

Adaptation of Existing Railroad Trackage for Levitated Maglev Vehicle Operations

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ABSTRACT: The 2nd generation Maglev-2000 vehicles have the unique capability for magnetically levitated and propelled along existing railroad tracks that have been adapted for Maglev use. A detailed study of the application of Maglev-2000 operation on existing railroads is described in which maglev vehicles would transport passengers and airfreight between New York City and Stewart International Airport, 73 miles north of the City. Stewart International Airport, located in Newburgh, NY could be the city's 4th major airport, but it is too far away to be practical using present transport systems. Projected daily air passenger traffic is estimated to be 44,000 persons annually, with a travel time of 30 minutes at an average speed of 145 mph for direct non-stop service.

1 INTRODUCTION

The purpose of this study is to determine the preliminary feasibility of establishing passenger service by a Maglev-2000 second generation superconducting maglev transport system from Grand Central Station in New York City to Stewart International Airport. With the extreme overcrowding of the three airports servicing the tri-state region, the almost impossible task of expanding the airports because of lack of land and, especially, air space, and the ever increasing demand for air travel, Stewart International „Airport would be an ideal “fourth” major hub airport for the Region if, satisfactory access could be developed. This was a primary motivation for the New York State Energy Research and Development Administration (NYSERDA) to direct this study.



Figure 1. Maglev 2000 Vehicle on Elevated Guideway

JFK has the highest total revenue passenger traffic, 47.8 million people per year, followed by 35.4 million for Newark, and 23.1 million for LaGuardia. Stewart revenue traffic is much smaller, only 0.75

million people annually – a result of the lack of a fast, effective way to access the Stewart airport.

Stewart is far too distant from the population centers in the NY/NY region (73 miles from Manhattan) for ready access by motor vehicles. There is no present access by train. Travelers would have to pay high sums for access by taxi, limo, shuttle and trip time to the airport would be well over an hour. Drive time to the airport by private or rental car would be as much as 2 hours, depending on location.

2 THE STUDY

This study examined three possible routes for NYC to Stewart:

1. Planar panels on the Metro North Hudson Line to the Tappan Zee Bridge, then elevated guideway along the NYS Thruway right of way to Stewart (total distance of 73 miles),
2. Planar panels on the Metro North Hudson Line to the Bear Mountain Bridge, then elevated guideway along the NYS Thruway right of way to Stewart (total distance of 71 miles), and
3. Planar panels on the Metro North Hudson Line to the Newburgh-Beacon Bridge then several miles of elevated guideway along the Interstate I-84 right of way to Stewart (total distance of 81 miles).

The study found that alternatives 1 and 3 were feasible, with 1 being the fastest and 3 being the least costly. Alternative 2 was not feasible.

2.1 Summary of Alternative 1, the Preferred Alternative.

- Metro-North Tracks can be Adapted for Levitated Travel of Maglev Vehicles.
- Maglev Vehicles Travel 25 miles From Grand Central Station on Metro North trackage to the Tappan Zee Bridge at Average Speed of 80 mph.
- Maglev Vehicles Travel 48 miles from Tappan Zee Bridge to Stewart Airport alongside NY Thruway at Average Speed of 250 mph.
- 30 minute trip time between Grand Central Station and Stewart Airport
- 44,000 passenger trips daily projected between Grand Central and Stewart Airport (2-way).
- Metro-North tracks now used by Poughkeepsie trains also modified for Maglev travel all the way to Poughkeepsie to eliminate scheduling conflicts between Maglev vehicles and slower diesel trains. Average Maglev Speed to Poughkeepsie is 80 mph; daily traffic is 10,000 passengers.
- Maglev vehicles reduce trip time to Poughkeepsie to 1 hour, compared to present 1 hour 45 minutes.
- Maglev vehicles leave Grand Central for Stewart Airport every 15 minutes and every 15 minutes for Grand Central from Stewart.
- Maglev vehicles leave Grand Central for Poughkeepsie every 30 minutes and every 30 minutes for Grand Central from Poughkeepsie.
- Maglev vehicles carry an average 100 passengers but have capacity to carry 150 (2/3 loading factor)
- Peak to average Maglev passenger traffic is 1.5/1
- During peak traffic periods, 5 vehicles Maglev consists are used for travel to Stewart, and 3 vehicle consists for travel to Poughkeepsie.
- 2.5 Billion dollars total construction cost for modification of Metro-North Line to Poughkeepsie (73 miles) plus construction of 48 mile elevated guideway from Tappan Zee Bridge to Stewart Airport
- 30 Maglev vehicle Fleet (50% extra above the 20 vehicles used in maximum service) for Grand Central to Stewart route.
- 18 Maglev Vehicle Fleet (50% extra above the 12 vehicles used in maximum service) for Grand Central Station to Poughkeepsie route
- 350 million dollars total capital cost of 48 Maglev vehicles fleet (5 million dollars per Maglev vehicle)
- 20 year amortization period for Maglev vehicles plus 5% charge per year for maintenance
- \$15.05 total trip cost per passenger for 73 mile one-way trip between Grand Central and Stewart Airport.
 - Includes amortization of guideway and vehicle capital costs, maintenance

costs, and costs for power, personnel, and traffic control.

