AASHTOWare BrD 6.8

Substructure Tutorial

BrD Substructure Overview

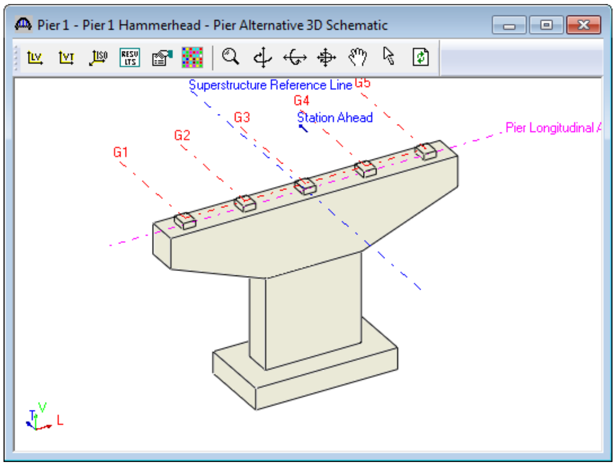
Topics Covered

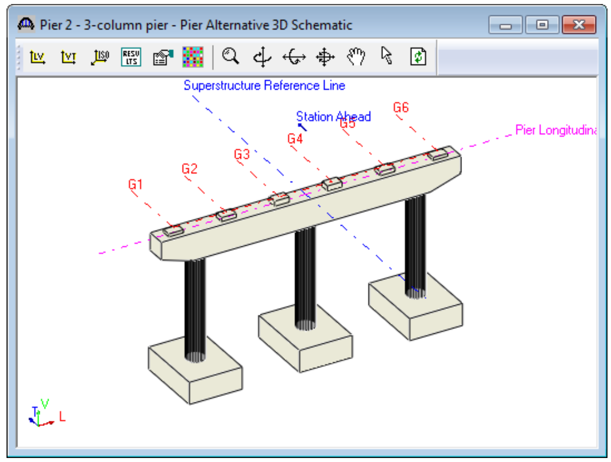
- BrD Substructure Capabilities
- Bridge Workspace
- Pier Components – Geometry and Reinforcement
- Loads
- Analysis and Spec Check
- Output
- “Engineer in the loop” spec checking

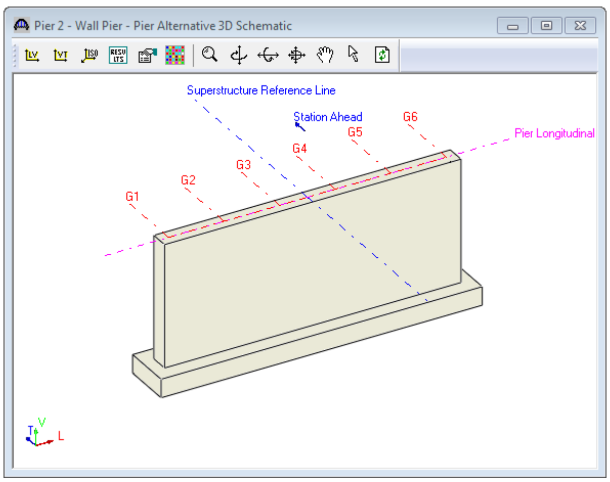
BrD Substructure Capabilities

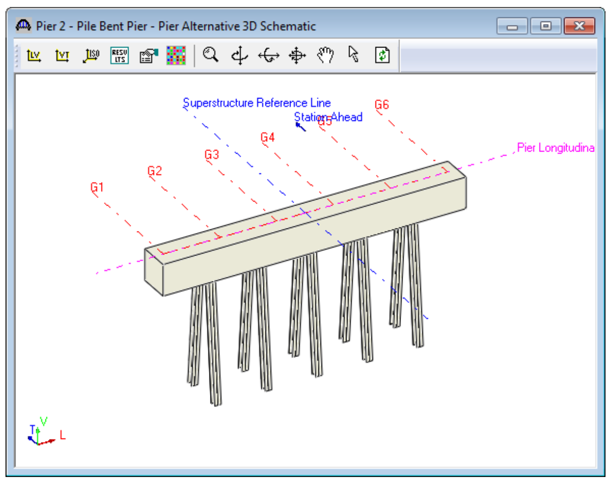
- Solid shaft (hammerhead), frame, wall and pile bent piers
- Spread and pile footings, drilled shaft structural analysis available (no soil interaction yet)
- BrD superstructure loads automatically transferred down to pier
- Define pier geometry and reinforcement
- Computed loads or user overridden loads
- Elastic first-order finite element analysis, with moment magnification
- Reinforcement development lengths automatically computed and taken into account in the spec checks
- Spec checking for:
    - AASHTO LRFD Bridge Design Specifications, 4th Edition, with 2008 interims
    - AASHTO LRFD Bridge Design Specifications, 4th Edition, with 2009 interims
    - AASHTO LRFD Bridge Design Specifications, 5th Edition
    - AASHTO LRFD Bridge Design Specifications, 5th Edition, with 2010 interims
    - AASHTO LRFD Bridge Design Specifications, 6th Edition
    - AASHTO LRFD Bridge Design Specifications, 6th Edition, with 2013 interims
    - AASHTO LRFD Bridge Design Specifications, 7th Edition
    - AASHTO LRFD Bridge Design Specifications, 7th Edition, with 2015 interims
    - AASHTO LRFD Bridge Design Specifications, 7th Edition, with 2016 interims
- “Engineer in the loop” spec checking – examine effects of changing reinforcement or geometry without re-analyzing the entire pier.

