3D Modeling Capabilities Available in AASHTOWare Bridge Design and Rating

Iowa Department of Transportation

Workshop on 3D Design and Modeling for Highway Structures

April 15, 2015

Topics

1. AASHTOWare
2. Software Overview
3. 3D Features and Capabilities
4. Summary

AASHTOWare Bridge Products

AASHTOWARE Bridge Rating™

(formerly Virtis)

Bridge Load Rating

AASHTOWARE Bridge Design™

(formerly Opis)

Bridge Design

AASHTOWARE Bridge Management™

(formerly Pontis)

Bridge Management

AASHTOWare

- Joint Development Effort
- Pooled Resources
- Software is owned by AASHTO
- Managed by a Task Force
- Tested by users (Technical Advisory Group)

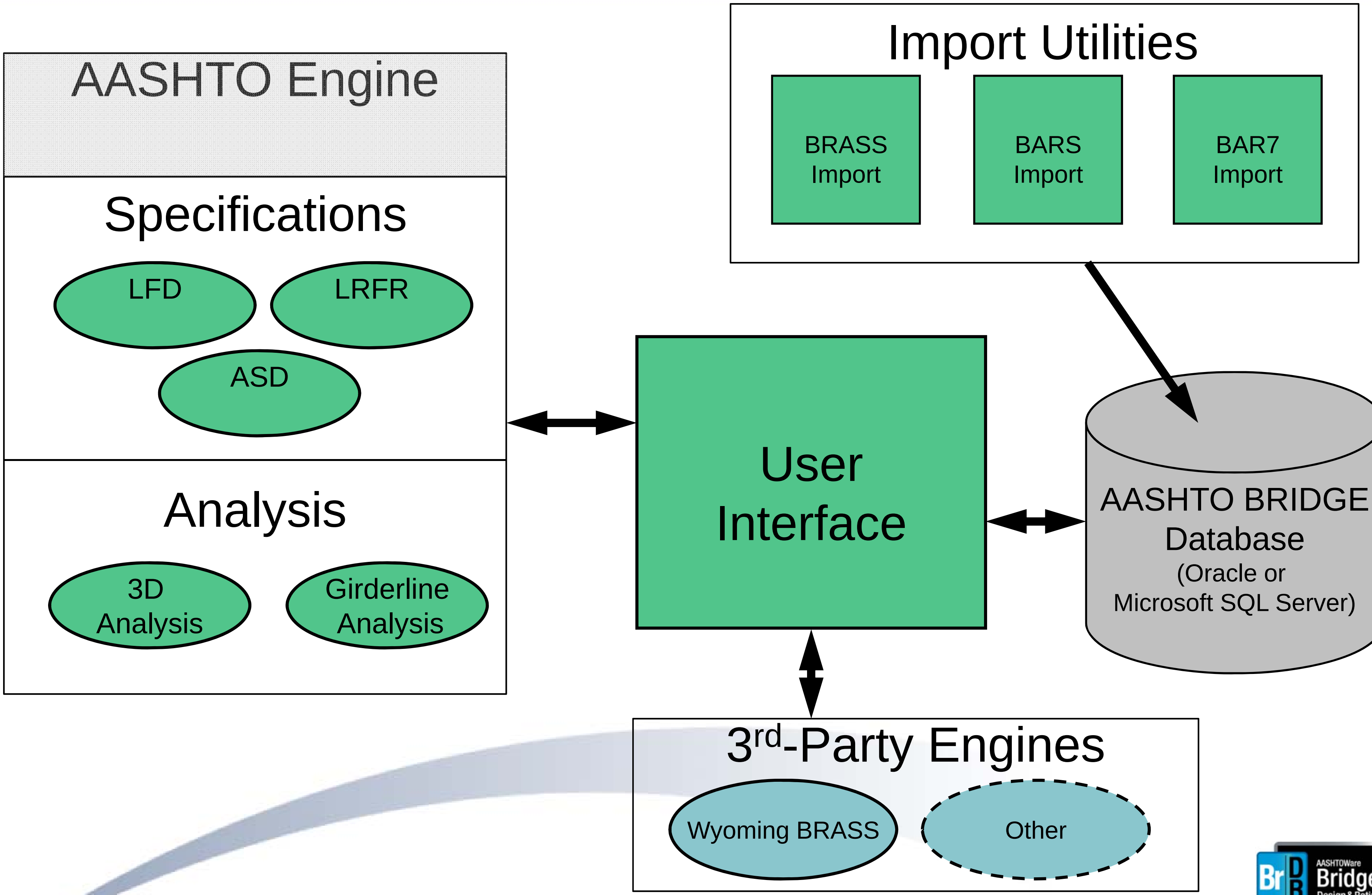
Task Force Members

- Todd Thompson, South Dakota DOT , Chairman
- Dean Teal, Kansas DOT
- Jeff Olsen, Montana DOT
- Amjad Waheed, Ohio DOT
- Joshua Dietsche, Wisconsin DOT
- Judy Skeen – AASHTO Project Manager
- Tom Saad – FHWA Liaison

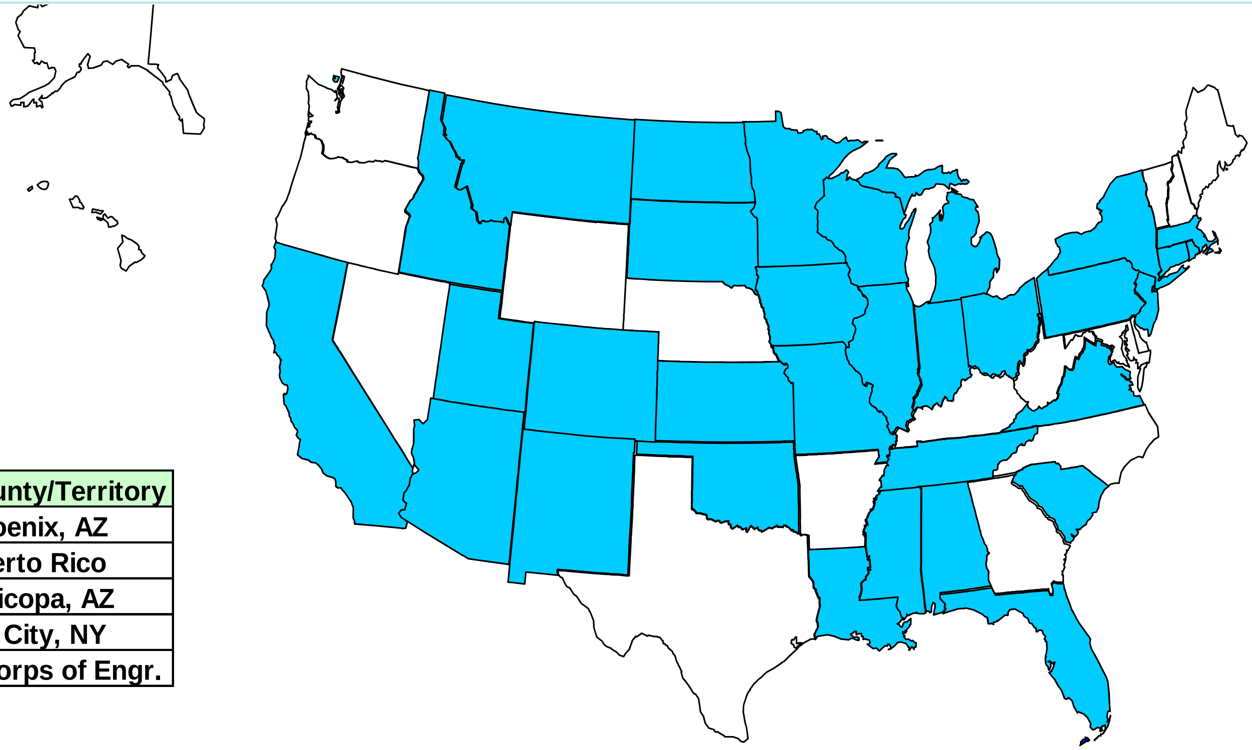
Software Overview

- Product Concept
- Licensees
- Major Capabilities

Product Concept



BrDR Licenses (FY 2015)



City/County/Territory
Phoenix, AZ
Puerto Rico
Maricopa, AZ
NY City, NY
Army Corps of Engr.

Country
Manitoba, Canada

Consultant Licenses = 612
Agency Licenses = 59

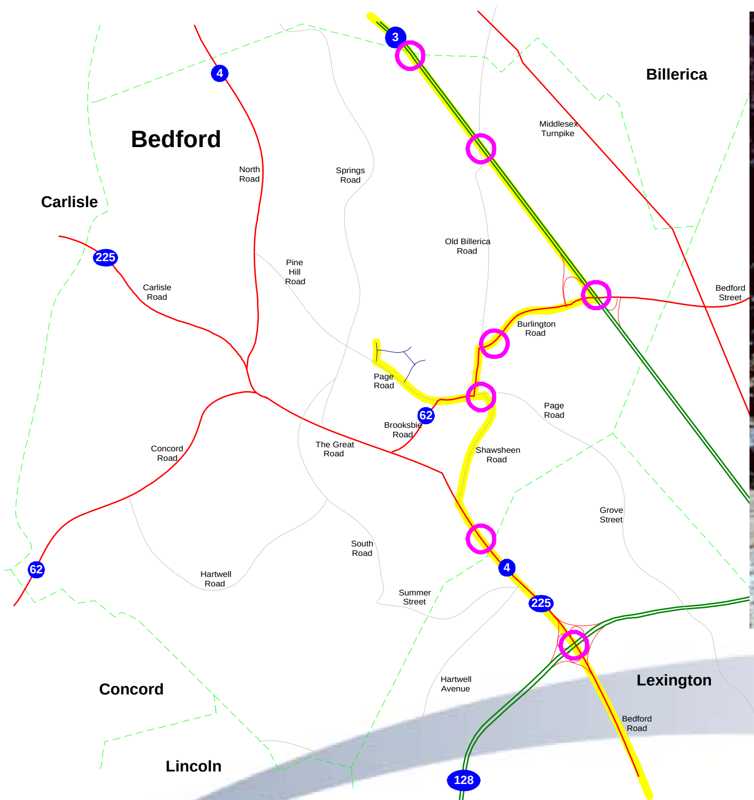
Map Key	
	Non- Licensee
	Licensee

Capabilities

Analysis, Load Rating, and Specification Checking of common bridge types

Capabilities

Support of Permit Routing



Capabilities

Load rating based on inspection results

Capabilities

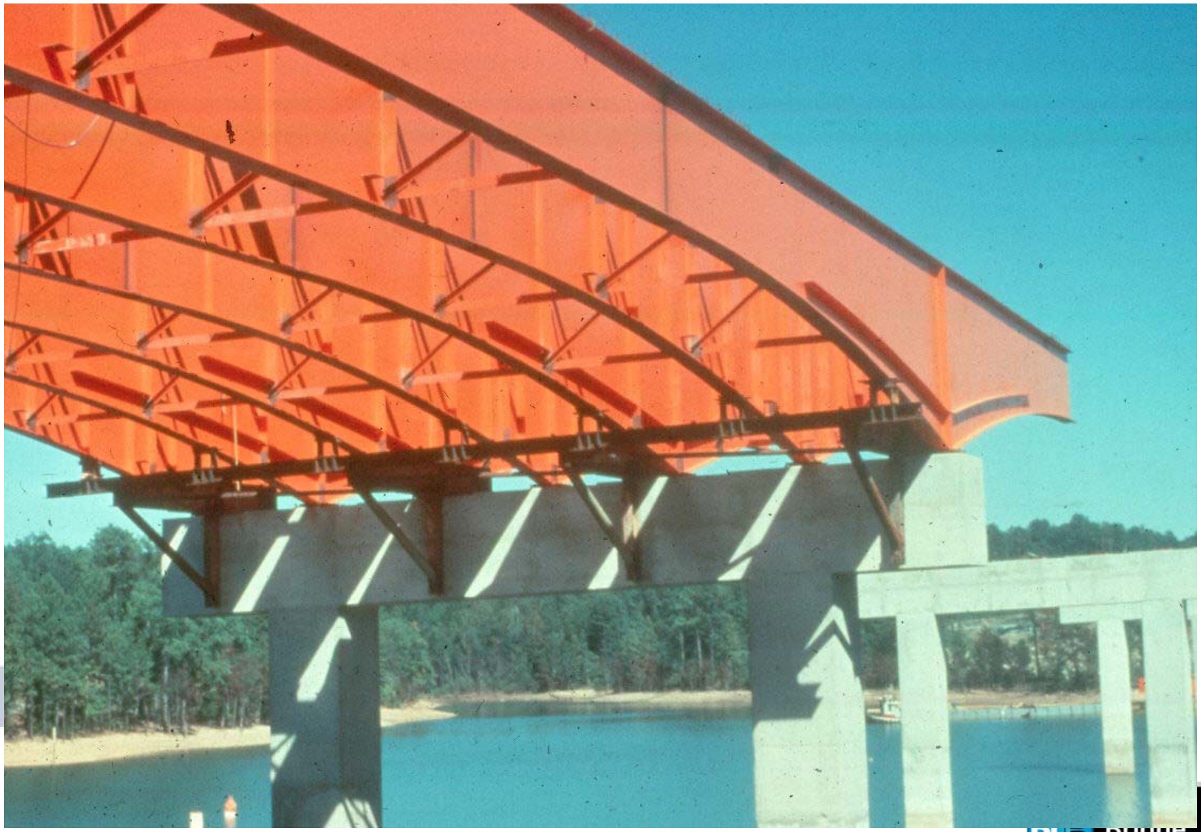
Comparison validation - enter a bridge once and…

