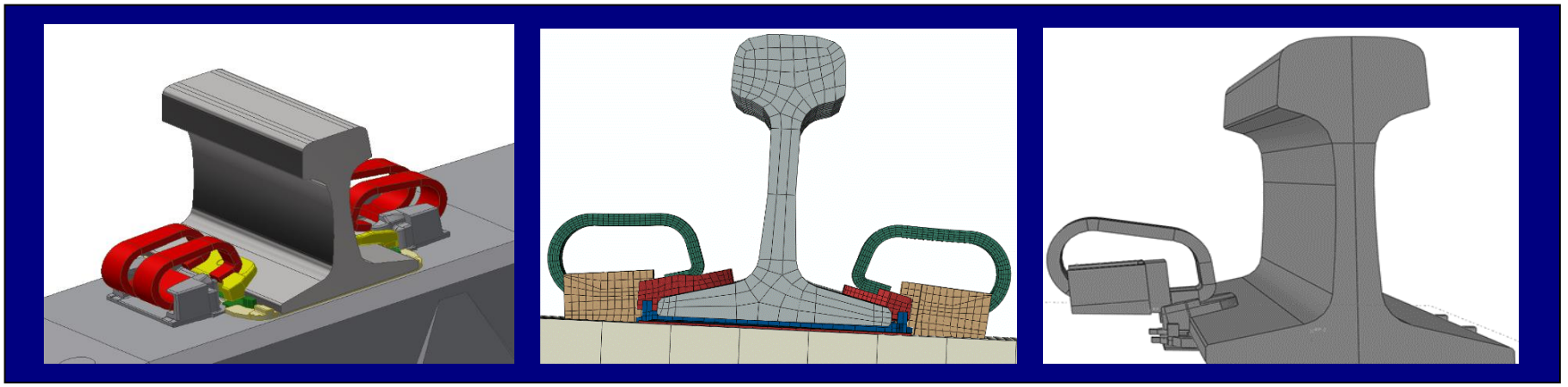
Development of an Analytical Tool for Track Component Response (I-TRACK)



UIUC FRA Tie and Fastener BAA - Industry Partners Meeting

Incline Village, NV

7 October 2013

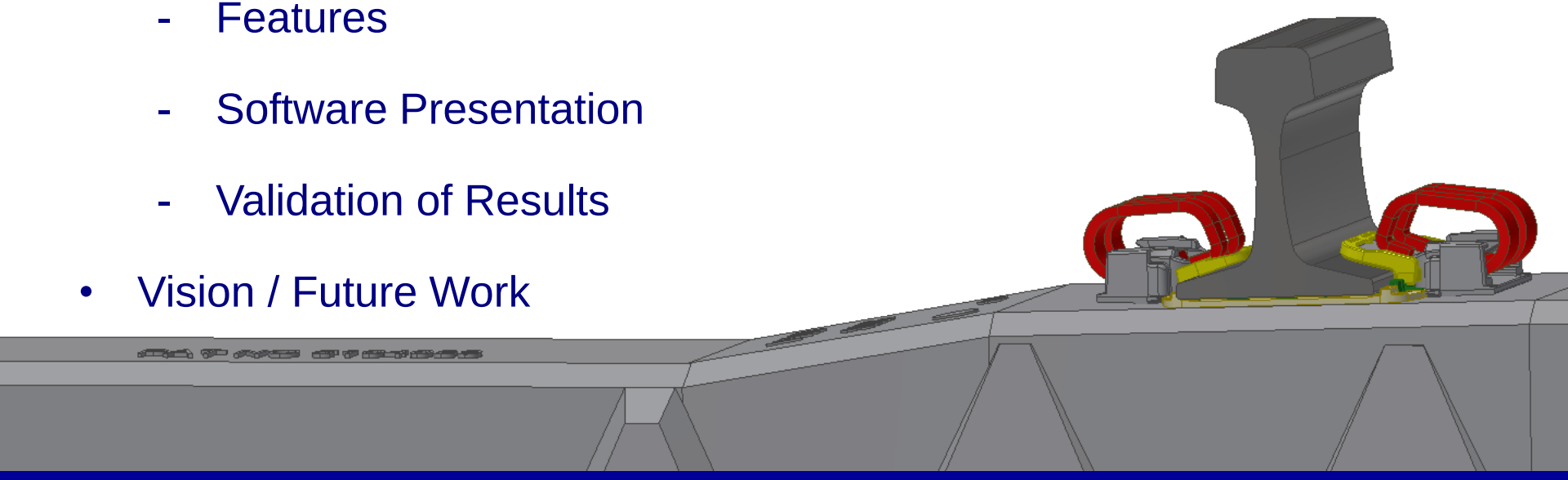
Thiago B. do Carmo, J. Riley Edwards, Ryan G. Kernes

