

Express-centric train operation of Korean capital wide-area railroad

Baekkyu Namkung*

*Department of Railway Management and Policy, Seoul National University of Science and Technology
232 Gongneung-ro, Nowon-gu, Seoul 01811, South Korea*

Sungbong Chung

*Professor, Department of Railway Management and Policy, Seoul National University of Science and Technology
232 Gongneung-ro, Nowon-gu, Seoul 01811, South Korea
(Corresponding author)*

***ORCID: 0000-0002-7843-6766 & SCOPUS ID-57190839043**

Abstract

There has been the increase of interest in the materialization of rapid transit system for the reduction of wide-area travel time between cities or provinces. Wide-area railroad is for handling the immense demands for daily transportation between cities or provinces by any relevant laws, the function and role of which is different from that of urban railroad constructed for smooth operation of urban traffic. But, as a matter of fact, the distinction between wide-area railroad and urban railroad is ambiguous. The analysis of inter-city or inter-province travel pattern in metropolitan area revealed the average speed of 45km/h, which is approximate to that of 47km/h in the system of wide-area railroad, which indicates that the role and the function for speed of express trains with the average speed of 58km/h is not enough. It was found that scheduled speed and stop spacing of express trains on Korean wide-area railroad were similar to or higher than those of the wide-area railroad system in Tokyo metropolis area of Japan where both local and express trains are served while the running frequency and the running distance of Japanese express trains were 42~46% and 180% of those of local ones respectively, which figures are a lot higher than those of Korea, 7~23% and 47~111% respectively. So, this paper analyzed problems of Korean wide-area railroad operation and suggested strategies of express-centric operating. As a result, it was saved average 10~30 minute when it replaced the express-centric with the local-centric. In conclusion, Korean wide-area railroad need the express-centric railroad operation.

Keywords: Express-centric railroad operation, Train scheduling, Express train, Wide-area railroad, Train diagram

INTRODUCTION

The first wide-area railroad in Korea was Line #1 of Seoul Urban Railroad, when it was called "Metropolitan Subway" It was introduced as another public transportation to cope with the rapid increase of population in Seoul. The term of "Wide-area Railroad" was first applied along with the enactment of [Special Act for Management of Wide-Area Traffic in Metropolitan Region] in the year of 1997. It can be defined as Urban Railroad or just as Railroad which meets daily transportation demand in metropolitan cities and between

provinces with promptness and in quantities. Also its meaning or character may be thought to be different from those of "Urban Railroad" defined by [Urban Railroad Act] which is served for smooth operation of urban traffic in urban transport area. In particular, since the wide-area railroad is operated among more than two cities or provinces, [Enforcement Ordinances for Special Act on Metropolitan Wide-Area Traffic Control] prescribes that the scheduled speed should be over 50km/h (over 40km/h with Extension of Urban Railroad).

In spite of the different roles and functions of urban railroad which deals with any problems to the traffic in a city, it is very difficult to clearly distinguish wide-area railroad from urban railroad in terms of train operation. Reviewed from the aspect of facility, the average distance between two stations of the former is 2.54km, which is 2.4 times as long as that of Seoul urban railroad, 1.06km. The customers of the former were found to travel the average of 25~28km, while those of the latter only 12km, half of the former's, which makes the roles of the two distinguished clearly. However, from the viewpoint of train operation, even though the former which is supposed to secure the competitiveness against any other transportations so that it may meet the demand for medium and long distance traffic, its trains, as those of the latter do, stop at almost all stations along with the operation of express trains stopping at only some stations on some lines and in specific time-frames for better service to the customers. Accordingly, in case of long-distance service, its competitive edge gets lower than that of other transportations. The wide-area railroad networks launched recently are being operated and new ones are being constructed under relevant regulations. But the scheduled speeds of Gyeongbu Line, Gyeongin Line, Gyeongwon Line, Gwacheon Line, Ansan Line and Bundang Line are not more than 40km/h.

The examination of modal splits of subways(urban railroad + wide-area railroad) in major cities of the world shows 50%, 65% and 86% in Paris, London and Tokyo respectively but that of Seoul is only 36%(Seoul Metropolitan City, 2013), which is less than the half of those in the other major cities. Especially, in Paris Region and Tokyo Region, express trains are served on a regular basis to secure speed. The Korean government is pushing ahead with the revitalization of railroad use through the construction of new wide-area railroad, but due to the limit to the revitalization by the construction of wide-area railroads

exclusively for the operation of trains stopping at all stations, which system is all the same as the current ones, it is indispensable that the scheduled speed be improved through turning the existing lines into those of express system so that the competitiveness of wide-area railroad network may be secured.

