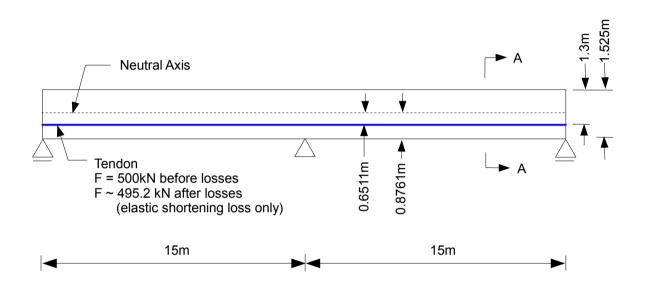
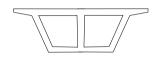
Obtaining hyperstatic (or secondary) forces for bridge object superstructures - test problem

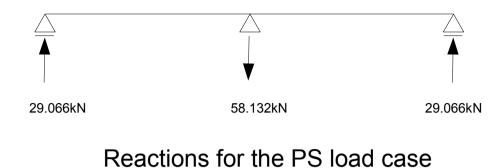
Geometry

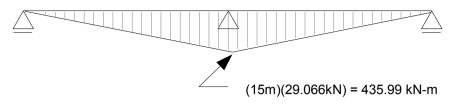




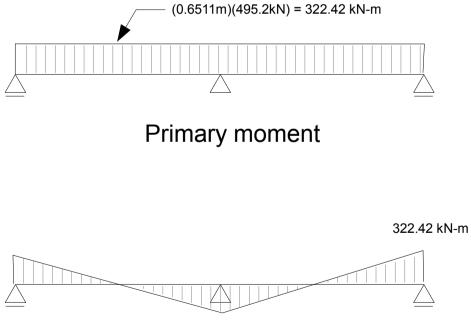
Section A-A (Schematically, Not To Scale)

Elevation (Schematically, Not To Scale)





Corresponding hyperstatic/secondary moment



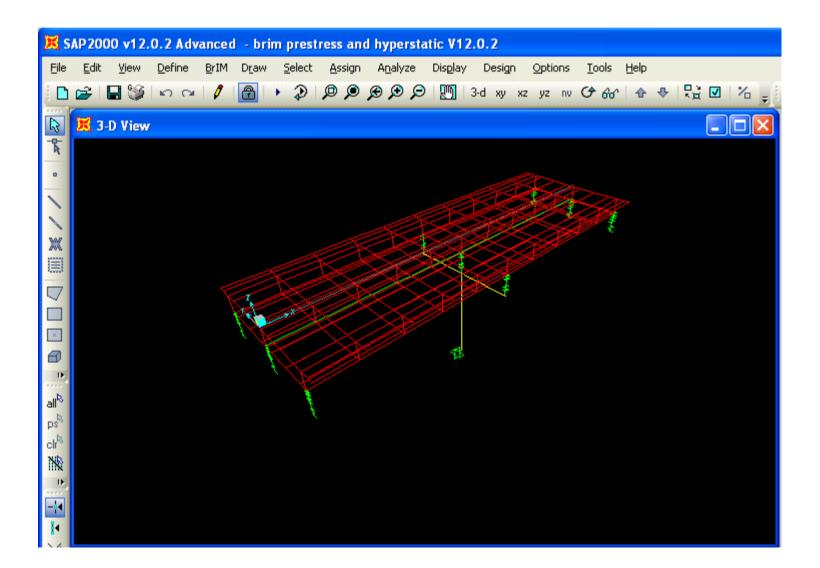
113.57 kN-m

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)

K SAP2000 v14.2.4 Advanced - brim prestress and hyperstatic V14.2.4 b
Bridge Object Response Display
Select Bridge Object Bridge Model Type Show Tabular Display of Current Plot Units BOBJ1 Image: Area Object Show Table Export To Excel KN, m, C
Select Display Component Show Results For Entire Bridge Section Force Stress Show Selected Girder Moment About Horizontal Axis (M3)
Bridge Response Plot
-400. BOBJ1 - Entire Bridge Section (Case PS) Moment About Horizontal Axis (M3)
400. Max Value = 110.5427 Min Value = -322.4218
Mouse Pointer Location Mouse Pointer Location Distance From Start of Bridge Object 0. Response Quantity Just Before Current Location N.A. Response Quantity Just After Current Location -322.4218