U.S. Department of Transportation
Federal Railroad Administration

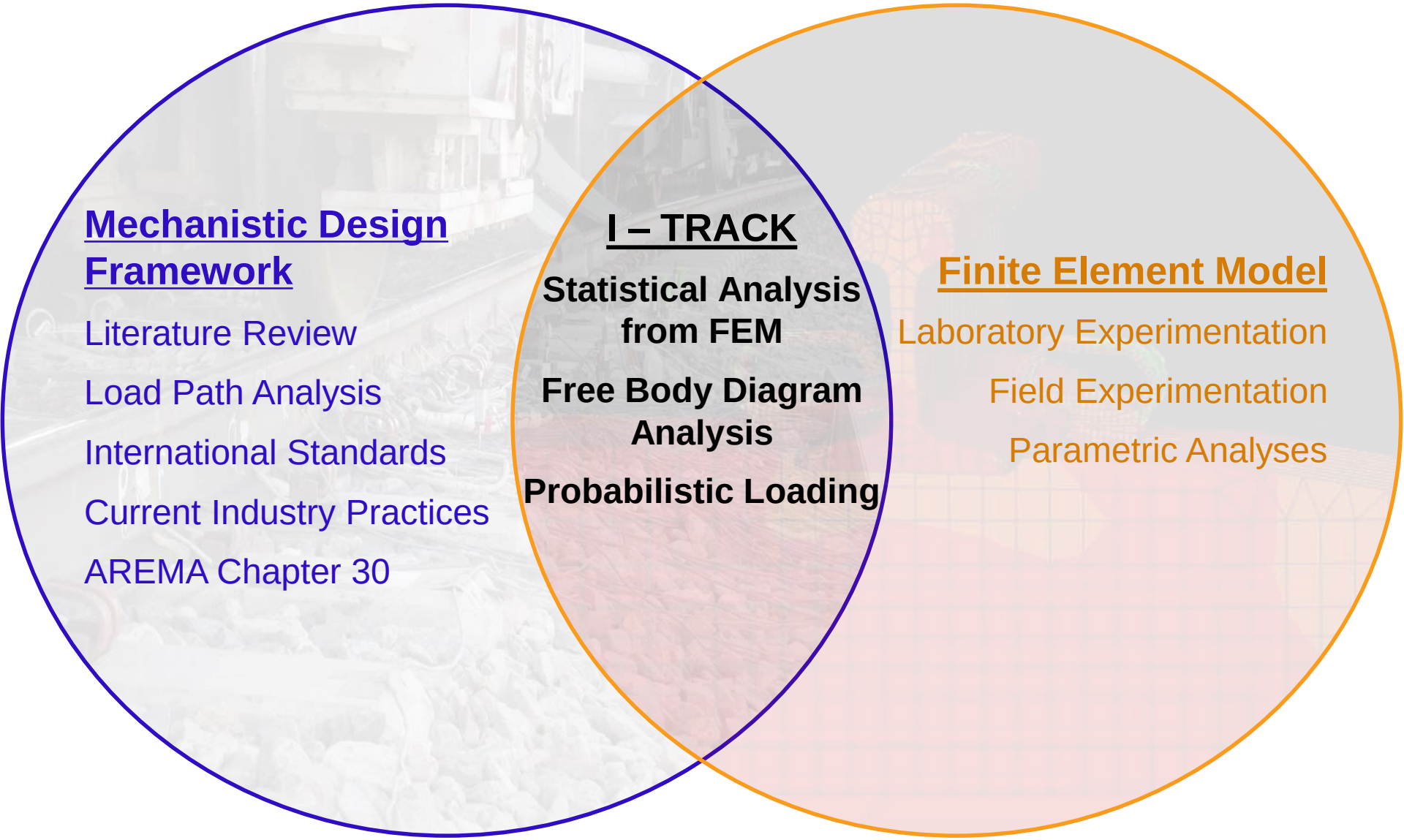
RAILTEC
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Outline

- Objectives
- Background
- Analytical Tool
  - Project Phases
  - Input and Output Parameters
  - Features
  - Software Presentation
  - Validation of Results
- Vision / Future Work

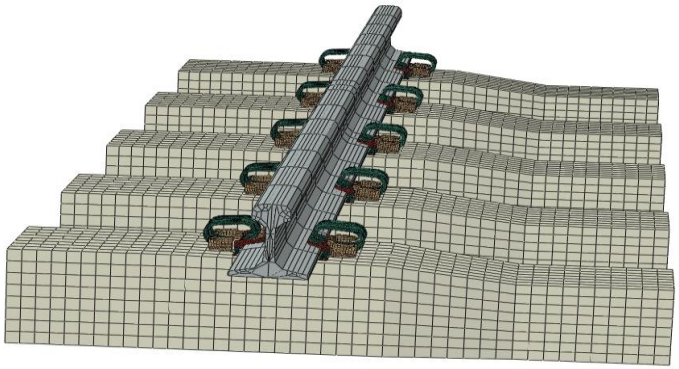


Overall Project Deliverables



Objectives

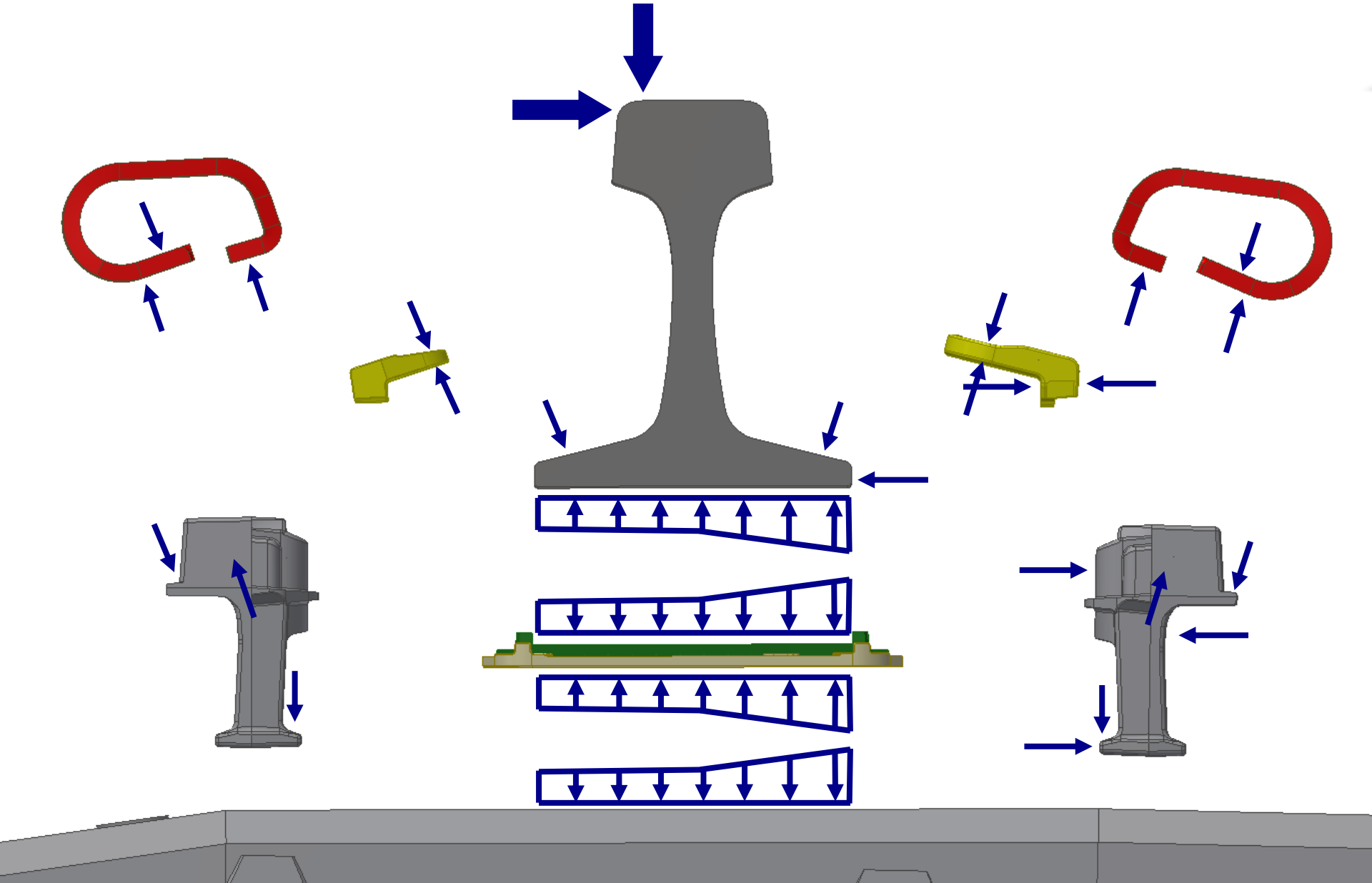
- Efficiently estimate track system and component response using mechanistic design
- Develop a tool to analyze the crosstie and fastening system components based on the finite element (FE) model results (validated by lab and field data)
- Analyze the influence of input parameters on track behavior
- Provide a practical tool to assist a mechanistic design approach of concrete crossties and fastening systems



