Analysis of Truss Swing Bridges in BrR

A Presentation to the 2018 RADBUG Meeting

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About the Presenter

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- 9+ Years with M&M
- 6+ Years Rating Experience


NOTICE
4 HOURS ADVANCE
NOTICE REQUIRED
FOR BRIDGE OPENING

Swing Bridge Mechanics

- In open position, bridge supports dead load only as fully cantilevered
- After bridge swings closed, mechanical devices are used to develop positive reactions at the rest piers
- Positive reactions are required to prevent “see saw” effect from occurring under live load

Wedge Device at Rest Pier

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Swing Bridge Mechanics

- Since truss is two-span continuous, dead loads in the truss members change as the wedges are driven
- Wedges generally designed only to create enough reaction to prevent the negative live load effect
- This results in dead load effects in the truss that are somewhere in between fully cantilevered and two-span continuous support conditions

Swing Bridge Mechanics

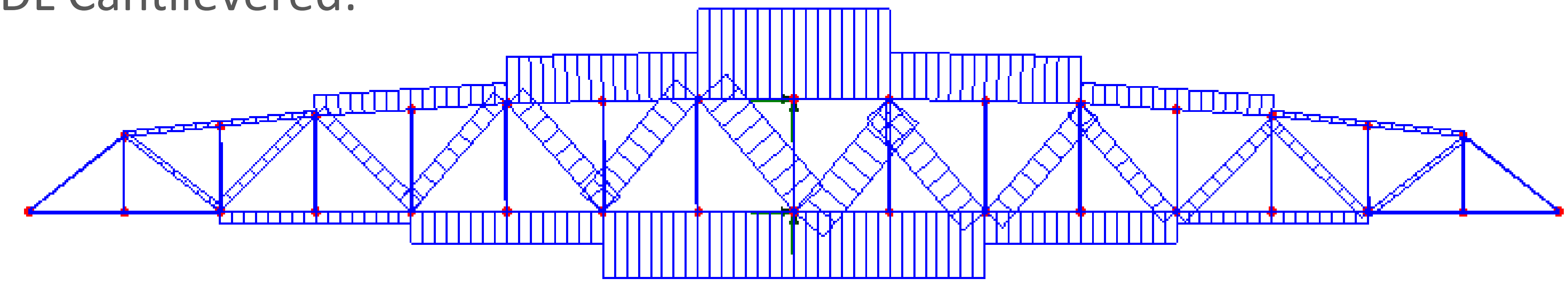
This results in unique support conditions for dead load and live load:

1. DL: In between cantilevered and two-span continuous (generally closer to cantilevered)
2. LL: Fully two-span continuous

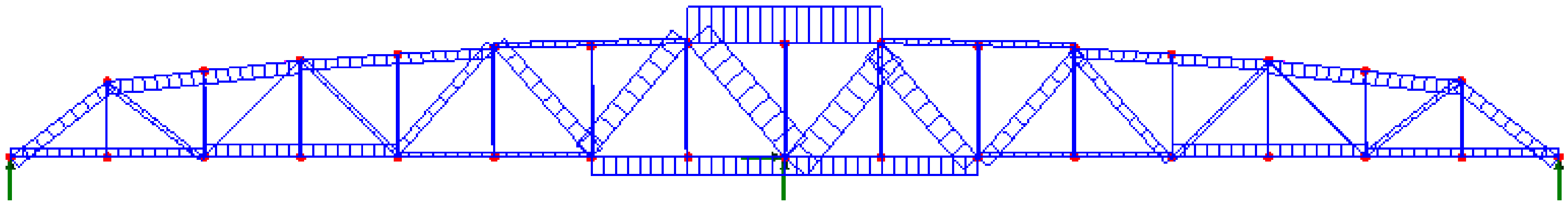
PROBLEM!

