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Focus

A Scheme to Build an Automated Container Transport System (AutoCon) Between Seoul and Busan

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Summary

- AutoCon allows automated handling of containers at loading/unloading zones while the wagons move on the track without stopping. At these zones, the wagons are made to slow down by bending in an accordion shape. This technology, the first of its kind in the world, ensures the bending by only using a mechanical principle. The system also features a loop structure, which makes it possible to climb up slopes without additional power. In this respect, it is suitable for a nation with many hilly and mountainous areas. The loop structure also precludes the possibility of accidents such as derailment and collision.
- The wagons would move on the track, built exclusively for the system, at a uniform speed (maximum speed: 72km/h, design speed: 56.3km/h). The system has been designed to handle up to 3.3 million TEUs of containers a year. It would take less than seven hours to transport a container box from Seoul to Busan.
- AutoCon's live load factor is just one third the amount of the existing container train system. This feature would help reduce costs for constructing necessary infrastructure facilities. It would also enhance the prospects for utilizing idle land along railways and expressways as well as building a solar power-generating system for self-supply of electricity. In addition, in association with a high-stack storage system, AutoCon could ensure smooth connections with other modes for rail and road transportation.
- Should AutoCon entirely carry out container transportation on the Seoul-Busan axis, it would save about 340 billion KRW in inland container transport costs and slash CO_2 emissions by 183,000 tons.

Technology That Can Reduce Logistics Expenses and Modal-Shift Costs

Total container throughput of Busan Port in 2011 is predicted to reach 16.093 million TEUs, and export/import cargo handled through the port is expected to account for nearly half the amount, registering 7.61 million TEUs. Among the export/import cargo, half or 3.8 million TEUs will represent the cargo flow on the Seoul-Busan axis, which covers the Seoul metropolitan area and the Chungcheong and Gyeongbuk provinces. This figure means that on average, more than 9,000 containers are transported on the Seoul-Busan axis every day. This breaks down to one container box moving in each direction of the axis every 20 seconds.

To increase the proportion of environmentally friendly transport modes, such as railways and coastal shipping, the government is devising various policies, including those aimed at promoting modal shifts through subsidies and incentives. The modal-shift policies would require enormous expenses. These costs could be saved, should the nation develop the following technologies and systems from long-term perspectives: green transport technology ensuring no greenhouse gas emissions,

Figure 1_ Artistic conception of AUTOCON and its basic operation principle

dedicated transport system for standardized containers, high-efficiency line-haul transport technology that ensures effective linkage, and high-stack warehousing and unmanned automated cargo handling systems.

Revolutionary Technology – AUTOCON

In developing logistics technologies for the future, emphasis should be placed on the following requirements: CO_2 emissions-free green transport, a unit-load system of ISO containers, line-haul transport that ensures efficient intermodal connections, and high-stack warehousing and unmanned automated cargo handling systems. To fulfill these objectives, the nation needs to promote economies of scale and a standardized unit loads system while trying to gain maximum effects from them.

Korea has limited land space, which makes it necessary to secure the capacity to speedily handle large-volume cargo and to ensure uninterrupted operation of the system throughout the year. In this regard, attention needs to be paid to building high-stack warehousing and unmanned automated cargo handling systems.

AutoCon technology is basically designed to use inertia while precluding static friction. This makes it possible to slow down container wagons by using a mechanical principle. There is no need to use electronic deceleration equipment. The container wagons keep moving while containers are loaded and unloaded. This is an environmentally friendly automated container transport system that requires just one tenth the driving energy needed for the existing container train system.

New-Concept Technology for Automated Container Transport in World's First-Ever Use

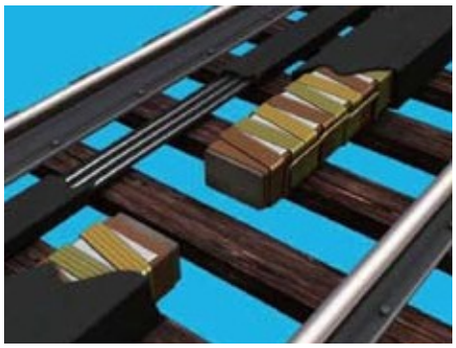
Linear Induction Motor (LIM) Driving Method

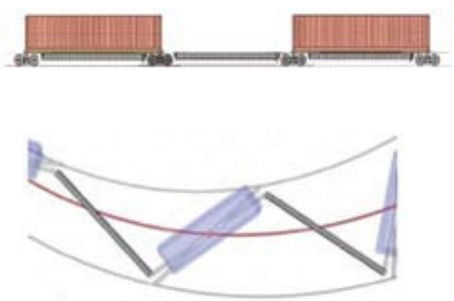
AutoCon gains driving power from linear induction motors placed along the track instead of using locomotives. This system uses less energy than the rotating system and can reduce the load weight by as much as the weight of the locomotive, which measures anywhere from 130 to 200 tons. For an almost constant flow of high-volume freight, using this system is more advantageous than employing trucks or cargo trains. There is no need to build separate depots.