FE Model

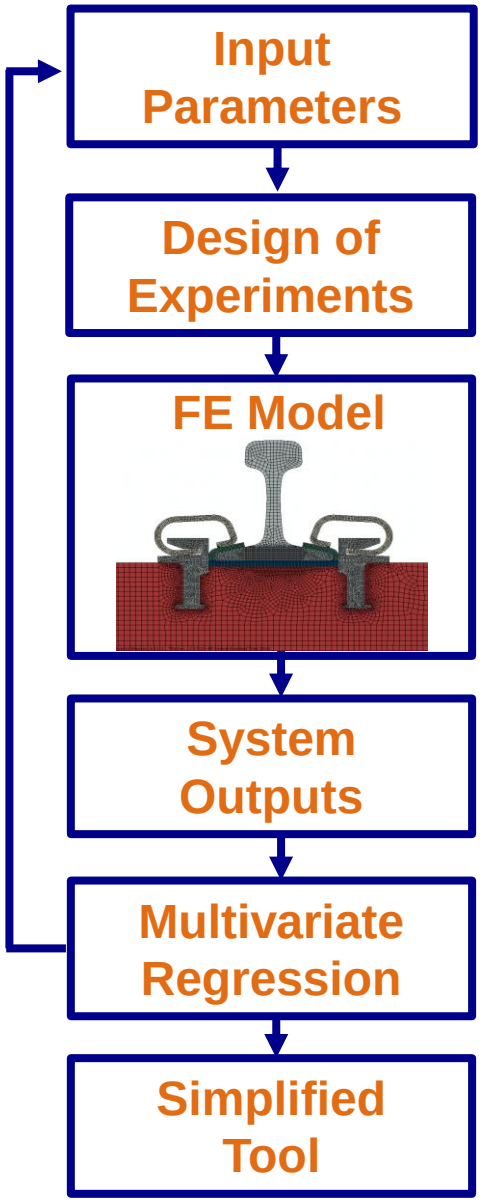
Spreadsheet

Loading Environment



Introduction to Track Response Tool I-TRACK

- Input and Output parameters were prioritized for each project phase
- Design of Experiments (DOE) used to reduce the number of model iterations
- Systematic variation of inputs results in equations that describe the component responses using multivariate regression
- I-TRACK composed of equations derived from FE model, laboratory experimentation, field experimentation, and FBD analysis

