Development status of a segmented scissors type switch for the urban Maglev

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ABSTRACT: A scissors type segmented maglev switch has been developed for the urban transit maglev system to be commercialized in Inchon International Airport at 2013. The scissors switch is composed of four 2-way segmented switches up and down and a turn table in the mid point. The main use of the scissors switch is for the train to change track up to down or down to up in the same or opposite directions or to make a turn at the end terminal. The total length of the switch is 61m. The distance between the up and down track centerlines is 6m. The switch is composed of many steel box type beams, actuators, moving and locking devices, rails for levitation and propulsion, and a control unit. Performance and reliable tests and continual operation tests are performed.

1 INTRODUCTION

In December 2006, Korean Urban Maglev Program started under the supervision of Korea Institute of Construction & Transportation Technology Evaluation and Planning with the support of the Ministry of Land, Transport and Maritime Affairs. In 2007 as shown in figure 1, the construction of 6.1km long double tracks in the neighborhood of Yeongjong Island and Mui Island was confirmed and PSC girders are under construction now.

Figure 1. Aerial view of the Maglev demonstration line.

Because the demonstration line consists of double tracks as figure 2, switching systems are necessary for the change of the running direction of the vehicle, emergency evacuation, marshaling at the train depot and so on.

Figure 2. Section view of the Maglev demonstration line.

Segmented switches will be utilized for urban Maglev trains, and various kinds of switches, such as two 2-way switches, four 3-way switches, two 2-way+2-way crossover switches, one 2-way+3-way switch, and one scissors switch, are under consideration. Through Urban Maglev Program, the 3-way switch was already developed and the scissors

switch was designed based on it. The scissors switch is installed near the end station and used to change the running direction of the vehicle. The scissors switching system occupies less area in contrast to the loop track and has an advantage in operation speed compared to the traverse type switch.

In this paper, the design, manufacture, development status and performance evaluation of the Korean first scissors type switch for maglev trains will be discussed.

2 THE STRUCTURE AND COMPONENTS OF THE SCISSORS SWITCH

2.1 The structure of the scissors switch

Switches for maglev trains have a different structure from those for steel-wheel trains on rails because bogies are surrounding guideways as shown in figure 3. Because box-type steel girders are used to ensure the required strength, maglev switches weigh high and the structures of their components, such as driving and clamping units, are complex.

The scissors switch with 6m center line spacing is composed of four 2-way switches and a turn table in the midpoint, and was developed for the first time in Korea. The outline of the scissors switch is depicted in figure 4.

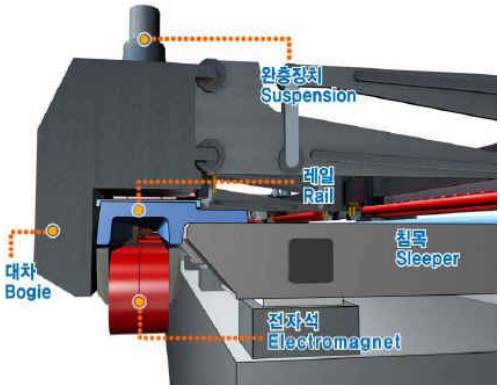


Figure 3. Structure of the Maglev bogie.

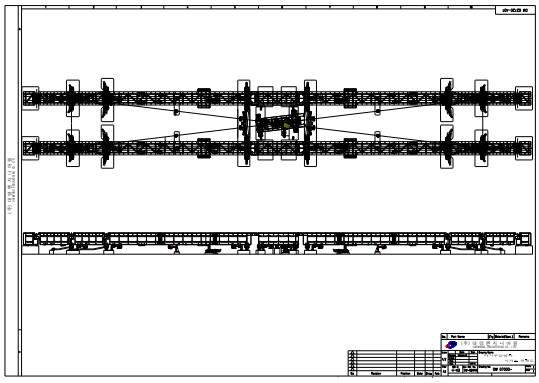


Figure 4. Design result for the scissors switch.

