion wons.

Twice as many locomotives as at the present will be needed for this, too.

The year capable of meeting the traffic demand will be up to 1978, as shown in Table 3-10 when the passenger train frequency of 8 times in 1981 is subtracted from the track capacity and the remaining capacity is used for freight train operation.

2) Double-header traction only in the 20 o/oo grade sections, using single-locomotive traction in the rest of the sections

Even here two ways are conceivable:

b1. Operate double-headed trains hauling 54 cars on the 20 o/oo grade section up to Chung Ju and from here on the 16 o/oo grade sections use single-headed trains of 32 cars, instead.

b2. Operate double-headed trains of 32 cars throughout on the 20 o/oo grade sections as well as on the 16 o/oo grade sections without making any changes at Chung Ju.

In the case of b1 above the transport capacity would be doubled. However, as the train length would be longer, the effective length of the station yard track would have to be extended to accommodate longer-consist trains, new facilities at O Song, Seo Cheong Ju and Mun Am for the higher train frequency constructed between Chung Ju and Jo Chi Weon for trains passing each other, the single-track automatic signal system used and the yard facilities at Je Cheon and Jo Chi Weon improved. Extension of the effective length of the tracks alone will cost about 7.5 billion wons.

In the case of b2 the transport capacity would not be raised as high as in the case of b1. The construction cost needed in extending the effective length of the tracks would be about 700 million wons.

As far as the number of locomotives needed, in addition to a greater number of additional locomotives needed for double heading in the case of b1, more locomotives would have to be put in regular service for the higher train frequency intended between Chung Ju and Jo Chi Weon.

The transport demand can be met up until 1978 in the case of b1 and 1977 in the case of b2, it is assumed.

3) Double-headed operation only in the steep grade section with 20‰, and single-headed in the rest of the line with 16‰ grade sections improved into 12.5‰ sections for higher tractive load between Chung Ju and Jo Chi Weon

Even here two ways are conceivable:

c1. Operate double-headed trains hauling 54 cars on the 20‰ grade section up to Chung Ju and from here on the 12.5‰ grade sections use single-headed trains of 40 cars, instead.

c2. Operate double-headed trains of 40 cars throughout on the 20‰ grade sections as well as on the 12.5‰ grade sections without making any changes at Chung Ju.

In the case of c1 above, the transport capacity would be doubled. However, as the train length would be longer, the effective length of the station yard track would have to be extended to accommodate longer-consist trains, new facilities at O Song and Seo Cheong Ju for the higher train frequency constructed between Chung Ju and Jo Chi Weon for trains passing each other, the grades and the yard facilities at Je Cheon and Jo Chi Weon improved. Extension of the effective length of the tracks and improvement of the grades alone will cost about 5.3 billion wons.

In the case of c2, the transport capacity would not be raised as high as in the case of c1. the construction cost needed in extending the effective length of the tracks and improving the grades would be about 4.1 billion wons.

The transport demand can be met up until 1978 in the case of c1 and 1977 in the case of c2, it is assumed.

(2) Reduction in the train handling time for a larger track capacity by turning the tablet block system into the single-track automatic signalling system

The improvement by turning the tablet block system into the single-track automatic signalling system would reduce the time to handle the tablet and raise the track capacity from 20 times to 24 times.

The work on the system change would cost around 3.9 billion wons.

The year the line would be capable of meeting the traffic demand would be up to 1977.

In case other steps are taken to strengthen the transport capacity after the single-track automatic signalling system has been introduced, it would mean a double investment.

(3) Establishment of new stations for the trains to pass each other in the low track capacity sections to raise its capacity

Establishment of new stations for the trains to cross each other in the sections where the track capacity is so low as 20 to 22 times, would enlarge the track capacity.

To be newly established for this are five stations, O Song, Seo Cheong Ju, Mun Am, San Deung and Weon Bag. The minimum track capacity would then be 29 times, that is, an increase by 9 times.

The investment needed for the work would be about 8,000 million wons.

The probable year capable of meeting the traffic demand would be until 1978.

(4) Track improvement (grades, curves and extension of the track effective length) and heavier track load and faster train operation to strengthen the transport capacity

By effecting the following improvements the present track capacity of 20 times could be increased to 30 times and the traction load could be raised from 27 cars as now to 40 cars.

If the transport capacity is so riased the line would be capable of satisfying the traffic ddmand in 1981, it is assumed.

The investment called for the work would be about 28,200 million wons. The transport capacity could not be raised so high for the huge investment.

1) Track improvement

	Present	To be improved
Steepest Grade	20 o/oo	12.5 o/oo
Minimum Radius of Curvature	300 m	400 m
Bridge Load	LS-15	LS-22
Rail	37 kg	50 kg

2) Facilities to be newly established for trains to pass each other, in 5 stations:

O Song, Seo Cheong Ju, Mon Am, Son Deung and Weon Bag

3) Extension of the effective track length

The present effective length of track in each station for accommodation of 27 to 32 cars, is to be extended for 40 cars.

4) A new delt a siding for Jo Chi Weon

A short-cut line enabling direct passage from the Chung Bug Line to the up-train track of the Gyeong Bu Line is to be constructed.

5) Improvement on the stations

Improvement of the O Song Station yard

Improvement of the Chung Ju Station yard

(5) Use of (2) to (4) methods in combination to bring up the transport capacity

When the typical ones of the methods mentioned above are used in combination, the following results would be attained:

1) When the single-track automatic signalling system and establishment of new stations (O Song, Seo Cheong Ju, Mun Am, Son Deung and Weon Bag) for the trains to pass each other are adopted together, the track capacity would be raised from 20 times as at the present to 36 times.

The track capacity so raised, the line would be capable of meeting the estimated traffic demand up until 1978.

The investment for this improvement would be about 12,100 million wons.

2) When the single-track automatic signalling system and the track improvement plan are adopted together

When the track were improved (grades, curves and extension of the effective track length), the traction load raised and the single-track automatic signalling system adopted, the track capacity would go up from 20 times to 38 times.

When the transport capacity were raised this way, the line would be capable of meeting the traffic demand up until 1983. However, the transport capacity thereafter would have to be raised by double tracking and this would call for huge extra expenditure wons.
The investment required for this work would be 32.1 billion won

(6) Speed-up in train operation through electrification and heavier traction load for a higher transport capacity

1) In case of electrification with the present facilities as they are

The traction load would be raised from 27 cars to 29 cars, and electrification would raise the track capacity from 20 times to 27 times.

By this way the transport capacity would be large enough to meet the traffic demand in 1978.

The investment on the work, excluding extension of the effective track length and construction of the rolling stock base, as well as the investment on rolling stock, would amount to some 10,900 million wons-that is, for electrification alone.

2) Electrification with the existing facilities partly improved

When electrification were undertaken after setting up new stations at O Song, Sea Cheang Ju, Mun Am, San Deung and Weon Bag in the sections where the track capacity is low, the effective track length extended for 40 cars, and the track improved (the grades to 12.5 o/oo, the minimum radius of curvature 400 m and the bridges LS22, the track strengthened for 50-kg rails and crossings improved), the traction load would be raised from 27 cars to 40 cars and the speed-up in train operation would raise the track capacity from 20 times to 31 times.

It is assumed that the transport capacity would then be large enough to meet the traffic demand in 1981.

The investment on the work would be about 37,600 million wons, not including that on the rolling stock base and rolling stock.

(7) Double-tracking to raise the track capacity

As there is a limit to effect improvement on the single track in meeting the growth of traffic demand in the future, it would do well to turn the single track into double track, effect improvement on the track (the grades reduced to 12.5 o/oo, the minimum radius of curvature enlarged to 400 m, the track up-graded for 50-kg rails and bridges strengthened to LS22 and extend the effective length to raise the track capacity.

This would raise the track capacity from 20 times as at the present to 59 times and the traction load from 27 cars to 40 cars.

The transport capacity so strengthened would be capable of satisfying the traffic demand in 1990, it is estimated.

The investment needed on this work would be about 29,800 million wons.

Table 3-10 Comparison of the Various Measures in Raising the Transport Capacity of Chung Bug Line.

				Facilities to be improved in brief		Track Capacity (Frequency)	Maximum transport capacity (per day)				Investment (in 100 mil. wons)	Year capable of meeting the traffic demand
							Traction load (car)	Total No. of cars	Loading tonnage	Hauling tonnage to increase		
			Present state	-		20	27	540	16,200	-	-	1977
1	Double-header traction	a	Double-headed	Extension of the effective length in all sections		20	54	1,080	32,400	16,200		1978
		b	Double-headed only on the sections with 20 o/oo grade	54-car load, Bong Yang-Chung Ju 32-car load, Chung Ju - Jo Chi Weon	Extension of the effective length, Bong Yang-Chung Ju New facilities for trains to pass each other (O Song, Seo Cheang Ju, Mun Am) Single-track automatic signals	20	54-32	1,080	32,400	16,200		1978
				32-car load in all section	Extension of the effective length, Bong Yang-Chung Ju		32	640	19,200	3,000		1977
		c	Turn grade sections with 12.5-16 o/oo into 12.5 o/oo, and double-headed traction in 20 o/oo sections only	54-car load, Bong Yang-Chung Ju 40-car load, Chung Ju - Jo Chi Weon	Extension of the effective length in all sections New facilities for trains to pass each other (O Song, Seo Cheang Ju)	20	54-40	640	32,400	16,200		1978
				40-car load in all sections	Extension of the effective length in all sections		40	800	24,000	7,800		1977
2	Single-track automatic signalling			Installation of single-track automatic signalling system		24	27	648	19,440	3,240	24	1977
3	New station for trains to pass each other			Five in all at O Song, Seo Cheang Ju, Mun Am Son Deung, Weon Bag		29	27	783	23,490	7,290	80	1978
4	Track improvement			Grade improvement(below 12.5 o/oo), Curve improvement (above 400-m), Track and bridge strengthening (50-kg, LS22), New stations for trains to pass at O Song, Seo Cheang Ju, Mun Am, Son Deung, Weon Bag Longer effective length, etc.		30	40	1,200	36,000	19,800	282	1981
5	(1)		Single-track automatic signalling, New stations for trains to pass	Installation of single-track automatic signalling, system, New stations for trains to pass at O Song, Seo Cheang Ju, Mun Am, Son Deung, Weon Bag		36	27	972	29,160	12,960	121	1978
	(2)		Single-track automatic signalling, Track improvement	Single-track automatic signalling in addition to track improvement in 4 above		38	40	1,520	45,600	29,400		1983

6	(1)	Electrification	Electrification with the facilities as they are	27	29	783	23,490	7,290	109	1978
	(2)	Electrification	Existing facilities partly improved for electrification	31	40	1,240	37,200	21,000	376	1981
7		Double tracking	Double tracking with improvement of grades, curves, track and bridges Double interlocking block	59	59	2,360	70,800	54,600	298	1985

Remarks: 1. Investments only for the direct construction cost within the Chung Bug Line. Improvement of facilities in the yards concerned, and investments on rolling stock and rolling stock base not included.

2. The years are compared in the last column, taking the number of passenger trains to be 8 and the freight service coefficient 0.9, without the fluctuations taken into consideration.

3. The number of locomotives to be put into use is estimated with Type 7,500 in unelectrified sections and Type 8,000 in the electrified sections.

Table 3-11 Track Capacity of the Chung Bug Line as Strengthened by Measures to be Taken

Station	Length in Km	Track capacity								
		At present	Single-track automatic signalling (2)	Facilities for trains passing each other (3)	Track improvement (4)	Single-track automatic signalling, facilities for trains passing each other (5)-1	Single-track automatic signalling track improvement (5)-2	Electrification (6)		Double tracking (7)
								With existing facilities as they are	With existing facilities partly improveed	
Jo Chi Weon	11.4	21	25	38	41	51	56	27	41	94
O Song										
Mi Ho				29	30	36	38		34	74
Jeang Bang										
Seo Cheang Ju	10.9	22	26	34	34	45	45	27	41	64
Cheong Ju				32	32	43	41		33	
Jeong Ha	6.4	29	36	29	30	36	38	36	36	78
O Geun Jung	7.4	34	45	34	34	45	45	33	33	
Mae Su										
Geum Am	8.1	30	38	30	30	38	38	31	31	68
Jeung Ryeang	5.2	40	54	40	40	54	54	41	41	78
Do An										
Mun Am	9.2	22	27	30	30	38	38	27	39	66
Bo Cheon				38	38	51	51		36	
Sang Dang	7.6	30	37	30	30	38	38	30	30	59
Eum Seang	6.5	34	45	34	34	45	45	35	35	84
So I	7.7	31	40	31	31	40	40	31	31	61
Ju Deog	7.2	32	41	32	32	41	40	33	33	68
Dal Cheon	4.0	43	60	43	43	60	60	43	43	102
Chung Ju	6.1	29	36	29	33	36	43	37	37	81
Mog Haeng	4.4	36	46	36	38	46	51	41	41	94
Dong Ryang	3.4	30	38	30	38	38	51	42	42	
San Cheog	6.8	22	26	43	42	60	58	31	40	72
San Deung				29	40	36	54		40	
San Tan	5.9	29	36	29	38	36	51	36	36	84
Gong Jean·	8.6	20	24	36	41	46	56	28	39	74
Weon Bag				29	41	36	56		39	
Bong Yang										
Min. track capacity		20	24	29	30	36	38	27	31	59

3-3 Double-tracking plan appreciably effective in improving

The points to be considered in double-tracking the Chung Bug Line are as follows:

1) The line to be double-tracked is mainly for passing-through freight service, rather than for the freight service arriving and leaving within.

2) The main body for transportation are such heavy-seight products as anthracite and cement, for which the transport demand fluctuates a little.

3) Much of the freight is hauled by up-trains.

4) Increase in traffic is expected to continue.

Much of the freight, therefore, is hauled from the producing districts to the consuming districts. That is, anthracite by the Tae Baeg Line and cement by the Jung Aug Line to the Gyeong Bu Line via the Chung Bug Line. With the grades and other track conditions taken into consideration so as to do the hauling of 40 cars set as the traction constant for the up-train traffic on the Tae Baeg and the Jung Aug Lines, elimination of the operations in adjusting the traction load constant at the Je Chean Yard must be considered.

The main body of freight being such heavy items as anthracite and cement, the demand for transport fluctuates only a little. However, as the number of through trains on the Tae Baeg, Jung Aug and Gyeang Bu Lines increases, the relief facilities within the line will have to be made elastic enough so as to be little affected by the other lines converned.

As the passing tonnage grows, strengthing of the track facilities for safety in operation as well as for labor saving in maintenance work, is desired.

It also is necessary to consider double-track automatic signals, CTC and electrification so as to be ready in dealing with the traffic expected to continue growing, keeping in mind that no investment would be wasted on the facilities once set up.

3-4 Summary

Typical means of improving the existing line have been explained in Paragraph 3-2-2. The limit to the track capacity of a single-track line ordinarily is said to be 40 to 50 times one way. Even when new facilities for trains to pass each other are set up, single-track automatic signals installed, track improved and electrification undertaken, there still will be a limit to the track capacity.

In the case of the Chung Bug Line there are steep grades of 20 o/oo between San Cheag and Bang Yang where the track capacity is deplorably low. In order to set up new facilities for trains to pass each other for the strengthening of the track capacity, the routing itself would have to be largely changed and the grades would have to be brought down to 8 o/oo at some points. This means that the construction cost would come up to a startling amount.

In case of double-header operation in this section, the length of trains would become longer, and in consequence the effective track length would have to be extended. If there arises the necessity of laying additional track in the future, it would mean a considerable loss to be construction cost.

When double-tracking is to be undertaken after the line has been electrified and single-track automatic signals installed, it will take a considerably long time and a vast amount of money in construction.

As far as the Chung Bug Line is concerned--the single-track line on which the transport demand is expected to continue growing, it still seems most proper to improve its track capacity by double-tracking when we think of the construction period and cost, as double track will leave a margin in the track capacity, ensure security in service and allow long enough train intervals for maintenance work.

IV. Double Tracking Project

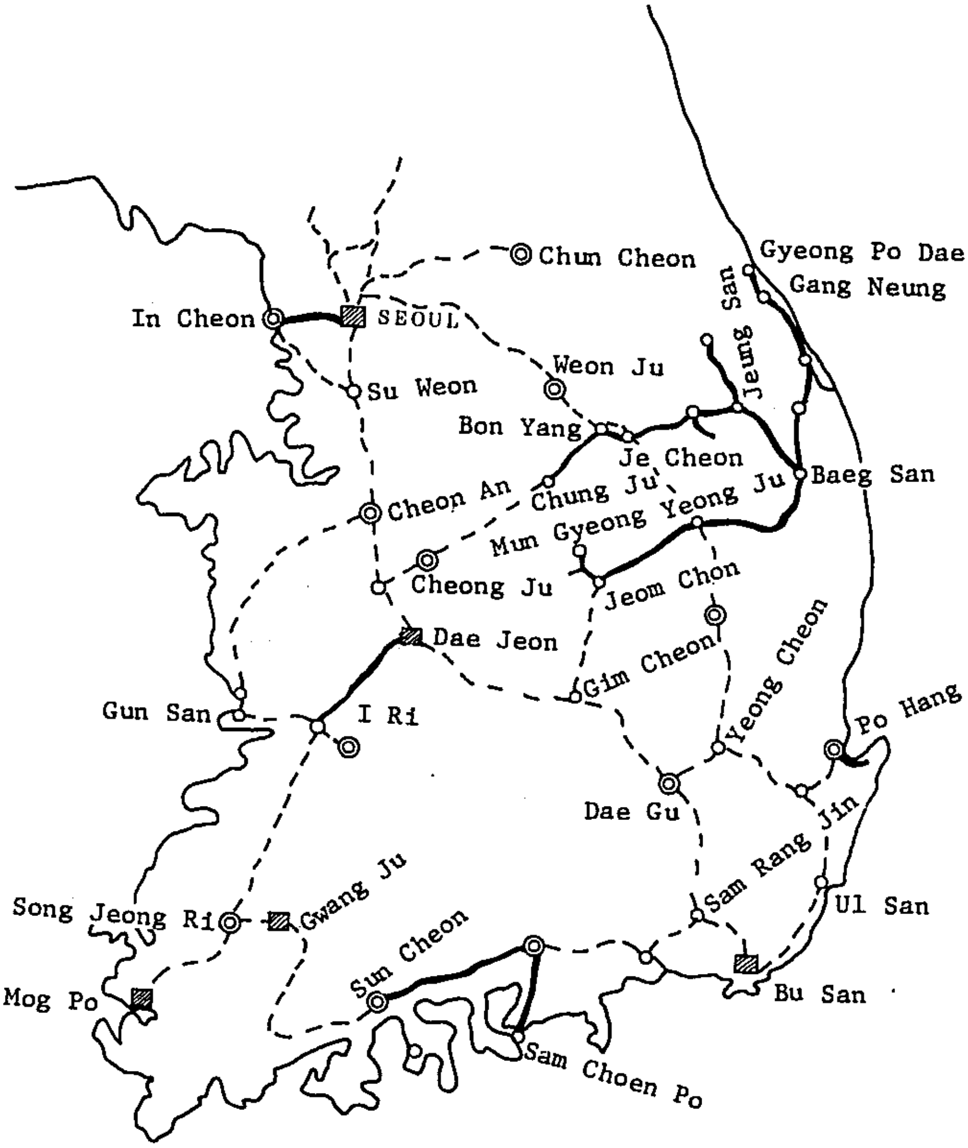
4-1 Showings of railway construction and development of the Chung Bug Line

4-1-1 Showings of railway construction

Railway lines amounting to a total track length of about 500 km were constructed in Korea since 1945. The lines constructed are as in the following:

1. Part of Chung Bug Line (Chung Ju ∿ Bang Yang)
2. Tae Baeg Line (Je Cheon ∿ Gu Jeol Ri) and its branch line. Double tracking on part of the Line is now under way.
3. Part of Jeong Seon Line (Jeung San ∿ Gu Jeol Ri)
4. Part of Yeong Dong Line (Yeang Ju ∿ Gyeong Po Dae) and its branch line.
5. Part of Gyeong Jeon Line (Jin Ju ∿ Sam Cheon)
6. Part of Ho Nam Line (double tracking between Dae Jeon and I Ri now under way)
7. Part of Jung Aug Line (double tracking between Bong Yang and Je Cheon)
8. Gyeong In Line (Yeong Deung Po ∿ In Cheaon)
9. Gyeong Bug Line (Jeom Chon ∿ Yeong Ju)
10. Bu San Line (Jin Ju ∿ Sam Cheon Po)
11. Part of Mun Gyeong Line (Buljeong ∿ Mun Gyeong)
12. Po Hang Line (Hyooja ∿ Gedong)

Fig. 4-1 Map of Railways Built Since 1945



Legend
- ———— Lines built since 1945
- -------- Lines built before 1945

Noteworthy on the Tae Baeg Line is the 4,505 m Jeang Am Tunnel built in 1974. Aside from this on the same line is the 2,148 m Jeong Seon Tunnel built a little earlier than the Jeong Am Tunnel.

As can be noted from the above, the Korean National Railroad (KNR) has abundant experience in railway construction, in which heavy construction equipment is widely introduced. Hence, it is considered that for the time being, there is no need of introducing construction machinery or employing work supervision from Japan for implementing the work of double tracking of the Chung Bug Line.

4-1-2 Development of the Chung Bug Line

The present Chung Bug Line is single tracket and its total length is 126.9 km of standard gauge, 1,435 mm. It connects Jo Chi Weon on the Gyeong Bu Line with Bong Yang on the Jung Aug Line via Cheong Ju and Chung Ju.

The Chung Bug Line was initially built as a private railway in November 1921, between Jo Chi Weon and Cheong Ju a length of 22.3 km. In Cecember 1928, a 69.4 km section between Cheong Ju and Chung Ju was opened, increasing its length to some 90 km and enabling it to perform the functions of a railway.

Around 1950, five years after Independence, the construction of a shortcut line providing direct passage between the Gyeong Bu Line and the Jung Aug Line was commenced by extending the Chang Bug Line from Chung Ju to Bong Yang on the Jung Aug Line. The extension work was met with enormous difficulties, since the line between Mog Haeng and Bong Yang had to pass through a rugged mountainous region requiring construction of numerous structures, such as the 400-m long Nam Hang Gang River Bridge and the 1,000-m long Baeg Ag Tunnel. In April 1956, the 6.1 km Chung Ju - Mog Haeng section was opened, and in May 1958, the remaining 29.1 km section from Mag Haeng to Bong Yang was completed.

As a result, the Chung Bug line steadily gained importance with the times by short-circuiting the Gyeong Bu and the Jung Aug Lines and thereby acting as an industrial line for hauling anthracite, cement, etc. produced along the Yeong Dong and Tae Baeg Lines.

The 90 km section between Jo Chi Weon and Chung Ju was, as previously mentioned, built as a private railway, and the roadbed and structures etc. are designed to the lowest standards. The minimum radius of curvature is 300 m and many curved places are of simple curve design. To avoid sudden change between a straight line and a curve, ordinarily, a special curve called "transition curve" is inserted. Inasmuch as a simple curve is without the transition curve, it not only limits the train speed but causes difficulties in track maintenance.

Although the section between Jeung Pyeang and Chung Ju has been improved by providing transition curves, the stretch between Jo Chi Weon and Jeung Pyeong is unfinished, there being about 40 curves requiring improvement work.

The width of roadbed in the section between Jo Chi Weon and Chung Ju is 4.8 m, the standard for Class 4 track, while between Chung Ju and Bong Yang 5.4 m or Class 3.

Between Jo Chi Weon and Chung Ju, the live load is LS-15 at 65 bridges totalling to a length of some 2,400 m. Improvement work is now under way to increase their load to LS-22 for heavier diesel locomotives on the line.

There are ten tunnels, a total length of 3,777 m, throughout the line. As will be mentioned in 4-2-1, the Chung Bug Line crosses two watersheds, that is to say, the tunnels are abundant in the Bo Cheon area about 60 km from Jo Chi Weon and the San Tam area about 110 km from Jo Chi Weon. The Bo Cheon area, however, is not so high and there are only two tunnels near a point 178 m above sea level. The largest number of tunnels are situated between San Tan area 220 above sea level and Bong Yang.

As mentioned in the above, the Chung Bug Line runs through the mountainous regions and there are steep grades at various places, especially the 20 o/oo grade sections corresponding to 10% of the entire length of the line impose unfavorable conditions on train operation.

Work is being carried out to change the rails of main tracks to 50-kg rails. At present 90 km of the main tracks, is of 50 kg rails and the remainder, of 37 kg rails.

All sleepers are of wood, laid at a rate of 44 pieces per 25 m.

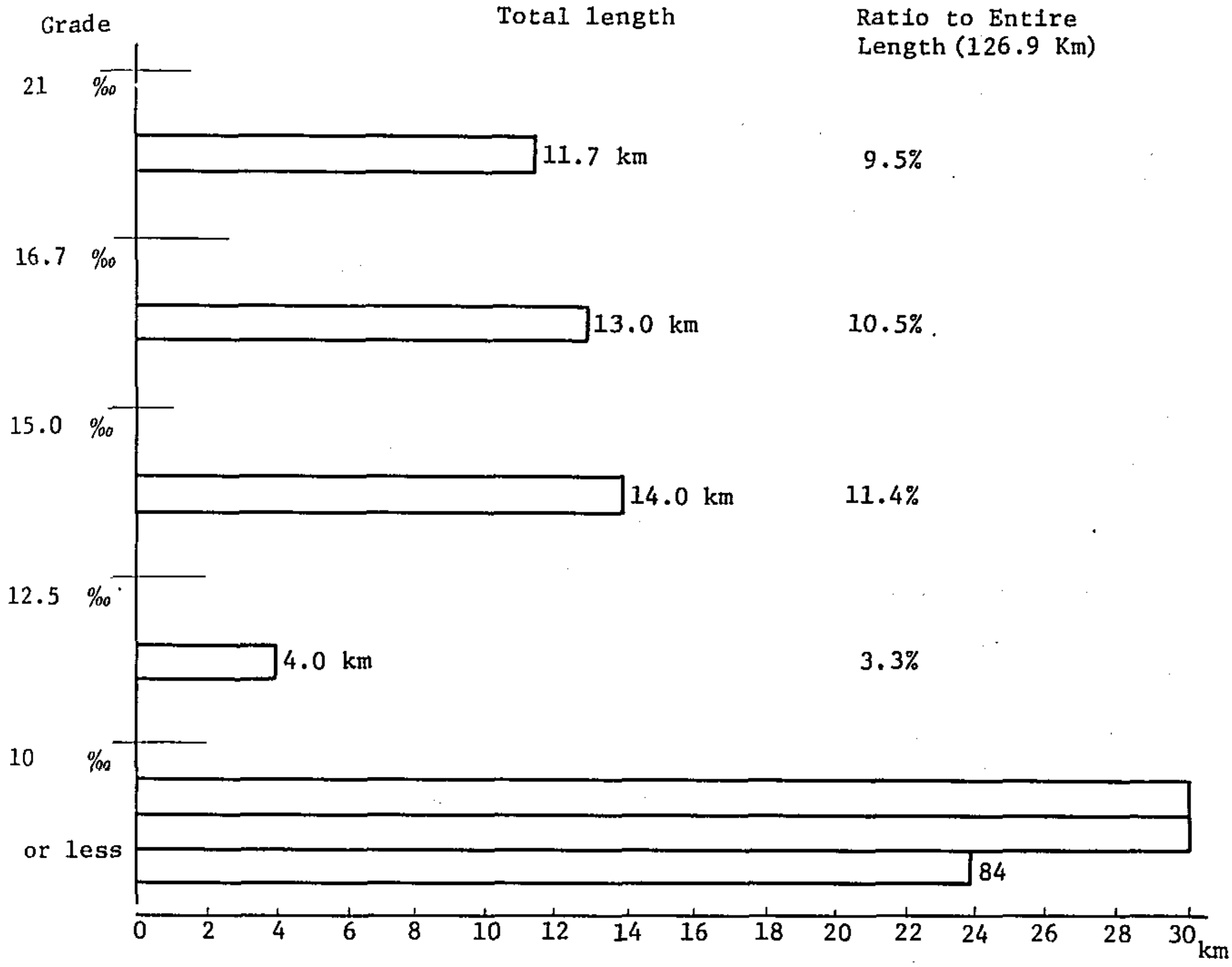
Crushed stone ballast is used to a depth of 220 mm below bottom surface of sleeper.

Tablet blocking system is employed between stations and second class mechanical inerlocking devices with semaphore signals in stations.

As for telecommunication facilities, an exchange office is established in Cheong Ju and Chung Ju Stations wherefrom overhead bare lines are stretched along the railway line.

Excluding San Cheog, San Tan and Gong Jeon, all stations have their exclusive transformers for station illumination and other purposes.

Table 4-1 Grades and Curves on Existing Line



Curves

Radius of Curvature	Over 801(m)	800	600	500	400	300	Total
No. of Curves	8	10	16	20	81	51	192

4-2 Terrain and climate

4-2-1 Terrain

4-2-1-1 Mountain ranges

Chung Cheong Bug Do prefecture through which the Chung Bug Line crosses is surrounded by two mountain ranges, the Cha Ryeang Range on the north and the So Baeg Range on the south. In the middle part of the prefecture, there is an old stage hill area in parallel with the So Baeg Range. It is mostly composed of granite and gneiss.

As a whole, it is not so high and becomes gradually lower on the southwest side.

Near the prefecture's northeast boundary between Gang Weon Do prefecture, soar the one thousand meter class mountains such as the Nam Dae San (1,132 m), Gam Ag Bong (885 m) and Baeg Un San (909 m) which are the major peaks of the Cha Ryeong Range. The Nam Han Gang River rans across the Range and its tributaries including the Cheong Gye Cheon River interrupt the Range to from variant groups of hills.

Mts. O Gab San (609 m), Gug Mang San (770 m), Seo Un San (547 m) and Og Nyeo Bong (456 m) are the typical old stage mountains.

The Cha Ryeong Range has comparatively rich underground resources of limestone, iron ore, gold and silver.

The So Baeg Range is mostly composed of granite and gneiss. In this mountain range there are many high peaks such as the So Baeg (1,421 m), Gug Mang San (1,420 m), Hyeong Je Bong (1,178 m), Sin Seon Bong (1,370 m), Yeon Hwa Bong (1,394 m) and the Sog Ri San (1,057 m), hindering the traffic in the Gyeong Bug region.

4-2-1-2 Rivers

Chung Cheong Bug Do Prefecture is in the basins of two large rivers, the Nam Han Gang River and the Geun Gang River.

The Nam Han Gang River which has its source near Mt. O Dae San flows through Chung Cheong Bug Do Prefecture from west to south. Near Dan Yang it forms a scenic gorge known as the "Don Yang Pal Gyeong". It then changes its direction to northwest. From near Geyong Gi Do, en route, it gathers the tributaries of Je Cheon and Dong Cheon and from near Chung Ju it joins with Dong Cheon River and flows north towards Gyeong Gi Do Prefecture. Along its valley are the eroded basins of Je Cheon, Dan Yan, Chung Ju and Eum Seong which form an important production belt.

Especially the Chung Ju Basin which was developed at the junction of Nam Han Gung River and the Dong Cheon River, along with Mi Ho Ryeong Ya in the west, make up the two great valleys in Chung Bug.

Moreover, Chung Ju Basin which is about 100 m above sea level forms hill groups and diluvial deposit land.

A plan is being materialized to build a dam (the Chung Ju Dam) by blocking the Nam Han Gung River near Mog Haeng north of Chung Ju City for the construction of 100,000 kW power plant. A 2,600 kW power plant (Gyoe San Hydraulic Power Plant) has been completed on the upstream of Dol Cheon River at Chil Seong Myeon in Gyoe San Country.

The Geun River which rises in Jang San County, Jeon Ra-Bug Do Prefecture flows north to near Sim Cheon on the Gyeong Bug Line whereat it makes a large bend changing its flow to northwest. Then, from Bu Gang on the Gyeong Bu Line it runs southwest into Chung Cheong Nam Do Prefecture. Joining the Geun Gang River en route are tributaries such as the Yeong Dong Cheon Jo Chean, Bo cheon, Gab Cheon and Mi Ho Cheon.

The largest valley in Chung Cheong Bug Prefecture is the Mi Ho Valley which the Mi Ho Cheon River irrigates. Although Mi Ho Cheon River which rises from the Cha Ryeong Mountain Range is but 89 km long, it joins such Rivers as the Cho Ryeong Cheon and the Mu Sim Cheon en route.

