Development of Live Load Distribution Factors for GBeam Highway Bridges

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The GBeam

GBeam highway bridges are experiencing wider deployment with four constructed to-date: two in Hampden, ME, one in Florida and one in RI. The GBeam is an open box girder made from a vacuum-infused fiber reinforced polymer (FRP) that incorporates both glass and carbon fiber in a complex architecture to optimize material use. The FRP GBeam behaves compositely with the concrete deck, which can be reinforced with steel or FRP rebar. A typical GBeam girder cross section is shown in Figure 1. While the GBeam is a direct replacement for a steel or concrete girder, it has higher corrosion resistance, lighter weight, and longer life spans compared to traditional steel or concrete members.

Current practice assumes an AASHTO type c open box girder live load distribution factor (DF) for GBeam design, but the applicability of this DF has not been experimentally verified. To assess live load distribution in GBeam bridges, two bridges in Hampden, Maine, the Grist Mill Bridge (HGMB) and the Hampden Twin bridge, were subjected to diagnostic live load tests conducted with heavy trucks, and will subsequently be analyzed with calibrated finite-element (FE) models to assess girder moments and shears under a wide range of load scenarios

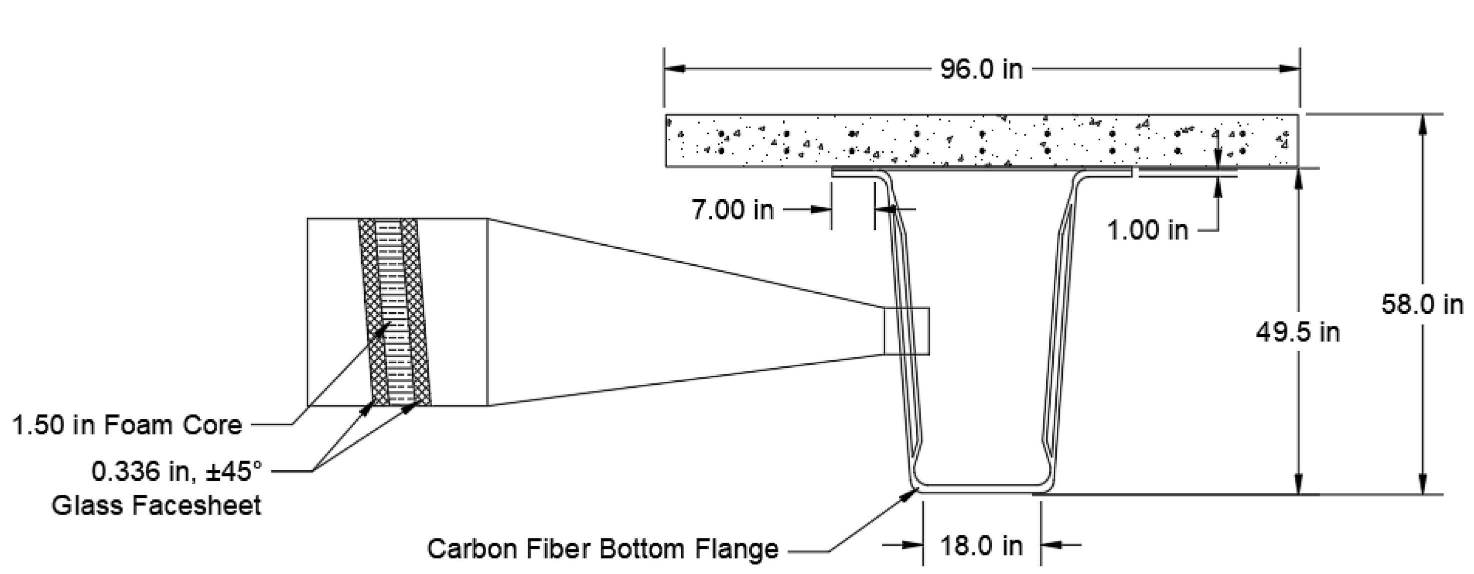

Figure 1: HGMB Girder Cross Section

Status and Work Plan

1. Live load test both Hampden Bridges – ***complete***
2. Create FE models of both Hampden bridges – ***complete***
3. Calibrate FE models to test results – ***in process***
4. Create suite of FE models for parametric studies – ***in process***
5. Develop LL DF equations based on parametric study results

