**Click here to enter Program or Project Title**

**Progress Report – Click here to enter a date.**

**Title:** Assessment and Repair of Prestressed Bridge Girders Subjected to Over-height Truck Impacts Pooled Fund Project

**Project Number:** TR202011

**Principal Investigator (PI):** Mohamed ElGawady PhD (PI)

**Co-PI(s):** William Schonberg PhD, PE (Co-PI)

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| --- | --- | --- | --- |
| **Award date:** | **1/1/2021** | | |
| **Scheduled completion date:** | **12/31/2023** | **% of project completed to date:** | **50%** |
| **Total budget:** | **$**755,000 | **% of budget expended to date:** | **47%** |
| **Draft report due:** | **9/30/2023** | **Final report due:** | **12/1/2023** | |

Provide a short description of the **work currently underway**.

*Use* [*additional notes section*](#bookmark=id.1t3h5sf) *if you need to provide more information.*

***Task 2. Experimental testing of bridge girders subjected to lateral impacts:***

* Working with a local precast supplier (Coreslab) to provide the prestressed girders.
* Finalizing the back-stoppers to accommodate the girders
* Preparing the impact mass
* Finalizing the data acquisition system. The current data acquisition system at S&T needed to be modified to acquire high-speed impact data. The required digital cards were delayed for nine months but finally arrived last week to S&T. Our lab engineer is finalizing the measurement system.

***Task 5: Develop finite element models for the beams. Task 5: Develop finite element models for the beams.***

* Finite element models are being developed for damaged girders and full-bridge to determine the residual capacity after different damage states.
* Finite element models are being developed to determine the residual capacity of bridge girders and full-bridge after repairing using three different repair options.

Provide a short description of the **noteworthy activities/accomplishments** during this reporting period.

*Use* [*additional notes section*](#bookmark=id.1t3h5sf) *if you need to provide more information.*

***Task 2. Experimental testing of bridge girders subjected to lateral impacts:*** The test setup is ready for testing as shown in the figures below. The cart empty weight is 2000 Ibs. Reinforced concrete slabs, 6 x 3 ft and 6 inch thick, will be used as cart weights to create different levels of damage. Four slabs will be used during testing. Each slab represents 1350 Ibs.

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| Fig. 1: Test setup ready for testing |

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| Fig. 2: Cart ready for testing |

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|  |
| Fig. 3: Reinforced concrete slab used as an additional weight for the impact cart |

***Task 5: Develop finite element models for the beams.***

Finite element models have been developed to simulate different damage scenarios before experimental testing. Examples of the work done is shown below:

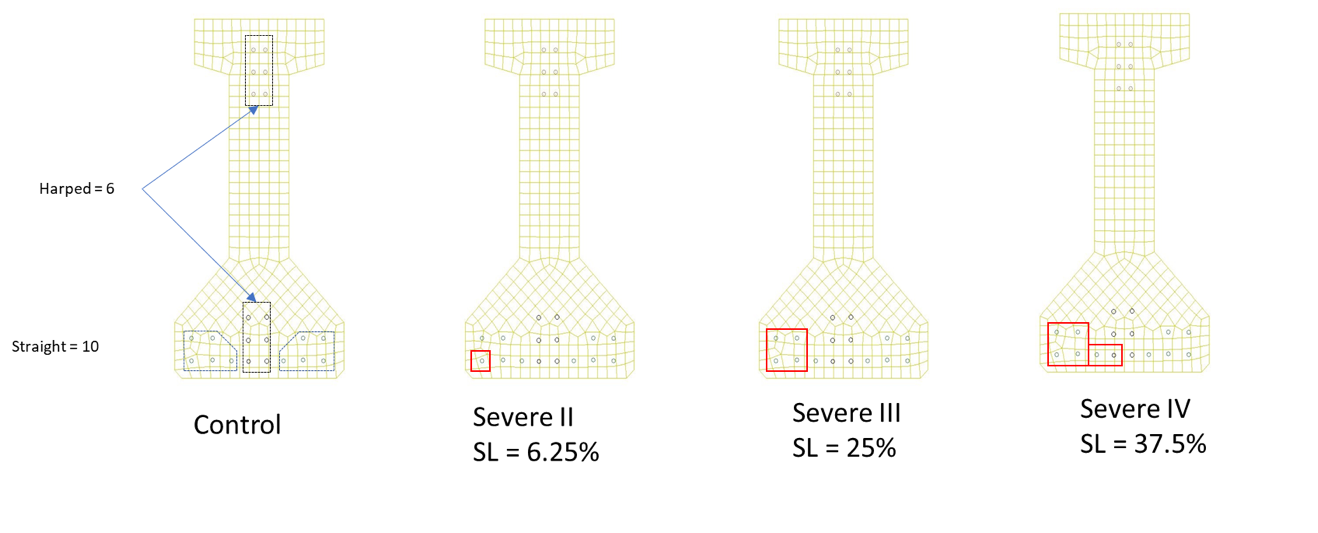
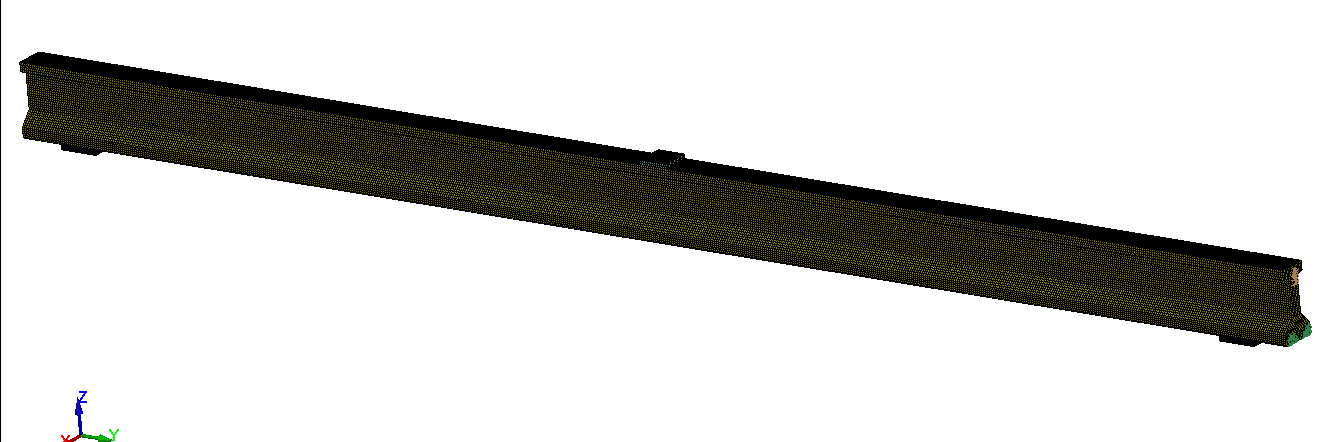


