Urban Maglev Integrated Guideway/Girder Module (IGGM) Design

No. 120

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ABSTRACT: This paper discusses the work performed by General Atomics in the development of the Integrated Guideway/Girder Module (IGGM). General Atomics' (GA) design goal for the Urban Maglev integrated guideway/girder module (IGGM) is to integrate the features of the current steel guideway module with a pre-stressed Steel Fiber Reinforced Concrete (SFRC) girder. The IGGM design approach is to combine the Maglev interface features of the existing guideway module with the functional support features of the guideway girder spans. This effort is complemented by the Guideway Steel Fiber Reinforced Concrete Hybrid Girder Design as discussed at the Maglev 2006 conference in Dresden Germany and the Urban Maglev Fiber Reinforced Concrete Girder Design and Development Testing presented at this Maglev 2008 conference. This paper will summarize the application of IGGM's to integrate the features of the guideway systems (LSM and levitation track) into the structural elements of the girder spans.

1 INTRODUCTION

General Atomics (GA) teamed with Mackin Engineering has developed an integrated Guideway/ Girder Module (IGGM). The IGGM design goal is to integrate the features of the Linear Synchronous Motor (LSM) and Levitation Track with the guideway girder spans. By combining the elements of the Maglev systems with the structural elements of the guideway into an integrated module, the goal of creating a lower cost, lighter weight support system with a small cross-sectional envelope can be met.

2 BACKGROUND

2.1 Guideway module design

The design concept for the General Atomics test track guideway was for a separate guideway module independent of its supporting foundation. This guideway module supports the propulsion and levitation components and provides the landing and braking surface for the vehicle. Since the test track was build at grade, the guideway module is supported along its length by the concrete foundation.

As illustrated in Figure 1, the guideway module assembly consists of two (carbon-steel) guideway top plates (1). These plates carry both the LSM assembly (2) and provide the landing surface for the station/emergency wheels. Also, the guideway levitation/propulsion module consists of two stainless steel angle brackets (3), which support the track assemblies (4). Both the LSM top plates and the angle brackets are interconnected with stainless steel

guideway frames (5). Running the length of the module on both sides are two stainless steel guideway side plates (6), which are welded to the guideway frames and provide the mounting surface for the track assemblies. The guideway module is then mounted on a separate girder or concrete foundation, as in the case of the test track.

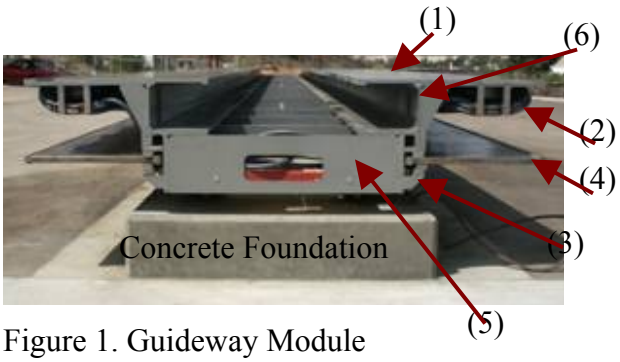

Figure 1. Guideway Module

2.2 Steel Fiber Reinforced Concrete Girder

The Steel Fiber Reinforced Concrete (SFRC) girder has been under development as outlined in the Urban Maglev Fiber Reinforced Concrete Girder Design, Development and Testing paper number 012. The SFRC girders consist of a specially formulated concrete mix including steel fiber reinforcement. The steel fiber replaces the steel reinforcing bars to resist creep, shrinkage and thermal expansion. In addition the steel fibers replace the steel reinforcing stirrups that are designed to carry the shear stresses induced by the imposed dead and live loads.

Even though steel fiber reinforced concrete girders require prestressing strands, their fabrication cost can be significantly reduced and their simplicity can be greatly improved when compared to the construction of conventional reinforced concrete girders with a complex reinforcement cage requiring many hours of touch labor to fabricate.

3 INTEGRATED GUIDEWAY/GIRDER MODULE

3.1 Design Goals

The design goal for the ICCM module is to integrate the existing features of the current test track guideway module with the structural girder spans. By combining the interface features of the guideway module into the concrete girders a more efficient, smaller cross-section, lighter weight, and lower cost structure can be achieved.

3.2 Design Approach

The existing test track guideway module provides features which provide: (1) a landing surface for the landing wheels, (2) a mounting surface for the LSM motor, and (3) a mounting interface for the levitation track. These modules were designed to be supported by a separate elevated girder or at grade foundation. These modules were designed to be manufactured in a factory setting and then transported to the site for installation.

The IGGM modules are designed to be manufactured in a factory or on location at a batch plant.

First, a set of standard molds are manufactured that represent the special geometry of the project alignment. This includes straight modules, transition modules and curved modules of specific lengths, radius, and super-elevation required for the alignment.

Since the IGGM girder contains no reinforcing bars, it is simple to manufacture and mass-produce. The accuracy of the girder is built into the forms into which the girder is cast. Once the forms are designed and manufactured, the finished girder replicates the contours and accuracy of the mold. This is a very important asset when it comes to manufacturing curved girders with super-elevation. The effort of casting a curved girder should be no more complex than casting a straight girder.

Each of the IGGM girders will include prestressing steel to carry the tensile stresses induced by the imposed dead and live loads. This may be accomplished by pre or post tensioning the beams.

Shown in figure 2 is an example of a completed IGGM girder after removal from its mold.