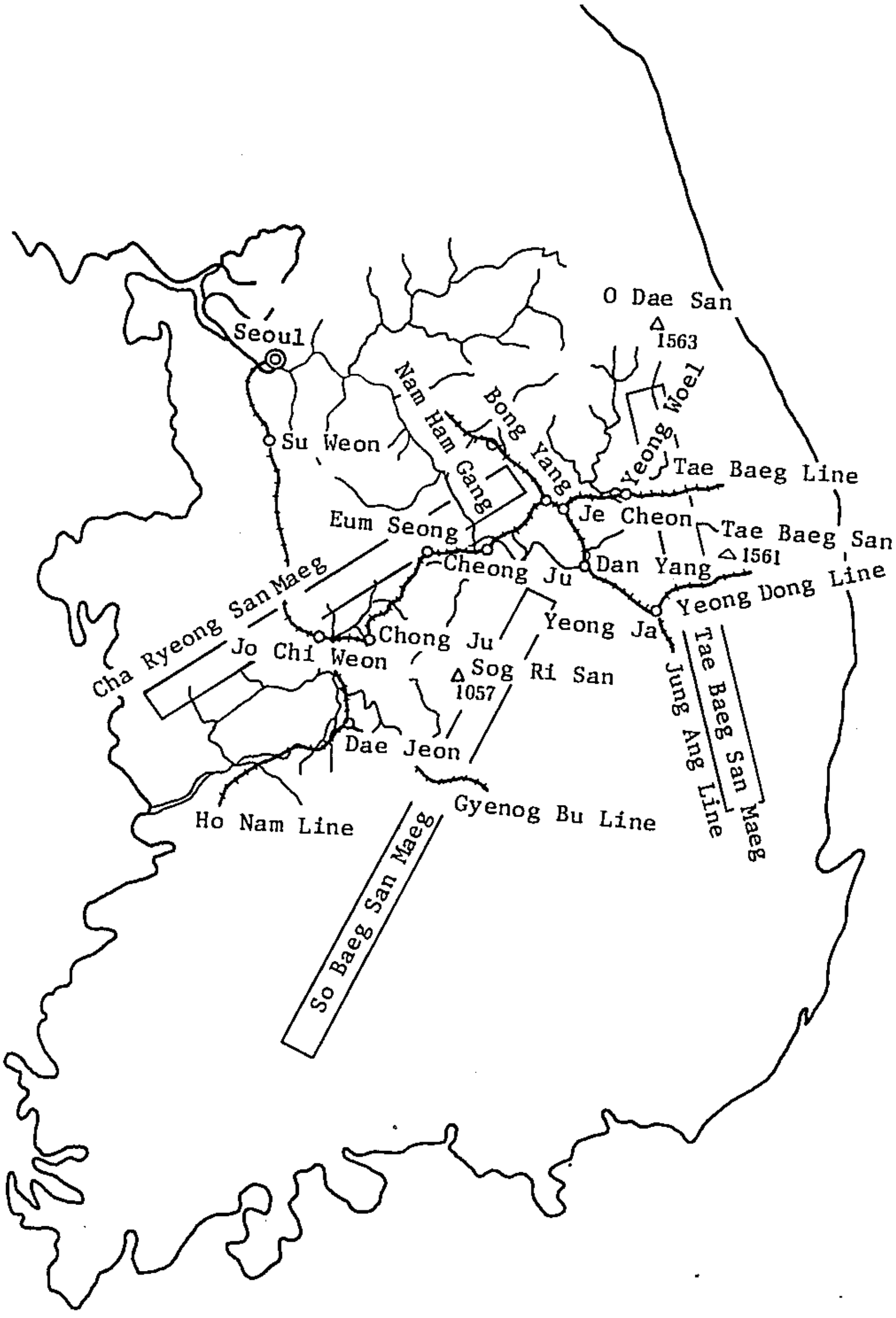
The Mi Ho valley extending from near Cheong An to Jo Chi Weon is a long valley and the largest granary in Chung Cheong Bug Do Prefecture. Upstream there are such basins as the Jin Cheon, Byeong Cheon and the Cheong Ju, and around these basins, rolling hills of some 200 m spread out.

Similar to the above, the northeast and southeast parts of Chung Cheong Bug Do Prefecture are regions of steep mountains, whereas the shouthwest and northwest are of comparatively low hills and the west is of plains.

Chung Cheong Bug Do Prefecture is the only inland prefecture in Korea. As a whole, its elevation is high, but Mi Ho Valley is low, being 22 m or so above sea level.

Only nine percent of Chung Cheong Bug Do Prefecture is lower than 100 m above sea level. About 75 percent is plains ranging from 100 to 500 m above sea level and about 14 percent is from 500 to 1,000 m and two percent is of highland above 1,000 m.

Fig. 4-2 General Topography of Chung Bug Line



4-2-1-3 Topographic features

The Chung But Line branches off from the Gyeong Bu Line at Jo Chi Weon and crosses the middle of Mi Ho Valley irrigated by the Mi Ho River. It then passes through Cheong Ju Basin and leads to Jeung Pyeong situated at the northwest end of the Mi Ho Valley.

From there is passes over Bo Cheon and Eum Seong which are the water-sheds of the Cha Ryeong and the So Baeg Mountain Ranges. Thereafter, it passes through Chung Ju situated in the Chung Ju Basin along the Nam Han Gung River and climbs toward the Tae Baeg Mountain Range. At Bong Yang, Chung Bug Line connects with the Jung Aug Line. The Chung Bug Line travels from southwest to northeast between the Cha Ryeong and So Baeg Mountain Ranges.

The line ascends from Jo Chi Weon 27 m above sea level to Bo Cheon, 178 m above sea level, and then descends to Chung Ju. From Chung Ju the Line climbs again to Gong Yang, 218 m above sea level.

The points Cheong Ju, Eum Seong and Chung Ju situated between Jo Chi Weon and Bong Yang are greatly diverged from the straight line drawn between Jo Chi Weon and Bong Yang and the route is of gradual upgrade from Chung Ju to Bong Yang making appropriate bends.

When viewed from Jo Chi Weon, it runs from valley to watershed and further, from basin to mountain. It connects the major cities en route at about even distances in central and upper Chung Cheong Bug Do Prefecture.

Administratively, Jo Chi Weon is under the jurisdiction of Cheong Weon Gum County of Chung Cheong Nam Do Prefecture; O Song, Mi Ho and Jeong Bong as well as Seo Cheang Ju, O Geun Jang and Nae Su under Cheong Weon Gun County of Chung Cheong Bug Do Prefecture; Cheong Ju under Cheong Ju City; Jeung Pyeong and Do An under Gyoe San Gum County; Mun Am, Bo Cheon, Sang Dang Eum Seang and So I under Eum Seong County; Dal Cheon, Chung Ju and Mag Haeng under Chung Ju City; Ju Deag, Dong Ryang, San Cheog and San Tan under Jung Weon Gun County; and Gong Jeon and Bong Yang under Je Cheon County.

4-2-2 Climate

4-2-2-1 Weather condition

Chung Cheong Bug Prefecture, through which the Chung Bug Line runs is situated in mid-south part of Korean Peninsular. Since it is far from sea coast, its climate is continental with large temperature variations. The temperature difference reaches about 26°C, the average temperature is January being about -1°C and in July, from 24 to 27°C.

On the other hand, the average minimum temperature in January is -13°C, about the same as in Seoul, and the average maximum temperature in July reaches around 35°C. The Chung Ju Basin, along with Dae Gu Basin, is known for the extreme heat.

The records of highest temperature are 38.9°C at Cheong Ju and 39.6°C at Chung Ju, while the lowest are -28°C at both Cheong Ju and Je Cheon.

The annual rainfall is roughly 1,200 mm, though there are some differences according to areas. Affected by seasonal winds, the wet and dry seasons are distinct.

As for the rainfall by seasons at Cheong Ju, Chung Ju and Je Cheon, it is only about 10% of the annual precipitation in winter (December through February), while in spring and summer (March through August) it is 70% of the annual and in autumn about 20%, that is, the climate is wet summer pattern. Although snow falls in winter, the amount is little throughout the area.

The summer seasonal winds caused by the assault of the northeast high atmospheric pressure bring extremely heavy rain and the tropical depressions become typhoons accompanying serious flood damages.

The number of rainy days per year in Cheong Ju district is about 117 and in Chung Ju district about 127. The rainy days in summer season amount to 10 to 15, and in winter season about 7 per month.

4-2-2-2 Rainfall

The monthly rainfall for the past five years in the districts of Cheong Ju City and Chung Ju City, the representative cities on the Chung Bug Line, is given in Reference Material No. .

The average annual rainfall in Cheong Ju and Chung Ju districts is 1,200 mm. During the July - September period, Cheong Ju district has about 700 mm of rainfall and Chung Ju district about 600 mm, namely 50 to 60 percent of the annual rainfall is concentrated in this period.

4-3 Routing

4-3-1 Policy for track addition

As mentioned in 4-2 above, the Chung Bug Line with mountain range on both sides is a so-called mountainous line crossing two water-sheds and terminating at Bong Yang on the Jung Aug Line.

The Jo Chi Weon-Chung Ju section was built before the Independence and 50 years have already past since its inauguration. On the other hand, the Chung Ju - Bong Yang section, built only 20 years ago, is a typical mountainous section with many sharp curves and steep grades.

While sharp curves give rise to difficulties in raising train speeds and maintaining tracks, steep grades restrict hauling tonnage. Namely, both are factors that greatly affect transport capacity.

Moreover, the Chung Bug Line is an industrial line in nature, carrying such assential goods as hard coal and cement from the producing districts of Tae Baeg and Yeong Dong to the consuming areas of Gyeong Bu and Ho Nam. Necessarily, traffic is one way in the direction from Bong Yang to Jo Chi Weon on the up-bound track. It is therefore necessary to place special attention on selecting the up-bound route of improved grades for augmenting transport capacity.

From the viewpoint of curtailing work expenditure, it is desirable to utilize as far as possible the land and structures of the existing line and moreover, to shorten the total track length.

With the above in mind, the following policy was adopted for track addition:

1. Utilize as far as possible the land and structures of the existing line and contrive levee widening wherever possible.

2. The track to be added shall be used for up-bound traffic, except when deemed unadvisable in various spects such as topography, work execution and construction cost.

3. On the existing line, curves with minimum radius of 300 m shall be improved to 400 m or more, and those with their radiuses 1,200 m or less shall be provided with transition curves.

4. The maximum grade on up-bound track shall be limited to 12.5 o/oo for increasing hauling tonnage.

5. A delta siding shall be installed at Jo Chi Weon to provide smooth traffic flow by making direct connection with up-bound direction of Gyeong Bu Line.

6. Tokenless blocking system shall be adopted using color light signals to promote safety.

4-3-2 Outline of track addition route

The outline of the track addition route of the Chung Bug Line as projected by KNR under the policy of 4-3-1 above is given in the following:

From Jo Chi Weon to Cheong Ju

Starting from Jo Chi Weon, track will be added on the left side of the existing line and upon building a new station near point 4.40 km, track adding will be continued on the left side. At point 11.20 km, Jeong Bong Station will be improved. Thereafter, new double track will be added on the left side and the line will be shortened by 7 km in compliance with the city planning of Chong Ju. Besides improving the present grade of 16.7 o/oo to 12.5 o/oo and minimum radius of curvature from 300 m to 500 m, three stations, Soe Cheong Ju, Cheong Ju and Jeong Ha will be closed. At point 20.8 km - before reaching O Geun Jang Station - New-Cheong Ju Station will be built and O Geun Jang Station disused.

From Cheong Ju to Chung Ju

After passing the old O Geun Jang Station, track will be added on the right side of the existing line and at point 27.90 km before reaching the present Nae Su Station, New-Nae Su Station will be built. From point 36.00 km before reaching New-Jeung Pyeong Station (36.40 km), it will be a new double track line and sobyo Station located in northern urban district of Jeung Pyeong City will be moved about 800 m.

The new track will extend to Do An Station which will be moved in connection with track layout modification work.

Leaving Do An Station, track will be added on the right side, and from point 54.00 km, before reaching Bo Cheon Station, it will be a new double track line up to the newly built Bo Cheon Station.

En route, a 780 m long Bae Ma Tunnel will be built.

The new double track line will extend as far as 2.50 km beyond Bo Cheon Station. The line will be grade separated with National Highway, and proceeding for about 400 m upon going through the Ma Song Tunnel (320 m), the new line will meet the existing line and track will be added on the right side, while improving the grades and curves.

From point 57.80 km, before reaching Eum Seong Station (59.27 km) it will be a new double track line as far as point 60.50 km on the other side of the station where it will meet the existing line and track will be added on the right side and curves improved.

From point 62.70 km (before reaching Soi Station, point 63.78 km), it will be a new double track line to point 64.10 km.

From there, to Je Cheon Station, track will be added on the right side while improving some curve.

Je Cheon Station will be improved and track will be added on the right side. From point 80.00 km to Chung Ju Station (82.00 km) it will be a new double track line to comply with Chung Ju City planning, whereby Chung Ju Station will be moved sest ward by about 1,000 m.

From Chung Ju to Bong Yang

From Chung Ju Station to point 84.30 km, it will be a new double track line and at this point the present level crossing will be elevated. From there to Mag Haeng Station, track will be added on the right side. The grade separated crossing near Mag Haeng Station will be windened along with improvement of the yard, and the track will be added on the right side down to Dong Ryang Station.

En route, the existing line of Nam Han Gung River Bridge will be left as it is and a new track will be added downstream to run parallel with the existing line at a distance about 40 m apart.

Dong Ryang Station (92.20 km) will be moved some 700 m and the route, before reaching Dong Ryang Station, will take a new double track line to right. Passing the Station it will still be a double track line for about 2,000 m and reach the portal of 4,260 m long In Deung Tunnel. The tunneling work will take about 36 months.

Large scale improvement work of San Tan Station will be performed. From there track will be added on the left side. In the mountainous region, two trunnels Myeong Am (800 m) and Mun Deog (280 m) will be constructed and from about 2,500 m before Gong Jeon Station, track will be added on the right side up to the station. Gong Jeon Station will be shifted about 100 m.

Beyond Gong Jeon Station, the existing line will be used for and for the up-bound track, tunnels Hyeon Bag (220 m) and Ju Po (310 m) will be constructed while making grade improvements shortening the distance by 1.2 km as against the down-bound track in reaching Bong Yang Station.

4-3-3 Comparison of principal routes

Of the new route described in 4-3-2 above, comparisons were made with alternatives in two areas in particular, one near Cheong Ju and the other between Dong Ryang and Son Tan. The results are as in the following:

4-3-3-1 Cheong Ju area

In connection with city planning, the route in the Cheong Ju area was greatly changed, and as a result, the existing route of 15.5 km was shortened to 8.5 km. Moreover, 19 curves (including five with 300 m radius) and a 16.7 o/oo grade were also improved.

The investment for the new route is estimated at 2,870 million won, while if a track is added to the existing line, the investment will amount to 2,690 million won. Apparently, the construction of the new route calling for 180 million won larger investment will be justified by the merits of the route - shortening of line length, improvement of curves and grades and saving of traveling time.

4-3-3-2 Dong Ryong San Tan section

There are numerous sharp curves, steep grades and tunnels between Dong Ryong and Bong Yang because the route meanders through the folds of So Baeg and Cha Ryeong Mountain Ranges.

Therefore, of the 10.2 km stretch between Dong Ryang and San Tan, about seven kilometers are of 20 o/oo steep grade and 11 out of 20 curves are of 300 m radius. There are three tunnels, the No.1 In Deung Tunnel of 520 m, No.2 In Deung Tunnel of 150 m and Baeg Ma Tunnel of 1,000 m.

The alternatives for the improvement and addition of track on this section were carefully examined and narrowed down to the following two:

Alternative No.1 is to construct In Deung Tunnel having a length of 4,260 m. With the double tracked, long tunnel, Dong Ryang - San Tan section will be double tracked by an entirely new line.

Alternative No.2 is to make a detour to the north along the contour line from the viewpoint of also improving the existing line grades.

Alternative No.1 was adopted because the length of section and the required traveling time would be 3.7 km and about five minutes shorter, respectively. Moreover, the roadbed work will be 23 million won cheaper. The construction period, however, in Alternative No.1 will be about eight months longer, requiring about 36 months.

Table 4-2 Comparison of Principal Double Track Sections

Section	Route	Max. grade	Track capacity	Distance between stations	Investment	Const. period	Difficulty in execution	Travel time	Safety in operation	Disaster prevention	Others	Remarks
Jeang Bang - New Cheong Ju	New double track line	o/oo 12.5	87	K 8.6	Million Won 2,877	Mon. 14	Easy	Min. 9.0	Very safe		In coordination with city planning	Adopted
	Double track line in parallel to existing	16.7	58	15.3	2,692	17	Close to existing line	29	"			
Dong Ryang - San Tan	Via In Deung Tunnel	12.5	72	6.3	5,049 (Road bed)	36	Long tunnel In Deung ℓ =4,260 m	12.0	Very safe	Soil good		Adopted
	Via San Cheag	12.5	56	10.0	5,072 (")	28	In Deung ℓ =1,160 Baeg Ma ℓ =1,720	17.5	"	"		

Table 4-3 Name of Stations

Existing line			Double tracking			Remarks
Location	Distance between stations	Station	Location	Distance between stations	Station	
(km)	(km)		(km)	(km)		Station in parenthes shows station in closure at present
0.000	0	Jo Chi Weon	0.000	0	Jo Chi Weon	
4.549	4.5	(O Song)	4.381	4.4	O Song	
7.730	3.2	(Mi Ho)				
11.352	3.7	Jeong Bong	11.174	6.8	Jeong Bong	
16.480	5.0	(Seo Cheang Ju)				
22.308	5.9	Cheang Ju	20.810	9.6	Cheang Ju	
24.882	2.6	(Jeong Ha)				
28.644	3.8	O Geun Jung				
36.027	7.4	Mae Su	27.900	7.1	Mae Su	
39.393	3.4	(Geun Am)				
44.170	4.8	Jeung Pyeong	36.410	8.5	Jeung Pyeong	
49.323	5.2	Do An	42.463	6.1	Do An	
54.675	5.3	(Mun Am)				
58.547	3.9	Bo Cheon	51.352	8.9	Bo Cheon	
62.535	4.0	(Sang Dang)				
66.107	3.6	Eum Seong	59.277	7.9	Eum Seong	
72.603	6.5	So I	63.777	4.5	So I	
80.323	7.7	Ju Deog	71.553	7.8	Ju Deog	
87.489	7.2	Doe Cheon	78.716	7.2	Doe Cheon	
91.513	4.0	Chung Ju	81.977	3.3	Chung Ju	
97.644	6.1	Mog Haeng	87.806	5.8	Mog Haeng	
102.051	4.4	Dong Ryang	92.239	4.4	Dong Ryang	
105.418	3.4	San Cheog				
112.199	6.8	San Tan	100.236	8.0	San Tan	
118.145	5.9	Gong Jean	105.945	5.7	Gong Jean	
126.8 5	8.6	Bong Yang	113.322	7.4	Bong Yang	
Total	126.9			113.4^{km}		
			(Delta)	5.5^{km}		
			Total length	118.9^{km}		

4-4 Plans for yearly investment and procurement of Imported supplies and materials

4-4-1 Review of total expenses for double tracking

According to the estimations made by KNR of the double tracking project of the 118.8 km Chung Bug Line, the total expense for the work was 29,800 million won (approximately 18,000 million yen). This sum was estimated as of April, 1975.

The appropriateness of this sum was reviewed from various aspects. Some of the items reviewed are given in the following as reference.

For double tracking, the Chung Bug Line can be geographically divided into the following three sections, the construction cost per km being 250 million wons:

(1) The section between Jo Chi Weon and Cheong Ju, which is consisted of almost all flat paddy fields, with many bridges and small curved portions. The construction cost of this section, with curve improvements, will be about 240 million wons per km.

(2) The section between Cheong Ju and Chung Ju, 50% of which are cibsusted of farm lands and the rest is of hills and mountains, with many portions almost in paralled to which the line has to be double tracked. The construction cost of this section will be about 180 million wons per km.

(3) The section between Chung Ju and Bong Yang, 25% of which are cibsusted of farm lands and the rest is mountainous.
On this section there are the In Deung Tunnel and the Nam Han Gang Bridge, and many structures will have to be newly built up.
The construction cost of this section will be 370 million wons.

In addition, the Jo Chi Weon triangular line will have to be constructed with overhead bridges built and grades separated, the construction cost per km being 330 million wons.

Comparison of wages, prices of construction materials, cement, gravel and sand in Korea with those in Japan shows that wages in Korea are 20 - 30 %, the cement, gravel and sand are 40 - 85% of those in Japan. It can be said, therefore, that the construction cost be appropriate when compared with that in Japan.

The construction cost for double tracking of the Chung Bug Line is shown in Table 4-4.

4-4-2 Yearly investment plan

The constructions cost by year corresponding with the overall project dealt with in 4-4 is as given in Table 4-5.

Table 4-4 Construction Cost for Double Tracking Project

(Unit: 1,000 won)

	Grand Total		Jo Chi Weon - Bong Yang								Jo Chi Weon delta sidings		Remarks
			Jo Chi Weon - Cheong Ju (21 km)		Cheong Ju - Chung Ju (61 km)		Chung Ju - Bong Yang (31.4 km)		Total (113.4 km)				
	Quantity	Sum	Quantity	Sum	Quantity	Sum	Quantity	Sum	Quantity	Sum	Quantity	Sum	
Land	2,303,010	2,589,883	$412,000^{m^2}$	460,940	$1,201,000^{m^2}$	1,332,300	$590,000^{m^2}$	666,420	$2,203,000^{m^2}$	2,459,660	$100,010^{m^2}$	130,223	E 6,612
	E $6,192,800^{m^3}$ (C 1,677,540 Em4,515,260) B $5,316^{m}$ T $7,309^{m}$	17,156,172	E $1,114,520^{m^3}$ (C 294,360 Em 820,160) B 1,017	1,967,609	E $3,371,110^{m^3}$ (C 879,320 Em2,491,790) B $1,386^{m}$ T $1,100^{m}$	5,663,256	E $1,363,070^{m^3}$ (C 481,320 Em 881,750) B $2,061^{m}$ T $6,209^{m}$	8,223,728	E $5,848,700^{m^3}$ (C 1,655,000 Em4,193,700) B $4,464^{m}$ T $7,309^{m}$	16,154,593	E $344,100^{m^3}$ (C 22,540 Em 321,560) B 852^{m}	1,001,579	B 3,551 T 6,067
Track	km 183	7,606,000	km 51	2,053,467	75^{km}	3,146,906	km 46	2,038,680	km 172	7,516,000	km 11	470,015	
Signal	Ele.signal, Remote control	675,000	4	138,000	9	310,500	5	172,500	18	621,000	Remote control	54,000	
Building	$4,700^{m^2}$	329,000	$1,100^{m^2}$	11,000	$3,000^{m^2}$	210,000	600^{m^2}	42,000	$4,700^{m^2}$	329,000	0'	0	
Electric Power	20 places 11	430,000	2 places	83,000	6 places	249,000	2 places	83,000	10 places	415,000	20 places 1	15,000	
Telecommunication	88^{km}	264,000	15^{km}	45,000	52^{km}	156,000	15^{km}	45,000	Telecom. line 28 82^{km}	246,000	6^{km}	18,000	
Incidental Expenses	Investigation, Survey	749,945		153,327		259,387		170,048		618,762		131,183	
Total	118.9	29,800,000	21^{km}	4,978,343	61^{km}	11,363,349	31.4^{km}	11,638,308	113.4^{km}	27,980,000	5.5^{km}	1,820,000	

E: Earth Work C: Cutting Em: Embankment B: Bridge T: Tunnel

Table 4-5　Construction Cost by Year for Double Tracking of Chung Bug Line

(in million won)

	Total sum		1st year		2nd year		3rd year		4th year		5th year	
	Breakdown	Sum	Breakdown	Sum	Breakdown	Sum	Breakdown	Sum	Breakdown	Sum	Breakdown	Sum
Land	2,303,010^{M2}	2,590	230,000	260	921,000	1,036	691,000	777	461,010	517	-	-
Roadbed	E 6,192,800^{M3} B 5,316^{M} T 7,309^{M}	17,157	O Song, Gong Jean B T	515	E 1,548^{M3} B 1,330^{M} T 1,825^{M}	3,775	E 1,858^{M3} B 1,595M T 2,195^{M}	5,147	E 2,477^{M3} B 2,125M T 2,925^{M}	6,862	E 310 ^{M3} B 266 T 364	858
Track	183^{KM}	(4,205) 7,606		-		-	Materials	4,596	114^{KM}	3,300	70^{KM}	115
Signal	Ele. signal,18 Remote control 1	675		-		-	3	104	7	241	9	330
Building	4,700^{M2}	329		-		-	700M2	49	1,000^{M2}	70	3,000^{M2}	210
Electric Power	places 11	430	Power for work site	120	Power for work site Interfering power facilities	170	place 3	40	place 2	25	place 6	75
Telecommunication	88^{KM}	264		-	Interfering telecom. facilities	9	15^{KM}	44	15^{KM}	44	58^{KM}	167
Incidental Expenses	Investigation, Survey, etc.	(15) 749		105		10		43		41		145
Total		(4,220) 29,800		1,000		5,000		10,800		11,100		1,900

4-4-3 Procurement plan of imported materials and supplies

The fund required for procurement of imported material and supplies for double tracking of the Chung Bug Line is given in Table 4-6.

Rails are 50kgN for main tracks and 37kg for sidetracks respectively. They are not produced in Korea at present and to be purchased by foreign exchange.

Wooden sleepers will be used for the following reasons:

1) PC sleepers are twice as high in price as wooden ones, and
2) only used for about 30% of the trunk lines in Korea.

The import of complete sleepers is banned in Korea, so the round legs for sleepers shall be imported from off-shore. The unit price of the foreign-exchange purchase items are $350 per ton for rial and $65 per cubic meters for round log, which are estimated in reference to the import price in 1974.

Survey instruments consist of 5 sets of Transits and Levels, of which price per set are estimated at $6,000.

Table 4-6 Materials and Supplies to be Imported

Item		Quantity	Unit Price	Sum	Remarks
Rail	50 kg N	16,000 t	350 $	5,600,000 $	
Rail	37 kg	2,500	350	875,000	
Log	for sleepers	33,770$^{m^3}$		2,195,000	
Survey instruments				30,000	

Total: $8,700,000 $4,220 mil.Won

(1$ = 485 Won)

4-5 Work schedule

According to the general work schedule in the stage of estimation made by KNR, it will take five years starting from the phase of study, survey and designing to work execution and test operation.

It is the construction of the 4,260 m In Deung Tunnel that greatly affects the entire work schedule.

According to a brief survey of the soil nature at the tunnel site, the soil is composed of granite and granite gneiss, and if bottom heading upper half section tunneling method is adopted in this case, the period needed for construction would be 3 to 3.5 years. Necessarily, detailed goelogical surveys will have to be performed before commencement of tunneling to determine the work schedule, but it is believed that the tunneling work will not affect the overall work schedule estimated at five years.

4-5-1 Overall work schedule

On the basis that the work period for constructing In Deung Tunnel would be 3 years as mentioned in the above, a total project schedule for double tracing was formulated as shown in Table 4-7.

In the initial year, as in the case of any project, effort is concentrated on the procurement of land. Next, preparatory works are commenced for construction of the 4,260 m In Deung Tunnel, 400 m Nam Han Gung River Bridge and the 348 m Mi Ho Cheon River bridge. Included in these preparatory works is the provision of electric power at the work Sites. The improvement work of O Song and Gong Jeon Stations will be next.

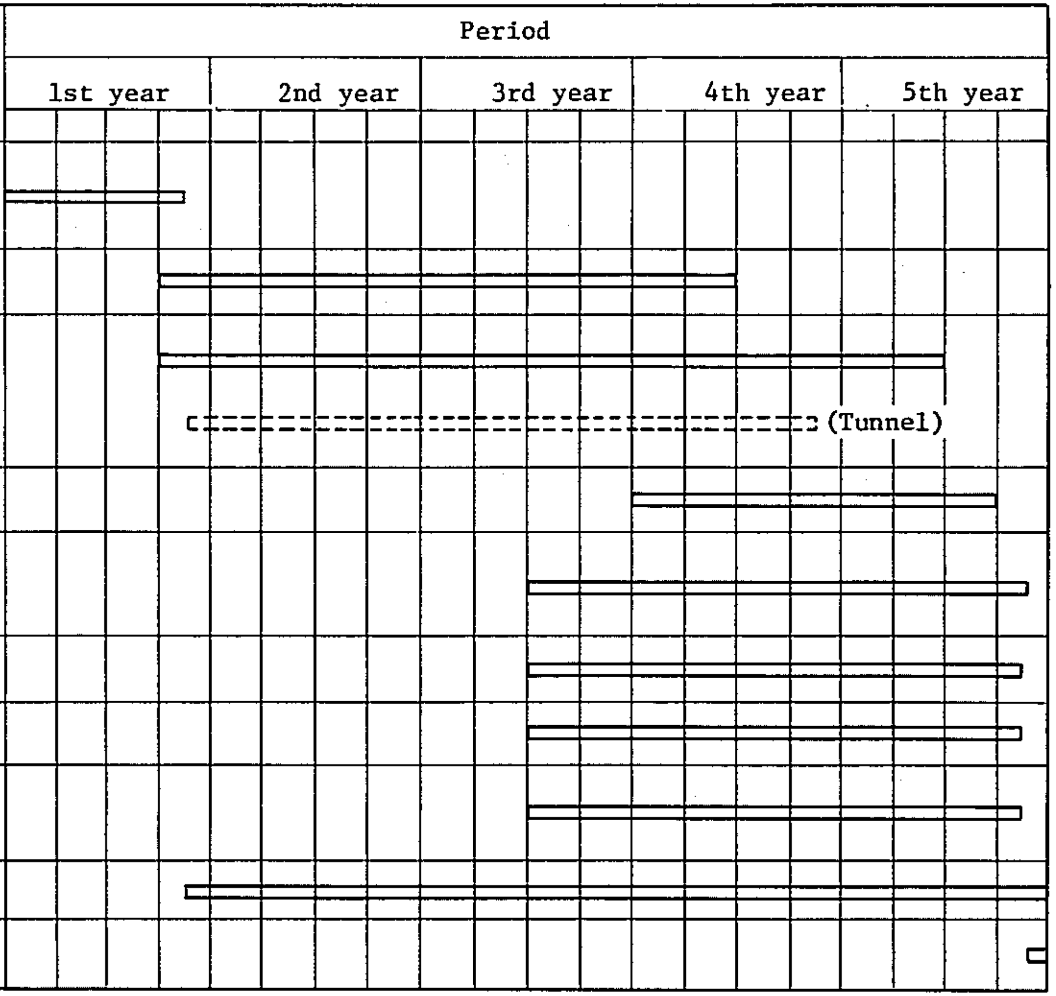
Principal work will start from the second year. In the third year, construction of station buildings, etc. will be initiated and track materials will be procured. In The fourth year, In Deung Tunnel will be completed and track laying work started. In the fifth year, all work will be completed.

Quantity of principal works is estimated as follows:

Cutting		1,677,000 cu. m
Embankment		4,515,000 cu. m
Bridges	88	Total length: 5,316 m
Tunnels	10	Total length: 7,309 m

Table 4-7 Work Schedule for Double Tracking of Chung Bug Line

Work	Quantity
Investigation Survey Designing	
Land	2,303 thousand m^2
Roadbed	Earth work 6,192 thousand m^3 Bridge 5,316 m Tunnel 7,309 m
Track	183 km
Signal	Ele. sig. 18 Remote cont. 1
Building	4,700 m^2
Electric power	11 places
Telecommunication	88 km
Incidental work	
Test run	



4-6 Summary

This survey was based on the detailed project materials prepared by KNR. Thanks to the carefully prepared data and close cooperation of KNR, the Study Team was able to effeciently conduct thorough investigation and study covering, in a short period of 30 days, a broad range of items including new routes extending some 180 km.

Of the present 127 km Chung Bug Line from Jo Chi Weon to Bong Yang, about 90 km between Jo Chi Weon and Chung Ju was built 50 years ago and has numerous sharp curves, many of them without transition curves. On the other hand, some 30 km from Chung Bug to Bong Yang built by KNR after the Independence runs through mountainous regions and thus has many steep grades and sharp curves as well as tunnels.

With the forecasts made by KNR as basis, route was selected from the viewpoint of reducing construction expenses by utilizing as far as possible the land and structures of the existing line. A typical example is the construction of an up-bound single track between Gong Jean and Bong Yang.

The Chung Bug Line is a unilateral industrial line mainly transporting hard coal and cement from producing districts of Yeang Dong and Tae Baeg. Therefore, the new route of augmented traffic capacity will be used as up-bound track and the existing line, upon making improvements will be utilized as down-bound track mainly for deadheading empty cars.

Steep grades of 12 o/oo in the mountainous section between Dong Ryang and San Tan need be improved, and at other places, the problem of steep grades has to be solved along with improvement of curves by usage of new double track line.

Moreover, a new double track line is intended in the Cheong Ju district in connection with the city planning whereby the sharp curves will be done away with and at the same time the line length will be shortened.

As a result, the breakdown of Chung Bug Line double tracking work will be as follows:

Double track by new route	:	49.1 km
One track by new route	:	6.9 km
One track by levee widening	:	62.9 km
Total	:	118.9 km

One track of 6.8 km by new route is between Gong Jeon and Bong Yang as mentioned in the above.

According to the estimations made by KNR, the construction cost for the double tracking of the Chung Bug Line is 29,800 million won (¥18,000 million).

Of the cost, the imported materials and supplied including rail and sleeper account for ¥4,220 million, Won. (¥2,600 million)

The contents of construction expenses assessed as of April 1975 was reviewed in various aspects.