Fig. 4: Different types of damages



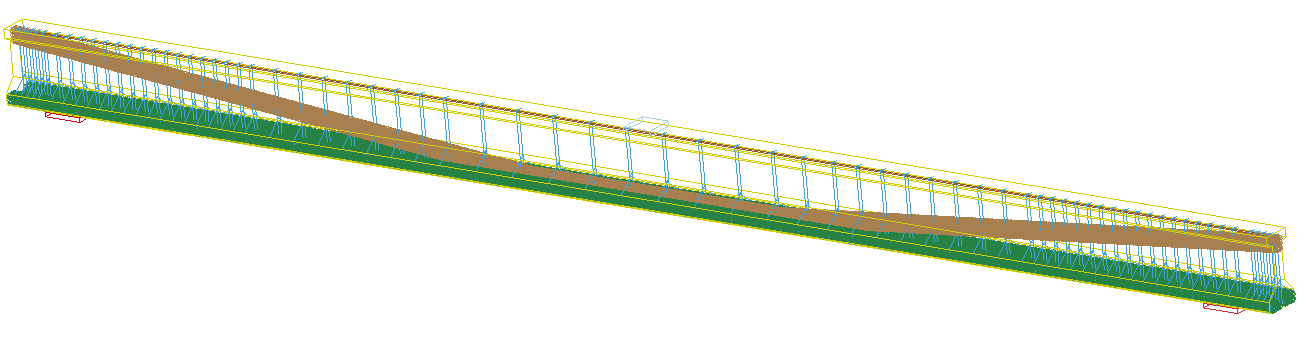


Fig. 5: Control girder

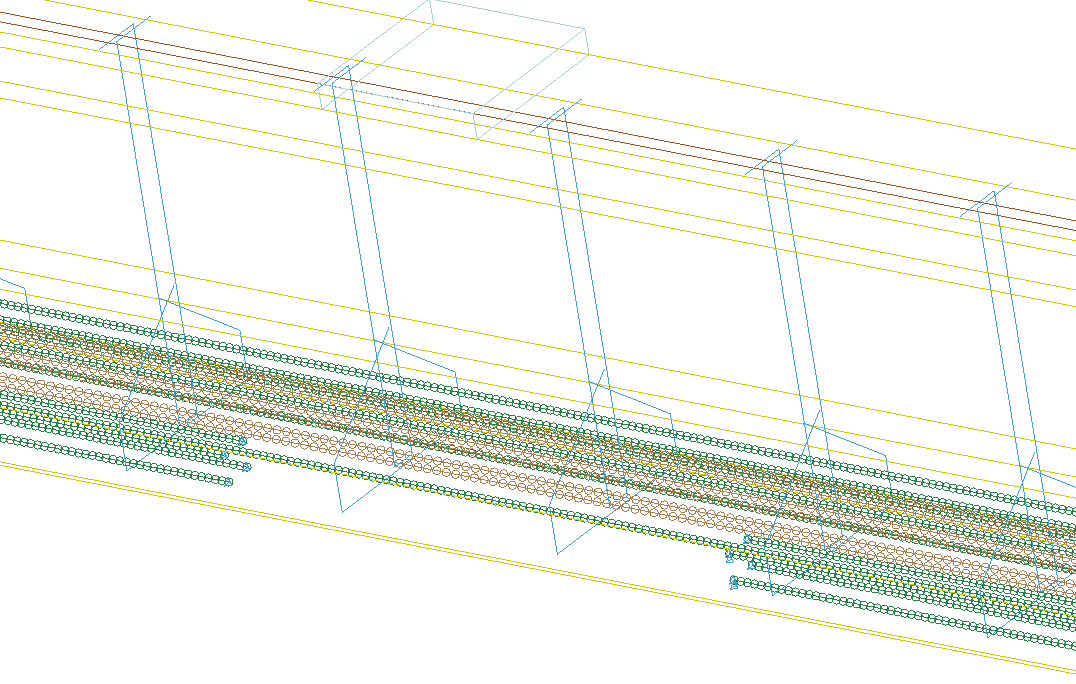


Fig. 6: An example of strand loss

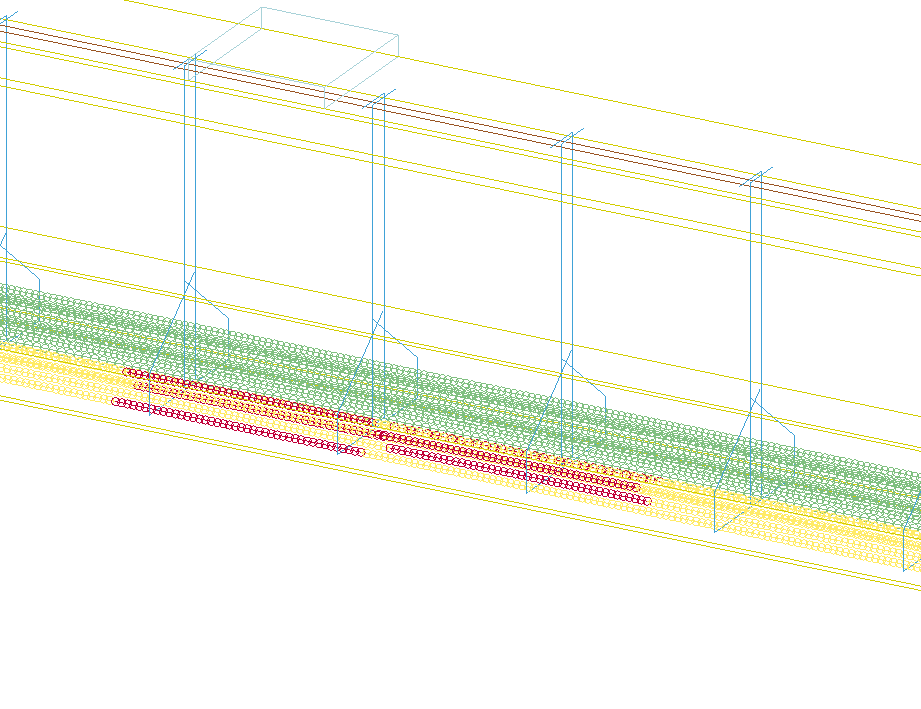


Fig. 7: An example of repair opetions

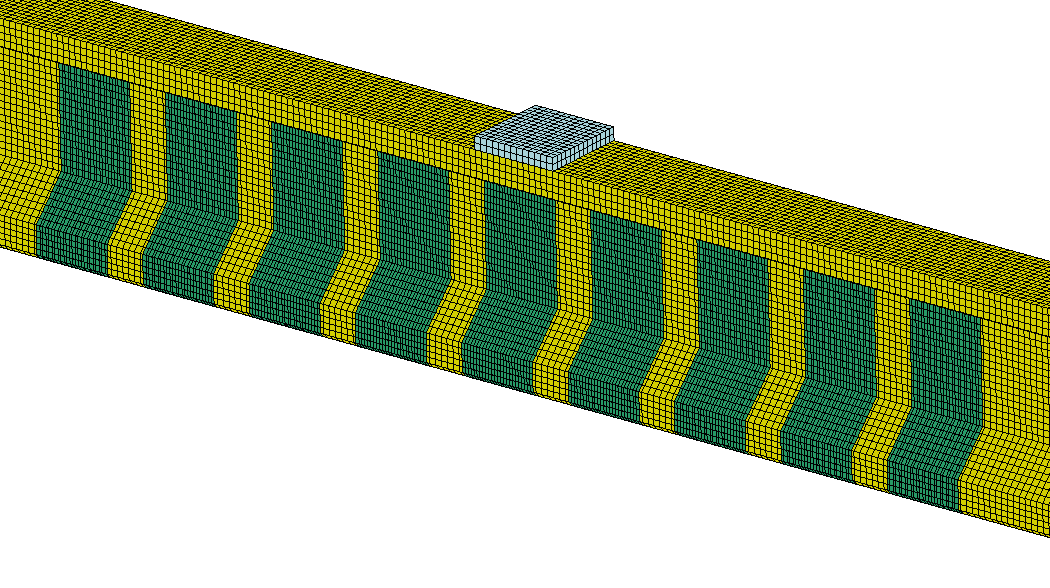
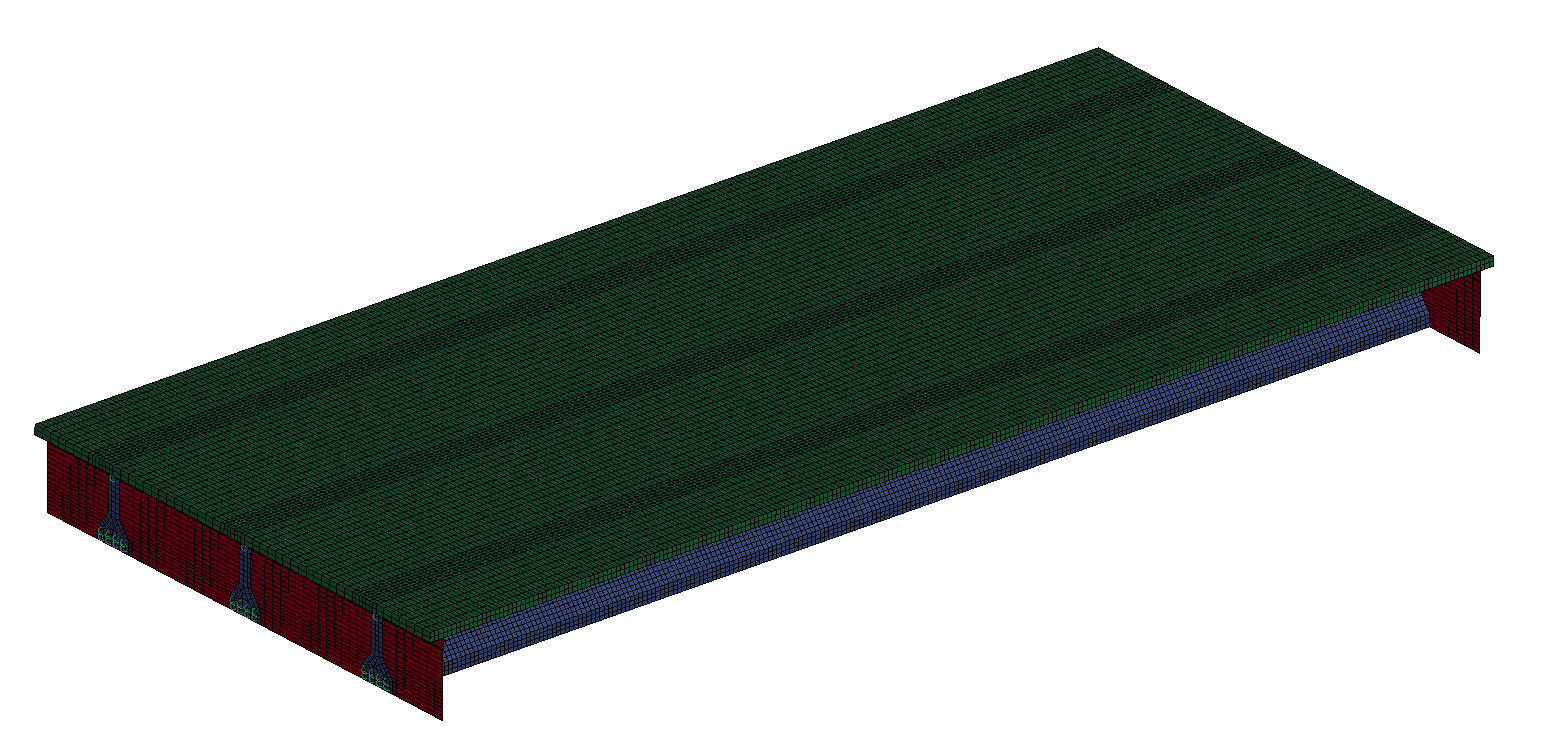