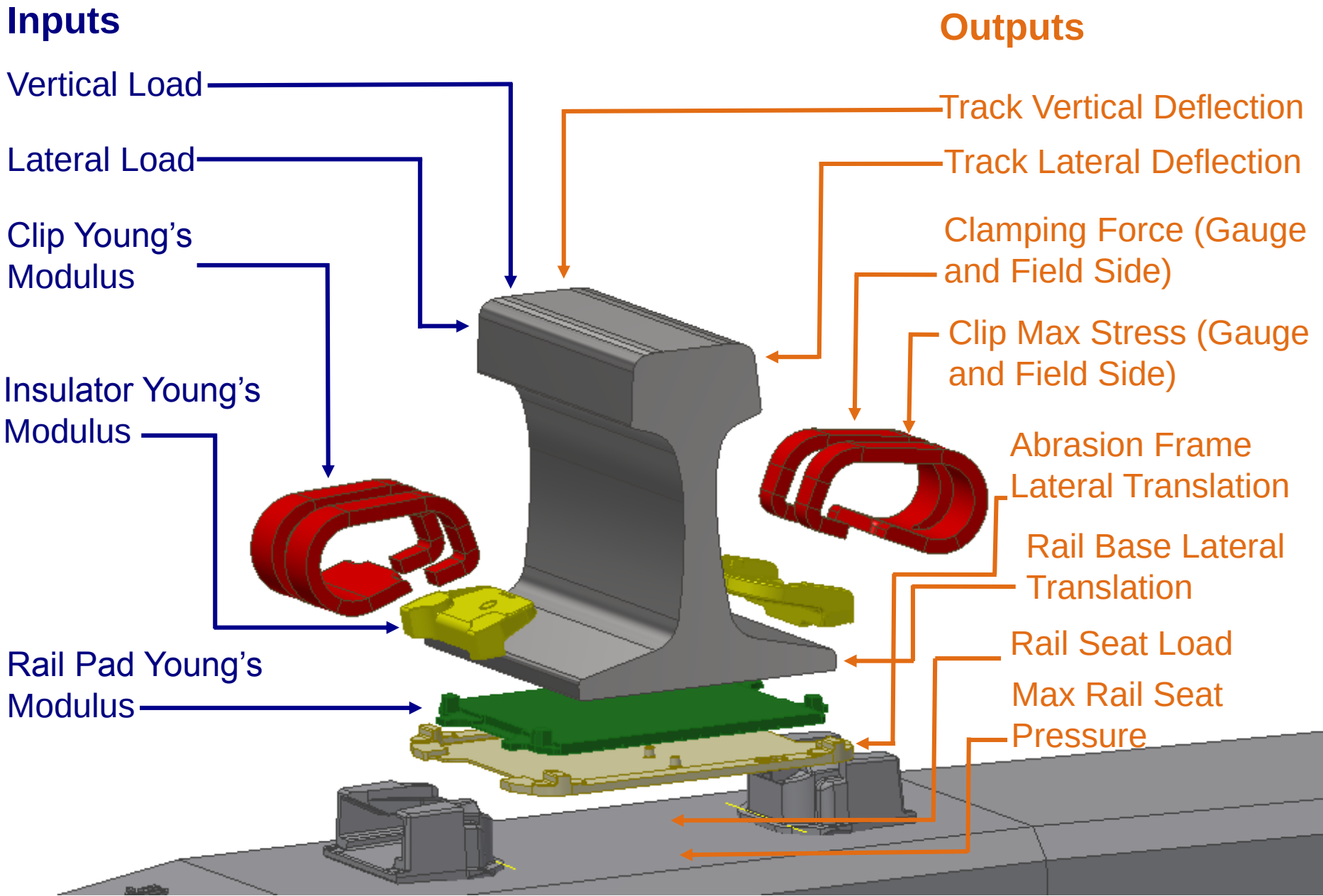


Project Phases

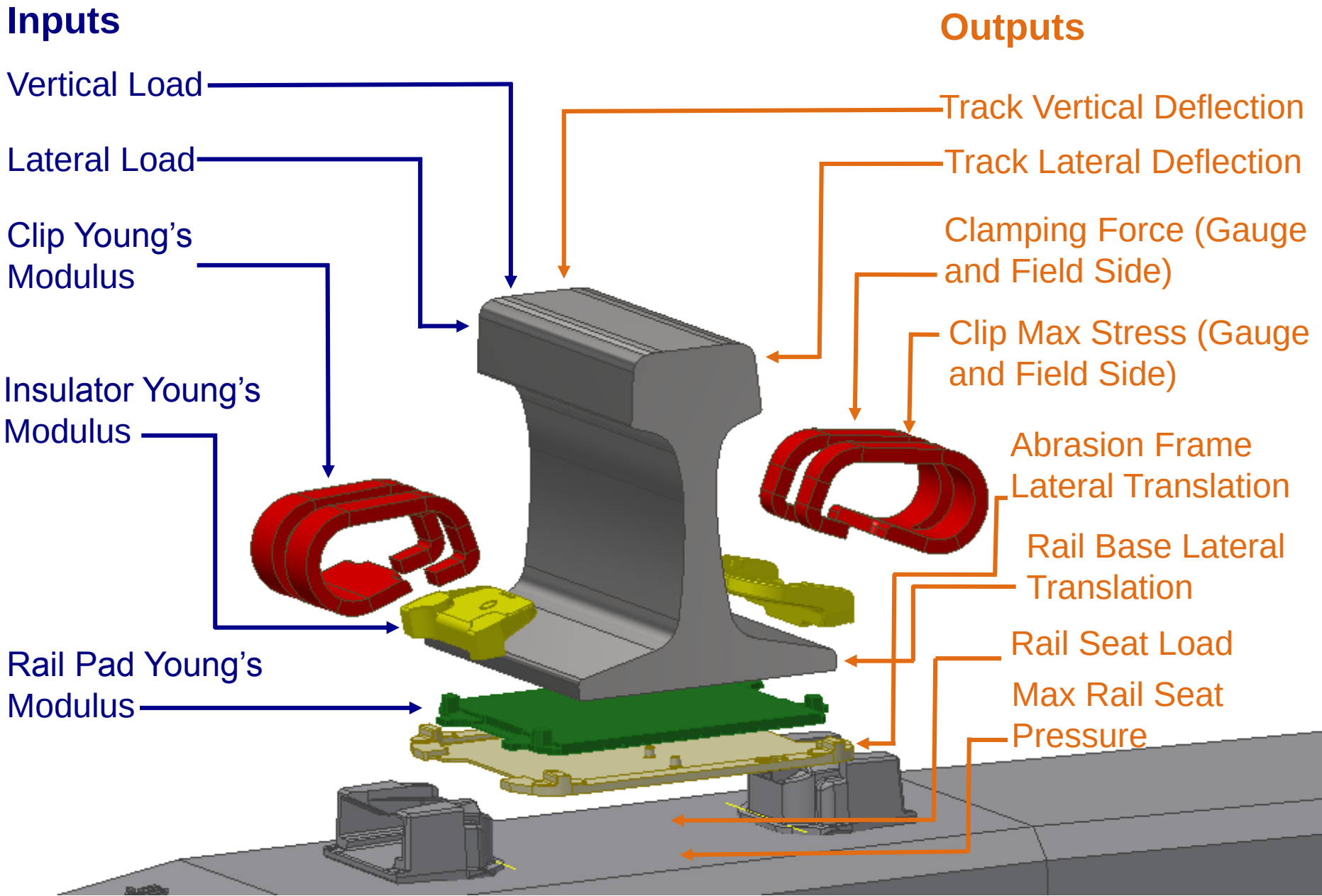
- Project is divided in 3 phases, which add additional complexity and design options
- Goal is to expedite the development process of the simplified tool and test the accuracy and functionalities on a continuous basis

Version	Input Capabilities	Release Date
v1.0	Load Materials	7 October 2013
v2.0	Interface Interactions Support Conditions	Spring 2014
v3.0	Geometry Components Relative Position	Summer 2014