Comparison of wages, prices of construction materials, coments, gravel and sand in Korea with those in Japan shows that wages in Korea are 20 - 30%, the cement, gravel and sand are 40 - 85% of those in Japan. It can be said, therefore, that the construction cost be appropriate when compared with that in Japan.

From the various showings of KNR, it is believed that KNR has sample experience in carrying out this construction project without the aid of construction machines and work supervision from Japan.

According to the work schedule worked out by KNR, the work period of the project is five years, of which three years for the construction of the In Deung Tunnel.

With the excavation methods and construction machinery employed in Japan as reference, the tunneling work period was examined particularly in respect to the scheduling of various items of work, and since the results thereof show that all items of work require three years, the work period is considered appropriate.

Upon reviewing each item as mentioned in the above, it is concluded that the appropriateness of the project is technically sufficient.

V. Evaluation of Investment

5-1 Outline of Investment Evaluation

5-1-1 Transport of anthracite and cement, and national living

(1) Production and Consumption of Briquests

Briquets are one of the most important living necessaries as well as cement in Korea. 90% of the anthracite production output are processed into briquests for the household use. Generally the basic construction structure of Korean traditional houses is the so-called "hot floor", and briquets, as an energy source, are indispensable to air-heating from under the floor during the coldest season of January and February (temperature down to -5°C ∿ -10°C), and also needed for the cooking use as fuel all through the seasons, for the people's staple food is cereals, such as rice and barley.

The past 10-year outputs of briquet production, covering from 1965 to 1975, are shown in the following Table 5-1.

Table 5-1 Past Outputs of Briquet Production

Production year	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Number of Briquet produced per 1 ton of anthracite (converted in 22-hole briquet)	220	220	220	220	240	240	240	245	245	277
Total production Number (in million pcs.)	1,565.9	1,860.5	1,758.1	1,684.4	2,206.6	2,396.3	2,425.5	2,586.0	3,189.1	3,782.9
Selling Price (₩ per piece)	11.0	12.5	14.5	14.5	15.5	18	20	22	22	30

Data : Presented by the Korean National Railroad.

According to the table, the briquet with 22 holes in it was priced at 30 won per piece in 1974, while at 33 won now in 1975. Until 1973, however, the price had seldom been revised, and restricted to rise within a small amount of 1 or 2 won, being reflected the importance to the people's living. (1 won at nearly 0.6 yen)

Since the 1st Five-year Plan for Economical Development started in 1962, the Korean national economy has shown a remarkable growth at an rate of over 8% as annual average, and the national income has necessarily increased on a large scale.

According to the data presented by Korean government, however, it is learnt that in the national distribution of income for labor households 47% were accounted for those with monthly income of under 20,000 won (12,000 yen) or yearly income of 550, 000 won (330,000 yen) as average in the year of 1973; the living standard was still low in 1973 for nearly half of the whole wage laborers. Concerning agricaltural households in 1973, the average of yearly income was 480,000 won, that was yet lower than that of wage labores. It is noted that the price of briquet could not have been high in view of stabilization of people's living, and that it has been held at an reasonable level from the standpoint of national economy.

Meanwhile, productivity has been much improved in the briquet manufacture: As compared to 220 briquests (converted into 22-hole ones) of production per ton of anthracite in 1960's, the output in 1974 was 277 ones. The total output in 1974 was 277 ones. The total output as of 1974 grew 2.5 times as much as of 1975. In this way much efforts have been made from a pricing as well as technical point of view in order to meet the increment in demand for the stabilized supply of the living necessary.

(2) Cement and "Sae-Maeul" Movement

The demand for cement will grow to keep up with the Sae-maeul movement, which is a kind of spiritual campaign for new village construction. It was started in 1971, and targeted at better living environment and higher income, which should be attained through "Self-support", "Cooperation" and "Dilligence" of the people. With a great emphasis on improving the basic environment, such as rebuilding of house roofs and kitchens, expanding of village roads, constructing of waterways, 355 bags each of cement were given to about 33,000 villages throughout the country in 1971. It was reported that a total of 3.558 millions households or 7.22 millions people throughout the country had participated in the movement eventually to accomplish 12 projects as average in each village. In 1972, 500 bags of cement with 1 ton of steel bar were supplied again to 16,600 villages that had marked a good record in the previous year achievement, for various works to be carried out. Thus, the Sae-Maeul movement have been promoted to be a nation-wide activity day by day, making a valuable contribution for the betterment of environment and increase in income. Especially, it has brought about a remarkable rise of the living stantard in agricultural districts.

The demand for cement will trend to the upward more and more in future: Cement will not only be used for construction of buildings and apartment-houses, but necessarily for levelling up of the national living.

(3) Transport of Anthracite and Cement, and Chung Bug Line

Chung Bug Line plays a vital role in transport of anthracite and cement. As described in the previous chapters, these materials are for the most part transported via Jung Ang Line to the special city of Seoul, the transport volume of Chung Bug Line itself has increased year by year along with the recent increase in demand, and its then planned to strengthen the transport capacity of Chung Bug Line enough to deal with the future increase in demand. The transport volume assigned to Jung Aug Line was 14.7 times for anthracite and 3.6 times for cement respectively as much as those to Chung Bug Line as of 1974. In the plan it is considered to transfer the traffic partly from Jung Ang Line to Chung Bug Line to effect the increase in the assigned transport on the side of Chung Bug Line, that is, in the distribution ratio of 2.2 times for anthracite and 1.1 times for cement in 1979, when track doubling is completed, and further in 1981 it will be 2.1 times for anthracite and 0.9 times for cement respectively.

On the other hand, a large-scale regional development has been under way in Ho Nam Area (both Jeon Ra Nam Do and Jeon Ra Bug Do) since 1965, and the regional agricultural development project in the basins along Geun Gang, Yeong Sang Gang and Seon Uin Gang. Furthermore, industrial zones are steadily under construction in Iri, Gwang Ju and Jeon Ju. Agricultural modernization and industrialization have been vigorously progressed in the country. As a result, the demand for anthracite and cement has been on the remarkable increase, and the transport of them has become an important problem to transit from Tae Baeg and Yeong Dong to the consuming areas along Ho Nam Line.

As a countermeasure, the track doubling was planned between Sae Dae Jeon and Iri (88.6 Km) on Ho Nan Line, and 45.9 Km of which project line has been already completed, with the remaining 42.7 Km now under construction to complete in 1977. When the track doubling of Chung Bug Line is finished, it will make the shortest cut to connect with Gyeong Bu Line, enabling the transport facilitated to Ho Nam Line, and will not only ensue a satisfactory supply of fuel and cement to the Ho Nam inhabitants, but an encouragement for the Sae-Maeul movement finally contributing a great deal to levelling up of the living standard as well as developing the national economy.

5-1-2 Object of Evaluation

The judgement of the effect of the Chung Bug track doubling has been made on the estimation of efficiency in transport of anthracite and cement from Tae Baeg and Yeong Dong to Seoul and Ho Nam areas, through the optimum transport route as already explained. In estimating the time of horizon was set for 12 years from 1979, when doubling is to complete, all through to 1990, for this sort of investment project is commonly studies for a period of 10 to 15 years.

5-2 Method of Investment Evaluation

5-2-1 Framework for Evaluation

Basic concept for estimating the investment effect is given as follows.

(1) Taken into account the role of Chung Bug Line in transporting anthracite and cement, evaluation was made from the viewpoint of national economy. A comparative study was conducted respectively to weigh the increases in benefit and cost, which would be resulted from the increased transport upon completion of doubling.

(2) The benefit and cost ratio was adopted as standard of evaluation, and the judgement was synthesized, supported by the calculation

results of internal rate of return.

(3) Benefit was limited to the direct measurables, and calculated to be the total of both increments in the value added and freight revenue from the transport of anthracite and cement, which should be expected upon completion of track doubling.

(4) Cost was composed of personnel and material expenses, plus depreciation and interest. The material expense, consisted of those for passenger and freight, and was estimated by the following formulas with the transport volume respectively.

Passenger material expense = Passenger traffic volume x 2.70 won/man-Km x (1 + Commodity price rising rate)^t

Freight material expense = Freight transport volume x 1.75 won/ton-Km x (1 + Commodity price rising rate)^t

(5) The increase in transport volume, a fundamental factor for evaluation, was estimated by deducting the trend from the total transport volume, which would be given after completion of track doubling in Chung Bug Line.

(i) In seeking for the transport ton-kilometers of anthracite and cement, the share of respective transport ton/Km out of the total transport tonnage was calculated on the data presented by KNR. The ton/Km was obtained respectively by proportional division of the total ton/Km. This was based on the assumption that the departure and arrival points would remain as unchanged in future as at present, so the average transport distance should be fixed accordingly.

(ii) Provided that the transport of cement should be transferred partially from trucking transport after completion of the track doubling, the transferred volume was estimated and added to the transport volume of cement in (i) in the above. In distributing to consumer areas, cement would be required mostly for middle- and long-range transport; it should have a large reliability on railway transport capable of mass transport.

(iii) Of the trend of total tonnage and transport tonnage respectively of anthracite and cement, the shares of the two items were calculated out of the total. The trend in total ton/Km was devided proportionally by the share to estimate the trend in ton/Km.

(iv) The net increase in transport volume of anthracite and cement respectively was estimated by subtracting the trend of (iii) from the transport ton/Km of the items of (i) and (ii).

(v) Estimation formulas of the trend are given in Table 5-2.

Table 5-2 Estimation Formulas (Trend):

$yt = a + bt$ (t = year)

	a	b	$\bar{S}$	$\bar{R}^2$	R	D.W.
Total Tonnage	-18,137.1813	274.1143 (60.8714)	254.6434	0.7940	0.8910	1.9411
Total Ton/KM	- 1,405.8857	23.7406 (3.4386)	51.8653	0.7821	0.8843	1.0164
Anthracite	- 9,225.7619	132.4285 (13.4831)	56.4039	0.9502	0.9747	1.9343
Cement	- 6,803.9714	107.7714 (48.4837)	202.8220	0.4407	0.6639	1.9196
Ton/KM of Truck Transport	- 786.4999	12.1153 (1.6580)	12.7821	0.8972	0.9472	1.7376

(Note) 1: (   ) in the column b shows standard error of b.

2: $\bar{S}$: standard error of y.

$\bar{R}^2$: Coefficient of dermination (degree of freedom already adjusted).

$\bar{R}$: Coefficient of correlation (ditto)

DW : DURBIN-WATSON's ratio.

(6) As given in the framework of estimating the effect, taken up were four factors, such as freight rising rate, wage rising rate, commodity price rising rate and transfer rate from truck to railway transport. The levels for these factors were set as shown in Table 5-3 by referring to the experience of KNR together with the trend of wholesale commodity prices in Korean market, so as to do sensitivity analysis on the levels in various combinations.

Table 5-3 Factors and levels in Sensitivity Analysis

Factor	1	2	3	4
Freight rising rate	10%	15%		
Wage rising rate	10%	13%	15%	20%
Commodity price rising rate	3%	5%	6%	8%
Transfer rate	60%	70%	80%	

Note: At the analysis, wage rising rate was devided in (10%, 13%) and (15%, 20%), and commodity price rising rate in (3%, 5%) and (6%, 8%).

The B/C ratio was estimated on condition that the freight rate would be revised every other year for the future, based on KNR's experience and plan, and that the time discount rate applicable to the benefit/cost analysis was assumed in three ways of 8%, 10% and 12% for calculating B/C ratio.

5-2-2 Level for Investment Evaluation

Evaluation of investment effect was performed chiefly on benefit/cost ratio, internal rate of return being studied as reference. These formulas are given as follows:

(1) Benefit cost ratio

$$\frac{B}{C} = \sum_{t=1}^{T} \frac{Bt}{(1+r)T} \Bigg/ \sum_{t=0}^{T} \frac{Ct}{(1+r)T}$$

Bt = benefit in "t" year

Ct = cost in "t" year

r = discount rate

T = Time of horizon

Interest: 5% of Foreign Currency
6% on Domestic Currency

(2) Internal rate of return

$$\sum_{t=0}^{T} \frac{It}{(1+r)T} = \sum_{t=1}^{T} \frac{Rt + Ot}{(1+r)T} + \frac{S}{(1+r)T}$$

It= amount of investment in "t" year

Rt= amount of income in "t" year

Ot= amount of expenses in "t" year

S = residual value

r = internal rate of return

5-2-3 Time Discount

The induction of discount rate in the above formulas stood on the following concept.

(i) The benefit and cost caused from the Chung Bug Line doubling would be produced not only at the time of project completion, but extend in future along the flow of time, and yet the value would appear at variance as time lapses.

(ii) In order to evaluate an investment project containing the flow of benefit/cost, it is necessary to make appraisal in converting into some value at a specific time. The specific time normally means the present time, and the value measurable at the present time is called "present value". In evaluating the investment effect on the Chung Bug line-doubling project, the present time was made at 1979, the time of project completed.

(iii) A certain amount of value at present time will not be the same at some future time, even if there were no inflation ivolved during the period between them. In other words, the value of one won at present is considered larger than that in future. One of the reasons is the possible increase in income: The present income will be increased in future, and there the Law of Diminishing Marginal Utilities can be applicable to the case. It is considered that a certain amount of value should be equivalent to the larger one in future. Secondly is uncertainty expected in future. Suppose a given property to have for sure at present, and possibly to have in future but for a larger amount. Preference would be made to the former, even if value is smaller. Thirdly is the human unrationality.
If no such uncertainty exists, there will be still a psychological unrationality to appreciate the present desire more highly than a future one, or very much likeliness to pursue the immediate enjoyment in deverting from social strains.

(iv) This is shown by the following formula characteristic of indifference curve:

$$\text{Marginal Substitution Ratio} = 1 + r$$

"r" is called a marginal rate of time discounting, or simply a time discount rate. Namely, it is considered that one won at present is equal in value to "1 + r" won in the next year, or it is evaluated that to spend one won a year later is equivalent to do 1/(1+r) won at present.

5-3 Estimation of Investment Effect

5-3-1 Benefit/Cost Ratio (B/C Ratio)

The calculation results of benefit/cost ratio is shown in Table 5-4(a), 5-4(b) and partly in Fig. 5-1.

(i) Tables 5-4(a) and (b) show the B/C calculation results that were obtained from 72 combinations of the levels of 4 factors, such as freight rising rate, wage rising rate, commodity price rising rate and transfer rate, representing the B/C value variation with given combinations of standards.

(ii) According to Table 5-4(b), the highest B/C ratio is 1.496, while the lowest is 0.955, in case that are set freight rising rate at (10%, 15%), wage rising rate at (15%, 20%), and commodity price rising rate at (6%, 8%). It is recognized that there will be much possibility for the B/C ratio to exceed 1.17.
In case that freight level is held unchanged, with wage rising rate at (10%, 13%) and commodity price rising rate at (3%, 5%), the B/C ratio points at 1.688 at its maximum and 1.097 at its minimum, and there should be a good possibility to be over 1.37. The benefit exceeds the cost in the project; it can be said safely that this investment project is feasible from the viewpoint of B/C ratio.
This is attributed to such a large increase in net transport volume as an annual average rate of over 20%, which would be resulted from the double tracking.

(iii) In the case were set freight rising rate at (10%, 15%), wage rising rate at (15%, 20%), commodity price rising rate at (6%, 8%), and transfer rate at (60%, 70%, 80%), the result of the analysis of variance showed that the significant factor for possible changes in revenue should be freight rising rate, wage rising rate and commodity price rising rate, but not transfer rate. The coefficient of determination was given 21.5%, 15.8%, and 12.7% respectively.

(iv) Fig. 5-1 is the graphic representation of a part of Table 5-4(a) and (b) (in the case of transfer rate at 60%), from which it can be learnt how largely freight and wage rising rates will influence on B/C ratio in sensitivity.

5-3-2 Internal Rate of Return

The maximum internal rate of return was 0.084', which was obtained when freight rising rat was set at 15%, wage rising rate at 10%, commodity price rising rate at 8% and transfer rate at 80%. With freight unchanged, wage rising rate at 13%, commodity price rising rate at 5%, and transfer rate at 60%, the internal rate of return became a little lower to be 0.048. Further, with rising rate at 13%, freight rising rate at 10%, commodity price rising rate at 3%, and transfer rate at 60%, the internal rate of return was given to be 0.033.

As a whole, there is much possibility for the internal rate of return to exceed 0.06. So it can be judged that the project is feasible from the viewpoint of internal rate of return, provided that capital cost is made lower than 6%. This was resulted from the large increasing rate of transport volume, as same as in B/C ratio.

5-4 Summary

(i) Anthracite and cement are essential commodities closely related with the daily living of Korean people. In the 4th Five-year Economic Development Plan (1977 - 1981) is designated the supply/demand project for these two materials, as one of major objectives. For anthracite, 90% of which production are supplied to household use as briquests, significant efforts are exerted to maintain the stabilized supply on both productivity and pricing sides. Cement is also essential for improving of living environments and levelling up of income.

(ii) The problem of vital importance is the stabilized transport of anthracite and cement from such producing areas as Tae Baeg and Yeong Dong to the special city of Seoul, its satellite cities and Ho Nam area in order to meet a sharply increasing demand. And that the problem should be treated immediately, so as to promote the Sae-Maeul movement and eventually the national economic development. The triangle transport route with Seoul at its top and Chung Bug Line at its base should be the optimum route, and the Chung Bug line doubling should be realized promptly for strengthening the needed transport capacity.

(iii) Estimation of the effect in the Chung Bug line doubling was conducted chiefly on benefit/cost ratio, taken into account the calculation results of internal rate of return. Comparative evaluation was made between the direct benefit increase and the cost increase, both of which would be brought from the increase in transport volume of anthracite and cement from Tae Baeg and Yeong Dong areas to Seoul district and Ho Nam area upon completion of Chung Bug line doubling. Sensitivity analysis was adopted to estimate its effect. In doing analysis was set up the levels of each of each of 4 factors, such as freight rising rate, wage rising rate, commodity price rising rate and transfer rate (from trucking to Chung Bug Line) by referring to KNR's experience and plan together with the trend of wholesale commodity price in Korea. Then, calculation was performed for benefit/cost ratio and internal rate of return on the various combinations of the established level. Followingly, analytical study was made of the calculation results, and of the relativity among given combinations.

(iv) The calculation results showed a good possibility for B/C ratio to exceed 1.2 and for internal rate of return to do 0.06 both of which were attributed to the probability that the transport capacity would be tripled by track doubling, and that the net increase in transport volume would reach an average rate of over 20% annually.

The Chung Bug Line Doubling Project has been judged to be feasible. It is obvious, however, that railway management would certainly be greatly involved and influenced by possible future changes in Korean national economy. It is strongly desired that sound railway management should be maintained with such appropriate measures as resonable revision of freight and wage rise. It is our sincere hope that the analysis will be of any help to the end.

Table 5-4(a) Analysis of Estimated Cost and Benefit of Chung Bug Line

(Unit: million won)

Discount rate	Transfer rate	Freight rising rate	Wages rising rate	Price rising rate	Benefit	Cost	B/C
8 %	60 %	10 %	10 %	3 %	167,970	107,745	1.559
				5 "	"	112,640	1.491
			13 %	3 "	"	110,826	1.516
				5 "	"	115,721	1.452
		10 %	10 %	3 "	176,010	"	1.634
				5 "	"		1.563
			13 %	3 "	"		1.588
				5 "	"		1.521
	70 %	10 %	10 %	3 "	170,994	108,195	1.580
				5 "	"	113,203	1.511
			13 %	3 "	"	111,276	1.537
				5 "	"	116,283	1.470
		15 %	10 %	3 "	179,602	"	1.660
				5 "	"		1.587
			13 %	3 "	"		1.614
				5 "	"		1.545
	80 %	10 %	10 %	3 "	174,542	108,632	1.607
				5 "	"	113,746	1.534
			13 %	3 "	"	111,712	1.562
				5 "	"	116,827	1.494
		15 %	10 %	3 "	183,345	"	1.688
				5 "	"		1.612
			13 %	3 "	"		1.641
				5 "	"		1.569
10 %	60 %	10 %	10 %	3 "	139,196	103,349	1.347
				5 "	"	107,609	1.294
			13 %	3 "	"	105,993	1.313
				5 "	"	110,253	1.263
		15 %	10 %	3 "	145,588	"	1.409
				5 "	"		1.353
			13 %	3 "	"		1.374
				5 "	"		1.320
	70 %	10 %	10 %	3 "	141,716	103,757	1.366
				5 "	"	108,116	1.311
			13 %	3 "	"	106,401	1.332
				5 "	"	110,760	1.279
		15 %	10 %	3 "	148,593	"	1.432
				5 "	"		1.374
			13 %	3 "	"		1.397
				5 "	"		1.342
10 %	80 %	10 %	10 %	3 %	144,694	104,153	1.389
				5 "	"	108,608	1.332
			13 %	3 "	"	106,797	1.355
				5 "	"	111,252	1.301
		15 %	10 %	3 "	151,729	"	1.457
				5 "	"		1.397
			13 %	3 "	"		1.421
				5 "	"		1.364
12 %	60 %	10 %	10 %	3 "	116,136	99,878	1.163
				5 "	"	103,611	1.121
			13 %	3 "	"	102,164	1.137
				5 "	"	105,897	1.097
		15 %	10 %	3 "	121,243	"	1.214
				5 "	"		1.170
			13 %	3 "	"		1.187
				5 "	"		1.145
	70 %	10 %	10 %	3 "	118,251	100,250	1.180
				5 "	"	104,072	1.136
			13 %	3 "	"	102,535	1.153
				5 "	"	106,358	1.112
		15 %	10 %	3 "	123,775	"	1.235
				5 "	"		1.189
			13 %	3 "	"		1.207
				5 "	"		1.164
	80 %	10 %	10 %	3 "	120,768	100,613	1.200
				5 "	"	104,520	1.155
			13 %	3 "	"	102,898	1.174
				5 "	"	106,805	1.131
		15 %	10 %	3 "	126,421	"	1.257
				5 "	"		1.210
			13 %	3 "	"		1.229
				5 "	"		1.184

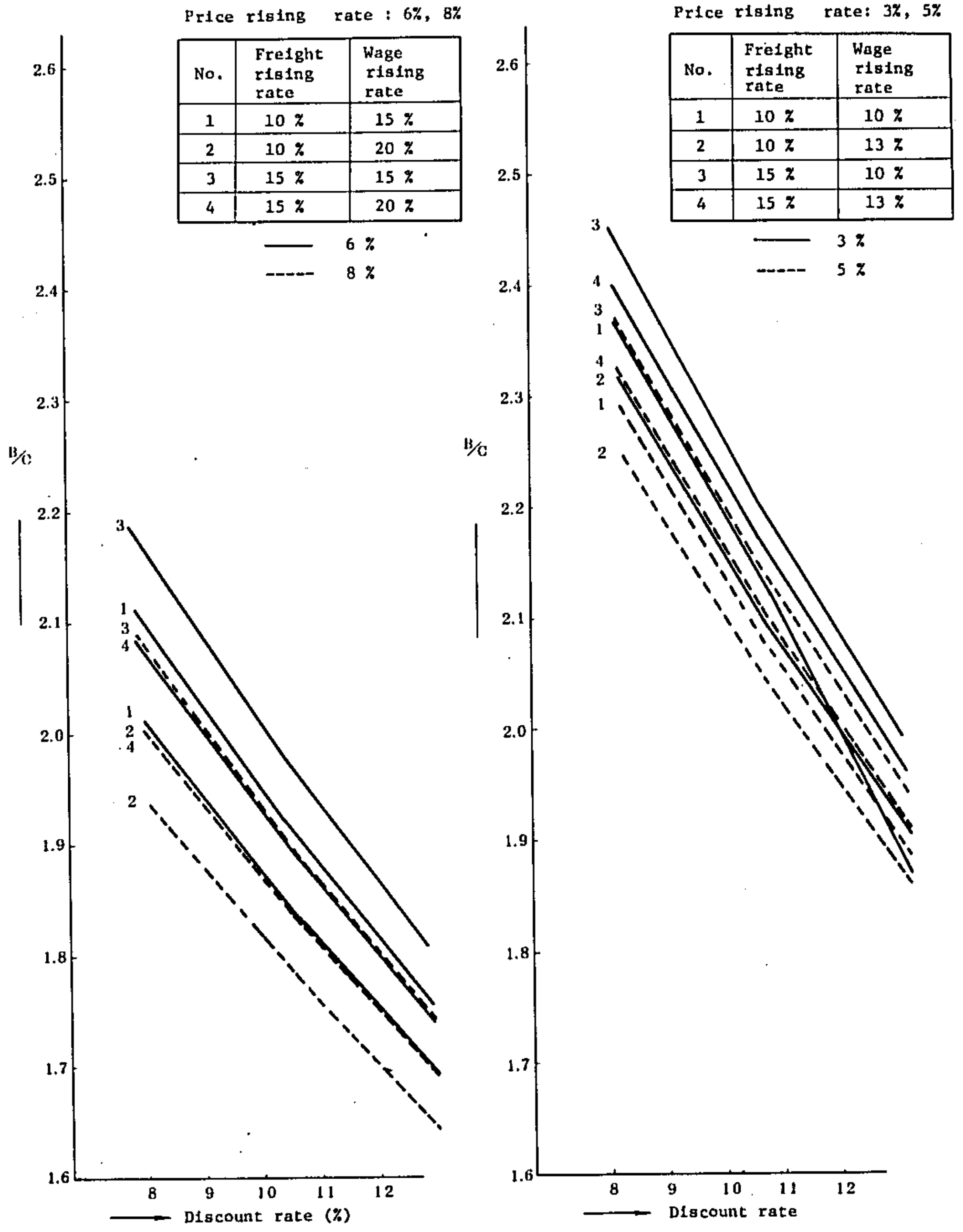
Table 5-4(b) Analysis of Estimated Cost and Benefit of Chung Bug Line

(Unit: million won)

Discount rate	Transfer rate	Freight rising rate	Wages rising rate	Price rising rate	Benefit	Cost	B/C
8 %	60 %	10 %	15 %	6 %	167,970	121,306	1.385
				8 "	"	129,021	1.302
			20 %	6 "	"	129,545	1.297
				8 "	"	136,586	1.230
		15 %	15 %	6 "	176,010	"	1.451
				8 "	"		1.364
			20 %	6 "	"		1.359
				8 "	"		1.289
	70 %	10 %	15 %	6 "	170,994	121,935	1.402
				8 "	"	129,133	1.324
			20 %	6 "	"	130,174	1.314
				8 "	"	137,372	1.245
		15 %	15 %	6 "	179,602	"	1.473
				8 "	"		1.391
			20 %	6 "	"		1.380
				8 "	"		1.307
	80 %	10 %	15 %	6 "	174,542	122,543	1.424
				8 "	"	129,882	1.344
			20 %	6 "	"	130,785	1.335
				8 "	"	138,121	1.264
		15 %	15 %	6 "	183,345	"	1.496
				8 "	"		1.412
			20 %	6 "	"		1.402
				8 "	"		1.327
10 %	60 %	10 %	15 %	6 "	139,196	115,094	1.209
				8 "	"	121,811	1.143
			20 %	6 "	"	122,153	1.140
				8 "	"	128,256	1.085
		15 %	15 %	6 "	145,588	"	1.265
				8 "	"		1.195
			20 %	6 "	"		1.192
				8 "	"		1.135
	70 %	10 %	15 %	6 "	141,716	115,660	1.225
				8 "	"	121,901	1.163
			20 %	6 "	"	122,720	1.155
				8 "	"	128,960	1.099
		15 %	15 %	6 "	148,593	"	1.285
				8 "	"		1.219
			20 %	6 "	"		1.211
				8 "	"		1.152
10 %	80 %	10 %	15 %	6 %	144,694	116,209	1.245
				8 %	"	122,575	1.180
			20 %	6 "	"	123,271	1.174
				8 "	"	129,634	1.116
		15 %	15 %	6 "	151,729	"	1.306
				8 "	"		1.238
			20 %	6 "	"		1.231
				8 "	"		1.170
12 %	60 %	10 %	15 %	6 "	116,136	110,124	1.055
				8 "	"	116,014	1.001
			20 %	6 "	"	116,220	0.999
				8 "	"	121,547	0.955
		15 %	15 %	6 "	121,243	"	1.101
				8 "	"		1.045
			20 %	6 "	"		1.043
				8 "	"		0.997
	70 %	10 %	15 %	6 "	118,251	110,638	1.069
				8 "	"	116,087	1.019
			20 %	6 "	"	116,733	1.013
				8 "	"	122,183	0.968
		15 %	15 %	6 "	123,775	"	1.119
				8 "	"		1.066
			20 %	6 "	"		1.060
				8 "	"		1.013
	80 %	10 %	15 %	6 "	120,768	111,137	1.087
				8 "	"	116,698	1.035
			20 %	6 "	"	117,234	1.030
				8 "	"	122,793	0.984
		15 %	15 %	6 "	126,421	"	1.138
				8 "	"		1.083
			20 %	6 "	"		1.078
				8 "	"		1.030

Figure 5-1 Analysis of Estimated Cost and Benefit of Chung Bug Line

(Transfer rate = 60 %)



Price rising rate : 6%, 8%

No.	Freight rising rate	Wage rising rate
1	10 %	15 %
2	10 %	20 %
3	15 %	15 %
4	15 %	20 %

Price rising rate: 3%, 5%

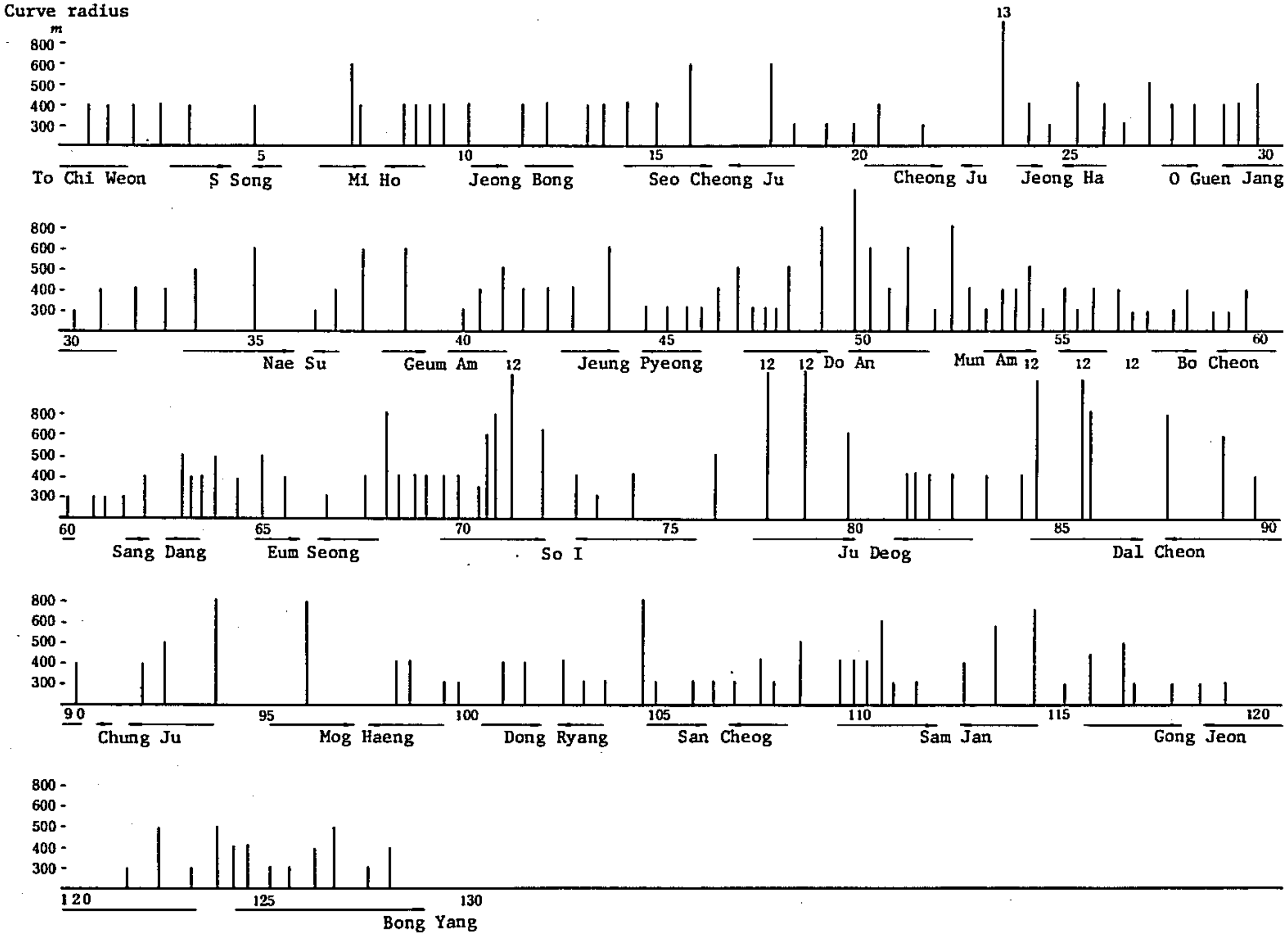
No.	Freight rising rate	Wage rising rate
1	10 %	10 %
2	10 %	13 %
3	15 %	10 %
4	15 %	13 %

