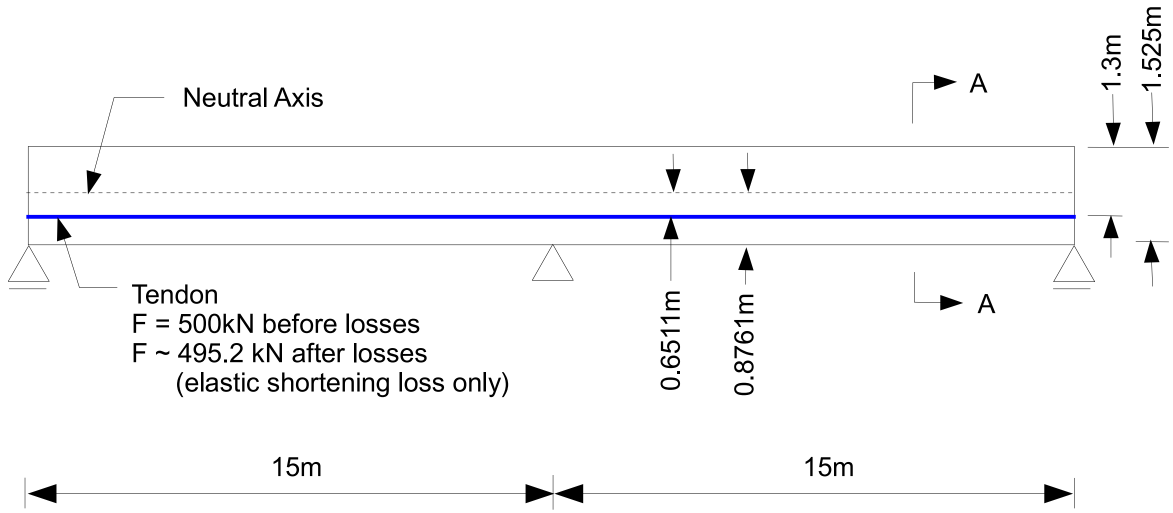
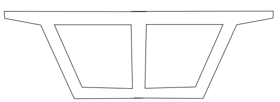
Obtaining hyperstatic (or secondary) forces for bridge object superstructures - test problem

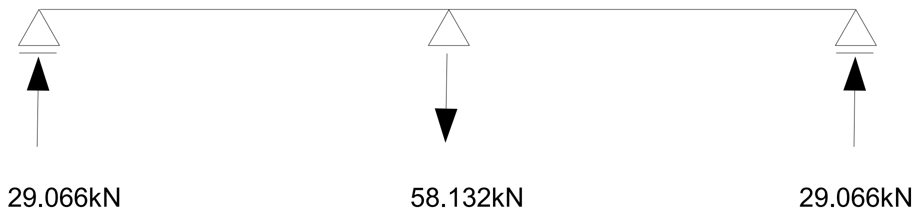
Geometry



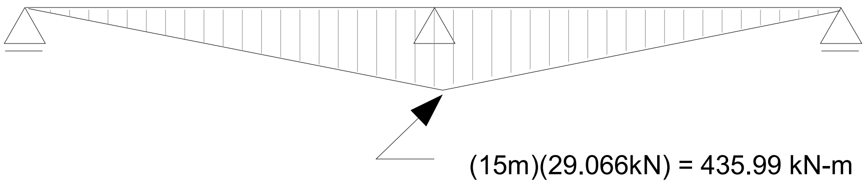
Elevation
(Schematically, Not To Scale)



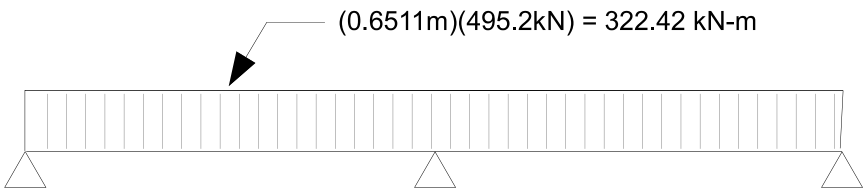
Section A-A
(Schematically, Not To Scale)