- Compare results between engines
- Compare results between different specifications (ASD, LFD, LRFR, LRFD)
- Compare results between different versions of the LRFD/LRFR specifications
- Compare results between 3D and girder-line analysis

Capabilities

Steel Girder Superstructures

- Rolled shapes
- Welded plate girders
- Built-up I shapes
- Straight and curved



Capabilities

PS Concrete Superstructures

Precast shapes

- I beams
- Boxes
- Multi-stem Tee
- U beams

Capabilities

Reinforced Concrete Superstructures

- Tee beams
- Slab lines
- I beams

Capabilities

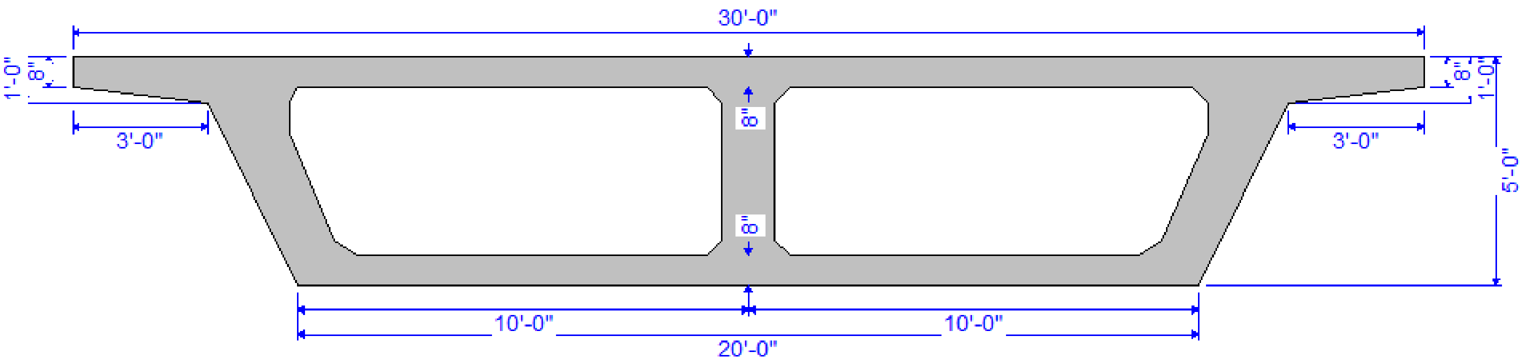
Reinforced and Post-Tensioned Concrete Multi-Cell Box Superstructures

- LRFD/LRFR
- User-defined box cross sections
- Line girder analysis, full box along with web-lines
- Integral with pier

Capabilities – Multi-cell boxes

Reinforced Concrete

Post-tension Concrete



Capabilities

Trusses (LFD)

- Continuous spans
- Suspended spans
- Counters
- Deck Trusses
- Through Trusses

Capabilities

Floor Systems
(ASD and LFD)

- Girder-Floorbeam-Stringer
- Girder-Floorbeam
- Truss-Floorbeam-Stringer
- Truss-Floorbeam
- Floorbeam-Stringer

Capabilities

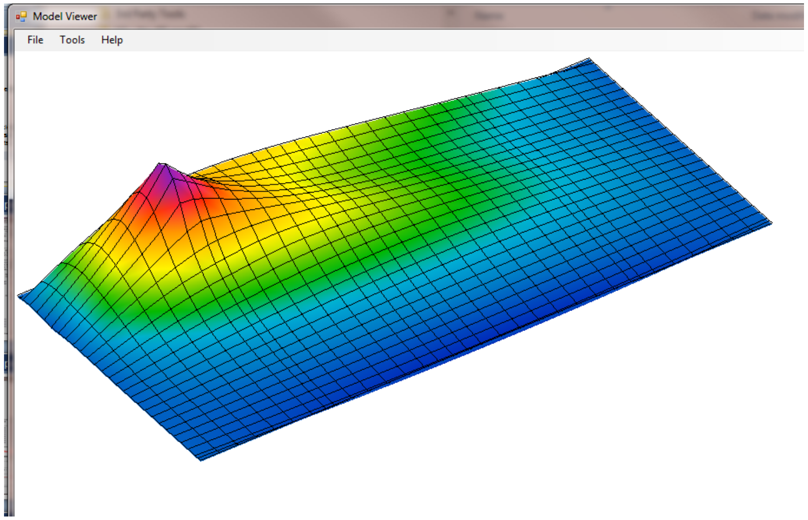
Reinforced Concrete Box Culverts (LRFR/LFR)

- Sloping fill
- Multiple cells
- Optional bottom slab
- Optional haunches

Capabilities

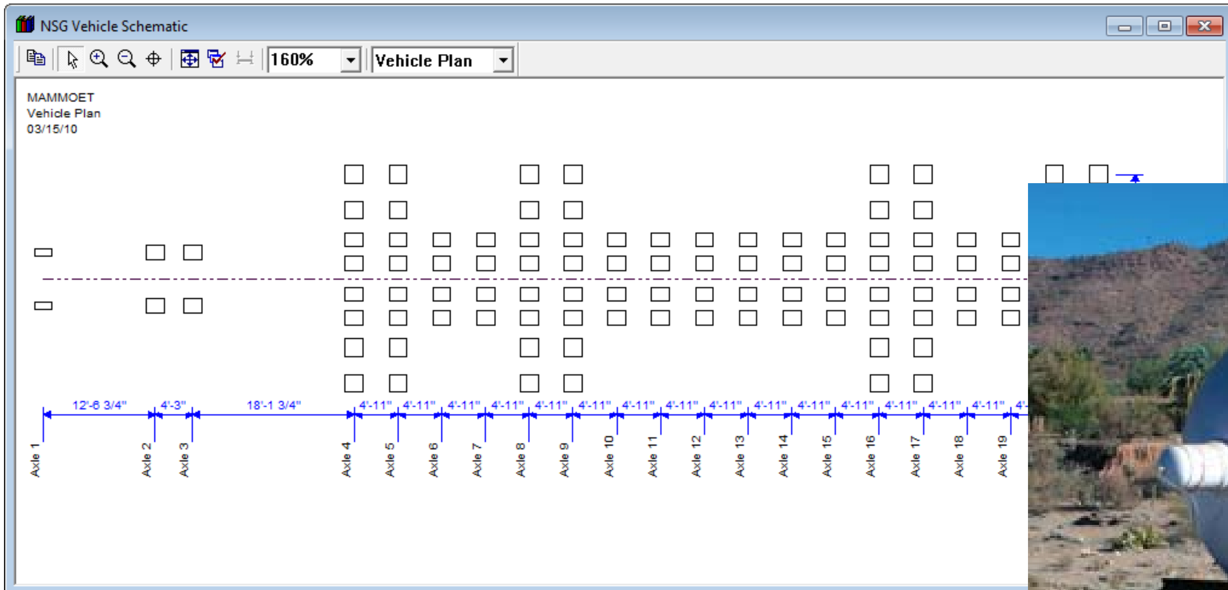
3D Analysis

- Straight and curved steel multi-girder systems
- Straight PS and RC multi-girder systems
- Dead and Live loads
- Live load - moves vehicles on influence surfaces to compute maximum and minimum effects



Capabilities

Analysis of nonstandard gage vehicles



Capabilities

Non-standard gage analysis

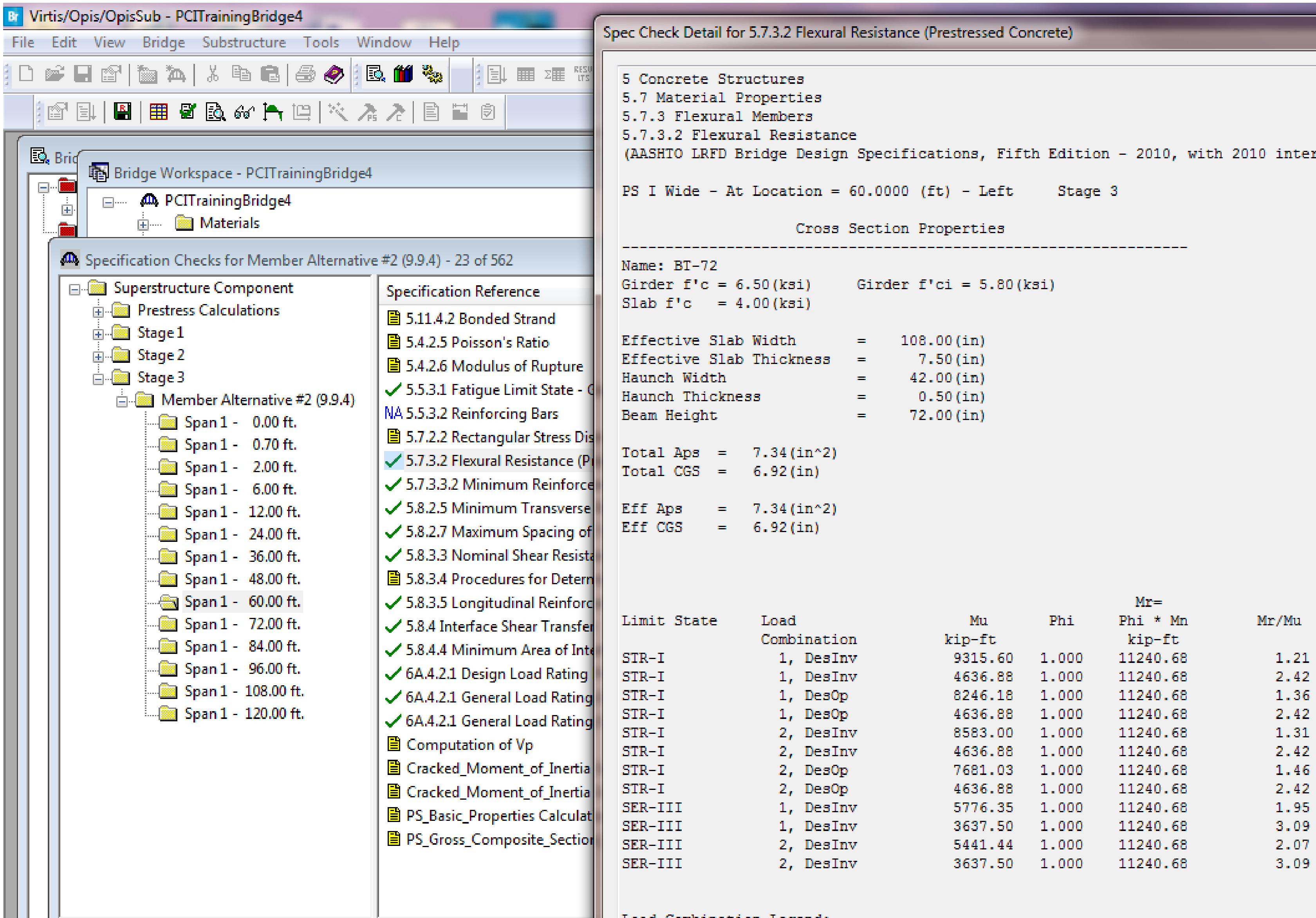
- Describe a non-standard gage vehicle
  - ➢Unlimited number of axles
  - ➢Unlimited number of wheels per axle