REFERENCE DATA

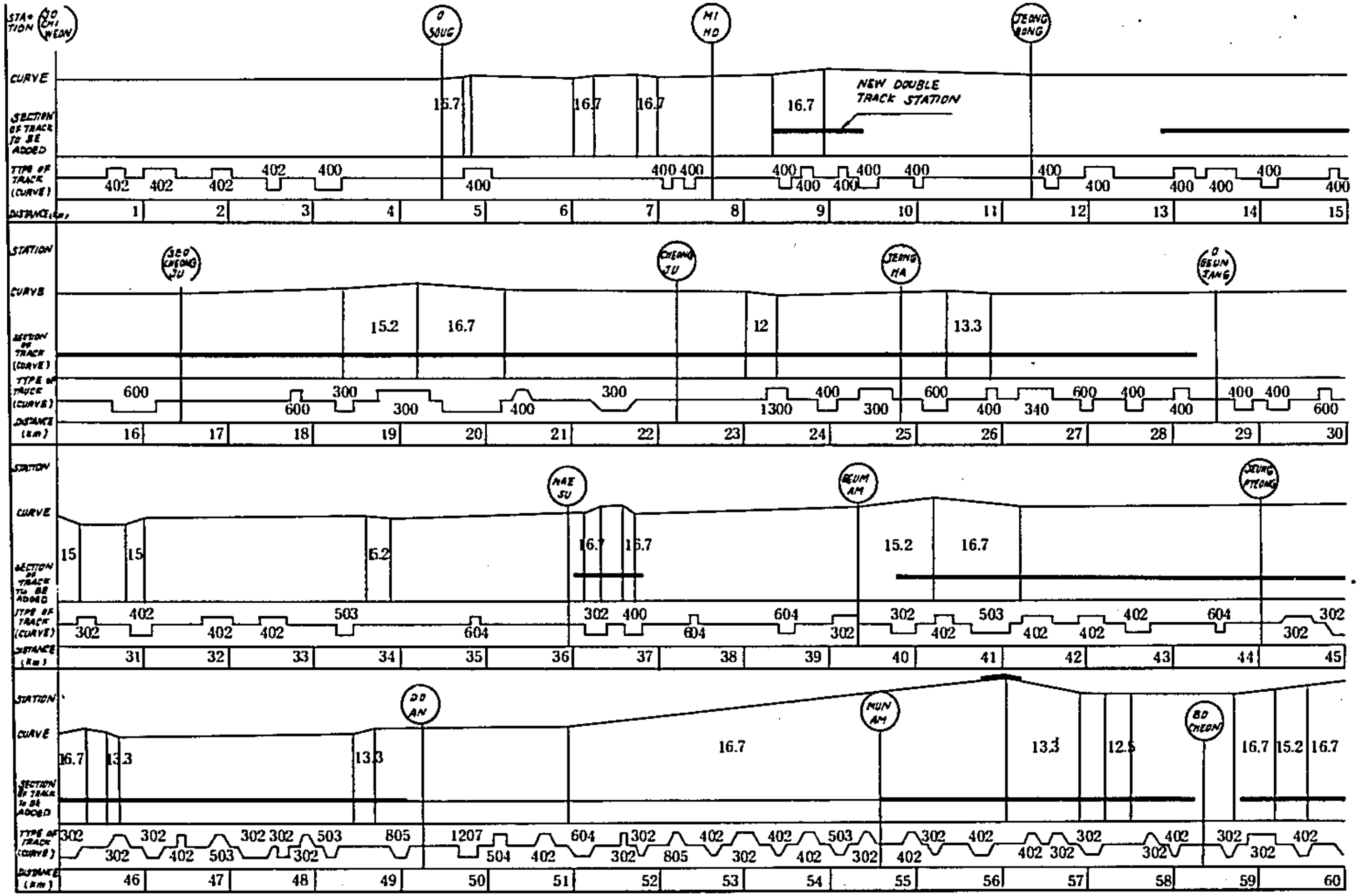
III. Present Status of Korean National Railroad (KNR)

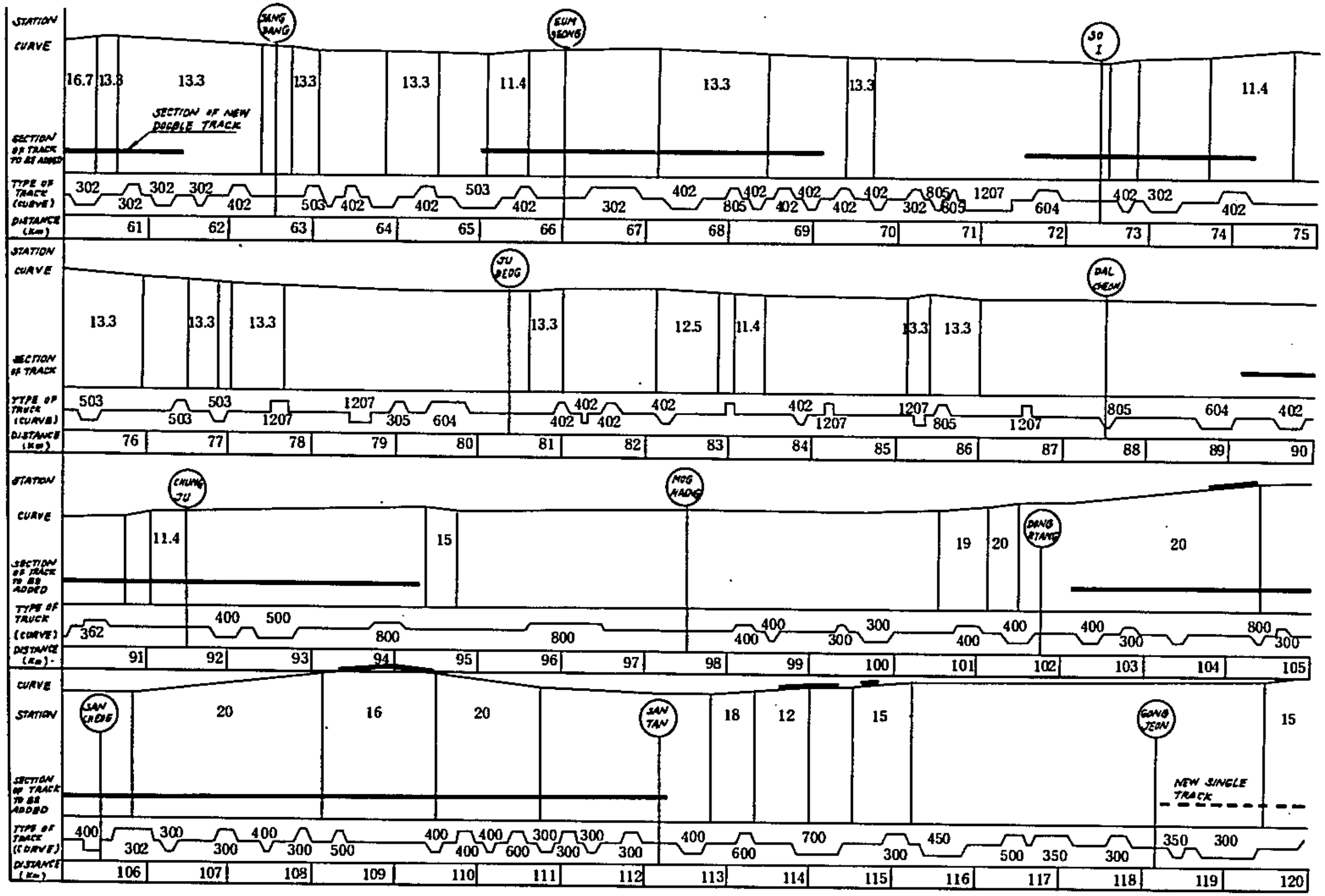
I. CHUNG BUG LINE's DATA

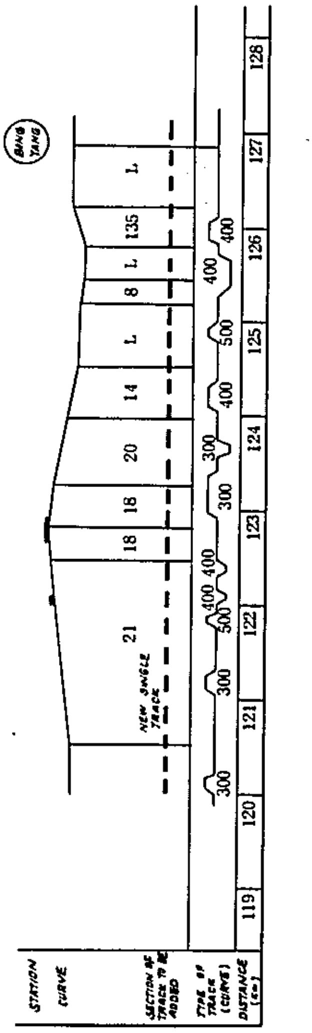
1. TABLE OF CURVES ON CHUNG BUG LINES (Existing Track)



2. SCHEMATIC OF MAIN GRADES AND CURVES (Existing Track)




STATION
CURVE
SECTION OF TRACK TO BE ADDED
TYPE OF TRACK (CURVE)
DISTANCE (Km)
JANG BANG
EUM SEONG
SO I
SECTION OF NEW DOUBLE TRACK
16.7
13.3
13.3
13.3
13.3
11.4
13.3
13.3
11.4
302 302 302 302 302 402 503 402 402 503 402 302 402 805 402 402 402 402 402 302 805 805 1207 604 402 302 402
61 62 63 64 65 66 67 68 69 70 71 72 73 74 75
JU BEOG
DAL CHEON
13.3
13.3
13.3
13.3
12.5
11.4
13.3
13.3
503 503 503 1207 1207 305 604 402 402 402 402 402 402 1207 1207 805 1207 805 604 402
76 77 78 79 80 81 82 83 84 85 86 87 88 89 90
CHUNG JU
MOG HANG
DANG RYANG
11.4
15
19
20
20
362 400 500 800 800 400 400 300 300 400 400 400 300 800 300
91 92 93 94 95 96 97 98 99 100 101 102 103 104 105
SAN CHEOG
SAN TAN
GONG JEON
20
16
20
18
12
15
15
NEW SINGLE TRACK
400 302 300 300 400 300 500 400 400 400 600 300 300 300 300 400 600 700 300 450 500 350 300 350 300
106 107 108 109 110 111 112 113 114 115 116 117 118 119 120


STATION
CURVE
SECTION OF TRACK TO BE ADDED
TYPE OF TRACK (CURVE)
DISTANCE (km)
BANG YANG
NEW SINGLE TRACK
21
18
18
20
14
L
8
L
135
L
300
300
500
400
400
300
300
400
500
400
400
119
120
121
122
123
124
125
126
127
128

3. TABLE OF GRADES ON EXISTING TRACK (Over 13.3%)

Section	Distance km	Terminal → Commencement Up(track)		Down(track)		Remarks
		%	Elonga-tion(m)	%	Elonga-tion(km)	
O Sang	5	13	101	13.3	101	Terminal → Commencement
	6					
Mi Ho	7	16.7	201			
Jeong Bong	9			16.7	644	Up grade of working train
SEO Cheong Ju	12			15	121	
	19			15.2	865	
Cheong Ju	20	16.7	972			Commencement → Terminal
Teong Ha	26	13.3	463			
O Geun Jang	30			15	210	
	31			15	201	Up grade of empty train
	34	15.2	241			
Nae Su	36			16.7	175	
Geum Am	37	16.7	320			
	40			15.2	885	
Jeung Pyeong	41	16.7	1025			
	45			16.7	271	
	46	13.3	161			
Do An	49			13.3	211	
Mun Am	51-56			16.7	4823	
	56			13.3	337	
Bo Cheon	57	13.3	609			
	59			16.7	505	
	60			15.2	402	
	60			16.7	577	
	60			13.3	248	
Sang Dang	61-62	13.3	1827			
	63	13.3	310			
Eum Seong	64	13.3	639			
	68	13.3	1285			
So I	70	13.3	349			
	73	14.0	201	13.3	337	
	75	13.3	986			
Ju Deog	77	13.3	976			
	81			13.3	423	
Dal Cheon	85			13.3	284	
Chung Ju	86	13.3	583			
Mog Haeng	95	15	403			
	101			19	650	
Dong Ryang	102			20	410	
San Cheog	103-105			20	2290	
	106-108			20	2271	
	109	16	598			
Sam Tan	110	20	1329			
	113			18	540	
Gong Jeon	115			15	680	
	120			15	840	Total
	121-122			21	2080	
	123	20 18	700 480	18	220	Up Down
	124	14	400			15,159 22,327
Bong Yang	125			13.5	440	

4. TABLE OF WEATHER CONDITION

Year/Month	Max. temp.	Min. temp.	Average	Average atmospheric pressure mb	Amount of rainfall mm	Amount of Evaporation mm	Average humidity %	Average wind velocity m/sec	Max. wind velocity m/sec	Wind direction	Time of occurrence
1964	35.5	-13.0	13.0	-	1,875.6	723.7	78	17	-	-	-
65	34.8	-12.5	12.6	-	1,248.1	1,093.5	74	1.9	-	-	-
66	35.0	-15.5	12.7	-	1,134.1	920.4	76	1.8	-	-	-
67	35.4	-24.1	11.5	1,010.1	1,010.0	1,147.6	74	2.2	17.2	SW	3.27
68	34.2	-16.2	11.5	1,010.2	911.7	1,143.2	75	2.1	15.0	SSW	2.14
69	34.2	-26.4	10.6	1,016.8	1,401.4	941.2	76	1.9	15.7	SSE	4.24
70	33.7	-20.0	11.2	1,017.6	1,339.8	1,031.3	76	1.6	16.0	SW	5.26
71	35.1	-23.2	11.3	1,017.1	1,115.2	1,044.6	75	2.1	14.3	NW	4.9
72	35.6	-11.0	11.9	1,016.5	1,323.6	1,012.5	73	3.1	23.3	N	7.26
73	35.7	-20.6	11.2	1,017.2	865.5	1,115.5	72	2.2	16.7	WSW	3.20.28
1973 Jan.	10.2	-14.7	-0.6	1,024.9	81.7	25.2	75	1.8	12.7	NE	1.24
Feb.	14.6	-10.2	0.5	1,022.9	14.0	45.2	68	2.5	10.7	N	2.6
Mar.	22.7	- 6.3	4.2	1,021.3	5.6	103.2	59	2.9	16.7	WSW	3.20.28
Apr.	27.4	- 3.8	12.3	1,015.0	102.4	117.8	64	3.1	13.3	WSW	4.24
May	26.6	6.6	17.0	1,012.2	75.3	134.8	64	2.8	12.0	WSW	5.30
June	30.8	11.8	21.6	1,008.8	132.0	144.2	69	2.3	10.0	SSW	6.11
July	35.7	20.3	23.9	1,008.3	107.0	170.8	72	2.2	11.7	S	7.19
Aug.	34.8	20.1	23.1	1,011.5	131.5	138.7	80	2.2	13.3	WSW	8.17
Sep.	28.4	4.9	19.4	1,014.2	117.5	100.1	79	1.6	10.8	SW	9.1
Oct.	25.2	- 0.9	11.8	1,021.1	54.7	65.1	79	1.8	11.0	N	10.21
Nov.	16.4	- 8.2	4.3	1,022.6	29.5	38.4	79	2.1	14.7	SW	11.16
Dec.	12.1	-20.6	-3.5	1,023.7	14.3	37.0	73	0.9	12.1	NW	12.21

ACCORDING TO CHUNG BUG ANNUAL STATISTICS

5. TABLE OF RAINFALL BY PLACE AND MONTH (1973)

(unit: mm)

Place (all within Chung Nam Dist.)	Total	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Yeon Gi Gun	841.6	93.1	14.7	4.8	119.1	94.3	167.1	106.2	146.3	52.0	37.9	2.5	3.6
Cheon Weon Gun	727.3	63.9	22.0	1.2	99.2	39.0	85.1	133.2	109.2	87.7	40.7	36.3	10.8
Cheon Ju Si	727.3	63.9	22.0	1.2	99.2	39.0	85.1	133.2	109.2	87.7	40.7	35.3	10.8
Gye San Gun	898.6	89.5	16.0	9.7	92.5	90.0	107.0	132.0	134.0	150.5	40.0	22.5	14.9
Jin Cheon Gun	990.6	95.2	9.3	3.8	137.0	90.5	177.5	81.0	156.5	126.0	54.5	37.5	21.8
Eum Seong Gun	1,055.5	99.1	10.1	4.7	126.5	90.0	206.0	82.0	170.5	168.0	46.5	36.2	15.9
Jung Weon Gun	879.2	91.4	9.6	4.2	80.0	67.5	173.5	122.5	131.5	101.5	49.0	32.4	16.1
Chung Ju Si	879.2	91.4	9.6	4.2	80.0	67.5	173.5	122.5	131.5	101.5	49.0	32.4	16.1
Je Cheon Gun	750.7	86.5	9.9	12.6	83.5	94.0	105.0	44.0	125.5	100.0	34.5	31.5	23.7

According to Chung Nam Meteorological Statistics (Central Meteorological Observatory)

6. TABLE OF MIN. TEMPERATURE BY PLACE AND MONTH (1973)

(unit: C°)

Place (Chung Nam Dist)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Min throughout year
Yeon Gi Gun	-15	-10	-6	13	14	18	25	25	24	22	9	-15	-15
Cheon Weon Gun	-14.7	-10.2	-6.3	-3.8	6.6	11.8	20.3	20.1	4.9	-0.9	-8.2	-20.6	-20.6
Cheong Ju Si	-14.7	-10.2	-6.3	-3.8	6.6	11.8	20.3	20.1	4.9	-0.9	-8.2	-20.6	-20.6
Gye San Gun	- 5.2	- 5.3	-2.7	4.9	10.8	16.6	22.0	21.4	13.9	4.5	-2.9	-10.3	-10.3
Jin Cheon Gun	-14.7	-10.2	-6.3	-3.8	6.6	11.8	20.3	20.1	4.9	-0.9	-8.2	-20.6	-20.6
Eum Seong Gun	- 5.0	- 4.7	-2.0	5.3	10.6	15.9	22.0	21.6	13.8	5.4	-1.7	- 9.5	- 9.5
Jung Weon Gun	-11.3	-10.6	-7.0	-4.6	5.5	9.7	22.0	21.2	3.6	-1.7	-11.4	-21.4	-21.4
Chung Ju Si	-11.3	-10.6	-7.0	-4.6	5.5	9.7	20.0	21.2	3.6	-1.7	-11.4	-21.4	-21.4
Je Cheon Gun	-13.5	-13.2	-10.0	-6.1	3.7	8.5	17.2	17.8	1.8	-2.6	-10.4	-24.8	-24.8

According to Chung Nam Meteorological Statistics (Central Meterological Observatory)

7. TABLE OF MAX. TEMPERATURE BY PLACE AND MONTH (1972)

Unit: C°

Place (Chung Nam Dist.)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Max. through-out year
Yeon Gi Gun	9	10	17	27	26	29	35	35	30	28	18	7	35
Cheon Weon Gun	10.2	14.6	22.7	27.4	26.6	30.8	35.7	34.8	28.4	25.2	16.4	12.1	35.7
Cheon Ju Si	10.2	14.6	22.7	27.4	26.6	30.8	35.7	34.8	28.4	25.2	16.4	12.1	35.7
Gye San Gun	3.8	5.9	10.8	19.1	23.8	27.2	32.2	30.7	25.2	18.3	9.6	5.5	32.2
Jin Cheon Gun	10.2	14.6	22.7	27.4	26.6	30.8	35.7	34.8	28.4	25.2	16.4	12.1	35.7
Eum Seong Gun	4.1	6.1	11.1	18.3	22.4	26.4	32.0	30.8	24.7	18.4	9.7	1.9	32.0
Jung Weon Gun	11.2	16.0	23.0	28.5	27.9	31.0	36.8	34.7	29.6	25.0	16.7	11.8	36.8
Chung Ju Si	11.2	16.0	23.0	28.5	27.9	31.0	36.8	34.7	29.6	25.0	16.7	11.8	36.8
Je Cheon Gun	8.7	14.6	20.8	27.6	26.8	30.0	34.8	35.0	27.8	23.5	17.0	9.3	35.0

According to Chung Nam Meteorological Statistics (Central Meteorological Observatory)

8. CLASS OF TRACKS AND STANDARD OF CONSTRUCTION IN CONNECTION WITH TRACK DOUBLING

Item		Doubling		Existing	
		Jo Chi Weon-Chung Ju	Chung In-Bong Yang	Jo Chi Weon-Chung Ju	Chung In-Bong Yang
Class of track		3rd class	3rd class	4th class	3rd class
Max. grade	Up track	12.5	12.5	16.7	21.0
	Down track	16.7	21.0		
Min. curve radius (m)	Up track	400		300	
	Down track	300			
Roadbed width (m)	Section of double track	9.4	9.4	4.8	5.4
	Section of single track	5.4	5.4		
Effective length of station (m)		550		450	
Design load	Up track	LS-22	LS-22	LS-15	LS-18
	Down track	LS-22	LS-18		
Type of tunnel		2nd class (Electric)		4th class	
Transition curve		included		Partially circular curve	Included
Track	Main	50 kg N		50 kg PS	
	Side	37 kg N		37 kg	
Signal		Electric signal		Mechanical signal	

9. TABLE OF RAILROAD CROSSINGS

Section	1st	2nd	3rd	4th	Total
Jo Chi Weon - O Geun Jaug	*1	*2	*2	38	43
O Geun Jang - Jeung Pyeong	*1	Δ3	*1	11	16
Jeung Pyeong - Eun Seong	*1	*4	0	13	18
Eun Seong - Chung Ju	0	*2	0	16	17
Chung Ju - Bong Yang	*1	0	0	16	17
Total	4	11	3	108	126
Grade separated crossing to be constructed at time of track doubling	4	8	3		15
Crossing gates to be abolished at time of track doubling		3			3

* Grade Separated Crossing

Δ Abolished

10. TABLE OF BRIDGES (1)

Location	Name of Bridge	Span	No. of Span	Extension			
				Single track		Double track	
				Floor Plate	Plate Girder	Floor Plate	Plate Girder
Jo Chi Weon	Nae Chang Cheon	6.0	3	20.6			
	Sin Se	2.5	1	2.5			
	Seo Chang	18.0	1		18.0		
O Song	To Cheon	12.0	11		146.2		
	Mi Ho Cheon	12.0	26		347.5		
	Weol Gog Cheon 1	4.0	2			8.9	
	Weol Gog Cheon 2	6.0	4			28.0	
Jeong Bong	Jeong Bong	12.0	1				12.0
	Gang Sao Cheon	9.0	6				60.1
	Nam Chon	9.0	1				9.0
	Nae Gog Cheon	12.0	1				12.0
	Sin Jeong	12.0	1				12.0
	Sang Sin Cheon	12.0	1				12.0
	Weon Pyeong	12.0	1				12.0
	Mun Am	12.0	1				12.0
	"	4.0	2			10.0	
	Mu Sim Cheon	12.0	17				281.6
Cheong Ju	Jeong Sang	12.0	1		12.0		
	Oe Ha Cheon	6.0	3	20.6			
	Ib Dong	5.0	1	5.0			

10. (2)

Location	Name of Bridge	Span	No. of Span	Extension			
				Single track		Double track	
				Floor Plate	Plate Girder	Floor Plate	Plate Girder
Nae Su	Sin An Cheon	9.0	6		60.1		
	Hag Pyeong Cheon	9.0	5		49.9		
	Nae Su	18.3	1				18.3
	Sin Dae Cheon	9.0	11				111.3
	Bu Yeon Cheon	5.0	2			11.0	
	Jang Tae Cheon	4.0	2			10.0	
	Ju Jang	12.0	1				12.0
	Song Jeong Cheon	9.0	1				9.0
	Geum Dae Cheon	9.0	1				9.0
Teung Pyeong	Sang Bung	9.0	1				9.0
	Gyoe San Je Il	9.0	2				19.3
	Bo Gang Cheon	12.0	6				79.1
	Cheong An Cheon	12.0	3				38.9
	Gyoe San 2	12.0	1				12.0
Do An	Hwa Seong Cheon	12.0	4				52.3
	Do An Cheon	18.0	1		18.0		
	Soug Teong	6.0	1	6.0			
	" 1	6.0	3	20.6			
	" 2	6.0	3	20.6			
	Mun Am	18.0	1				18.0

10. (3)

Location	Name of Bridge	Span	No. of Span	Extension			
				Single track		Double track	
				Floor Plate	Plate Girder	Floor Plate	Plate Girder
Bo Cheon	Bo Cheon	12.0	1				12.0
	Bo Cheon Cheon	9.0	1				9.0
	Ma Song Cheon	12.0	2				25.0
	Gyoe San Ga Do	9.0	1				9.0
	Sang Dang Cheon	6.0	2	13.0			
	Je I Ha Dang Cheon	6.0	4	27.1			
	Ha Ro Cheon	6.0	4	28.0			
	Je II Ha Dang Cheon	9.0	5		49.9		
	O Cheon Cheon	9.0	3				29.4
Eum Seong	Eum Seong Cheon	9.0	11				112.0
	Gyoe San Ga Do	6.0	1			6.0	
So I	Hwa Jang Cheon	9.0	4				39.0
	Je I Hu Mi Cheon	6.0	3			20.4	
	Mi Cheon	4.5	2			11.1	
Ju Deog	Je II Hu Sam Cheong Cheong	6.0	1			6.0	
	Mi Rag Cheon	9.0	1				9.0
	Ma Chi Cheon	9.0	1				9.0
	Geum Gog Cheon	6.0	3	20.0			
	Je Il Man Jeog	6.0	3	20.0			

10. (4)

Location	Name of Bridge	Span	No. of Span	Extension			
				Single track		Double track	
				Floor Plate	Plate Girder	Floor Plate	Plate Girder
	Je I Man Jeog	5.0	2	11.1			
Dal Cheon	Dog Jang Cheon	3.0	2	7.1			
	Je I Dal Cheon	9.0	3		29.4		
	Je II Dal Cheon	21.3	11		251.9		
Chung Ju	Dal Weol Cheon	4.0	2			8.9	
	Chung Ju Cheon	12.0	8				104.0
	Tan Gun Ga Do	9.0	2				19.0
	Gum Neung Cheon	9.0	3				29.0
Mog Haeng	Mog Haeng Cheon	9.0	1		9.0		
	Yomg Deung Cheon	12.0	3				39.0
	Nam Han Gang	30.0 24.4	6 4		400.0		
Dong Ryang	Jo Dong Cheon	9.0	2				18.0
	Dong Ryang	6.0	1			6.0	
	So Mo	6.0	1			6.0	
	Myeong Seo Cheon	12.0	3				39.0
	Myeong Seo	9.0	1				9.0
Sam Jan	Sam Tan	18.0	16	Arch 333.0			
	Myeong Am Cheon	12.0	9		120.0		
	Jin So Cheon	12.0	12		160.0		

10. (5)

Location	Name of Bridge	Span	No. of Span	Extension			
				Single track		Double track	
				Floor Plate	Plate Girder	Floor Plate	Plate Girder
	Gong Jeon Cheon	12.0	3		39.0		
	Ju Po Cheon III	12.0	10		133.0		
	Ma Gog Cheon	12.0	1		12.0		
	Ong Cheon	12.0	15		200.0		
	Hyeon Bag Cheon	12.0	10		133.0		
	Je E Ju Po Cheon	12.0	7		93.0		
	Ju Po Cheon II	12.0	12		160.0		
	Total			(15 bridges) 555.2	(21 bridges) 2,441.9	(13 bridges) 145.6	(37 bridges) 1,321.3
	15 bridges	Floor plate		(10 bridges 142.1			
		T girder		(4 bridges 80.1)			
		Arch		(1 bridge 333.0)			
					13 bridges	(9 bridges 107.2 (2 bridges 26.4 (2 bridges 12.0	

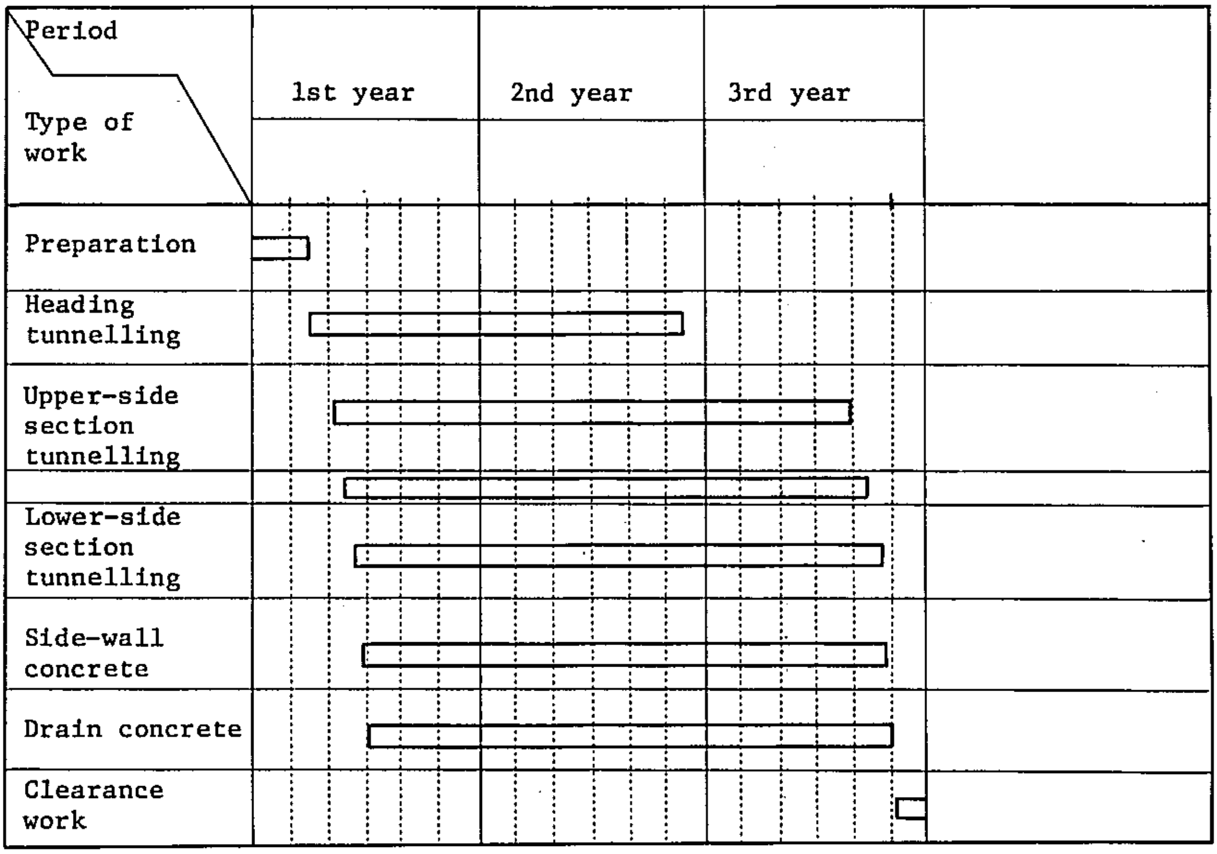
10. (6)

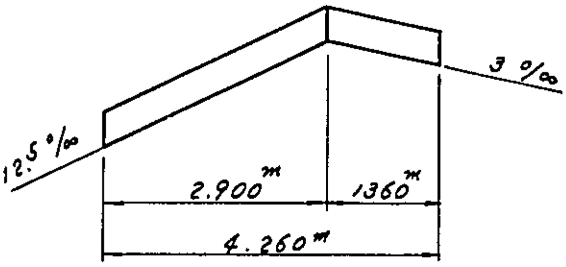
Location	Name of Bridge	Span	No. of Span	Single track		Double track		
				Floor Plate	Plate Girder	Floor Plate	Plate Girder	
Jo Chi Weon	deltea siding track							
	Jo Chi Weon	18.0 21.0 38.0 18.0	11 2 1 14	543.9				T girder PC Composite girder T girder
	Jo Cheon	12.0	11				146.2	
	Total			(1 bridge) 543.9			(1 bridge) 146.2	

11. TABLE OF TUNNELS

Location		Name of Tunnel	Tunnel length		
Estimated	Virtual (approx.)		Single track	Double track	
54^{k} 570	48 65	Baeg Ma			Between Do an and Bo Cheon (R=500m)
61^{k} 920	53.2	Ma Song		320	Between Bo Cheon and Eum Seong (R=500m)
94^{k} 060 (actual)	94 24	In Deung		4,260	Between Dong Ryang and Saw Tam
115^{k} 608	104 75	Sam Tan No.1	135		Between Sam Tan and Gong Jeon
115^{k} 793	104 8	Sam Tan No.2	70		"
115^{k} 898	105.2	Meong Am	810		" (R=700m)
116^{k} 910	106.3	Mun Deog	280		" (R=600m)
118^{k} 338	106.5	"	124		(R=500m)
124^{k}020	113.3	Hyeon Bag	220		Between Gong Jeon and Bong Yang (R=600m)
125^{k} 480	114.7	Ju Po	310		" (R=400m)
Total			1,949m	5,360	

12. WORK SCHEDULE OF IN DEUNG TUNNEL CONSTRUCTION

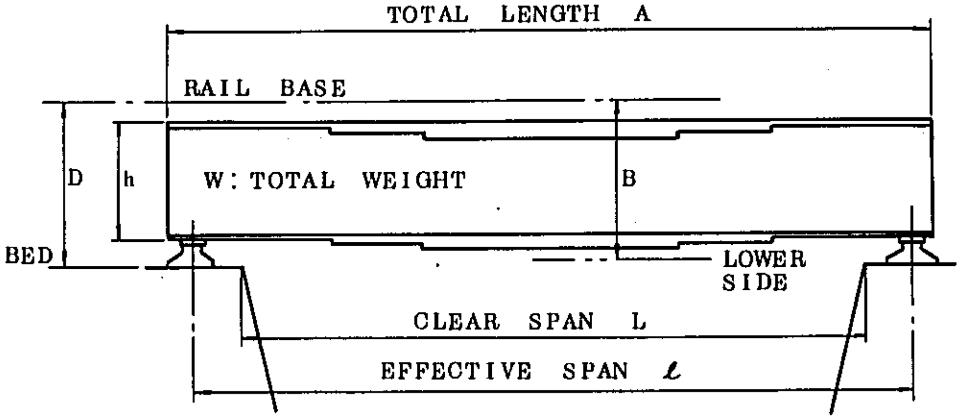


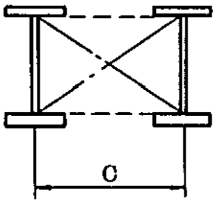


Work shall be executed in bottom heading drift method tunnelling.