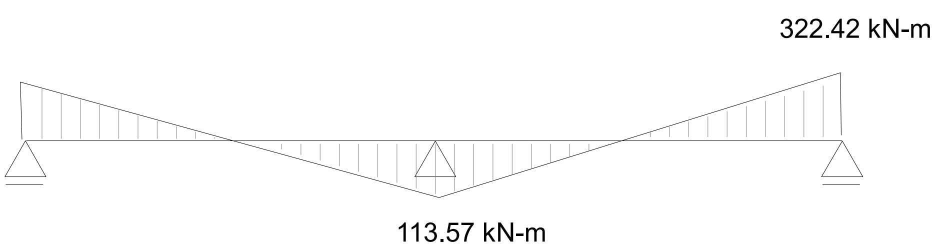
Reactions for the PS load case



Corresponding hyperstatic/secondary moment



Primary moment

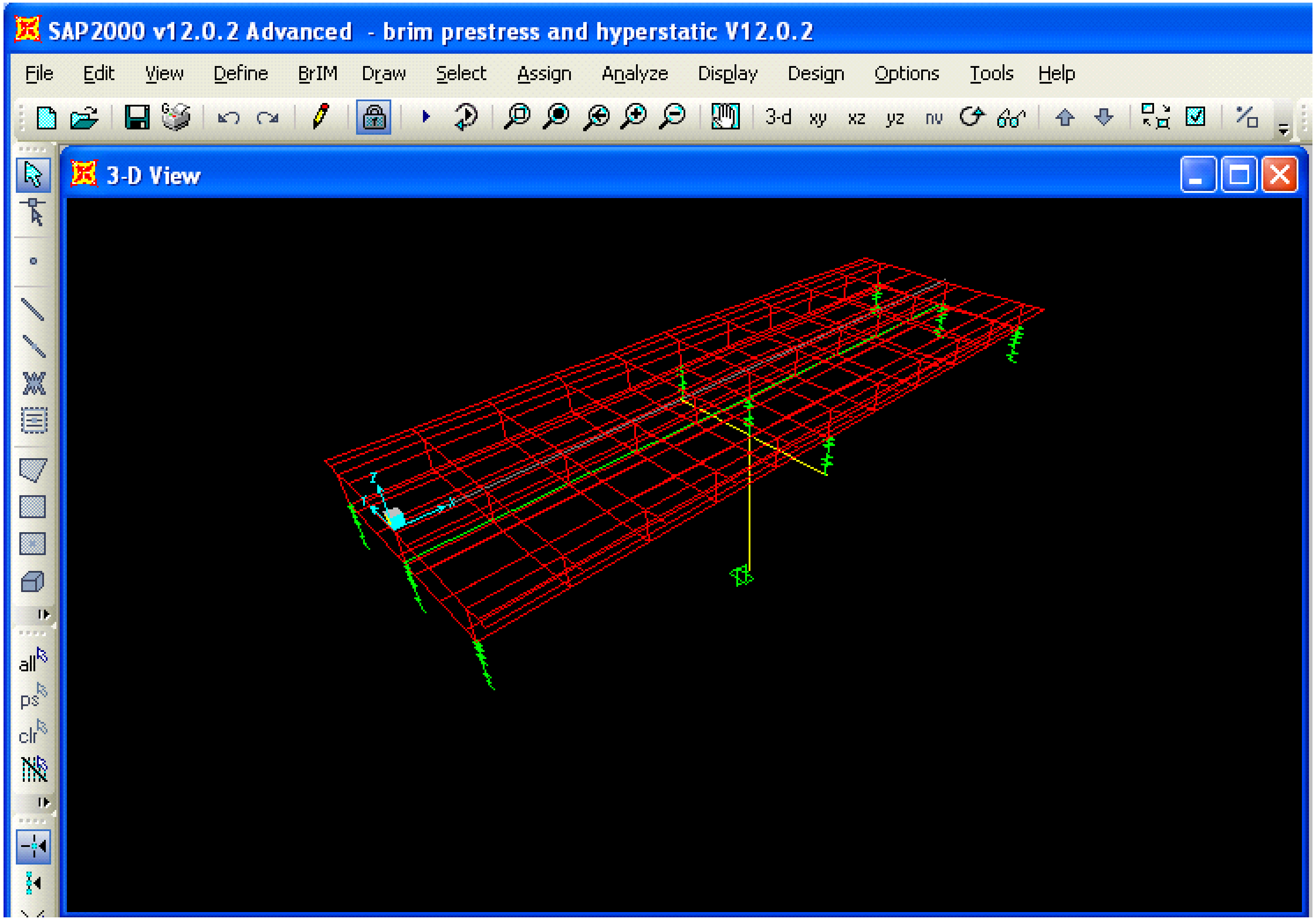


