Review on Incheon International Airport & Urban MagLev Interface

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ABSTRACT: This paper provides an overview of Incheon International Airport that has ranked No.1 in global airport service quality assessment for 6 years after opening in 2001, reviews interferences between airport facilities and railroad facilities-notably from the perspective of air flight safety which represents a critical consideration in airport area and introduces MagLev operation plan lastly.

1 INTRODUCTION

Since its historic opening in 2001, Incheon International Airport (IIA) has grown into one of the world's top-tier airports in all aspects of airport operation, service and logistics by improving stability and efficiency of operation. Following the grand Phase 2 opening in 2008, IIA has advanced into a world's best class airport linking more than 170 cities in 60 countries around the world, with passenger turnover of 44 million persons and cargo throughput of 4.5 million tons a year.

Incheon International Airport Corporation (IIAC), specialized in airport construction and operation, won an urban MagLev pilot line project envisioned as one of the government-funded R&D projects in 2007 to deliver a differentiated and environment-friendly transport service. As a result, IIA will be the world's first airport linked by MagLev line in the 2nd half of 2013. In addition, IIAC is implementing Phase 3 airport expansion and Air-City development projects to beef up its competitiveness as a hub airport and lay solid platform for future growth.

Unlike ordinary urban districts, construction of MagLev line in airport area requires resolution of various aeronautical interface issues pertaining to air flight safety and interface with airport operation systems, etc. Accordingly, IIAC secured operational safety of airport and railroad by studying potential interference with airspace from MagLev line construction and impacts on air navigation safety, with focus on enabling MagLev to provide a differentiated railroad transport service by providing interface to airport operation systems such as air flight information system.

Figure 1. Incheon International Airport.

2 INCHEON INTERNATIONAL AIRPORT

2.1 Facilities & Operations

With cutting-edge world-class technologies incorporated in effective management and safety control systems, Incheon International Airport (IIA) is meeting customer needs by facilitating immigration processes and delivering services of great quality with focus on responsiveness and convenience.

Table 1 shows the Incheon Airport facilities and figure 2 shows the immigration processing times

Table 1. Inchoen Airport Facilities

Total Area	56.06 million m²
Runways	3
Aprons	Passenger: 2.44 mil. m² Cargo: 740,000 m²
Passenger terminal	500,000 m²
Concourse	170,000 m²
Transportation Center	250,000 m²
Navigation Facilities	Control Tower, Radar, Airport Lighting
Free Trade Zone	Cargo Terminal: 230,000 m² Logistic Park: 990,000 m²

Figure 2. Immigration processing Times

2.2 *Growth & Accomplishment*

In just 10 years since its opening, IIA has enhanced the value of Korea by hitting a grand slam for airport services and has contributed to economic development as one of the leading airports in the world by continuously showing good performances.

ACI (Airport Council International) ranked IIA as the best airport worldwide in its airport service quality assessment program for 6 years in a row. Figure 3, 4 show the present conditions of Incheon Airport.

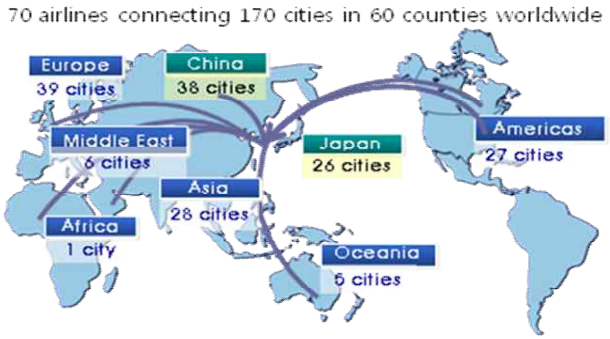

Figure 3. Airlines and Destinations

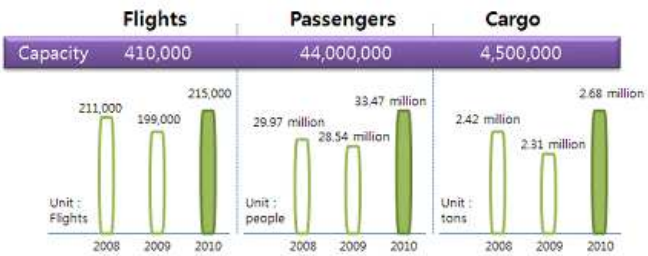

Figure 4. Airport operations

2.3 *Change & Innovation*

By continuing to promote the culture of change, innovation, and openness, IIA is advancing drastically as a global airport operator and meeting social responsibilities as a public entity.

