Solution for Hanging Girder with Wind Sufficient to reverse the assumed Tilt Direction

This analysis addresses a case related to section 3.2.3 of the PCI Recommended Practices for Lateral Stability of Precast, Prestressed Concrete Bridge Girders.

The wind force, WS, is sufficient to reverse the direction of assumed tilt when . The tilt angle, , reverses when . This condition is illustrated in the sketch below.



For this condition the rotation is opposite the assumed rotation, therefore take and .

# Equilibrium condition

Equilibrium requires the acting and resisting moments to be equal and opposite.

The acting moment is

The resisting moment is

Note that is subtracted because .

The lateral deflection of the girder’s center of mass is

For small angles

Substituting, the resisting moment becomes

Note that reduces the moment arm because .

Set the acting moment equal to the resisting moment and solve for the equilibrium tilt angle.

This equation is the same as provided in PCI 3.2.3.2.

# Factor of Safety against Cracking

Determine the maximum tilt angle at the onset of cracking.

Note the sign change preceding and compared to the formulation of the equilibrium condition. This is due to the sign change of .

# Factor of Safety against Failure

After cracking, the lateral stiffness of the girder is reduced and the lateral deflection is amplified. Mast defined the effective stiffness as

The resisting moment is

Note the sign change preceding and compared to the formulation of the equilibrium condition. This is due to the sign change of .

The acting moment is

The factor of safety at some post-crack angle is

The angle that maximizes the factor of safety is

The factor of safety against failure is

The step by step development of follows

Find that maximizes. when

Recognize that is in the form

Therefore

When

Solve for

Divide by

Expand and simplify

Solve