The following schematics from BrD Substructure illustrate the pier types that can be modeled:



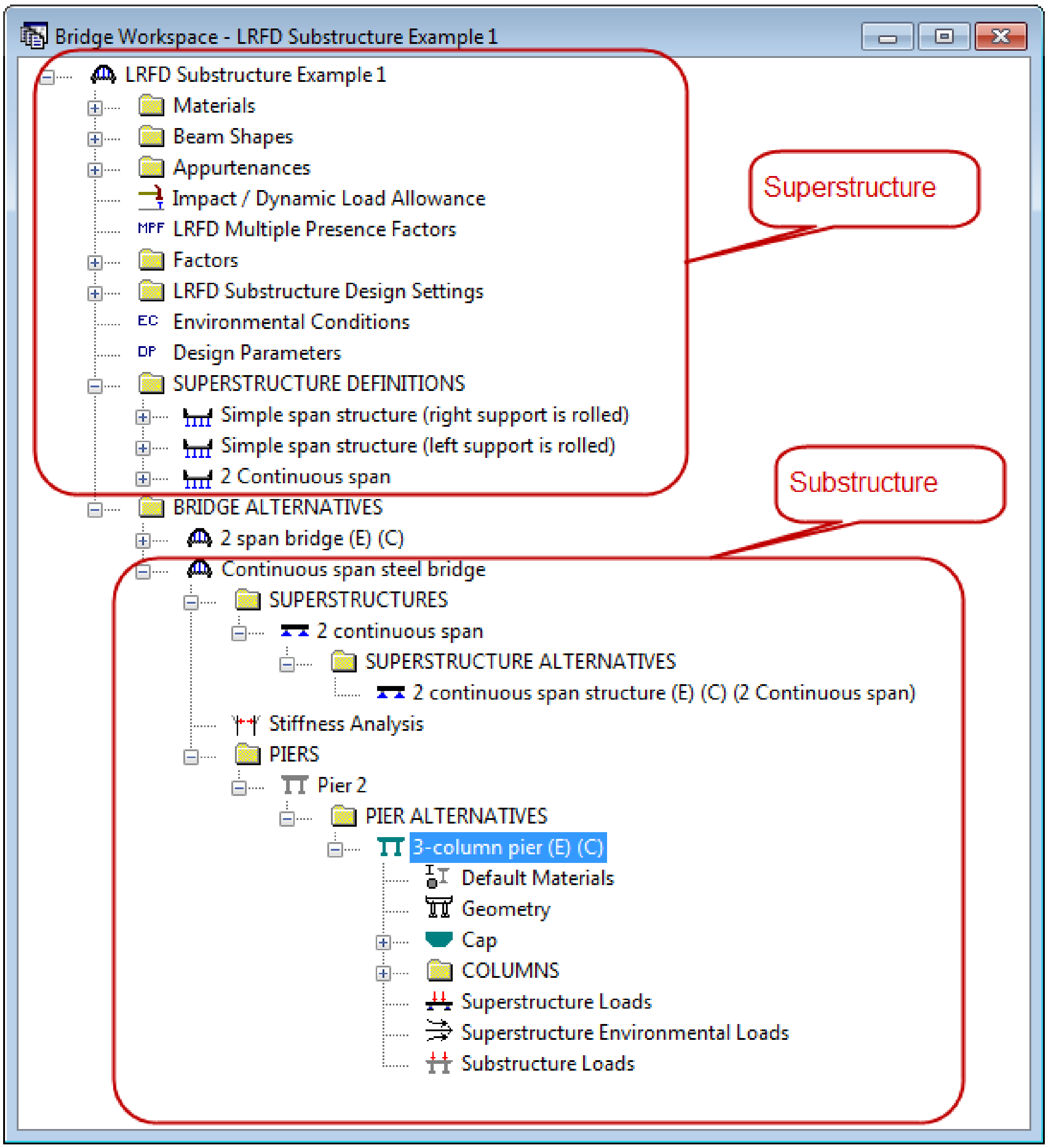






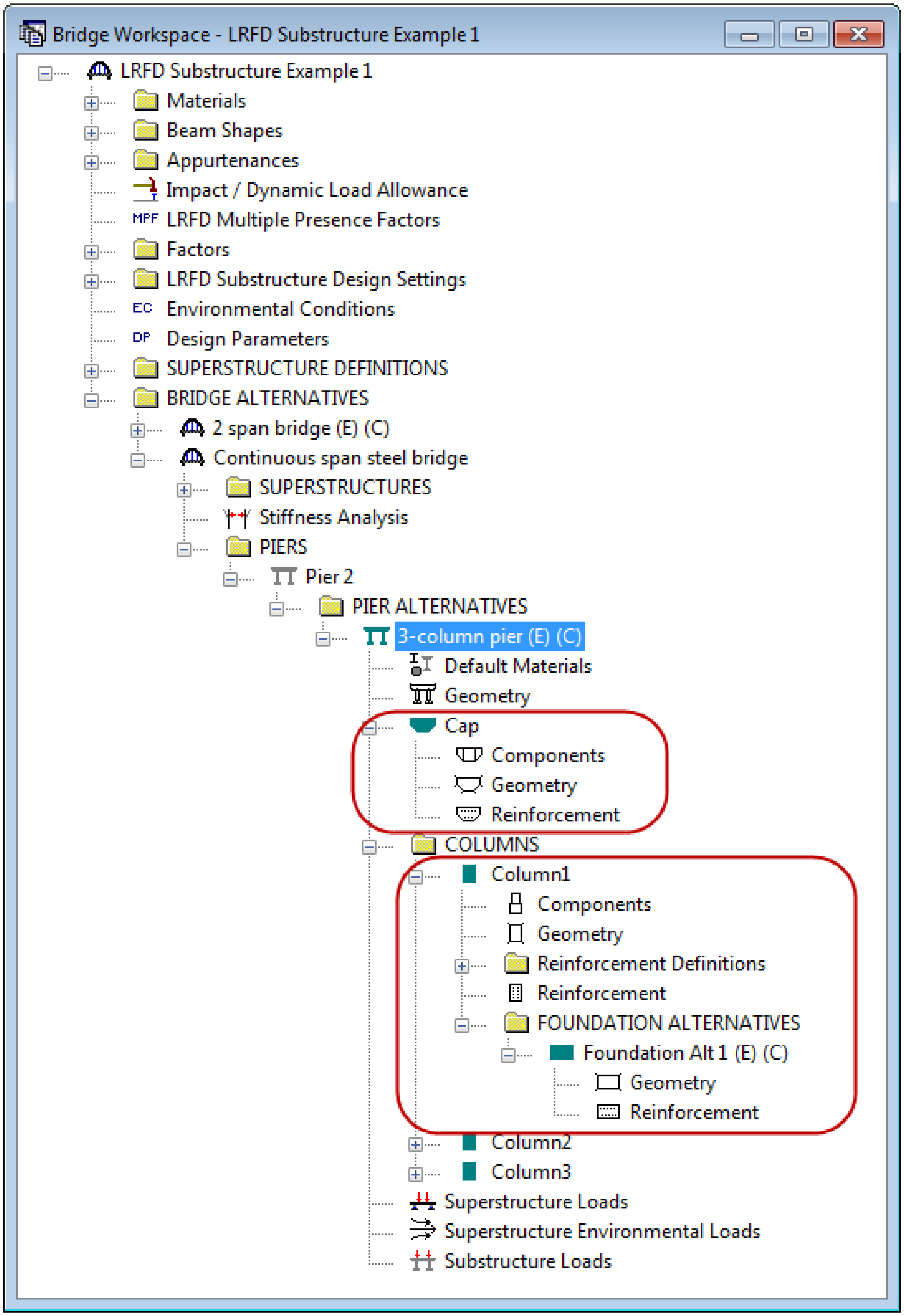
Bridge Workspace

Superstructure definitions are defined in the upper portion of the BWS tree. The superstructure definition is assigned to a bridge alternative and then piers are defined to support this superstructure. Pier alternatives can be used to compare designs (e.g., hammerhead vs. frame pier).