In this study, the status of wide-area traffic between provinces and cities in capital area has been examined and the problems to the wide-area railroad network in current operation have been reviewed for the suggestion of plan for rapid transit system on the existing wide-area railroad lines so that a momentum for the changeover of the operation paradigm at the current wide-area railroad may be created.

STATUS ANALYSIS OF WIDE-AREA RAILROAD IN KOREAN CAPITAL REGION

Operation status of wide-area railroad in Korean capital region

In terms of law, the wide-area railroad means the lines defined by the notification of the competent Ministry of Land, Infrastructure and Transport according to 「Special Act on Metropolitan Wide-Area Traffic Control」 and capital-region

subway which has been being operated along with the enactment of relevant laws in 1998 is performing the function of wide-area railroad. But it should be categorized as local railroad business not as wide-area railroad business in terms of law. Since some out of those sections where electric trains are operated with the application of Metropolitan Unity Fare System were regarded as belonging to local railroad business, they are not sections of wide-area railroad any more if they should be defined by the relevant law.

Still, because some operation sections of electric trains which are not designated as wide-area railroad are playing the role of handling the wide-area traffic by the service between more than two cities or provinces, this study has defined the section (the section with Metropolitan Unity Fare System applied) of electric trains operated by Korean Railroad Corporation in capital region as wide-area railroad.

The wide-area railroad section operated by Korea Railroad Corporation(KORAIL) has the total of 11 lines, where most trains stopping at every station are being operated in the type of local-train operation system. The average scheduled speed is 47.3km and the average distance between stops 2.54km(Table 1).

Table 1 : Local Train of Korean Capital Wide-area Railroad

Class.	Service Section	No. of Sta.	Service Distance (km)	Travel Time (min)	Schedule Speed (km/h)	Ave. Stop Spacing (km)
Gyeongbu Line	Seoul~Cheonan	39	96.6	119.0	48.7	2.48
Gyeongin Line	Guro~Incheon	20	27.0	46.0	35.2	1.35
Gyeongwon Line	Soyosan~Cheongnyangni	24	42.9	64.0	40.2	1.79
Gyeongui-Jungang Line	Munsan~Yongmun	50	118.7	157.0	45.4	2.37
Ansan-Gwacheon Line	Namtaeryeong~Oido	21	40.4	58.5	41.4	1.92
Suin Line	Oido~Incheon	12	20.4	30.0	40.8	1.70
Bundang Line	Wangsimni~Suwon	34	52.9	84.0	37.8	1.56
Ilsan Line	Jichuk~Daehwa	11	19.2	28.0	41.1	1.75
Janghang Line	Cheonan~Sinchang	6	19.4	19.0	61.3	3.23
Gyeongchun Line	Sangbong~Chuncheon	19	81.3	81.0	60.2	4.28
Gyeonggang Line	Pangyo~Yeoju	10	54.8	48.0	68.5	5.48
Average					47.3	2.54

Data : KORAIL Homepage, <Http://www.korail.com>

With 11 systems on 6 out of the lines, the express trains increase their speed by not stopping at some stations. Their average scheduled speed is 58.5km/h, which is 11.2km/h higher

than that of local trains. The average distance between stops is 4.92km, 2.38km longer than that of local trains(Table 2).

Table 2 : Express Train of Korean Capital Wide-area Railroad

Class.	Service Section	No. of Sta.	Service Distance (km)	Travel Time (min)	Schedule Speed (km/h)	Ave. Stop Spacing (km)
Gyeongbu Line	Seoul~Cheonan	12	96.6	80.5	72.0	8.05
	Yongsan~ Cheonan	16	93.4	90.0	62.3	5.84
	Yongsan~Byeongjeom	10	45.5	51.5	53.0	4.55
	Yeongdeungpo~ Byeongjeom	6	39.6	32.0	74.3	6.60
Gyeongin Line	Yongsan~ Dongincheon	9	25.1	32.0	47.1	2.79
Gyeongwon Line	Gwangun Univ.~ Dongducheon	8	34.9	37.0	56.6	4.36
Gyeongui- Jungang Line	Seoul~ Munsan	9	46.3	48.0	57.9	5.14
	Yongmun~ Susaek	20	80.5	88.5	54.6	4.03
	Yongmun~ Munsan	39	118.7	143.5	49.6	3.04
Ansan Line	Geumjeong~Ansan	4	19.5	19.0	61.6	4.88
Bundang Line	Jukjeon~ Suwon	4	19.3	21.3	54.4	4.83
Average					47.3	2.54

