

PGSuper™ Technical Note (TN002)

Updated Girder Stability Design and Analysis

Background

The Precast/Prestressed Concrete Institute (PCI) has published recommended practices for lateral stability of precast, prestressed concrete bridge girders. PCI Pacific Northwest (PCI/PNW) and local heavy haulers have requested WSDOT update design practices to account for modern hauling equipment and provide better communication of design assumptions. The WSDOT Standard Specifications, Bridge Design Manual, Girder Standards and the PGSuper software incorporate changes to the engineering practice related to girder stability analysis.

This document provides guidance for using PGSuper Versions 2.9 and 3.0 with respect to the new design approach and new information required for the girder schedule.

New Design Approach for Girder Stability during Hauling

The new approach to designing girders for stability during hauling is very simple. Design girders for the least stiff hauling configuration, chosen from a list of hauling configurations representative of the regional fleet of hauling equipment, for which stress and stability requirements are satisfied. The hauling vehicle parameters, with the exception of the support rotational spring constant and the center-to-center wheel spacing, are unchanged from the previous design method. Table 1 shows the support rotational spring constant and center-to-center wheel spacing.

Put simply, the new design approach is to start with configuration 1 from Table 1 and design the girder. Repeat the design process with each subsequent configuration until the design is successful.

	Shipping Support Rotational Spring Constant K_{θ} (kip-in/rad)	Center to Center Wheel Spacing W_{cc} (in)
1	40,000	72
2	50,000	72
3	60,000	72
4	60,000	96
5	70,000	96
6	80,000	96

Table 1- Haul Configuration Parameters

New Girder Schedule Information

Figure 1 shows the new parameters on the girder schedule. These parameters, along with the information in the Standard Specifications, provide builders, fabricators, and haulers the complete set of assumptions used when determining the lifting and bunking locations.

SHIPPING AND HANDLING DETAILS					
MAXIMUM MIDSPAN VERTICAL DEFLECTION AT SHIPPING	L	L1	L2	K_{θ} MINIMUM SHIPPING SUPPORT ROTATIONAL SPRING CONSTANT	W_{CC} MINIMUM SHIPPING SUPPORT CNTR.-TO-CNTR. WHEEL SPACING
-	-	-	-	-	-
-	-	-	-	-	-

Figure 1 - New Girder Schedule Information

The Shipping and Handling Details girder schedule parameters are:

- Maximum Midspan Vertical Deflection At Shipping = The deflection due to self-weight and prestressing at mid-span of the girder in the shipping configuration.
- L = Location of lifting support locations
- L1, L2 = Location of bunk points
- K_{θ} , Minimum Shipping Support Rotational Spring Constant = rotational spring constant determined from analysis
- W_{CC} , Minimum Shipping Support Cntr-to-Cntr wheel spacing = center-to-center, transverse, wheel spacing of the hauling vehicle, determined from analysis.

PGSuper 2.9

PGSuper 2.9 uses the now obsolete method of determining the truck support rotational spring constant. Manual iteration through the hauling equipment configurations is required for design.

Procedure for Design and Analysis

Use the following procedure for design and analysis:

- 1) Create custom project criteria
 - a. Open your PGSuper project or create a new project
 - b. Select **Library > Edit Libraries**
 - c. In the Library Editor window, select the Project criteria library
 - d. Right click on the project criteria with a red check next to it and select Duplicate. This will create a copy of the project criteria that is currently in use.
 - e. Right click on the copy and select Rename. Enter a meaningful name (we'll use MyCriteria for this example).
- 2) Select custom project criteria

- a. Select **Project > Project Criteria**. Select “MyCriteria” from the list. “MyCriteria” is now the project criteria. Modify the hauling parameters as needed.
- 3) Set haul truck parameters in “MyCriteria”
 - a. In the Library Editor window, double click on the “MyCriteria” object
 - b. Select the Hauling tab
 - c. In the Hauling Parameters section, select “Constant” for the Roll Stiffness of the Truck Trailer and enter the Roll Stiffness and Truck Width from the table above starting with configuration 1.
- 4) Design/Analysis
 - a. Perform a design or specification check analysis. A successful specification check analysis may require adjusting the bunking locations and temporary strands.
 - b. Return to Step 3 and use the next configuration if girder stability is inadequate.
 - c. Repeat until the hauling configuration is adequate.

Girder Schedule Information

The new girder schedule parameters can be determined as follows:

- Maximum Midspan Vertical Deflection, Shipping: Estimate the effect of camber on the location of the center of gravity of the girder by increasing the location of the center of gravity with respect to the roll axis by 2%. Estimate the maximum midspan vertical deflection as $0.02(Y_{bg} + H_{bg} - H_{rc})$ where Y_{bg} is the location of the girder centroid measured from the bottom of the girder, H_{bg} is the height of the bottom of girder above the roadway surface, and H_{rc} is the height of the roll axis above the roadway surface. H_{bg} and H_{rc} can be found in the Project Criteria on the Hauling tab.
- Minimum Shipping Support Rotational Spring Constant: Use the value K_{θ} found in the Hauling Check Details chapter of the Hauling or Details Reports.
- Minimum Shipping Support Cntr-to-Cntr Wheel Spacing: Use two times the value z_{max} found in the Hauling Check Details chapter of the Hauling or Details Reports. Alternatively, use the value for Truck Width (C-C distance between dual tires) found in the Project Criteria on the Hauling tab.

PGSuper 3.0

PGSuper 3.0, which is part of the BridgeLink suite of tools, uses the new method of determining the haul truck parameters. Update old PGSuper projects so that the old hauling parameters are not used.

Updating Older Project Files

Update PGSuper™ projects created prior to adding the new stability and haul truck features. The following procedure details the necessary steps.

- 1) Identify if input modifications are required
 - a. Open your PGSuper project file

- b. Select **Library > Edit Libraries**
 - c. In the PGSLibrary Editor window, select the Haul Truck library
 - d. If there are haul truck entries in your project library (entries with a red check and without the lock icon) that have a name beginning with “Old Haul Truck –”, update the project.
 - 2) Assign a pre-defined Haul Truck configuration to all girders
 - a. Select **Edit > Girder**. Choose Span 1, Girder A
 - b. Select the Temporary Conditions tab
 - c. Change the haul truck to “HT40-72”
 - d. Press [OK]
 - e. Select **Edit > Copy Girder Properties**
 - f. Copy properties from Span 1, Girder A to All Girders, All Spans. Uncheck all properties to copy except for “Copy Temporary Conditions”.
 - g. Press [Copy Now] followed by [Close]. NOTE: This will copy all temporary support conditions, even those for lifting. If you need more fine control over changing the haul truck, edit each girder individually.
 - 3) Delete “Old Haul Truck” from library
 - a. Return to the Haul Trucks library in the PGSLibrary Editor window
 - b. The haul truck named “Old Haul Truck” should no longer have a red check. Right click on this truck and select Delete.
 - 4) Design/Analysis
 - a. Perform a design of specification check analysis. The designer will find the haul truck with the least stiffness that satisfies the project criteria.
 - b. If performing a specification check analysis, change the hauling bunk points, temporary strands, and haul truck as needed to satisfy the project criteria.

Girder Schedule Information

The new parameters for the girder schedule are available in the WSDOT Girder Schedule report. Simply create a WSDOT Girder Schedule report, verify the information, and enter the information into the girder schedule.