High-Speed Rail in Korea: Lessons for the Midwest

The Republic of Korea (South Korea) launched Korea Train eXpress (KTX) in 2004, becoming the fifth nation to launch high-speed rail service.

South Korea has developed its high-speed rail infrastructure in a phased, blended approach that could provide an implementation model for high-speed rail development in the Midwest.

The nation’s manufacturers have made great strides in developing next generation high-speed rail technology and could be a significant resource for equipment and expertise as the Midwest progresses with its plans.
Routes Used by KTX Trains
The Market

South Korea has population of 50 million—which is slightly larger than the combined populations of Illinois, Ohio, Michigan, Indiana, Missouri, Wisconsin, and Minnesota. And yet this nation occupies only about 38,000 square miles, slightly less than the area of Ohio. The city proper of Seoul, the nation’s capital, has a population of more than 10 million. Nearly 26 million people live in the entire metropolitan area.

The nation’s Gross Domestic Product, at just over $1 trillion, ranks 15th among the world’s economies—approximately equal to the combined economies of Illinois and Ohio, the Midwest’s two largest states.

South Korea’s primary transportation axis runs from Seoul to Busan, the country’s second largest city with a population of 3.4 million. A secondary population belt stretches along the western coast from Seoul to Mokpo. Another transportation corridor of growing importance runs east from Seoul to PyeongChang, host city of the 2018 Winter Olympics, and on to the northeast coast.

KoRail and KTX

In 2012, KTX trains carried nearly 53 million passengers, compared with Southwest Airlines’ 112 million enplanements for fiscal year 2012.
KTX trains are operated by the Korea Railroad Corporation (Korail), the national railroad operator. A special purpose entity, Korea High Speed Rail Construction Authority (KHSRCA), was formed in 1992 to construct the initial high-speed track.

In 2005 Korail was split into separate government-owned operating and infrastructure entities. Korail became the operating unit overseeing train and station operations. The Korea Rail Network Authority was formed to finance, build, and maintain the nation’s entire railroad infrastructure. KHSRCA was absorbed by the network authority.

Korail is divided into four units:
- Passenger: high-speed trains, long-distance intercity services and metros
- Station Area Development
- Logistics
- Overseas: technical consulting, operation & maintenance, rolling stock rehabilitation and training & education

In 2012, Korail operated 200 KTX trains per day carrying 53 million passengers. In 2011, KTX trains generated an operating profit of $426 million on revenues of $1.3 billion. The long-distance and metro units receive government operating support.

A key to the success of the KTX is the South Korean approach to incremental improvements and blended service. The high-speed infrastructure program includes not only entirely new state-of-the-art high-speed lines, but also electrifying and upgrading track on existing corridors. The result is that KTX trains can leave the trunk lines and share conventional track with diesel trains, allowing very flexible schedules that offer KTX service to stations not directly served by the trunk lines.

Seoul–Busan Gyeongbu line

The corridor serves over 70% of the country’s population, including Daegu and Daejeon, South Korea’s fourth and fifth largest cities (population 2.4 million and 1.5 million respectively).

Seoul and Busan are 260 miles apart, compared with Chicago and St. Louis at 280 miles distant. Before the KTX, the conventional line provided a 4-hour 10-minute trip time between Seoul and Busan utilizing diesel-powered trains.

The first proposals for a high-speed rail line originated from a study prepared between 1972 and 1974 by France's SNCF and Japan Railway Technical Service. Additional feasibility studies demonstrated a possible 90-minute travel time with all new infrastructure.

The government committed to the project in 1989 and targeted a 1998 completion date. The planned travel time was 1 hour 51 minutes. The project broke ground in June 1992 but was delayed by the Asian Financial Crisis.

The first two segments of high-speed line were completed in 2004, reducing travel times to 2 hours and 40 minutes.

As part of the project, the conventional line was upgraded and electrified so that KTX could use the conventional tracks from Daegu to Busan. Conventional tracks were also used to access downtown Deajeon and Deagu. KTX trains used (and still use) Metro Line 1 (a four-track railroad very similar to Metra’s Electric Line in Chicago) between Seoul Station and the beginning of the new high-speed line.

