BRIDGpretension v3
CHBDC Pretensioned Girder Design
User's Manual

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CONTENTS

1.0 INSTALLATION

1.1 Hardware Requirements

To successfully install BRIDGpretension, your computer must be equipped with the minimum:

- Windows XP or later operating system
- P2 processor
- 64 MB of Ram
- 2 MB of free disk space
- 800 x 600 video
- Microsoft Excel 2010 or later

1.2 Installation and Uninstall Program

BRIDGpretension is equipped with an automatic installation program.

- The program is run and installed directly from our website. The package includes the Excel workbook required as the starting point of your first new design. Later designs may utilize this workbook or other saved workbooks generated from the original Excel file.

- The application as received will require registration to enable full Design functionality. The program will operate in demo mode until registered.

- The Excel files contain macros. The User will need to accept the macros to enable the program functionality.

- An Uninstall routine will be installed in the same directory as the program directory. The program may be uninstalled and then reinstalled during an active license without issue.

- Your system requires Microsoft .NET Framework (included in Windows 7 and later) to operate the BRIDGpretension program. During the BRIDGpretension installation, your system may automatically be directed to the Windows download website to retrieve the necessary file.

- After installation, the program will automatically check for the latest program version when the application is re-opened.

2.0 DEFINITIONS

For definitions, see the applicable section of the Canadian Highway Bridge Design Code (CHBDC) CAN/CSA-S6-19 except as follows.

girder end – the length of girder end that has different section properties than the midspan: the very end of the girder

3.0 NOTATION

For notations, see the applicable section of the Canadian Highway Bridge Design Code (CHBDC) CAN/CSA-S6-19 and as follows:

Ag or A_g – area of girder
F.E.M. – fixed end moment
j – fraction of the distance to opposite resultant forces
k – fraction of the depth to neutral axis from the extreme compression face
M – moment force
n – modular ratio
N.A. – neutral axis
N/A – not applicable
OPSD – Ontario Provincial Standard Drawings
SIDL – superimposed dead load
VB – Visual Basic
wdl – weight from dead loads

4.0 INTRODUCTION

4.1 General

BRIDGpretension by Simplified Bridge Solutions Ltd. is a program that provides fully pretensioned girder design conforming to the Canadian Highway Bridge Design Code (CHBDC) CAN/CSA-S6-19. The intent of this program is to provide a user-friendly tool for the majority of the pretensioned girder bridge structures being designed today.

As most of the User information is contained in the CHBDC, the User should refer primarily to the bridge code more so than the BRIDGpretension manual when using the program. Therefore, references to clauses, sections, tables and figures shall be that of the CHBDC unless noted otherwise.

4.2 Description

BRIDGpretension is a program that uses Microsoft Excel (output) and Visual Basic (input) for designing pretensioned girders with composite concrete decks.

The design process is for vertical loading during construction and the completed structure stage. Transverse or horizontal effect or loads do not form part of this program release.

Positive moment regions within the span length and negative moment regions at integral abutment and piers are addressed along with the positive moment connection and shear requirements. Other design checks are done that include vibration, hold down forces, and anchorage zone requirements.

Positive moment connection drawings may be available as a provincial standard drawing. It is likely the positive bending moment connection derived by BRIDGframe and designed by BRIDGpretension will exceed that given by provincial standards.

Design is based on fully prestressed girders with the option of including temporary prestressing at the girder top to counter stresses from girder bottom prestressing, during transfer. Design closer to the girder ends will include reinforcing bars if added by the User.

5.0 INPUT

5.1 General

The bridge structure is first modeled and analyzed using our BRIDGframe program or other appropriate software.

To begin using the BRIDGpretension program, the User is required to LOAD (see the LOAD buttons found on the file tab of the program) the BRIDGframe excel model into BRIDGpretension and then load the example BRIDGpretension excel file. (See Appendix 3)

Imported BRIDGframe output results per load case can be accepted, editing, or values can all be manually input onto BRIDGpretension various Loads tabs.

Locations between the BRIDGframe output results will be interpolated for design values used in BRIDGpretension. Therefore, the more output increments requested in BRIDGframe, the more accurate the BRIDGpretension design when designing locations that do not correspond with the BRIDGframe output.

Input data is posted to the various Excel tabs to be utilized by the program, by the selection of the 'Synchronize' button found at the bottom left corner of the program tabs.

The program uses fixed units of measurement in the international or metric system.

Girders are assumed to be symmetrical.

5.1.1 Sign Convention

All input shall be entered as positive values unless noted otherwise. Dimensions from the neutral axis of the section are negative. Tension stresses are negative.

5.2 Input

The input sheet determines the basic geometry of the girder, the design location, and the design stage.

The input provides information to the program to establish how the girder length fits relative to the BRIDGframe span modeled.

After the girder has been designed using the predefined Design Stages, the User may check the 'Design Moment Connections at Girder End' box to design the positive moment connection.

The Design Location is input as a fraction relative to the x/L location represented in the BRIDGframe model.

5.2.1 Stage 1 In-service

Most of the girder will be designed during this stage.

Design will include:

- material properties and parameters
- establishing section properties
- in-service midspan girder design at SLS and ULS
- permanent and temporary pretension girder end design at transfer
- permanent and temporary pretension design at hold-downs at transfer
- allowable hold-down forces
- design at solid to voided transition location
- design at debonded to bonded transition of strands
- design at construction supports
- vibration and anchorage zone

5.2.2 Stage 2 In-service

The remainder of the girder will be designed during this stage (excluding construction loading design).

Design at the selected location will include:

- in-service girder moment design at SLS and ULS 1 to 4
- shear and shear interface design
- negative moment design for semi-continuous structures
- positive moment connection design for semi-continuous structures

5.2.3 Stage 3 Construction

If the User deems it necessary, this stage may be used to check the girder during construction. Design steps are similar to that shown in Stage 1 In-service.

The User is not making changes to the girder as designed using Stage 1. The User is simply confirming there are no construction issues with the Stage 1 design. Any changes for Stage 3 should be done in Stage 1 and rechecked in Stage 3.

5.2.4 Stage 4 Construction

If the User deems it necessary, this stage may be used to check the girder during construction. Design steps are like that shown in Stage 2 In-service.

The User is not to be making changes to the girder as designed using Stage 2. The User is simply confirming there are no construction issues with the Stage 4 design. Any changes for Stage 4 should be done in Stage 2 and rechecked in Stage 4.

5.3 Properties

The Properties tabs provide the input for defining the pretensioned concrete girder and concrete deck.

5.3.1 Properties 1

The Properties1 tab is used to input the material properties and parameters, and material resistance factors. See the CHBDC cl.8.4.2.1.3, 8.4.3.3, 8.4.6, 8.5.3.1 and 8.6.2.7.4.

Where temporary strands will be incorporated into the design to counter high concrete stresses at transfer, an input box is provided for the concrete strength at time of cutting of these strands.

5.3.2 Properties 2

Section properties of the midspan are input on this tab.

The Height of Haunch is the concrete between the top of girder and underside of deck. Its width is taken as equal to the girder top flange width.

Standard sections may be selected from the pull-down box. For sections not preloaded into the program, the User may manually enter the name and properties of the section.

5.3.3 Properties3

The Properties3 tab is used to input the section properties of the ends.

For some girders the ends will be that of the midspan. In such cases the Copy button may be selected which will copy the midspan section properties to the ends. For this condition the Length of End = 0.

For voided girders with solid end sections the User will enter the section properties of the solid ends. The length of the solid ends is also defined on this tab.

5.4 Loads

The Loads tabs are primarily used to input the forces at the specific location being designed.

For Design Stage 1 and 3, the forces to be input are to be the maximum within the midspan region or between the group 1 hold-down locations.

The skew limit in accordance with cl.5.6.1.1 and 5.7.1.1 has been included in BRIDGpretension rather than in BRIDGframe, to eliminate any indication that BRIDGframe results may include skew effects. The User may increase BRIDGframe live load shear values as per CA5.1.3 for input into BRIDGpretension.