Data : KORAIL Homepage, <Http://www.korail.com>

Table 3 : Express Train Ratio of Korean Capital Wide-area Railroad

Class.	Rush Hour (%)	Non-Rush Hour (%)
Gyeongbu Line	10.0	14.3
Gyeongin Line	44.4	33.3
Gyeongwon Line	22.2	-
Gyeongui-Jungang Line	11.1	-
Ansan Line	33.3	-
Bundang Line	18.2	-
Average	23.2	7.9

Data : KORAIL Homepage, <Http://www.korail.com>

The analysis of Daily Operation Schedule on Gyeongbu Line Section and Gyeongin Line Section where express trains are being served both at rush hour and at non-rush hours revealed that express trains were running longer-distance than local ones on the south-bound line of Gyeongbu (Gwangun Univ. → Cheonan) but that the running of trains was at the level of 10% or so. On the south-bound line of Gyeongin (Soyosan → Incheon), express trains were found to be running short distances at 47% compared to local ones and their running frequency was about 42%, which indicates that both lines were operated by the pattern of operation based on mainly local trains(Table 4).

Table 4 : Analysis Result of Wide-area Railroad Timetable

Class.		Average Service Distance (km)	No. of Train (No./day)	Ratio of Train (%)
Gyeongbu Line	Express	92.5	17	11.0
	Local	83.0	137	89.0
Gyeongin Line	Express	29.4	118	42.0
	Local	62.4	163	58.0

Data : KORAIL Homepage, <Http://www.korail.com>

Travel behavior of wide-area railroad in Korean capital region

The wide-area traffic can be defined as passing through more than two cities or provinces depending on the functions of “Wide-area Road” and “Wide-area Railroad” defined in 「Special Act on Metropolitan Wide-Area Traffic Control」.

For the analysis of travel behavior between cities and provinces, this study employed the O/D & Network in capital region as of 2015 from 「National Transport Survey and Database Build Project」 distributed in September, 2016. As with in capital region, unlikely in other metropolitan cities, 3 O/Ds of morning rush hour(am 7~9), afternoon rush hour(pm 6~8) and all day have been distributed, all of which are applied to the analysis of the traffic volume at morning rush hour, afternoon rush hour and non-rush hours with the exception of that at morning rush hour and afternoon rush hour from the O/D of the day before.

First, the examination of inter-city and inter-province traffic volume and internal traffic volume revealed that regardless of time frame about 30% out of the total traffic volume was 30%. The investigation of traffic distribution also showed that it was around 71.6% at morning rush hour from Gyeonggi/Incheon to Seoul, 71.1% at afternoon rush hour from Seoul to Gyeonggi/Incheon, which explains that at morning rush hour the traffic volume was concentrated toward Seoul and at afternoon rush hour it was the opposite. At non-rush hours it was 44.7% from Gyeonggi/Incheon → Seoul and 47.2% from Seoul → Gyeonggi/Incheon, which suggests that most of the railroad travelers pass through Seoul and Gyeonggi/Incheon(Table 6)

Table 5 : Railroad Traffic in Korean Capital Region (unit : trip)

Class.	Rush Hour (am 2 hours)	Rush Hour (pm 2 hours)	Non-Rush Hour(20 hours)
Internal Traffic	1,605,657 (69.44%)	1,258,081 (69.06%)	2,945,472 (70.96%)
External Traffic	706,747 (30.56%)	563,619 (30.94%)	1,205,655 (29.04%)
Total	2,312,404 (100.0%)	1,821,700 (100.0%)	4,151,127 (100.0%)

¹ For the comparison with the scheduled speed of wide-area railroad, the time spent in the train except for the time spent on approaching was employed for estimation. Also the travel-volume-weighted average time spent in trains by Eup/Myun/Dong was estimated.