13. TABLE OF DECK PLATE GIRDER

(LS-22)

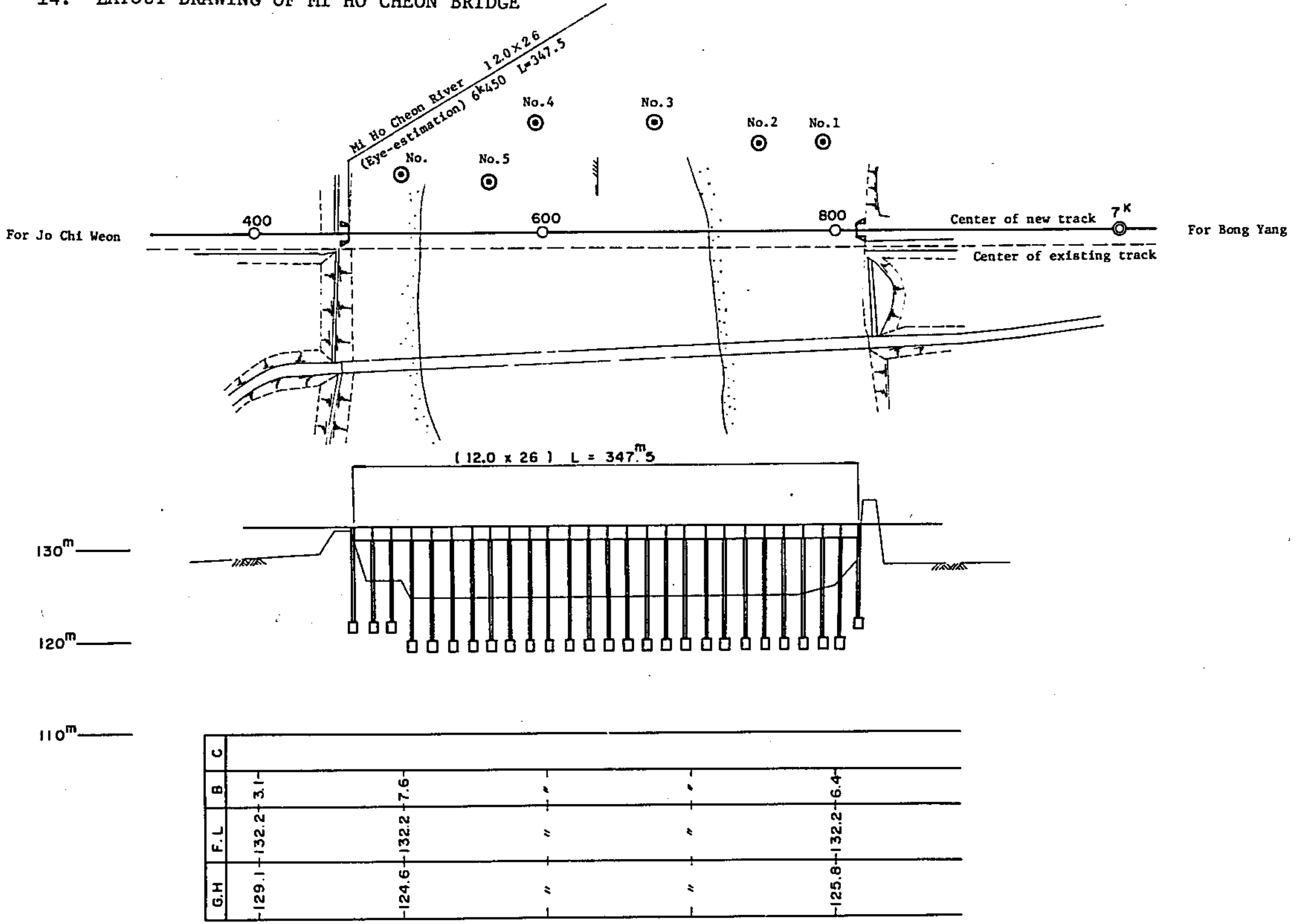




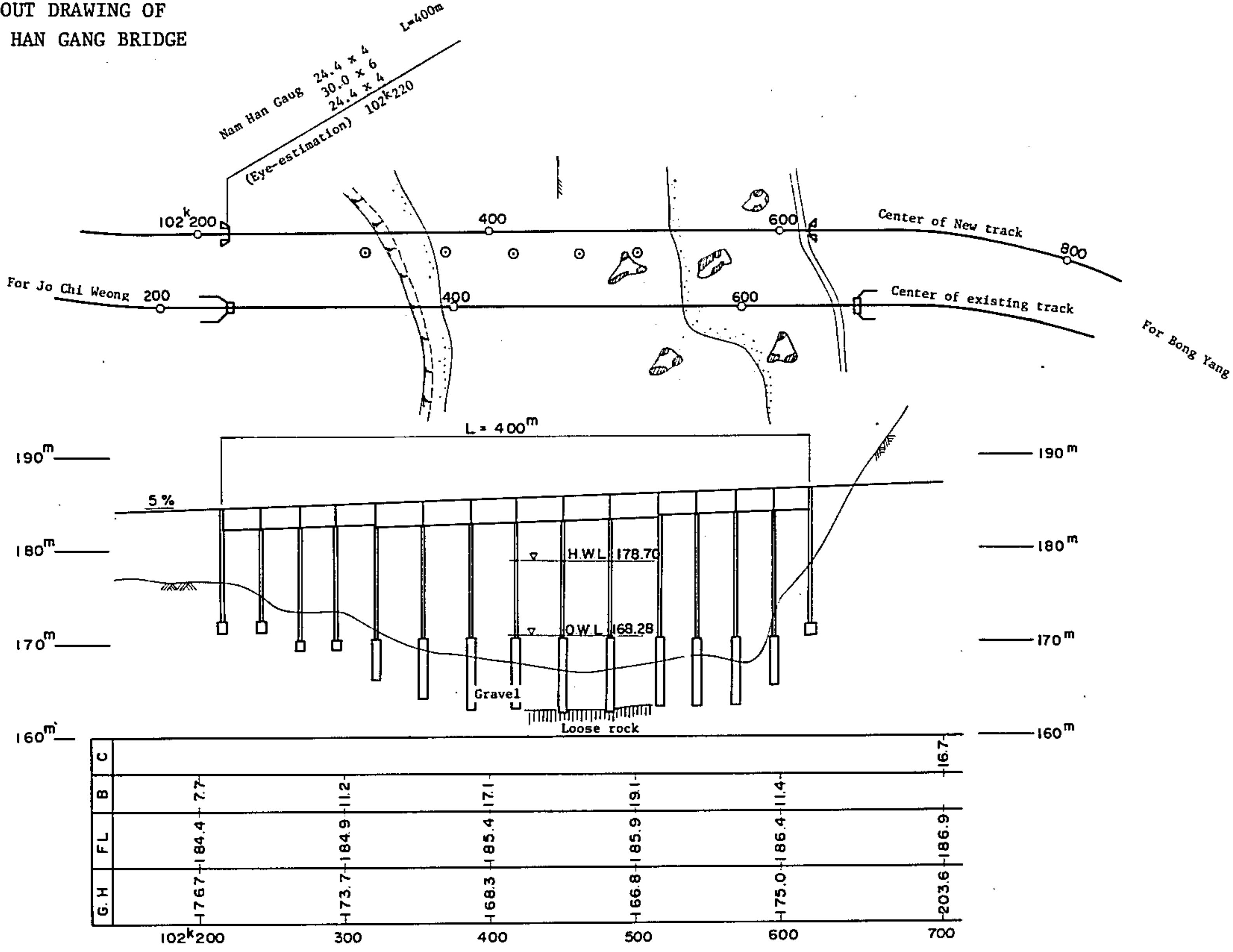
EACH DIMENSIONS & TOTAL WEIGHT

L(m)	6.00	9.00	12.10	15.20	18.30	21.30	24.40	30.00
ℓ (m)	6.60	9.70	12.90	16.00	19.20	22.30	25.40	31.10
A (")	7.00	10.14	13.40	16.50	19.74	22.90	26.04	31.80
B (")	1.186	1.478	1.680	1.891	2.115	2.316	2.546	2.888
C (")	1.60	1.60	1.80	1.80	2.00	2.00	2.00	2.00
D (")	1.326	1.636	1.836	2.057	2.289	2.491	2.711	3.051
h (")	0.949	1.239	1.439	1.650	1.872	2.074	2.284	2.624
W (t)	2.68	4.83	7.83	10.09	18.04	24.49	29.21	46.54

14. LAYOUT DRAWING OF MI HO CHEON BRIDGE



15. LAYOUT DRAWING OF NAM HAN GANG BRIDGE



16. SIGNALS AND SAFETY FACILITIES

1. Regarding Blocking System

Block section must be ensured for safe and smooth operation of trains and following list is the comparison of various different systems.

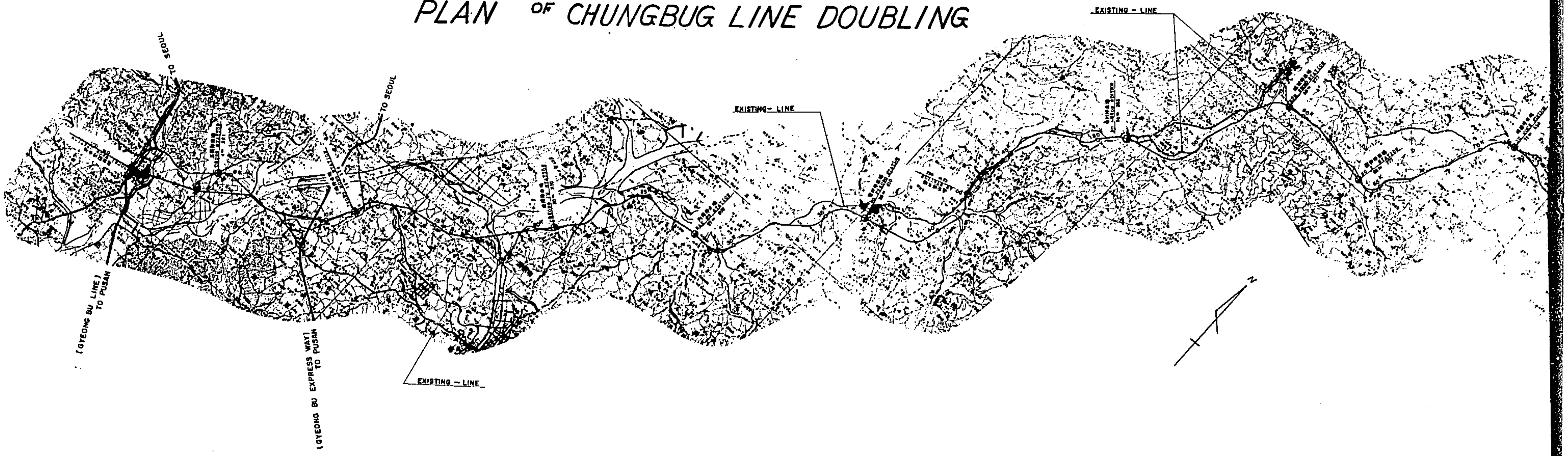
		Automatic Block System (A)	Tokenless Block System (B)	Composite Block System (C)
1.	Applicable section	Section of frequent train passage	Section of relatively many train passage	Section of few train passage
2.	Handling	Blocking and signalling are made automatically bh the train itself, hence no handling of device is required.	To be handled by joint operation of both stations concerned.	Same as (B)
3.	Operative safety	As this is the device synchronizing departure signal at station yard and blocking, no manual operation is involved, hence high safety secured.	Blocking is made by manual control but can be connected with depararture signal at station yard, hence higher safety than (C) secured.	In addition to manual control, it is difficult to connect with departure signal at station yard, hence safety secured lower.
4.	Increase of track capacity	By splitting block section between stations, increase of track capacity is made possible.	As block section is fixed between stations, increase of track capacity is impossible.	Same as (B)
5.	Future improvement of facilities	No modification is required in case of such improvement as CTC, ARC.	A little modification is required in case of such improvement as automatic blocking system.	Replacement of all equipment is required in case of such improvement as tokenless system or automatic blocking system.
6.	Others			Equipment for this system is not being manufactured.

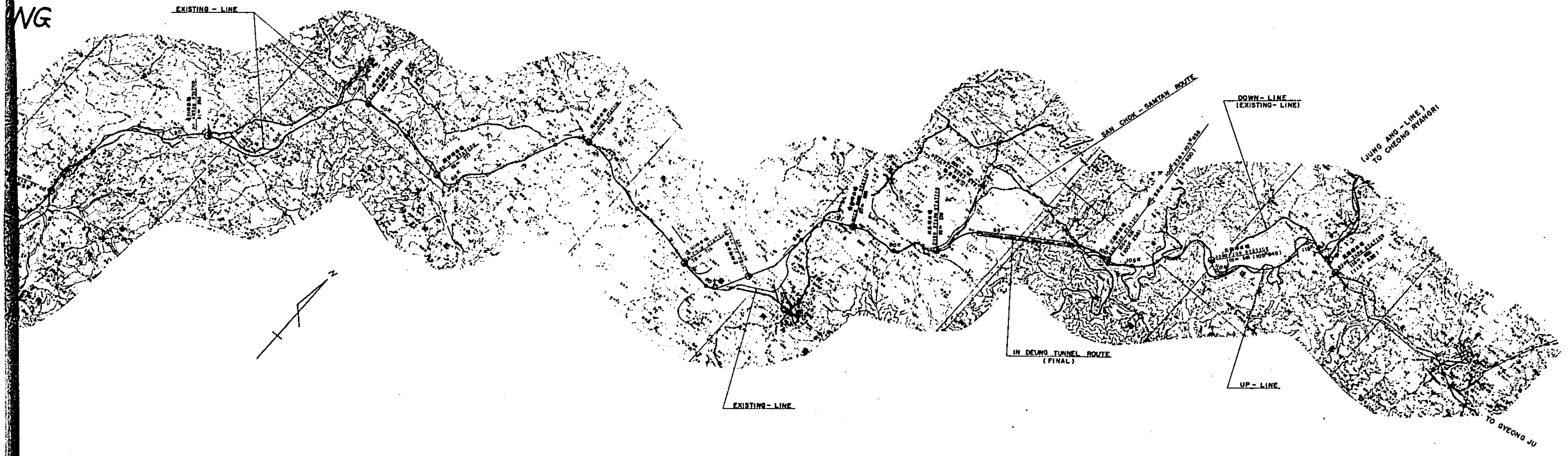
2. Signal

Fixed signal is classified in color light signal and semaphore (signal) from the structural point of view.

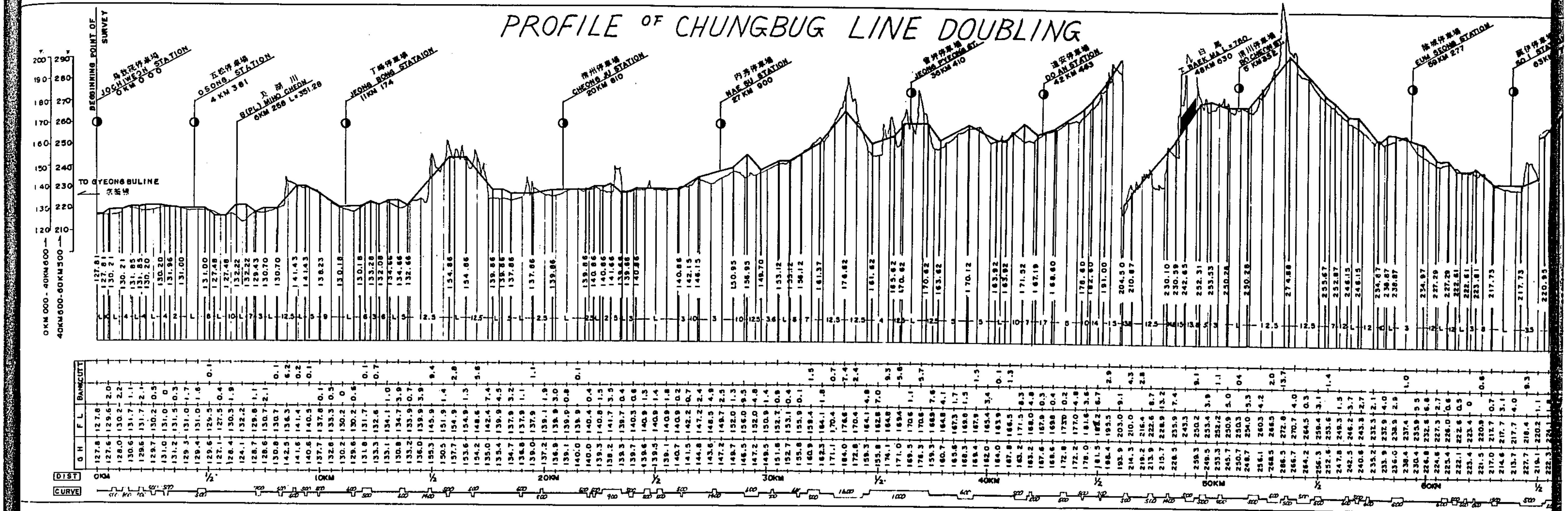
		Color Light Signal	Semaphore (Signal)
1.	Handling	Simple	Manpower required
2.	Operative safety	.Connection with blocking system is easy and sufficient visibility is also obtainable, hence high safety secured.	Connection with blocking system is difficult and visibility is insufficient depending on condition, hence low safety secured.
3.	Weather & Climate	No influence	Sometimes operation becomes impossible due to the expansion and contraction of wire caused by temperature.
4.	Future improvement of facilities	It can be used as it is in case of improvement of facilities.	Replacement of all equipment is needed in case of improvement of facilities.
5.	Maintenance	No problem	Daily check like oil supply, wire adjustment is required. Besides, there is difficulty in procurement of repairing material.
6.	Others		Equipment for this type of signal is not being manufactured.

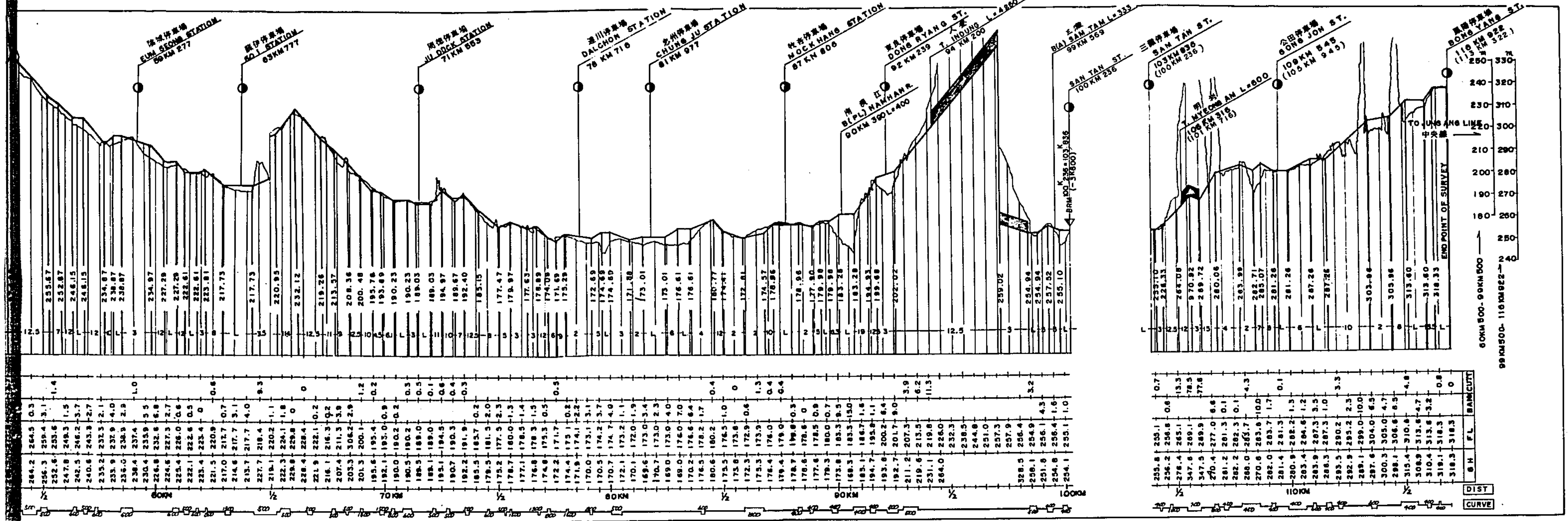
PLAN OF CHUNGBUG LINE DOUBLING



NG
EXISTING - LINE
EXISTING- LINE
SAN CHOK - SAMTAN ROUTE
IN DEUNG TUNNEL ROUTE (FINAL)
DOWN- LINE (EXISTING- LINE)
UP- LINE
(JUNG ANG - LINE) TO CHEONG RYANGRI
TO GYEONG JU
N
105K
110K

PROFILE OF CHUNGBUG LINE DOUBLING



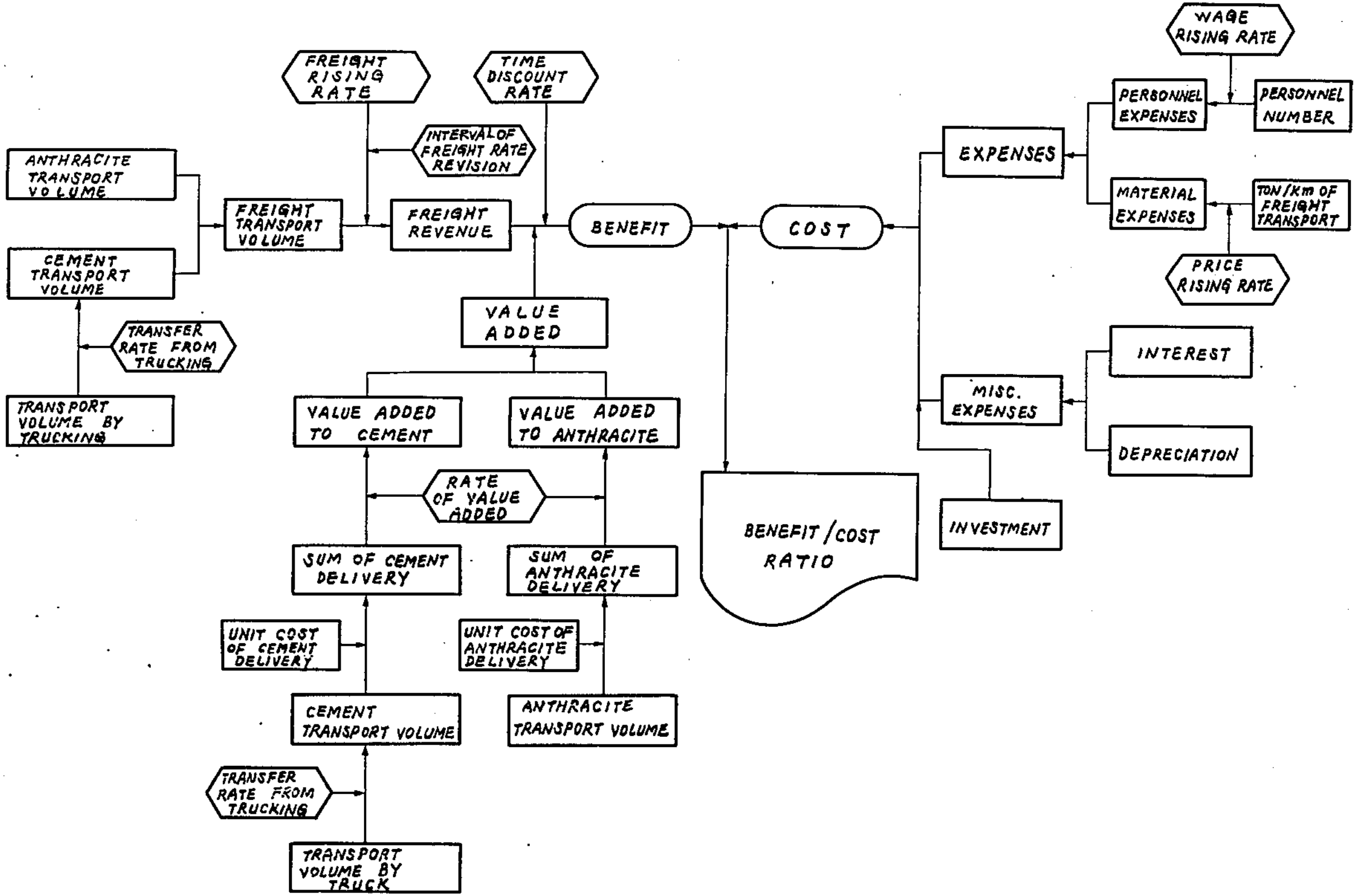

陰城停車場
EUM SEONG STATION
59KM 277
蘇伊停車場
SO I STATION
63KM777
周德停車場
JU DOCK STATION
71KM 553
達川停車場
DALCHON STATION
78 KM 716
忠州停車場
CHUNG JU STATION
81KM 977
牧杏停車場
MOCK HANG STATION
87 KM 806
東良停車場
DONG RYANG ST.
92 KM 239
南漢江
B(PL) NAMHAN R.
90KM 390 L=400
人登
T. INDUNG L=4850
94 KM 200
三灘
B(A) SAM TAM L=333
99 KM 569
SAN TAN ST.
100 KM 236
K 100 236 = 103 836 K
(−3K600)
三灘停車場
SAN TAN ST.
103KM 836
(100KM 236)
明岩
T. MYEONG AN L=600
106 KM 316
(101 KM 716)
公田停車場
GONG JON ST.
109KM 545
(105 KM 945)
鳳陽停車場
BONG YANG ST.
116 KM 922
(113 KM 322)
TO JUNG ANG LINE
中央線
END POINT OF SURVEY
m 250 240 230 220 210 200 190 180
m 330 320 310 300 290 280 270 260 250 240
60KM500 - 90KM500
99KM500 - 116KM922
½
60KM
70KM
80KM
90KM
100KM
110KM
BANK
CUT
FL
GH
DIST
CURVE

II Evaluation of Investment

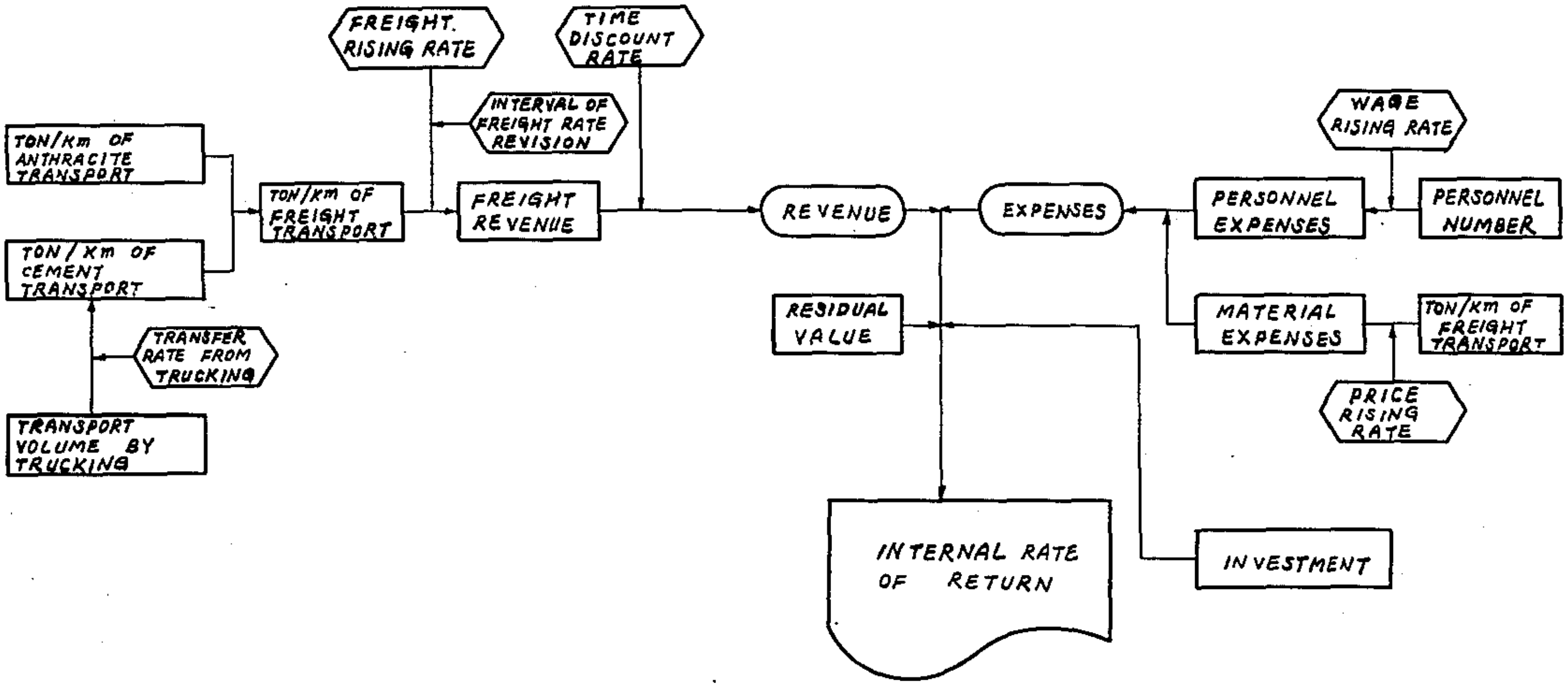
The evaluation of investment on the Chung Bug Line doubling project was made out as related in Chapter V, and the analysis was carried out in full use of electronic data process system.
The calculation program was such as shown in the following flow chart.

The present time of the evaluation was set to be as of 1979, and the estimated amounts of the required project costs for the track-doubling work were used the figures listed in the following table.