5.4.1 Loads 1

The Loads 1 tab is used to input dead and superimposed dead, load factors.

5.4.2 Loads 2

The Loads 2 tab is used to input live, K, wind, settlement, and soil pressure load factors.

5.4.3 Loads 2 to Loads 4

Loads 2 to Loads 4 tabs will contain the load cases results imported from BRIDGframe, or manually entered.

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6.0 DESIGN

Design is relative to the Stage as selected on the File tab.

6.1 Design 1

The Design 1 tab is part of the Stage 1 design process.

This tab is primarily for defining the size of strands that will be used and the layout of strands within the midspan. In the midspan region, all strands remain at a constant location within the cross section of the girder.

This tab will establish the design requirements at SLS for in-service design at the midspan.

As the program is for design of fully pretensioned girders, an option to enter rebar reinforcing is not provided for at this point in the design.

Minimum Prestress Jacking Force:

The User will select a minimum prestress jacking force, along with the other required input. The User may select a value of zero to begin the automated design. Upon clicking the Synchronize button, the program will find the actual minimum jacking force required, assuming the strand size and layout will work as input. The User may continue design with the automated derived value or select a value greater than the absolute minimum but less than or equal to the maximum value input. If the program is not able to establish the minimum allowable value, the strand size, and/or number of strands, and/or strand layout, or concrete strength, etc., will need to be revised.

The distance from the girder bottom to the first draped strand in a group is input. The location of the remainder of the strands in a group is determined by the program based on the number of strands in a group and the spacing of the strands, as input by the User.

6.2 Design 2

The Design 2 tab is part of the Stage 1 design process.

The Design 2 tab is primarily used to establish the strand requirements within the ends of the girder.

Input primarily includes the cross-sectional layout of the strands at the girder ends, the hold down location of the draped strands, the number of debonded strands, and the debonded length of the strands.

This tab will provide the additional information to check the girder design at transfer of the pretensioning at the; girder ends, hold down locations, ends of debonded strands, section transition between ends and midspan (solid to voided section), and the anchorage zone.

6.3 Design 3

The Design 3 tab is part of the Stage 1 design process.

This tab is used to check the capacity of the girder at ULS under in-service conditions. Rebar may be included in the design at this point.

Vibration limits will be checked.

If Concrete Strength at Cutting of Temporary Strands was included in the input on the Properties 1 tab, the box containing the Temporary Prestressing will be visible.

Minimum Prestress Jacking Force:

The User will select a minimum prestress jacking force for the temporary prestressing, along with the other required input. The cross-sectional area of the temporary strands is defaulted to match that of the permanent strands. The User may select a value of zero to begin the automated design. Upon clicking the Synchronize button, the program will find the actual minimum jacking force required, assuming the strand size and layout will work as input. The User may continue design with the automated derived value or select a value greater than the absolute minimum but less than or equal to the maximum value input. If the program is not able to establish the minimum allowable value, the strand size, and/or number of strands, and/or strand layout, or concrete strength, etc., will need to be revised on the Design 1 and Design 2 tab.

6.4 Design 4 and 5

These tabs are part of the Stage 2 design process.

They provide the input design at SLS, ULS, and FLS under in-service conditions at any remaining location between the inside face of support at each end of the span.

Rebar may be included in the design. Design of longitudinal rebar requirements is automated.

Both positive and negative moments regions, and shear; is designed at this phase of the program.

Prestressing stands that project beyond the ends of the girder after fabrication and remain for in-service, may be input.

6.5 Design 6

This tab is used to determine the area of shear friction requirements.
Typically, the area of shear friction rebar input is equal to the stirrup requirements that is established by using the Design 4 and 5 tab.

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7.0 OUTPUT

7.1 General

References to the CHBDC are provided on each output sheet to assist the User in verifying the application.

7.2 Results

Only the Excel worksheets relative to the Design Stage (Input tab) will be shown to assist the User in locating the applicable worksheet. All other non-applicable worksheets at a Design step will be hidden.

Worksheets containing design have an Error Summary located at the top of each worksheet directing the User to the various design checks being done on that worksheet.

7.2.1 Info

The Info worksheet contains the material properties and parameters, basic geometry and property of the girder and girder layout, and the location being designed.

7.2.2 SECT1

This worksheet contains detailed properties and geometric sectional dimensions of the midspan portion of the girder. If the girder section is constant over the girder length, SECT2 will not be applicable.

7.2.3 SECT2

This worksheet contains detailed properties and geometric sectional dimensions of the ends portion of the girder.

7.2.4 Various load case worksheets

The load case worksheets contain the values posted from the program and refinement to establish the forces in an exterior or interior section. The values are for one design location only. The exterior or interior section is made up of one girder plus a contributing composite deck. These forces are then used for design of the section.

The forces from girder self weight and concrete deck are not used from the BRIDGframe results. Instead, BRIDGpretension calculates these forces relative to the actual placement of the bearings which may differ from the span length used in BRIDGframe model.

The output results from BRIDGframe are applied to the actual location they would be on the prestressed girder. Therefore, for example, x/L = 0.3 in BRIDGframe may be 27% the girder length from girder end.

7.2.5 STR MID

The STR MID worksheet is the fully prestressed girder design calculations for the maximum positive moment forces for in-service conditions within the midspan.

7.2.6 STR ENDS

This worksheet contains the design calculations for the girder at transfer of prestressing at the girder ends.

7.2.7 STR GR1 to STR GR3

These worksheets contain the design calculations at the hold-down locations of the draped strands. The results are for the instant the prestressing forces are transferred to the concrete girder. The results include the effect of temporary prestressing in the top of the girder if present.

7.2.8 STR GR1 (2) to STR GR3 (2)

These worksheets contain the design calculations at the hold-down locations of the draped strands. The results are for the instant the temporary prestressing is cut, therefore eliminating the effects of the temporary prestressing. The concrete strength is greater at the time of cutting the temporary strands then at transfer.

7.2.9 ULS P

The ULS P worksheet provides the design calculations at ULS for the maximum positive moment force for in-service conditions within the midspan.

For simplicity, this worksheet uses section properties of rectangular shapes only. Therefore, tapered fillets or haunches between the flanges and webs are not considered in ULS design. See Appendix 6.

7.2.10 HOLD DOWN

This worksheet confirms the uplift forces at the hold-down locations do not exceed the capacity of the hold-down equipment.

7.2.11 STR BONDED and STR BONDED2

These worksheets provide the design calculations for the girder at transfer, at the location where the debonded strands of layer 1 (STR BONDED) and layer 2 (STR BONDED2) become fully bonded. These sheets are not applicable where no debonded strands have been designated. The results include the effect of temporary prestressing in the top of the girder if present.

7.2.12 STR BONDED (2) and STR BONDED2 (2)

These worksheets provide the design calculations for the girder at transfer, at the location where the debonded strands of layer 1 (STR BONDED) and layer 2 (STR BONDED2) become fully bonded. These sheets are not applicable where no debonded strands have been designated. The results are for the instant the temporary prestressing is cut, therefore eliminating the effects of the temporary prestressing. The concrete strength is greater at the time of cutting the temporary strands then at transfer.

7.2.13 STR SECT 1-2

The STR SECT 1-2 worksheet provides the design calculations for the girder at transfer, at the location where the girder transitions from midspan section properties to girder ends properties. This sheet is not applicable when the section properties are constant over the entire length of girder. The results include the effect of temporary prestressing in the top of the girder if present.

7.2.14 STR SECT 1-2 (2)

The STR SECT 1-2 (2) worksheet provides the design calculations for the girder at transfer, at the location where the girder transitions from midspan section properties to girder ends properties. This sheet is not applicable when the section properties are constant over the entire length of girder. The results are for the instant the temporary prestressing is cut, therefore eliminating the effects of the temporary prestressing. The concrete strength is greater at the time of cutting the temporary strands then at transfer.