Inputs and Outputs (v1.0)



Inputs and Outputs (v2.0)



Inputs and Outputs (cont. v2.0)

Inputs

COF between insulator and shoulder

COF between rail and rail pad

COF between rail seat and abrasion frame

Concrete Compressive Strength

Support Conditions

Outputs

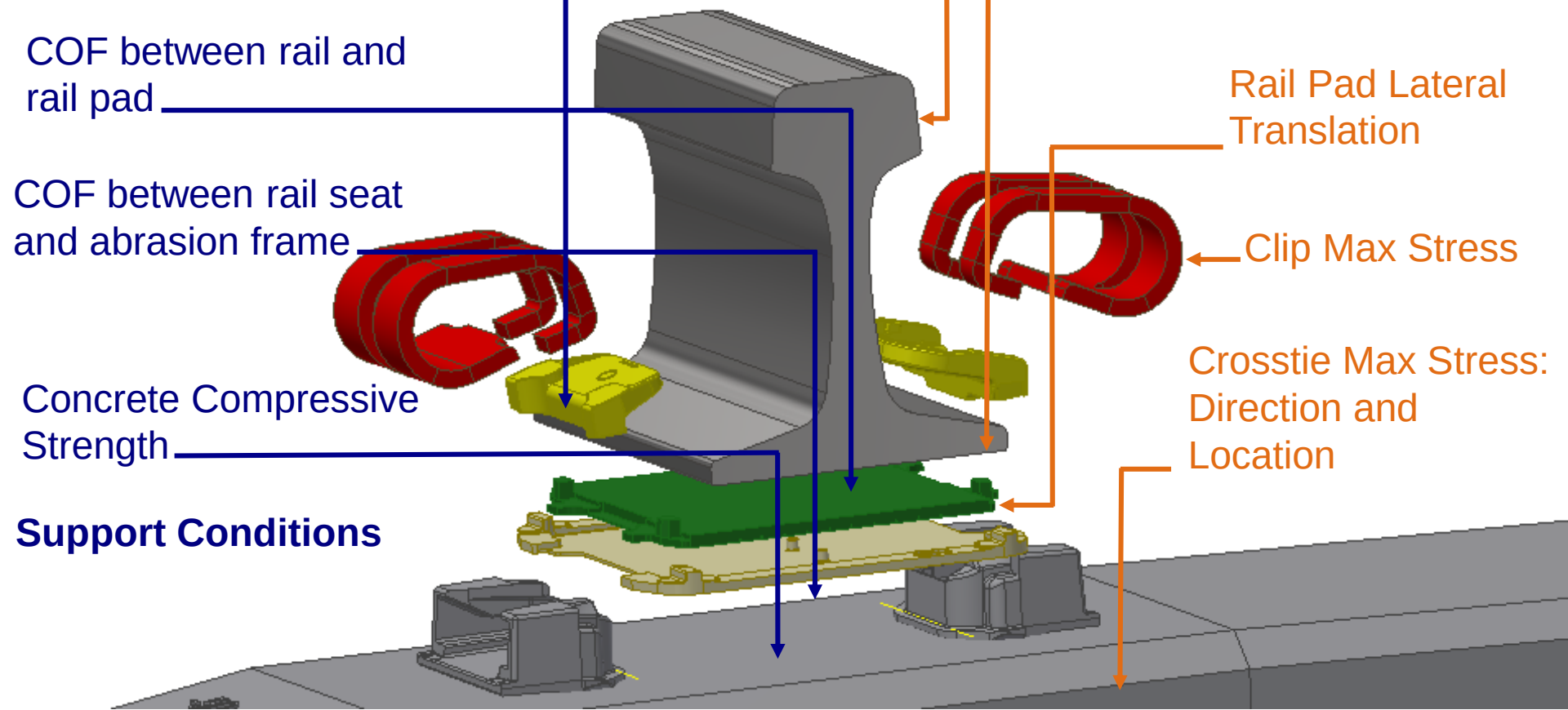
Max Rail Head Lateral Deflection

Rail Base Rotation

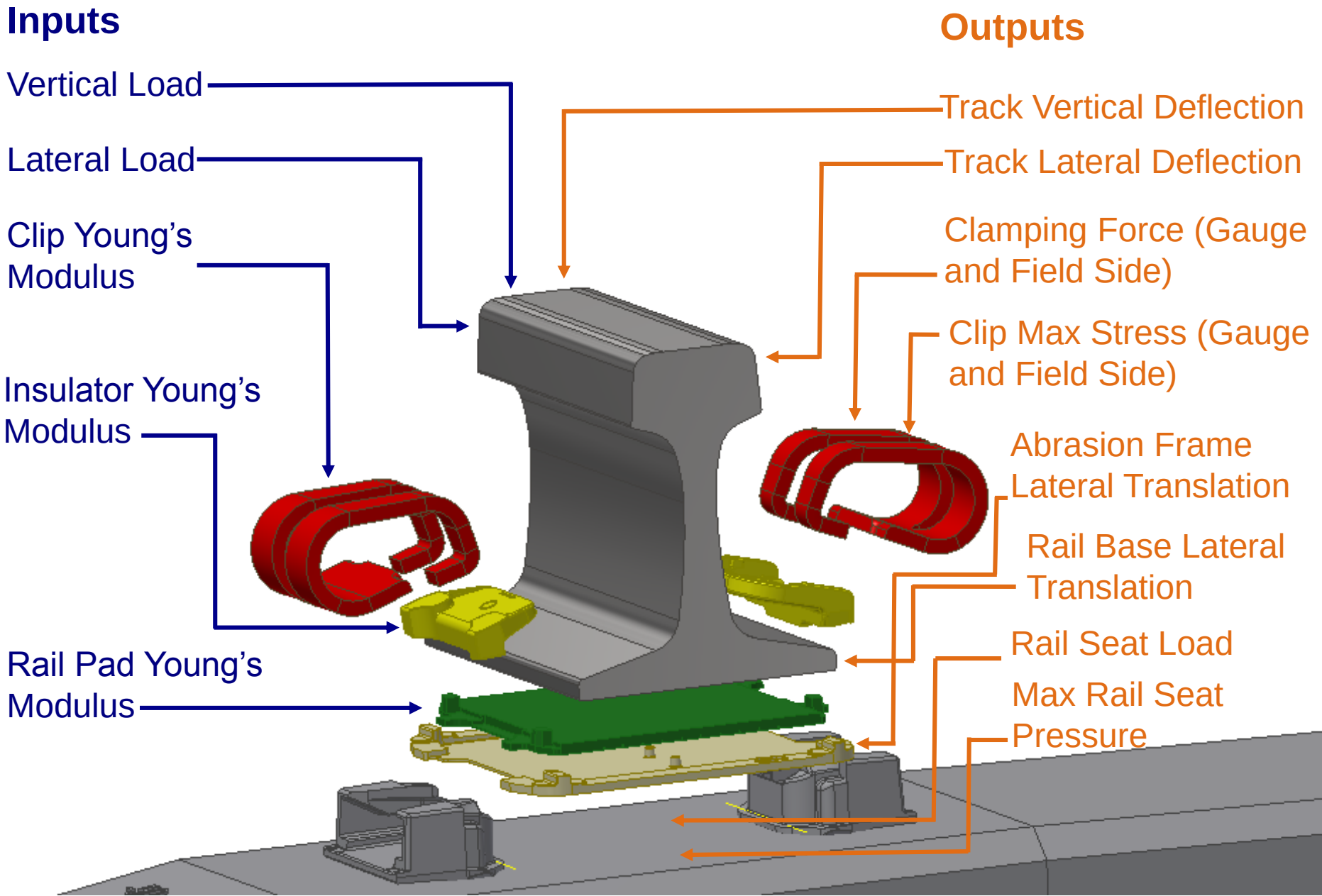
Rail Pad Lateral Translation

Clip Max Stress

Crosstie Max Stress: Direction and Location