Fig. 8: Another example of repair options



Reinforced Concrete **End Diaphragm**

**Prestressed Girders:**

Concrete SOLID ELMS + MAT CSCM

Strands BEAM ELMS + MAT\_PLASTIC\_KINEMATIC

Apply prestressing force using Temperature

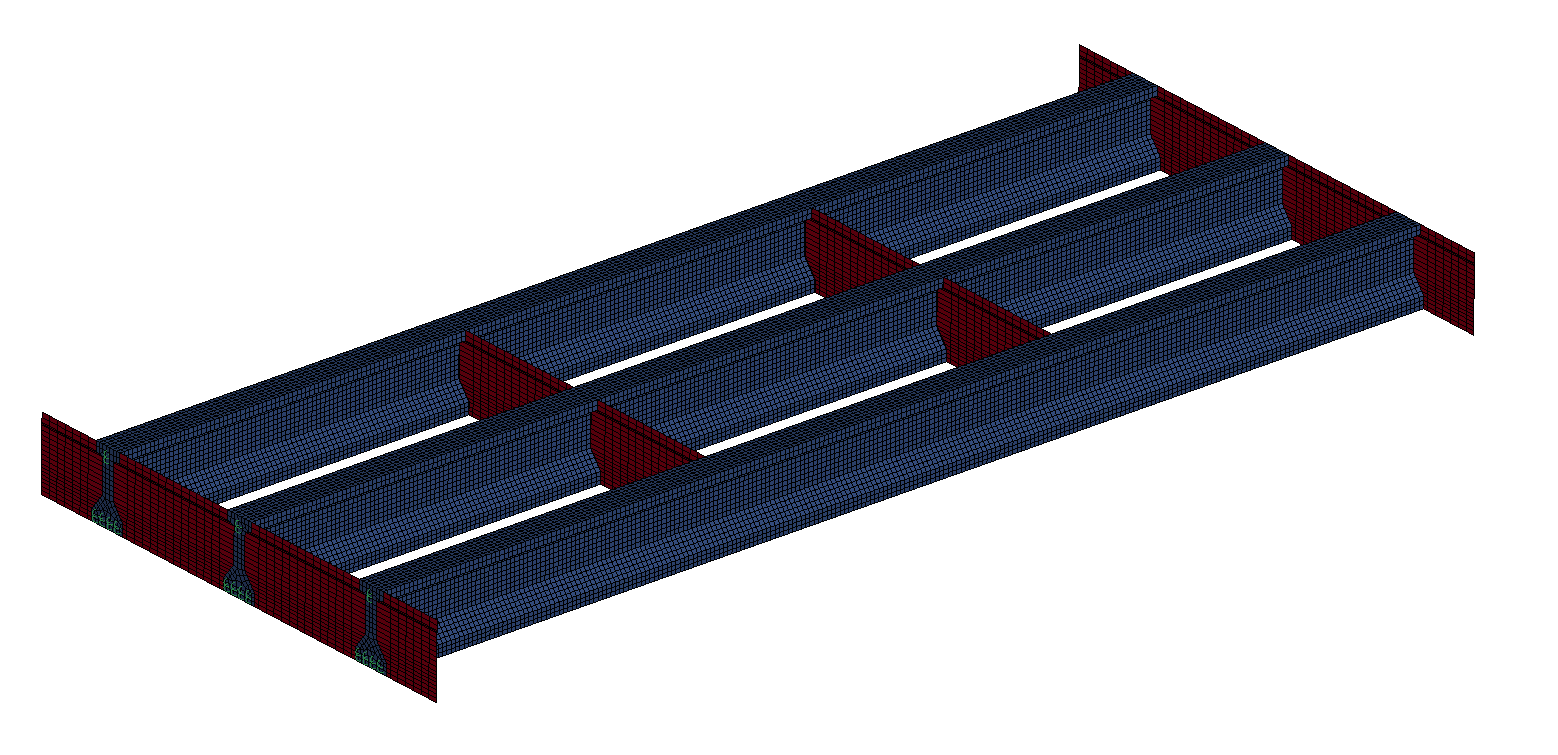
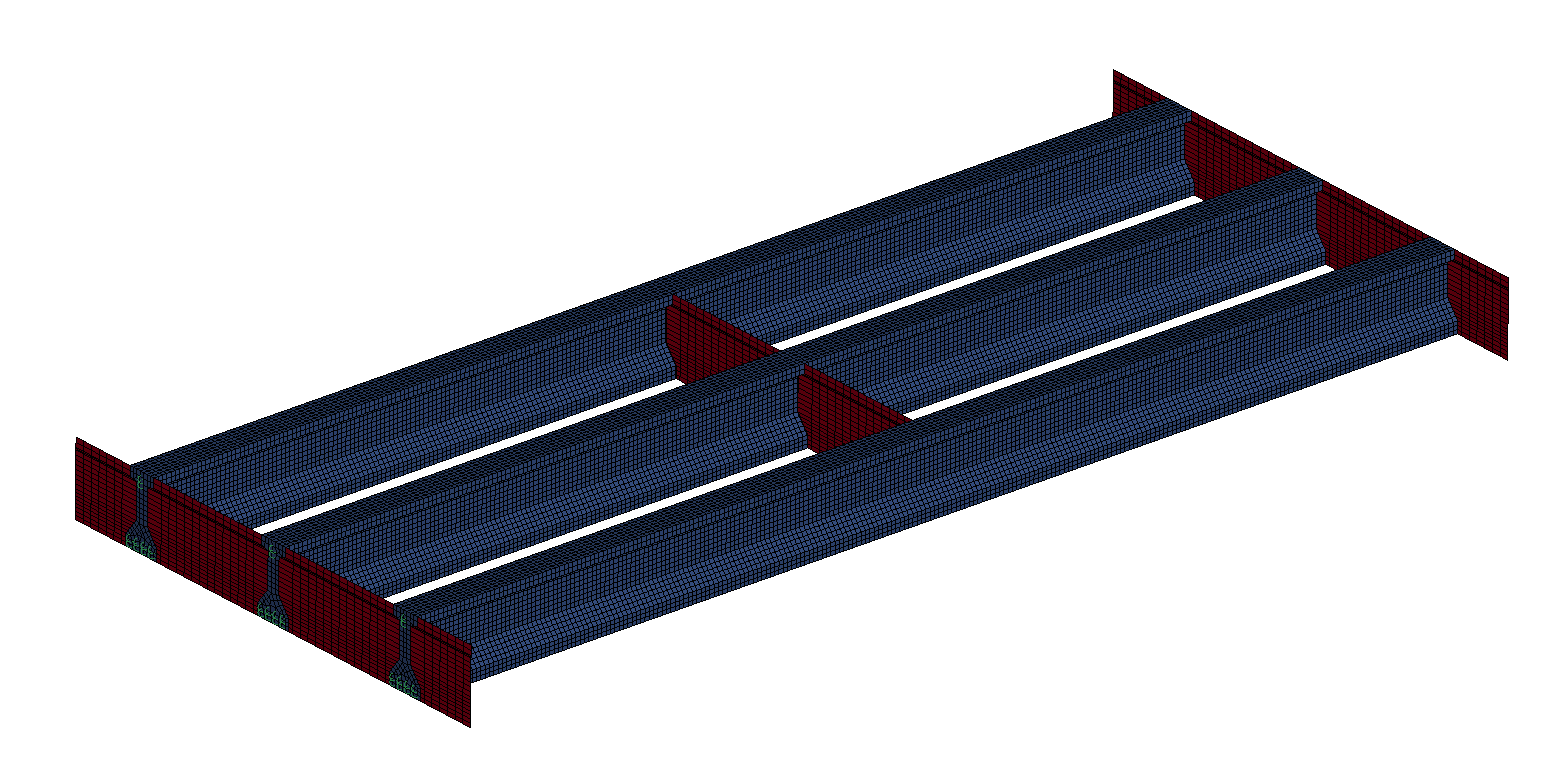
**Reinforced Concrete Deck:**