Total moment (primary + hyperstatic)

SAP2000 model results

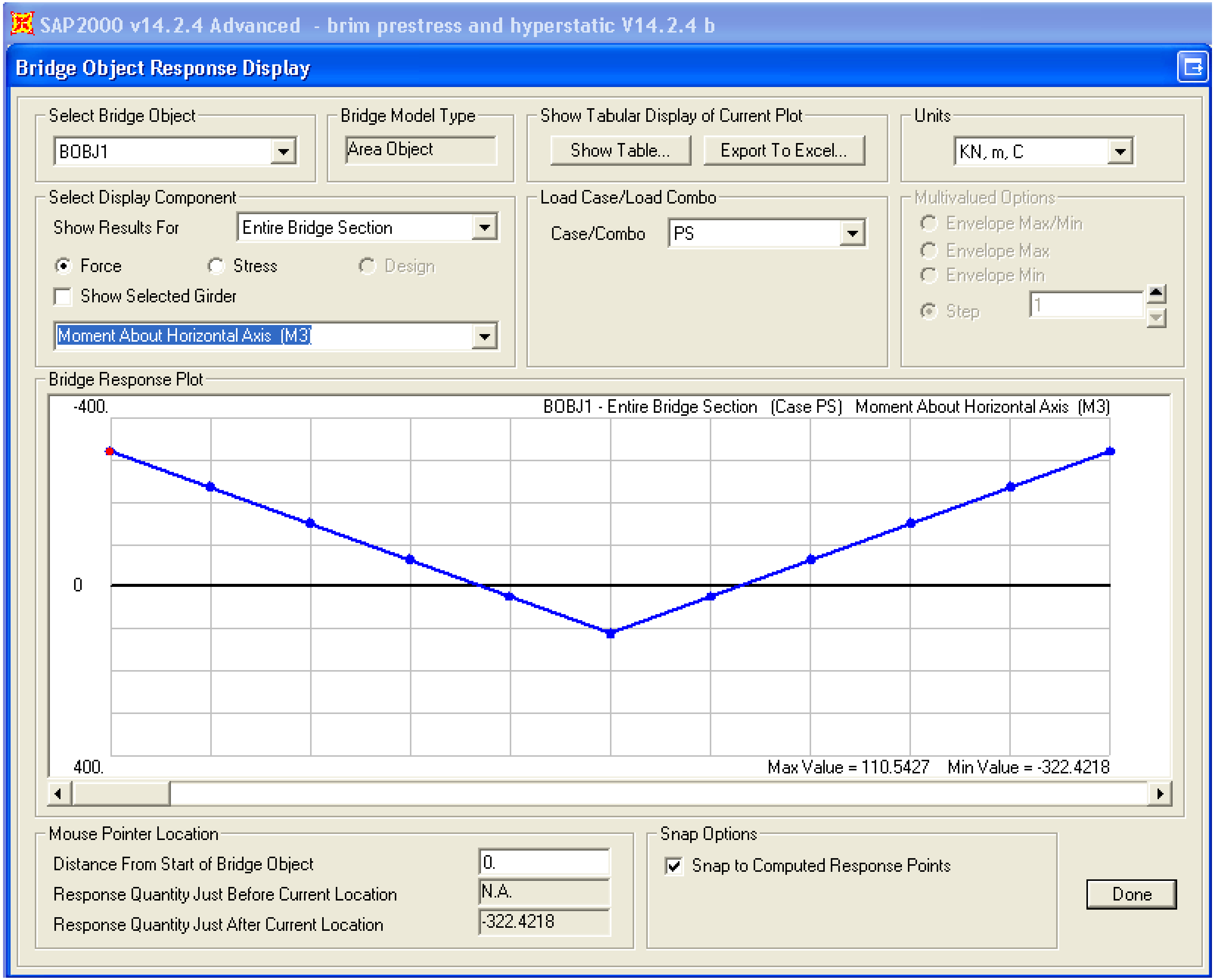
- Note that similar results can be obtained from CSiBridge.

