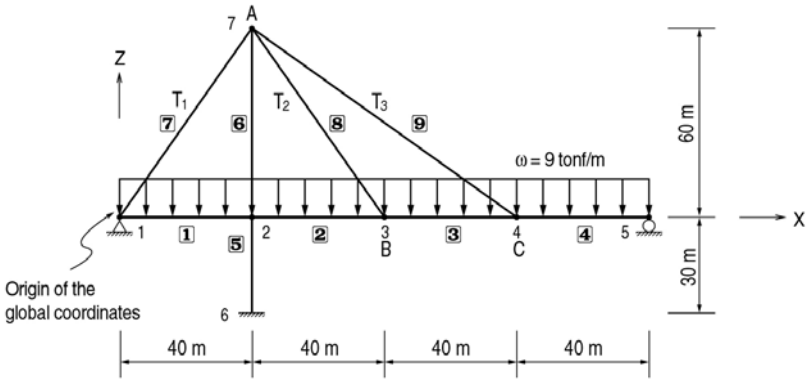
LFO-1

Title

Tensile forces of cable members in a cable stayed bridge

Description

Given is a cable stayed bridge subjected to a uniformly distributed load.
Determine the required initial tensile forces in the cable elements such that the horizontal displacement at the top of the main tower (Node A) and the vertical displacements of the nodes B and C are all zeros.



Structural geometry and analysis model

Model

Analysis Type

2-D static analysis

Unit System

m, tonf

Dimension

Length 160 m Height 90 m

Element

Main girder and main tower	Beam element
Cable	Truss element

Material

Steel	Modulus of elasticity	$E = 2.1 \times 10^7$ tonf/m^2
	Poisson's ratio	$\nu = 0.3$

Section Property

Cable	Radius 0.25 m	
Main girder	Box $3 \times 20 \times 0.03/0.05$ m	
Main tower	Bottom Box $10 \times 2 \times 0.05/0.05$ m	
	Top (Tapered section)	I-End Box $10 \times 2 \times 0.05/0.05$ m
		J-End Box $5 \times 2 \times 0.05/0.05$ m

Boundary Condition

Node 1 ; Constrain Dx, Dy, and Dz. (Hinge support)

Node 5 ; Constrain Dy, and Dz. (Roller support)

Node 6 ; Constrain all DOFs (Fixed support)

Load Case

A unit tensile force is applied to each cable

Load Case 1 ; A tensile force, 1.0, is applied to the truss element 7.

Load Case 2 ; A tensile force, 1.0, is applied to the truss element 8.

Load Case 3 ; A tensile force, 1.0, is applied to the truss element 9.

Load Case 4 ; A uniform load, ω = 9 ton/m is distributed in the -Z direction.

Composition of equations

Constitute equations in order to find load combination factors.

The number of unknown load combination factors and required limitations should be equal.

Limitation; Set the horizontal displacement at the node 7 and the vertical displacements at the nodes 3 and 4 to zero.