2.4 *Future of Incheon Airport*

IIA, as the best brand of world's air transport industry and a global leader spearheading the airport industry, will provide customers with brand new impression and value.

3 AIRPORT & MAGLEV INTERFACE

3.1 *Airspace*

In an airport, it is critical to review and control obstacles in order to ensure air flight safety. Compliance with global standards is necessary and addition or expansion of new or existing structure requires careful review in accordance with relevant regulations. The MagLev line section between Train stop 104 and 105 crosses the direction in which aircrafts take off and land to the south of Runway 3. Factors requiring consideration in relation to obstacle limit surface include transfer surface, horizontal surface, conical surface and approach surface. Among them, what concerns the MagLev line is the approach surface. Pier elevation must be designed to be lower than the approach surface and construction equipment elevation must be lower than the approach surface as well. Airspace limit at a location where the MagLev line stays closest to the runway is E.L. 45.37m. As the elevation of pier to be built is E.L. 16.79m, there is 28.58m of clearance.

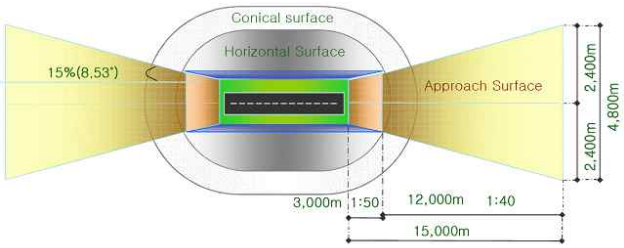

Figure 5. Obstacle limit surface.

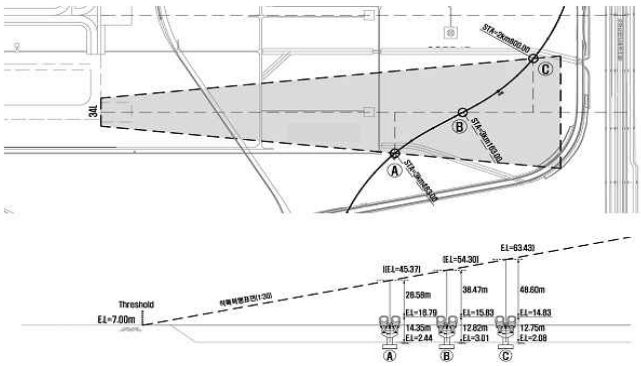

Figure 6. 3 MagLev line at the southern edge of the runway

3.2 Helipad

The helipad of IIA sits near Train stop 103, with 66m clearance from the MagLev line. Elevation of the MagLev line in a section near the helipad is E.L. 22.7m including rolling stock and applicable regulations require minimum clearance of 138.6m between the MagLev line and the helipad. Therefore, additional clearance of 72.6m is required at least. Furthermore, as additional considerations in addition to the minimum clearance required by applicable regulations, urban MagLev needs to be suspended from operation when wind speed is more than 26km/h and wind blow from a variety of helicopters when they land or take off must be considered, as well as wind speed in IIA located in coastal area. All things considered, to ensure operational safety of the MagLev line, 220m clearance between the helipad and the MagLev line was considered. Although it is possible for helicopters to land/take off in both directions of the helipad, landing/taking off only in the opposite direction of the pilot MagLev line was allowed and the other direction was closed to ensure safety until construction of new helipad.

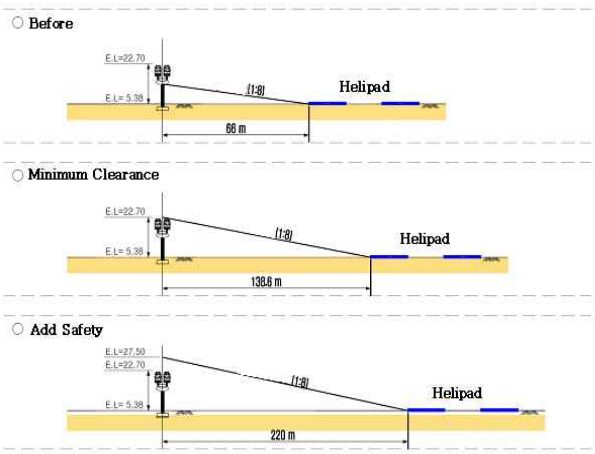

Figure 7. Helipad airspace limit & safety clearance.