Model geometry

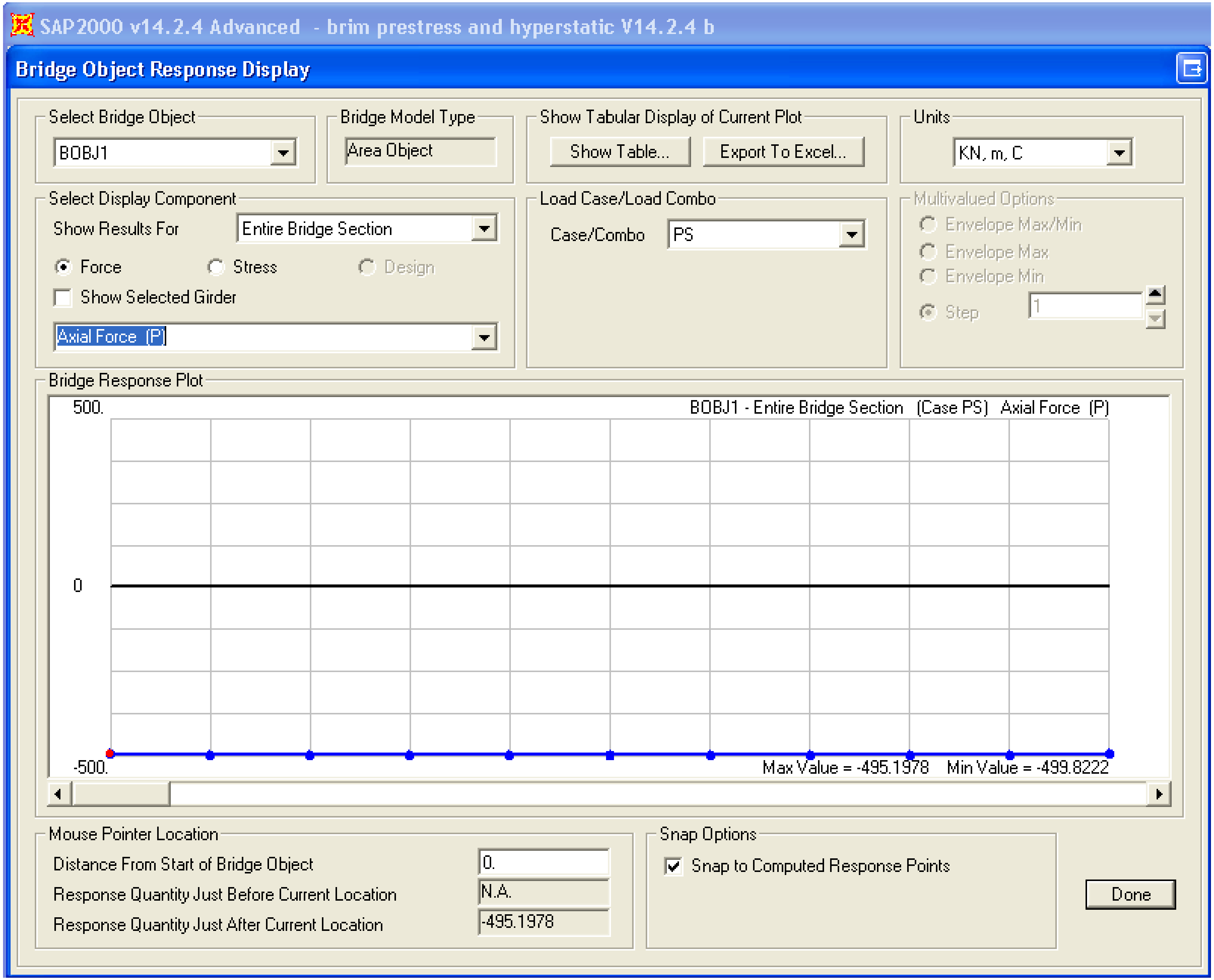


Total forces (primary + hyperstatic)