Concrete SOLID ELMS + MAT\_CSCM

RFT BEAM ELMS + MAT\_PLASTIC\_KINEMATIC

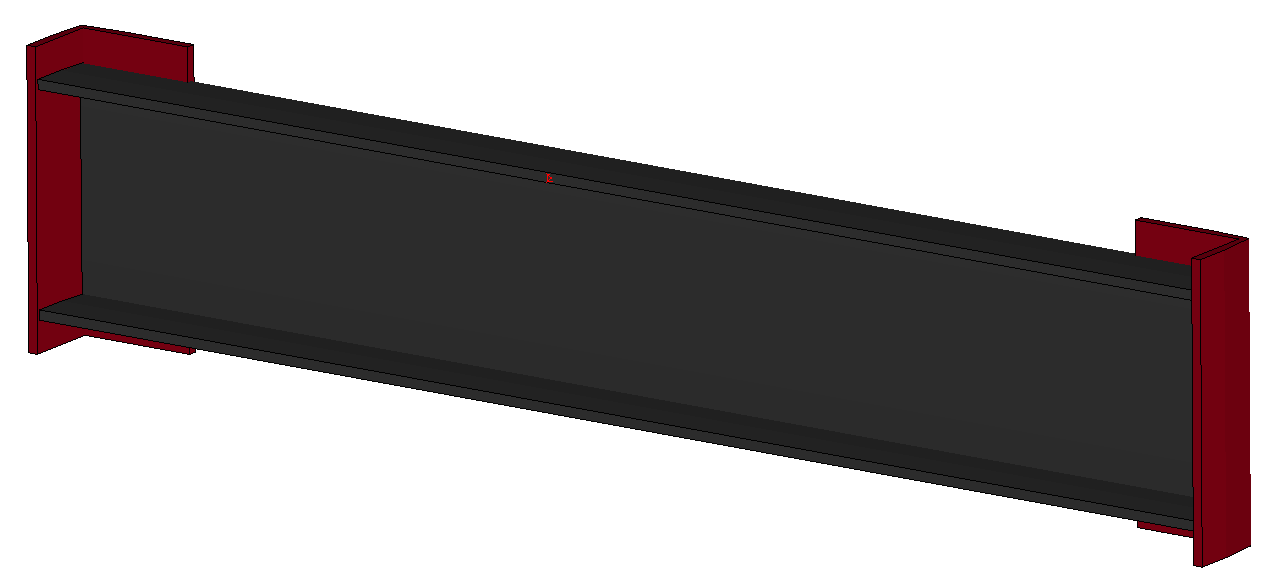
Coupling **shared nodes** or **CLIS**

Fig. 9: Full-scale finite element bridge model



**b) RC.3:** 6"RC intermediate diaphragm at third points

**a) RC.1:** 6"RC intermediate diaphragm at the midspan



C15x33.9x5’-3’’

L6x4x1/2x1’-4’’

