Bridge shrinkage example

Test Problem

Name:	Bridge shrinkage example
Description:	Evaluate shrinkage for a one-span and a continuous two-span bridge system.
Program:	CSiBridge
Version:	18.1.1
Model ID:	1402

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Model overview

Internal shrinkage forces are evaluated for one-span and continuous two-span bridge structures. These bridges have the following properties:

- Span length = 10m
- Deck-section type: T-beam section with a 0.5m-deep, 3m-wide deck and two 0.5m-wide, 1.5m-deep beams

A 3D view of the one and two-span bridge models is shown in Figure 1:

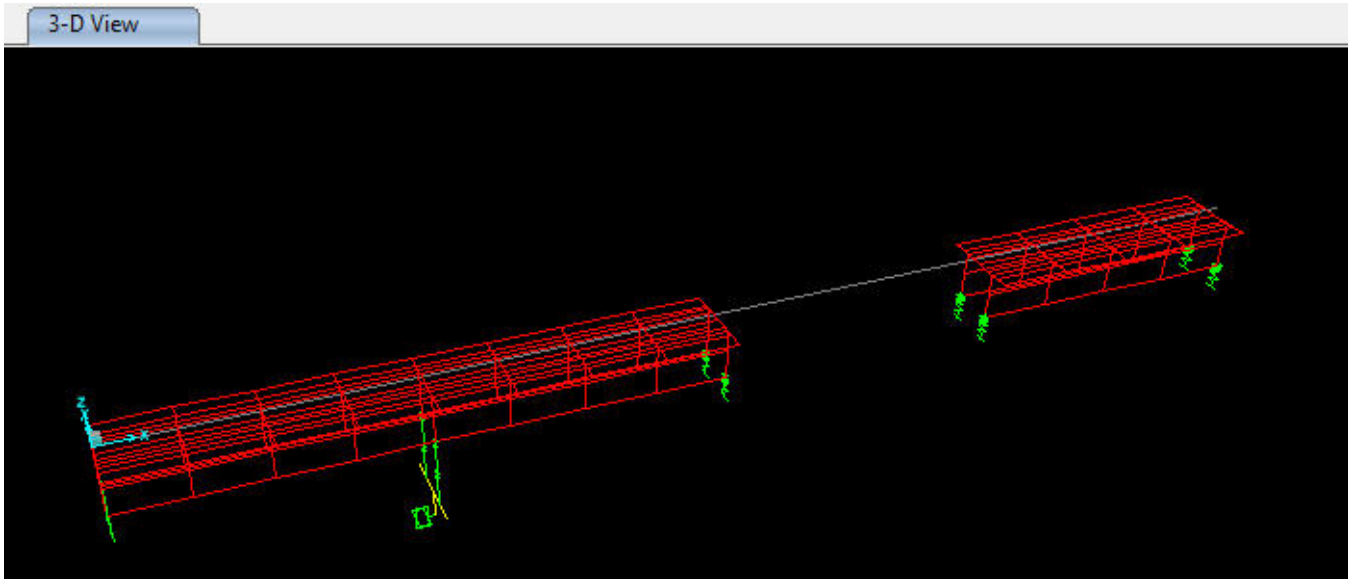


Figure 1 - Bridge model

The cross-sectional geometry of the bridge deck is shown in Figure 2:

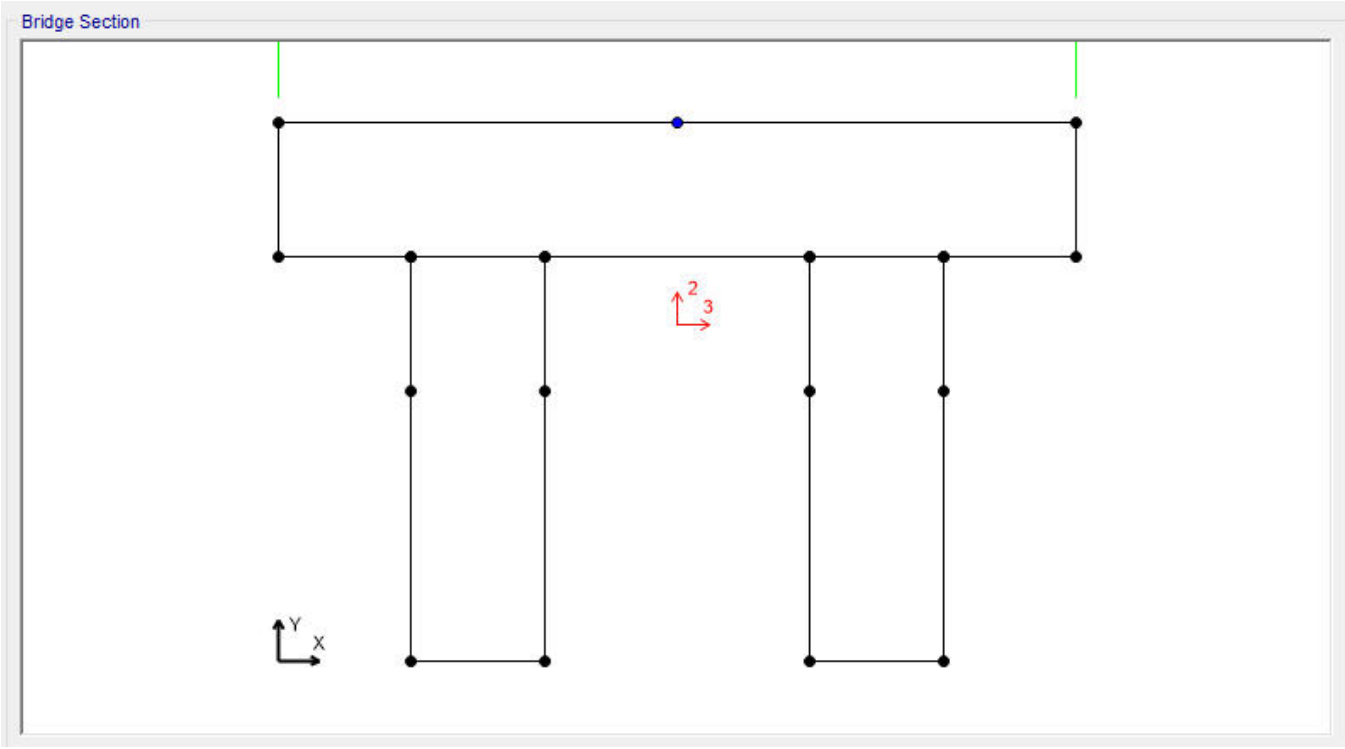


Figure 2 - Bridge deck section

Key modeling steps

- Define shrinkage characteristics for the default, 4000psi concrete material. Create a copy of this material and label it '4000psi no shrinkage'. Concrete girders will use this new material, and shrinkage will not be considered. Next, add shrinkage properties to the 4000psi concrete material as follows:
    - Use "Components Tab > Properties > Materials > select 4000psi material > click the Modify button" to ope the "Material Property Data" form
    - Check the "Switch to Advanced Property Display" checkbox
    - Click the "Modify/Show Material Properties..." button to open "Material Property Data" form
    - Click the "Time Dependent Properties..." button to open "Time Dependent Properties for Concrete" form
    - Under "Time Dependence Considered For" heading, check Shrinkage.
- Define the two bridges using a single, straight layout line. The two-span bridge will have a beginning station at 0m and an end station 20m. The one-span bridge will have a beginning station at 30m and an end station at 40m.
- Define the bridge deck section as Tee Beam, with dimensions listed above in the Model Overview section. Assign 4000psi concrete material to the deck, and the '4000psi no shrinkage' material to the girders. This will enable shrinkage consideration for the deck and not for the girders.
- Define a pinned-bearing condition for the start abutment, and roller-bearing condition for the end abutment. For the two-span bridge, defined a fixed foundation spring at the bottom of the column, and pinned bearings at the top.
- Directly within the bridge object definition (Bridge Tab > Bridge Object > Groups), define staged construction bridge groups for the deck and girders of the one-span and two-span bridge objects.
- Define a staged-construction load case named Staged. Add the entire structure in the first stage and define several empty stages with nonzero durations in order to evaluate response due to shrinkage as time progresses. Be sure to check Time Dependent Material Properties on the Nonlinear Parameters menu.
- Run the analysis, then use the "Home Tab > Display > Show Bridge Superstructure Forces/Stresses" menu command to review the staged-construction load-case results.

Results

For both the one-span and the two-span bridge objects, the deformed shape indicates that deck shrinkage causes shortening of deck fibers, and it causes the entire bridge to bow downwards, as expected. This behavior is shown in Figure 3:

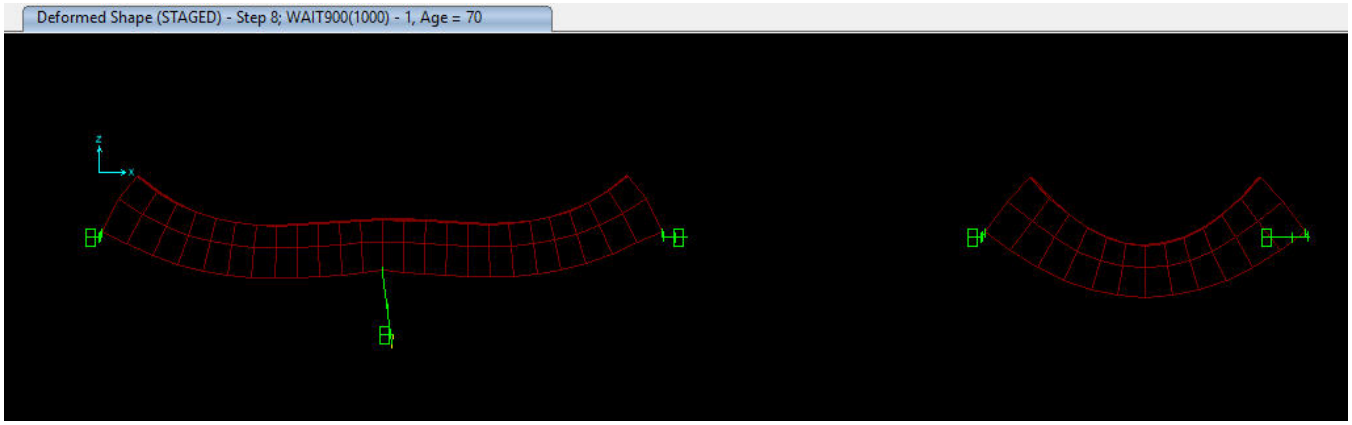


Figure 3 - Shrinkage deflection

For the one-span bridge, since the structure is statically determinate, no internal forces are generated. However, the two-span bridge is statically indeterminate, and redundant reactions do cause internal moments. At the interior pier, tension is generated in the top fibers, as shown in Figure 4:

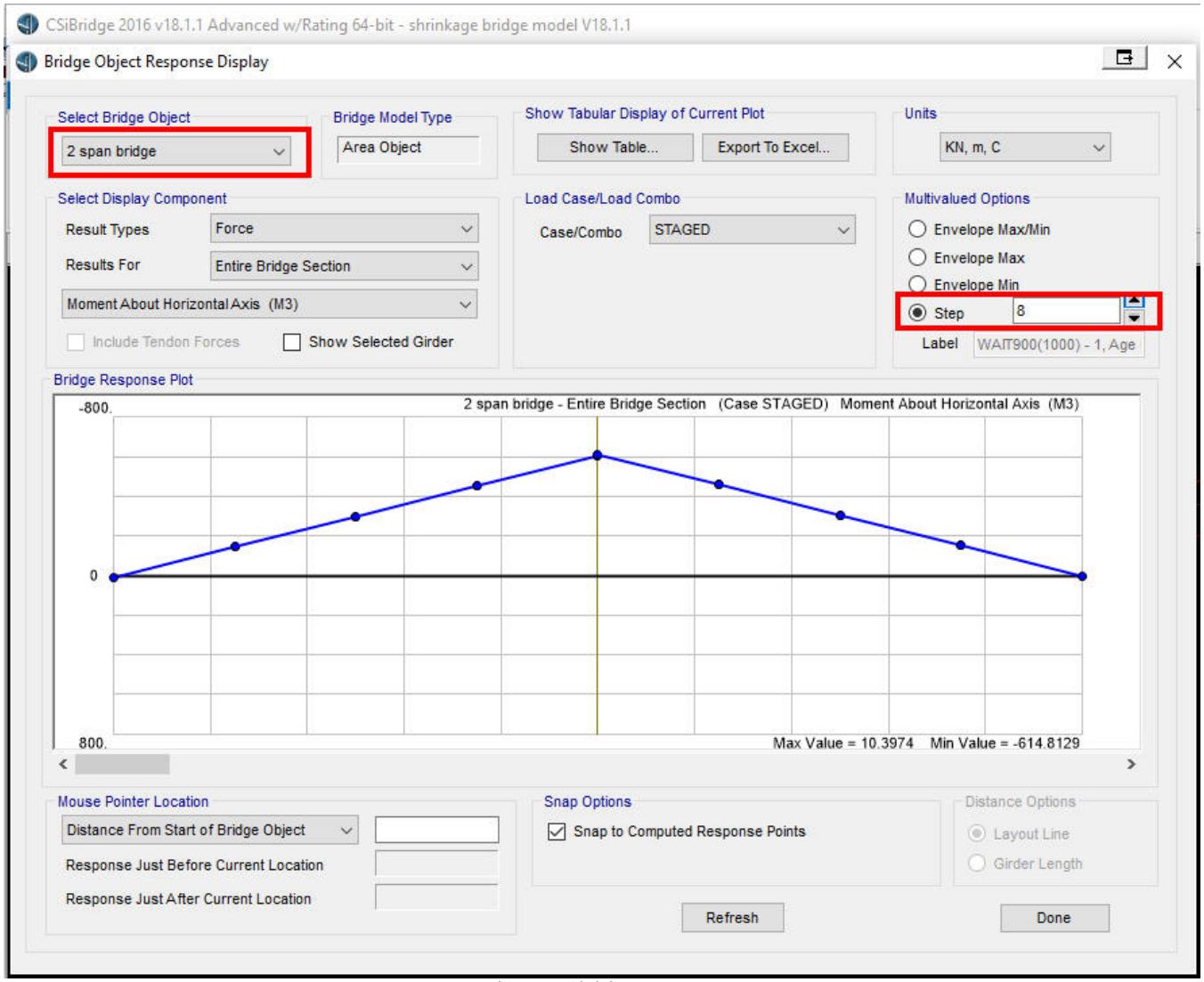


Figure 4 - Shrinkage moment

Attachments

- shrinkage bridge model (CSiBridge V18.1.1).zip (zipped BDB file)