Concrete moment
(obtained as resultant of concrete forces; corresponds to total moment)



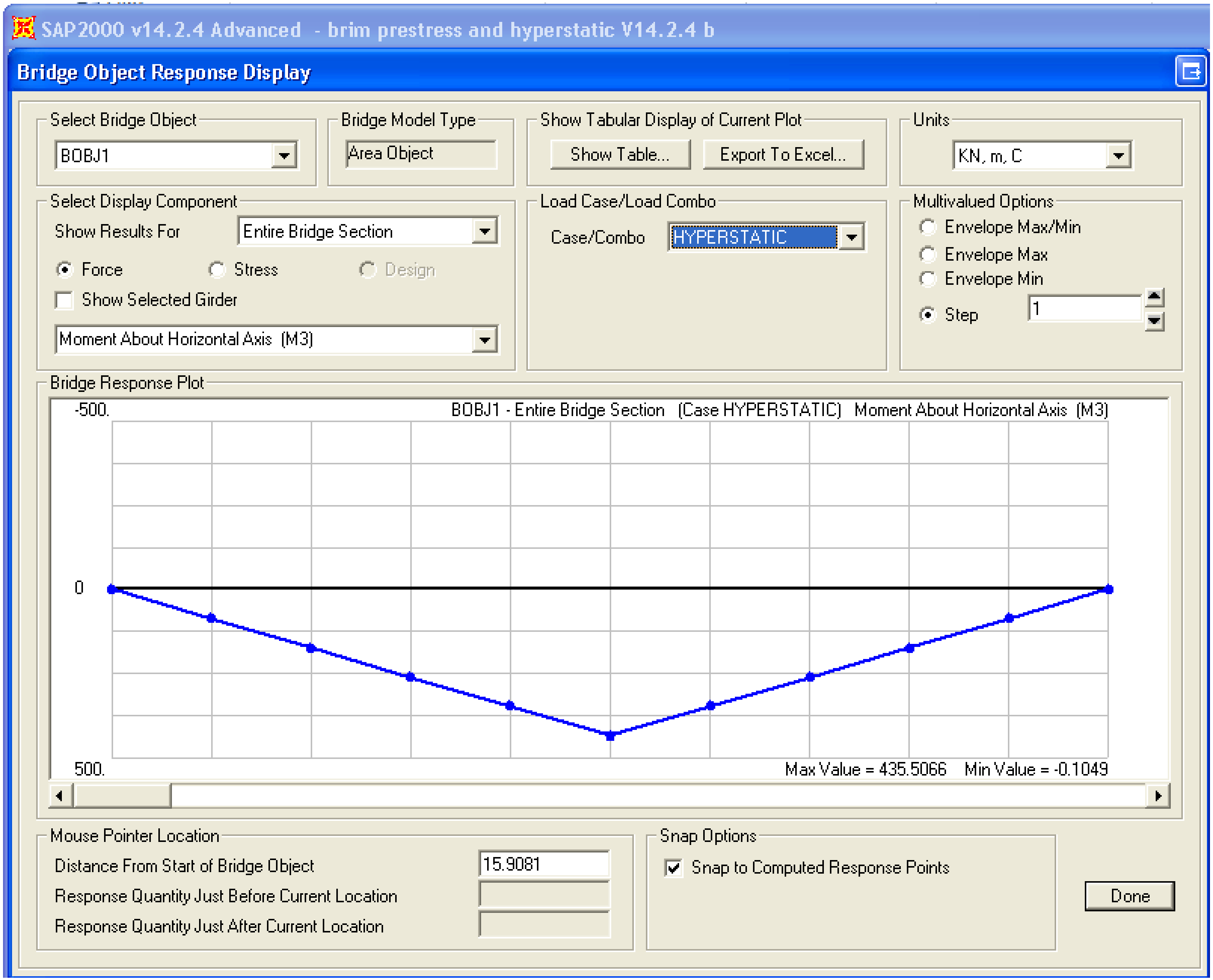
Concrete axial forces
(obtained as resultant of concrete forces; corresponds to total axial forces)