**C) C1:** Steel intermediate diaphragm typical section

Fig. 10: intermediate diaphragms details

a) Prestressed beam using temperature method

b) Husain’s (2019) model

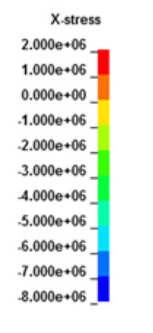
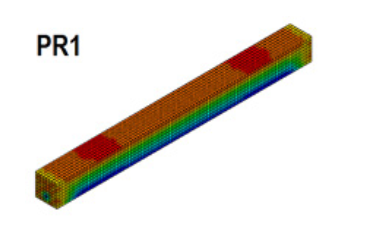
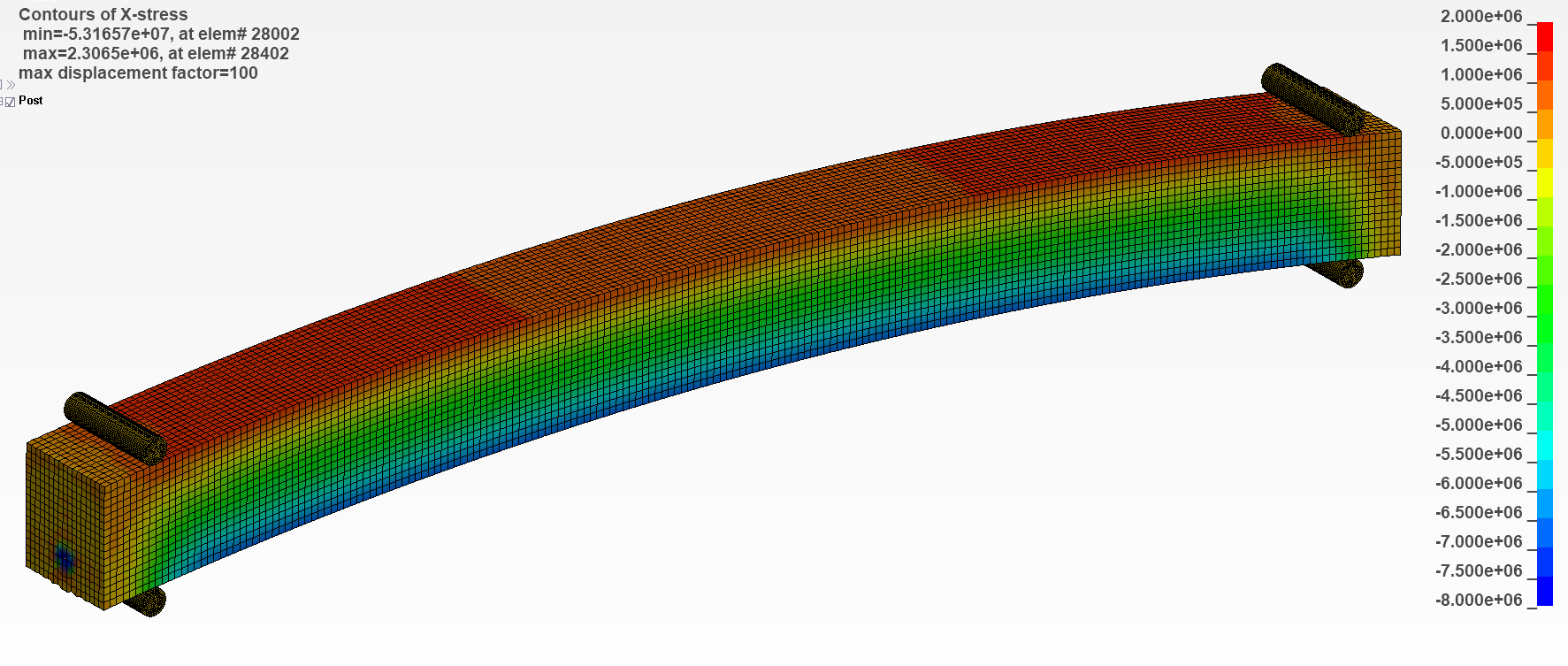
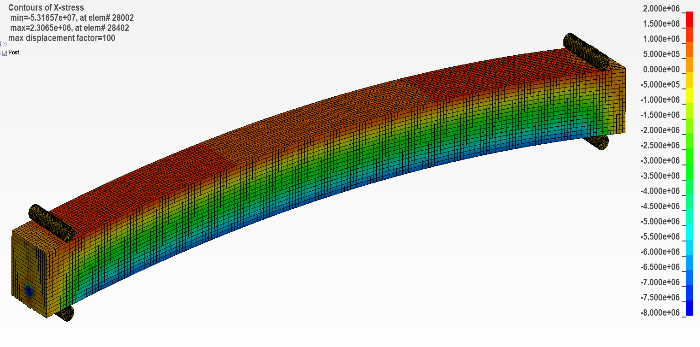
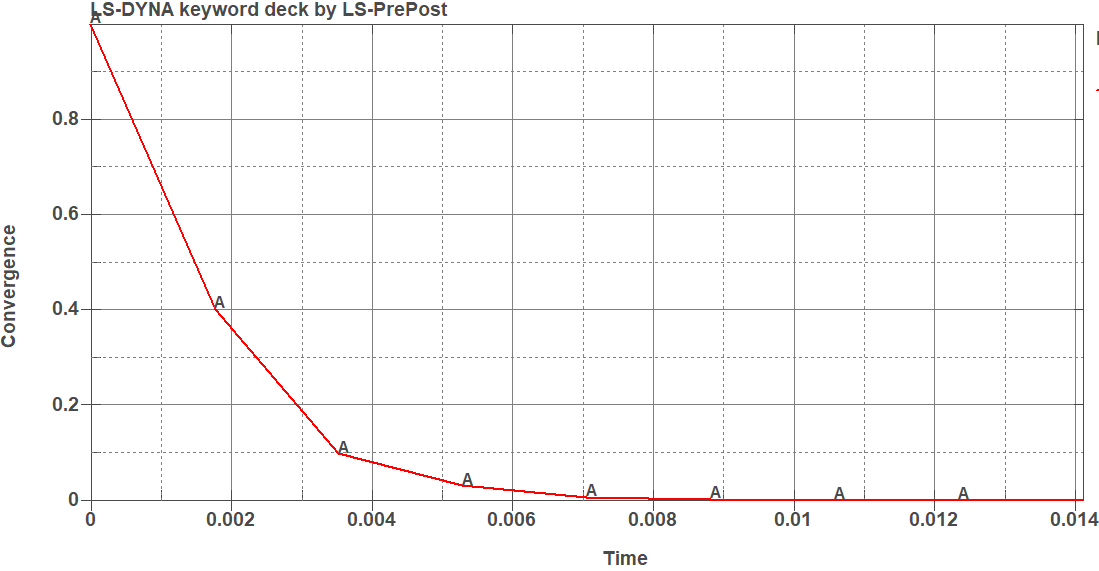
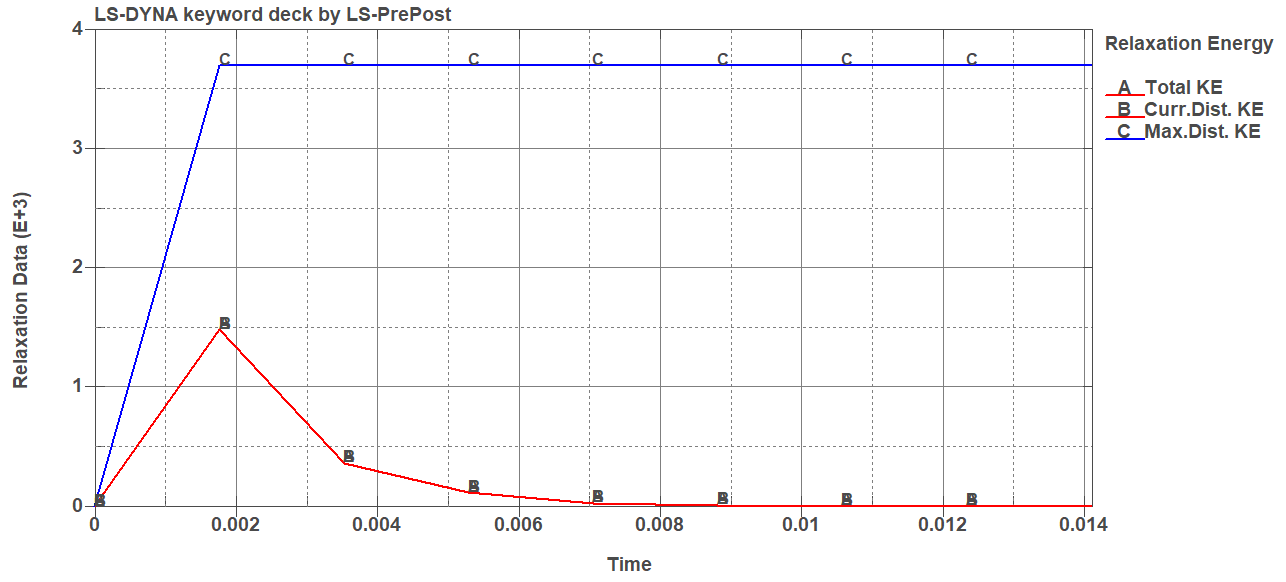


Fig. 11: Validation of the prestressing force

a) compressive stresses at midspan

b) tensile stresses at midspan

Fig. 12: Mesh sensitivity analysis for prestressing force

a) convergence

b) distortion vs total energy

Fig. 13: Dynamic relaxation results

RC.3 Intermediate Diaphragm  
Load: Point 6

Displacement: Point 5 (vertical)

RC.3 Intermediate Diaphragm  
Load: Point 6

Displacement: Point 6 (vertical)

RC.1 Intermediate Diaphragm  
Load: Point 6

Displacement: Point 5 (vertical)

RC.1 Intermediate Diaphragm  
Load: Point 6

Displacement: Point 6 (vertical)

No Intermediate Diaphragms  
Load: Point 6

Displacement: Point 5 (vertical)

No Intermediate Diaphragms  
Load: Point 6

Displacement: Point 6 (vertical)