The scissors switch is installed between up and down tracks as shown in figure 4, and is applied to change the track when the train enters or exits the end station.

Figure 5 shows the scissors switch which is set curved. When passengers get on/off the vehicle after the train enters the end station passing by the straight section, the scissors switch is put in this configuration to prevent other trains from running in the same track.

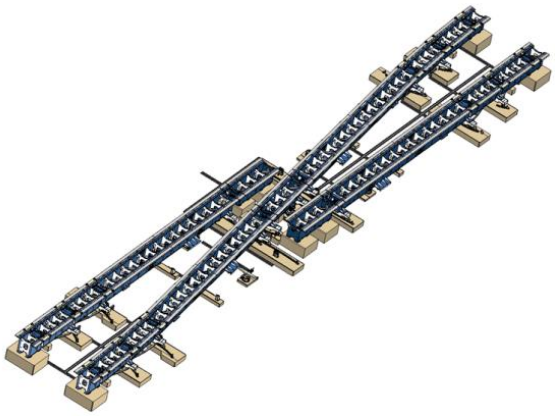


Figure 5. Scissors switch which is set as Curve Track.

2.2 The components of the scissors switch

As mentioned in the previous section, the scissors switch with 6m center line spacing consists of four 2-way switches and a turn table in the midpoint. Components of the 2-way switch and the turn table are as follows.

2.2.1 Girders

The 2-way switch has four girders including one short-span girder of the starting segment, two short-span girders of moving segments, and one long-span girder of the ending segment. One rotating girder is applied to the turn table, and two fixed girders are installed on the left and right sides of the turn table, respectively. Girders are made of box-type steels and the height of girders is 1.4m. Levitation and propulsion rails are laid on them acting as the opposite sides of levitation electromagnets and linear induction motors. Girders are placed with 2.3° refraction angles, and rails can be aligned in curve articulating at joints. A bearing is installed in the middle of the turn table, and the rotating girder is put on it. Transfer carriers and rollers are located at both ends of the girder to support it.

2.2.2 Driving unit

The driving unit consists of a driving motor, a gearbox, a cam bar and a cam guide. The gear ratio is 1/300, and the cam guide is designed to move 2.7m in 7 seconds. The detailed drawings of the driving unit are drawn in figure 6.

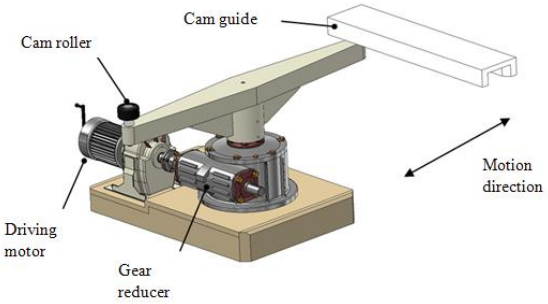


Figure 6. Driving unit of the scissors switch.

2.2.3 Clamping unit

The clamping unit is designed to keep switches in exact linear shapes and reduce the vibration of the switch providing mechanical contacts between adjacent unrestrained girders. The detailed structure of clamping unit is illustrated in figure 7.

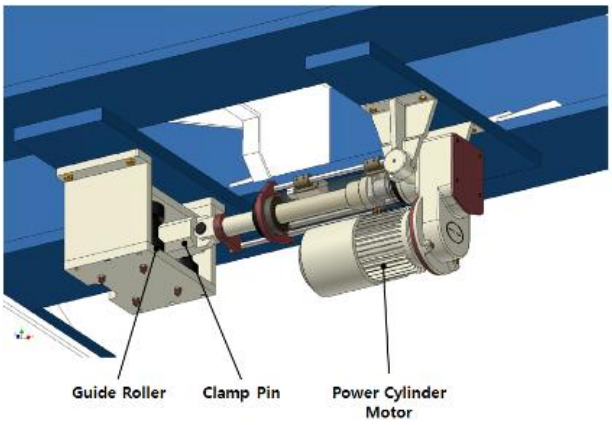


Figure 7. Clamping unit of the scissors switch.