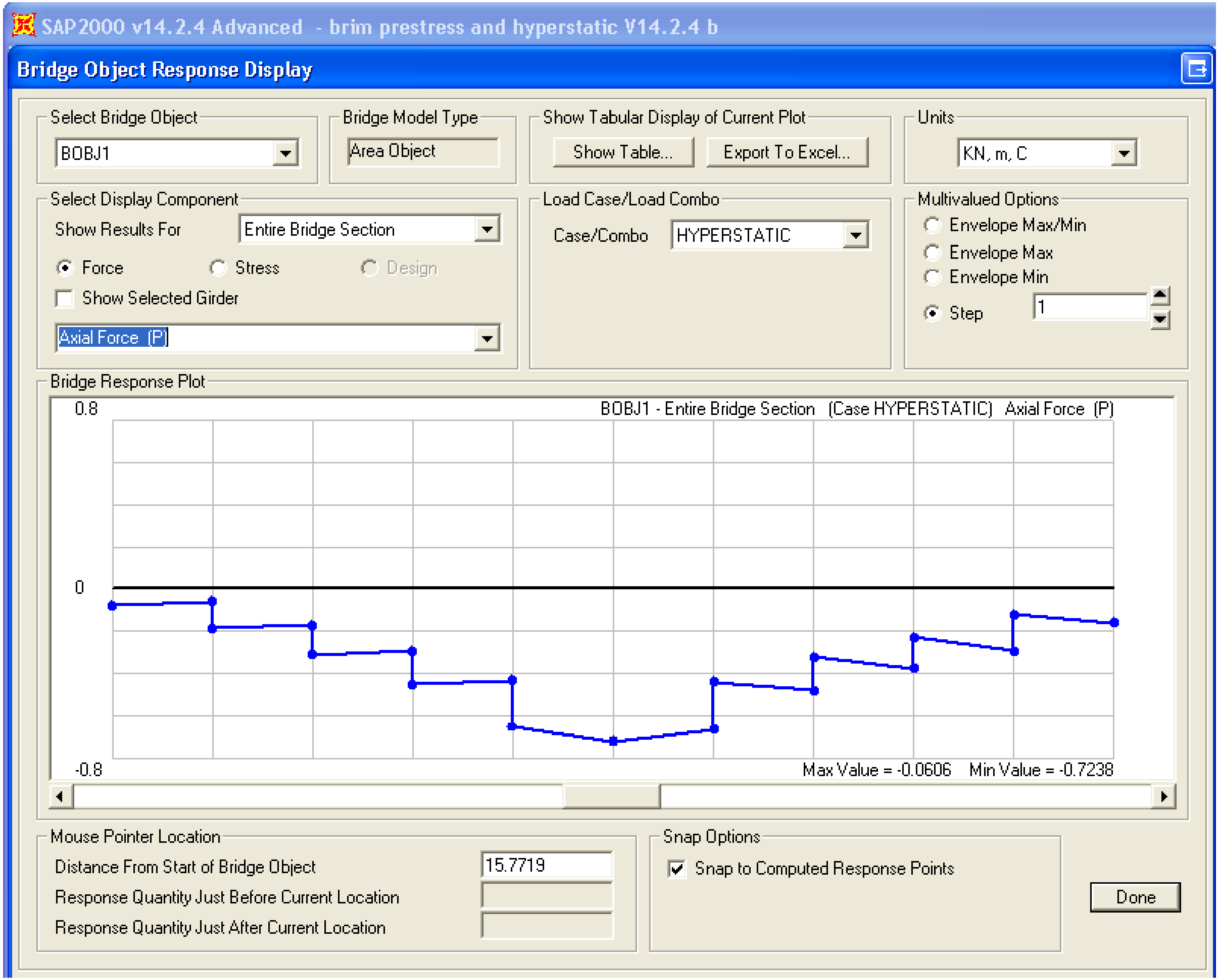
Hyperstatic Forces
Approach 1 - via hyperstatic load case

- This approach may not be always reliable when substructure is modeled.