3.3 Navaid System (VOR/DME)

VOR is an omni-directional beacon that sends radiowave in 360 degrees all around so that pilots in receiving aircrafts can determine their bearing and flight direction. DME is distance measurement equipment that shows the distance between an aircraft and the DME on the ground in numerals on the instrument of applicable aircraft. IIA has VOR/DME at two locations and one of the locations sits close to the MagLev line to the south of Runway 3. VOR/DME is critical to air flight safety, tolerating no interference in any conditions. According to international standards, it must be flat without any obstacle within 300m from the center of VOR/DME no facility can be built 1.2 degrees above the horizontal plane. Distance between the MagLev line and the VOR/DME at a location where they are closest to each other is 312m and the elevation limit is E.L 16.54m and the design elevation is E.L. 15.34m, resulting in 1.2m clearance.

- VOR : VHF Omni-direction Range
- DME : Distance Measuring Equipment

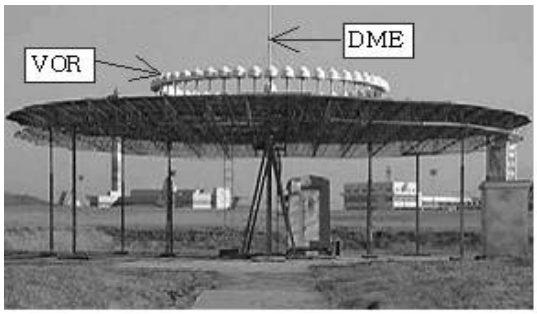

Figure 8. VOR/DME.

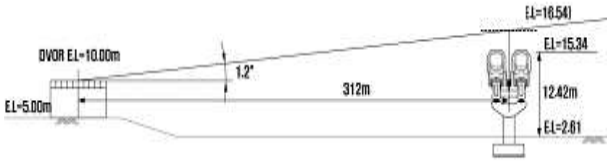

Figure 9. Airspace limits and design elevation near VOR/DME.

3.4 Airfield Light System

Airfield light system is necessary for aircrafts to land/take off safety at night or in fog and uses a variety of lamps. According to international standards, no facility can be built over 2 degrees from 900m to 1,100m away from the end of runway. The location where the MagLev line sits closest to the airfield light system sits to the south of Runway 4 to be built in the future, with clearance of 350.02m. Elevation limit at the location is 19.22m and design elevation is 14.43m, which results in the clearance of 4.79m.

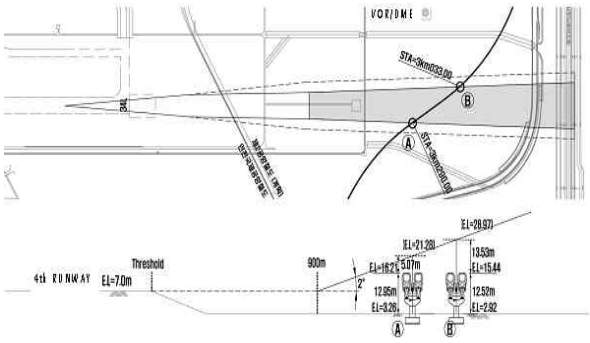

Figure 10. Airspace limits and design elevation near ALS.

3.5 Electro-Magnetic Interference

As aircrafts rely on radio communication with airports to land/take off safely, it is important to review electro-magnetic compatibility of the MagLev line with air navigation safety systems of IIA and radiowave impacts. Airport facilities sitting near the pilot line include Instrument Landing System (Localizer, Glide Slope, Marker) and VOR/DME, etc. and they use radio frequency in 75 ~ 1100MHz band. Since the MagLeve line uses 5 ~ 18 GHz band, it seems that there will be no signal interference. However, to ensure complete and thorough verification, the project group will verify the safety of radiowave environment during the trial-run period in order to ensure electro-magnetic compatibility between aircrafts and the MagLev line.