7.2.15 VIBR

This worksheet checks the live load deflection against the allowable static deflection.

7.2.16 STRX P

The STRX P worksheet is the fully prestressed girder design calculations for the maximum positive moment force for in-service conditions at the designated design location.

7.2.17 ULSX P

The ULSX P worksheet provides the design calculations at ULS for the maximum positive moment force for in-service conditions at the designated design location.

For simplicity, this worksheet uses section properties of rectangular shapes only. Therefore, tapered fillets or haunches between the flanges and webs are not considered in ULS design. See Appendix 6.

7.2.18 STRX ULSX N

This worksheet is the fully prestressed girder design calculations for the maximum negative moment force for in-service conditions at the designated design location. SLS, ULS, and FLS conditions will be checked within the single worksheet.

For simplicity, at ULS design only, this worksheet uses section properties of rectangular shapes only; therefore, tapered fillets or haunches between the flanges and webs are not considered. See Appendix 6.

7.2.19 SHEAR1 X

The SHEAR1 X worksheet provides the design calculations at ULS for shear requirements. Shear is designed for both positive and negative moment regions. Stirrup requirements and proportioning of longitudinal reinforcing is provided.

The check for proportioning longitudinal reinforcing is not always applicable. Refer to the bridge code for locations of applicability.

If ε_x of cl.8.9.3.8(f) is negative using 2(Es As + Ep Aps), ε_x will be set to zero.

7.2.20 SHEAR2

The SHEAR2 worksheet contains the design of the interface between the top of the girder and the contact area of the deck.

7.2.21 ANCH ZONE

This worksheet provides the requirements for additional stirrups at the ends of the girder. Additional stirrups are required to resist the effects of the prestressing forces transferred into the girder ends.

7.2.22 DISPL

The DISPL worksheet provides the F.E.M. and compressive force required by BRIDGframe to complete the prestressed creep effects

This worksheet also provides a tool for calculating screed elevations, deck haunch height, rotations for girder undercutting details, and rotations for bearing design.

Values are entered into this sheet directly, and not through the VB interfacing.

7.2.23 DWG DATA

The worksheet contains typical data that may be required on the engineering drawings. The information is applicable after stage 1 design.

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8.0 Printing

Printing of Excel sheets is done by selection of each tab as found on the program 'Print' tab. Printing may also be done manually by selecting the data of interest and designating it for printing using the Print Area command.

To print the program input sheets (tab dialogue pages), the User may: i) press 'Ctrl,' 'Alt' and 'Prt Sc' simultaneously when on the sheet of preference to print; then in Microsoft Word place the cursor where the top left corner of the saved print screen will be dropped and press 'Ctrl' and 'V' simultaneously.

See Appendix 5.

9.0 Troubleshooting

If the User does not Load a compatible Excel file, an Error or Error message will appear. Probable Resolution: Load a compatible Excel BRIDGpretension spreadsheet that was received with the program.

The program fails during registration confirmation. Probable Resolution: The firewall may be blocking communication with our website. Configure the firewall to allow communication with www.bridge-structural.com. Confirm there is an internet connection. Further configuration of the firewall may be required to allow BRIDGpretension.exe and BRIDGpretensionUpdater.exe to access the internet.

If the appearance of the program is not as per the screen prints shown in the Appendix 3 Input Examples, the issue may be with the monitor settings. Right click on the Desktop, select Properties/ Settings/ Advanced/ General Tab/ the DPI setting should be that of Normal Setting.

The program fails and gives an error message when trying to analyze. Probable Resolution: Macros have not been allowed to run. Excel 2007 and later require special attention to have Trust settings configured to allow macros within BRIDGframe to run.

Computer Regional Settings must be set for English. See also www.support.microsoft.com/kb/320369

Error Number 5 Access to the path 'C:\ProgramFiles(x86)\Simplified Bridge Solutions\BRIDGframe\SBS.ini' is denied. Probable Resolution: writing permission is required to C:\ProgramFiles\Simplified Bridge Solutions\BRIDGframe, or location program is saved in.

10.0 Limitations

Shear failure in a girder may occur starting from the inside face of the bearing and extending to the girder end face. This mode of failure is not checked by the program.

Torsion does not form part of this program.

APPENDIX 1 - PROGRAM FEATURES

BRIDGpretension
composite steel girder design software

- conformance with the Canadian Highway Bridge Design Code CAN/CSA-S6-19
- simple and minimal tabular input
- importing of input data and load case results from BRIDGframe
- User is free to edit input data including forces from load cases
- design of positive and negative moment regions, shear / shear interface, and vibration
- SLS, ULS and FLS design
- In-service conditions and under construction design check
- drop-down menus of standard precast sections
- print tab makes printing worksheets simple
- print results are as per they appear on the worksheets
- output is very clearly defined
- output is in Microsoft Excel, making it very accessible for viewing and generating graphical output
- pop up notices regarding errors during progress of design
- error summary provided for each worksheet

APPENDIX 2 - SOFTWARE LICENSING AGREEMENT AND INSTALLATION

BRIDGpretension
Software Licensing Agreement

By installing the BRIDGpretension Software (which consists of software, documentation, and other items; hereafter: "Software") created by Simplified Bridge Solutions Ltd., you agree to be bound by the terms and conditions of this License Agreement. As used in this License Agreement, "You" shall mean the individual using or installing the Software together with any individual or entity, including but not limited to your employer, on whose behalf you are acting in using or installing the Software. You shall be the "licensee" under this License Agreement.

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4. Support, Upgrades and Service Releases

Simplified Bridge Solutions Ltd. shall offer free technical support that does not fall under the scope of providing engineering services, and product upgrades for the licensed term after purchasing the product. The product license expires at the term end; therefore, you must pay the annual maintenance fee in order to receive a renewal license and ongoing support and product upgrades.

5. Termination

This Agreement is effective until terminated. This Agreement will terminate automatically without notice from Simplified Bridge Solutions Ltd. if you fail to comply with any provision contained herein or if the funds paid for the license are refunded or are not received. Upon termination, you must destroy the Software, and all copies of the Software, in part and in whole, including modified copies if any.

6. Non-Waiver

The failure by either party at any time to enforce any of the provisions of this License Agreement or any right or remedy available hereunder or at law or in equity, or to exercise any option herein provided, shall not constitute a waiver of such provision, right, remedy, or option or in any way affect the validity of this License Agreement. The waiver of any default by either party shall not be deemed a continuing waiver, but shall apply solely to the instance to which such waiver is directed.

BRIDGpretension Installation:

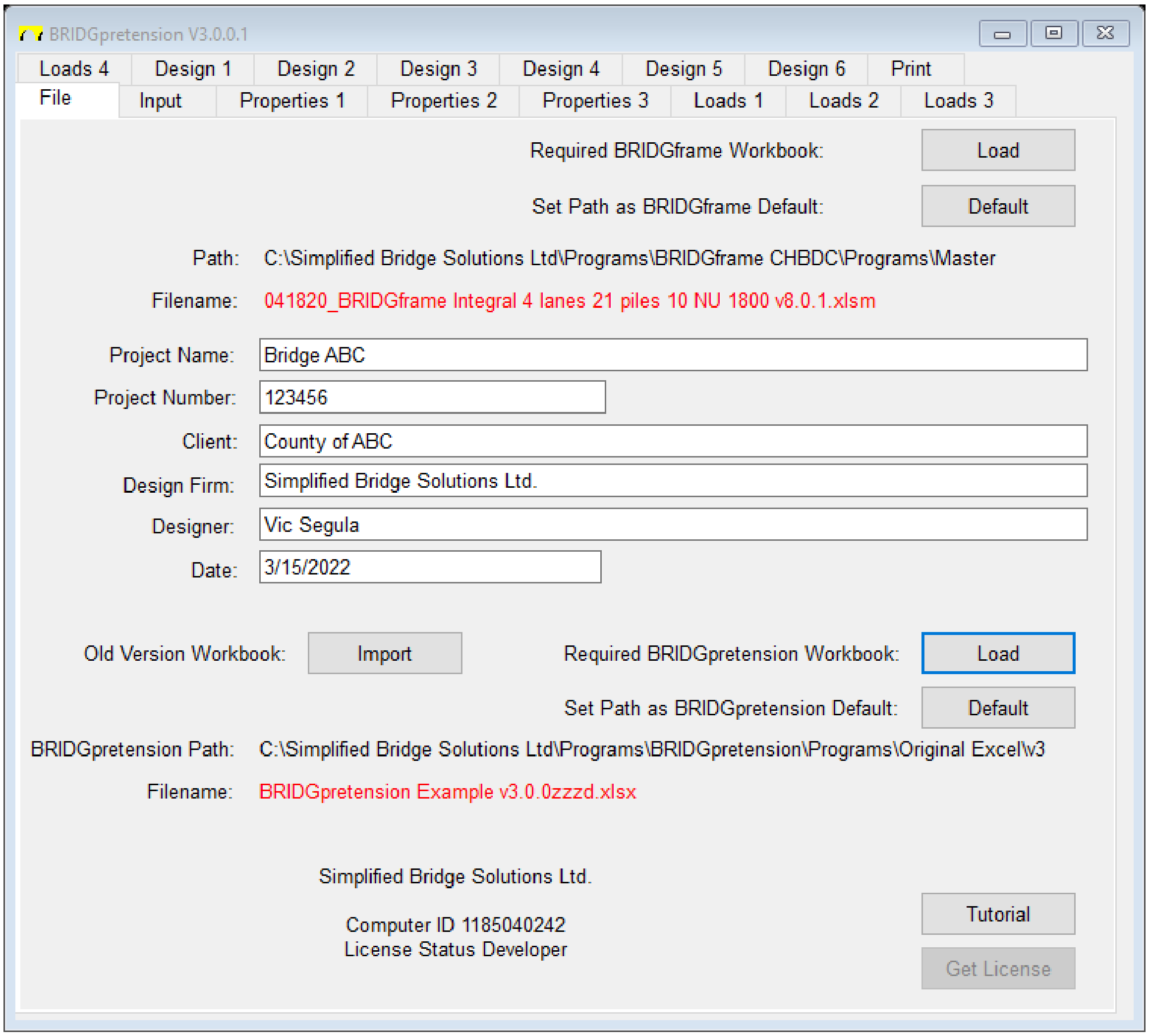
Design parameters and calculation results for pretensioned girder designs are stored in Excel workbooks, one workbook per design. BRIDGpretension is a dialog that provides the User Interface to these Excel workbooks. An example workbook is required as the starting point for your first new design. Later designs may utilize this workbook or other saved workbooks generated from the original Excel file. All files are available for download directly from our website.

Some input boxes are fixed with defaulted values until the application is registered.

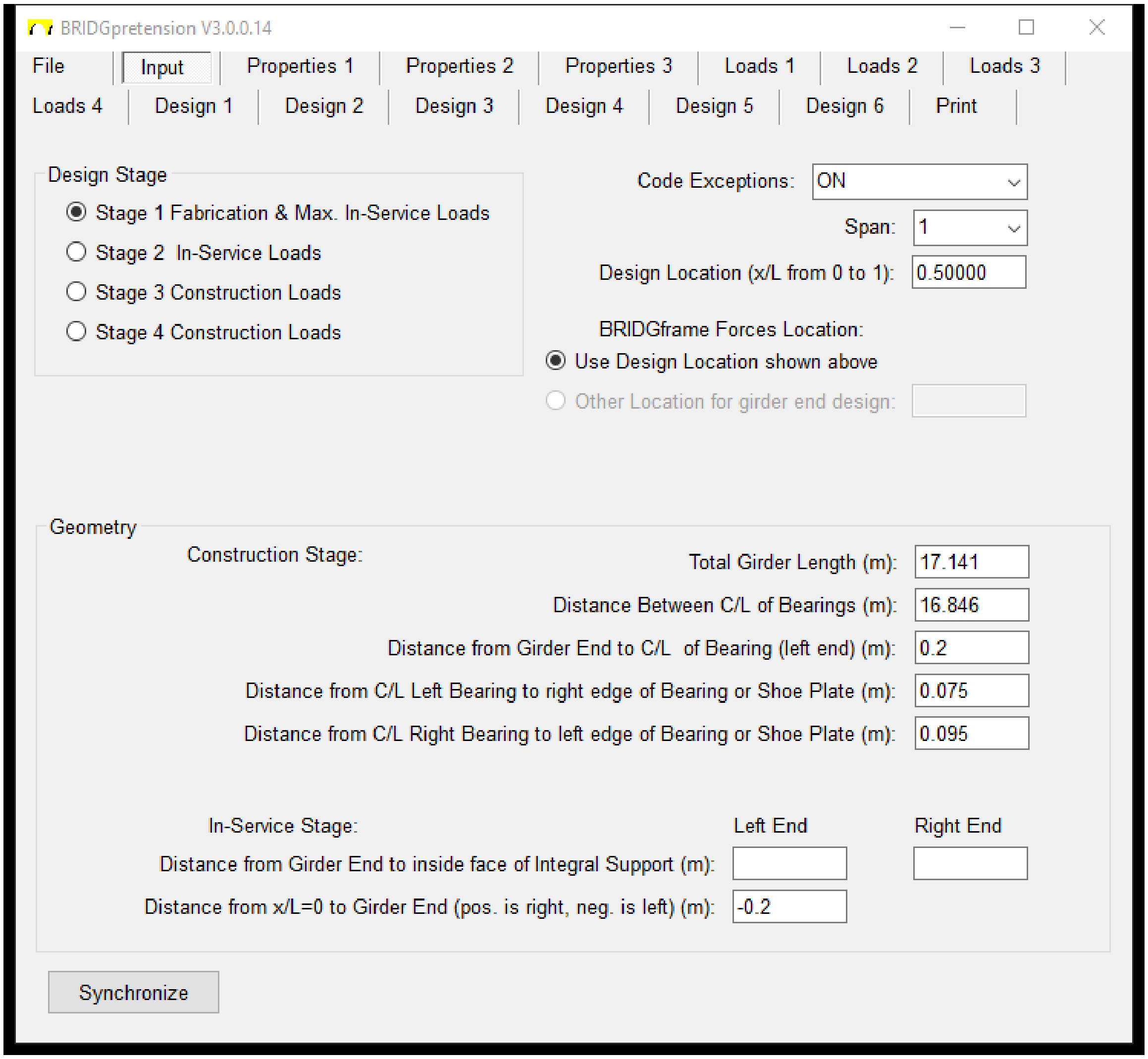
BRIDGpretension will run in Demo mode until it is registered.

