INDOT Bridge Design Practice Pointers

The following information was compiled by the ASCE-INDOT Structures Committee to raise awareness regarding bridge design software idiosyncrasies and bridge detailing practices. The list is not all inclusive and intended only as a useful tool for designers. Some information may no longer be applicable as new versions of software are released. Indiana Design Manual (IDM) and AASHTO LRFD Bridge Design Specifications (LRFD) references have been added for convenience to identify how the software affects design requirements. Where no reference is given the information is a preferred common practice or corrections to computer program glitches.

Please contact any INDOT or Consultant ASCE-INDOT Structures Committee member with comments and suggestions.

SOFTWARE

Merlin-Dash

1. The inputted haunch includes the beam top flange thickness.

Conspan

1. Toggle "Exclude Non-Composite Moments from Mu". **IDM 406-12.05**
2. Toggle "Exclude Beam and Slab Contribution from Vu". **IDM 406-12.05**
3. When designing multi-span bridges, ensure that the Double Truck and Double Tandem Live Loads are selected in the live load window. Conspan has been known to accidentally remove these during multiple runs. **LRFD 3.6.1.3**
4. Distribution Factors must be manually changed for Dead Loads due to barrier railing, curbs, sidewalks, or other attachments to meet the criteria in **IDM 403-2.06**. These can be changed under the "Analysis Factors" tab.
5. When Importance is set to 1.05 and "Non-composite moment effects are EXCLUDED from Mu" is toggled, the Mu-req'd in the "Reinforced Design" does not compute correctly. If "INCLUDED" is used and/or importance = 1.0, the numbers are correct, but the combination of the two causes unconservative results. The solution can be to run with Eta = 1.00 and then scale up the steel required by 5%.
6. Adjust the design importance factors under the "analysis factors" tab per Indiana Design Manual Guidelines. **IDM 403-1.02**
7. Under the "project design parameters tab", alter the relative humidity from 75% to 70% per INDOT guidelines. IDM 406-4.02(01)
8. Adjust deflection multipliers within the "project design parameters" tab. Conspan defaults the at erection deflection multipliers to 1.85. Per Indiana guidelines, these should be adjusted to 1.75 unless more accurate methods are utilized. **IDM 406-12.04(03)**

Conspan (con'd)

9. Under the "project design parameters tab", check the box titled "check at lifting point". Due to the large amount of strand that can sometimes be placed in certain beam types, beams can fail due to concentrated stresses and the lifting points. This will provide an additional check for stresses at the lifting points allowing the designer to adjust mild reinforcement within the beam to compensate for this.
10. Under the "project design parameters tab", check the box for horizontal shear auto designed for intentionally roughened surface. **IDM 406-7.03**
11. Verify that Conspan is applying the correct resistance factor correctly for semi-lightweight and lightweight concrete in the Vu/f'c computation used to determine the max stirrup spacing for vertical shear and horizontal shear. **IDM 406-5.04**
12. Have had difficulties matching the values for dv and a. This tracks through the rest of the results.
13. Have had difficulties matching the values for longitudinal reinforcing.
14. Trouble reproducing Conspans fps, c & a results for ultimate moment.
15. Designer should not input thickness greater than the minimum since CONSPAN will use for composite section properties, but input additional as a non-composite load on precast.
16. Include additional concrete due to residual camber and vertical curve correction as a trapezoidal precast DC load. These can be adjusted along the length of the beam to account for additional concrete dead load associated with differences between beam camber and the profile grade.
17. Conspan outputs Bursting or Anchorage Zone Steel in Prestressed Beams as one value. Designers need to make sure they are looking at the top of beam and bottom of beam separately when they are draping strands.
18. Flared beam analysis - After entering all the geometric data, if you go back and change any information in the "Layout" dialogue (like deck widths & offsets or abutment widths & offsets), then the beam analysis goes haywire. As a temporary solution, you just need to wipeout and reenter all the beam data in the "Cross Section" dialogue after you've made all changes to the "Layout". (Version 11.00.01.05)
19. Deck thickness should be entered as the structural thickness (typically 7.5"). Sacrificial thickness (typically 1/2") should be added as a non-composite dead load. **IDM 404-2.01**
20. Beams are typically supported at their bearing locations within the yard. The designer should consider having their release span and bearing to bearing span match within the program.
21. When the designer has finished generating their strand pattern, if the design stresses pass, but you still receive a "NG" under release stresses, this is due to the beam failing at the lifting points. The designer can view these stresses in the report under "positive envelope stresses". The second table reports the stresses at the lifting point. The designer can add additional mild steel or increase the allowable release strength improve this. **IDM 406-5.01**

RC Pier

1. RC Pier incorrectly applies the eta factor for the minimum case. It should be 1/eta. RC Pier always multiplies by eta. This can be unconservative. The designer should alter the min and max load factors to account for this, however, this leads to very long run times for Strength V.
2. For cap design, RC Pier is overly conservative by applying the max torsion with the max vertical shear when they are not concurrent.
3. For cap design, RC Pier appears to always use dv = d-a/2 and does not account for 0.72 H or 0.9 de.
4. RC Pier conservatively calculates the max pile load and assumes that this load is present in all piles. Very conservative.
5. Verify that RC Pier is not incorrectly calculating pile reactions for Extreme Event.
6. When designing pile footings, RC-Pier takes the conservative approach of designing the footing bending and shear using the maximum pile reaction on all piles across a given width or length. The more appropriate design is to take the controlling load combination axial loads and bending moments to calculate the individual pile reactions based on P/n +/- Mx/Sx +/- Mz/Sz, then use those values to calculate shear and moment in order to determine the needed footing depth and the needed reinforcing bars.
7. To design for a wall type pier, select the “Multi Columns” option and simply enter one column that is the width of your wall pier
8. When auto-generating loads within RC-Pier, one should look into importing their reactions from their own Conspan Run. When working within Conspan, the designer can select file, export to rc-pier as an option. This produces a text file that contains all the dead and live loads within Conspan. When working within RC-Pier, the designer can then select auto-generate loads, import from Conspan, and select the text file they wish to use. Superstructure data from both runs must match exactly, including skew, in order to allow the loads to be imported.
9. When generating live load combinations within RC-Pier, the designer can sometimes be left with 20 – 30 LL cases with only 1 braking or centrifugal case. RC-Pier does not allow a standard analysis when the number of braking and centrifugal cases does not match the same number of LL cases, thus requiring cross combinations to be generated. This can result in hundreds of analysis tables being generated, or several hours of analysis runs. To cut this time in half, or more, the designer can simply copy his braking and centrifugal force to match the number of LL combinations. This will allow the program to run standard combinations and cut the run time by almost 75%.
10. Like above, the designer can look to reduce some of the generated wind cases to cut down on run time. Using discretion, the engineer could choose to only investigate 0, 30, and 60 degree wind angles, or simply 0 and 45 to reduce the number of cases.
11. When designing pier columns within seismic zones, the designer should adjust the minimum reinforcement area to meet AASHTO specific criterion for their specific seismic zone. AASHTO LRFD 5.10.11 or Section 8 of AASHTO Guide Specifications for LRFD Seismic Bridge Design.

BRIDGE DETAILING

1. Hold-Down Points in Prestressed Beams - While not recommended as standard practice, but when needed, hold-down points may be staggered from 15” to 18” in order to facilitate the use of more draped strands and to minimize the hold-down force at an individual location.
2. Semi-integral End Bent Diaphragms - Ensure that the side faces of the keyways are parallel to the bridge/beams to allow for longitudinal movement.