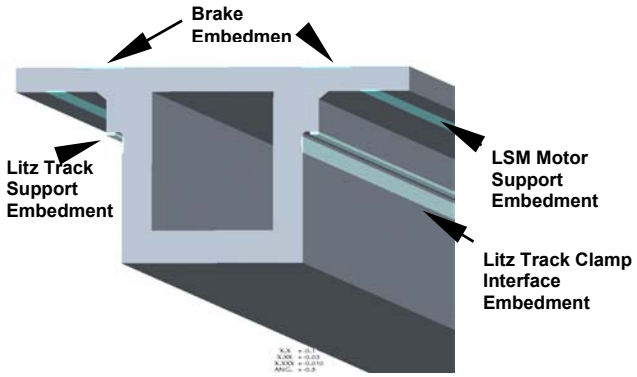

Figure 2. IGGM girder with embedded features

Included in these molds are features for supporting embedded structures. These structures provide the interface features for supporting both the LSM motor and levitation components.

Shown in figure 3 is a cross-section of the IGGM girder showing the details of how the embedments are anchored into the girder.

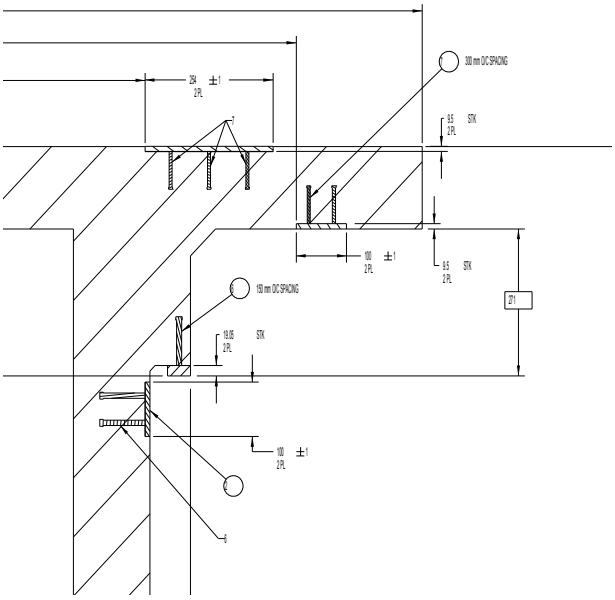

Figure 3. IGGM girder cross-section

An example of an embedment structure is shown in the following figure 4. This is the copper rails for the Holloman Maglev Beam which is installed in a steel fiber reinforced beam with no reinforcing bars.

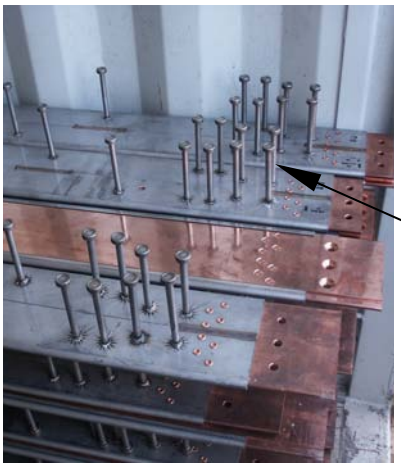

Figure 4. Example of embedment structure

After the IGGM girder has fully cured, the LSM motor and levitation track components are attached using these embedment structural surfaces. Shown in figure 5 is a view of the completed IGGM girder.

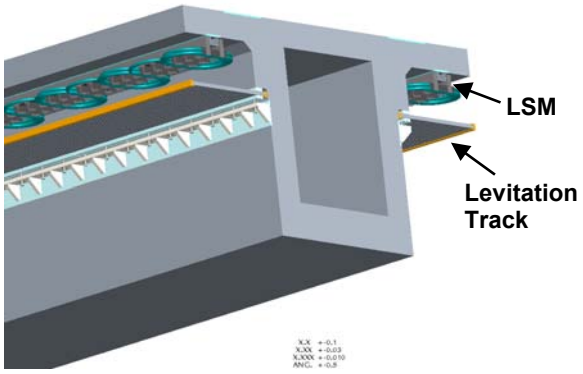

Figure 5. Completed IGGM girder

4 CONCLUSIONS

The IGGM girder is simple to manufacture and mass-produce. The accuracy of the girder is built into the forms from which the girder is cast. Once the forms are designed and manufactured the girder replicates the contours and accuracy of the mold. Curved IGGM girders with super-elevation should be no more complex to manufacture than a straight IGGM girder.

The IGGM girder is mostly concrete requiring little or no maintenance to prevent corrosion and maintain its aesthetic appearance. Metal guideway structures require routine maintenance, such as scraping and repainting to prevent corrosion and maintain its aesthetic appearance.

Another advantage of the IGGM girder is its small cross-sectional envelope, due to the integration of the structure as well as functional aspects of the guideway. A comparison of the cross-section area of the IGGM girder is compared to the existing test track guideway module design in figure 6. This comparison clearly displays the efficiency of integrating the functional and structural features into one structure.

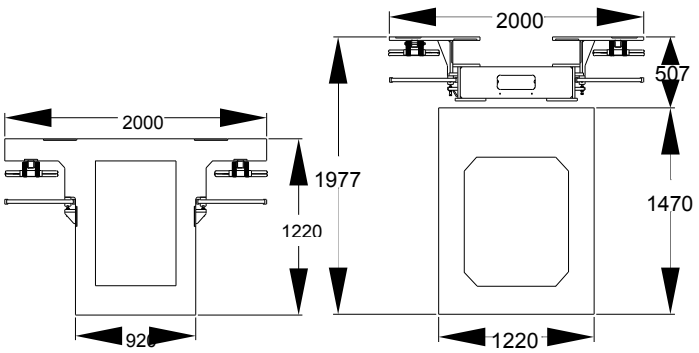

Figure 6. Cross-Section envelope comparison

5 REFERENCES

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