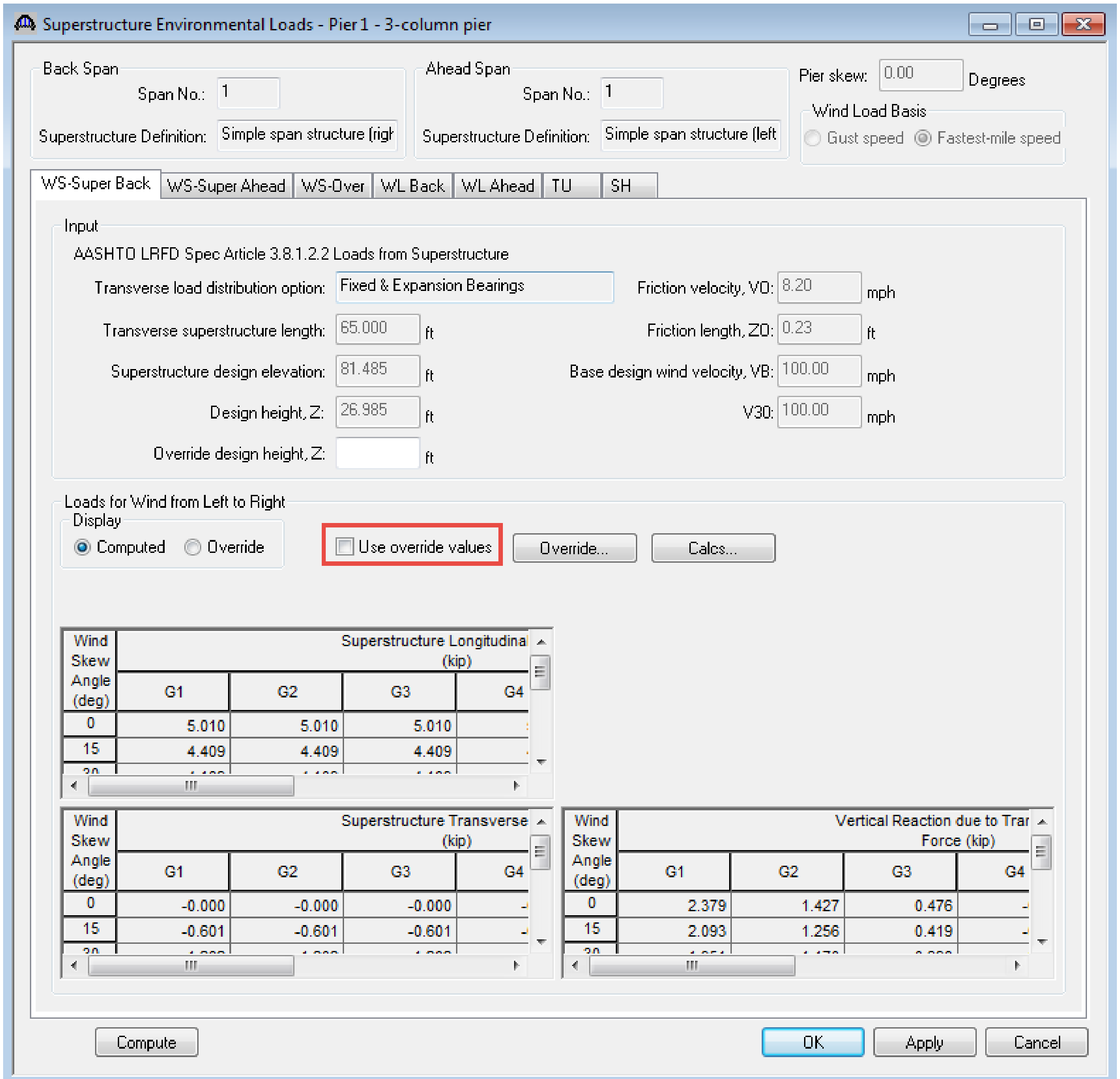
Pier Components

You can describe the geometry and reinforcement for each pier component (cap, column, foundation).



Loads

BrD computes the superstructure dead and live loads and transfers them down to the pier. BrD also computes all of the additional superstructure and substructure