A. Flow Chart for calculation of the effect from the Chung Bug Line doubling. (Benefit/Cost Ratio)

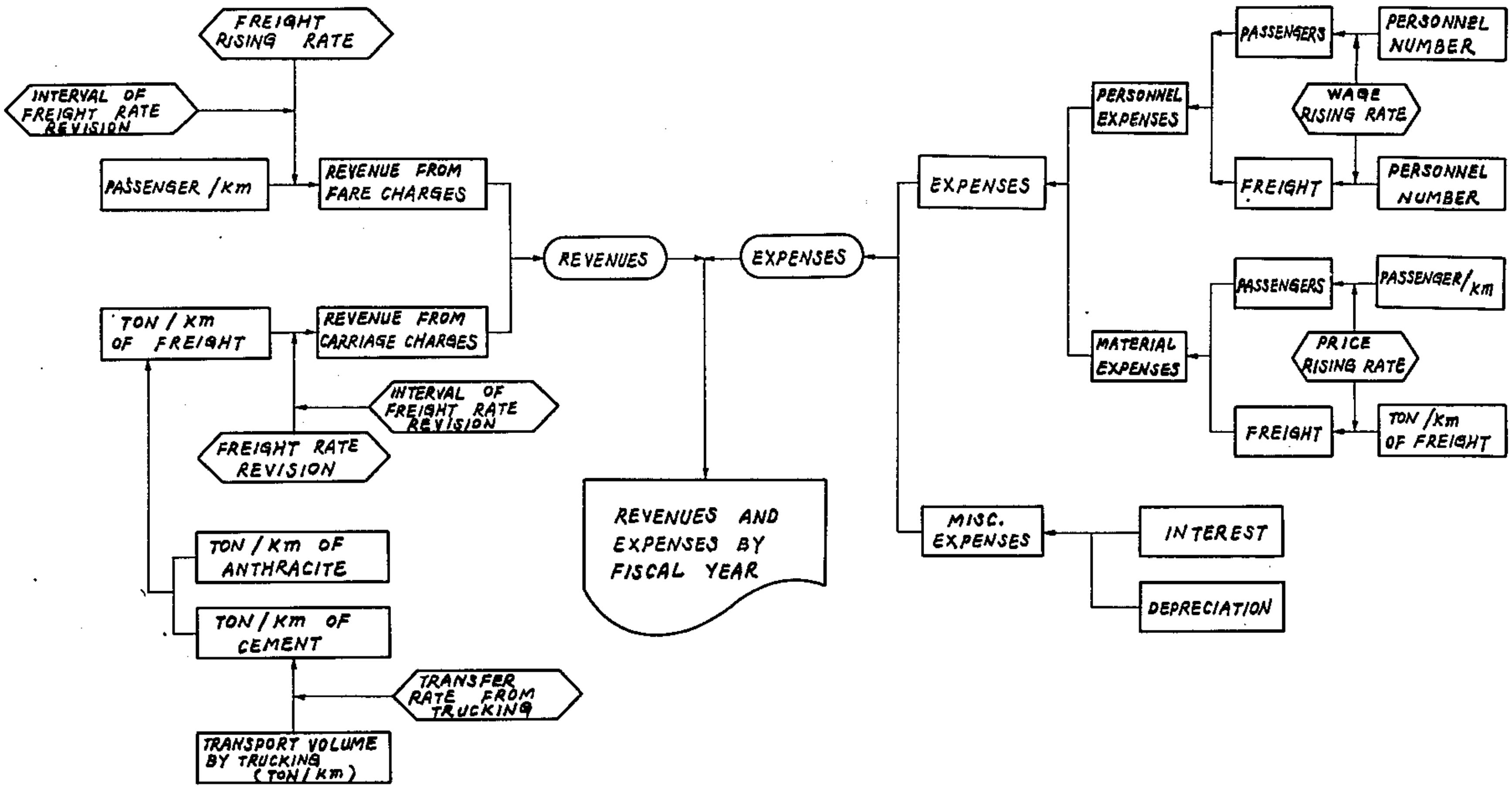


B. Flow Chart for Calculation of the Effect from the Chung Bug Line Doubling. (Internal Rate of Return)



Note: As for the revenues and expenses treated in the calculation are confined to those increments resulted from the effected track-doubling.

C. Double-tracking Effect on Chung Bug Line (Revenues and Expenses by Fiscal Year)



ESTIMATED AMOUNTS OF REQUIRED PROJECT COSTS BY FISCAL YEAR FOR CHUNG BUG LINE DOUBLING.

Item		Total Sums of A Columns	1st Year		2nd Year		3rd Year		4th Year		5th Year		Total Sums of B Columns	Labor Cost Ratio (%)	Remarks
			A	B	A	$B^{1.13}_{1.06}$	A	$B^{1.28}_{1.12}$	A	$B^{1.44}_{1.19}$	A	$B^{1.63}_{1.26}$			
Land		2,590	260	260	1,036	1,036	777	777	517	517	0	0	2,590	0	Total sums of A columns are as of April 1975.
Roadbed	Earth Work	6,612	198	198	1,455	1,577	1,984	2,333	2,645	3,378	331	459	7,945	35	
	Bridge	3,551	107	107	781	852	1,065	1,269	1,420	1,849	178	253	4,330	45	
	Tunnel	6,067	182	182	1,335	1,443	1,820	2,125	2,427	3,070	303	415	7,235	30	
	Others	927	28	28	204	221	278	326	370	472	46	63	1,110	35	
	Total	17,157	515	515	3,775	4,093	5,147	6,053	6,862	8,769	858	1,190	20,620		
Track		(4,205) 7,606	0	0	0	0	(4,205) 4,291	(4,899) 4,998	3,200	4,008	115	155	(4,899) 9,161	25	
Signal		675	0	0	0	0	104	119	241	298	330	440	857	20	
Building		329	0	0	0	0	49	56	70	87	210	284	427	25	
Electric power		430	120	120	170	183	40	46	25	31	75	101	481	25	
Telecommunication		264	0	0	9	9	44	51	44	56	167	232	348	35	
Incidental Expenses		(15) 749	(15) 105	(15) 105	10	11	348	423	141	188	145	214	(15) 941	60	
Total		(4,220) 29,800	(15) 1,000	(15) 1,000	5,000	5,332	(4,205) 10,800	(4,899) 12,523	11,100	13,954	1,900	2,616	(4,914) 35,425		

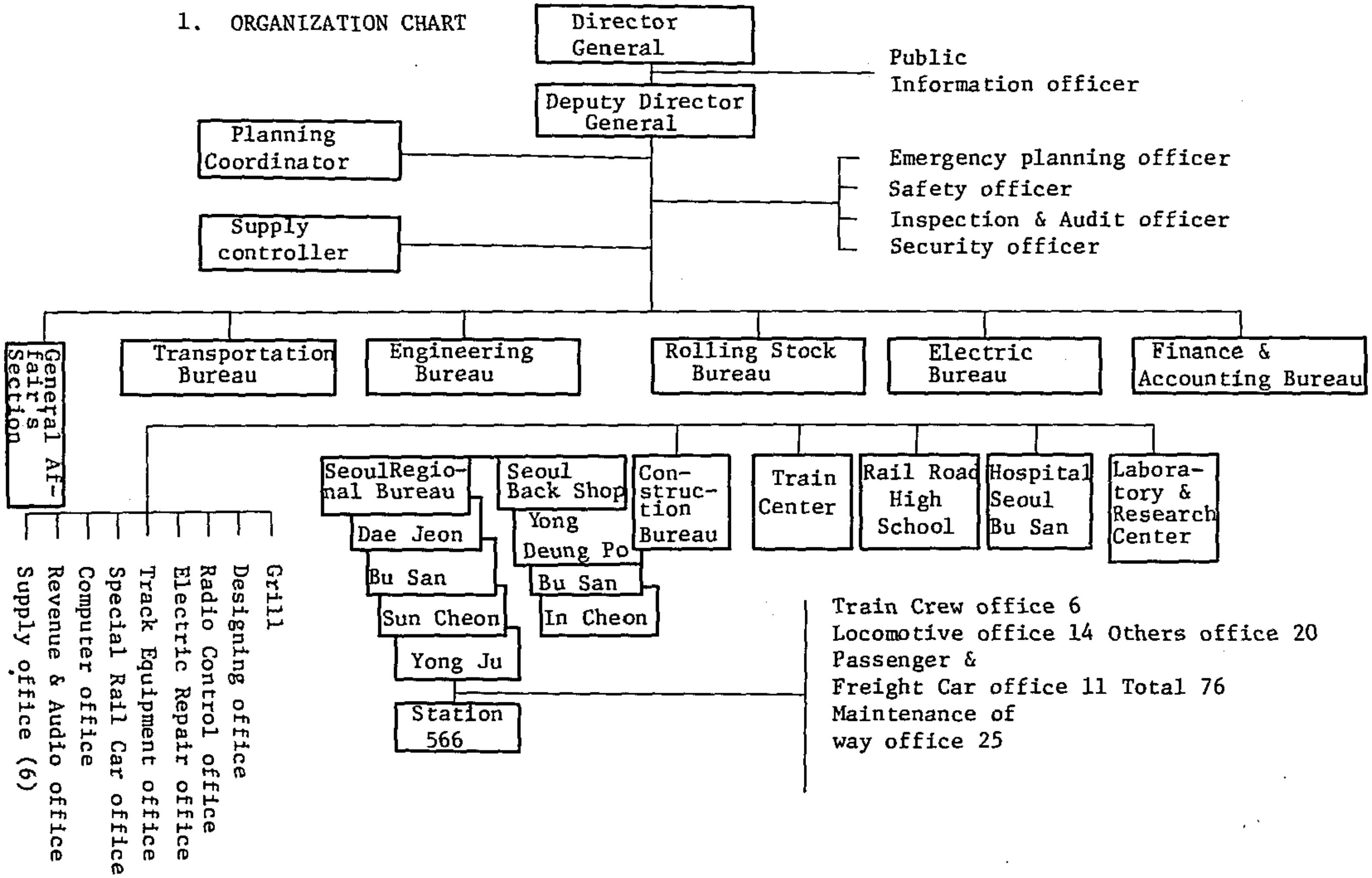
Note: (1) In the parenthesized are those for foreign currency purchase items.

(2) The annual rising rates are assumed at 13% for wage, and 6% for material and other costs.

(3) The costs of foreign currency purchase items are assumed at \$400/t for rail instead of \$350/t, and \$80/m^3 for round log instead of \$65/m^3.

III. PRESENT STATUS OF KOREAN NATIONAL RAILROAD (KNR)

1. ORGANIZATION CHART



2. PERSONNEL STATUS

DISTRIBUTION OF PERSONNEL BY FUNCTION

FUNCTION	YEAR	70	71	72	73	74
MANAGEMENT ST. AFFS	HEAD OFFICE	690	690	500	500	496
	REGIONAL BUREAU	1,808	1,808	1,121	1,018	990
	TOTAL	2,498	2,498	1,621	1,518	1,486
DIRECT STAFFS	TRANSPORTATION	11,293	11,293	12,506	11,549	10,584
	TRAIN OPERATION	4,328	4,328	4,723	4,392	4,654
	FACILITY MAINTENANCE	9,291	9,291	9,450	9,242	9,692
	ROLLING STOCK MAINTENANCE	6,867	6,867	6,544	6,131	6,221
	TOTAL	31,779	31,779	33,223	31,314	31,151
INDIRECT STAFFS	CONSTRUCTION & IMPROVEMENT	509	509	342	312	299
	TECHNICAL RESEARCH	157	157	155	49	49
	HOSPITALS	75	75	67	39	39
	SUPPLY CONTROL	384	384	366	398	398
	TRAINING & EDUCATION	71	71	130	110	128
	GRILL	10	110	10	8	8
	TOTAL	1,206	1,206	1,070	916	921
TOTAL OF OFFICIAL		35,483	35,483	35,914	33,748	33,558
OTHER STAFFS	SHOP TECHNICIANS	3,525	3,525	3,445	2,876	2,911
	HOSPITAL STAFFS	263	263	248	231	231
	GRILL STAFFS	316	316	356	200	200
	EDPS & APTITUDE RESEARCH STAFFS					89
	RAILROAD SECURITIES	1,076	1,076	1,076	1,221	963
	TEMPORARIL EMPLOYEES			4,354	3,692	1,959
	TOTAL	5,180	5,180	9,479	8,220	6,353
GRAND TOTAL		40,663	40,663	45,393	41,968	39,911

3. PASSENGER SERVICE OF MAJOR STATIONS

(PER DAY)

PRIORITY	CLASSIFICATION STATION	DEPARTURE	ARRIVAL	TOTAL	REMARK (LINE)
1	SEOUL	12,897	12,445	25,342	GYEONG-BU
2	CHEONG RYANG RI	4,716	5,984	10,700	GYEONG-WON
3	YEONG DEUNG PO	5,177	4,922	10,099	GYEONG-BU
4	DONG IN CHEON	5,209	3,532	8,741	GYEONG-IN
5	BU SAN	3,265	3,417	6,682	GYEONG-BU
6	I RI	2,892	3,132	6,024	HO-NAM
7	YONG SAN	3,169	2,794	5,963	GYEONG-BU
8	JE MUL PO	3,005	2,908	5,913	GYEONG-IN
9	DAE GU	2,247	2,499	4,746	GYEONG-BU
10	DONG DAE GU	2,466	2,207	4,673	GYEONG-BU
11	BU PYEONG	2,342	2,216	4,558	GYEONG-IN
12	BU CHEON	2,297	2,094	4,391	GYEONG-IN
13	SU WON	2,220	2,019	4,239	GYEONG-BU
14	DAE JEON	2,035	1,983	4,018	GYEONG-BU
15	CHEON AN	1,538	1,749	3,287	GYEONG-BU

4. FREIGHT SERVICE OF MAJOR STATIONS (PER DAY)

UNIT: THOUSAND TON

PRIORITY	CLASSIFICATIONS STATION	DEPARTURE	ARRIVAL	TOTAL	REMARK (LINE)
1	MUG HO HANG	551	3,778	4,329	YEONG-DONG
2	SAN HWA	2,220	604	2,824	BUG-PYEONG
3	CHEOL AM	2,556	124	2,680	YEONG-DONG
4	DO DAM	2,098	536	2,634	JUNG-ANG
5	BU SAN JIN	1,118	1,453	2,571	GYEONG-BU
6	GO HAN	2,292	128	2,420	TAE-BAEK
7	SANG YONG	1,987	417	2,404	TAE-BAEK
8	I MOON	1	2,330	2,331	MANG-U
9	JANG SAENG PO	1,665	375	2,040	DONG HAE NAM-BU
10	HWANG JI	1,582	127	1,709	TAE-BAEK
11	SU SAEG	55	1,451	1,506	GYEONG-EUI
12	BAN YA UEL	33	1,437	1,470	DAE-GU
13	YEONG DEUNG PO	164	1,168	1,332	GYEONG-BU
14	IN CHEON	577	731	1,308	GYEONG-IN
15	JEOG RYANG	999	284	1,283	RYO-CHON

5. TRAIN OPERATION

NUMBER OF TRAIN/DAY

DESCRIPTION		NO. OF TRAINS	TRAIN km	REMARK
PASSENGER	SAE MA EUL (SUPPER EXPRESS)	6	2,667	PASSENGER 224km FREIGHT 149 km
	EXPRESS	52	20,632	
	ORDINARY EXPRESS	30	7,236	
	ORDINARY	350	38,928	
	ELECTRIC CAR	275	8,230	
	MIXED CAR	9	373	
	BAGGAGE	6	2,562	
	TOTAL	728	81,571	
FREIGHT	EXPRESS	8	3,496	PASSENGER 1,092km FREIGHT 1,639km
	ORDINARY	471	53,214	
	MIXED	45	2,731	
	TOTAL	524	58,498	
GRAND TOTAL		1,252	140,069	

(1974) EXCEPTED SPECIAL TRAINS (5%)

6. PRINCIPAL STRUCTURES & EQUIPMENT

DESCRIPTION	NUMBER	QUANTITY	REMARK
TOTAL TRACKAGE		5,663.6km	
STATION	566		
DOUBLE TRACK	10 LINES	744.4km	175.9km (CONSTRUCTION IN PRESS)
ELECTRIC RAILWAY	6 LINES	319.4km	67.5km (CONSTRUCTION IN PRESS)
TUNNEL	406	141.1km	
BRIDGE	2,364	98.1km	
SQUARE PYEONG OF ARCHITECTURE		303,056	
COMMUNICATION LINE (CABLE)		51,562km (766)	
POWER LINE (CABLE)		4,466km (605)	
MACHINERY & EQUIPMENT		3,246	
WOODEN CROSSTIE		7,135,000	
P.C CROSSTIE		1,738,000	

7. ROLLING STOCK

(1) NUMBER OF LOCOMOTIVES BY TYPE

TYPE \ YEAR	70	71	72	73	74
DIESEL LOCOMOTIVE	277	337	336	336	336
STEAM LOCOMOTIVE	109	95	95	93	88
DIESEL CAR	158	157	157	133	126
ELECTRIC LOCOMOTIVE	-	-	30	57	66
HEATER CAR	126	136	141	141	140
ELECTRIC RAILCAR	-	-	-	-	126

(SPECIFICATION OF LOCOMOTIVES)

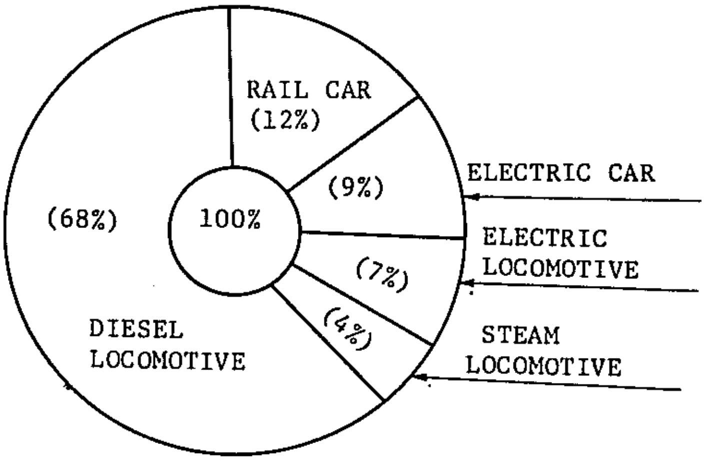
CLASSIFICATION	WEIGHT (t)	PULLING (HP)	CARkm/ DAY (km)	MAXIMUM SPEED (km/H)	SERVICE LIFE (YEARS)
DIESEL LOCOMOTIVE (SERIES 7,500)	126	3,000	370	105	20
ELECTRIC LOCOMOTIVE	132	5,300	480	85	40
ELECTRIC CAR	45	1,300	450	110	20
RAIL CAR	39	360	218	105	20

(2) OPERATION OF MOTIVE POWER BY MODES

UNIT: THOUSAND km

YEAR / CLASSIFICATION	70	71	72	73	74
DIESEL LOCOMOTIVE	40,698	43,123	46,413	46,684	45,784
STEAM COLOMOTIVE	4,659	4,516	3,186	3,295	2,555
RAIL CAR	11,900	12,286	12,091	9,376	8,221
ELECTRIC LOCOMOTIVE				2,336	4,984
ELECTRIC CAR					6,103
TOTAL	57,257	59,925	61,690	61,691	67,647

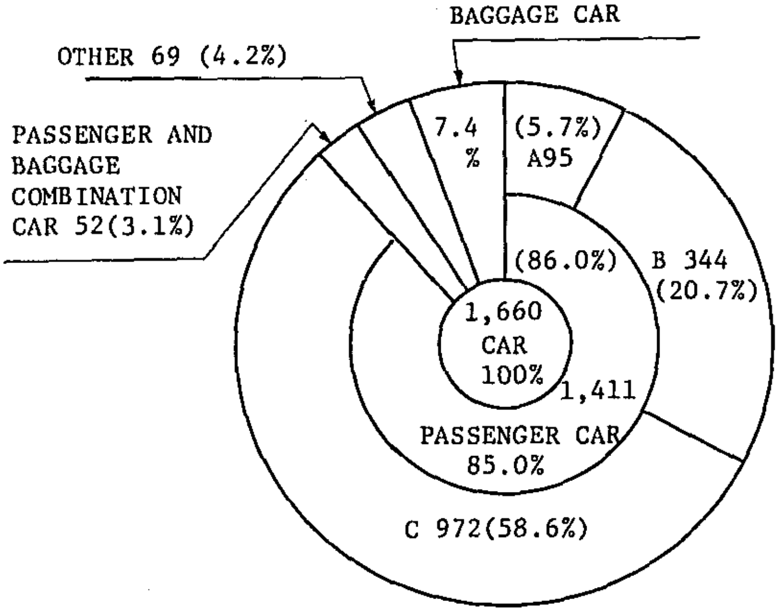
COMPONENT RATIO OF '74



(3) NUMBER OF PASSENGER CARS

UNIT: CAR

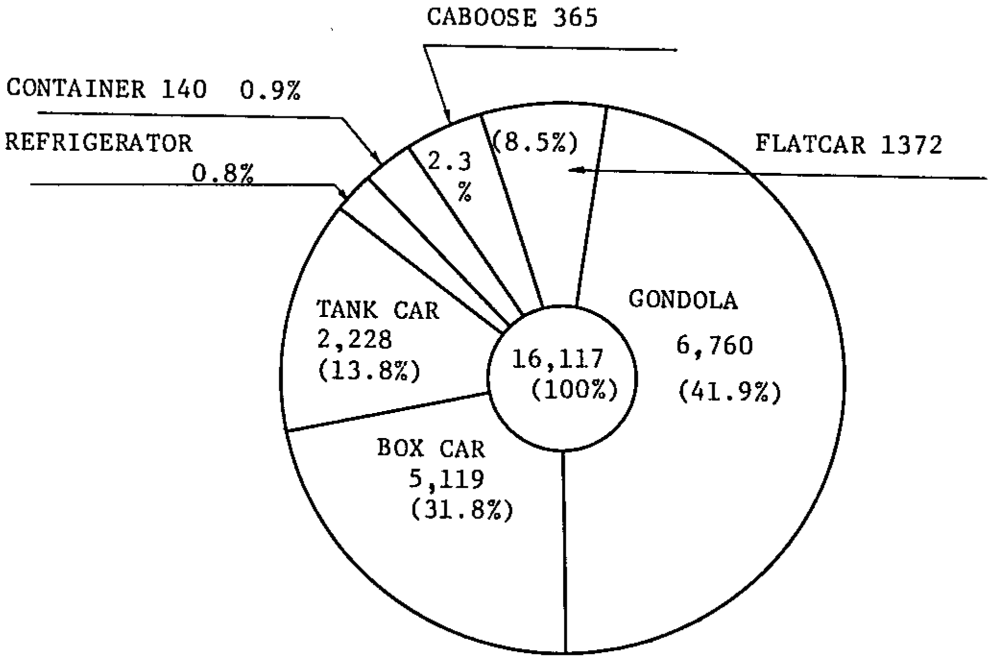
YEAR CLASS		70	71	72	73	74
PASSENGER CAR	A MODE	95	95	95	95	95
	B MODE	214	214	254	279	344
	C MODE	1,117	1,068	1,006	966	972
	TOTAL	1,426	1,377	1,366	1,340	1,411
PASSENGER & BAGGAGE COMBINATION CAR		43	58	58	57	52
BAGGAGE CAR		65	40	40	109	123
GENERATOR CAR		5	5	5	5	5
OTHER		142	141	139	66	69
GRAND TOTAL		1,681	1,621	1,597	1,577	1,660



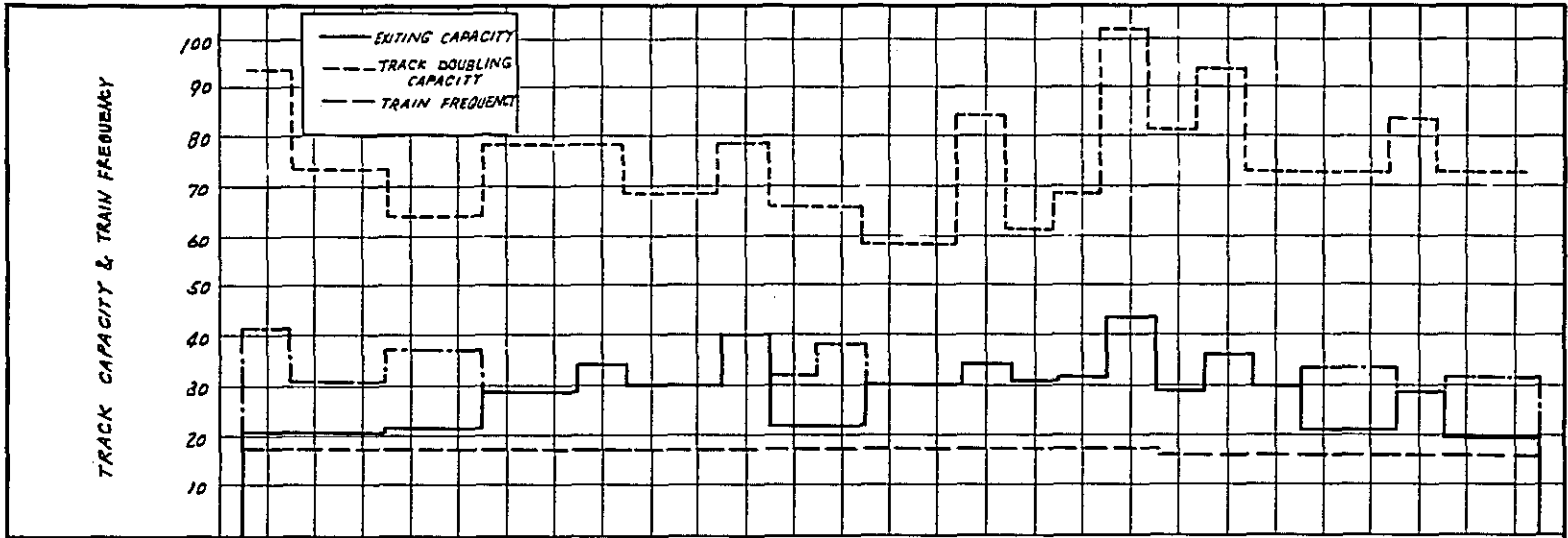
(4) NUMBER OF FREIGHT CARS

UNIT: CAR

YEAR CLASS	70	71	72	73	74
BOX CAR	4,944	5,333	5,507	5,333	5,119
GONDOLA	6,047	5,915	7,003	6,670	6,760
FLAT CAR	780	1,131	1,509	1,440	1,372
TANK CAR	2,107	2,313	2,301	2,253	2,228
REFRIGERATOR CAR	162	156	115	120	133
CABOOSE	367	341	333	353	365
CONTAINER			40	100	140
TOTAL	14,407	15,189	16,808	16,269	16,117



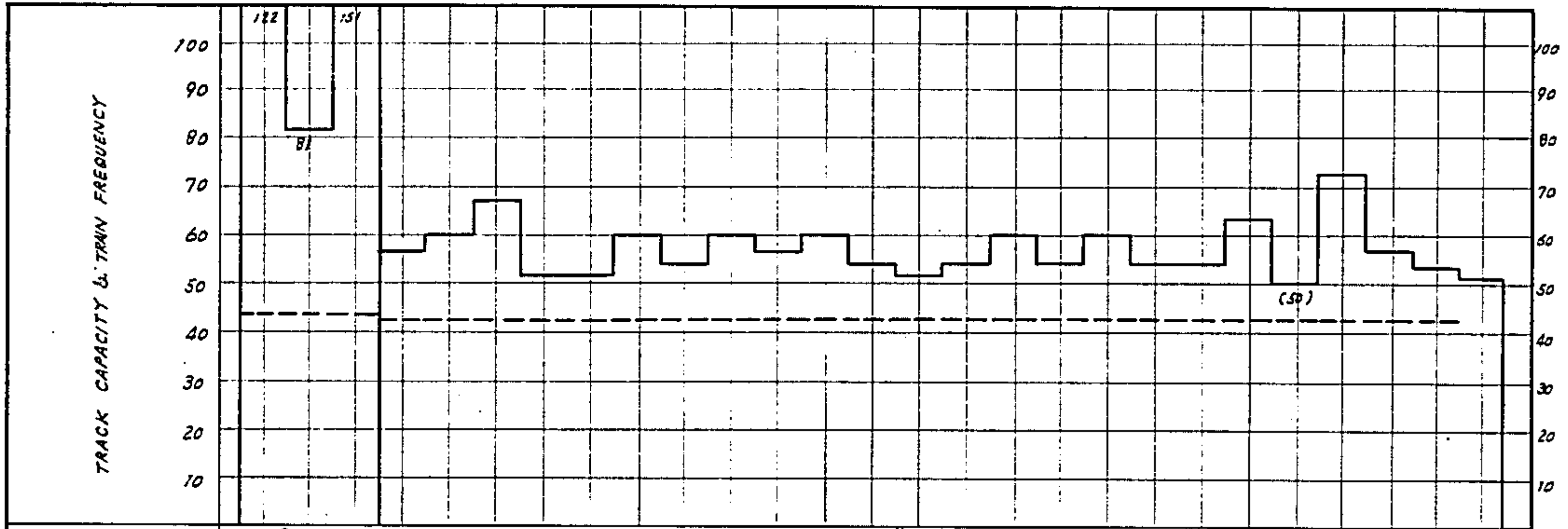
8. TABLE OF RELATIVE LINE BY SECTION (CHUNG BUG LINE)



STATION	DISTANCE Km	EFFECTIVE LENGTH ON MAIN TRACK DOWN	EFFECTIVE LENGTH ON MAIN TRACK UP	EFFECTIVE LENGTH ON SIDE TRACK DOWN	EFFECTIVE LENGTH ON SIDE TRACK UP	TRACTIVE CAPACITY DOWN 5000 TYPE	TRACTIVE CAPACITY UP 5000 TYPE	GRADE (STANDARD, UP) UP TRAIN	GRADE (STANDARD, UP) DOWN TRAIN	BLOCKING SYSTEM
JO CHI WEON		51	45	45	46					
	4.5					32.5	32.5	3	2	TABLET BLOCK SYSTEM
O SONG										
	3.2							4	5	
MI HO										
	3.7							8	11	
JEONG BONG		43	43		16					
	5.0							—	5	
SEO CHEONG JU										
	5.9							16	14	
CHEONG JU		57	57	24	67					
	2.6							5	3	
JEONG HA										
	3.8							3		
O GEUN JANG		41	42		8					
	7.4							1		
NA SU		48	45	40	8					
	3.4							—	5	
GEUM AM										
	4.8							17	14	
JEUNG PYEONG		39	40	35	16					
	5.2							—	6	
DO AN		51	51	15						
	5.3							10	17	
MUN AM										
	3.9									
BO CHEON		41	41	13						
	4.0							13	16	
SANG DANG										
	3.6							11	7	
EUM JEONG		47	43	17						
	6.5							13	5	
SO I		52	47	9	35					
	7.7								11	
JU DEOG		43	43	14						
	7.2							11	7	
DAL CHEOG		41	41	14	20					
	4.0							2	5	
CHUNG JU		41	41	23	23					
	6.1					27	27	9	6	
MOG HAENG		32	53	27	27					
	4.4							—	19	
DONG RYANG		39	39		10					
	3.4								20	
SAN CHEOG		44	45		9					
	3.4							20		
SAN SEUNG										
	3.4									
SAM TAN		42	42	13	11					
	5.9							—	15	
GONG JEON		49	48	9	23					
	4.3							19	20	
WEON BAG										
	4.3									
BONG YANG		81	57	56	40					

8.

(JUNG ANG LINE 1)



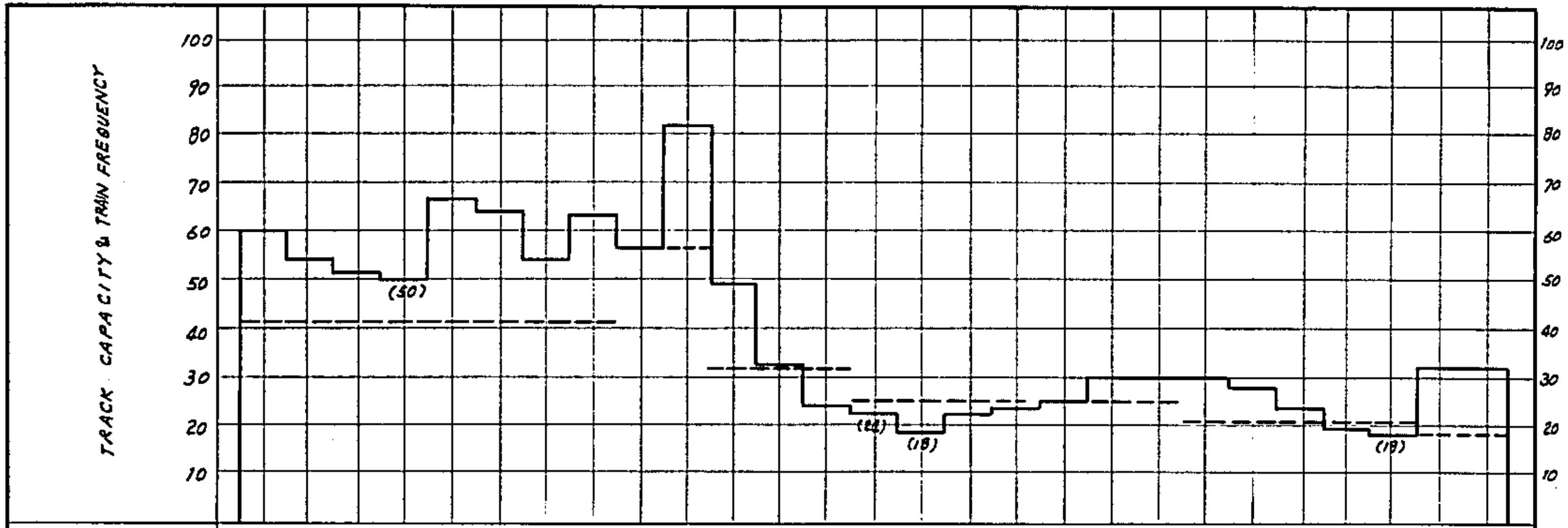
STATION		YONG SAN	SEO BING GO	WANG SIB RI	CHEONG RYANG RI	MANG U	DONG GYO	DO NONG	DEOG SO	PAL DANG	NEUNG NAE	YANG SU	SIN WEON	GUG SU	A SIN	YANG PYEONG	WEON DEOG	YONG MUN	JI PYEONG	SEOG BUL	GU DUN	MAE GOG	YANG DONG	PAN DAE	GAN HYEON	DONG HWA	MAN JONG	WEON JU	YU GYO
DISTANCE Km			3.6	6.8	2.2 ◎	4.6	3.9	3.2	6.1	6.5	5.0	5.4	4.6	3.8	4.1	5.3	6.1	5.7	3.5	4.2	4.1	4.3	4.4	3.8	7.2	3.2	4.7	4.9(09.4)	5.9
EFFECTIVE LENGTH ON MAIN TRACK	DOWN		46	49		65	72	55	54	56	57	55	52	58	60	57	52	53	58	67	50	56	58	61	56	55	53	53	74
	UP		41	45		54	72	65	54	56	57	55	52	58	60	58	52	53	57	67	50	56	55	61	58	55	53	56	74
EFFECTIVE LENGTH ON SIDE TRACK	DOWN		46	50		41			18	32	57		52		58	47	55	40	27	67	58	57	36	63	33	57	53	36	
	UP		36	40		26		19		32	57	30	52	26	58	43	55	40	40	67	56	57	32	63		54	53	36	
TRACTIVE CAPACITY DOWN	EL TYPE 8000				40																								
TRACTIVE CAPACITY UP	EL TYPE 8000				40																								
BLOCKING SYSTEM		DOUBLE TRACK AUTOMATIC SYSTEM			CTC SYSTEM																								

GRADE (STANDARD, UP)

UP TRAIN	5 3	6	11	9	7	6	9	6	5	9	8	12	1		10	13	8	13	10	
DOWN TRAIN	5 2	6	12	10	9	8	7	6	12	6	10	10	11	12		5		11	12	

8.