BrR truss analysis cannot model unique support conditions for different load cases

DL Cantilevered:



DL Two-Span Continuous:



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Workaround Options

Override DL for each member in truss input

- Possible issues:
  - Requires stress sheet in plans with wedged condition values for all members
  - Difficult to take into account any differences between bridge as designed and current condition
  - Could be time consuming if testing different cases; lots of changes to make in truss input language

Workaround Options

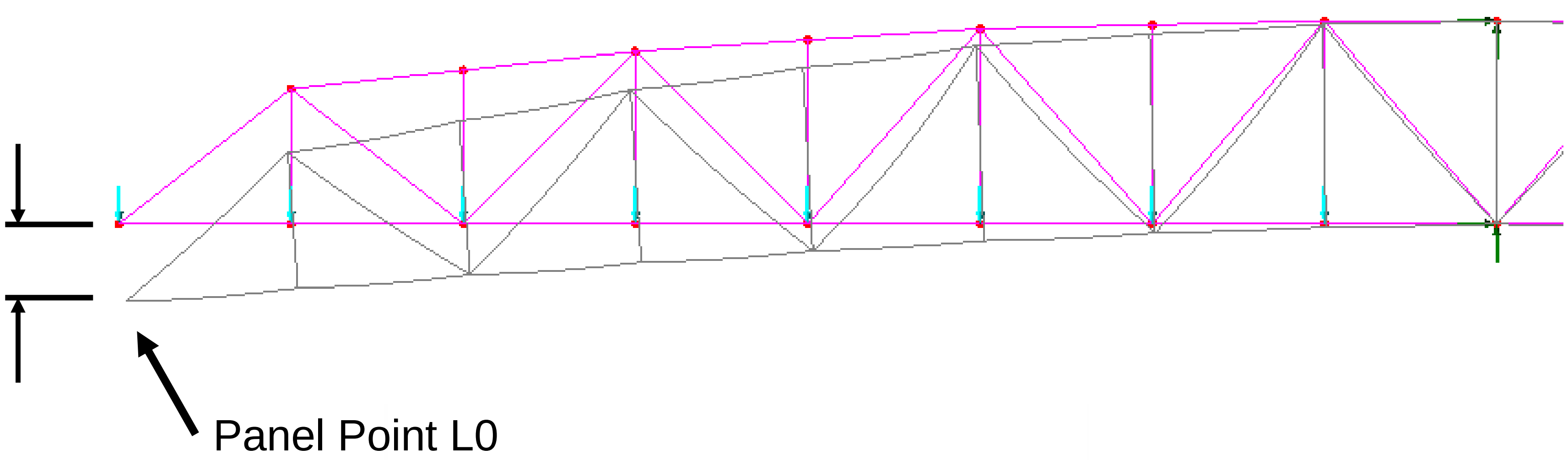
Use a dummy member in top chord over pivot pier and a crushing force to replicate wedged case dead loads

- Benefits:
  - Does not require a stress sheet from the plans
  - Can determine dead loads based on actual wedge displacements (current condition)

  However, typically requires a second truss model to be built in a separate analysis program

Dummy Member Workaround

Step 1: Get DL deflection in open position



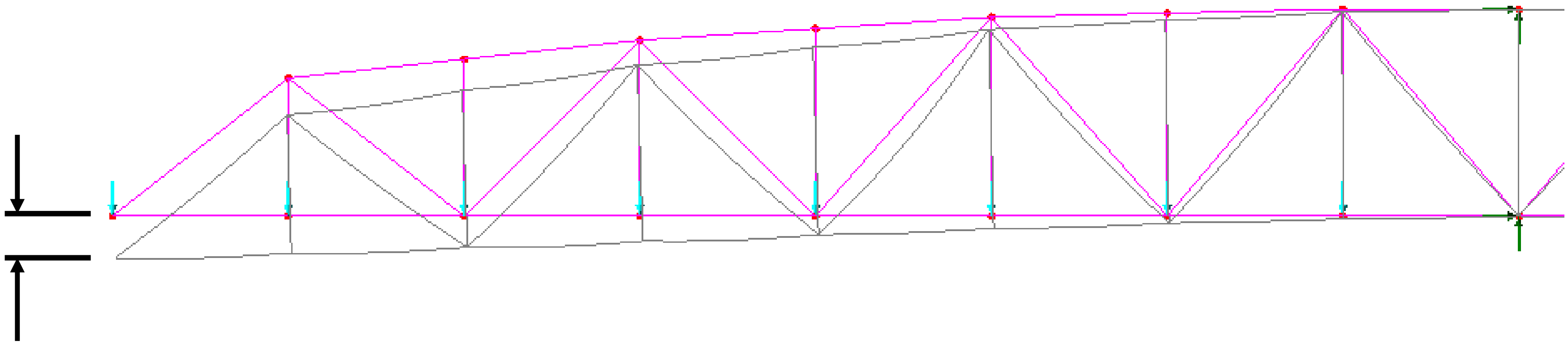
Dummy Member Workaround

Step 2: Adjust deflection to account for wedge displacement by

a. Using a prescribed displacement equal to the open position DL deflection minus the wedge displacement, or
b. Applying an upward reaction at L0 that results in same