loads such as wind, water, temperature and shrinkage and applies them to the pier finite element model. The user has the ability to use these loads or override them with their own loads.



Analysis and Spec Check

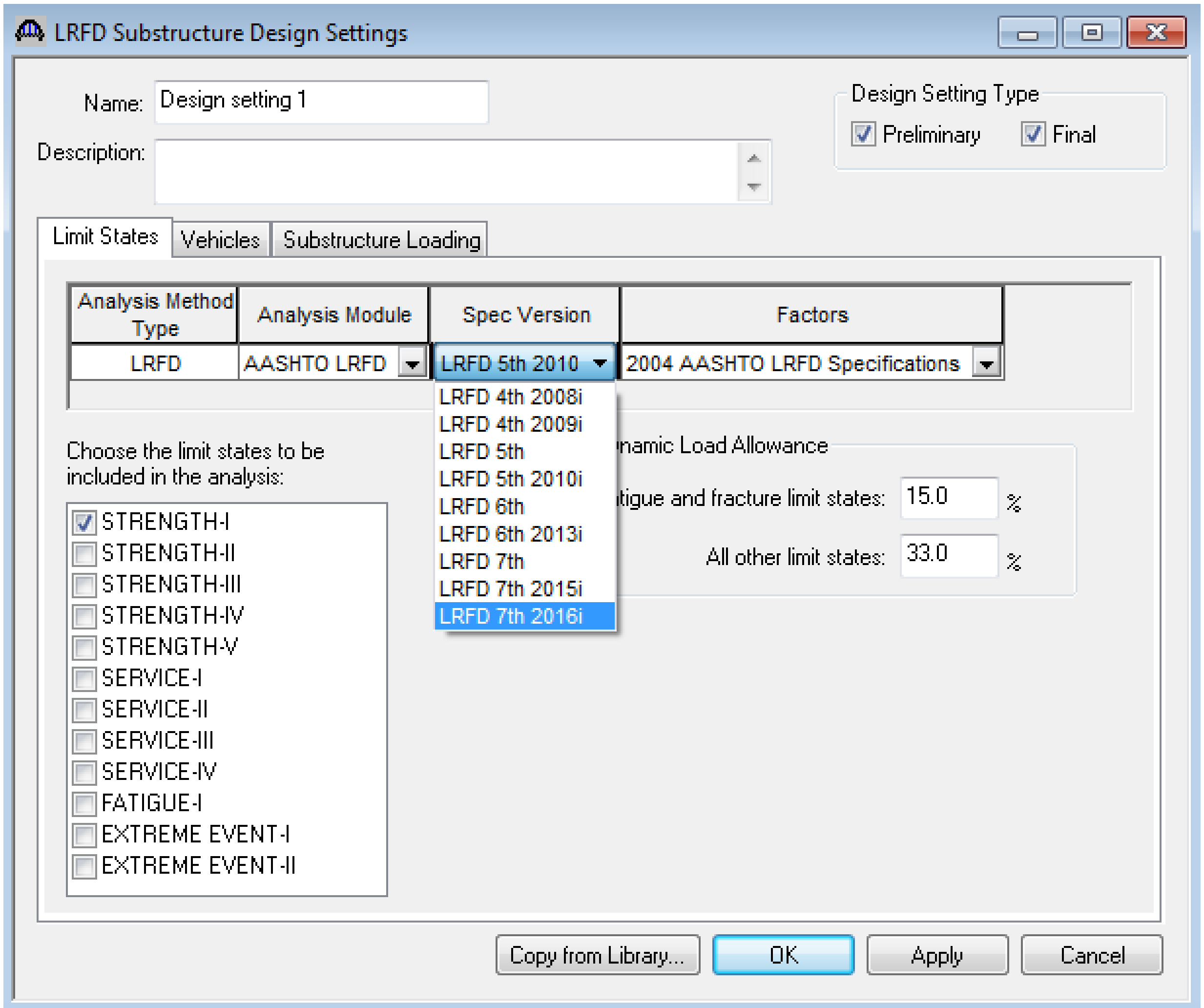
The ‘Spec Check’ toolbar button can be used to analyze the pier.