(JUNG ANG LINE 2)



STATION	DISTANCE Km	EFFECTIVE LENGTH ON MAIN TRACK DOWN	EFFECTIVE LENGTH ON MAIN TRACK UP	EFFECTIVE LENGTH ON SIDE TRACK DOWN	EFFECTIVE LENGTH ON SIDE TRACK UP
YU GYO		74	74		
	3.4				
BAN GOG		59	59	21	
	4.1				
GEUM GYO		74	74		
	5.8				
CHI AG		58	58		
	5.2				
CHANG GYO		75	75		
	3.2				
SIN RIM		65	65	31	
	3.5				
YEON GYO		68	68		
	4.6				
GU HAG		64	64	16	
	4.0				
BONG YANG		81	57	56	48
	5.0				
SWITCHING YARD		107	70	75	53
	2.1 (USS.2)				
JE CHEON		56	59		
	3.5				
GO MYEONG		59	59		59
	6.0				
SAM GOG		46	46	46	69
	7.8				
DO DAM		67	67		
	10.2				
DAN YANG		71	71	31	19
	9.0				
JUG RYEONG		59	59		20
	7.9				
HI BANG SA		49	47	9	
	6.1				
PUNG GI		45	46	35	18
	6.2				
AN JEONG		42	42	12	18
	6.0				
BUG YEONG JU					
	1.3				
YEONG JU					
	6.7 (219.2)				
MUN SU (SEUM HUN)		39	39	18	
	6.8				
PYEON WEON		43	40	13	
	6.8				
ONG CHEON (CHA SA)		39	39		15
	9.6				
I HA		39	41	19	
	8.8				
AN DONG		59	49	38	42
	7.3				
MU REUNG		50	47	25	25
	6.8				
UN SAN		40	40	11	

TRACTIVE CAPACITY

DOWN	EL 8000 TYPE	40	7500 TYPE 40	7500 TYPE 40
UP	EL 8000 TYPE	40	7500 TYPE 40	7500 TYPE 40

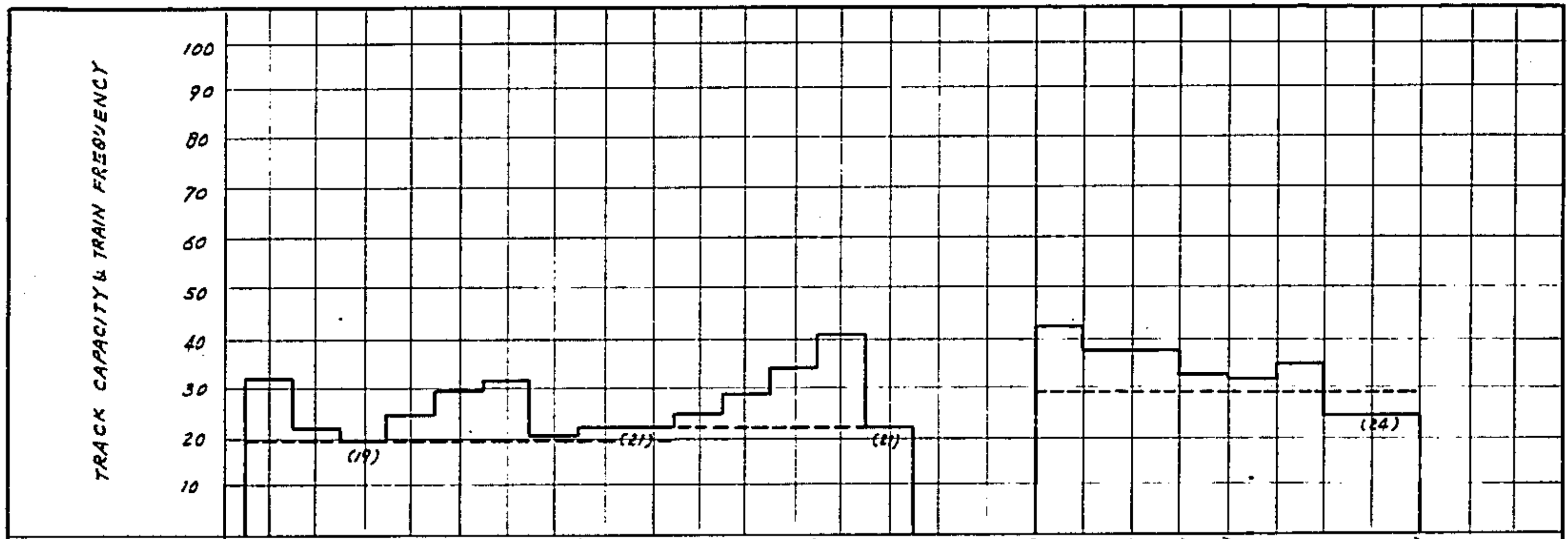
GRADE (STANDARD, UP)

UP TRAIN	–	13	12	11	–	–	13	10	11	–	18	25	12	11	8	7	9	11	13	11	4
DOWN TRAIN	12	18	11	–	3	6	7	7	–	11	24	–	–	4	11	12	11	–	5	12	

BLOCKING SYSTEM	CTC SYSTEM	TOKANLESS BLOCK SYSTEM (DOUBLE TRACK)	TABLET BLOCK SYSTEM

8.

(JUNG ANG LINE 3, DAE GU LINE)



STATION	DISTANCE Km	EFFECTIVE LENGTH ON MAIN TRACK DOWN	EFFECTIVE LENGTH ON MAIN TRACK UP	EFFECTIVE LENGTH ON SIDE TRACK DOWN	EFFECTIVE LENGTH ON SIDE TRACK UP
UN SAN		40	40	11	
DAN CHON	5.5	89	39		23
EUI SEONG (BI BONG)	8.9	40	40		
TAB RI	11.7	40	40		15
U BO	8.7	38	38	24	
HWA BON	7.9	48	48	20	
BONG RIM	5.4	38	38		29
SIN RYEONG	9.8	38	38	21	
HWA SAN (HO DANG)	6.4	38	38	21	
YEONG CHEON (DONG PO)	10.6	50	48		
IM PO	9.2	63	63		24
A HWA	5.9	39	39		
GEON CHEON	5.9	58	57		51
MO RYANG (UE DONG)	3.9	39	39	8	
GYONG JU	12.6	39	33		24
	(382.7)				
DONG DAE GU					
DONG CHON	3.1	60	60	60	28
SIN PYEONG	2.5				
BAN YA WEOL	2.9	63	63	63	63
CHEONG CHEON	5.5	59	56	50	12
HA YANG	6.0	64	56	17	49
GEUM HO	4.9	59	59		28
BONG JEONG	4.4				
YEONG CHEON	5.6				
	(34.9)				

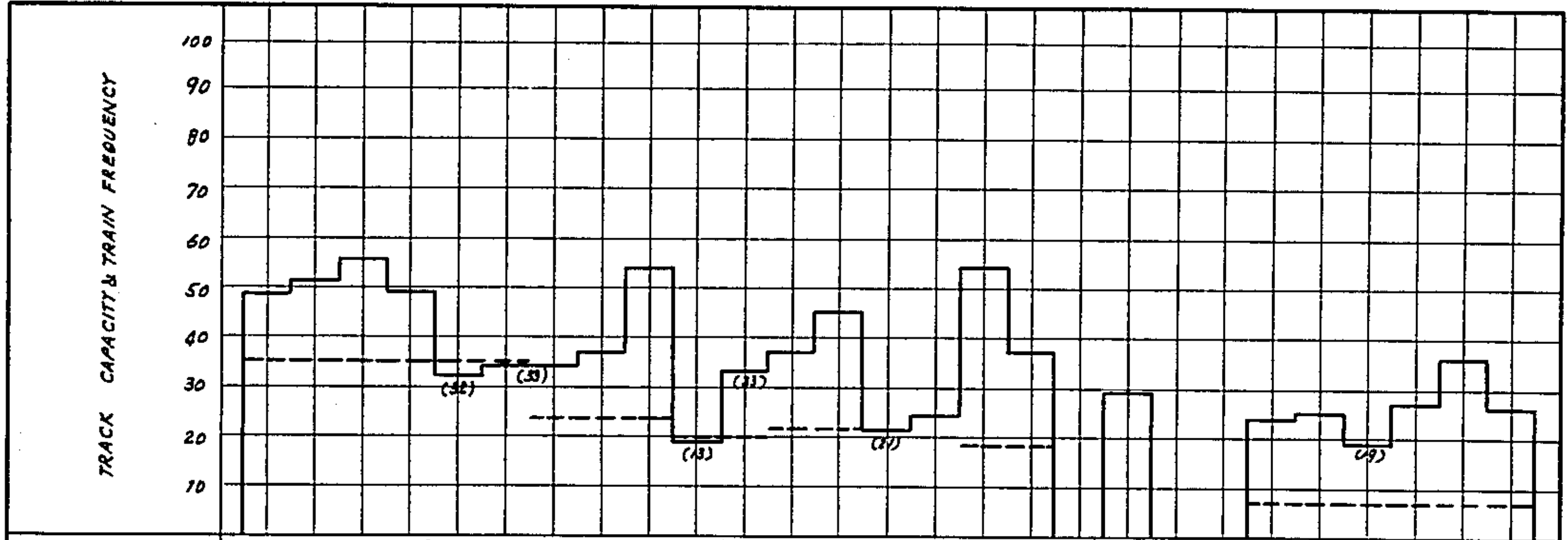
TRACTIVE CAPACITY		UN SAN – GYONG JU	DONG DAE GU – YEONG CHEON
DOWN	7500TYPE	40	3000 TYPE 25
UP	7500 TYPE	40	3000 TYPE 25

GRADE (STANDARD, UP)															
UP TRAIN	7	13	11	8	—		13	8	5	7	13	12	8	13	9
DOWN TRAIN	11			13	10	11	12	5	6	4	13	—			8

GRADE (STANDARD, UP)								
UP TRAIN	6	—	-	5	–	—		—
DOWN TRAIN	—	2	13	6	5	4	5	5

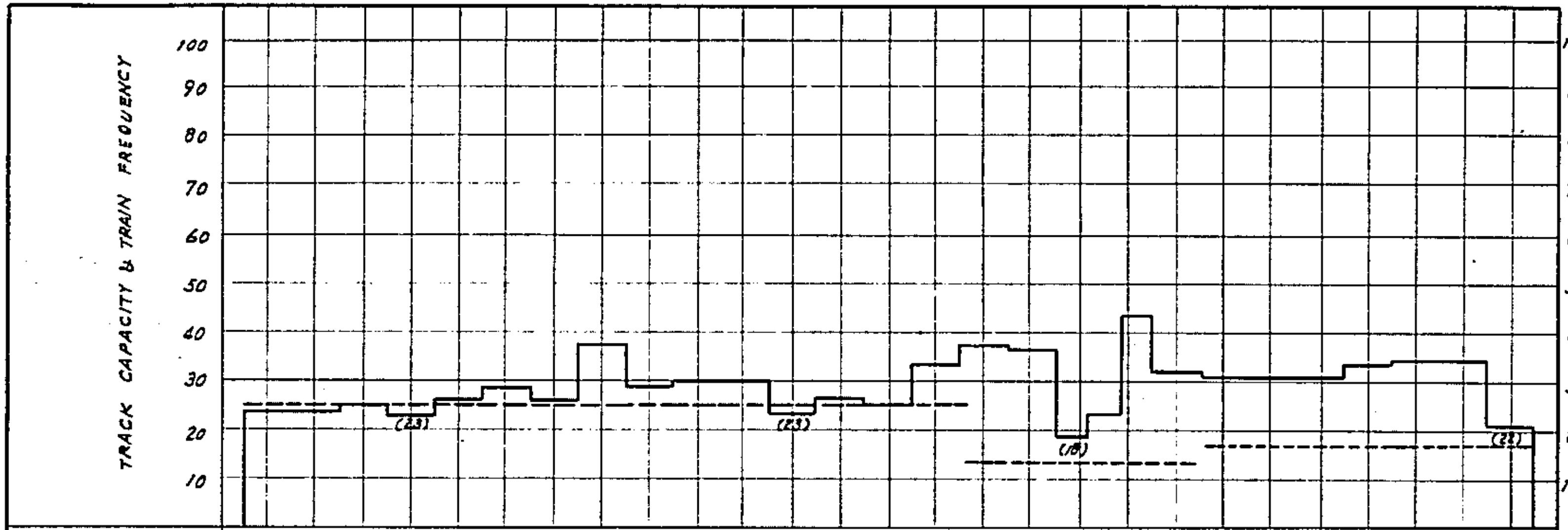
BLOCKING SYSTEM: TABLET BLOCK SYSTEM (UN SAN – GYONG JU); TABLET BLOCK SYSTEM (DONG DAE GU – YEONG CHEON)

8. (TAE BAEG LINE, HAM BAEG LINE, JEONG SEON LINE)



STATION	DISTANCE Km	EFFECTIVE LENGTH ON MAIN TRACK DOWN	EFFECTIVE LENGTH ON MAIN TRACK UP	EFFECTIVE LENGTH ON SIDE TRACK DOWN	EFFECTIVE LENGTH ON SIDE TRACK UP	TRACTIVE CAPACITY DOWN EL 8000	TRACTIVE CAPACITY UP EL 8000	GRADE (STANDARD, UP) UP TRAIN	GRADE (STANDARD, UP) DOWN TRAIN	BLOCKING SYSTEM
JE CHEON										
	5.0					40	40	4	10	TOKENLESS BLOCK SYSTEM)
JANG RAG		43	43	43						
	4.8							15	14	
SONG HAG		51	51							
	3.3							15	16	
IBSEOG RI		49	49	43						
	4.6							12	18	
SSANG YONG		58	58							
	7.6							19	17	
YEON DANG		45	45							
	9.1							—		
YEON WEOL		45	45							
	7.6					31	31	—	24	
YEON HA		45	45							
	6.7								22	
SEOG HANG		50	50							
	3.1							3	20	
YE MI										
	10.9					20	20	—	30	
JAMI WEON		46	46							
	6.7					20	20	24	—	
JEUNG SAN										
	6.1							–	26	
SA BUG		46	46							
	4.6							–	28	
GO HAN		52	52	49	49					
	9.0					20	20	17	30	TABLET BLOCK SYSTEM
CHU JEON		55	55							
	6.0							30	—	
HWANG JI										
	3.0							29		
MUN GOG		20	30	30	30					
	5.0							30	25	
BAEG SAN	(103.7)									
YE MI										
	5.2					7500 TYPE 24 •	7500 TYPE 24 •	–	28	TABLET BLOCK SYSTEM
HAM BAEG										
JEUNG SAN										
	6.3					7500 TYPE 21	7500 TYPE 21	22	23	TABLET BLOCK SYSTEM
BYEOLEO GOG		43	43	43	43					
	7.0							18	–	
SEON PYEONG		43	43	43	43					
	9.0							25	30	
JEONG SEON		42	39	42	39					
	10.0							2	15	
RA JEON		34	34	30	30					
	6.3							10	—	
YEO RYANG		40	40	40	40					
	7.3									
GU JEOL RI	(38.	48	47							

8. (YEONG DONG LINE)

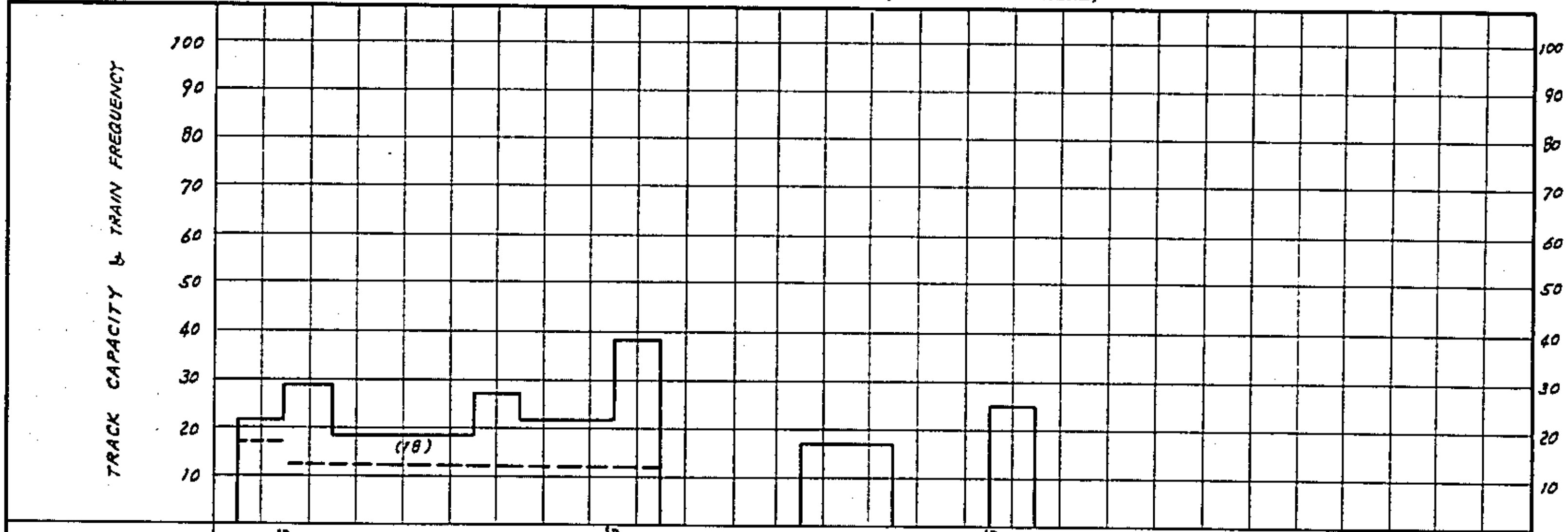


STATION	DISTANCE Km	EFFECTIVE LENGTH ON MAIN TRACK DOWN	EFFECTIVE LENGTH ON MAIN TRACK UP	EFEECTIVE LENGTH ON SIDE TRACK DOWN	EFEECTIVE LENGTH ON SIDE TRACK UP	TRACTIVE CAPACITY DOWN 7500 TYPE	TRACTIVE CAPACITY UP 7500 TYPE
YEONG JU						31	31
	0.8						
BUG YEONG JU							
	8.2						
MUN DAN		46	46	46	46		
	5.7						
BONG HWA		39	31	21	27		
	5.4						
GEO CHON		39	39	23			
	5.5						
BONG SEONG		38	35		15		
	6.5						
BEOB JEON		44	44	27			
	6.7						
CHUN YANG		32	37	18	26		
	4.9						
NOG DONG		38	38	38	38		
	4.8						
IM GI		39	37				
	5.1						
HYEON DONG		45	45	39	26		
	6.6						
BUN CHEON		36	35	15	12		
	9.9						
SEUNG BU		41	37	16			
	7.7						
SEOB PO		41	39		27		
	6.1						
DONG JEOM		44	44	22	22		
	4.1						
CHEOL AM		31	13		13	15.5	15.5
	4.3						
BAEG SAN							
	4.4						
TONG RI		32	38	24	24		
	7.1						
SIM PO RI		43	43				
	4.3						
HEUNG JEON		32	38				
	1.6						
NAHAN JEONG		15	16				
	3.3						
DO GYE		40	38	10	25	40	40
	4.7						
GO SA RI		36	36				
	1.6						
GO SA RI							
	3.5						
MA CHA RI		46	46	34	23		
	5.4						
SIN KI		35	35	30			
	5.2						
SANG JEONG		30	30	6			
	5.1						
MI RO							
	3.3						
DI GYEONG RI		34	34		22		

GRADE (STANDARD, UP) UP TRAIN	–	14	4	5	–	15	16	4	6	4	—	30	23	16	13	14	12	22	5
GRADE (STANDARD, UP) DOWN TRAIN	–	20	5	21	24	9	20	15	14	20	22	12	23	15	17	—	4	8	

BLOCKING SYSTEM: TABLET BLOCK SYSTEM

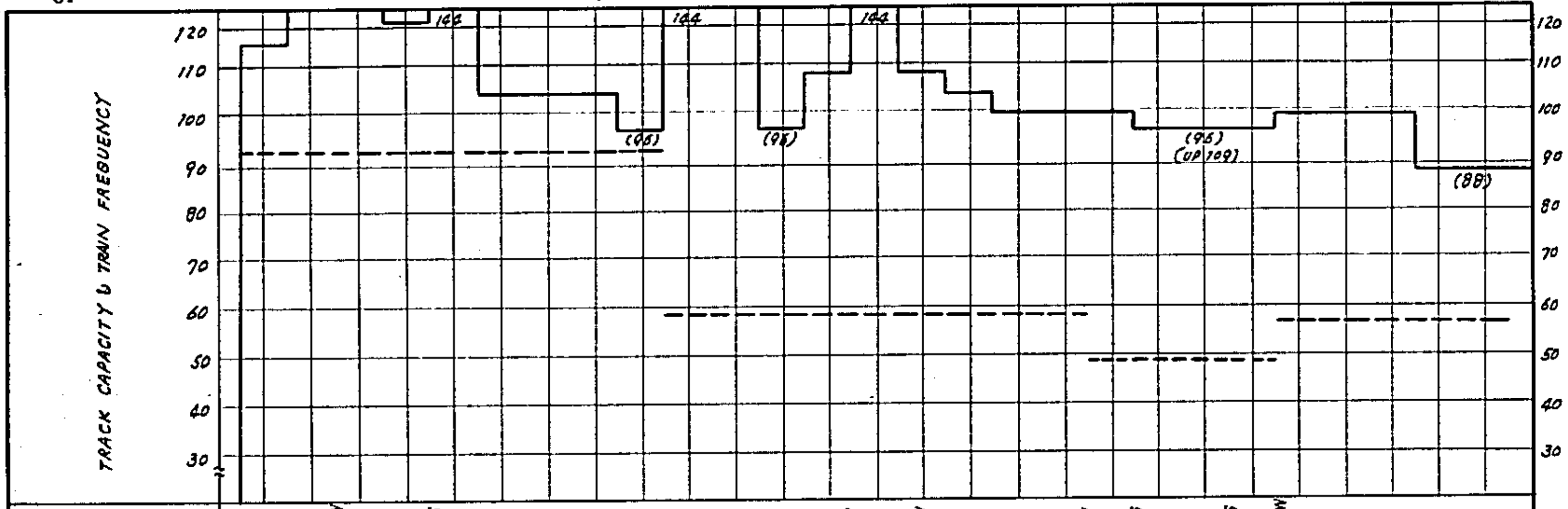
8. (YEONG DONG LINE, SAM CHEOG LINE, BUG PYEONG LINE)



STATION		PO GYEONG RI		BUG PYEONG		MUG HO		MANG SANG		OG GYE		JEONG DONG JIN		AN IN		SI DONG		GANG NEUNG		GYEONG PO DAE		BUG PYEONG		HU JIN		SAN CHEOG		BUG PYEONG		SAM HWA
DISTANCE Km			7.5		5.9		6.1		5.5		11.4		7.2		2.7		6.4		5.7		(199.7)		7.8		5.1		(12.9)		6.5	
EFFECTIVE LENGTH ON MAIN TRACK	DOWN	34				37				45		25		43				51		26						39				35
	UP	34				37				45		25		43				51		26						39				35
EFFECTIVE LENGTH ON SIDE TRACK	DOWN	22				37				45		25		43				38		26										37
	UP					37				45		25		43				26		26										37
TRACTIVE CAPACITY	DOWN 7500 TYPE		40		3000 TYPE 25																		3000 TYPE 25						3000 TYPE 20	
	UP 7500 TYPE		40		3000 TYPE 25																		3000 TYPE 25						3000 TYPE 20	
GRADE (STANDARD, UP)	UP TRAIN		25		10		12		2		13		5		4		11		6				6		7				—	
	DOWN TRAIN		7		10		12		7		14		5				14		3				6		10				20	
BLOCKING SYSTEM			TABLET BLOCK SYSTEM																				TABLET BLOCK SYSTEM						TABLET BLOCK SYSTEM	

8.

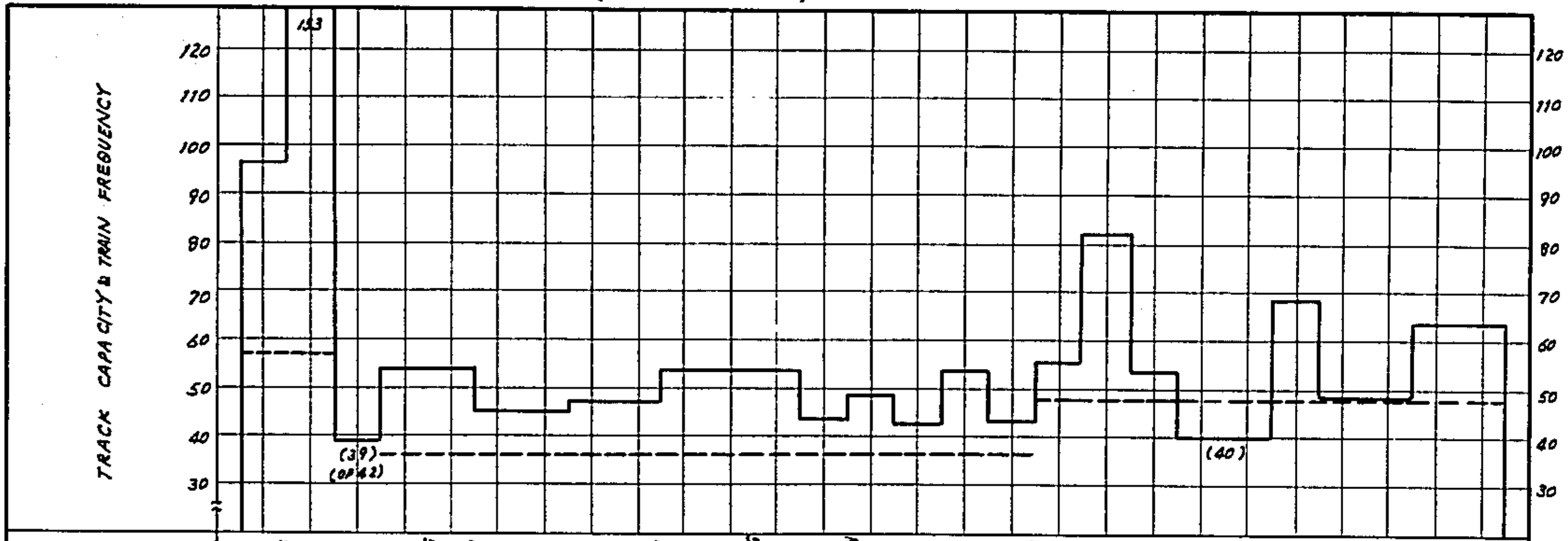
(GYEONG BU LINE 1)



STATION	DISTANCE Km	EFFECTIVE LENGTH ON MAIN TRACK DOWN	EFFECTIVE LENGTH ON MAIN TRACK UP	EFFECTIVE LENGTH ON SIDE TRACK DOWN	EFFECTIVE LENGTH ON SIDE TRACK UP	NOMINAL TRACTIVE CAPACITY DOWN 6000 TYPE	NOMINAL TRACTIVE CAPACITY UP 6000 TYPE	GRADE (STANDARD, UP) UP TRAIN	GRADE (STANDARD, UP) DOWN TRAIN	BLOCKING SYSTEM
SEOUL		68	39	35	35	52	52			
	3.2							9	—	
YONG SAN		61	59	45	42					
	2.7							1	5	
NO RYANG JIN			30	39	30					
	3.3							3	2	
YEONG DEUNG PO		62	55	62	62					
	4.9								3	
GA RI BONG										
	3.2									
SI HEUNG		103	103	83	34					
	6.6								10	
AN YANG		47	49	47	49					
	5.9							1	8	
GUN PO		47	46	47	46					
	3.7							10		
BU GOG		75	58	75	57					
	3.0 (41.5)									
SU WEON		55	48	47	48					
	2.9							6	– –	
SE RYU		51	32							
	4.3							3		
BYEONG JEOM		49	49	49	49					
	8.2							8	10	AUTOMATIC BLOCK SYSTEM (DOUBLE TRACK)
O SAN		63	66	61	66					
	7.8							1		
SONG TAN										
	2.3							7	—	
SEO JEONG RI		46	46	47	47					
	8.4							9	6	
PYEONG TAEG		49	49	49	49					
	9.4							– –	3	
SEONG HWAN		47	47	47	47					
	5.4								4	
JIG SAN		66	64	66	64					
	6.9 (97.1)							9	10	
CHEON AN		63	59	55	53					
	10.8							8		
SO JEONG RI		45	45	45	45					
	7.6							10	8	
JEON EUI		48	48	48	48					
	7.7							7	—	
JEON DONG										
	6.7 (122.9)							8	1	
JO CHI WEON		51	45	45	46					
	5.6							1	4	
HAE PAN										
	4.9							8	8	
BU GANG		50	50	50	50					
	4.6							10	9	
MAE PO										
	7.5							9	10	
SIN TAN JIN		48	49	48	49					
	5.6							10		
HOE DEOG		45	45	43	45					

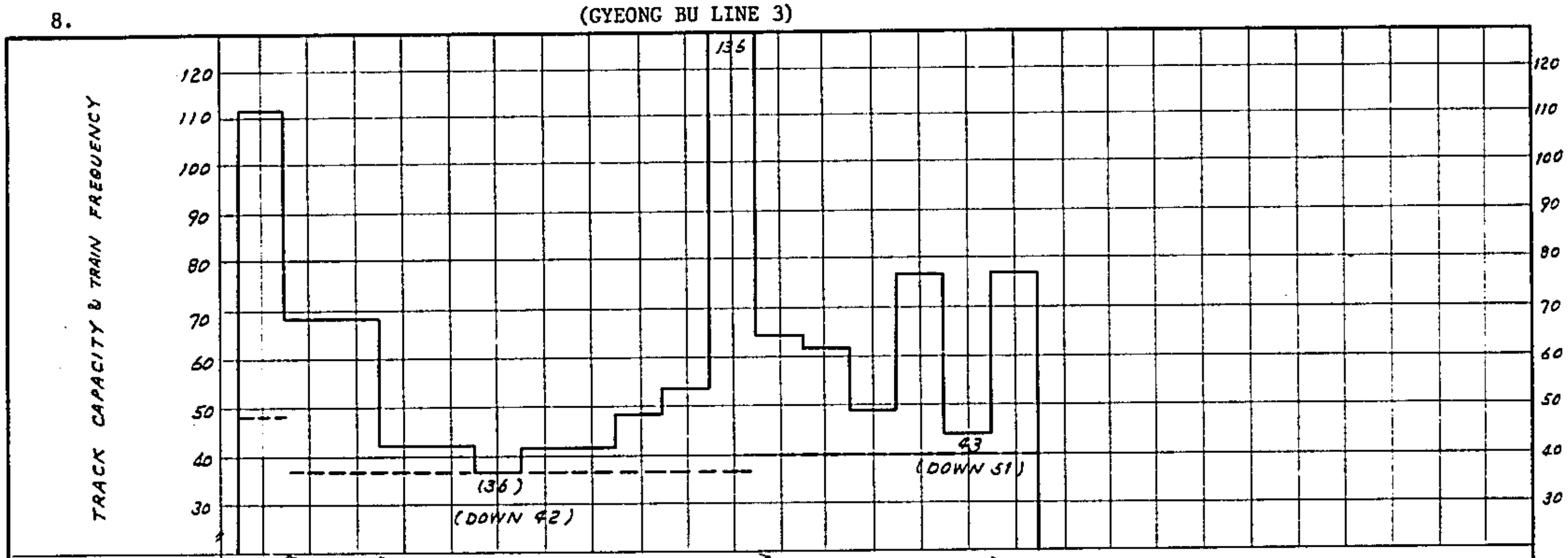
⊗ REMARKS : 1) TRACK CAPACITY —— LOWER CAPACITY OUT OF UP AND DOWN TRACK USED.
2) TRAFFIC FREQUENCY —— BASED ON ONE WAY IN 1975.6.
3) EFFECTIVE TRAIN LENGTH —— BASSED ON 11 m PER UNIT.
4) NOMINAL TRACTIVE CAPACITY —— BASED ON 43.5 TONS PER TRAIN.

