PGSuper™ Technical Note (TN002)

Updated Girder Stability Design and Analysis

# Background

The Precast/Prestressed Concrete Institute (PCI) has recently published their recommended practices for lateral stability of precast, prestressed concrete bridge girders. At roughly the same time, industry has requested WSDOT improve the communication of girder stability analysis assumptions used to determining the lifting and bunking locations shown on the girder schedule, improve estimates for girder haul truck parameters to reflect the modern fleet of hauling equipment, and adopt a new design approach that minimizes hauling equipment requirements and provide haulers more flexibility in choosing specific hauling equipment. The WSDOT Standard Specifications, Bridge Design Manual, and Girder Standards are being updated to reflect these changes. PGSuper™ has also been updated.

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. Girders are to be designed 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. The support rotational spring constant and center to center wheel spacing are shown in Table 1.

Put simply, the new design approach is to start with configuration 1 from Table 1 and design the girder. If hauling stability cannot be achieved, repeat the design process with configuration 2 then 3 and so on, until a successful design is achieved.

|  |  |  |
| --- | --- | --- |
|  | Shipping Support Rotational Spring Constant K (kip-in/rad) | Center to Center Wheel Spacing Wcc (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

Several new parameters are provided on the girder schedule, as see in Figure 1. 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.

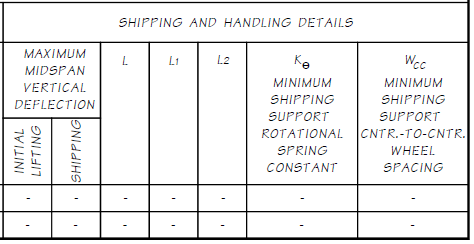


Figure 1- New Girder Schedule Information

The Shipping and Handling Details girder schedule parameters are:

* Maximum Midspan Vertical Deflection, 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, Minimum Shipping Support Rotational Spring Constant = rotational spring constant determined from analysis
* Wcc, 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
   1. Open your PGSuper™ project or create a new project
   2. Select **Library > Edit Libraries**
   3. In the Library Editor window, select the Project criteria library
   4. 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.
   5. Right click on the copy and select Rename. Enter a meaningful name (we’ll use MyCriteria for this example).
2. Select custom project criteria
   1. Select **Project > Project Criteria**. Select “MyCriteria” from the list. “MyCriteria” is now the project criteria and the hauling parameters can be modified as needed.
3. Set haul truck parameters in “MyCriteria”
   1. In the Library Editor window, double click on the “MyCriteria” object
   2. Select the Hauling tab
   3. 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
   1. Perform a design or specification check analysis. A successful specification check analysis may require adjusting the bunking locations and temporary strands.
   2. If adequate stability during hauling cannot be achieved, return to Step 3 and use the next configuration.
   3. Repeat until an adequate hauling configuration is found.

## Girder Schedule Information

The new girder schedule parameters can be determined as follows:

* Maximum Midspan Vertical Deflection, Shipping: The effect of camber on the location of the center of gravity of the girder is estimated by increasing the location of the center of gravity with respect to the roll axis by 2%. The maximum midspan vertical deflection can be estimated as where is the location of the girder centroid measured from the bottom of the girder, is the height of the bottom of girder above the roadway surface, and is the height of the roll axis above the roadway surface. and can be found in the Project Criteria on the Hauling tab.
* Minimum Shipping Support Rotational Spring Constant: Use the value 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 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. PGSuper™ projects created with older versions of the software will have to be updated so that the old hauling parameters are not used.

## Updating Older Project Files

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

1. Identify if input modifications are required
   1. Open your PGSuper™ project file
   2. Select **Library > Edit Libraries**
   3. In the PGSLibrary Editor window, select the Haul Truck library
   4. 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 –“, the project needs to be updated.
2. Assign a pre-defined Haul Truck configuration to all girders
   1. Select **Edit > Girder**. Choose Span 1, Girder A
   2. Select the Temporary Conditions tab
   3. Change the haul truck to “HT40-72”
   4. Press [OK]
   5. Select **Edit > Copy Girder Properties**
   6. Copy properties from Span 1, Girder A to All Girders, All Spans. Uncheck all properties to copy except for “Copy Temporary Conditions”.
   7. 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
   1. Return to the Haul Trucks library in the PGSLibrary Editor window
   2. 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
   1. Perform a design of specification check analysis. The designer will find the haul truck with the least stiffness that satisfies the project criteria.
   2. 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 WSDOT Girder Schedule report has been updated to include the new parameters for the girder schedule. Simply create a WSDOT Girder Schedule report.