APPENDIX 3 – PROGRAM TABS

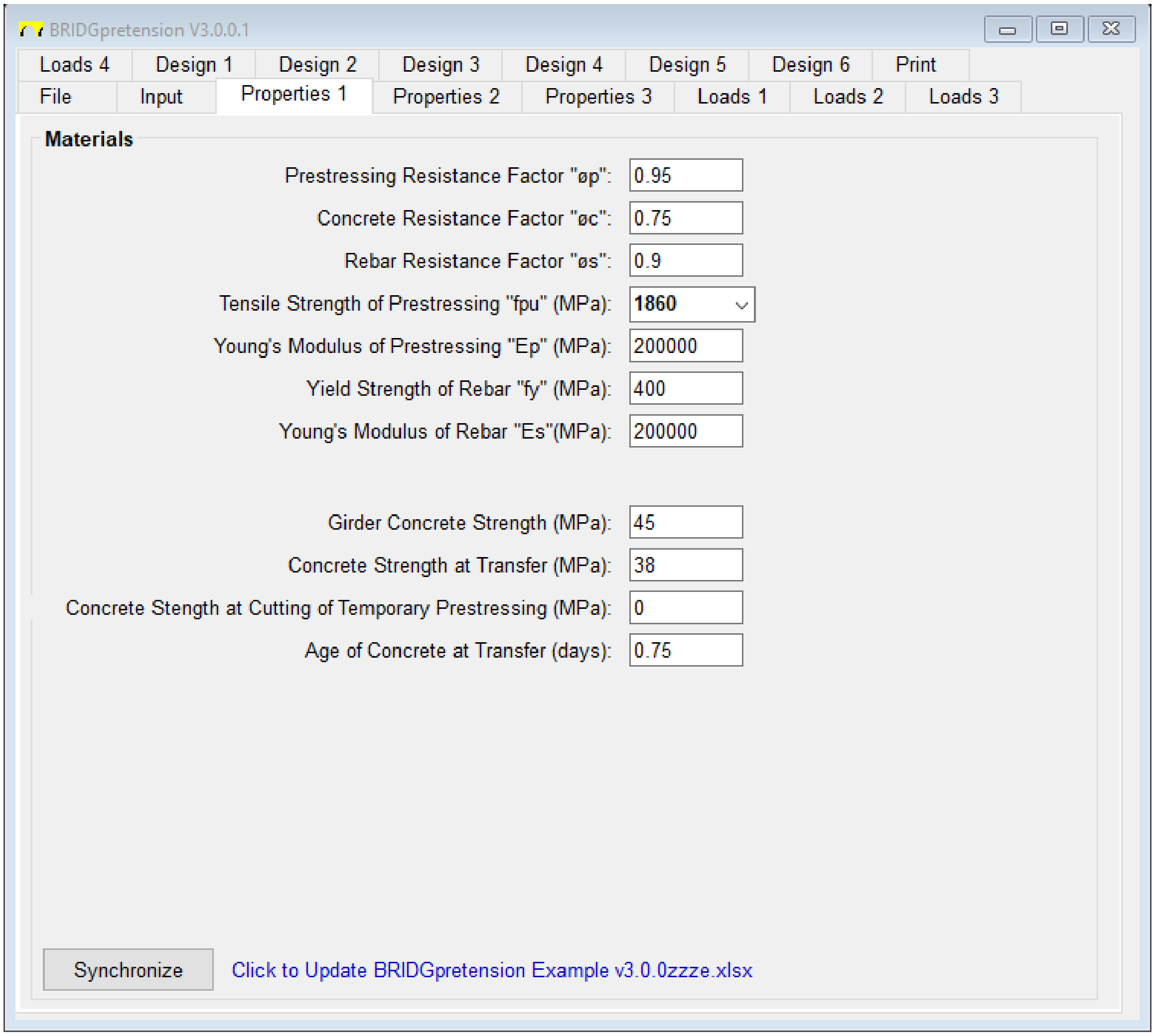
The following tab screen prints are for Stage 1 input only.



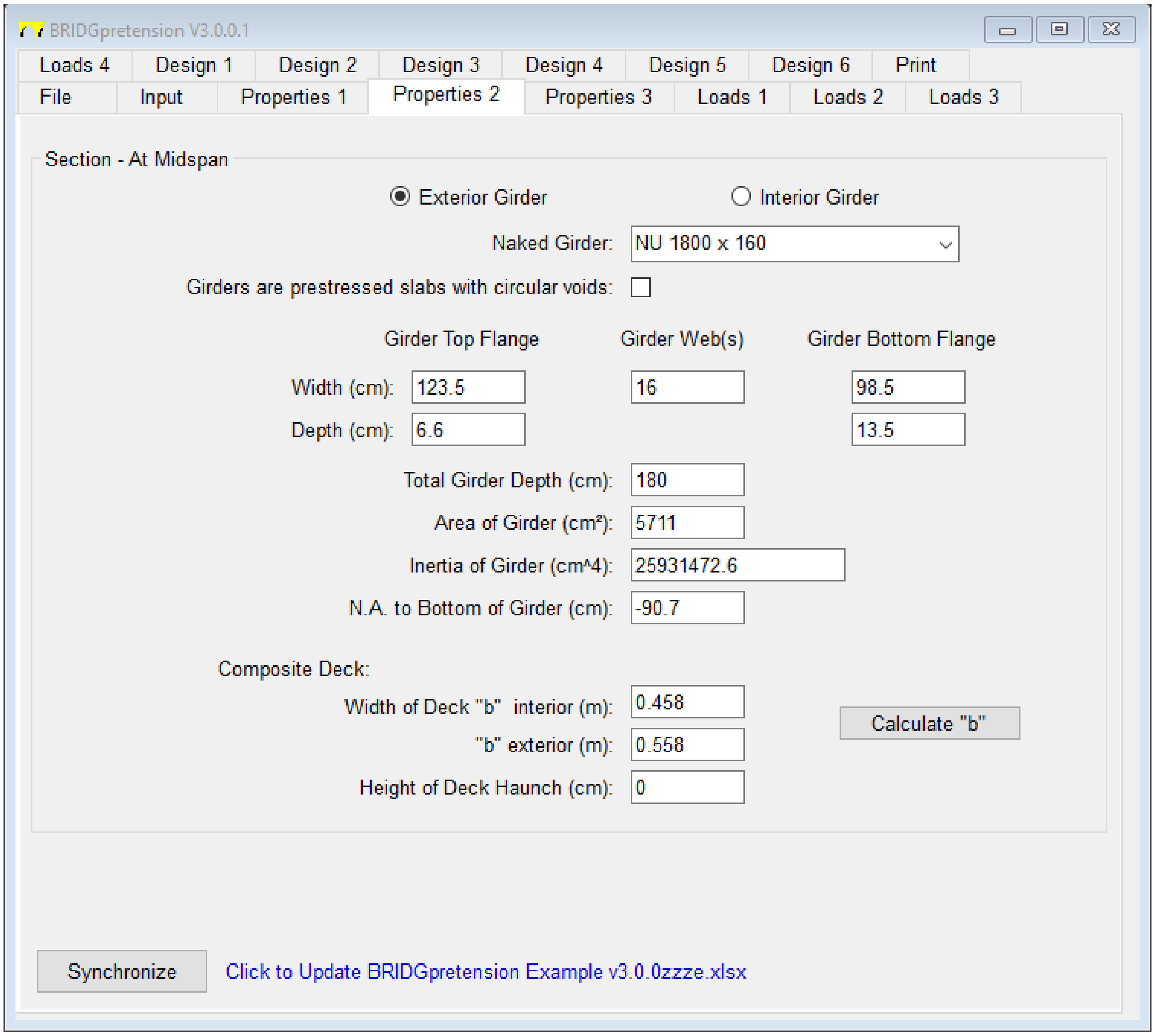
- Load Buttons: load the BRIDGframe and BRIDGpretension Excel file to be used in design
- Default: resets to the path of the loaded excel file, where the program will automatically open to upon reopening
- Import: imports data from one Excel file into the loaded Excel file.
- Input project particulars
- Tutorial: this button provides a link to the web site
- Get License: this button provides a link to the web site



- always begin at Stage 1 Design; Design Stages to be completed in order
- only Design Stage 1 to be used to input all properties and parameters, and design of prestressing requirements
- designer may pass design at Stage 3 and 4 if deemed not governing
- Design Stage 3 and 4 is similar to Design Stage 1 and 2, but at Construction Loading
- Ontario and British Columbia Code Exceptions are included