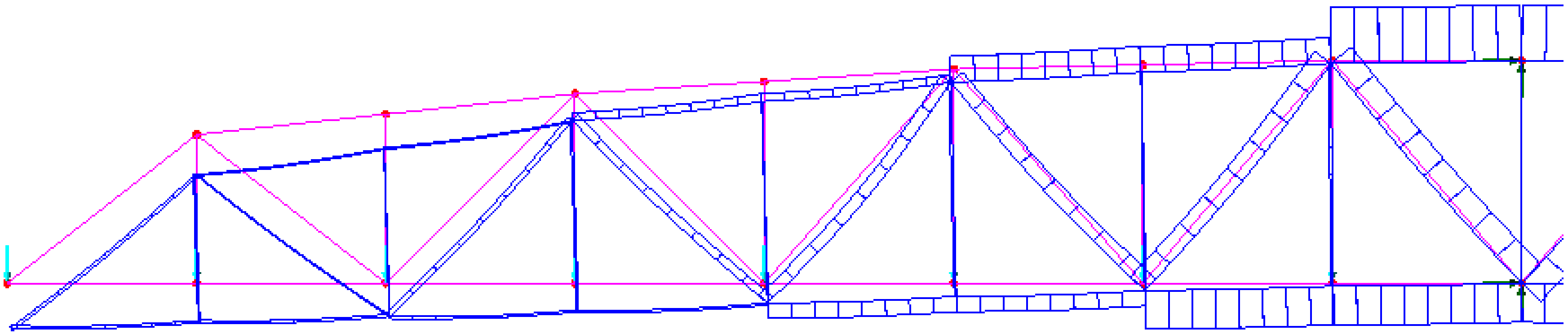
Dummy Member Workaround

Deflection after wedges driven:



Dummy Member Workaround

Step 3: Get member dead loads from wedged condition



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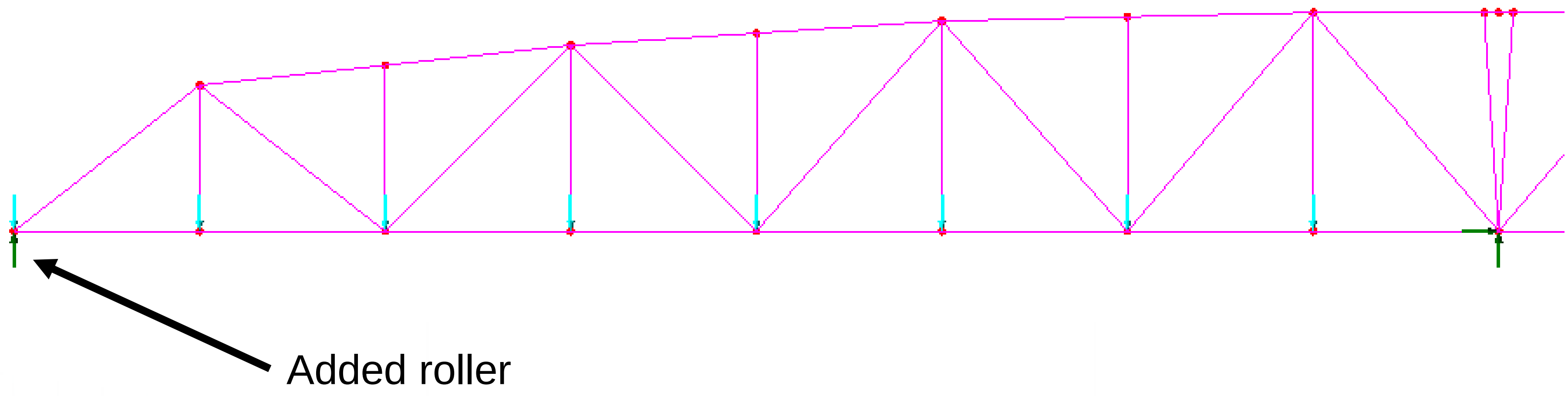
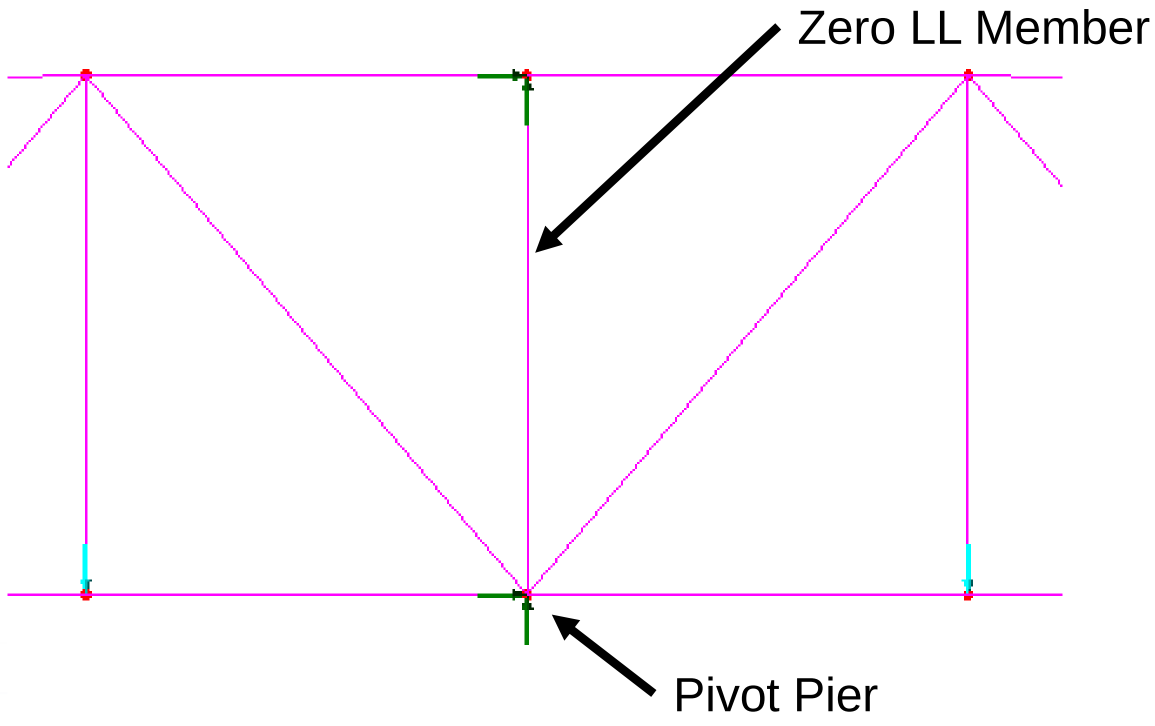
Dummy Member Workaround