The superstructure will first be analyzed to determine the superstructure dead load reactions. The remaining loads acting on the pier (such as live load, wind, etc.) are computed and applied to the pier finite element analysis. Load combinations are generated and then the specification checks are processed.

BrD performs spec checks at each node in the finite element model along with locations where the reinforcement is developed and at a distance dv from the face of each column.

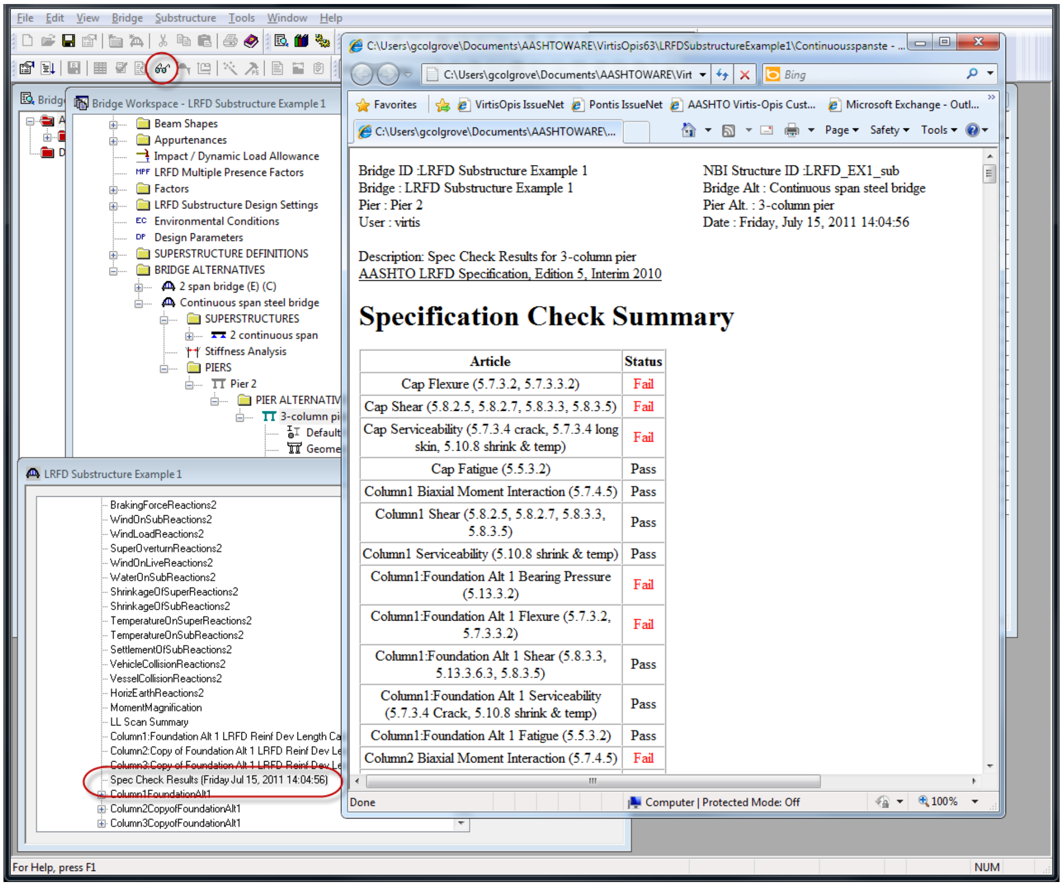
If the FE analysis results do not exist on your hard drive when you select to do a Spec Check, BrD will perform the FE analysis automatically. The next time you want to do a Spec Check BrD will use the existing FE analysis results. This allows you to fine-tune your reinforcement quickly and geometry without re-doing the FE analysis every time. Once you find reinforcement and geometry that satisfies the spec checks you can do a final FE analysis and then spec check.

With Version 6.8, the user can pick from the following specifications to use for spec checking:


LRFD Substructure Design Settings
Name: Design setting 1
Description:
Design Setting Type
Preliminary
Final
Limit States
Vehicles
Substructure Loading
Analysis Method Type
Analysis Module
Spec Version
Factors
LRFD
AASHTO LRFD
LRFD 5th 2010
2004 AASHTO LRFD Specifications
LRFD 4th 2008i
LRFD 4th 2009i
LRFD 5th
LRFD 5th 2010i
LRFD 6th
LRFD 6th 2013i
LRFD 7th
LRFD 7th 2015i
LRFD 7th 2016i
Choose the limit states to be included in the analysis:
STRENGTH-I
STRENGTH-II
STRENGTH-III
STRENGTH-IV
STRENGTH-V
SERVICE-I
SERVICE-II
SERVICE-III
SERVICE-IV
FATIGUE-I
EXTREME EVENT-I
EXTREME EVENT-II
namic Load Allowance
tigue and fracture limit states: 15.0 %
All other limit states: 33.0 %
Copy from Library...
OK
Apply
Cancel