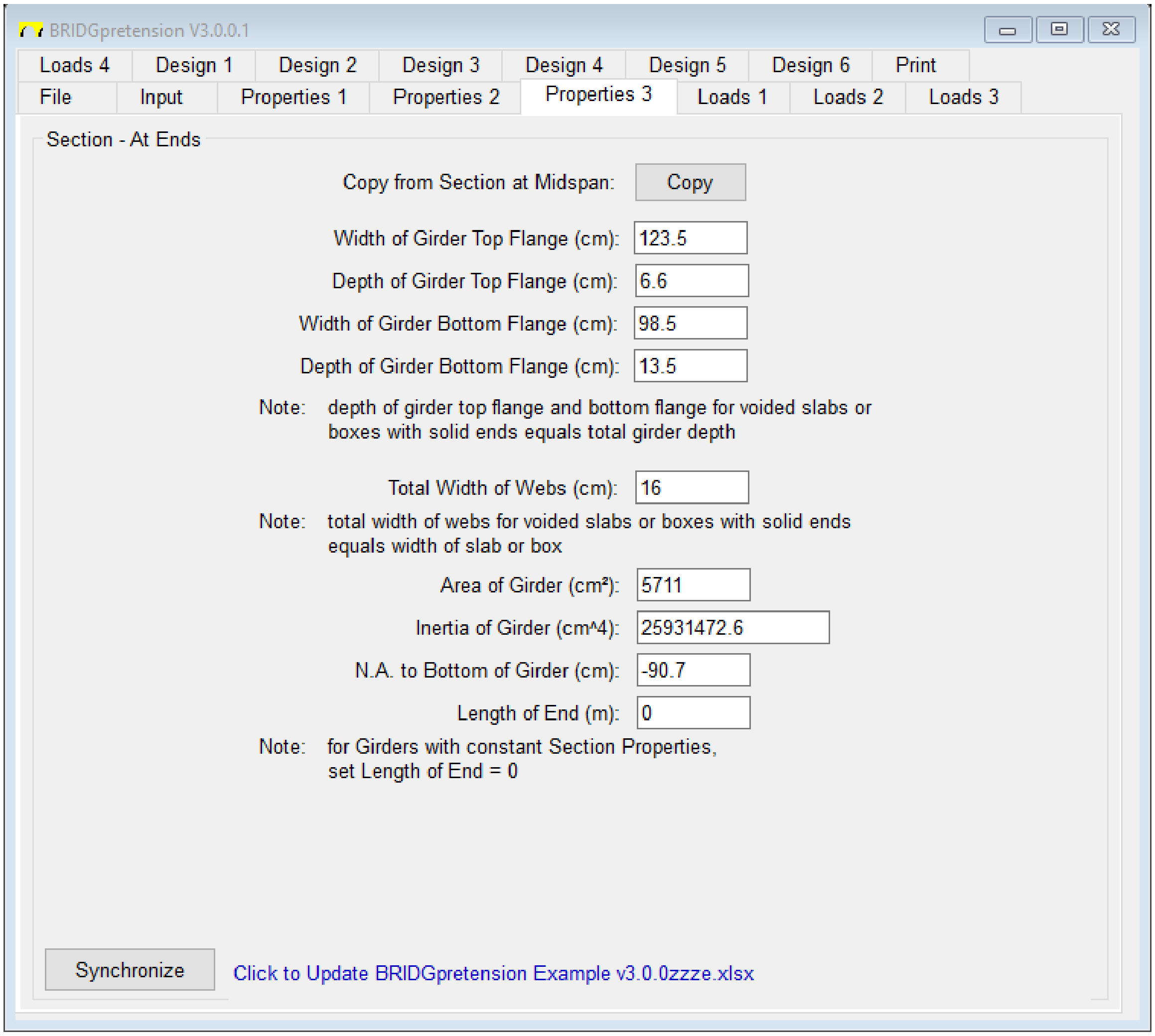


- 'Concrete Strength at Transfer' is the concrete strength at first release of all strands
- 'Concrete Strength at Cutting of Temporary Prestressing' is the concrete strength typically taken at time of cutting temporary strands. Cutting may occur just prior to pouring of deck slab for example.



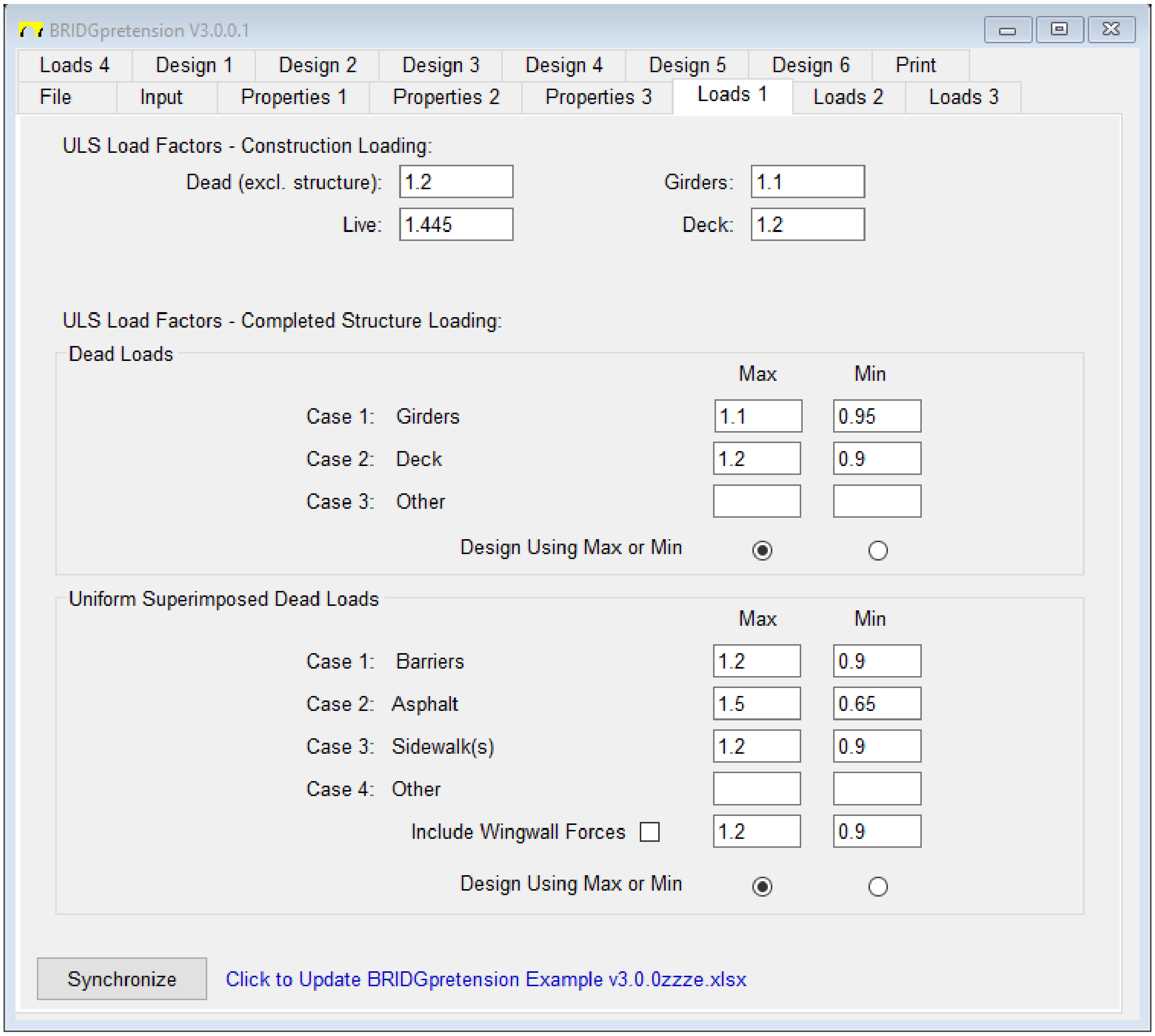
- 'b' interior is assumed to be the same value each side of interior girder
- 'b' exterior is hidden when not designing the exterior girder
- the deck haunch is assumed to equal the girder top flange width and is the cast in place concrete between the top of girder and underside of deck slab; it is typically assumed to equal zero since actual haunch height is unknown
- Stress limitations apply to prestressed slabs with circular voids, as such check box is provided designate such girder types for design

Note: 'b' is the deck width on one side beyond the edge of flange.