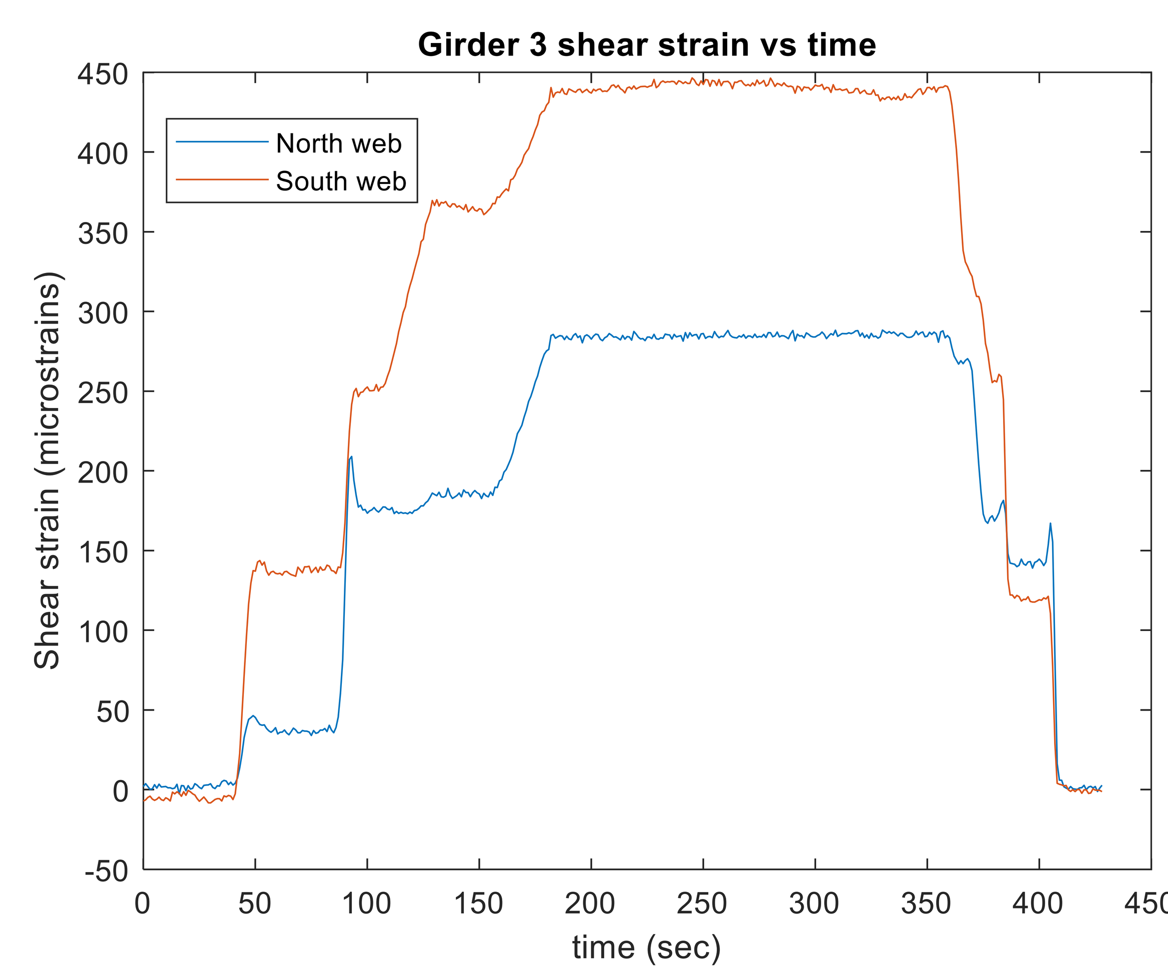

Figure 2: Shear Strains most interior girder maximized shear load test run HGMB 2023