2.2.4 Angle reliving unit

If the refraction angle of levitation rails on the girders is big, then the lateral gap between the rail and levitation electromagnets at the articulating joint increases, which deteriorates the levitation stability and may cause levitation failure. To cope with this problem, auxiliary levitation rails are installed using linkage mechanisms so that the refraction angle decreases by half. The angle reliving unit is shown in figure 8.

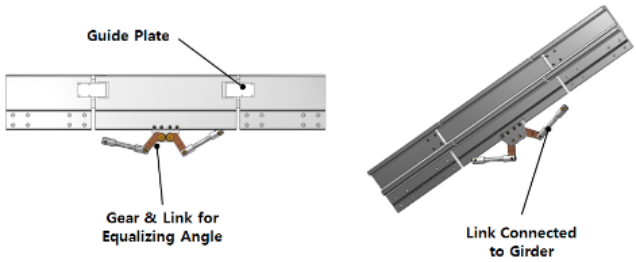


Figure 8. Angle reliving unit at the refraction part.

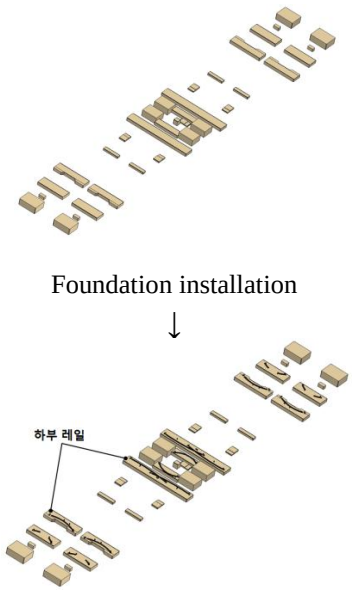
2.2.5 Terminals connecting unit

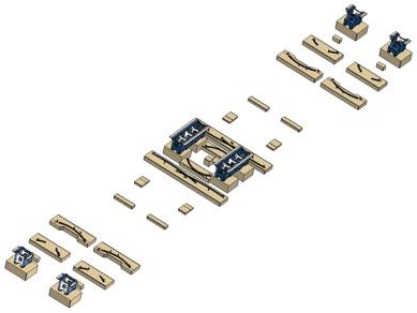
Cantilever hinges are added to the terminals of the switch to compensate the construction error and adjust the linearity and relative height of the structure of the switch.

3 FACTORY INSTALLATION AND PERFOMANCE EVALUATION

3.1 Documentation on the installation manual

The developed scissors switch has 6m center line spacing and is about 65m long. On the contrary to its big size, the installation tolerance is rather tight so that the vertical and lateral differences at joints should be less than 1mm and 0.5mm, respectively, and the longitudinal error should be maintained in ±3mm/10m. To meet these requirements, the installation procedure shown in figure 9 was prepared, and factory installation and performance evaluation were completed according to the manual. The manufactured switch is planned to be transferred to the demonstration line of Incheon International Airport in mid 2011.





Installation of fixed girders at starting, middle and ending points

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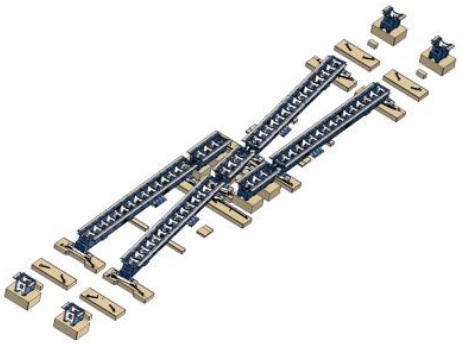