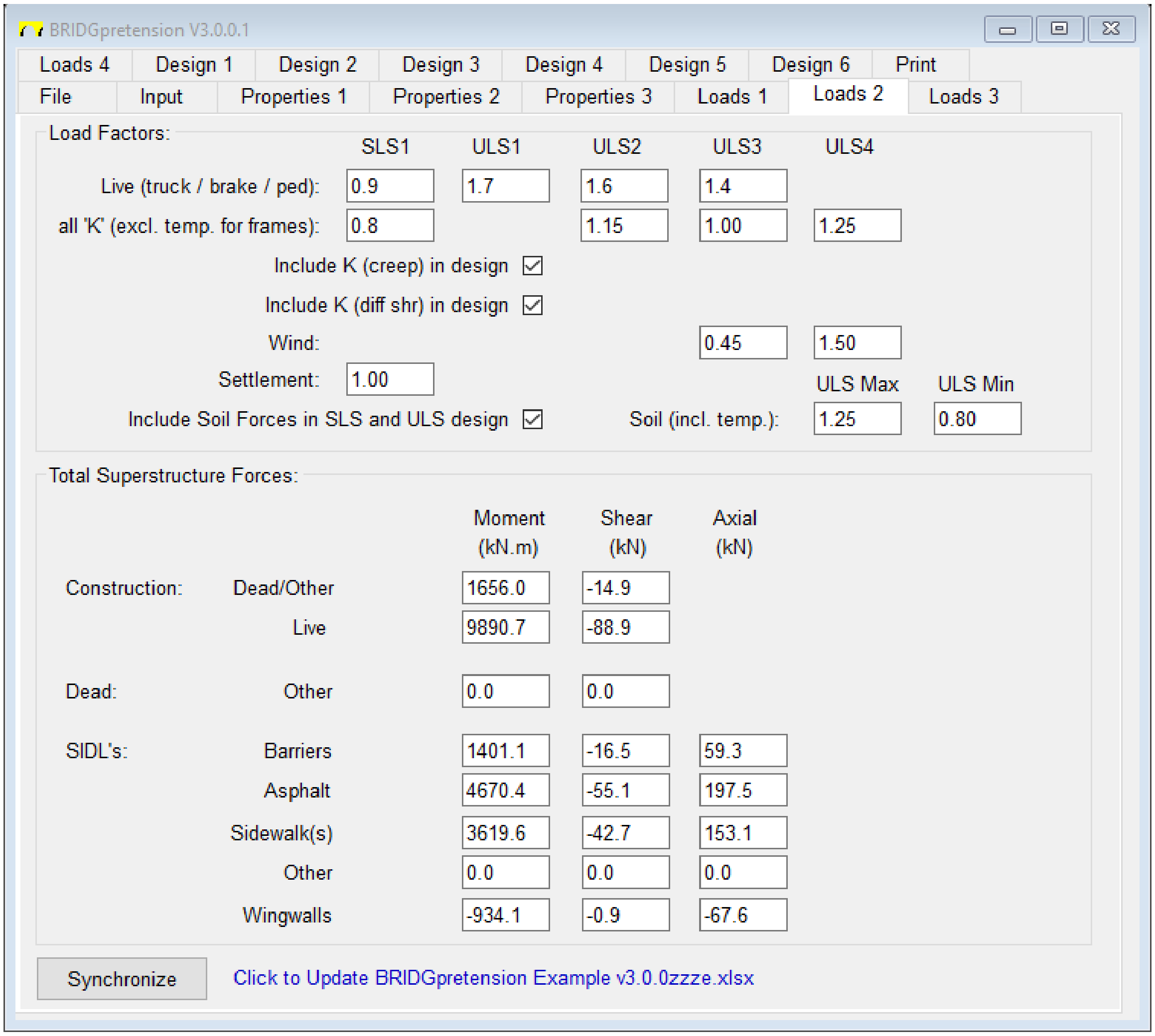


- ends require defining even when girder section properties are not changing over their entire length

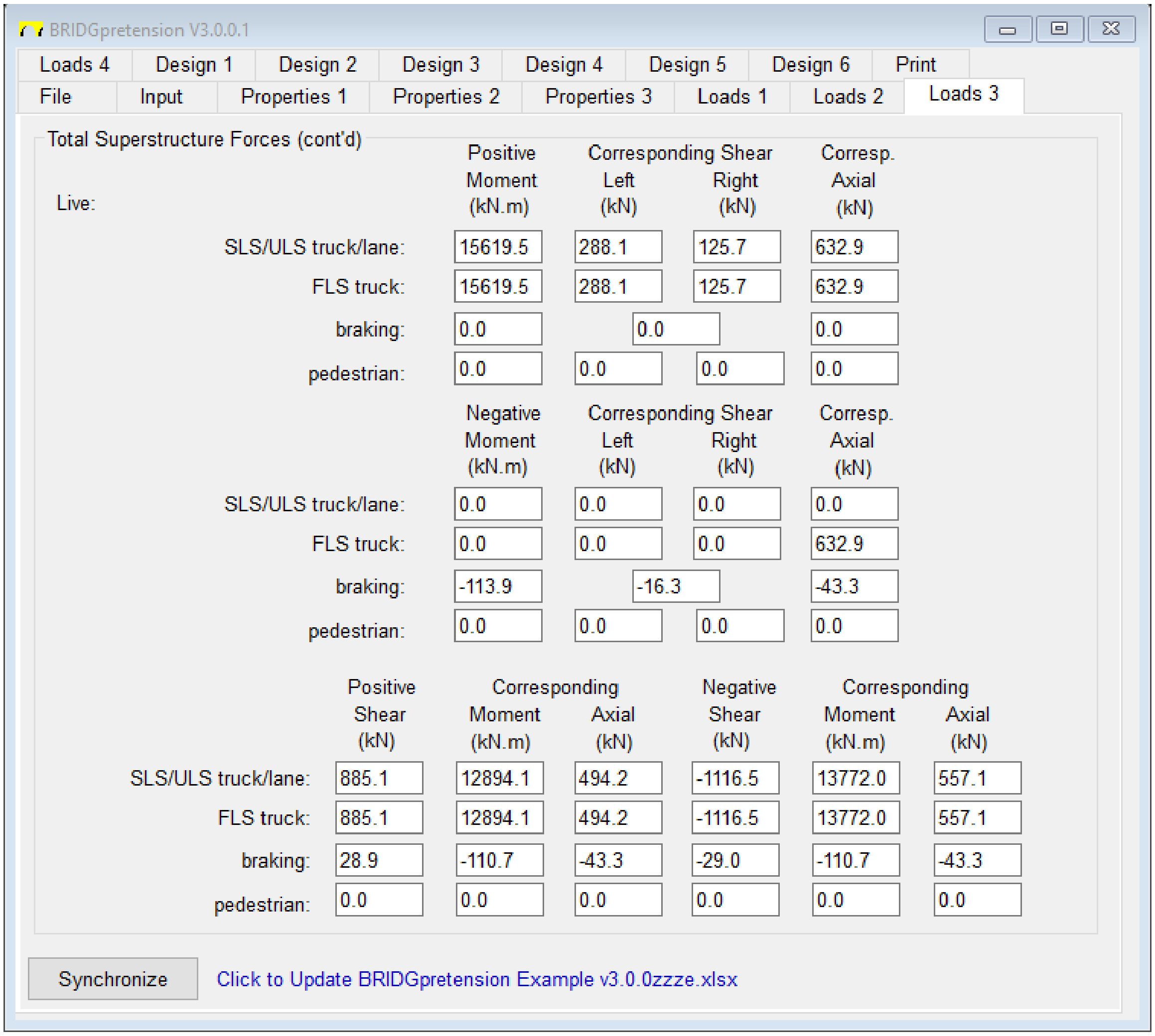
Note: For a box girder or core slab that has voids that do not continue through to the ends, therefore have a solid end length, input the Length of End in the last box provided