- Describe a loading path for the vehicle

- 3D analysis – loading of an influence surface for live load actions

- Rating

AASHTO LRFD Spec Checking



AASHTO LRFD Spec Checking

Bridge ID : 28
Bridge : Draft Bridge (jso 10-2013)
Superstructure Def : three span steel
Member : G1
Analysis Preference Setting : None

NBI Structure ID : L33028000_07001
Bridge Alt :

Member Alt : exterior G1

AASHTO LRFD Specification, Edition 7, Interim 0

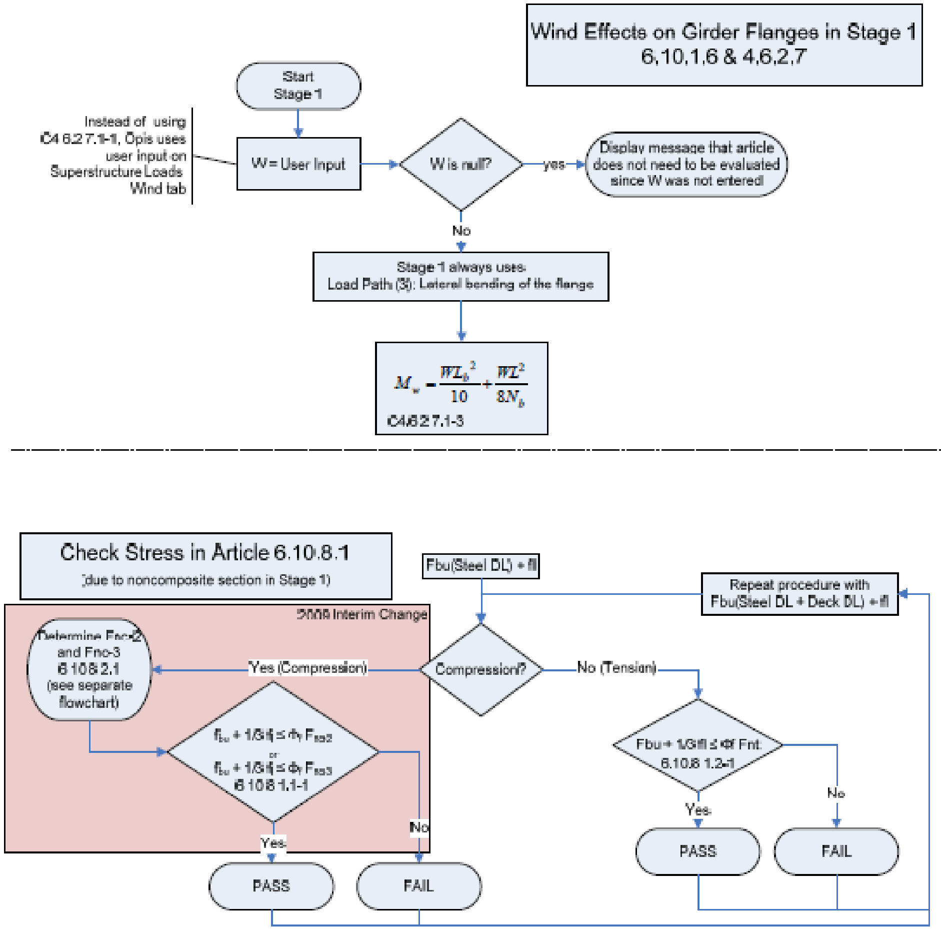
Specification Check Summary

Article	Status
Flexure (6.10.7.1.1, 6.10.7.2.1)	Pass
Shear (6.10.9)	Pass
Fatigue (6.10.5.3)	NA
Serviceability (6.10.4.2.2)	Pass
Constructability (6.10.3.2.1, 6.10.3.2.2, 6.10.3.2.3)	Pass
Transverse Stiffeners (6.10.11.1.2, 6.10.11.1.3)	Pass
Longitudinal Stiffeners (6.10.11.3.1, 6.10.11.3.2, 6.10.11.3.3)	NA
Bearing Stiffeners (6.10.11.2.2, 6.10.11.2.3, 6.10.11.2.4)	Pass
Shear Connector (6.10.10.1, 6.10.10.4)	NA

Bridge Workspace - Design

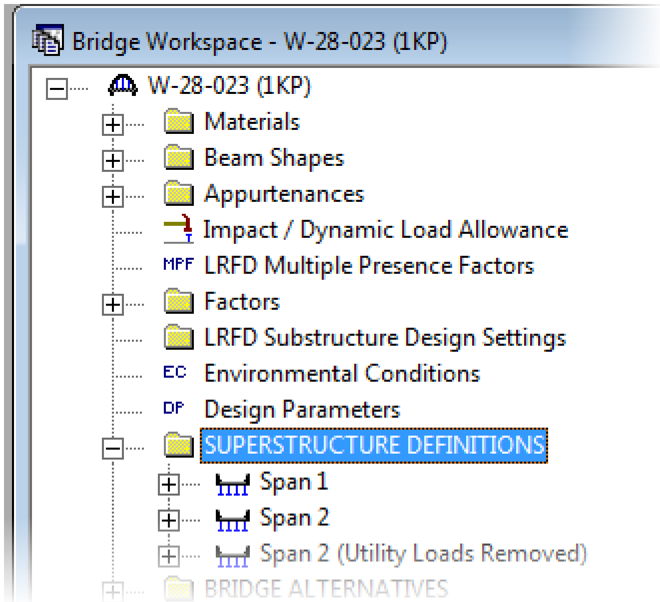
LRFD Method of Solution Manual

LRFD 5th Edition



Includes detailed flow charts

Bridge Definition

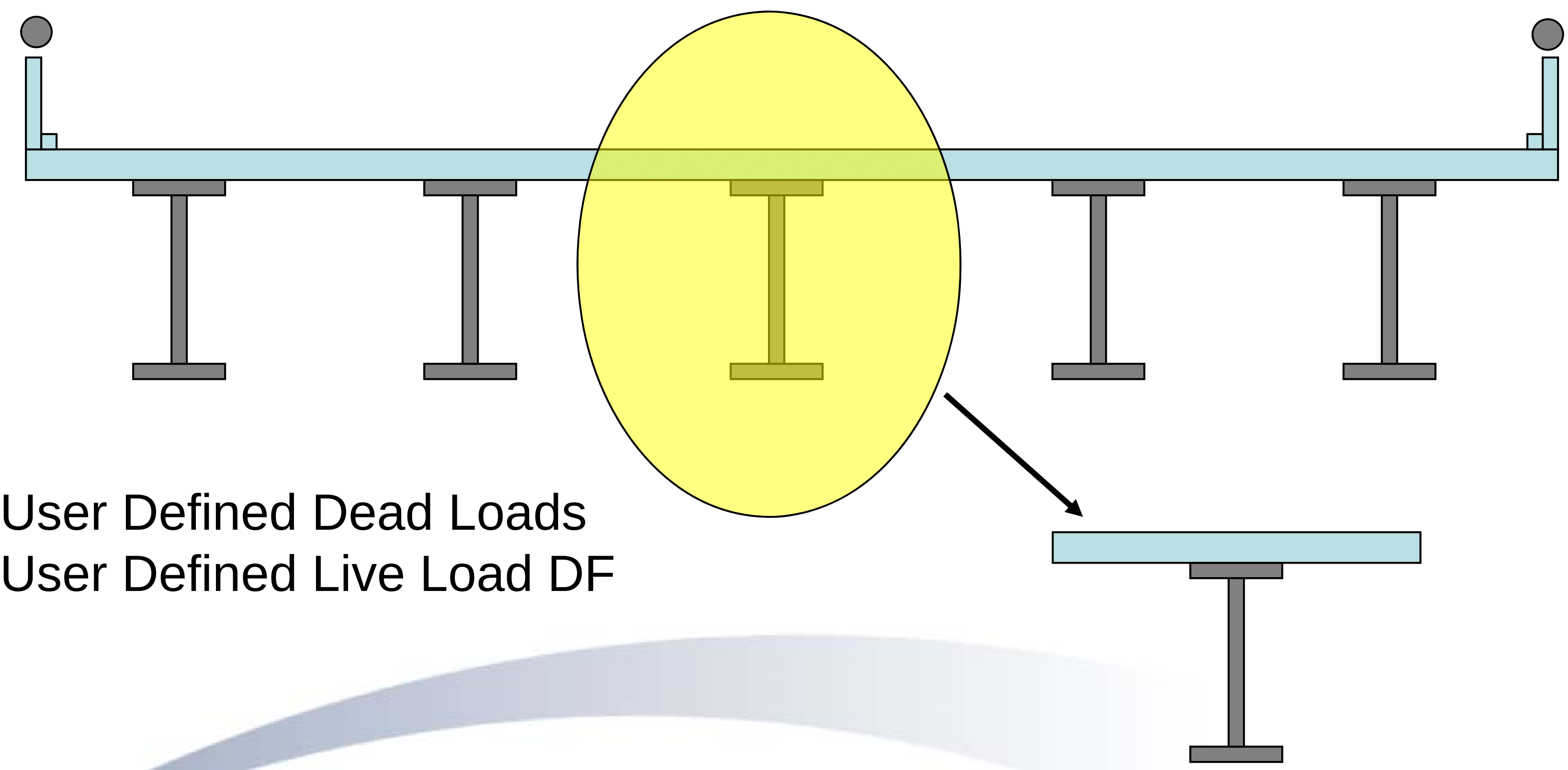


Detailed description of each structure within the bridge.