3.6 Operating System Interface

Interface items between airport's operating system and maglev system are as follows.

Table 2. Major interface item

1. Flight Information Service
2. Airport Information Service
3. Emergence Announcement
4. Fire Alarm System & Rescue
5. SCADA System
6. Internet Service
7. Digital TRS
8. CCTV

4 EXPANSION PLAN

When adopting the pilot MagLev line, Incheon City and IIAC planned Phase 2 and 3 line expansion up to 2020 following the construction of the pilot line. Notably, Phase 2 expansion was planned to be completed by 2014 Incheon Asian Games. However, as the global financial crisis delayed development projects in the neighboring area, the expansion project is still being delayed. Phase 2 expansion line is planned to link coastal area and cover 9.7km with 5 train stations up to the international business complex II of IIA and Phase 3 or the last phase expansion line is designed to be a ring-type alignment circumnavigating Yeongjong Island around IIA, covering 37.4km with 16 train stations. IIAC operating the pilot MagLev line in Phase 1 plans to participate in the construction of Phase 2 and 3 expansion lines to a certain degree.

Figure 11. Phase 2 & 3 expansion line alignment

5 IIA INTRA AIRPORT TRANSIT(IAT)

IIA has operated unmanned rapid transit system transporting passengers between the passenger terminal and concourse A since 2008. The line is about 900m long and has 2 train stops, with headway of 2.5 to 5 minutes and service available on passenger call at nighttime from 24:00 to 04:00 to save energy and deliver transit service in a responsive manner. A total of three trainsets are in operation and one trainset consists of 3 cars, is 35m long and accommodates 261 passengers. Trains are powered by DC 750V, has rubber wheels and support completely unmanned operation. About 35% of total airport users or about 34,000 persons per day on average use the IAT system.

Figure 12. IAT

6 OPERATION & MAINTENANCE PLAN

Urban MagLev line will be run by IIAC. Drawing upon the experience in operating the IAT which is the 1st unmanned railroad transit system in Korea, IIA is making preparations to ensure safe and efficient operation. As the MagLev line is to be built within

IIA, a lot of services available in the airport such as air flight information service, airport information service, emergency announcement, fire control and emergency rescue service will interface with the railroad line to ensure safety and convenience for airport users and operation staffers. The MagLev line plays a critical role in the green airport strategy of IIA and IIA will transform into a leader of global airport industry by realizing the vision of low-carbon green airport. What attracted the urban MagLev pilot line to IIA was the geographic advantage of IIA that could maximize the promotion effects toward both domestic and global audiences and many other airports around the world are expected to benchmark the urban MagLev line project. IIA is the world's first airport that builds and operates a MagLev intra-airport transit system and IIAC will be able to build know-how in MagLev line construction and operation and make significant contribution to MagLev line construction projects in other global airports, including consulting service. The MagLev line will be put in operation from the 2nd half of 2013 and the operational parameters during the initial days of operation will be as follows.

Table 3. Key Operation Parameters

Contents	Setting
Daily service hour	05:00 – 23:00
Headway (peak-semi peak-non peak)	7.2 mn-15mn-20mn
Round trip time	22mn
Daily trip count	88 trips
Trainsets	4 trainsets in total - 3 trainsets in service - 1 trainset on standby
Passenger capacity of trainset	230 persons

7 CONCLUSION

A variety of light rail transit systems are being adopted as new mode of intra-airport transport. IIA will operate a high-end green transit system which is MagLev line to differentiate transport services made available to airport users and operation staffers, playing a pioneering role in upgrading the quality of airport transit services. The MagLev line will also contribute effectively to Air-City construction and promotion by improving accessibility to the neighboring area from the passenger terminal. In addition, the MagLev line will play an important role in the green airport strategy of IIAC, making contribution to the IIAC vision of low-carbon and green airport. Lastly, IIAC, specialized in airport construction and operation, provides world's best infrastructure facilities and services as well as consulting services for other global airports in relation to its knowhow in airport construction and operation. IIAC also plans to provide intra-airport transit system consulting services to other airports in foreign countries, drawing upon its knowhow in the MagLev system construction and operation.

8 REFERENCES

[1] Pilot line hosting proposal, Incheon City & IIAC, June 2007,
[2] Alternative design artifacts
[3] IIA VISION 2015.