- \$8.53 total trip cost per passenger for 73 mile one-way trip between Grand Central and Poughkeepsie.
 - Includes amortization of vehicle costs (guideway costs are assigned to Stewart route, maintenance costs, and costs for power & personnel
 - 1/4th of present actual cost for Metro-North travel
- 4.9 KWH (e) consumed per one-way passenger trip for Grand Central to Stewart service
- Driving to Stewart or Poughkeepsie from Grand Central would consume 120 KWH of gasoline energy at 20 mpg.
- 11-megawatts average power demand to transport 44,000 passengers daily to and from Stewart, plus 10,000 passengers daily to and from Poughkeepsie.

With a one-way trip price of \$25 per passenger trip, a capital cost of \$9.73 and an O&M cost of \$7.08 that leaves excess revenues of \$8.19 per passenger. At 16 million passengers per year, the excess annual revenues will exceed \$131 Million.

2.2 Environmental Issues

- The all electric, highly energy efficient superconducting Maglev system uses less electricity per passenger and ton-mile than steel-wheeled electric trains, busses, and autos.
- Maglev has no emissions of pollutants and green house gasses.
- Maglev is a faster means of transport.
- Maglev is much quieter than steel-wheeled rail.
- Maglev maintenance and operating costs are much less than electric trains.
- Maglev does not create brake “dust” when entering stations. Maglev is slowed by a change in the electric current not by brake shoes.

There will be substantial environmental studies, assessments, and a major environmental impact statement required to accomplish the construction of the elevated guideways along the right of way of the Thruway. Land acquisition should be minimal;

however construction impacts will have to be examined. The resultant long-term impacts should be significantly positive.

2.3 Safety Benefits

Enabling the existing Stewart International Airport complex to become the fourth major international airport for the New York City region will yield significant safety benefits. The local airways would be less congested, reducing the possibility of airplane collisions, and flights could more readily divert to less stressful landings in bad weather conditions. In addition, by transporting passengers to the airport by maglev, plus additional commuter passengers on the Metro North railroad system, will reduce congestion and accidents on the region’s highways. This will save many lives and avoid serious injuries. There also will be substantial public health benefits by reducing pollution from motor vehicles.

2.4 Economic Benefits

Construction of the proposed New York City to Stewart Maglev route will bring substantial economic benefits to New York State and the Nation. Transport costs on the maglev route will be significantly less than by using present modes of transport and the time savings will increase economic productivity. Moreover, the construction of the guideway route and maglev equipment will provide large numbers of jobs, and act to start a major U.S. maglev industry for further implementation of additional systems in the U.S. and other countries. This has the potential for creating large numbers of jobs and export shipments.

2.5 The results

Figure 2 shows a map of the route from Grand Central Station to Stewart, using the Metro North Hudson Line to the Tappan Zee Bridge. The Maglev elevated guideway will be constructed on the right of way of the New York State Thruway, enabling 250 mph maglev travel from the Tappan Zee Bridge to Stewart International Airport. Figure 3 shows a Google view of the Stewart Airport complex, with long runways capable of handling international air flights.

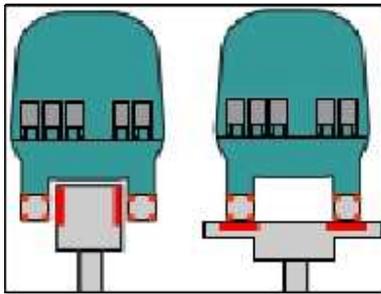


Figure 5. Concept drawing of the elevated guideway system and the planar system.

Aluminum conductor loops on the guideway carry currents induced by superconducting magnets on the vehicle as it moves past. Induced currents levitate the vehicle 4 inches above the guideway, stabilize it against external forces with 2 g stability. Propulsion loops in the assembly carry AC current from external power source to propel and brake the vehicle. Aluminum loop assemblies are encapsulated in polymer concrete panels that can either be attached to sides of the elevated guideway beams or laid flat for the planar guideway on existing RR track beds. The aluminum coil assemblies are currently being designed to be encased in concrete supported by RR ballast.

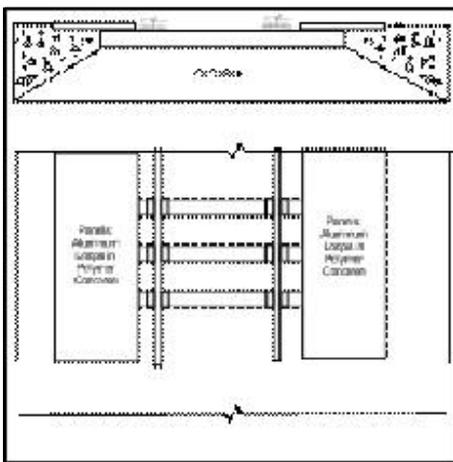


Figure 6. Schematic layout of planar system support

Figure 6 shows the concept for supporting infrastructure of the planar system. The aluminum coils that make up the levitation function, the stability function, and the propulsion function are placed along the railroad trackage, supported by the ballast and encased in concrete. The propulsion loop is powered by AC current. The levitation and stability loops are passive, with current induced by the moving superconducting magnets on the vehicles. The supporting structure and the depth of the coils

embedded in the concrete have yet to be designed and tested.

