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MagneMotion Maglev Demonstration on ODU Guideway

SUMMARY

MagneMotion and Old Dominion University undertook a cooperative agreement to demonstrate the MagneMotion *M3* urban maglev technology on an existing elevated guideway on the ODU campus in Norfolk VA. *M3* was designed for urban applications with speeds up to 100 mph, acceleration up to 1.6 m/s^2, and a 60 foot turn radius. Figure 1 shows the “sled” vehicle on the ODU guideway. This vehicle was weighted to simulate the operation of one section of an operational vehicle. This project involved constructing and testing the suspension and propulsion system with the objective of demonstrating *M3* is a viable alternative for urban transport, both in performance and cost.

Figure 1. *M3* vehicle on the ODU guideway

BACKGROUND

Starting in 2001, FTA funded an Urban Maglev project with the objective of exploring the potential of maglev to provide an alternative to more conventional wheel based urban transit.

Historically, maglev was viewed as an alternative to high speed rail, but this project was based on the premise that maglev has advantages for lower speed urban applications because of the reduced noise, energy consumption, and passenger travel time.

MagneMotion’s proposal was accepted and FTA provided cost shared funding for both an initial study and a follow on project to construct a reduced scale vehicle. Operation of this first vehicle was successful and led to a desire for higher speed testing of a full-scale model, and this led to a cooperative effort with Old Dominion University to use their existing maglev guideway.

ODU has an elevated guideway, shown in Figure 2, constructed for an urban maglev design that was never able to operate because of interactions between the vehicle and the guideway causing beam resonances.

Figure 2. Existing ODU guideway

M3 uses a permanent magnet suspension and Linear Synchronous Motor propulsion. The design uses lightweight vehicles and a wide gap (20 mm) suspension so it could operate successfully on the existing guideway. The *M3* design was first tested on an indoor guideway at MagneMotion in Devens, MA using beams designed to replicate the ones used at ODU. Figure 3 shows the test vehicle operating on the Devens guideway.

Figure 3. Test sled on guideway in Devens, MA

OBJECTIVES

The objective was to prove that *M3* design could propel an urban transit vehicle on a relatively lightweight guideway. Tests of noise and ride quality were designed to show that the design has better ride quality and lower noise than conventional wheel based transit, important criteria for operation in an urban area.

It was also important to develop a cost effective way to construct the LSM stator and suspension rail components and then install them on an elevated guideway.

METHODS

This project was organized in two phases:

1. Established system requirements with ODU and FTA, complete the design to meet those requirements, perform a risk reduction build in Devens MA, and execute a test plan.
2. Demonstrate *M3* technology on the existing outdoor elevated guideway at Old Dominion University in Norfolk Virginia.

Both phases involved extensive testing of performance parameters, noise, and ride quality.

An important part of the project was to develop a cost effective method of constructing the LSM and suspension components and installing them on the guideway beams. This was achieved by constructing 12 meter long sub-assemblies in Devens MA and shipping them to ODU via truck. The assemblies were then lifted by a crane and installed on a guideway that had been prepared to receive them. Figure 4 shows the crane lifting one sub-assembly, Figure 5 shows the guideway before the LSM and suspension components were installed, and Figure 6 shows the guideway after the LSM and suspension components were installed.

Figure 4. Crane lifting stator and rail module

Figure 5. Guideway before installation

Figure 6. Guideway after installation

RESULTS

All of the objectives were realized. The Devens test facility was used to develop and demonstrate the key elements of suspension control and propulsion, and the ODU installation demonstrated operation on an outdoor elevated guideway at higher speeds. Following are a few of the test results, all of which exceeded the goals of the Project.

- Track length 78 m
- Speed 10.5 m/s
- Acceleration 2 m/s^2
- Total mass 4.5 Mg
- Lateral force 15 kN

The Devens and ODU installations have, together, allowed testing for over one thousand hours of operation and travel of over six thousand kilometers.

MMI also measured ambient sound levels using a sound level meter. With the vehicle traveling overhead it was difficult to sense any increase above 50 to 52 dB ambient noise. It was noted that a campus HVAC system several hundred feet away dominated the background noise and that the *M3* noise was indistinguishable from background — low noise is an important advantage of urban maglev as compared with any other suspension system.

Ride quality was estimated by measuring vibration in all six degrees of freedom. We could not operate at a high enough speed to determine ride quality under anticipated operating conditions, but at the speeds we did operate ride quality was excellent. The use of a secondary suspension in the vehicle will contribute to improved ride quality. The testing showed that *M3* could operate successfully on the ODU guideway, but the beams used for this guideway were not designed for the *M3* system. We believe that beams with about the same size and cost can provide better ride quality, particularly at higher speeds. It is expected that for a fully developed commercial system the ride quality will be significantly better than for any other suspension system.

CONCLUSIONS

The *M3* design operated successfully on the ODU guideway with acceleration up to 2 m/s^2 and a speed up to 10.5 m/s (23 mph), limited only by the length of the section of the guideway populated with LSM stators and suspension.

FUTURE ACTION

The *M3* Urban Maglev system has been demonstrated to the point that there is little technical risk in continuing the development, but before commercial installation is possible a number of developments must be completed, including:

- Construction of a horizontal curve, vertical curve, and switch.
- Construction of a passenger carrying vehicle.
- Development of a source for onboard power for HVAC, possibly using inductive transfer — suspension power is negligible because of the use of permanent magnets.
- Demonstration of operation at higher speeds.
- Extensive testing with an emphasis on proving safety and reliability are suitable for commercial operation.

MagneMotion is currently exploring ways to continue the development. One option is to complete installation on the entire 1 km ODU guideway and construct a commercial vehicle. This would allow testing at speeds up to at least 30 m/s (66 mph) and certification of safety and reliability. Another option is to complete a test facility near Devens that would allow completion of a design to the point it could be used for a commercial installation.

With relatively minor changes we believe the *M3* could operate at speeds substantially higher than the design speed of 45 m/s (101 mph). This higher speed operation could be used as an alternative to high speed rail.

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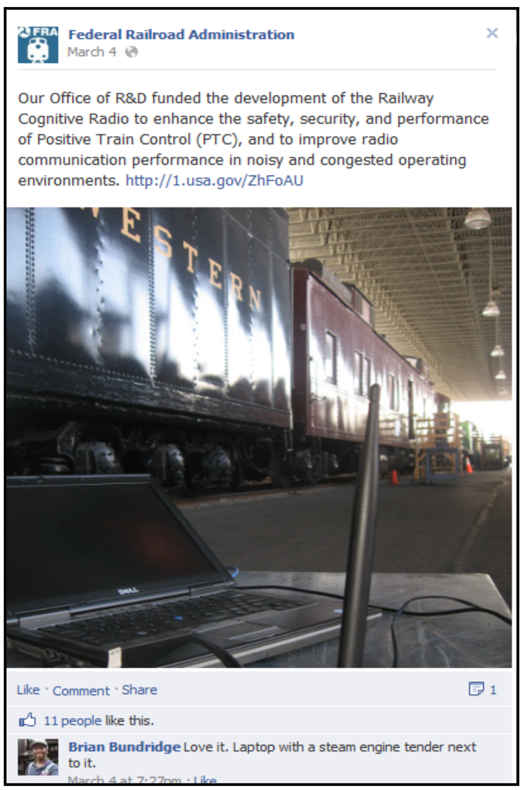

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