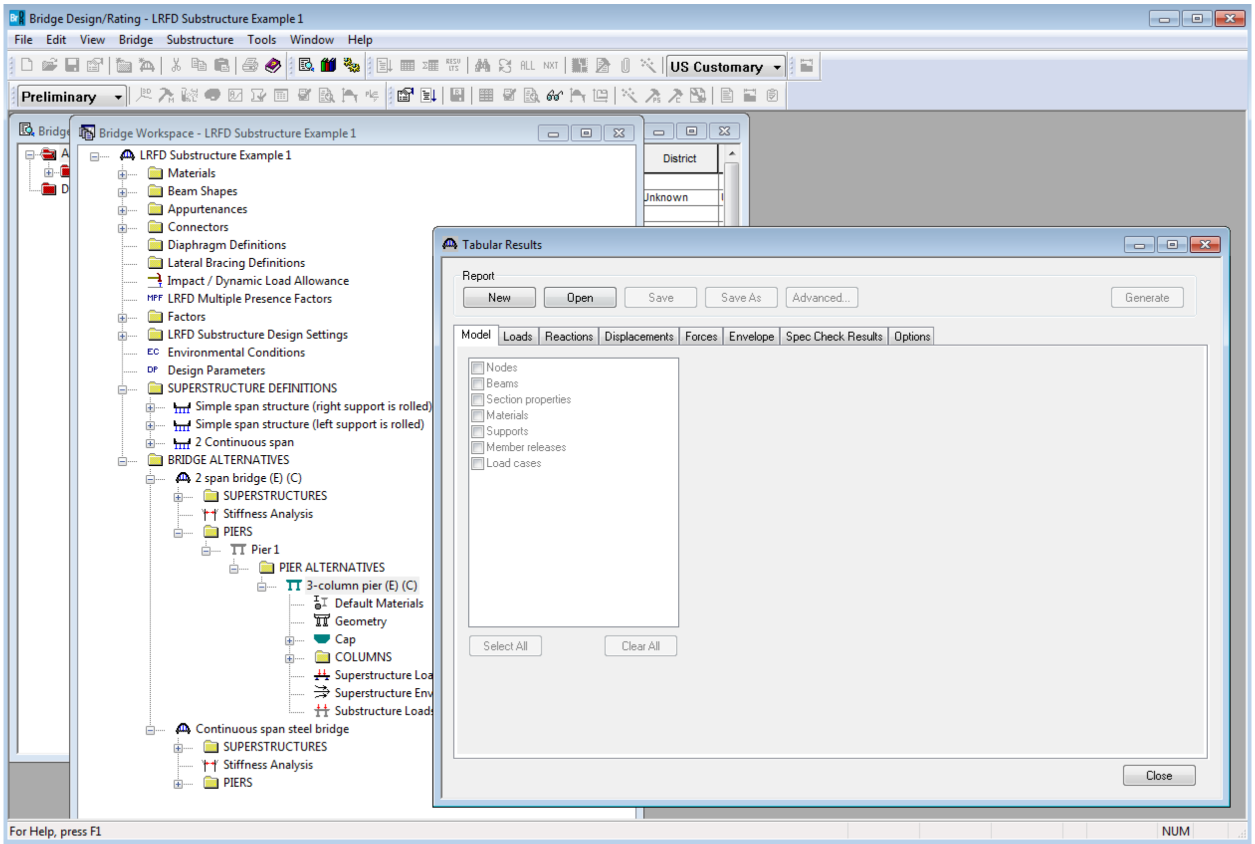
Output

Reports are automatically created that contain a summary of the specification checks, the loads computed by BrD, the reinforcement development length calculations, footing bearing pressure details, etc.