Table 6 : Trip Distribution Ratio in External Traffic (unit : %)

Class.	Rush Hour (am 2 hours)	Rush Hour (pm 2 hours)	Non-Rush Hour(20 hours)
Seoul→Incheon	2.1	12.6	7.4
Seoul→Gyeonggi	18.8	58.5	39.8
Incheon→Seoul	11.8	2.6	7.6
Incheon→Gyeonggi	5.6	1.8	3.7
Gyeonggi→Seoul	59.8	20.2	37.1
Gyeonggi→Incheon	1.8	4.3	4.3
Total	100.0	100.0	100.0

Average travel time¹ and travel distance² between cities and provinces were found to be 32.3 ~ 37.6 minutes and 25.6 ~ 28.6km respectively depending on time frame. The average speed was measured to be 44.9km/h ~ 45.6km/h, which was approximate to 47.3km/h, the scheduled speed of wide-area railroad in capital-region. That is, when it is considered that the scheduled speed of express trains operated on wide-area railroad in capital region is 58.5km/h, it is thought not to have much influence to the travel between cities and provinces(Table 7).

Table 7 : Railroad Traffic Characteristics in External Traffic

Class.	Rush Hour (am 2 hours)	Rush Hour (pm 2 hours)	Non-Rush Hour(20 hours)
Average Travel Time (min.)	32.3	35.3	37.6
Average Travel Distance (km)	25.6	26.6	28.6
Average Speed (km/h)	44.9	45.2	45.6

ANALYSIS OF TRAVEL BEHAVIOR OF EXPRESS TRAINS IN JAPANESE TOKYO REGION

The representative cases of express train operation can be found in Paris of France and Tokyo in Japan. In Paris, trams, urban railroad and RER are connected to one another in mutually organic system, where RER, operated in the pattern of express

² For the comparison with the scheduled speed of wide-area railroad, the time spent in the train except for the time spent on approaching was employed for estimation. Also the travel-volume-weighted average time spent in trains by Eup/Myun/Dong was estimated.

downtown in Paris, connects its downtown area to its outskirts. However, while only one-class train is running on the same track, the distance between stations is considerably far, which makes it possible to determine that there is not any difference from the Korean wide-area railroad except for the long distance between stations for an express train with no combined operation of local train and express train. As with in Japan, diverse railroad networks have been constructed by JR and large private railroad companies in the capital region (Tokyo), and for a rapid travel through Tokyo and its satellite towns a variety of express systems are employed for express train service so that the needs of travelers may be met.

The examination of operation pattern of express trains by Japanese capital(Tokyo) wide-area railroad system showed that their average scheduled speed and average stop spacing were 49.2km/h and 4.30km respectively. Additionally, the express rates at rush hour and at non-rush hour were found to be 42.8% and 46.2% respectively, which indicates the rate of express trains run by the system to the total running frequency at both hours is about 40%(Table 8).

Table 8 : Express Train Operation in Tokyo Wide-area

Class.	Express Train Schedule Speed (km/h)	Ave. Stop Spacing (km)	Rush Hour Ratio (%)	Non-Rush Hour Ratio (%)
Tokaido Line	64.3	6.15	19.0	40.0
Tohoku/Takasaki Line	57.3	6.34	10.0	14.3
Jyoban Line	56.1	5.09	46.2	77.8
Sobu Line	53.5	4.47	44.4	42.1
Chuo Line	46.6	3.79	58.3	56.0
Hokuso Line	71.4	6.43	40.0	40.0
Tsukuba Express	56.8	6.48	23.8	33.3
Seibu Ikebukuro Line	53.5	3.12	47.8	46.7
Keisei Line	49.2	4.08	50.0	50.0
Keikyu Line	48.4	3.86	71.4	57.1
Tobu Tojyo Line	45.8	3.93	38.1	50.0
Seibu Sinjuku Line	43.6	2.64	62.5	46.2
Odakyu Line	39.3	4.13	61.9	66.7
Tozai Subway Line	38.9	1.93	26.1	33.3
Tokyu Toyoko Line	40.3	3.54	28.6	55.6
Tokyu Denentosi Line	38.1	3.15	35.0	42.9
Keio Line	32.6	4.06	65.0	33.3
Average	49.2	4.30	42.8	46.2