Step 4: Add support at rest pier, resulting in two-span continuous condition



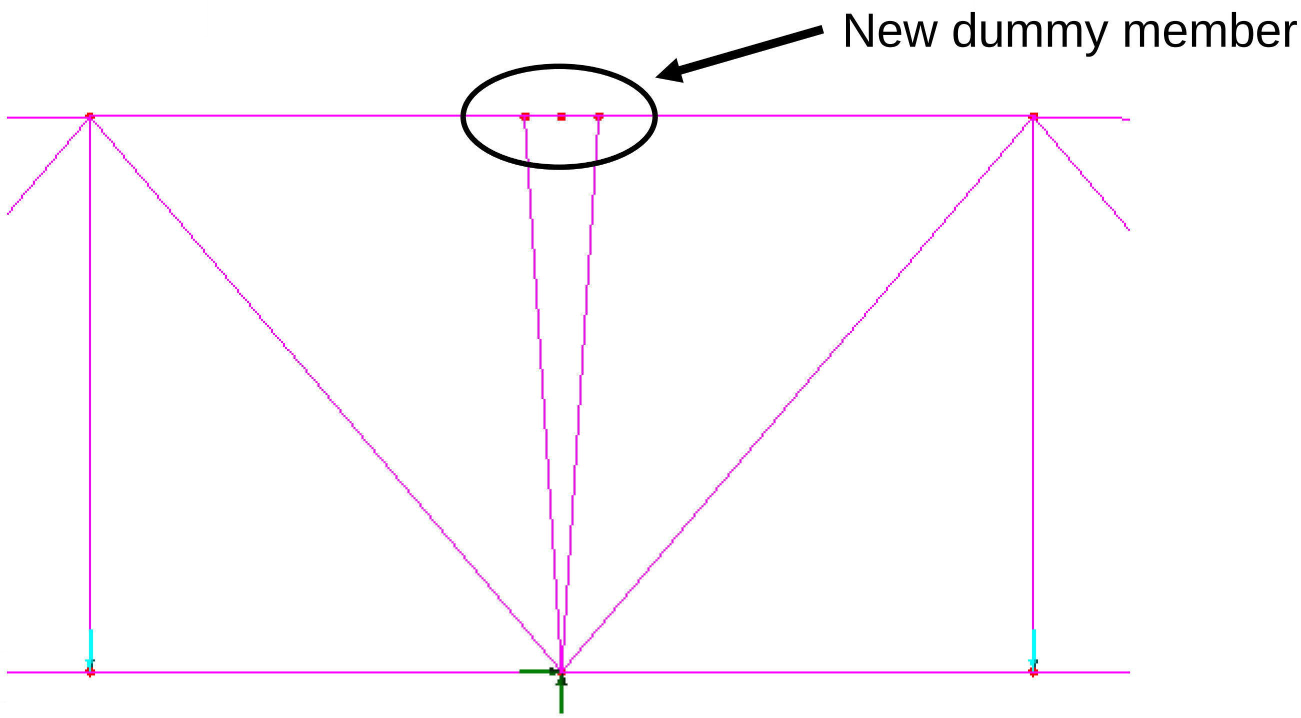
Dummy Member Workaround

Step 5: Implement dummy member



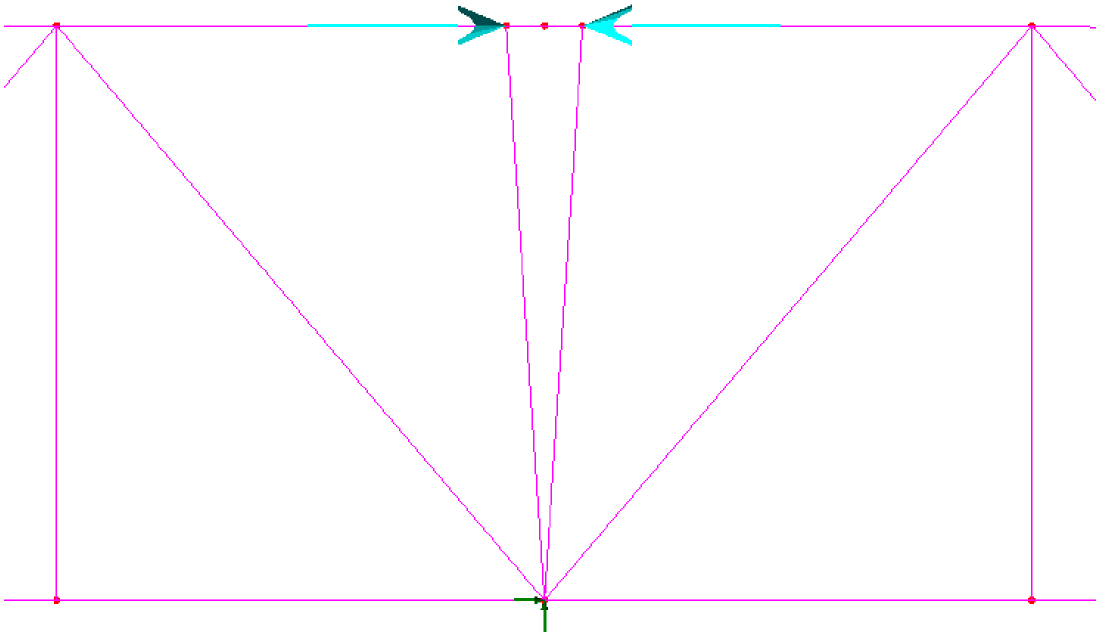
Dummy Member Workaround

Step 5: Implement dummy member



Dummy Member Workaround

Step 6: Add “crushing force” to dummy member over pivot pier

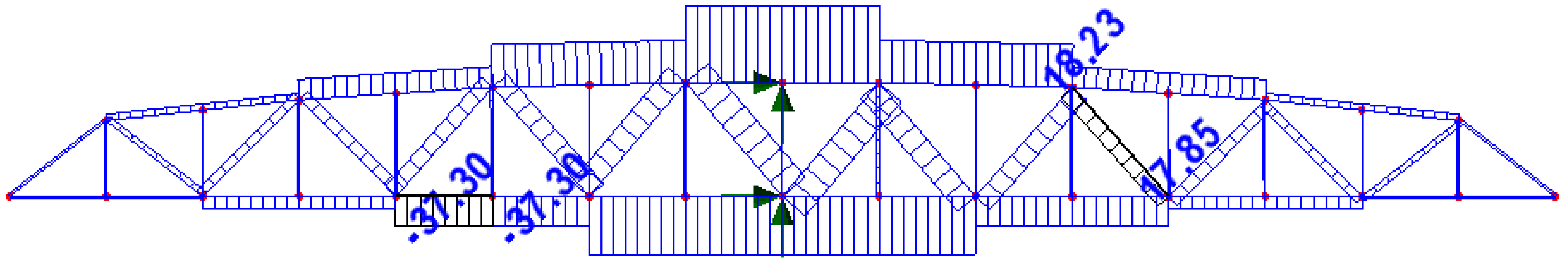


Dummy Member Workaround

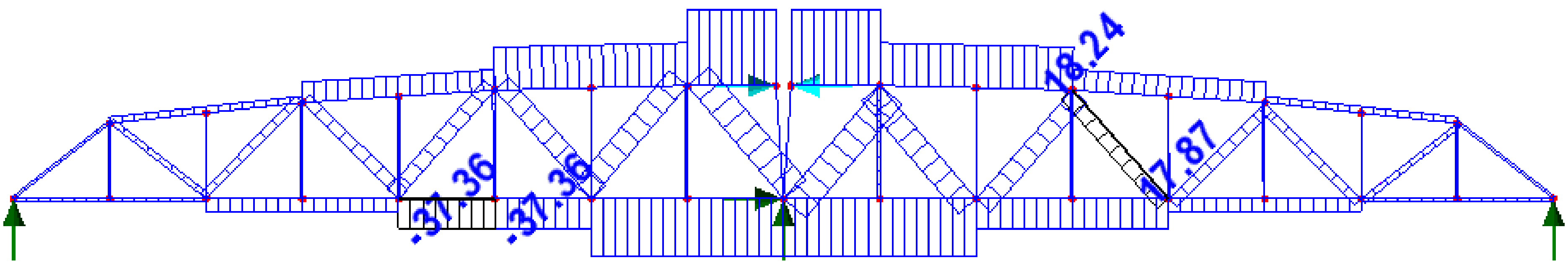
Step 7: Adjust crushing force to achieve desired dead load distribution in the truss members

- The higher the force, the closer the dead load distribution will trend toward fully cantilevered
- Force should be chosen that corresponds to current condition wedge displacements
- It can be shown that for a specific force, the dead load distribution will match exactly the fully cantilevered case

Fully Cantilevered Support Condition:



Two-span Continuous Support Condition:



Dummy Member Workaround

SUCCESS!

With the crushing force and two-span continuous supports applied to the model in BrR, the truss members can now be rated for correct dead loads combined with correct live loads

Dummy member with large compression dead load will not control rating results since it experiences tension only live load

Dummy Member Workaround: Recap

Step 1: Get dead load deflection of bridge in open position

Step 2: Adjust deflection to account for wedge displacement

Step 3: Get member dead loads from wedged case

Step 4: Add support at rest piers to make two span continuous

Step 5: Implement dummy member in top chord over pivot pier

Step 6: Add “crushing force” to dummy member

Step 7: Calibrate crushing force value required for wedged condition dead load distribution

Thank You!

Questions?

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