Results

Load Combination Factors

```
[ Unknown Load Factor Item : UNK ]
-------------------------------------------------------------------------------

 Selected Load Combination : LCB

     LCase        LCase Factor   Weighted Factor
-------------- -------------- -----------------
        CASE1       Unknown           1.000
        CASE2       Unknown           1.000
        CASE3       Unknown           1.000
        CASE4         1.000

Object Function Type : Linear Absolute Sum
Sign of Unknown Factors : Both


---------------- Constraints ----------------

Constraint  DISP-3  : The Displacement,DZ of Node 3  =      0.0000
Constraint  DISP-4  : The Displacement,DZ of Node 4  =      0.0000
Constraint  DISP-7  : The Displacement,DX of Node 7  =      0.0000


 The determined load factors by above constraints
-------------------------------------------------------
     LCase             LCase Factor
-------------- ----------------------
        CASE1       1496.4721679688
        CASE2       565.86749267578
        CASE3       722.65740966797
-------------------------------------------------------
 Object Function Value = 2784.9970703125
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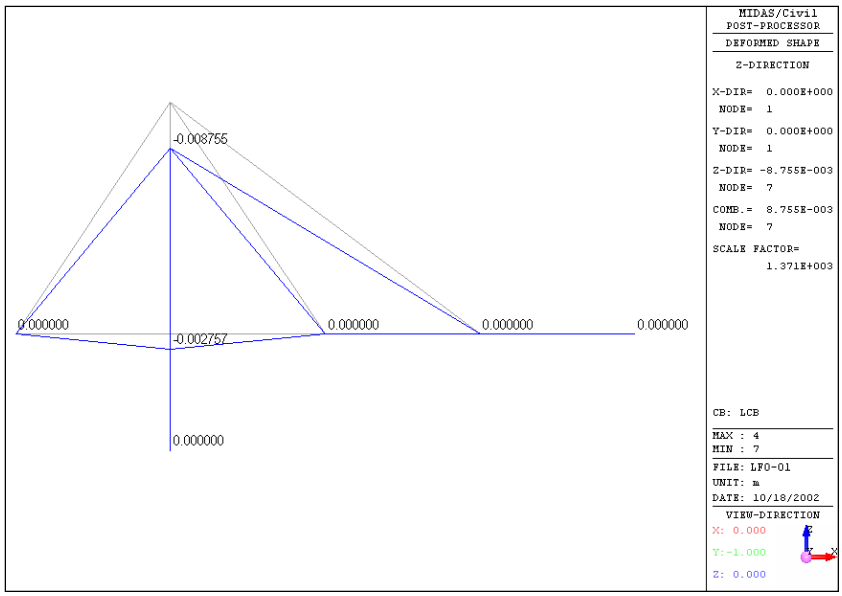
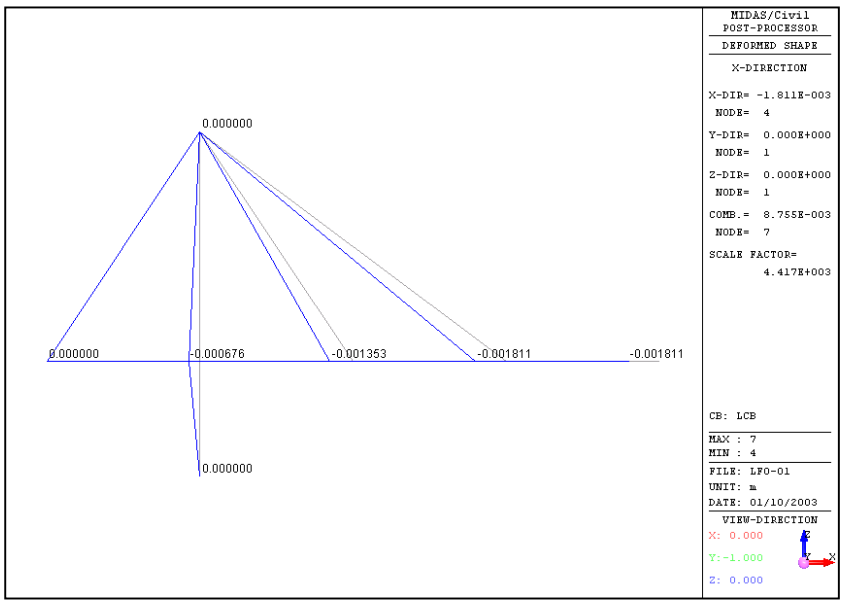


Combined Z- displacements of the structure



Combined X-displacements of the structure

Results of MIDAS/Civil

Unit : m, tonf

Load Case	Load combination factor	Limitation	After combination
1	1496.47217	Vertical displacement at the node 3	0.0
2	565.86749	Vertical displacement at the node 4	0.0
3	722.65741	Horizontal displacement at the node 7	0.0