It was found from the examination of the one-day operation schedule of out-bound line (Tokyo → its outskirts) on Keikyu Line and Odakyu Line both of which have high operation rates of express trains at Table 8 that five classes of trains with the features of express run the average distance of 47.2~73.2km, taking up about 70% out of all the trains. In contrast, the trains of regular class stopping at each station run that of 40.5km, occupying around 30%. As with Odakyu Line, three classes of trains with the features of express run the average distance of 66.2~70.7km, taking up about 60% out of all the trains, and on the other hand, the trains of regular class stopping at each station run 39.9km, occupying around 40%. In short, rapid trains with the features of express are responsible for medium/long travel on capital (Tokyo) wide-area railroad (outskirt railroad) and those stopping at every station(local) are in charge of the connection to short and rapid trains, which shows the pattern of express-oriented train operation(Table 9).

Table 9 : Analysis Result of Tokyo Wide-area Railroad Timetable

Class.		Average Service Distance (km)	No. of Train (No./day)	Ratio of Train (%)
Keikyu Line	Express			
	Keikyu Wing	63.3	11	1.9
	Ltd.Exp. (Kaitoku)	64.6	108	18.3
	Ltd.Exp. (Tokkyu)	72.2	58	9.8
	Airport Ltd.Exp.	73.2	12	2.0
	Airport Exp.	47.2	225	38.1
Local		40.5	177	29.9
Odakyu Line	Express			
	Rapid Exp.	66.2	52	14.8
	Exp.	70.7	140	39.8
	Semi Exp.	68.0	14	4.0
Local		39.9	146	41.5

STRATEGIES FOR OPERATION OF EXPRESS-CENTRIC WIDE-AREA RAILROAD

Plan for establishing express-centric train operation system

The comparison of operation pattern of express trains at Tokyo wide-area railroad in Japan with that in Korean capital region revealed that the scheduled speed of express trains on wide-area railroad in Korean capital region and their stop spacing were 9km/h higher and 0.62km longer than those of Japan, while the running rate and average travelling distance rate of express trains to those of local ones were 23.0 ~ 34.9% lower and 69.3% ~ 130.1% lower than those in Tokyo region(Table 10).

Table 10 : Comparison of Express Train Operation in Korea Capital Wide-area and Japan Tokyo Wide-area

Class.	Korea Capital (A)	Japan Tokyo (B)	Gap (A-B)
Average Schedule Speed (km/h)	58.5	49.2	↑9.3
Average Stop Spacing (km)	4.92	4.30	↑0.62
Average Express Ratio (%)	7.9~23.2	42.8~46.2	↓23.0~34.9
Average Express Service Distance Compared with Local Service (%)	47.1~111.4	177.2~180.7	↓69.3~130.1

The train operation patterns on Keikyu Line and Odakyu Line of Japan are a kind of shuttle operation by local trains stopping at each station at a certain section and the service of only downtown-ward direct-connection express trains owned by private companies, which is for rapid access to the center of Tokyo from its outskirts (Figure 1 and 2). On the other hand, as with such wide-area railroad as Gyeongbu Line and Gyeongin Line of Korea, express trains are responsible for part of lines, while local ones stopping at all stations are linked to the section of private companies for a long-distance service, which requires more than one transfer to local trains for customers to enter the downtown area of Seoul even when they take express trains first, which proves that as seen at the analysis result of travel behavior of capital wide-area railroad the express trains are thought not to have any big influence to inter-city or inter-province travel (Figure 3 and 4). That is, in spite of taking an express train, since the time for awaiting a local train is supposed to be additionally spent, the average time for travelers between cities or provinces to spend comes to be almost the same as the scheduled speed of local trains even though the scheduled speed of express ones are relatively high, which causes a lack of significance of any express ones to the wide-area railroad in capital region.