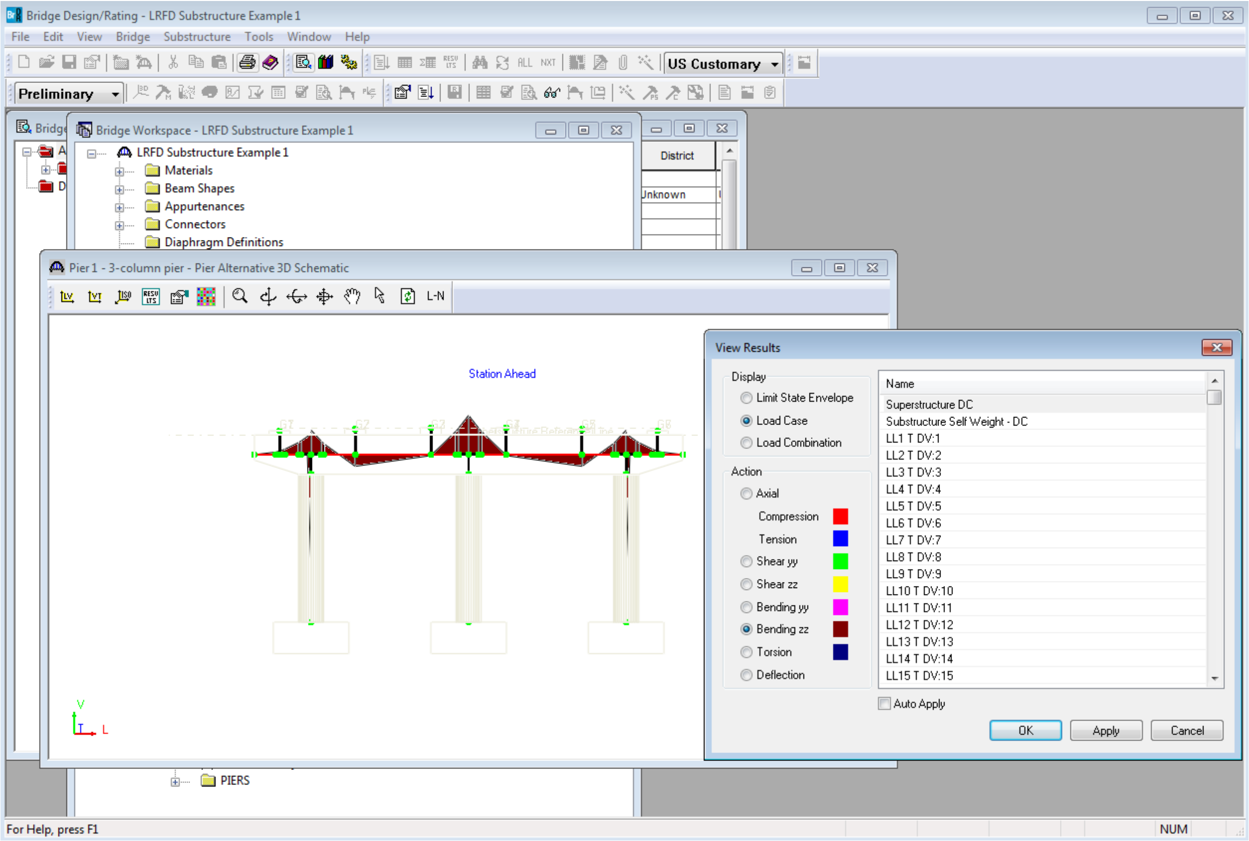


This file contains a summary of the results of each spec check along with the design ratios for each spec article at each spec check location point. The design ratio is the ratio of the capacity to demand. A design ratio less than one indicates the demand is greater than the capacity and the spec article fails. A design ratio equal to 99.0 indicates the section is subject to zero demand.

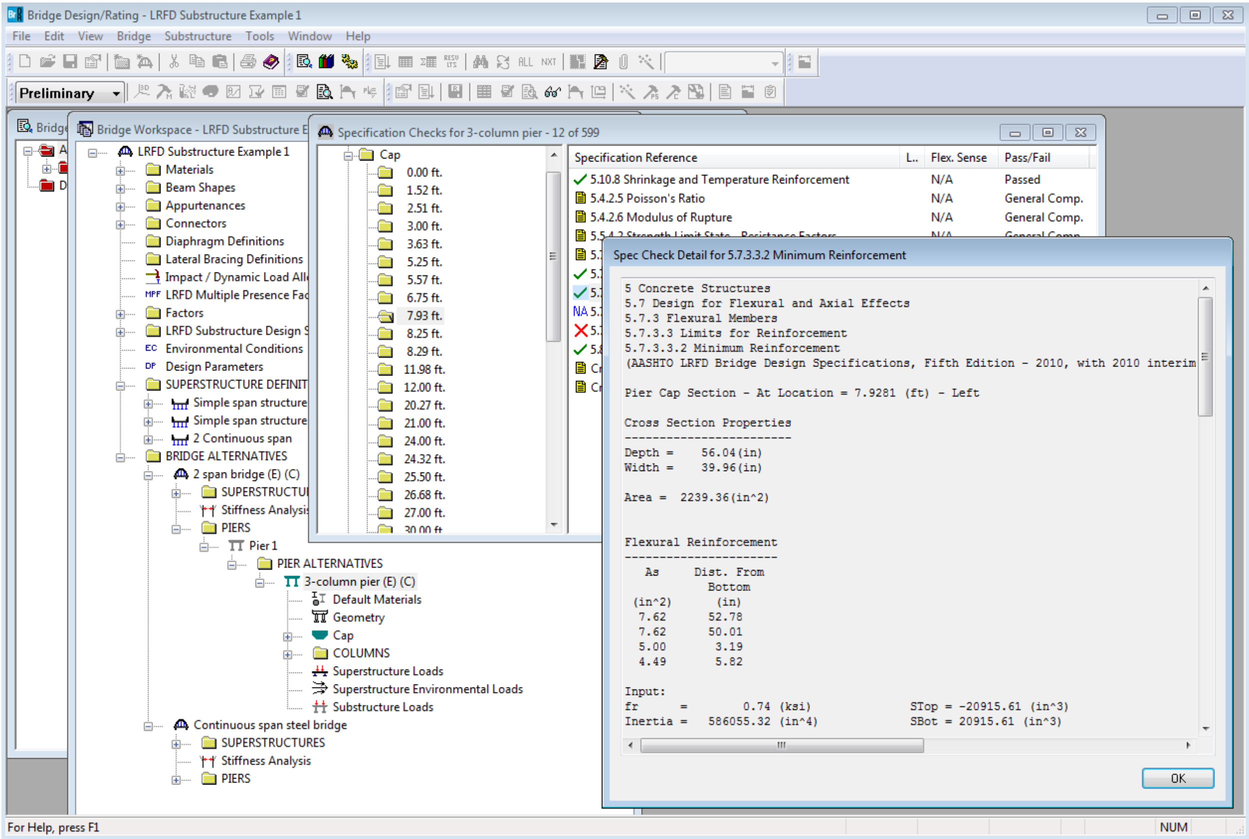
Additional reports can be tailored to the user's needs and generated in the Tabular Results window.



The FE model and results can be shown graphically in the Pier schematic.