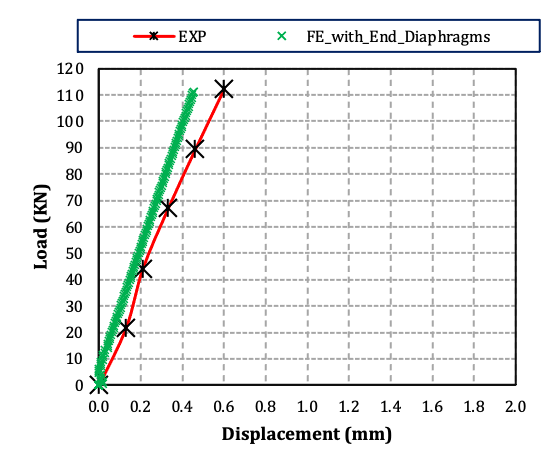
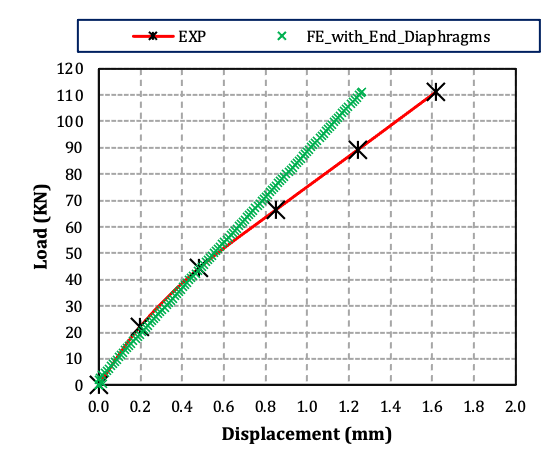
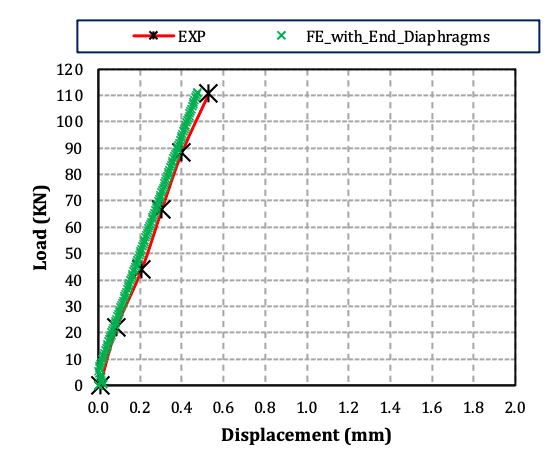
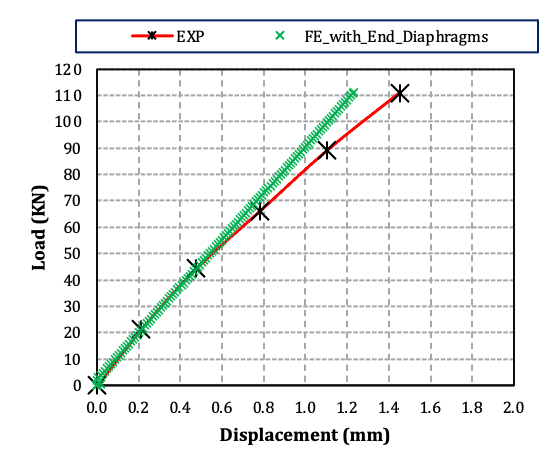
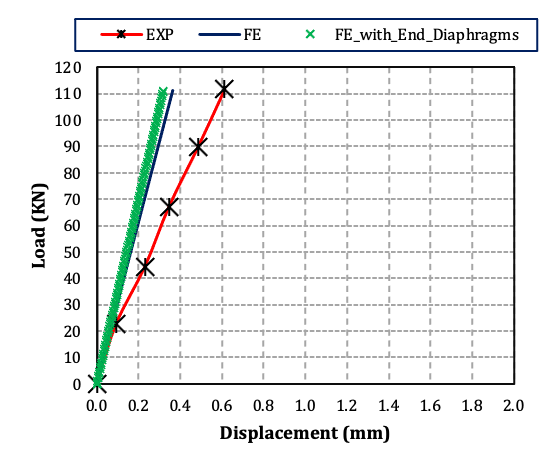
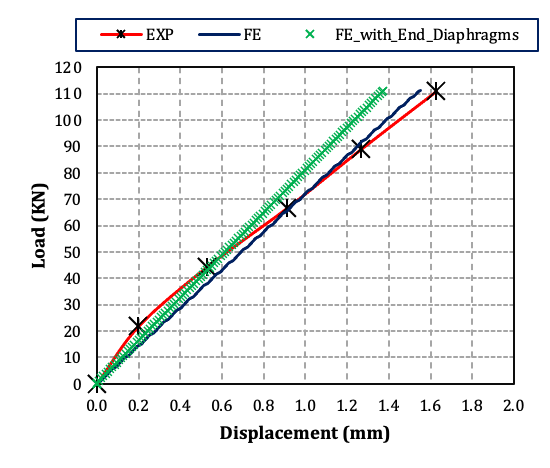


Fig. 14: Load-displacement verification results

Without Intermediate Diaphragm  
Load: Point 6

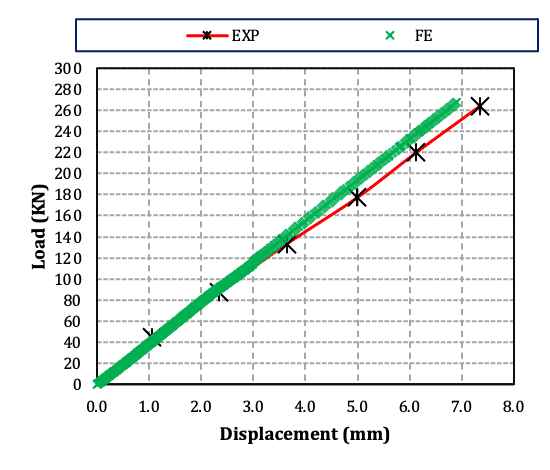
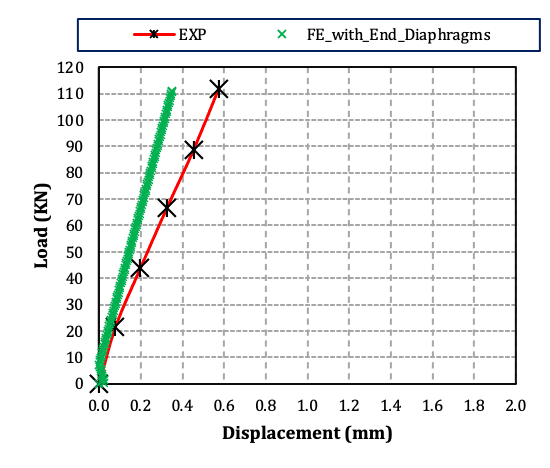
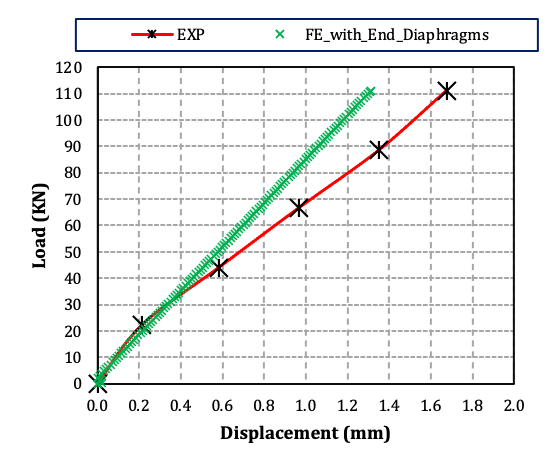
Displacement: Point 6 (horizontal)