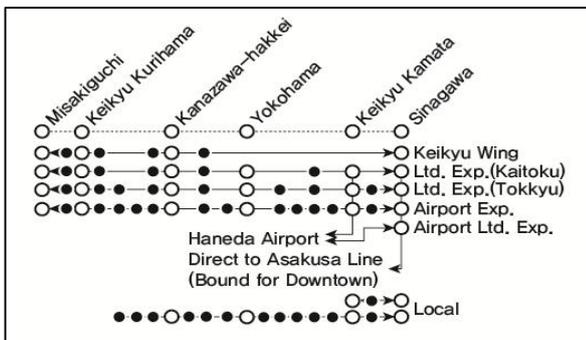


Figure 1 : Train Operation Pattern of Keikyu Line(Japan) Proposal

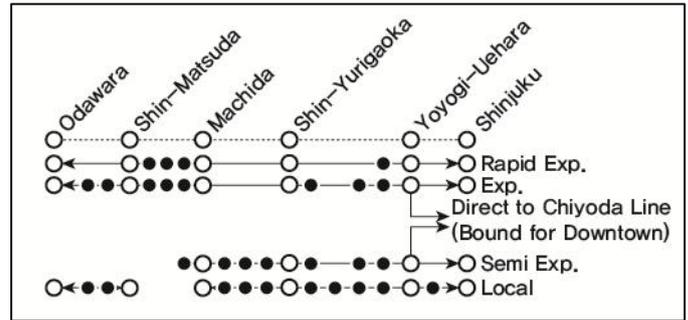


Figure 2 : Train Operation Pattern of Odakyu Line(Japan)

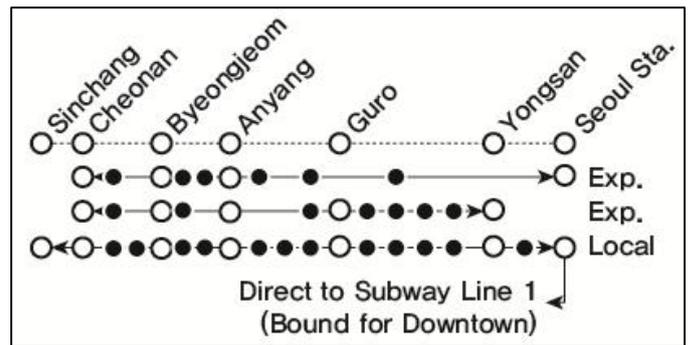


Figure 3 : Train Operation Pattern of Gyeongbu Line(Korea)

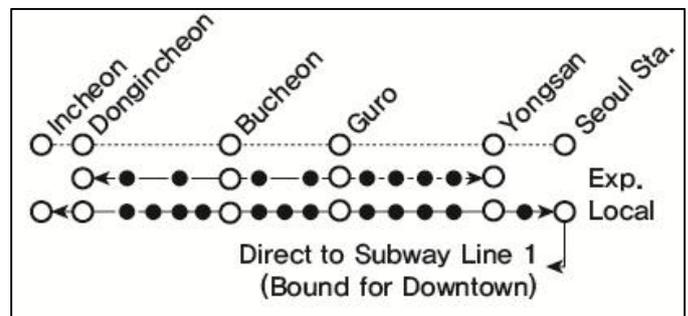


Figure 4 : Train Operation Pattern of Gyeongin Line(Korea)

In conclusion, when the wide-area railroad (outskirt railroad) on Tokyo Region is compared with that of Korea, it is shown that scheduled speed and stop spacing of express trains in those two countries are similar to each other or, rather, those of Korea are higher but it also suggests that in terms of service frequency, travel distance and operation pattern the wide-area railroad system (outskirt railroad) of Japan is considered to meet the needs of wide-area travelers more efficiently than that of Korea. Medium/long distance express trains are to be operated as seen at Figure 5 and those local trains stopping at every station had better be served for short-distance travel with the concept of shuttles if the scheduled speed of 50km/h should be sought for and the daily traffic demand should be handled with promptness and in large by the wide-area railroad as defined by [Enforcement Ordinances for Special Act on Metropolitan Wide-Area Traffic Control]. At the same time with the Japanese cases referred to, the following methods are to be

established so that the wide-area railroad may perform the function of urban railroad and any other wide-area transportation: the travel distance should be determined to be less than 40km, semi-express trains are to be planned to stop at each station in the area of more than 40km away from the downtown area and the strategies of train service centered on express trains must be adopted along with the classification of trains into Ltd Exp. Exp. Semi Exp. and Local to satisfy the different characteristics of each line.