The Daegu–Busan segment was opened in 2010 resulting in a 2 hour 18 minute trip. Construction of this segment was delayed by concerns that a tunnel might drain an important wetland. The Supreme Court ruled in favor of the railroad in 2006.
High-speed infrastructure in Daejeon and Daegu is expected to be completed by 2014. These are short segments where local disputes about the new corridor alignment delayed construction.

**Financing**

The Gyeongbu High Speed Railway was funded through a combination of sources, including government grants (35%), government and foreign loans (10% and 24% respectively), domestic bonds (29%), and private capital (2%). The project cost $16 billion at 1998 prices.

**Passenger Volumes**

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<th>Total</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
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<td>73</td>
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<td>Gyeongbu KTX</td>
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<td>26,852</td>
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Unit = Passengers (thousand). Occupancy Rate (%) = Passengers / Seats * 100

When the project was launched, KTX was projected to become one of the world's busiest high-speed lines. A study in 1991 forecast around 200,000 passengers per day in the first year of operation, growing to 330,000 passengers per day twelve years later. This compares with ridership estimates ranging from 10,000 to 21,000 riders per day for 220-mph high-speed service between Chicago and St. Louis.

However, the delay in reaching the transit time target combined with overly optimistic projections of economic conditions resulted in lower but still very successful results. The first year of operation produced 70,000 passengers per day and in 2012—the eighth year of operation—ridership was 144,000 passengers per day.

Within four years of its launch, KTX increased Korail’s share of the Seoul–Busan travel market from 40% to 65%. Airlines’ share during that period dropped from 42% to 17%.
Seoul–Mokpo Honam Line

South Korea’s second high-speed project is the Honam Line from Seoul to Mokpo, a city of approximately 250,000 on the country’s far southwest coast 253 miles from Seoul. As a comparison, Chicago and Cincinnati, Ohio (population 296,000) are 296 miles apart.

Today, KTX trains using the Honam Line depart from Seoul at the Yongsan Station, two stops from Seoul Station on Metro Line 1. Like the trains to Busan, Mokpo trains use the Metro Line 1 tracks to reach the Gyeongbu high-speed line. They divert to the conventional Honam line at Daejeon. The conventional Honam line was electrified to accommodate KTX trains in 2004, which reduced travel times between Seoul and Mokpo from 4 hours 32 minutes to 2 hours 58 minutes.

The government committed to the construction of a new Honam high speed line in 2006. It is being constructed in two phases. The ultimate goal is to reduce the Seoul to Mokpo transit time to 1 hour 55 minutes.

The first segment will diverge from the Gyeongbu high-speed line at Osong and reconnect with the conventional line at Gwangju. It is expected to cost $7.5 billion. The government provided direct grants for 50% of the cost with the other 50% being financed with bonds.
Direct Airport Service

The Airport Railroad Express (AREX) terminates in a tunnel under Seoul Station. This arrangement makes it convenient for KTX passengers to connect to AREX trains, but it does not allow for KTX trains to serve the airport directly.

A 2-mile segment now under construction northwest of Seoul Station will allow KTX trains to continue through Seoul Station and link to the AREX line. The AREX line is being upgraded as part of the project. When completed, KTX trains will share tracks with AREX trains and Metro trains for the roughly 40-mile trip from Seoul Station to Incheon International.

Suseo High Speed Railway

Construction began in 2010 on a 38-mile branch off the Gyeongbu line that will terminate in the Suseo area in southeast Seoul. There will be an intermediate station at Dongtan. New commercial and residential developments are being coordinated with station construction.

KTX trains will continue to serve Seoul and Yongsan stations. Seoul is a very large and congested city. It can take an hour to reach Seoul Station from the southeast neighborhoods, so having additional access in the Suseo area will increase overall traffic on KTX trains.

The Suseo high speed line may be continued to the Samseong neighborhood and Yongsan station.

2018 Olympics

In 2012, construction began on a new 70-mile long, 155-mph high-speed line from Wonju and Gangneung. The line will pass through PyeongChang, host city of the 2018 Winter Olympics, and is expected to be completed by 2017, one year ahead of the games. An existing railroad from Seoul to Wonju will be upgraded. Visitors and foreign athletes will be able to ride KTX trains directly from the Incheon International Airport directly to Olympic venues without having to transfer trains.
Trainsets

The government has been very proactive about developing a domestic high-speed equipment industry. Hyundai Rotem was instrumental in delivering the country’s first high-speed rolling stock, partnering with dozens of other companies and government-owned research institutes and universities.