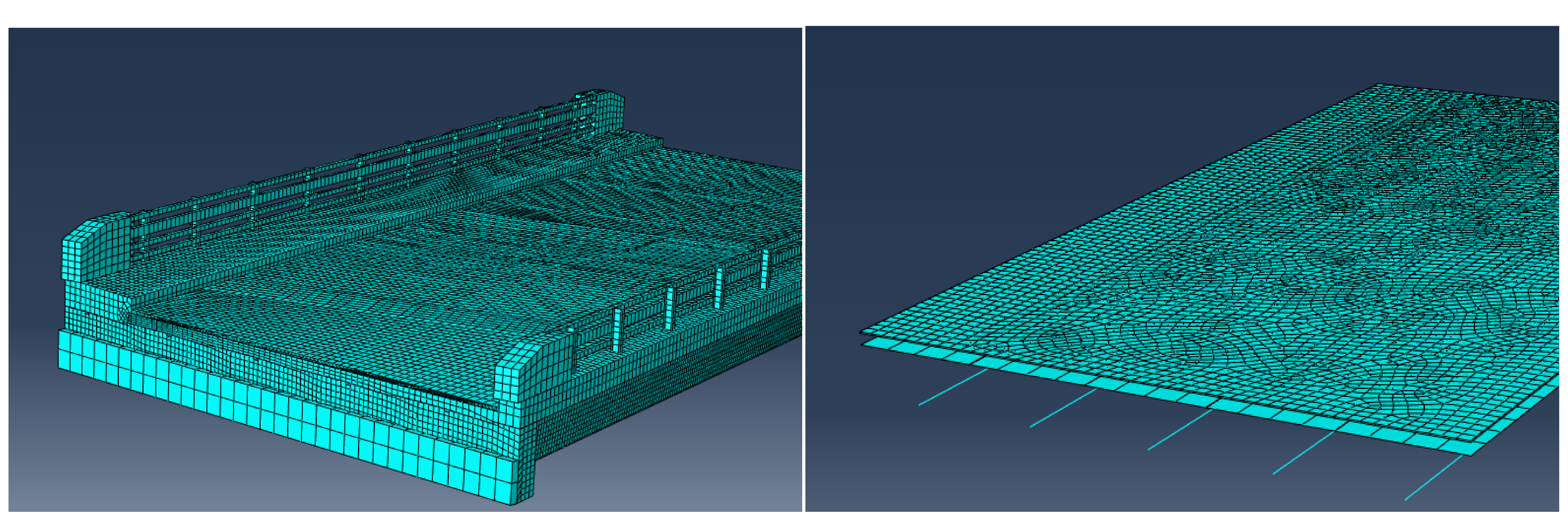

Figure 3: HGMB High-Fidelity (left) and Simplified (right) Models Meshed for M42 2022 Test

Table 1: Comparison of AASHTO DFs and Maximum Test Computed GLFs

Source	Girder 1	Girder 2	Girder 3	Girder 4	Girder 5
AASHTO	0.286	0.601	0.601	0.601	0.609
HGMB 12/20	0.520	0.441	0.539	0.441	0.645
HGMB 7/22	0.506	0.386	0.528	0.593	0.636

Current Findings

- Figure 2 shows how individual girders experience different shear strains across two separate webs, which may need to be accounted for in future shear DF equations.
- Table 1 shows inferred Moment Girder Lane Fractions (GLFs) from diagnostic live load tests compared to AASHTO class c girders. AASHTO can be slightly conservative for interior while unconservative for exterior girders. A GLF is the number of lane loads carried by each girder under a certain test scenario.
- Initial calibration results shown in Figure 4 compare the FE model predictions with field load tests data, indicating that the calibrated and simplified models very accurately predict live load moment distribution.