Wagons Linked in a Conveyor-Type Loop Structure

All the container wagons running in a section are linked in a loop shape, making them suitable for operation in Korea with its many hilly and mountainous areas. This mechanism helps ensure the safety and reliability of the system. If it is difficult to cover the entire distance from Seoul to Busan with one loop, a three-loop system could be considered by dividing the distance into three sections. The three loops would be connected one after another. Another possibility is to link a certain number of wagons (i.e. about 500) as a unit, which could be operated like a train.

Figure 2_ LIM-type driving gear and the shape of linked wagons





Mechanical Principle-Based Nonstop Deceleration Method for Cargo Handling

Container wagons do not stop at cargo handling zones, but rather slow down by using a mechanical mechanism that allows a 90-degree bending in the shape of an accordion. This is the most creative aspect of the AutoCon system. At cargo handling zones, the wagons keep moving at the speed of 0.8m per second without stopping, precluding the need for additional power control for acceleration or deceleration. Thus, this system needs just one tenth the power required for operation of other existing systems driven by linear induction motors.

Dedicated Container Transport System

Designed exclusively for containers, this system has the live load factor amounting to just 29.4% of existing national railroads. This feature will help reduce costs for constructing facilities for rail track infrastructure. In addition, the system will contribute to promoting inland transportation of export/import containers and cargo standardization for line-haul transportation, thus enhancing the prospects for realizing rational development of the local logistics industry.

Unmanned Automated Cargo Handling System

The system adopts an unmanned automated cargo handling system to ensure effective and speedy loading/unloading of large-volume cargo nonstop, 24 hours a day and 365 days

a year. It would be desirable to unify the processes for handling containers and transferring them to high-stack warehouses. Should it be difficult to realize this scheme, the two processes could be separated.

Figure 3_ Various possible applications of AUTOCON

High-Stack Storage System

To ensure high-volume cargo transportation, it is vitally necessary to secure large-scale storage capacity at cargo handling facilities. However, it becomes increasingly difficult to secure affordable land plots that could accommodate such storage facilities. To tackle this problem, AutoCon ensures its linkage to high-stack warehouses, a new-concept cargo storage facility being developed at home and abroad.

Solar Power Self-Generating System

Should a photovoltaic power generation system be installed along the entire 400-km section from Seoul to Busan, it could generate 160,000 MWh of electricity a year. This would be more than enough to meet the power requirements for AutoCon, which needs about 0.134 kWh per km/TEU. Up to half of the generated power could be sold as excess electricity. However, this self-power supply scheme, which needs building recharging facilities along the track, may not be adopted. Instead, a power generation company would be given the right to operate the solar power generation project and take profits from the operation. In return, it would provide electricity to the AutoCon system, under a contract for a different scheme.

National Infrastructure That Costs Less Than KTX

An estimated 3.7 trillion won would be needed for pilot implementation of AutoCon in the Uiwang-Bugang section (112km). When expanded to cover the entire Uiwang-Yangsan section (387km), the system would cost 13.1 trillion KRW. The government could make only infrastructure investments, while inducing private-sector investments in equipment and facilities. In this case, the government's financial burden would amount to about 2 trillion KRW for the pilot implementation section and 7 trillion KRW for the entire project.

This amount corresponds to 32.1% of the costs spent to build the infrastructure for the Seoul-Busan high-speed rail (land compensation, civil engineering and power leads). Transportation equipment expenses differ depending on the container handling capacity and the operation frequency. They are roughly expected to amount to 1.3 trillion KRW for the Uiwang-Bugang section and 4.7 trillion KRW for the entire Uiwang-Yangsan section.

AutoCon to Save 340 Billion KRW in Logistics Expenses and 220 Billion KRW in Truck Fuel Costs a Year

Assuming that AutoCon covers current container flows of 3.3 million TEUs on the Seoul-Busan axis, the benefits of saving logistics costs would reach an estimated 340 billion KRW a year. The benefits from reduced fossil fuel consumption by large cargo trucks are predicted to amount to 220 billion KRW a year.

Implementation of AutoCon would lead to the removal of large container trucks from the Seoul-Busan expressway, the effect of which would be tantamount to building a new expressway. Travel benefits from this effect would reach 9,675 billion KRW. In addition, the shift from container trucks to the automated container transport system is expected to significantly lower the risks of accidents and lessen damage to roads.

CO_2 emissions would drastically decrease to 2.84 CO_2g/ton-km, which corresponds to 1.1% of the present road-sector emission level of 264.2 CO_2g/ton-km and 11.2% of the rail sector's emission level of 25.4 CO_2g/ton-km.

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