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

🔀 SAP2000 v14.2.4 Advanced – brim prestress and hyperstatic V14.2.4 b
Bridge Object Response Display
Select Bridge Object Bridge Model Type Show Tabular Display of Current Plot Units BOBJ1 Image: Area Object Show Table Export To Excel KN, m, C
Select Display Component Show Results For Entire Bridge Section Force Stress Design Show Selected Girder
Bridge Response Plot
500. BOBJ1 - Entire Bridge Section (Case PS) Axial Force (P) Image: Section (Case PS) Axial
-500. Max Value = -495.1978 Min Value = -499.8222 Image: Mouse Pointer Location Mouse Pointer Location Image: Snap Options Distance From Start of Bridge Object 0. Image: Snap to Computed Response Points Response Quantity Just Before Current Location N.A. Image: Snap to Computed Response Points Image: Done Response Quantity Just After Current Location Image: Height After Curr

Hyperstatic Forces Approach 1 - via hyperstatic load case

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

Hyperstatic moment

K SAP2000 v14.2.4 Advanced - brim prestress and hyperstatic V14.2.4 b
Bridge Object Response Display
Select Bridge Object Bridge Model Type Show Tabular Display of Current Plot Units BOBJ1 Image: Area Object Show Table Export To Excel Image: KN, m, C Select Display Component Load Case/Load Combo Multivalued Options
Show Results For Entire Bridge Section © Force © Stress © Show Selected Girder Moment About Horizontal Axis (M3) Case/Combo HYPERSTATIC Case/Combo HYPERSTATIC Case/Combo HYPERSTATIC Case/Combo HYPERSTATIC © Envelope Max © Envelope Max © Envelope Min © Step 1
Bridge Response Plot
-500. BOBJI - Entire Bridge Section (Case HYPERSTATIC) Moment About Horizontal Axis (M3)
500. Max Value = 435.5066 Min Value = -0.1049
Mouse Pointer Location Snap Options Distance From Start of Bridge Object 15.9081 Response Quantity Just Before Current Location Image: Computed Response Points Response Quantity Just After Current Location Image: Computed Response Points

Hyperstatic axial force (essentially zero as expected)

K SAP2000 v14.2.4 Advanced - brim prestress and hyperstatic V14.2.4 b
Bridge Object Response Display
Select Bridge Object Bridge Model Type Show Tabular Display of Current Plot Units BOBJ1 Image: Area Object Show Table Export To Excel Image: KN, m, C Select Display Component Load Case/Load Combo Multivalued Options
Show Results For Entire Bridge Section Force
Bridge Response Plot
0.8 0.8 0.8 0.8 0.8 0.8 0.0 0 0 0 0 0 0
-0.8 Max Value = -0.0606 Min Value = -0.7238
Mouse Pointer Location Snap Options Distance From Start of Bridge Object 15.7719 Response Quantity Just Before Current Location Snap to Computed Response Points Response Quantity Just After Current Location Done

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.

Load Combination Data							
Load Combination Name	c PS Modify/Show Notes						
Load Combination Type	Linear Add						
Options Convert to User Load Cor Define Combination of Load C Load Case Name PS PS		Scale Factor 1. Add Modify Delete					
Cancel							

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

Name				d DUMMY	PS NET RESUL	
Notes				Modify/Show		
Bridge Object				BOBJ1	•	[
Check Type Station Ranges				Conc Box	Flexure 💌	[
_	pe Start Type	s Start Sta	ation End	Туре	End Station	Add
1. Both	Bridge Start		Billog	je End		Delete
	ameters			Мо	dify/Show	
Design Request Par Demand Sets		ombo			-	Add
		ombo PS		Mo Parameter Modify/Shou	\$	Add Delete

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.

BOBJ1 BOBJ1 B			Show Tabula	ar Display of Current Plo able Export To I	Units KN, m, C		
,	or Entire Brid C Stress red Girder Horizontal Axis (M3)	ge Section 💌 © Design	Design/Ratin Request Positive Negativ	d DUMMY PS	NE	Multivalued Option C Envelope Ma C Envelope Mir C Step	x/Min x 1
ridge Response -500.		- d DUMMY PS NET RE					
0							
500.	· · ·			Max	Value = 435.9	9764 Min Value = -1	
Response Quan	ocation tart of Bridge Object tity Just Before Curre tity Just After Current	nt Location	5.8054	Snap Options	ited Respons	e Points	Done