South Korea’s first high-speed train was called the KTX, which has now become the brand for all high-speed services. They are articulated trains with two power cars and 18 passenger cars, offering 900 seats per train. Of the initial 46 KTX trains, the first twelve KTX were built by Alstom and 34 were built by Hyundai Rotem under a contract with Alstom. These operate in Seoul–Busan service.

A domestically-built test train, the HSR-350x, was based on the Alstom technology and was tested between 2002 and 2008. A commercial train based on the HSR-350x, the KTX-II, first started commercial service in 2010. They are also articulated with two power cars per train, but are half the length. Two KTX-II trains are frequently operated in tandem leaving Seoul and separate at online stations to service different branches.

In 2007, a consortium of Hyundai Rotem, the Korea Railroad Research Institute, and other private companies and universities launched a project to build a second experimental high-speed train, which became known the HEMU-430X. This train achieved 260 mph during testing in the spring of 2013. This train uses distributed power rather than separate locomotives in order to improve performance and increase seating capacity.

A commercial version of the HEMU-430X the KTX-III, is expected to enter revenue service in 2015.

Industry

Korail has extensive experience in railroad planning, operations and maintenance that is available to Midwestern projects through Korail’s Overseas unit.

South Korea’s private sector also offers comprehensive expertise in high-speed rail manufacturing, engineering, and construction.

Hyundai Engineering & Construction has long been recognized as the leader of the Korean construction industry. Established in 1947, Hyundai E&C played a significant role in boosting Korea’s economic development while winning world-wide recognition. The company’s history is one of innovative technologies amassed from activities throughout the world. Therefore, its
expertise, experience, and leadership in all construction areas—including civil, building, plant and power & energy works—have been and remain unparalleled.

**DAELIM Industrial Co., Ltd.** was founded in 1939 and is South Korea’s oldest builder. Daelim consists of 13 affiliates spanning building & housing construction, civil engineering, industrial facilities, petrochemicals, information & communications, automobiles, education and cultural activities. Daelim is recognized as a global contractor with leading edge technologies, boasting a distinguished record of projects around the world.

**DOHWA Engineering Co., Ltd.** is a comprehensive multi-disciplinary Engineering Consulting Firm offering services in planning, feasibility studies, design, analysis, testing, supervision in areas such as urban planning, structures, rail, and environmental engineering. The company’s railway group specializes in railway, urban, high-speed and light-rail transit systems and new transportation systems including monorail, maglev train, and trams. They are pioneering work in countries such as Bolivia, the Democratic Republic of the Congo, Algeria, Georgia, and Indonesia.

**Yooshim Engineering Corporation** is one of the leading engineering consulting firms in South Korea. Specializing in transportation facilities such as roads, airports, railways, high-speed railways, subways, bridges, tunnels, and ports, Yooshin also provides various planning & design services in the living environmental sectors such as water resources, urban planning, leisure & landscape, and environment improvement over the past four decades. Founded in 1966, the company boasts diverse projects including detailed design and construction supervision of Gyeongbu High Speed Railway; planning, design, and construction supervision of Incheon International Airport in the early 1990s; and technical consulting services on the three-dimensional (3D) cable installation for the Oakland Bay Bridge Project.

**SOOSUNG Engineering Co., Ltd.** is a multi-disciplinary engineering consulting firm in the fields of transportation, bridges and structures, railways, subways, urban planning, and landscape architecture. Founded in 1991, SOOSUNG has expanded its global civil engineering expertise in Asia, the Middle East, Africa, and South America.

**POSCO E&C** is a general construction company established in 1994 with expertise in engineering technologies which developed from its integrated steelworks capabilities. POSCO has completed the first-phase construction of Incheon International Airport Railroad between Seoul and the airport, and has been currently performing the second-phase construction of the airport railroad. The company has completed and is currently operating the Busan–Gimhae light rail project, the first completely automated light rail system in Korea. In addition to domestic projects, POSCO E&C is actively implementing projects in Vietnam, Kazakhstan, and Uzbekistan.

**Daeje Construction Co., Ltd.** was founded in 1992 and has expertise in the fields of building construction, environmental services, dredging, and electrical systems.