- System definition
- Line definition

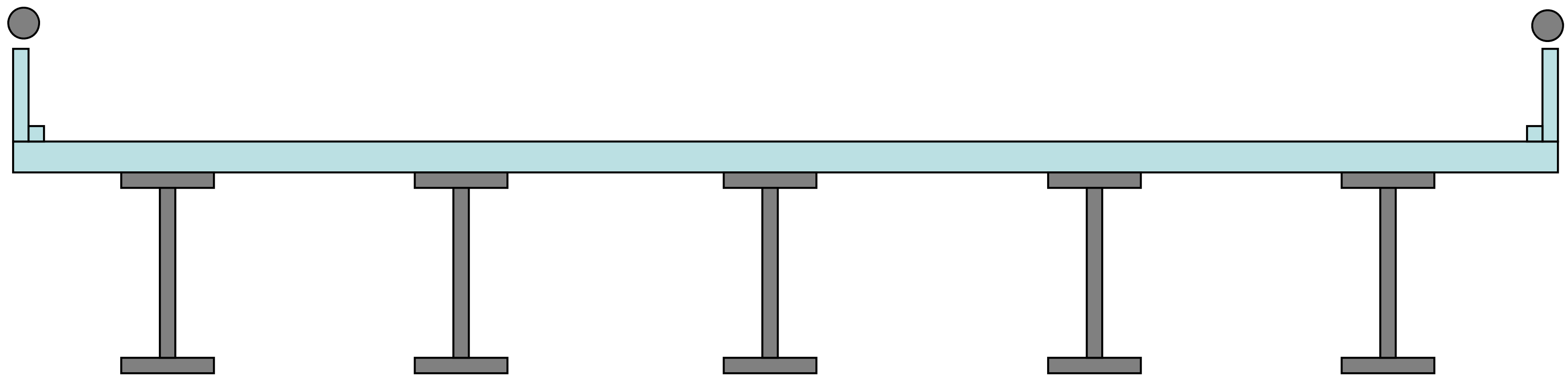
Bridge Workspace – Struct Def

Line Definition



- User Defined Dead Loads
- User Defined Live Load DF

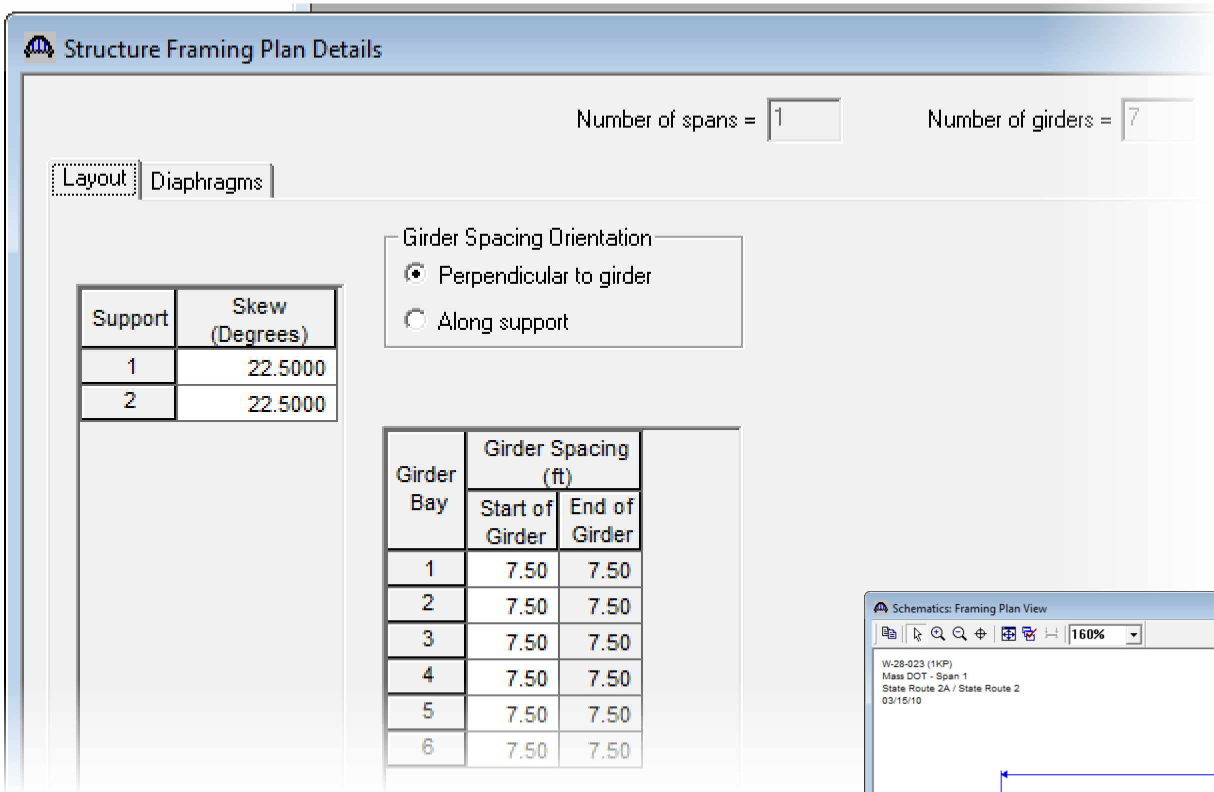
System Definition

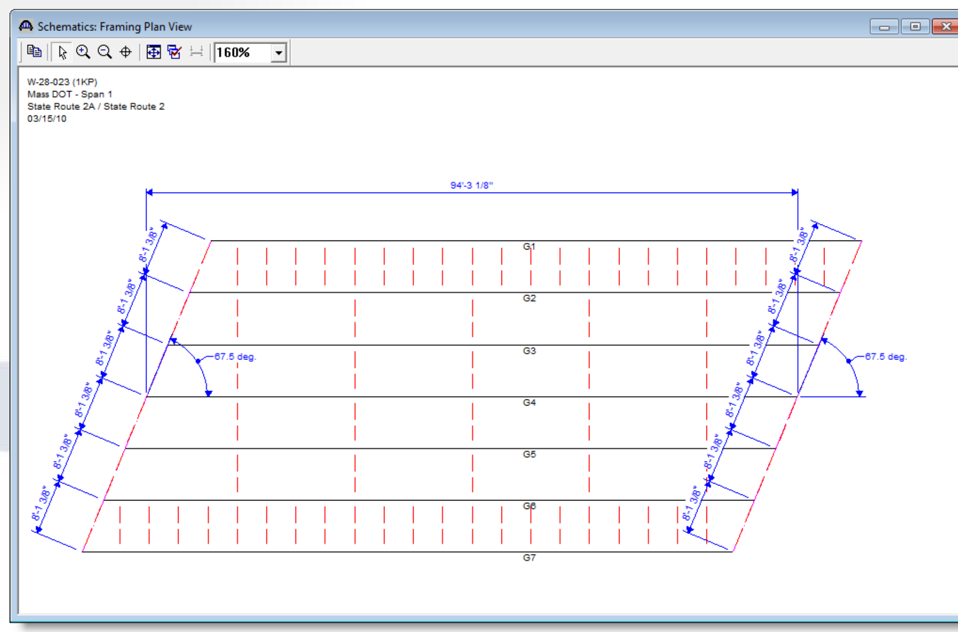


- System Computed Dead Loads
- System Computed Live Load Distribution Factors

- Suitable for 3D analysis

Bridge Workspace – Framing Plan

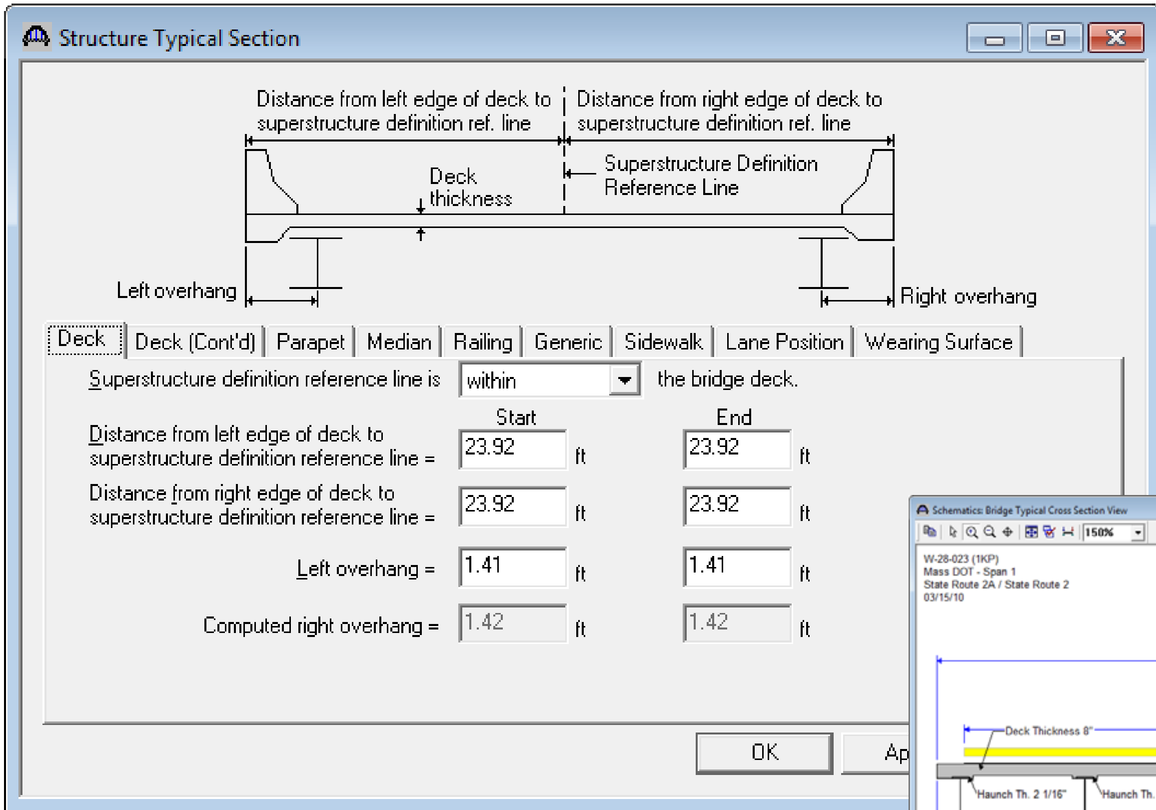


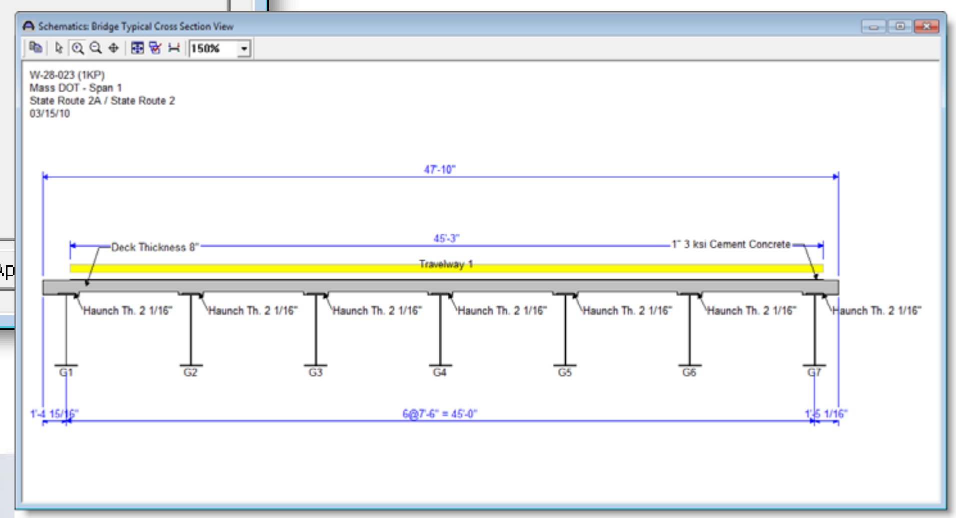


Used to define:

- Girder layout – skew and spacing
- Diaphragms

Bridge Workspace



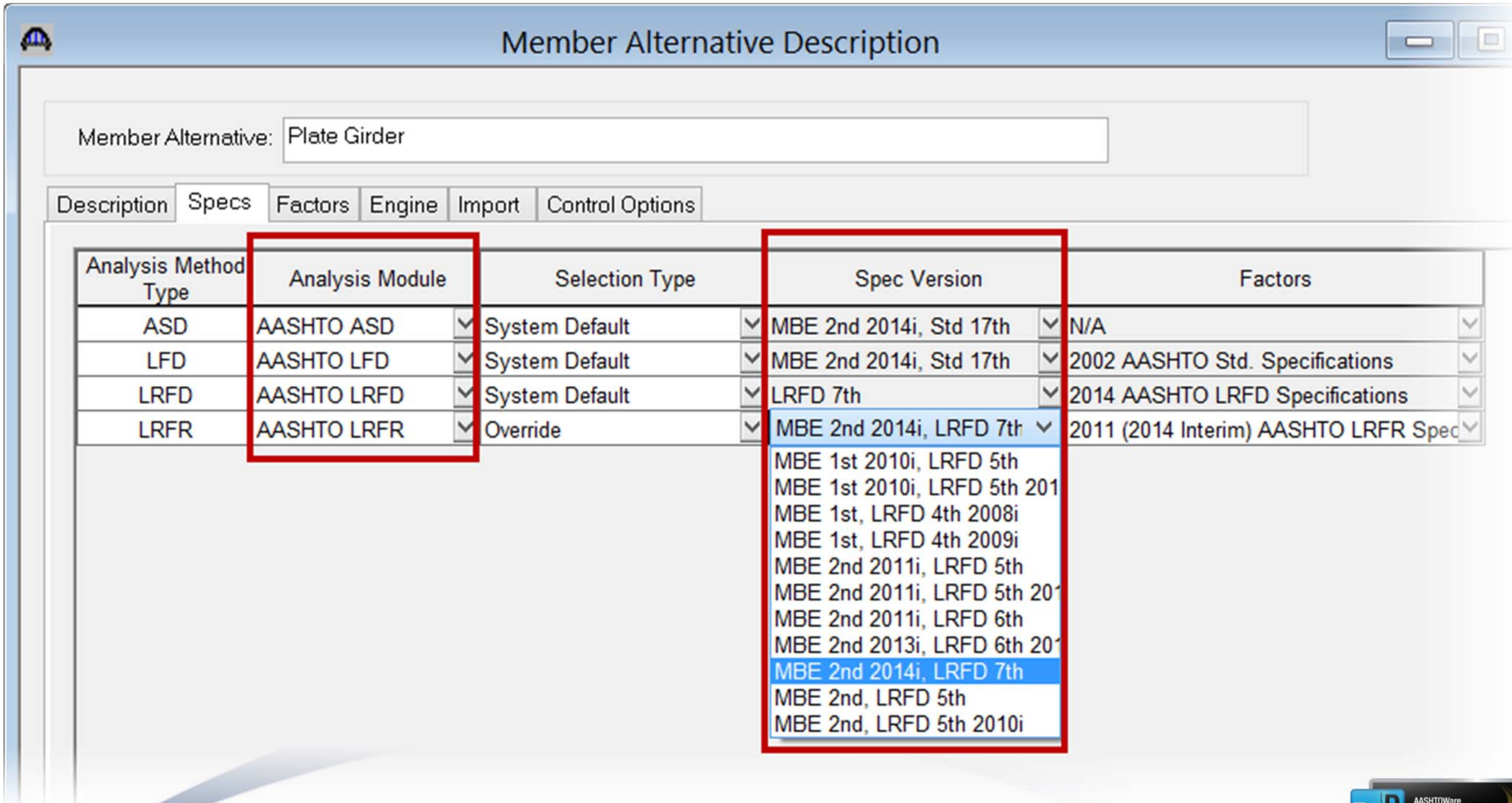


Used to define:

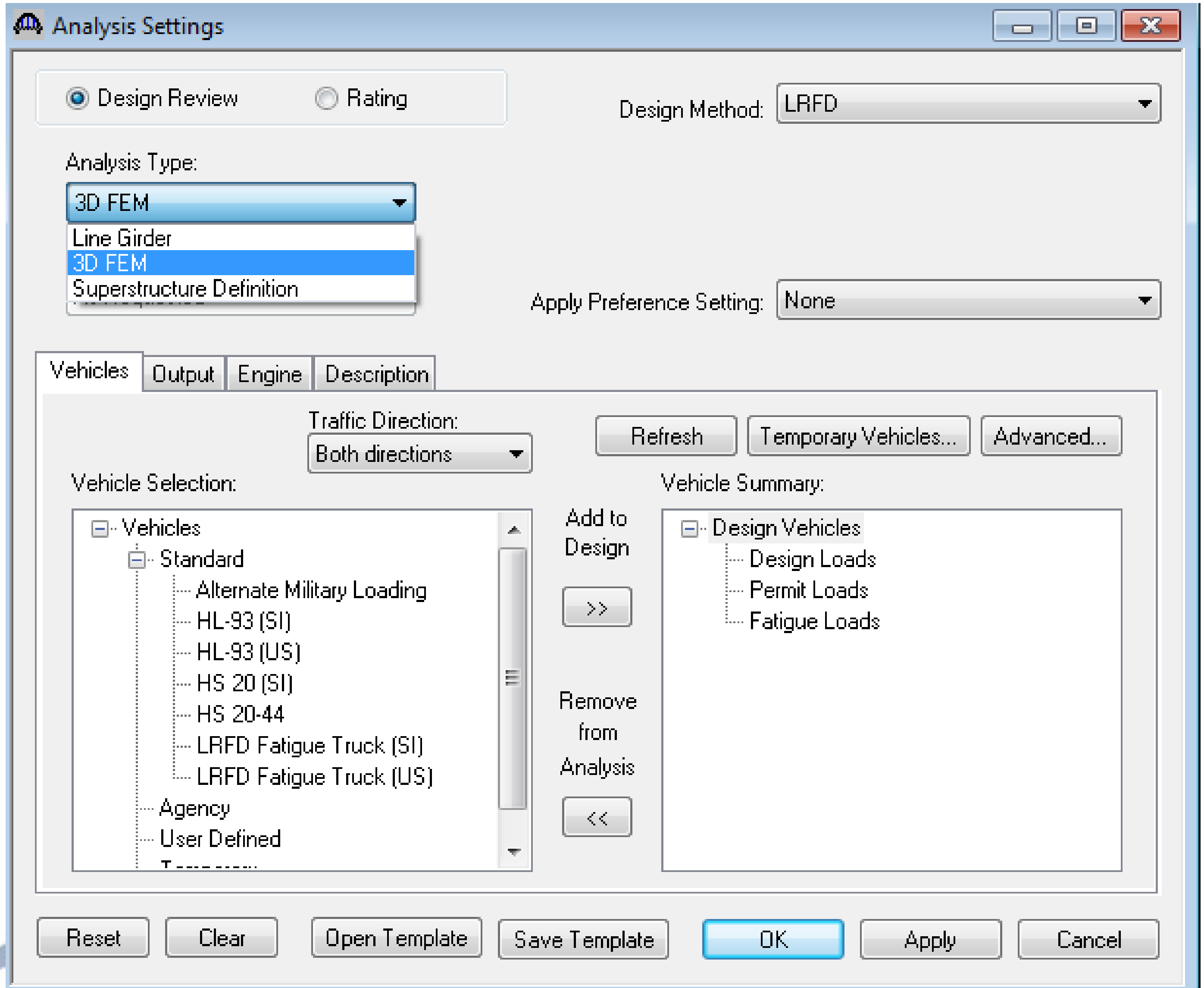
- Deck, wearing surface, lane positions
- Parapets, medians, railings, sidewalks

Bridge Workspace

Choose analysis module and spec version…



Bridge Workspace – Design Review



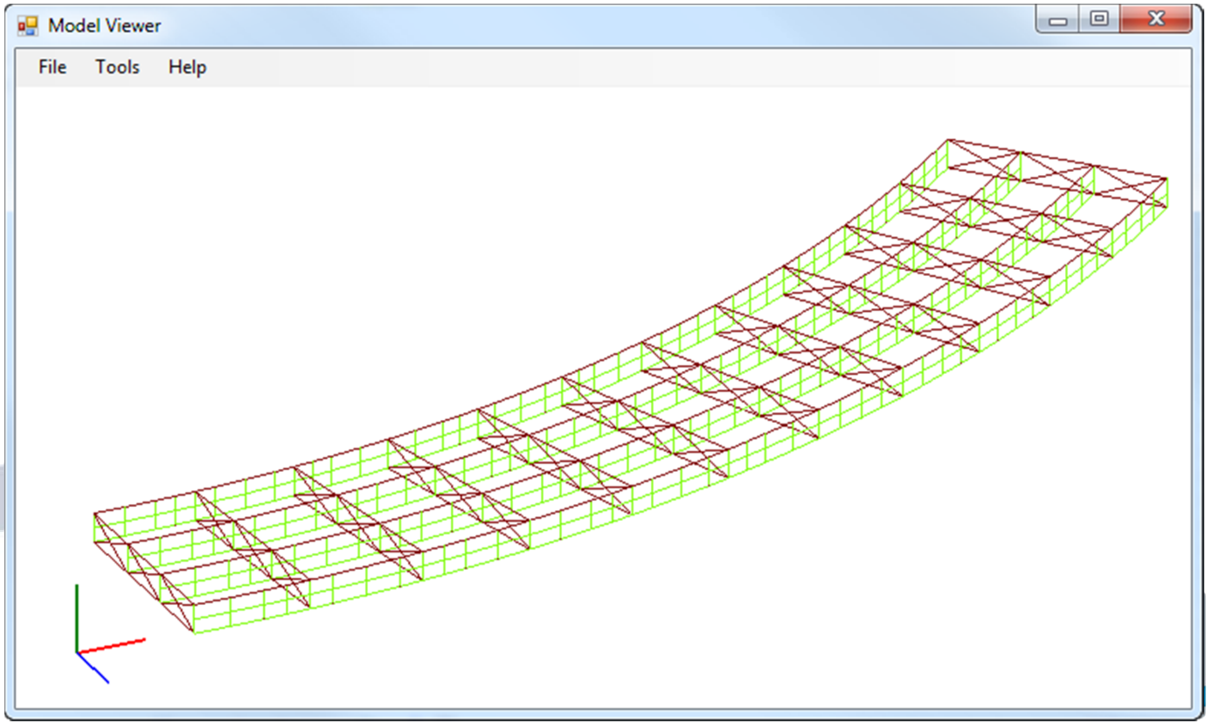
3D Features and Capabilities

- Multi-Girder Superstructures
  - Steel (Straight or Curved)
  - Prestressed Concrete (Straight)
  - Reinforced Concrete (Straight)

3D Features and Capabilities

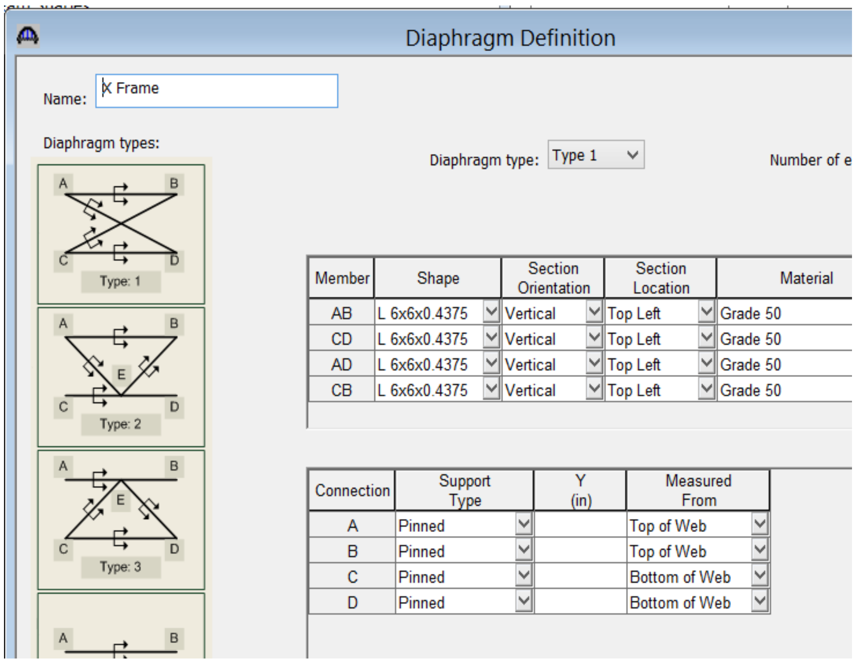
- Automated 3D Model Generation for Structural Analysis and Design

- 3D Model Viewer



3D Features and Capabilities

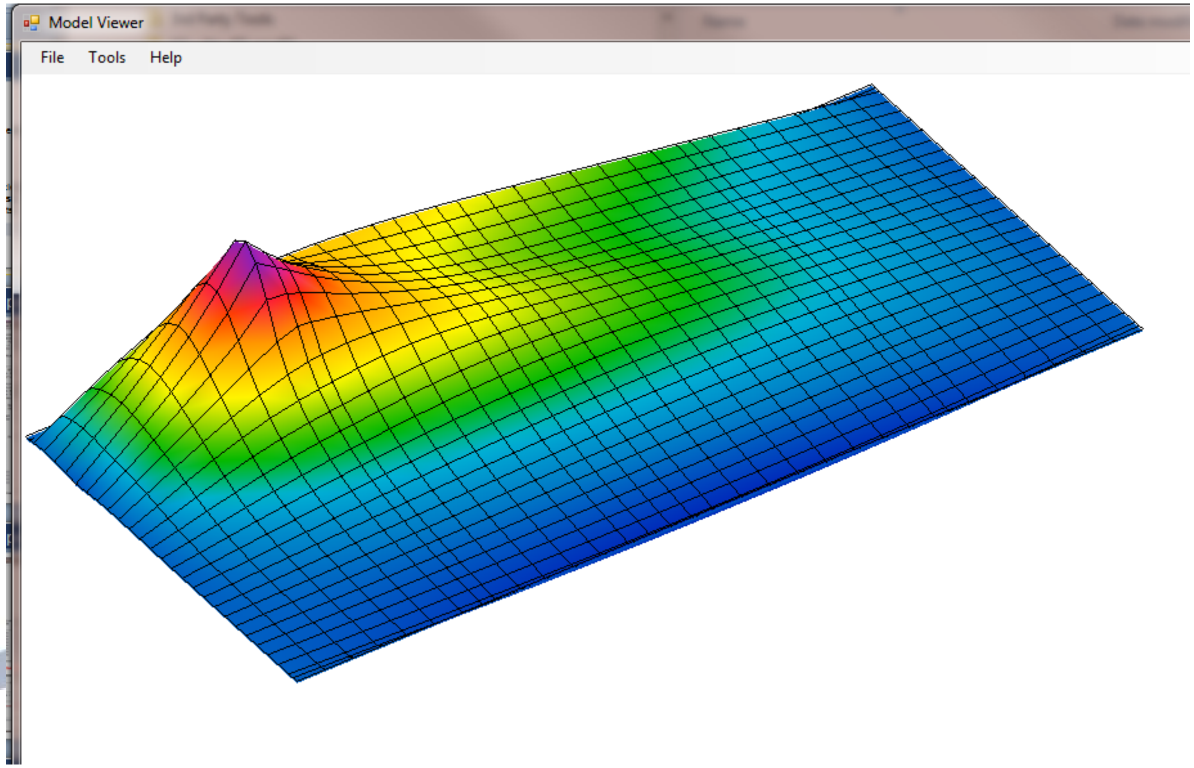
- Multi-Girder Superstructures
  - o Analysis of diaphragms