The cost estimate for the elevated guideway is based on the design shown in Figure 7, 8 and 9. The concept for the pier foundation is shown in Figure 7. It consists of a 16" -6" x 18" -0" x 4" -0" pile cap supported by 8 steel cased 24" diameter concrete filled drilled piles or caissons. The precast segmented column (shown in Figure 8) is post tensioned to the pile cap with cables as shown in the drawing. The two-way pier cap is shown in Figure 9.

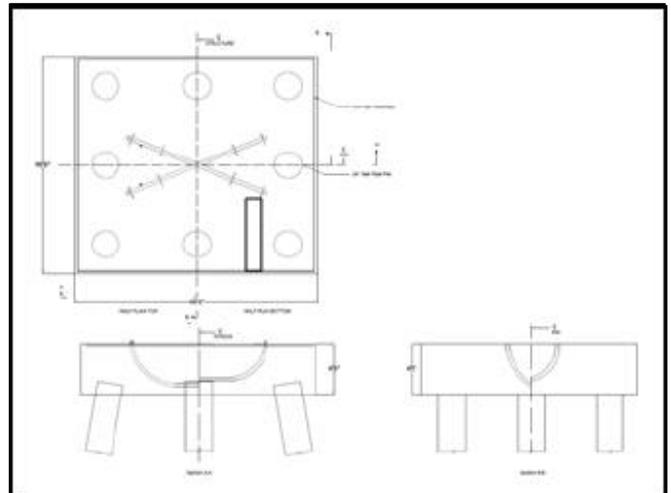


Figure 7. Design for Pier Foundation (Wolek 2010)

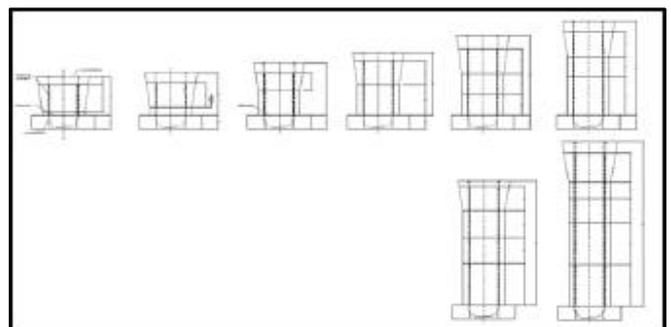


Figure 8. Segmented Precast Post Tensioned Stacked Pier Concept Design (Wolek 2010)

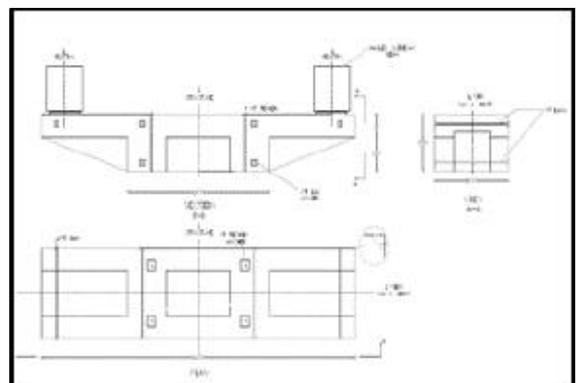


Figure 9. Precast Post Tensioned pier cap with center maintenance beam (Wolek 2010)

Based on these concept designs, the construction costs per two-way mile is:

Elevated Guideway

Panels	\$ 4.37 Million
Structure	25.50
PMAD	1.91
Safety	0.22
C&C	0.14
<hr/> TOTAL	<hr/> \$32.14 Million

Planar Guideway

Panels	\$ 4.37 Million
Structure	4.63
PMAD	1.91
Safety	0.22
C&C	0.14
<hr/> TOTAL	<hr/> \$11.27 Million

4 CONCLUSION

There is no technical reason why the second generation superconducting Maglev2000 system cannot be constructed to link Grand Central Terminal in New York City to Stewart International Airport, thereby relieving the stress of crowded air space on the three major hub airports in the Metropolitan Region. There are political, financial, and some environmental issues that will have to be addressed. Alternative 1 has a capital cost of about \$3 Billion, depends on the approval of Metro North Rail to convert to all Maglev2000 vehicles, the construction of the new Tappan Zee Bridge, a positive Environmental Impact Statement for the construction of an elevated guideway on the New York Thruway right-of-way, and, of course, the political will to fund the project.

Alternative 3 is an attractive option since its capital cost is about 40% of alternative 1. This alternative will also have some of the same issues as the preferred alternative except there is less elevated guideways (about 3 miles on I84 right-of-way) and the Beacon-Newburg Bridge will have to be reinforced to carry the Maglev vehicles. The total trip time will be increased by 15 to 20 minutes. However, the total cost per passenger trip will be \$4.77 or 35% less than the preferred alternative.

5 REFERENCES

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