Inputs and Outputs (v3.0)



Inputs and Outputs (cont. v3.0)

Inputs

COF between insulator and shoulder

COF between rail and rail pad

COF between rail seat and abrasion frame

Concrete Compressive Strength

Support Conditions

Outputs

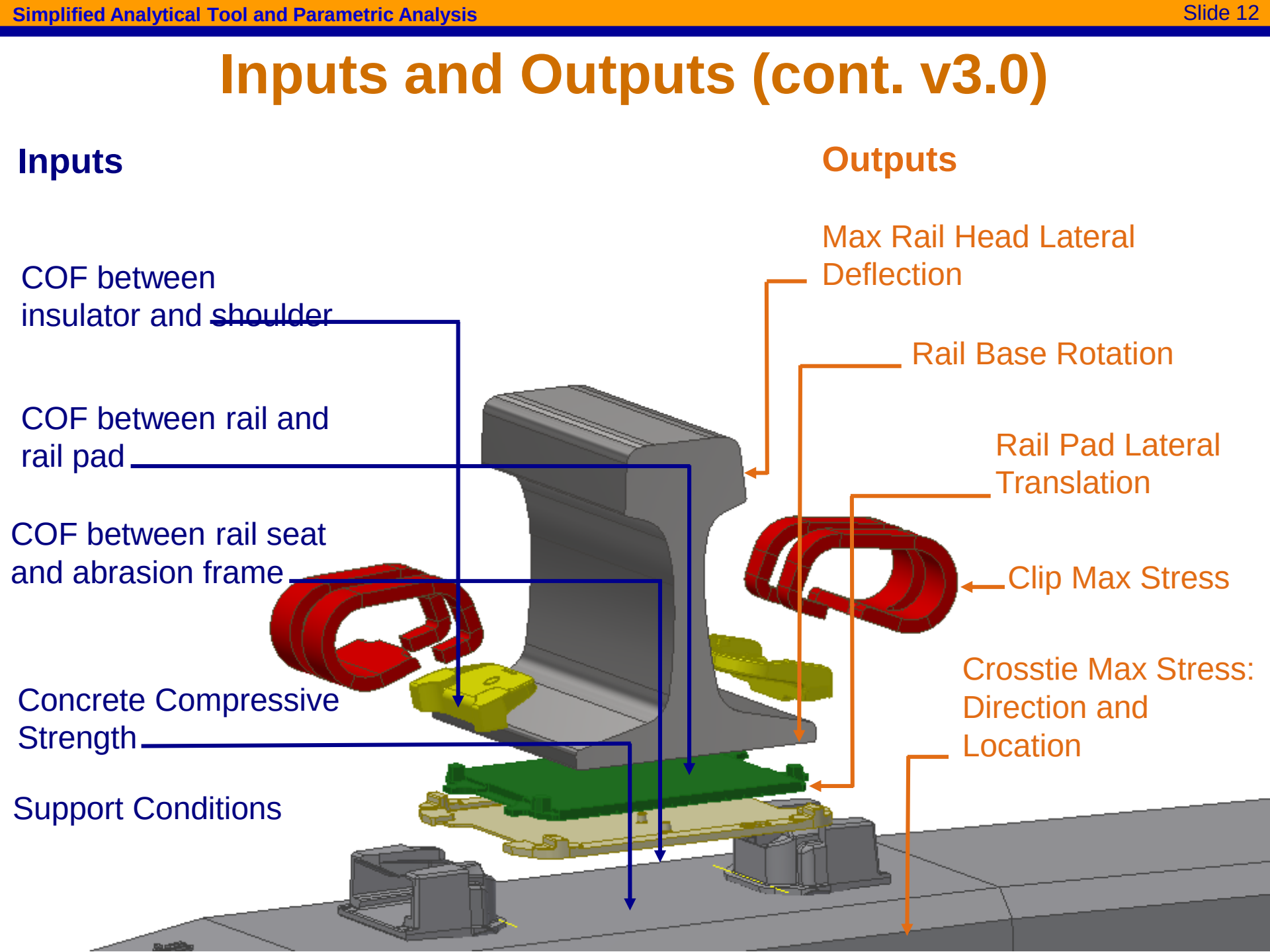
Max Rail Head Lateral Deflection

Rail Base Rotation

Rail Pad Lateral Translation

Clip Max Stress

Crosstie Max Stress: Direction and Location



Inputs and Outputs (cont. v3.0)