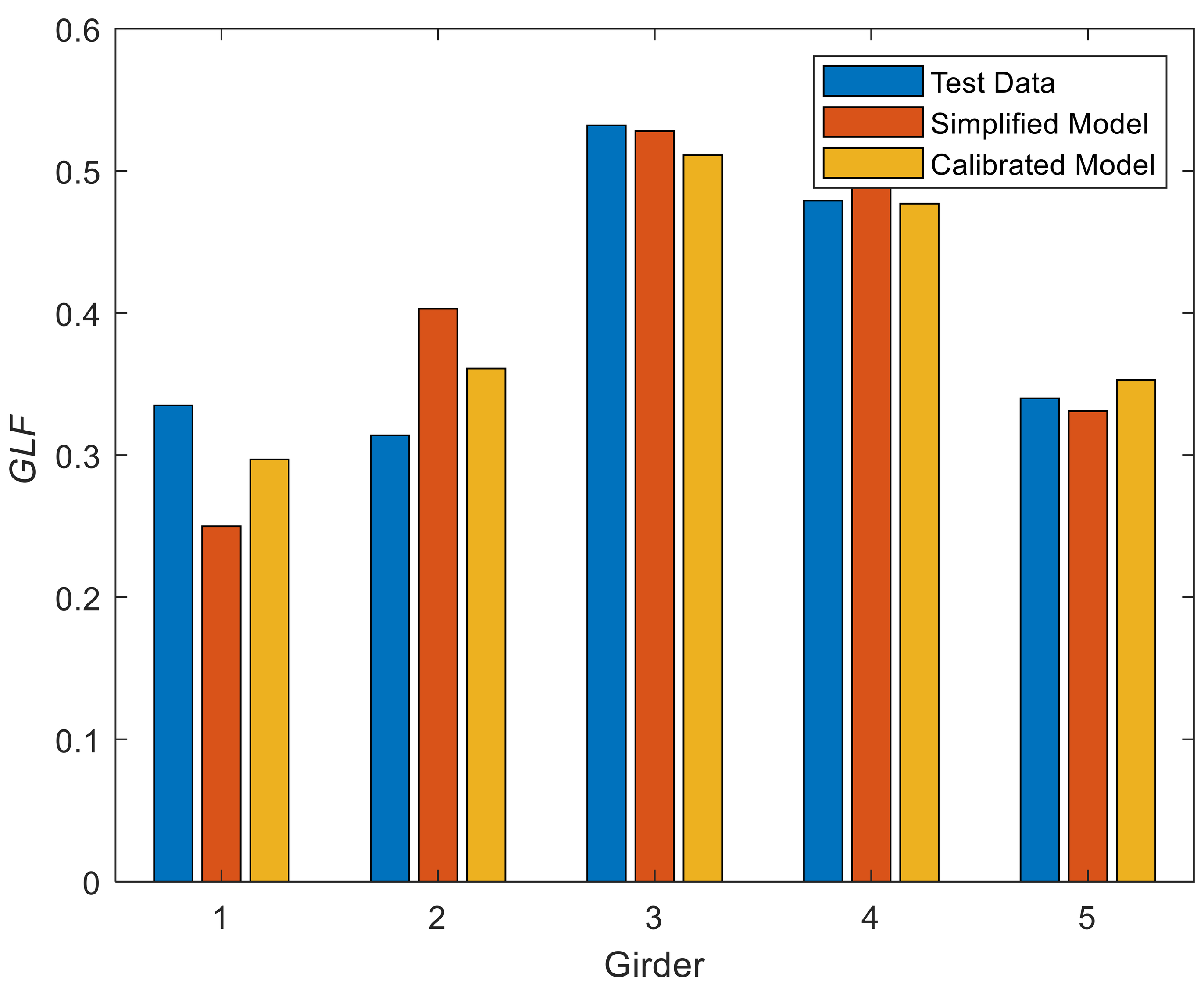

Figure 4: HGMB MGLF Comparison M42 Test 2022 (Calibrated vs Simplified Model)

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