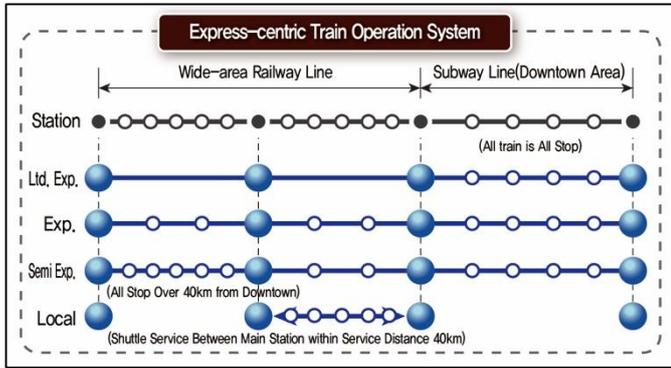


Figure 5 : Express-centric Train Operation System

Effect of introducing express-centric train operation system

When the traveling times are compared along with the assumption that the current stops of express trains between Incheon/Cheonan and Seoul Station should be applied to the sections of Gyeongbu Line (Seoul ~ Cheonan) and Gyeongin Line (Seoul ~ Incheon) where regular expresses are in service and they stop at every station in the downtown section after Seoul Station, it has been estimated that at least 10 minutes or 33 minutes up to the hilt may be reduced at the sections from Gyeonggi/Incheon to Seoul downtown area (to Jongro-3-Ga Station) and also it was confirmed that the longer travel distance is, the bigger the effect of travel-time reduction gets. Considering the current expresses with only one class are in service, its classification into five classes such as Ltd. Exp. Exp. Semi Exp. and Local is expected to result in more effect from the reduction of travel time (Table 11).

Table 11 : Comparison of Travel Time with Express-centric Train Operation

Origin	Destination	Local-centric(A)	Express-centric(B)	Gap (B-A)
Cheonan	Jongno 3-ga	127	94	-33
Pyeongtaek		106	75	-31
Osan		87	62	-25
Suwon		70	50	-20
Anyang		45	31	-14
Incheon		74	54	-20
Juan		62	47	-15
Bupyeong		52	40	-12
Bucheon		43	33	-10

CONCLUSION

This study has examined the legal definition of the wide-area railroad in service in Korea to suggest the plan for adopting express-centric wide-area railroad operation system along with the appreciation of problems to inter-city and inter-province wide-area railroad operation system for clearer prescription of its function so that it may be distinguished from any urban railroad.

It is the reality that the wide-area railroad with trains most of which stop at every station is ambiguously differentiated from urban railroad in the aspect of train operation system despite that its function and role, which is to meet the daily inter-city and inter-province traffic needs promptly as defined by its relevant law, must be different from that of urban railroad for dealing with smooth urban traffic.

The estimation of capital travel behavior has found that express trains are not playing any significant role for any smooth inter-city or inter-province travel even though some trains are operated in some time frames on some lines for the promptness of wide-area railroad, which implies that its promptness function specified in its relevant law is insignificant.

Accordingly, this study, trying to establish a plan to clarify the promptness function of wide-area railroad which is differentiated from urban railroad, has reviewed the outskirts railroad network in Tokyo Region as a comparison subject where the promptness function of wide-area railroad is being utilized through the combined operation of local and express trains on the existing lines. The comparison led to the fact that scheduled speeds and stop spacing of the express trains at the wide-area railroad in the Korean capital region and those of outskirts railroad in Tokyo region were similar to each other or those of the former are higher and wider while there were bid differences at service frequency, service distance and operation system of express trains.

That is to say, it was estimated that, in order to strengthen the promptness function of wide-area railroad, it is necessary to increase 50 ~ 60% more from the current service frequency of express trains like Japanese do and to drastically reduce the running distance of local trains which stop at every station for the adoption of express-centric operation system instead of to increase the running distance of express trains for the travel of the medium/long distance, which adoption will reduce the travel time by at least 10 minutes or 30 minutes to the hilt. It is expected that customers can travel more promptly without suffering any inconvenience of transfer when they come to the downtown area because express trains running medium/long distances not the current short-distance will reduce the time spent in waiting for local trains for transfer or in transferring from express to local.

Though this study has suggested a basic directivity for adoption plan of express-centric railroad system along with the indication of problems to the operation system of wide-area railroad in capital area of Korea, there will should be more profound research into the plan for how to classify the stops by class, train classes by their facility size and their travel property on each line such as Ltd. Exp., Exp., Semi Exp. and Local and also for how to determine the train-distribution rate by class.

ACKNOWLEDGEMENTS

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