Hyperstatic moment



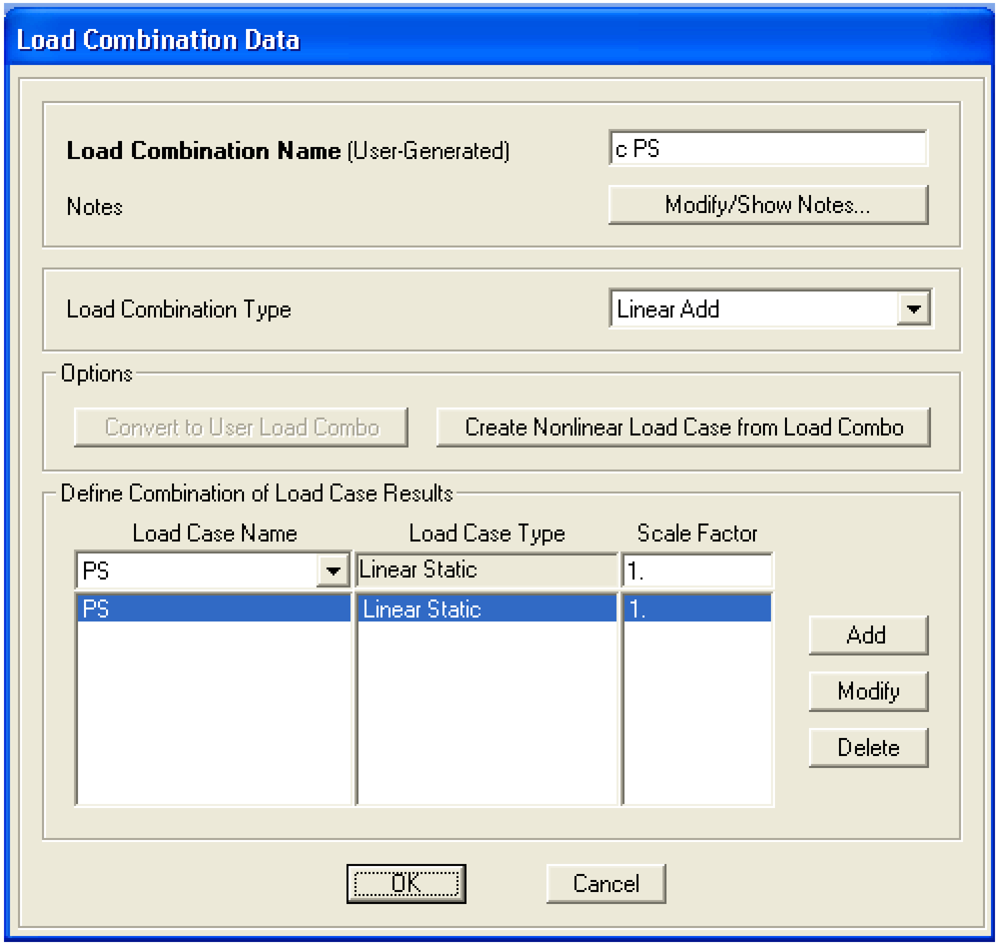
Hyperstatic axial force (essentially zero as expected)