8. (GYEONG BU LINE 2)



STATION	DISTANCE Km	EFFECTIVE LENGTH ON MAIN TRACK DOWN	EFFECTIVE LENGTH ON MAIN TRACK UP	EFFECTIVE LENGTH ON SIDE TRACK DOWN	EFFECTIVE LENGTH ON SIDE TRACK UP	TRACTIVE CAPACITY DOWN 6000 TYPE	TRACTIVE CAPACITY UP 6000 TYPE	GRADE (STANDARD, UP) UP TRAIN	GRADE (STANDARD, UP) DOWN TRAIN	BLOCKING SYSTEM
HOE DEOG		69	44	59	59					
	6.1					52	52	9	9	AUTOMATIC SYSTEM (DOUBLE TRACK)
O JEONG		56	43	55	38					
	2.7(166.9)							4	4	
DAE JEON										
	7.4							–	1	
SE CHEON		44	45	44	44					
	4.1							10	8	
JEUNG YAG										
	5.0								6	
OG CHEON		44	44	43	43					
	3.9									
GA PUNG										
	4.4								10	
I WEON		48	47	47	47					
	5.6								5	
JI TAN										
	4.4							9	10	
SIM CHEON		50	50	52	50					
	8.7							–	2	
GAG GYE										
	7.1							3	8	
YEONG DONG		50	50	52	50					
	5.5							10	10	
MI REUG										
	9.1							–		
HWANG GAN		52	52	53	53					
	8.4									
CHU PUNG RYEONG		48	49	49	49					
	6.0							10	–	
SIN AM										
	5.5									
JIG JI SA		43	44	44	44					
	7.6								3	
GIM CHEON		66	64	63	63					
	9.7							6	10	TOKENLESS BLOCK SYSTEM (DOUBLE TRACK)
DAE SIN		47	48	47	48					
	6.7							4		
A PO		44	44	45	45					
	7.5							10	–	
GU MI		45	51	45	50					
	4.6							3	6	
SA GOG										
	4.2							8	9	
YAG MOG		49	40	49	40					
	6.5								1	
WAE GWAN		59	54	52	54					
	6.2							9	9	
YEON HWA										
	3.7									
SIN DONG		51	51	51	51					
	7.4								–	
JI CHEON		46	46	47	46					
	9.8 (3/4.1)							2	7	
DAE GU		66	53	50	47					

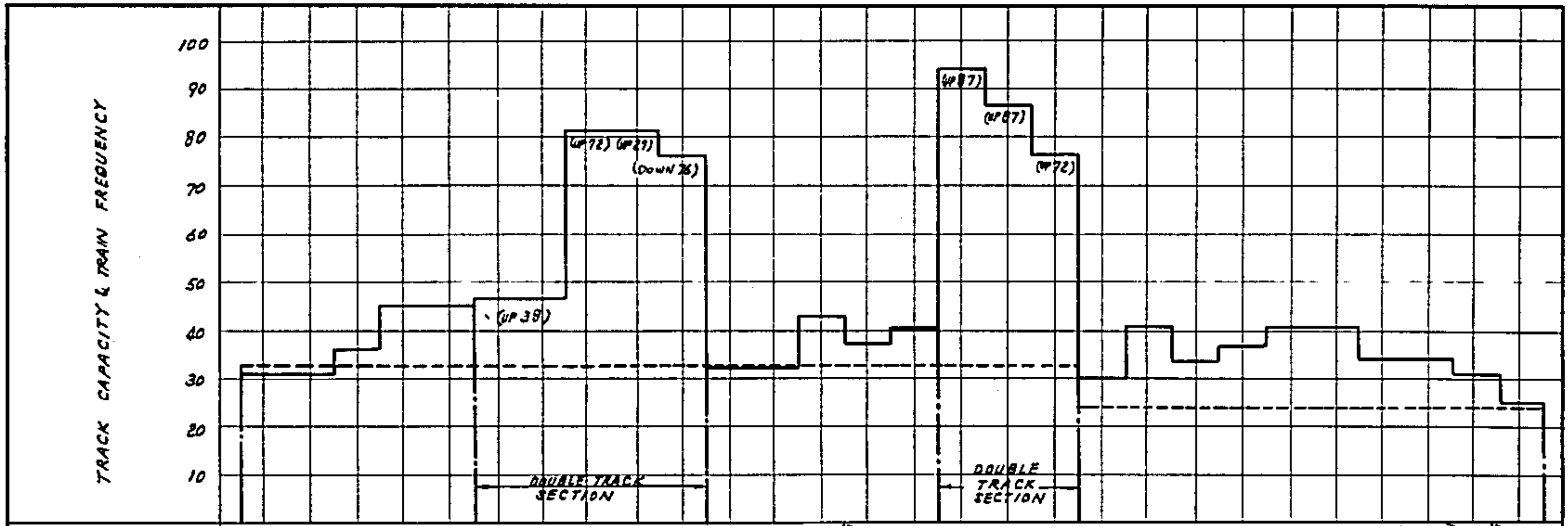
8. (GYEONG BU LINE 3)



			DAE GU	DONG DAE GU	GO MO	GYEONG SAN	SAM SEONG	NAM SEONG HYEON	CHEONG DO	SIN GEO	YU CHEON	MIL YANG	MI JEON	SAM RANG JIN	WEON DONG	MUL GEUM	GU PO	SA SANG	BU SAN JIN	BU SAN
STATION			DAE GU	DONG DAE GU	GO MO	GYEONG SAN	SAM SEONG	NAM SEONG HYEON	CHEONG DO	SIN GEO	YU CHEON	MIL YANG	MI JEON	SAM RANG JIN	WEON DONG	MUL GEUM	GU PO	SA SANG	BU SAN JIN	BU SAN
DISTANCE Km			3.2	5.6	6.8	7.1	7.6	8.7	5.6	6.1	9.4	11.1	1.5	9.2	9.2	13.0	5.1	9.6	1.8 (444.5)	
EFFECTIVE LENGTH ON MAIN TRACK	DOWN			75	44	50	48	43	45		45	45		57	57	48	44	46	41	67
	UP			75	44	51	47	45	46		45	46		60	43	47	46	45	44	45
EFFECTIVE LENGTH ON SIDE TRACK	DOWN			76	44	44	48	43	46		45	45		42	51	48	42		45	54
	UP			79	44	50	47	45	44		45	45		54	38	47	46	45	41	54
TRACTIVE CAPACITY	DOWN	6000 TYPE	52																	
	UP	6000 TYPE	52																	
GRADE (STANDARD, UP)	UP TRAIN		9		4		5	10			8	7	2	5	7	3	1	10	3	
	DOWN TRAIN		9		10	9	10		2		5	9		5	6	4	8	9	3	
BLOCKING SYSTEM			TOKENLESS BLOCK SYSTEM (DOUBLE TRACK)																	

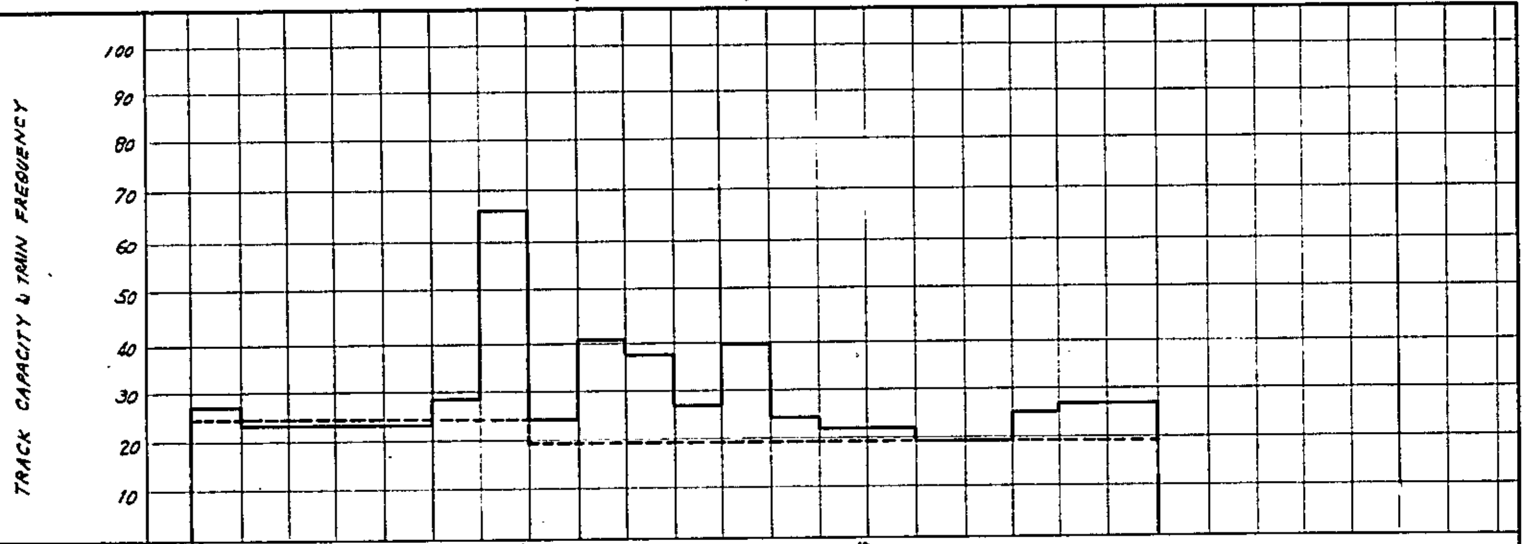
8.

(HO NAM LINE 1)



STATION	DISTANCE Km	EFFECTIVE LENGTH ON MAIN TRACK DOWN	EFFECTIVE LENGTH ON MAIN TRACK UP	EFFECTIVE LENGTH ON SIDE TRACK DOWN	EFFECTIVE LENGTH ON SIDE TRACK UP	TRACTIVE CAPACITY DOWN 3000 TYPE	TRACTIVE CAPACITY UP 3000 TYPE	GRADE (STANDARD, UP) UP TRAIN	GRADE (STANDARD, UP) DOWN TRAIN	BLOCKING SYSTEM
DAE JEON										
	5.7					25.0	25.0	2	6	TABLE BLOCK SYSTEM
SEO DAE JEON		48	48	8	21					
	6.3							13	12	
GA SU WEON		44	44		6					
	4.8							3	9	
HEUG SEOG RI		46	46		7					
	4.7							9	13	
WEON JEONG		77	77		21					
	4.2								12	
DU GYE		54	54	53	53					
	2.7									COMPOSITE SYSTEM (DOUBLE TRACK)
SIN DO										
	6.7									
GAE TAE SA		54	54	54	54					
	5.0									
YEON SAN		45	51	45	45					
	5.2									
BU HWANG		57	57	25	57					
	6.4									
NON SAN		34	40	34	34					
	5.1							4	4	TABLE BLOCK SYSTEM
CHAE HWA										
	1.7									
CHAE UN		54	55	26	26					
	3.2							3	4	
GANG GYEONG		46	50	39	39					
	6.0								3	
YONG AN		54	54	13	54					
	5.2							3	5	
HAM YEOL		56	56	56	56					
	3.8							3	3	COMPOSITE SYSTEM (DOUBLE TRACK)
DA SAN		54	54		54					
	5.6							8	10	
HWANG DEUNG		30	55	30						
	6.6							5	10	
I RI		53	51	34	34					
	7.2							5	3	TABLE BLOCK SYSTEM
BU YONG		31	31		23					
	3.7									
HA RYONG										
	7.0							7	10	
GIM JE		31	31		15					
	7.0									
GAM GOG										
	5.4							10	8	
SIN TAE IN		30	32	18						
	5.6							7	10	
CHO GANG										
	8.1								6	
JEONG EUB		35	35	15	17					
	5.9								6	
CHEON WEON		29	25	22	17					
	5.0								13	
NO RYEONG		50	50		50					
	7.1							12	13	
BAEG YANG SO		34	34	12						

(HO NAM LINE 2)

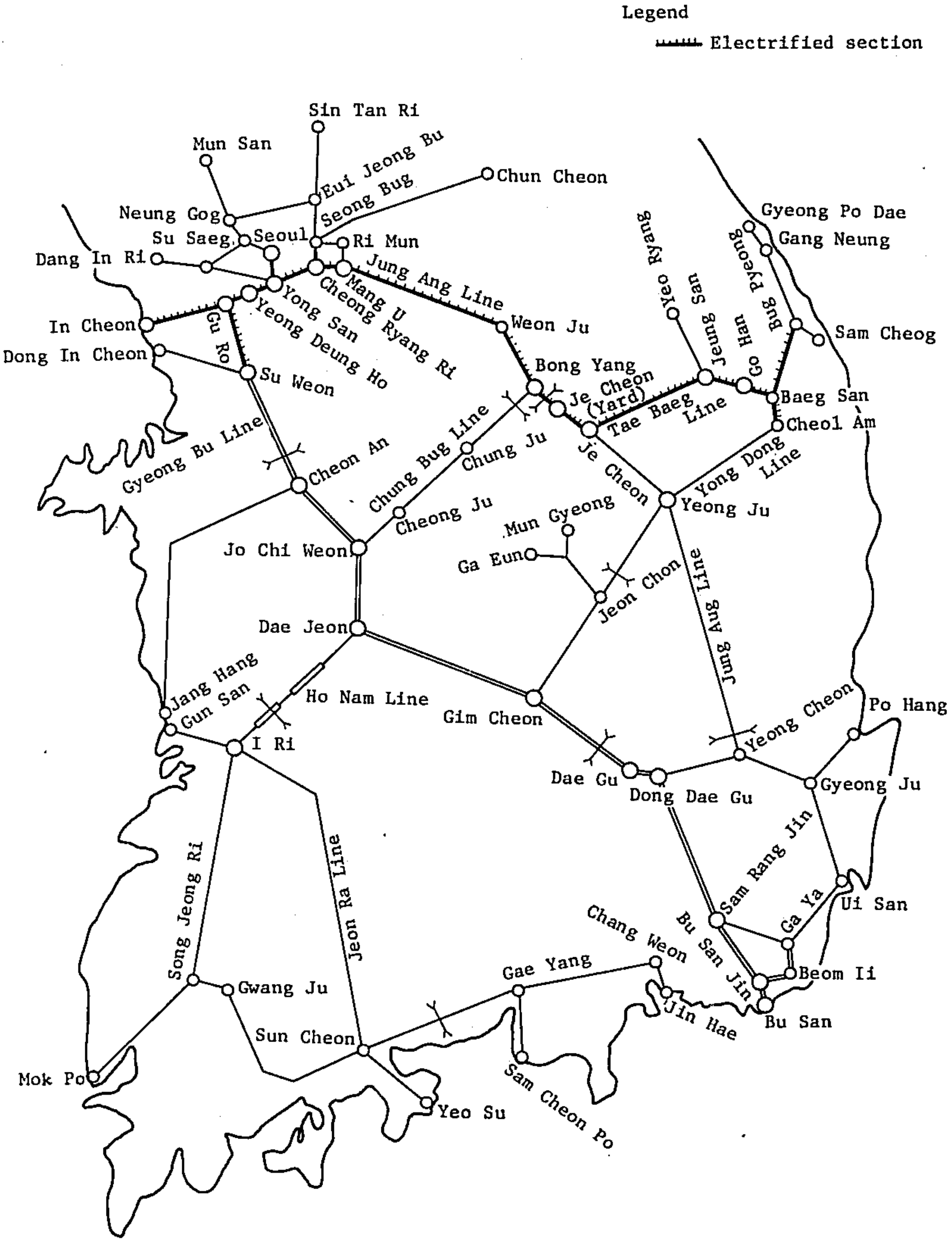


STATION	DISTANCE Km	EFFECTIVE LENGTH ON MAIN TRACK DOWN	EFFECTIVE LENGTH ON MAIN TRACK UP	EFFECTIVE LENGTH ON SIDE TRACK DOWN	EFFECTIVE LENGTH ON SIDE TRACK UP	TRACTIVE CAPACITY DOWN 3000 TYPE	TRACTIVE CAPACITY UP 3000 TYPE	GRADE (STANDARD, UP) UP TRAIN	GRADE (STANDARD, UP) DOWN TRAIN	BLOCKING SYSTEM
BAEG YANG SO						25	25			TABLET BLACK SYSTEM
	7.0							10		
SIN HUNG RI		35	34	20						
	5.9							5		
AN PYEONG										
	4.4							3		
JANG SEONG		33	33	21	15					
	5.2							5	2	
OG JEONG										
	5.3							3		
IM GOG		31	33	21						
	8.8							12	9	
BUB SONG JEONG										
	6.1									
SONG JEONG RI		38	38	24	24					
	9.6							10	10	
NO AN		32	32	32	32					
	4.5							5	2	
NA JU		34	34	33	34					
	3.4							5	6	
YEONG SAN PO		37	38	10	11					
	6.7							13	1	
DA SI		32	32	32	32					
	3.2							12	10	
GO MAG WEON		33	33		16					
	8.0							10	13	
HAG GYO		41	41	28						
	5.4							1	8	
SA CHANG										
	4.8							6	6	
MONG TAN		32	32		32					
	4.6							3	3	
MYEONG SAN										
	6.2							13	12	
IL RO		29	29		15					
	6.7							13	13	
IM SEONG RI		31	31		18					
	4.6							13	13	
DONG MOG PO										
	3.5							7	7	
MOG PO		31	26							

9. TABLE OF CLASS OF TRACKS

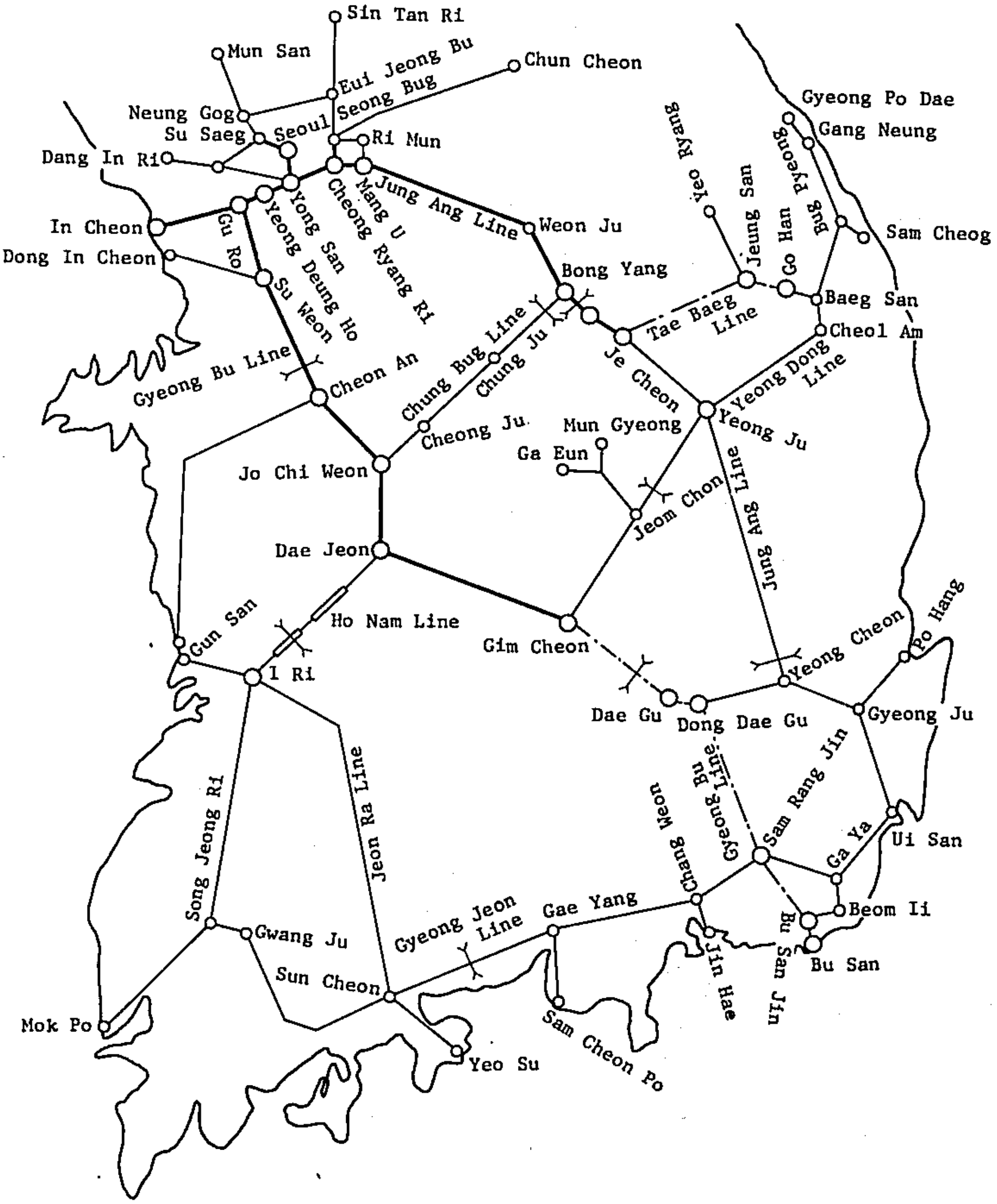
Line / Class	No. of Line	Name of Line
1st class	0	
2nd class	1	Geong Bu Line
3rd class	31	Jung Ang Line, Ho Nam Line, Jeon Ra Line, Yeong Dong Line, Tae Baeg Line, Gyeong In Line, Gyeong Jeong Line (4th class between sun Cheon and Gwang In), Chung Buy Line (4th class between Jo Chi Weon and Chung In), Gyeong Buy Line (4th class between Gim Cheon and Jeom Chon), Dae Gu Line, Dong Hae Nam Bu Line (4th class between Gyeong Ju and Po Hang), Gyeong Eui Line, Gyeong Weon Line (4th between Seong Buy and Shin Tai Ri), Gyo Oae Line, Yong San Line, Nam Po Line, Mun Gyeong Line, Ga Eun Line, Gang Gyeong Line, Ga Ya Line, Jim Hae Line, Bu Jeon Line, Gye Dong Line, Jang Saeng Po Line, Yeo Cheon Line, Han Baeg Line, Sam Cheog Line, Buy Pyeong Line, Mang U Line, Jeong Seon Line, Dang In Ri Line
4th class	8	Jang Hang Line, Gyeong Chun Line, An Seong Line, Bu San Line, Gun San Line, Hwa Sun Line, Mug Ho Line, Og Gu Line
Narrow gage	1	Su In Line
Total	41	

10. SKETCH SHOWING KNR'S EXISTING ELECTRIFIED SECTIONS

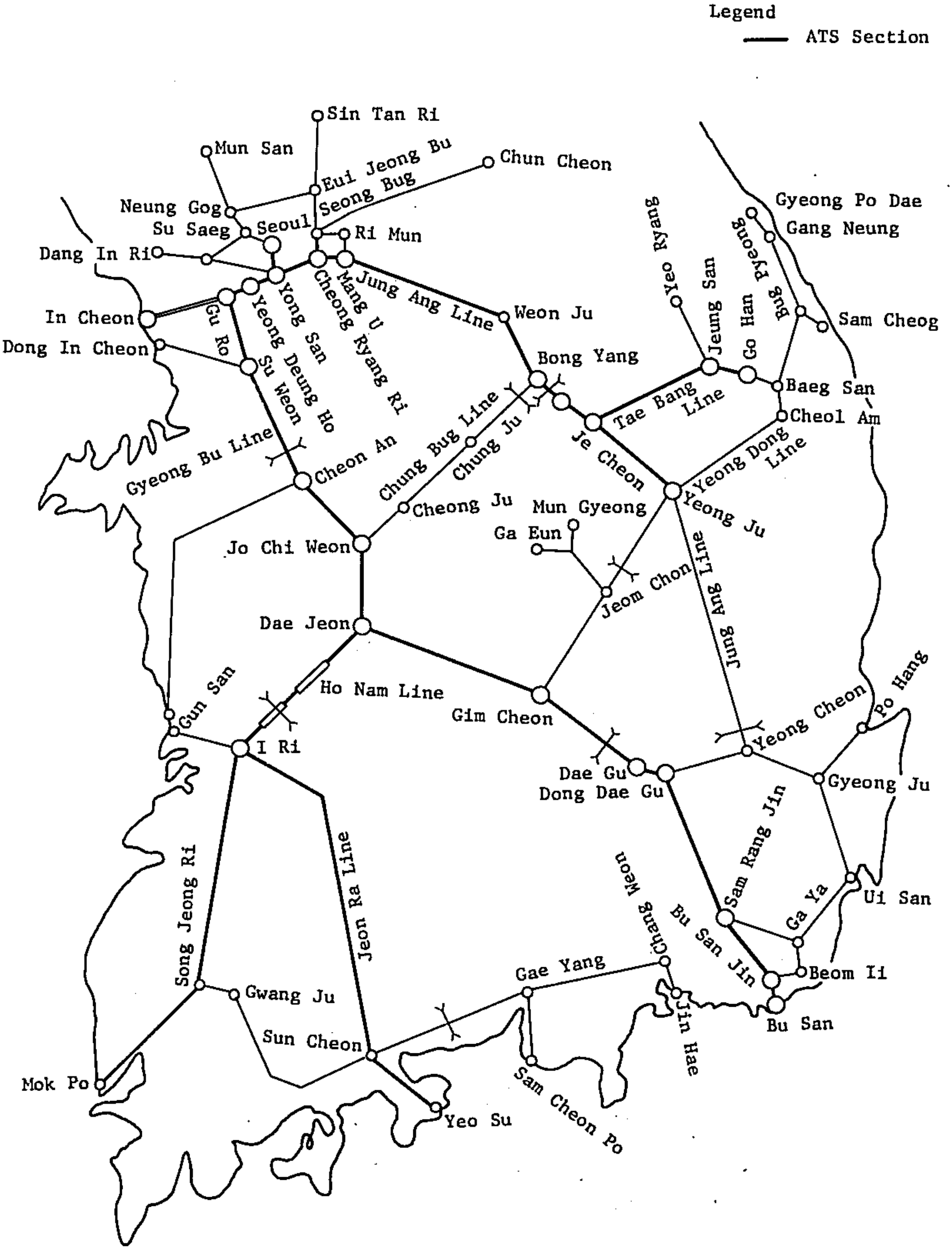


11. SKETCH SHOWING KNR'S EXISTING BLOCKING FACILITIES

Legend
- Section having automatic block system (single & double track)
- -·- Section having controlled manual block system (single & double track)
- ═ Section having
- — Section having tablet block system



12. SKETCH SHOWING KNR'S EXISTING ATS SECTION



13. MAIN FEATURES OF DIESEL LOCOMOTIVES

		2000 (SW8)	2100 (SW1001)	3000 (G8)	3100 (ALCO)	4000 (G12)	4100 (G12)	4200 (G22)	5000 (SD9)	6000 (SD18)	6100 (S P28)	6200 (SDP38)	6300 (SDP38)	7000 (G26CW)	7500 (GT26CW)
Engine		8-567BC	8-645E	8-567CR	6-251B	12-567C	12-567C	12-567E	16-567C	16-567D	16-567E	16-567E	16-567E	16-645E	16-645E3
Bore Stroke mm		216x254	230x254	216x254	228.6 x 268.7	216x254	216x254	216x254	216x254	216x254	216x254	216x254	216x254	230x254	230x254
Cycle		2	2	2	4	2	2	2	2	2	2	2	2	2	2
Compression Ratio		16:1	16:1	16:1	16:1	16:1	16:1	16:1	16:1	16:1	16:1	16:1	16:1	16:1	14.5:1
Rotating Direction rpm															
Idling rpm		275	315	275	375	275	275	275	275	275	275	275	275	315	315
8 Notch rpm		800	900	835	1025	835	835	835	835	835	835	835	835	900	900
Engine Governor		PG	"	"	"	"	"	"	"	"	"	"	"	"	"
Tractive Horse-power		800	1,000	875	950	1,310	1,310	1,310	1,750	1,800	1,800	1,800	1,800	2,000	3,000
Operating Service Weight ton		94.5	87.0	75.0	71.5	78.5	85.0	88.0	141.0	147.0	147.0	147.0	148.0	99.0	132.0
Axle weight ton		23.5	22.0	19.0	18.0	19.5	21.0	22.0	23.5	24.5	24.5	24.5	24.5	16.5	22.0
Wheel Diameter mm		1,016	1,016	1,016	914	1,016	1,016	1,016	1,016	1,016	1,016	1,016	1,016	1,016	1,016
Axle Bearing															
Axle Diameter mm		140x254	165x305	140x254	165x305	140x254	140x254	140x254	165x305	165x305	165x305	165x305	165x305	165x305	140x254
Truck Wheel Base mm		2,438	2,438	2,438	2,438	2,438	2,438	2,438	4,140	4,140	4,140	4,140	4,140	3,700	3,721
Center to center distance between trucks mm		6,706	6,706	7,620	7,010	7,620		7,620	10,668	10,668	10,668	10,668	10,668	9,769	12,540
Min. Curve Radius mm		30.5	44.5	58.8	45.7	58.8	58.8	58.8	76.2	76.2	76.2	76.2	76.2		55.8
Gear Ratio		62:15	62:15	62:15	93:18	62:15	62:15	62:15	62:15	62:15	62:15	62:15	62:15	57:20	62:15
Length mm		13,420	13,610	14,325	14,650	14,325	14,325	14,170	18,500	18,500	18,500	18,500	18,500	15,765	19,650
Width mm		3,100	3,150	2,820	2,820	2,870	2,080	3,140	3,250	3,250	3,130	3,050	3,050	2,820	3,270
Height mm		4,425	4,570	4,210	3,670	3,850		4,100	4,560	4,570	4,680	4,680	4,680	3,830	4,250
Fuel Oil	gal.	600	1,000	1,000	1,000	1,000	1,000	1,000	2,400	2,400	2,400	2,400	1,200	1,200	2,400
	lit.	2,270	3,785	3,785	3,785	3,785	3,785	3,785	9,685	9,085	9,085	9,085	4,540	4,540	9,085
Lue Oil	gal.	130	130	130	139	165	165	165	200	220	243	243	243	200	243
	lit.	492	492	492	526	625	625	625	757	833	920	920	920	757	920

Cooling water	gal.	190	190	190	133	214	214	173	260	260	275	275	275	220	230
	lit.	720	720	720	415	810	810	665	985	985	1,040	1,040	1,040	830	960
Sand	m³	0.853	0.850	0.365	0.364	0.365	0.305	0.340	1.415	1.415	0.850	0.850	0.850	0.340	0.850
Main generator	Type	D15C	D25C	D15E	GT584	822F	D32F	D32T	D12C	D22C	D32T	D32T	D32T	D32T	AR10AE-D14
	Continous Rating A	1,300		1,400	1,220	2,200	2,200	2,200	2,200	2,200	2,200	2,200	2,200		
	Output kW	560	710	610	670	920	920	920	1,240	1,280	1,280	1,280	1,280	1,420	2,130
Aux. generator	Type	A-7159	A-7159A5	A-7159	GMG-158	A-7159	A-7159A4	A-7159A5	A-7159A4	A-7159A2 A-8102A2	A-8102A3	A-8102A3	A-8102A3	A-7159A5	A-8102A3
	Current Rating A	125	125	125	100	125	125	125	125	125, 225	225	225	225	125	225
	Output kW	10	10	10	7.5	10	10	10	10	10, 18	18	18	18	10	18
AG generator	Type	-	-	-	-	-	-	-	D14	D14	D14	D14	D14	-	D14
	Rating KVA	-	-	-	-	-	-	-	100	100	100	100	100	-	100
Traction motor	Type	D27	D75B	D47B	GF761	D57B1	D77B	D75B	D37B	D57B1	D77B	D75B	D75B	D75B	D77B
	One hour rating A	900	1,075	925	625	925	1,075	1,075	925	925	1,075	1,075	1,075	1,075	1,075
Storage Battery	V V	64	"	"	"	"	"	"	"	"	"	"	"	"	"
	A AH	284	"	"	"	"	"	"	"	"	"	"	"	"	"
Braking Method		6BL	26NL	6BL	26L	26L	26L	26L	6BL	26L	26L	26L	26L	26L	26L
Air Compressor	Type	WXE	WBO	WXD - Old WBO - New	3CWD	WBO	WBO	WBO	WBG	WBG	WBG	WBG	WBG	WBO	WBG
	Output Capacity CFM	800RPM 178	900RPM 254	835 RPM 235	1,000RPM 307	835RPM 235	835 RPM 235	835 RPM 235	835RPM 370	835RPM 370	835RPM 370	835RPM 370	835RPM 370	900RPM 254	900RPM 400
Main Air Storage Volume		0.820	0.820	0.820	0.505	0.820	0.820	0.820	0.820	0.820	0.820	0.820	0.820	-	0.820
Braking Ratio		5.5	-	6.71	-	6.71	6.71	6.71	6.71	5.65	5.65	5.65	5.65	-	5.75
Capacity of Brake Generator		-	-	-	-	-	700	700	700	700	700	700	700	-	700
Number of Braking Cylinder		4	4	4	8	8	8	8	12	12	12	12	12	8	12
Bore & Stroke for Braking Cylinder		254x152.4	254x152.4	254x216	216x216	216x216	216x216	216x216	228.6x216	228.6x216	228.6x216	228.6x216	228.6x216	254x216	203x203