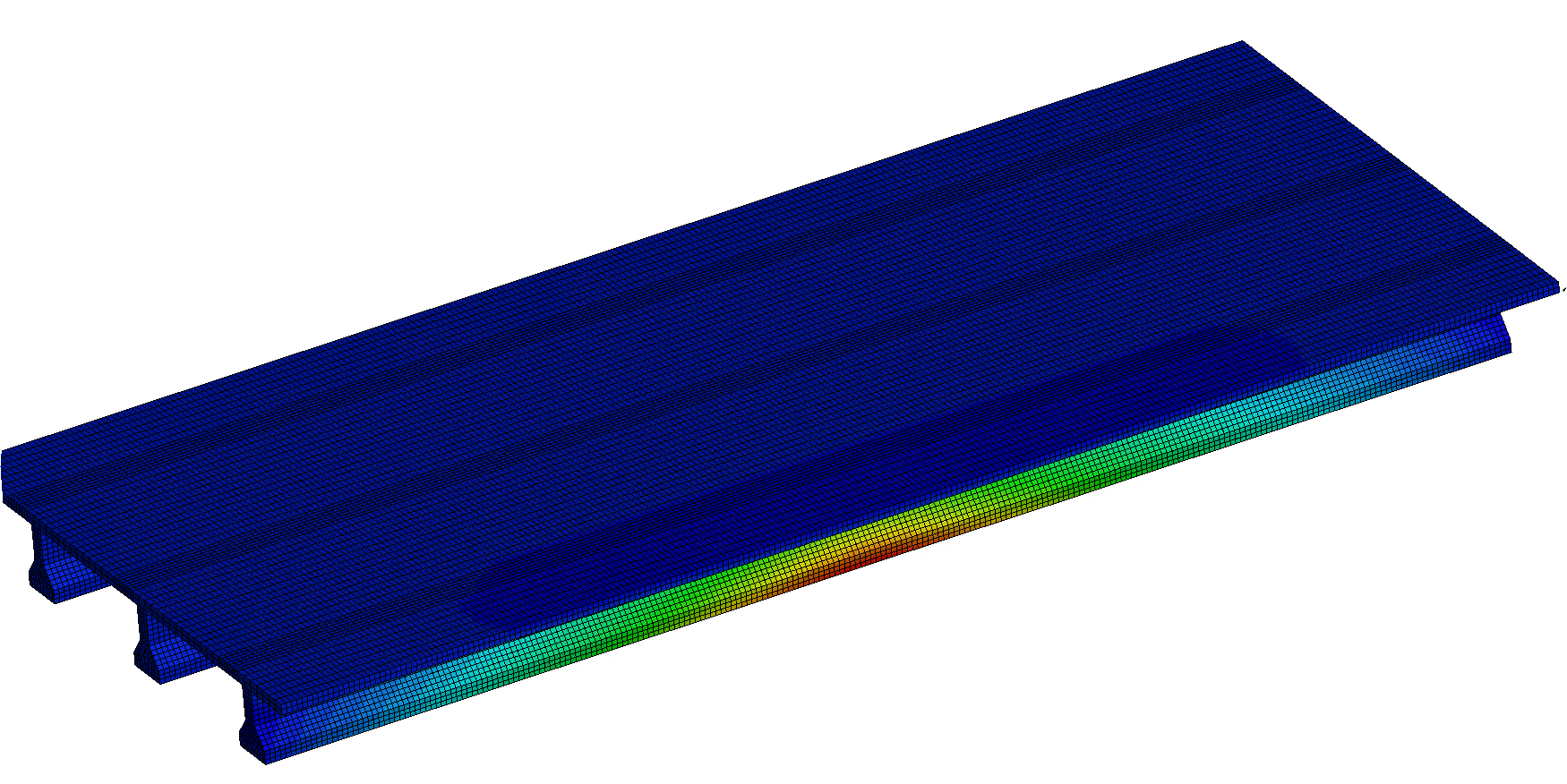
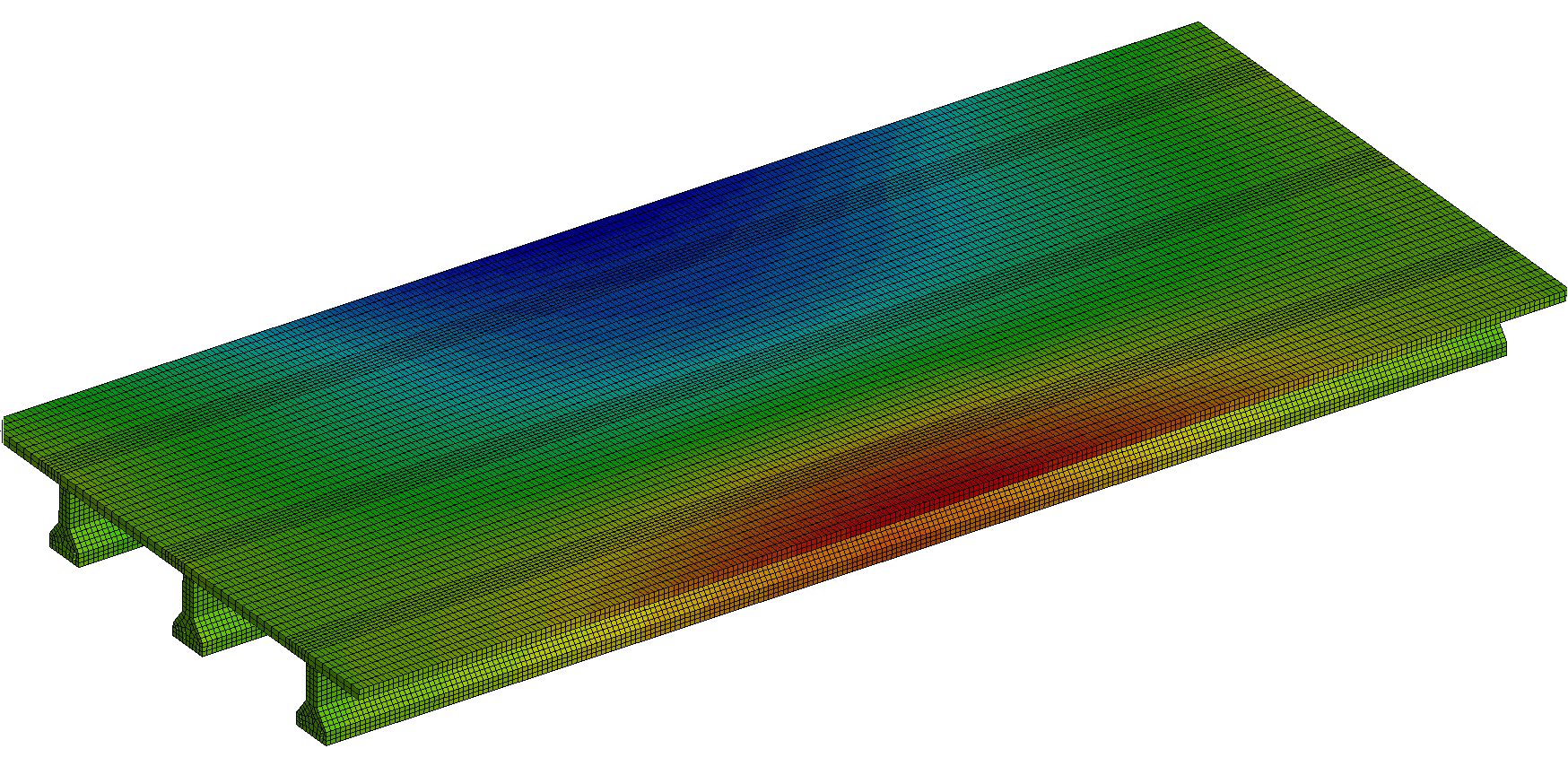
C1 Steel Intermediate Diaphragm  
Load: Point 6

Displacement: Point 5 (vertical)

C1 Steel Intermediate Diaphragm  
Load: Point 6

Displacement: Point 6 (vertical)