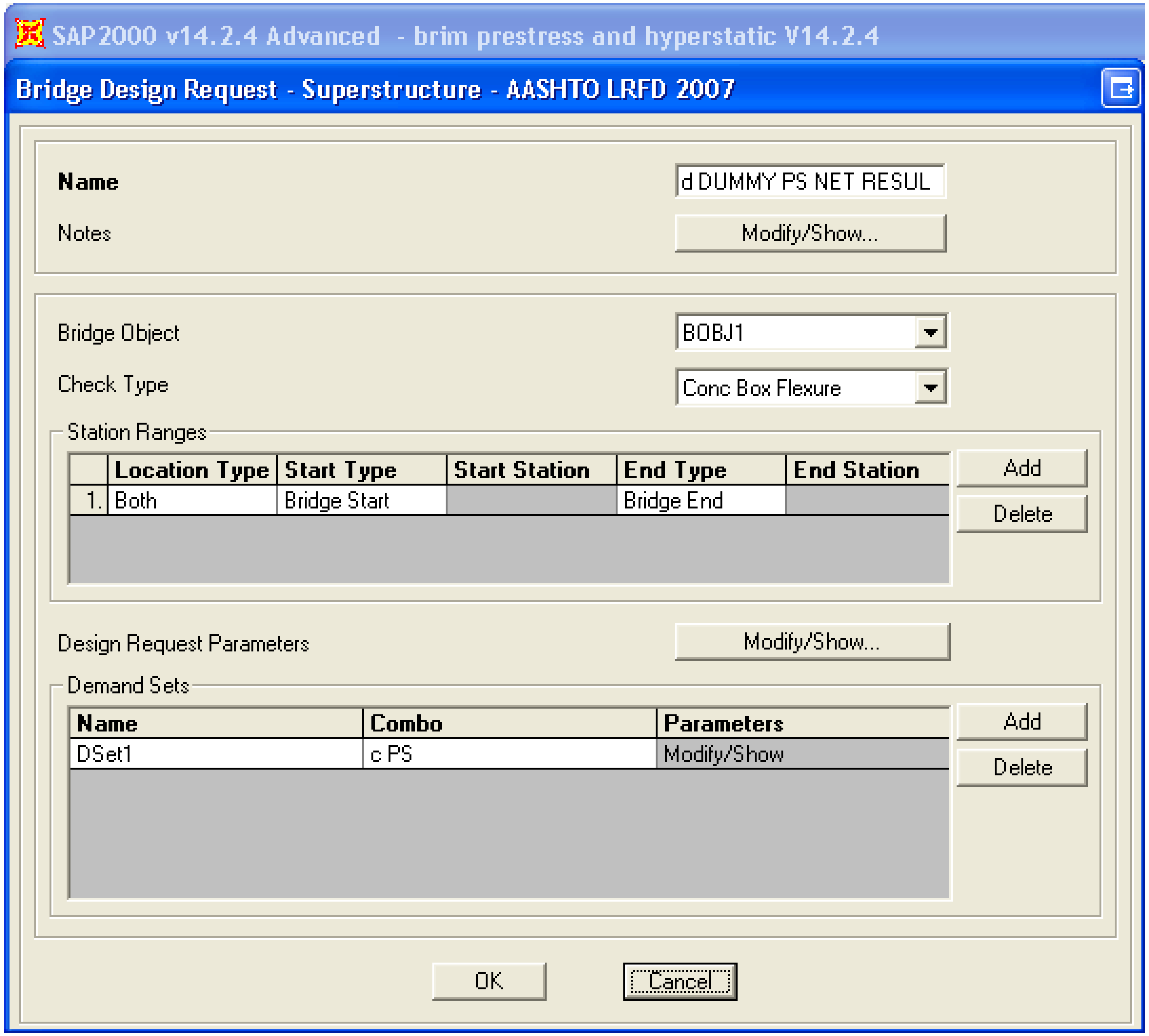
Hyperstatic Forces Approach 2 - as a Net Resultant of Design Section Forces

- Flexural design request check for prestressed concrete box girder superstructure fully accounts for secondary (hyperstatic) forces by calculating the demand forces as a sum of both the forces in the concrete and the tendons (which is by definition the hyperstatic force).
- Therefore, the hyperstatic forces can be indirectly obtained by plotting the demand forces for the flexural design request as shown on the following pages.

Define load combination containing only the load case in which the prestressing is applied.



Define dummy flexural design request for the load combination containing only the prestress load case



The demand moments for this design request are obtained as a net resultant of forces (in concrete and tendons) acting on the cross-section, which matches the definition of the hyperstatic moment.