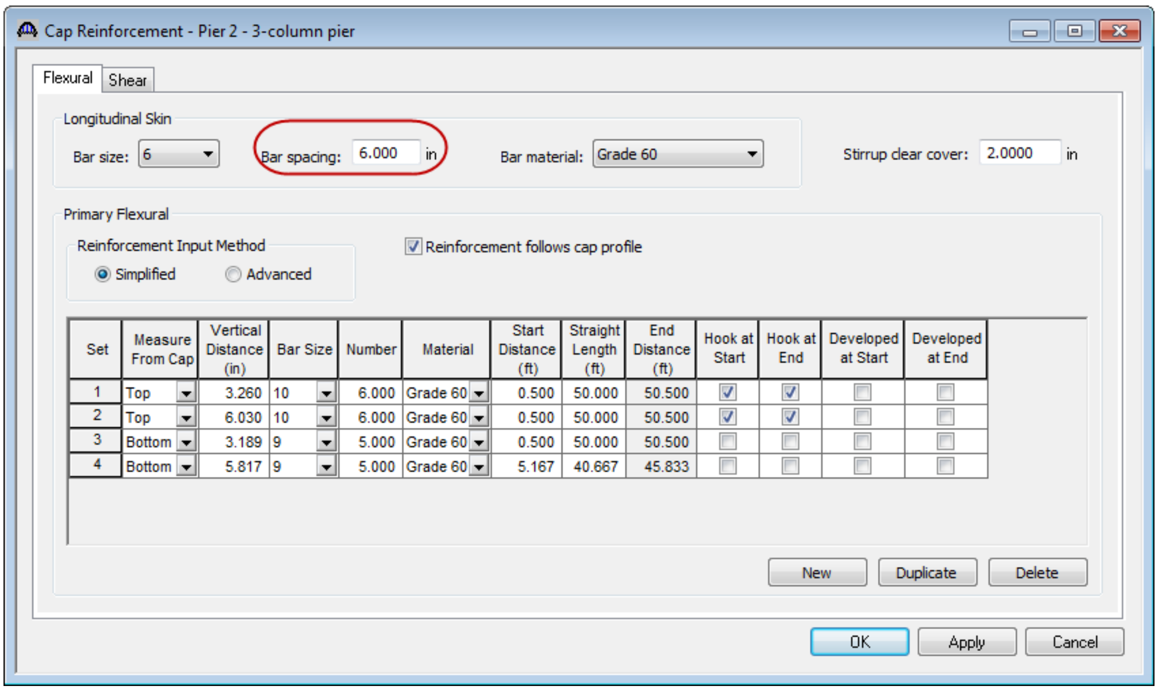
Details for each spec article evaluated can be viewed n the Spec Check viewer. Reports containing these article details can be generated and saved.



Engineer in the Loop Spec Checking

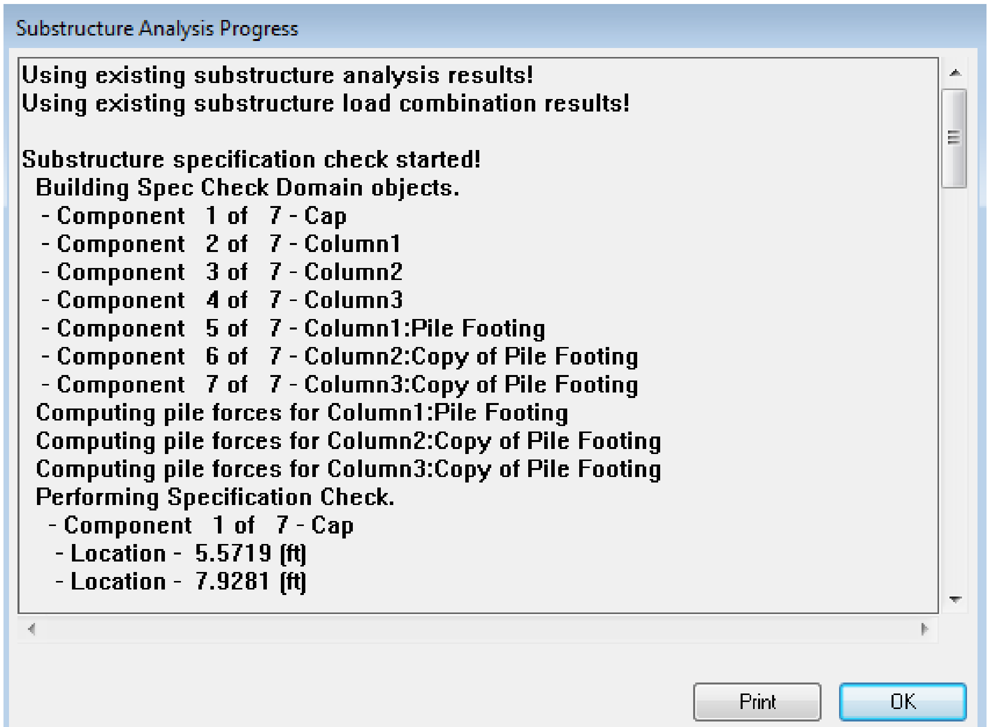
"Engineer in the Loop" refers to the ability of the engineer to refine the reinforcement or section dimensions and evaluate the spec articles without having to do another full-blown finite element analysis.

In this example, the cap longitudinal reinforcement was shown as failing in the Spec Check Summary report. The user can change the longitudinal reinforcement spacing from 15" to 6" and process the Spec Checks again.



Click the Spec Check button on the Substructure toolbar.

The spec checks will be performed again using the results of the previous finite element analysis.



The engineer can use this process to fine-tune the design. After you find reinforcement and dimensions that satisfy the specification articles, you can do a final finite element analysis and spec check.