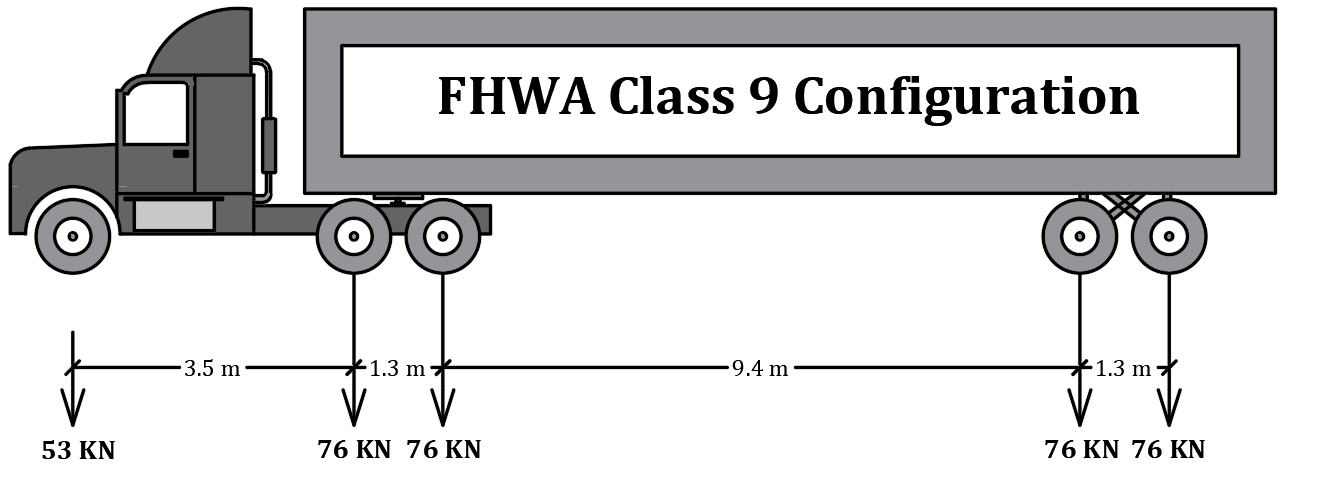




b) Horizontal Displacement

a) Vertical Displacement

Fig. 15: Vertical and horizontal displacement contour plots



b) Truck Details

a) Truck FE model

Fig. 16: Truck model details

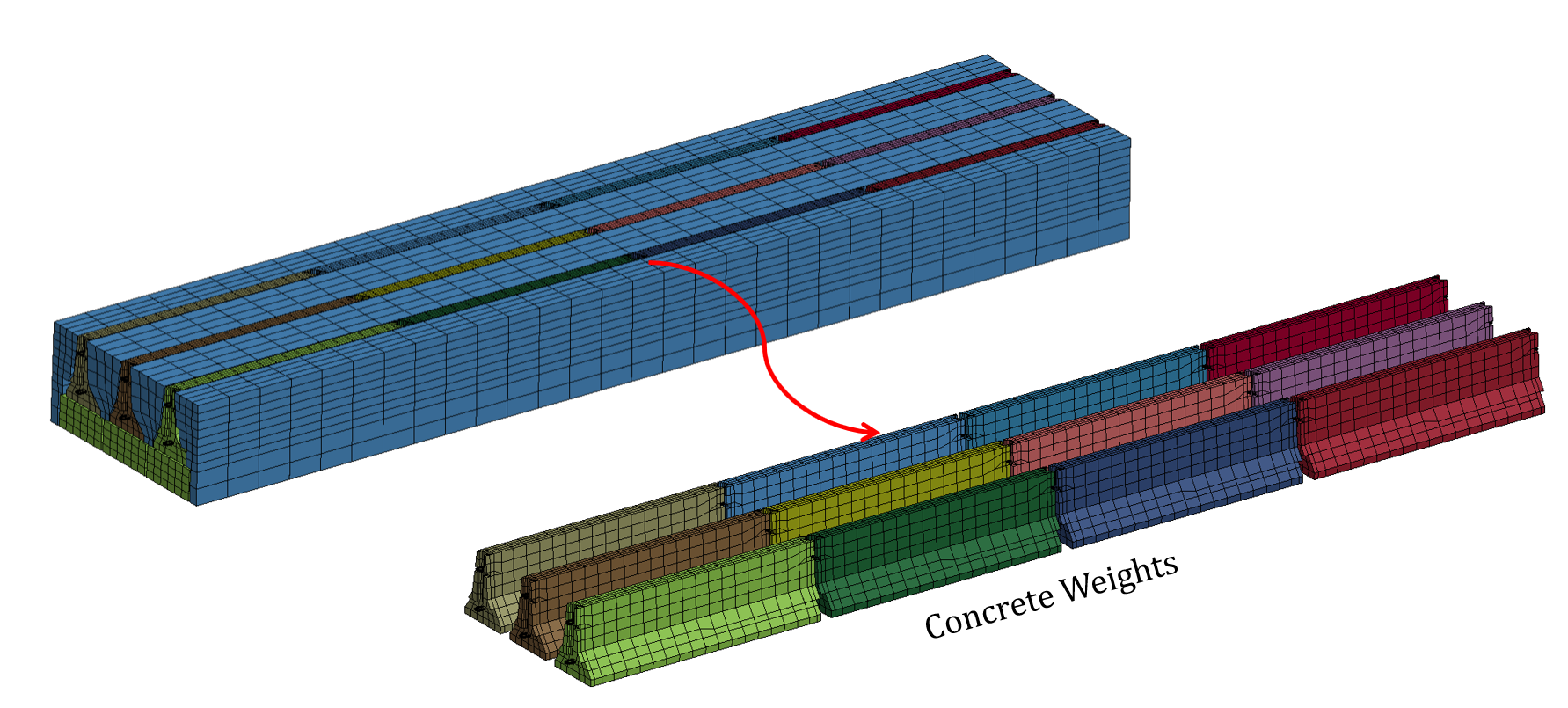


Fig. 17: Ballast weight for the trailer

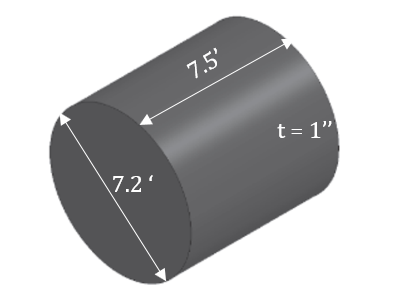
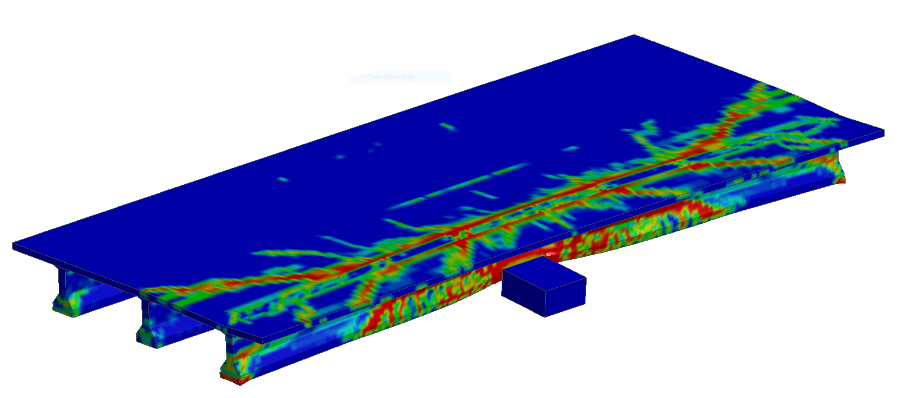
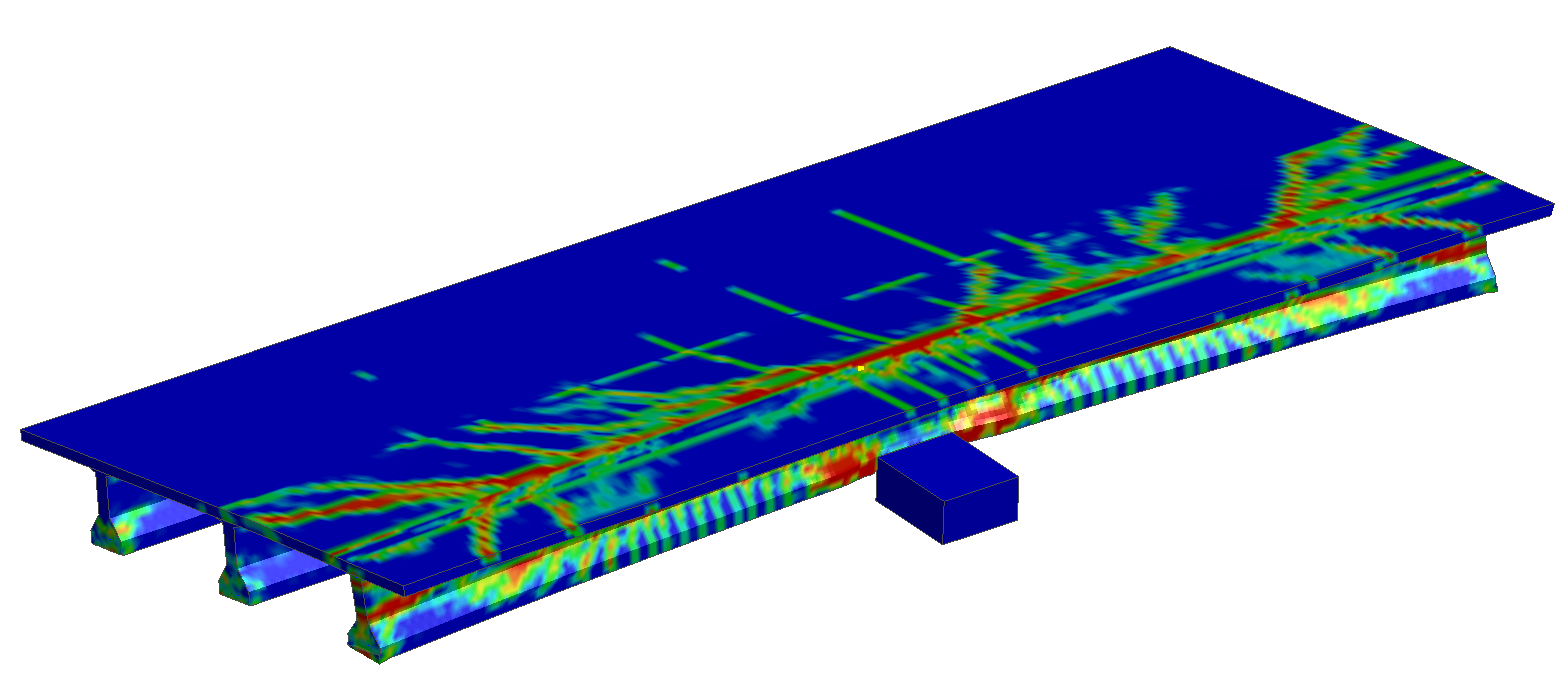


Fig. 18: Steel tank rigid impactor details



Fig. 19: Bridge failure





b) Impact at 25 mph speed

a) Impact at 50 mph speed

Fig. 20: Preliminary impact results