  - o Spec-checking and rating of diaphragms coming soon

3D Features and Capabilities

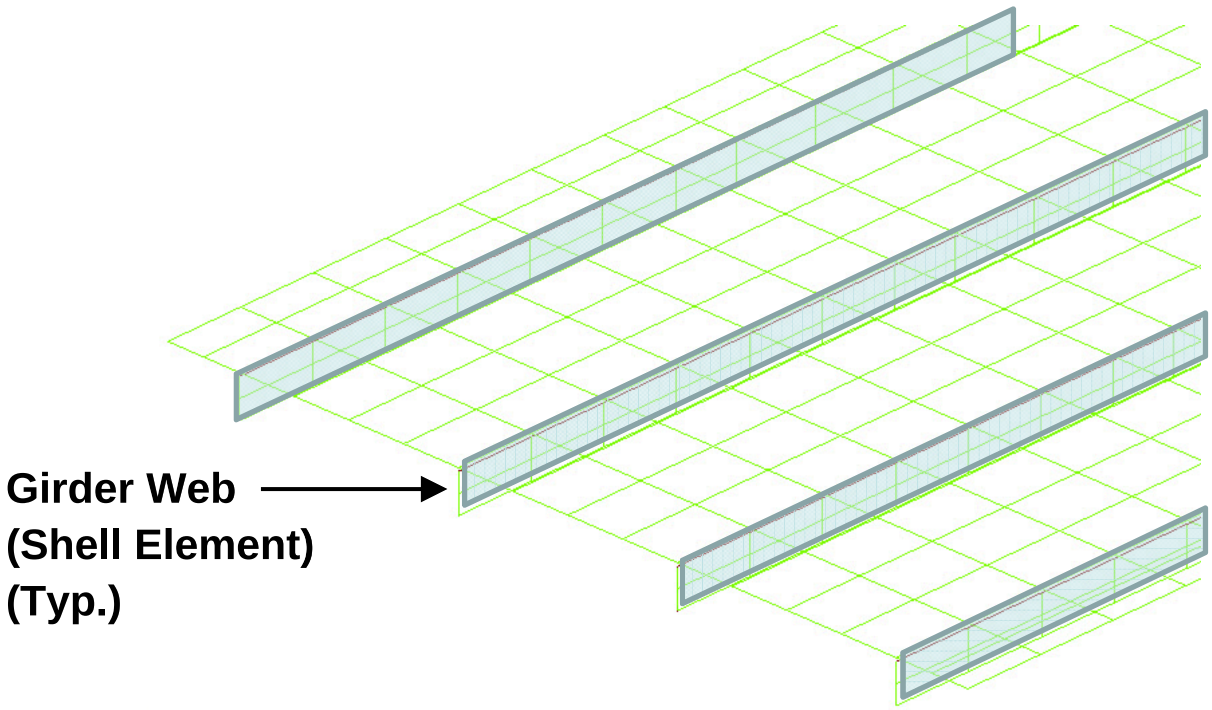
- Live load - moves vehicles on influence surfaces to compute maximum and minimum effects
- Longitudinal and transverse live load analysis or user-defined vehicle loading path



3D Model Generation

Shell elements:

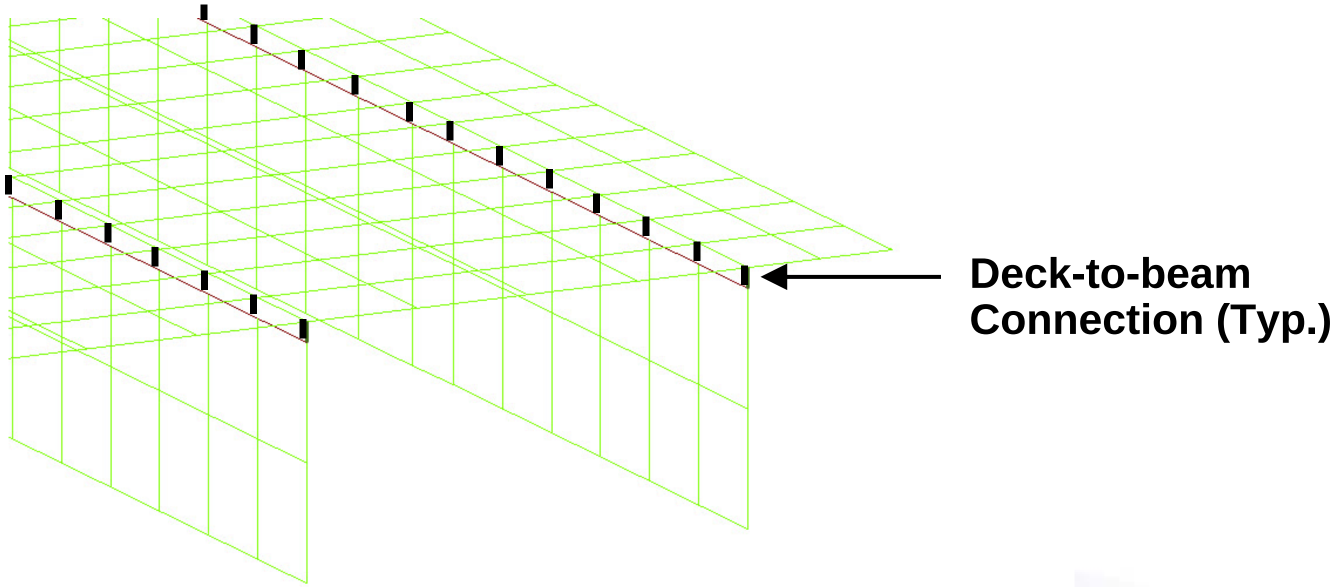
- Are used for the steel girder web and the deck
- Have four nodes with six DOFs at each node



3D Model Generation

Deck-to-beam connection:

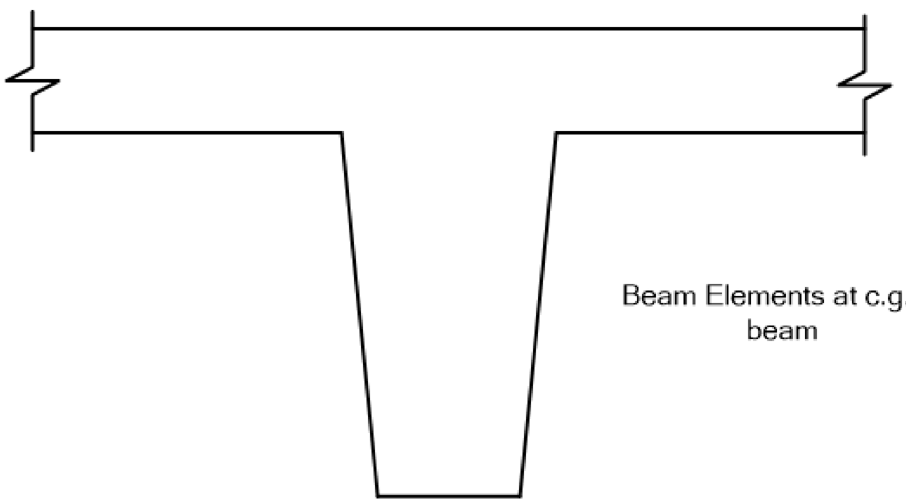
- Master-slave constraints
- Connects center of gravity of deck to girder top flange



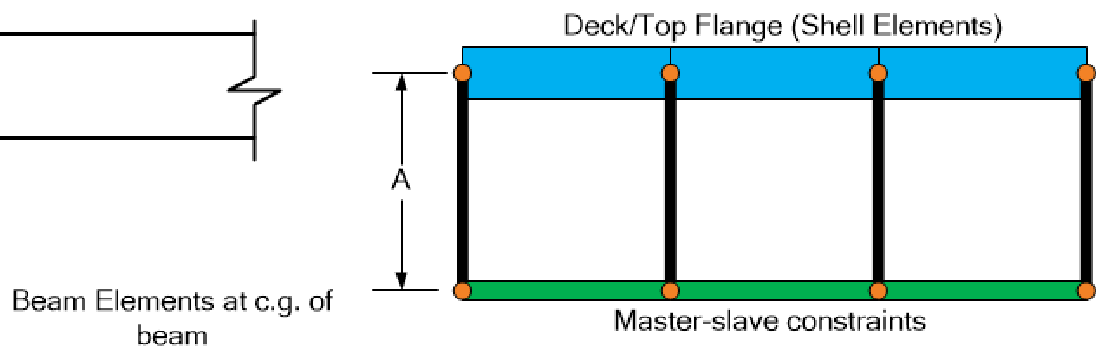
3D Model Generation

Modeling of reinforced concrete sections:

- Beam elements used for reinforced concrete beam
- Shell elements used for deck/top flange
- Master-Slave constraints used for connection



Reinforced Concrete Section

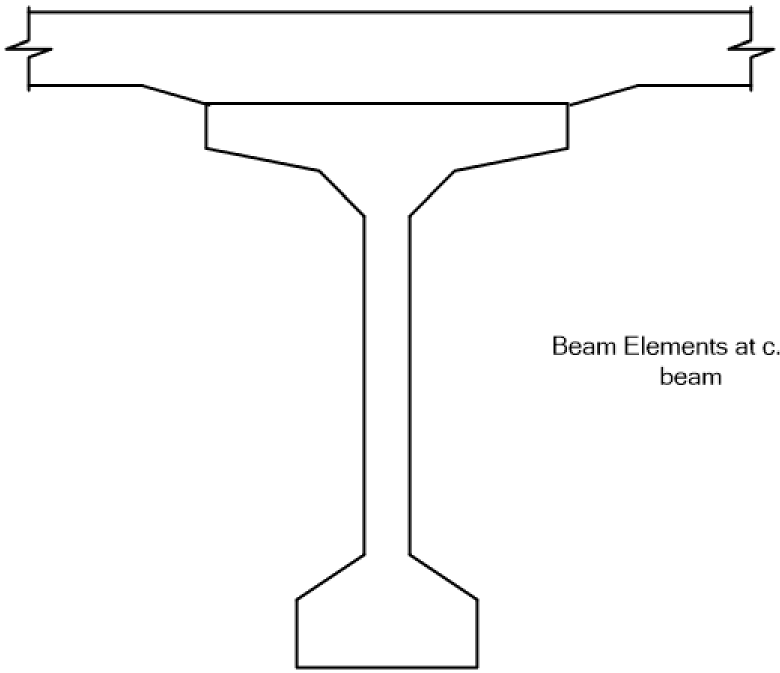


Partial Elevation View of Model

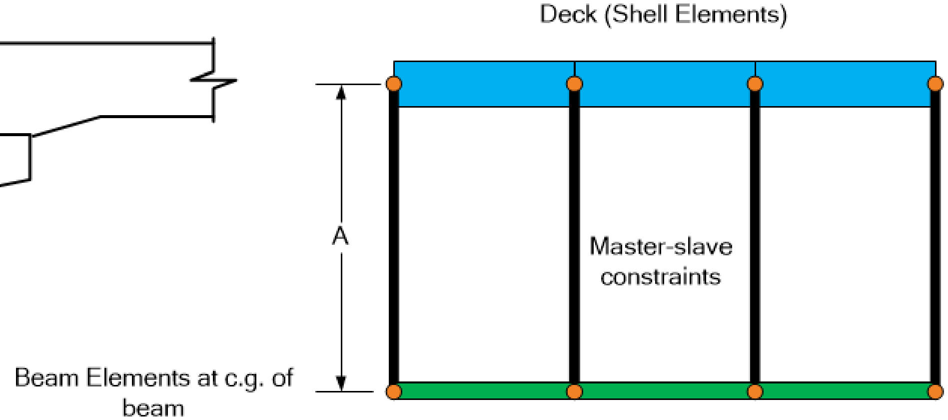
3D Model Generation

Modeling of prestressed concrete sections:

- Beam elements used for prestressed concrete beam
- Shell elements used for deck/top flange
- Master-Slave constraints used for connection



Prestressed Section

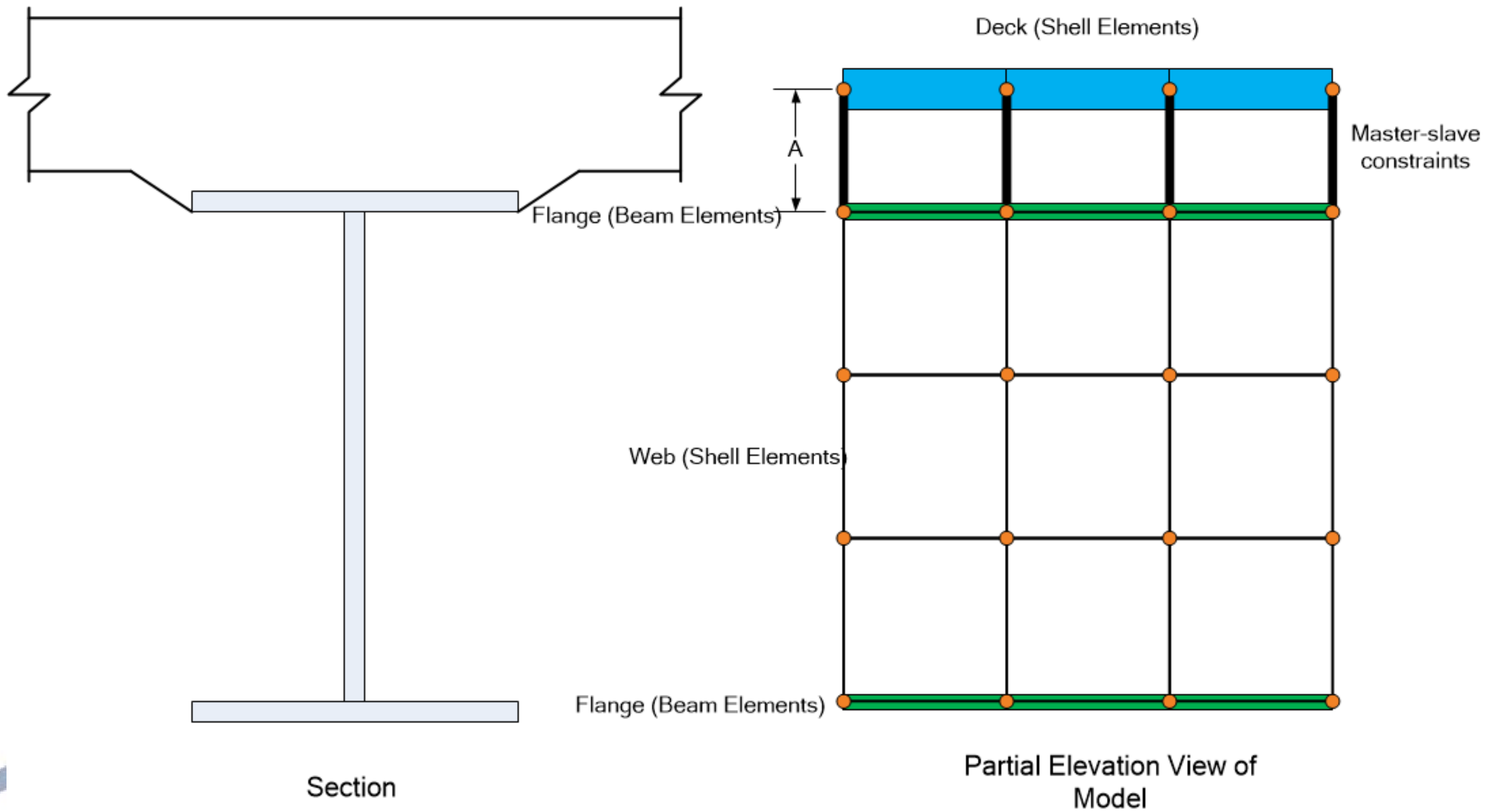


Partial Elevation View of Model

3D Model Generation

Modeling of steel beam with concrete deck:

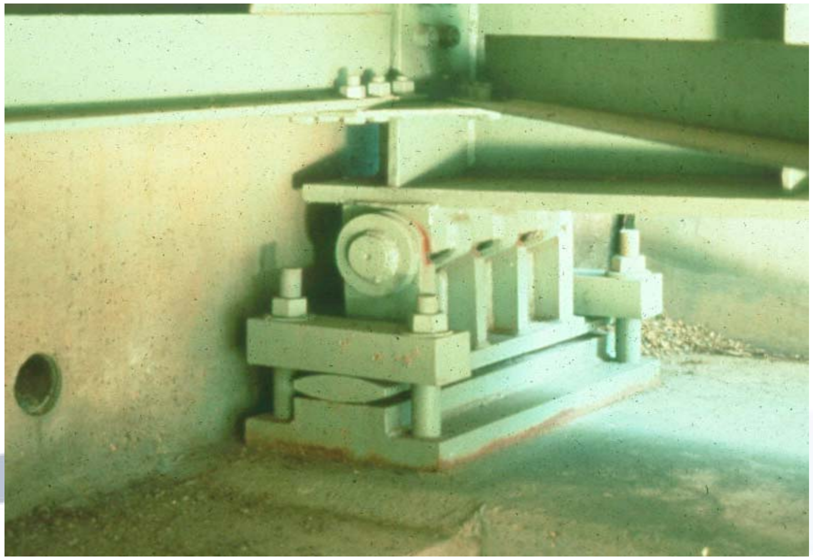
- Beam elements used for steel girder flanges
- Shell elements used for deck and steel girder web
- Master-Slave constraints used for connection



3D Model Generation

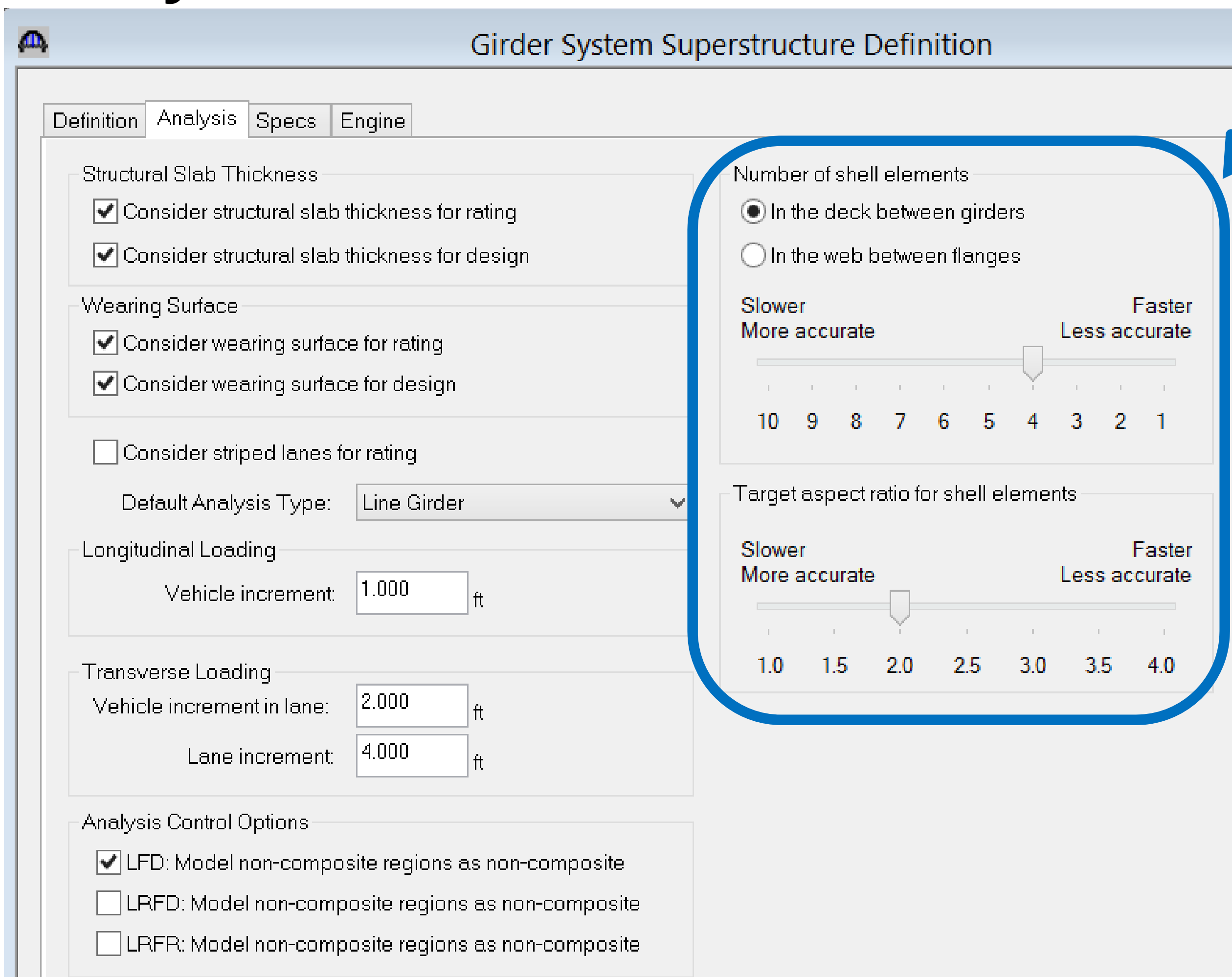
Support conditions:

- Free bearings – permit translation in all directions
- Guided bearings – permit translation in only one direction, usually either longitudinal or transverse
- Fixed bearings – do no permit translation in any direction



3D Model Generation

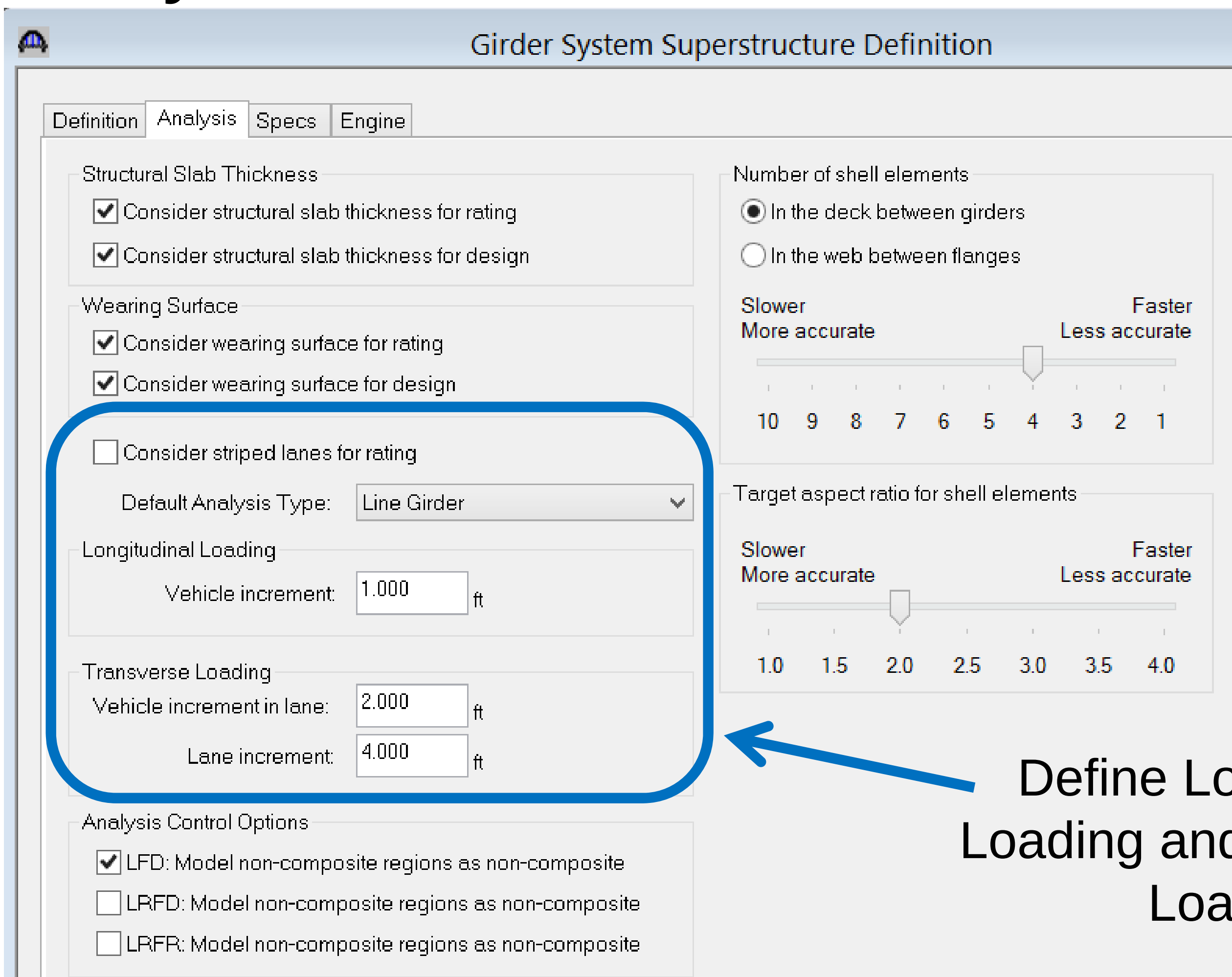
Analysis controls:



Specify mesh generation parameters

3D Model Generation

Analysis controls:

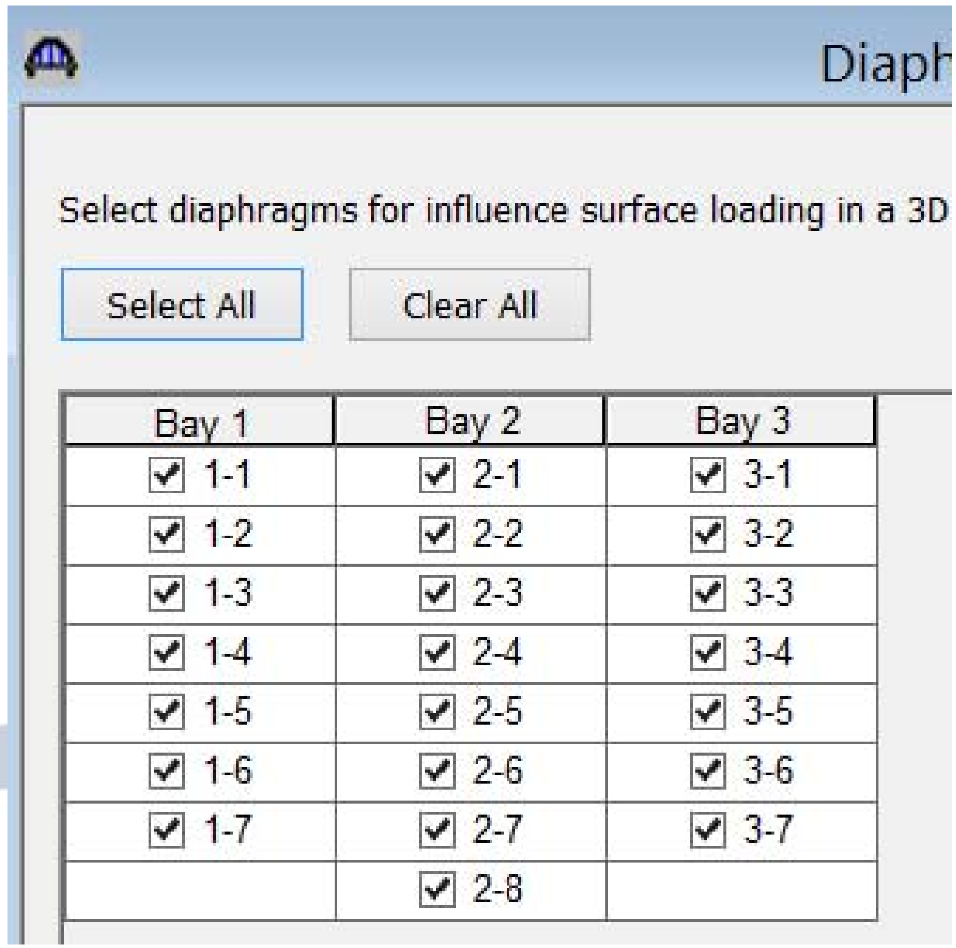


Define Longitudinal Loading and Transverse Loading

3D Features and Capabilities

Analysis Controls:

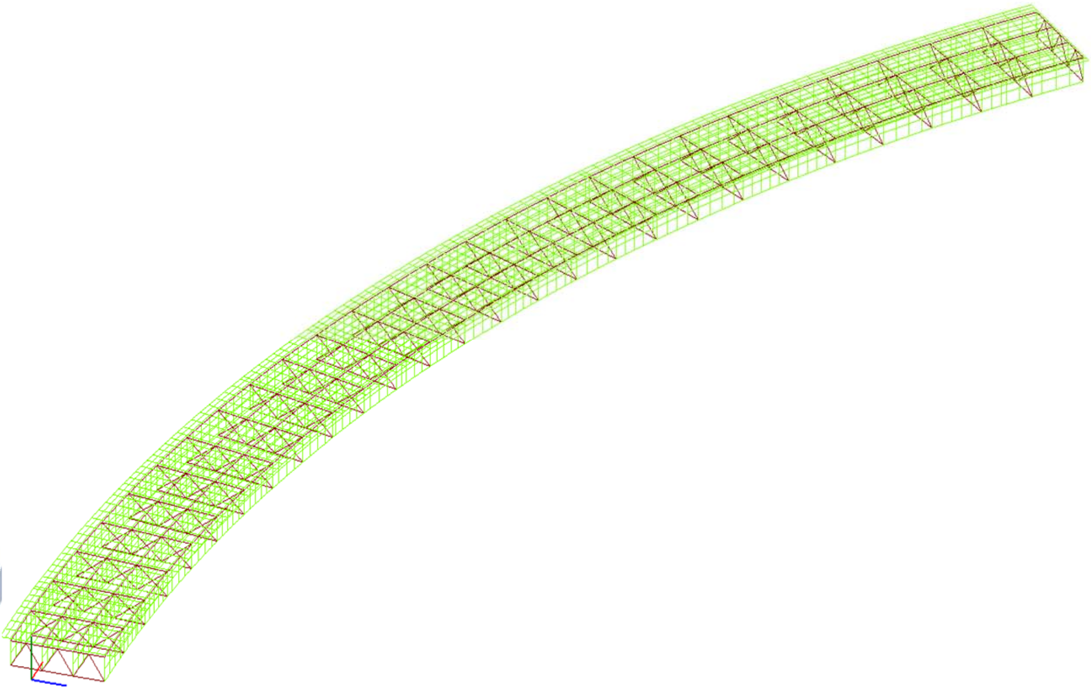
- Select the diaphragms for which diaphragm forces are to be computed



3D Features and Capabilities

Model Viewer:

- Model can be viewed graphically
- Model Viewer permits view from many different vantages
- Ability to select what portions of the model are viewed
- Ability to view influence surfaces and load paths

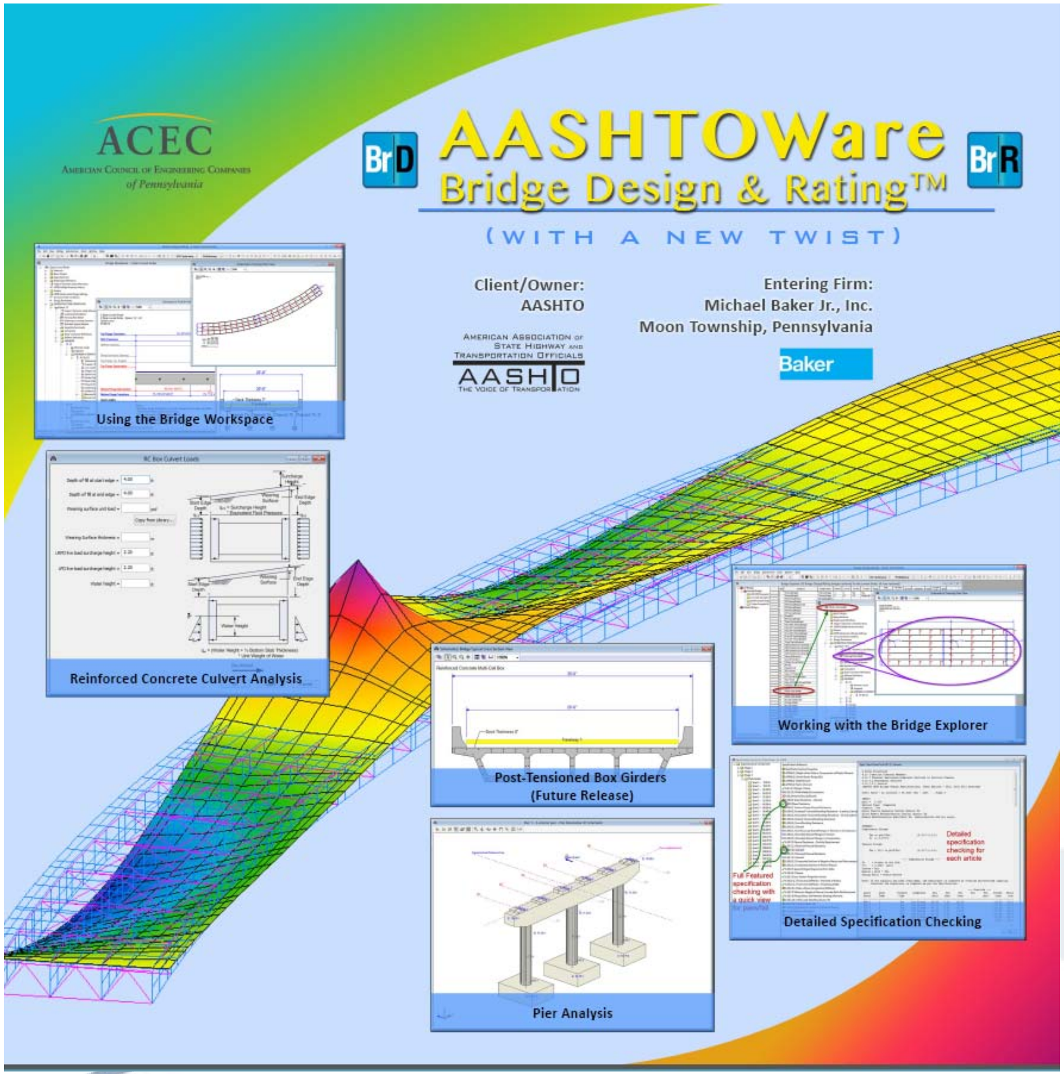


3D Features and Capabilities

- 3D Finite element analysis based on an investigative study to identify best practices

Awards

American Council of Engineering Companies



2014 National Recognition Award Winner

Summary

1. One user interface handles most bridge types and is used for both design review and rating
   - Improved productivity by learning one user interface
   - Consistency across many bridge types

2. Database for storing bridge descriptions
   - Security
   - Backups

3. Simplified administration of one product

Summary

4. General 3D description not specific to:
   - A particular edition of the AASHTO specification
   - An analysis method (Line or 3D)
   - An analysis engine

5. As specifications and methods change the data does not have to be re-input

6. Enter data once and evaluate with different AASHTO specifications (ASR, LFR, LRFR), or different editions of a specification, or different models

Summary

7. Research – Evaluate specification changes before they are adopted for production use

8. System allows for 3rd party analysis engines
   - Wyoming BRASS
   - Bentley (LARS and former Leap products)

9. Opportunity for agency customization (Service Units)
   - Agencies can request features
   - Users vote on features
   - Technical Advisory Groups – advise how features should be implemented

Thank you