Inputs

Component Geometry

COF between insulator and ~~shoulder~~

COF between rail and rail pad

COF between rail seat and abrasion frame

Concrete Compressive Strength

Support Conditions

Outputs

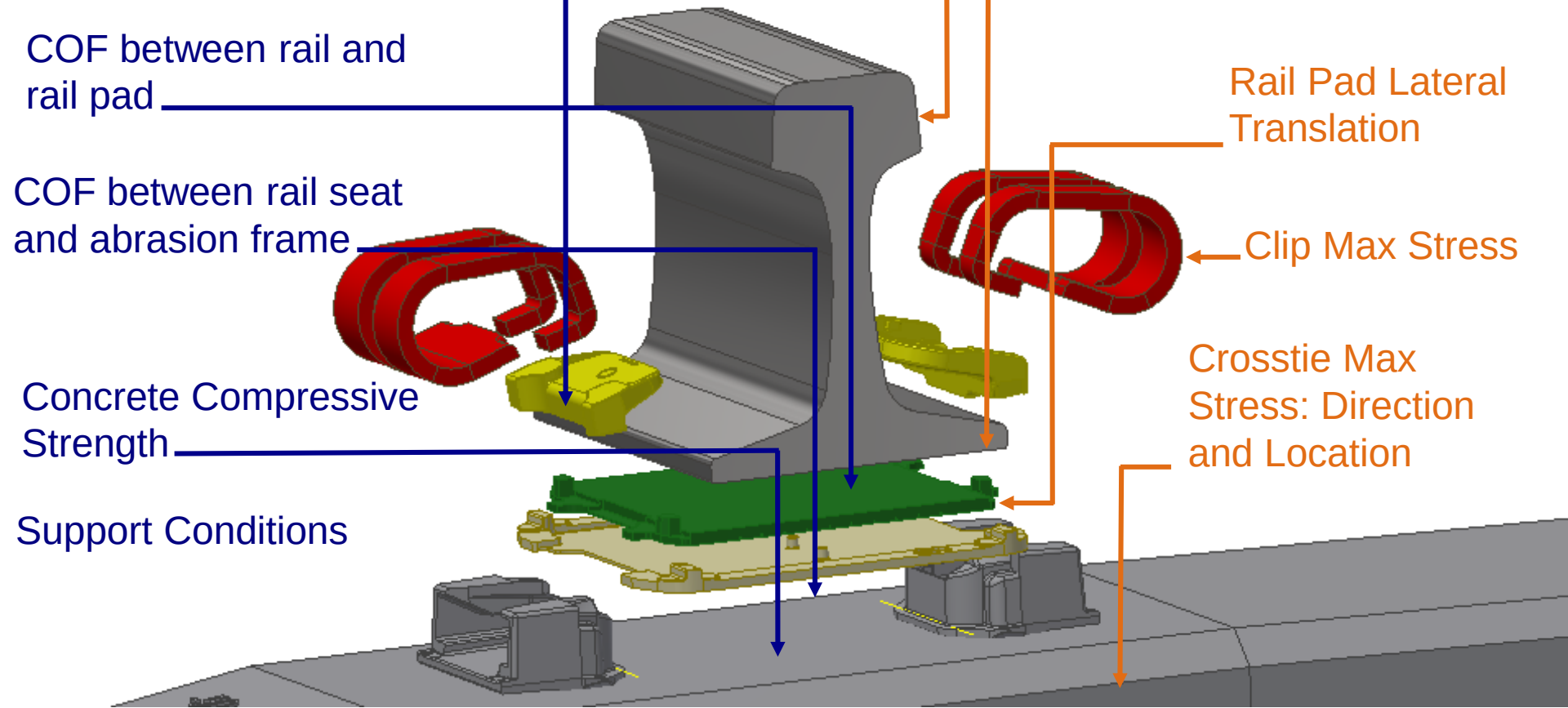
Max Rail Head Lateral Deflection

Rail Base Rotation

Rail Pad Lateral Translation

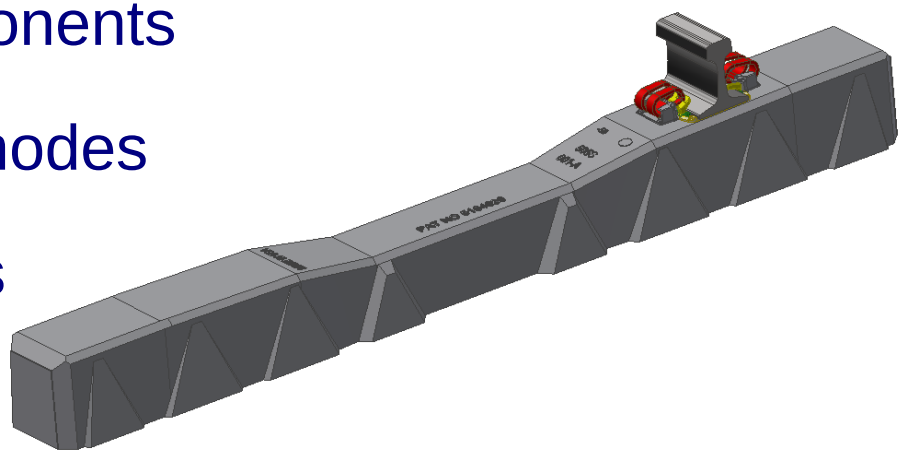
Clip Max Stress

Crosstie Max Stress: Direction and Location

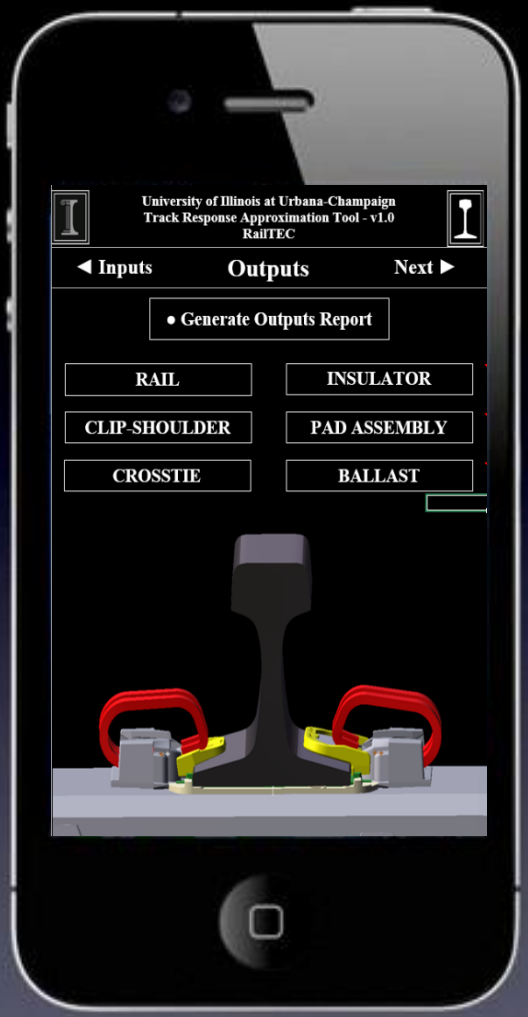


I-TRACK Features

- User friendly interface that can be adapted to user's level of expertise in railroad engineering and track component design
- Initially software, potential for iPhone app and other platforms
- Tutorial explaining functionality and examples
- Database containing geometry and material properties of standard components