Installation of long-span moving girders

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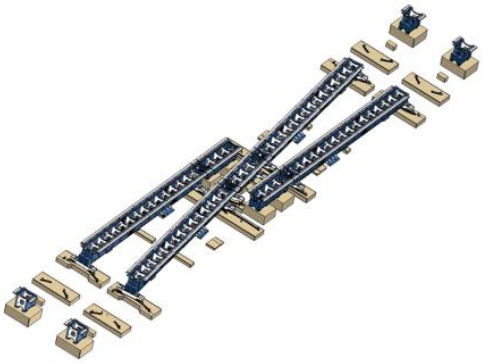

Installation of terminals connecting units

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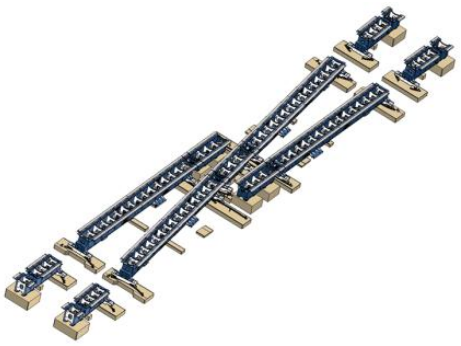

Installation of #1 short-span moving girders

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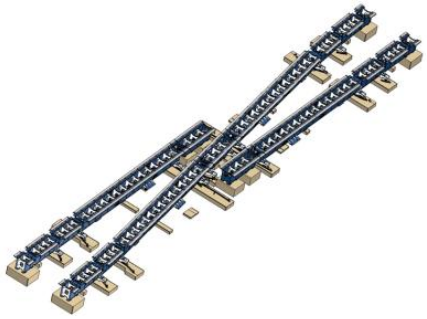

Installation of #2 short-span moving girders

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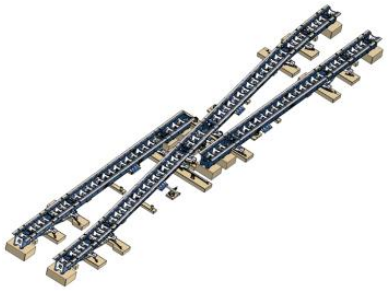

Installation of driving, moving and clamping units

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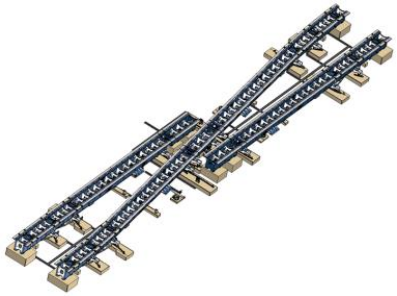

Installation of lower and inner ducts

Figure 9. Installation procedure for the scissors switch.

3.2 Factory installation and performance evaluation

The scissors switch was developed by Korea Institute of Machinery and Materials and Daemyung Engineering Co., LTD. The operability and design validity of the developed scissors switch were proven through factory installation and performance evaluation and so on. The operations according to several settings are illustrated in figure 10~12. Performance evaluation in factory includes the 100,000-cycle continuous operation test, the measurement of the linearity of the track, the measurement of the operation noise, the operability test of the control panel and mechanical devices, and so on. Through the performance evaluation, the reliability which is applicable to the demonstration line can be guaranteed.

Figure 10. Scissors switch which is set as Straight.

Figure 11. Scissors switch which is set as Curve Type1.

Figure 12. Scissors switch which is set as Curve Type2.

4 CONCLUSIONS

A scissors switch was successfully developed in this research. The scissors switch has 6m center line spacing, and require no fixed girder between the terminal of the 2-way switch and the rotation girder of the turn table. The scissors switch is the most complex one, and was developed by reflecting the designs and modifications of the previously developed 3-way switch. The smoothness and noise of the operation, i.e. the weakness of the previous 3-way switch, were enhanced and the operability and reliability of the scissors switch were guaranteed through the 100,000-cycle continuous operation test. The scissors switch is the most frequently operated one among all switches in the demonstration line of Incheon International Airport, and will contribute to the urban Maglev train as public transportation for the future.

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