- Broad list of outputs providing a framework to understand the mechanistic behavior of components
- Prediction of possible failure modes
- Generation of printable reports



The new I-TRACK



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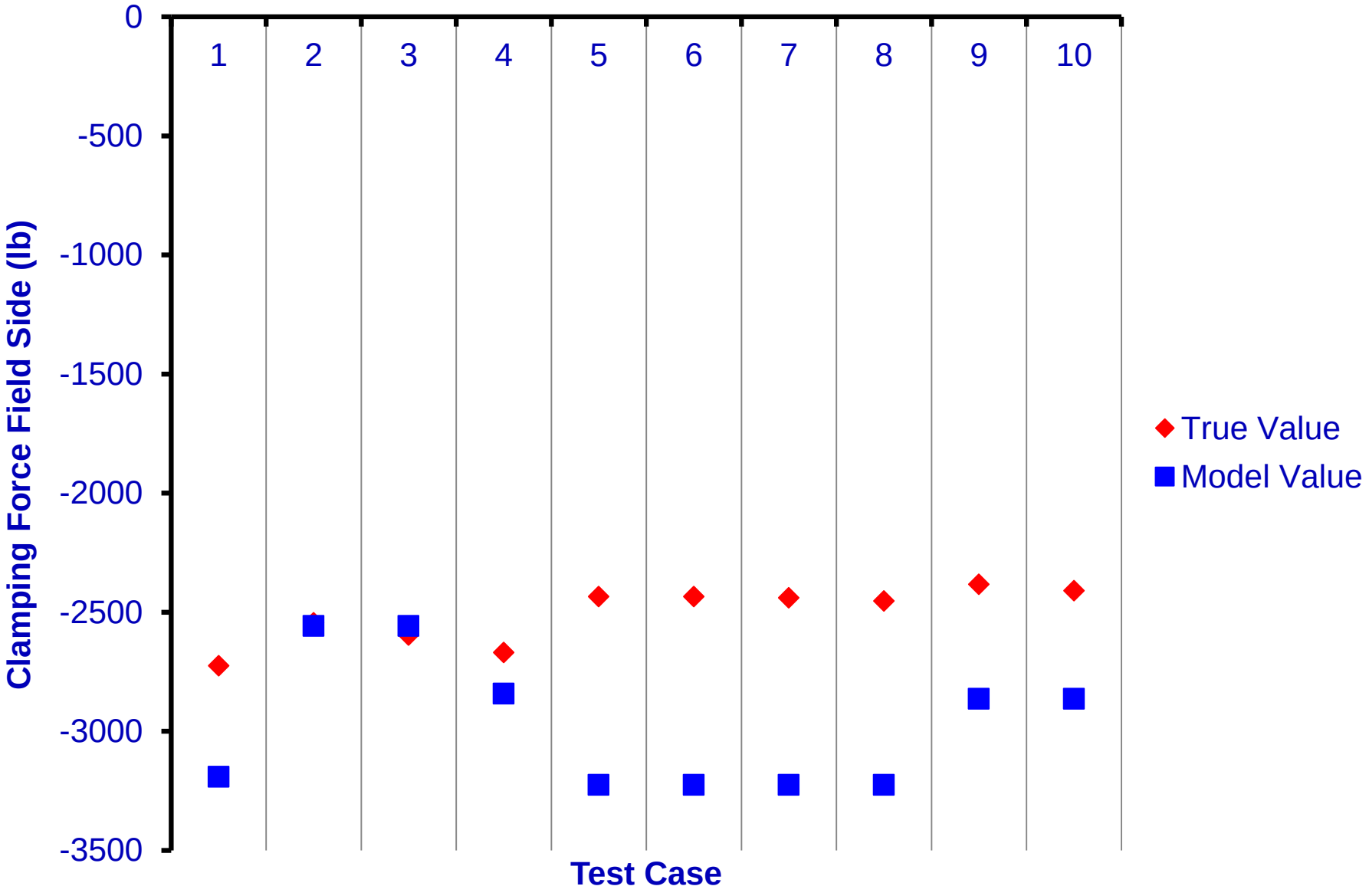
I-TRACK Validation – Clamping Force



Future Work

- Development of I-TRACK 2.0 and I-TRACK 3.0 (add surface interactions, support conditions, and geometry as spreadsheet inputs)
- Continue improving the accuracy of the spreadsheet by running additional interactions on the FE model and refining the equations
- Launch the simplified tool in different platforms: software, phone app (IPhone and Android)
- Deliver final product Fall 2014

Acknowledgements

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LBFoster
CXT Concrete Ties
TTX

Questions?

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Thank you!