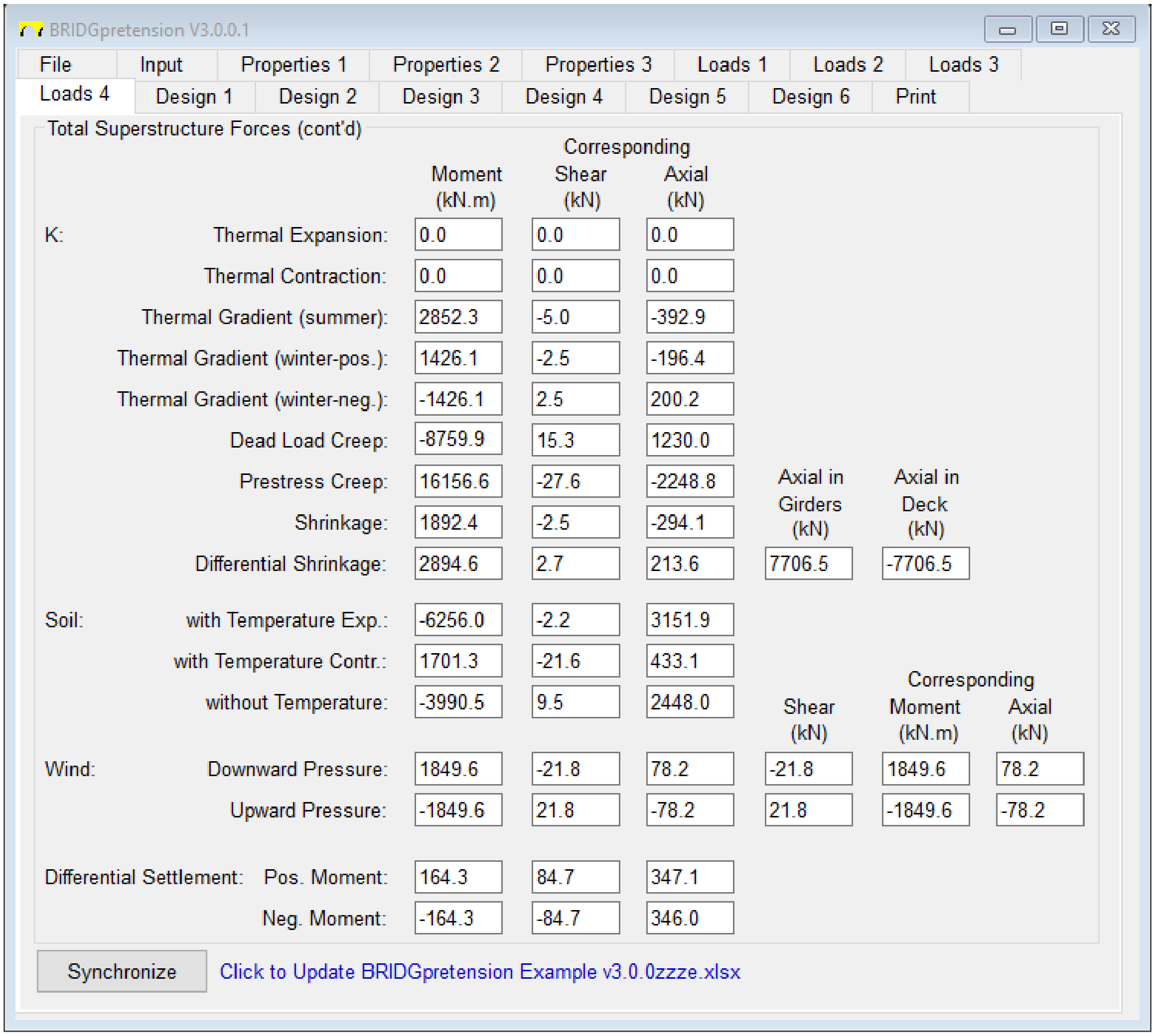


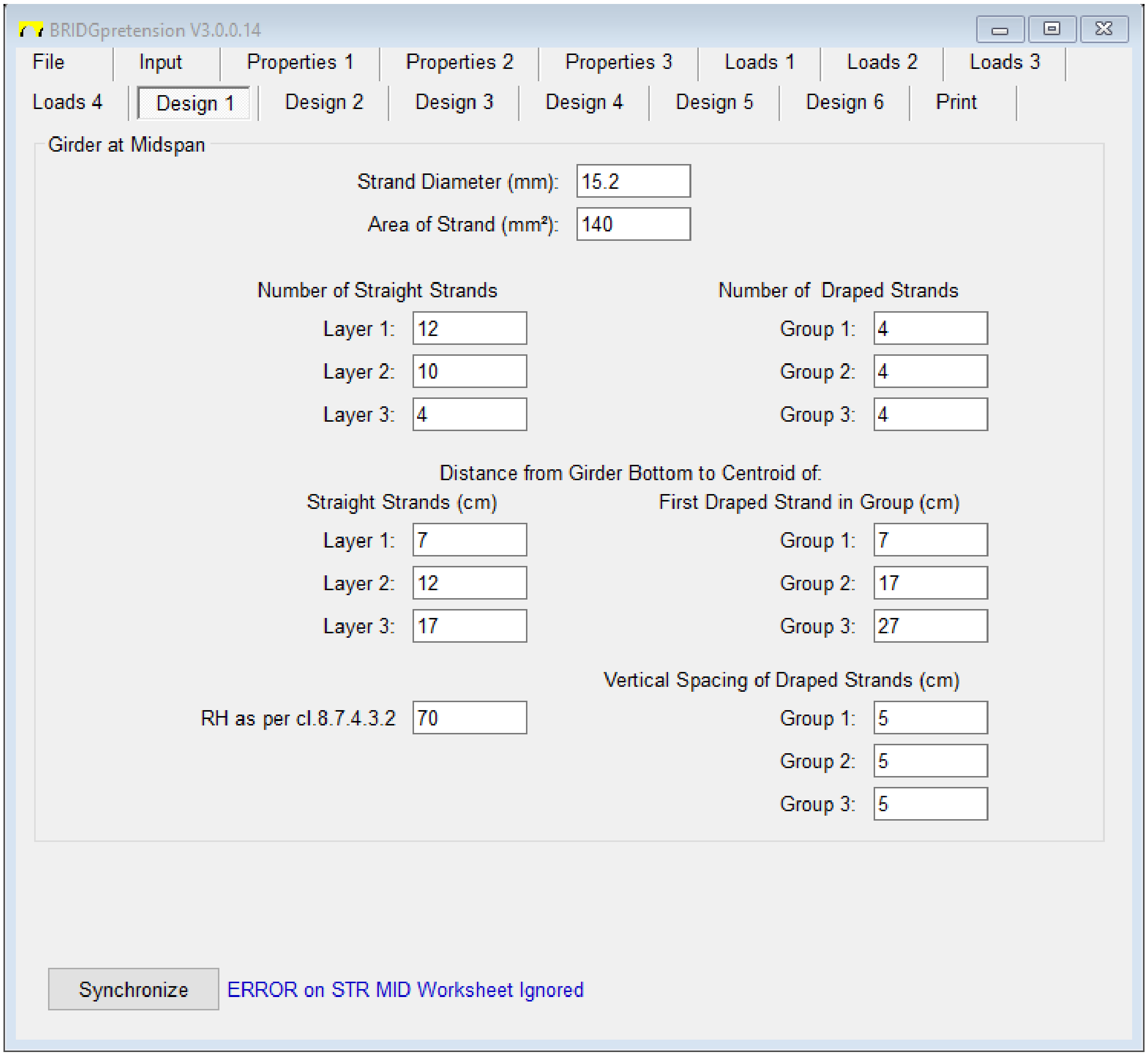
- two sets of load factors may be input but only one set is required
- load case names are imported from BRIDGframe

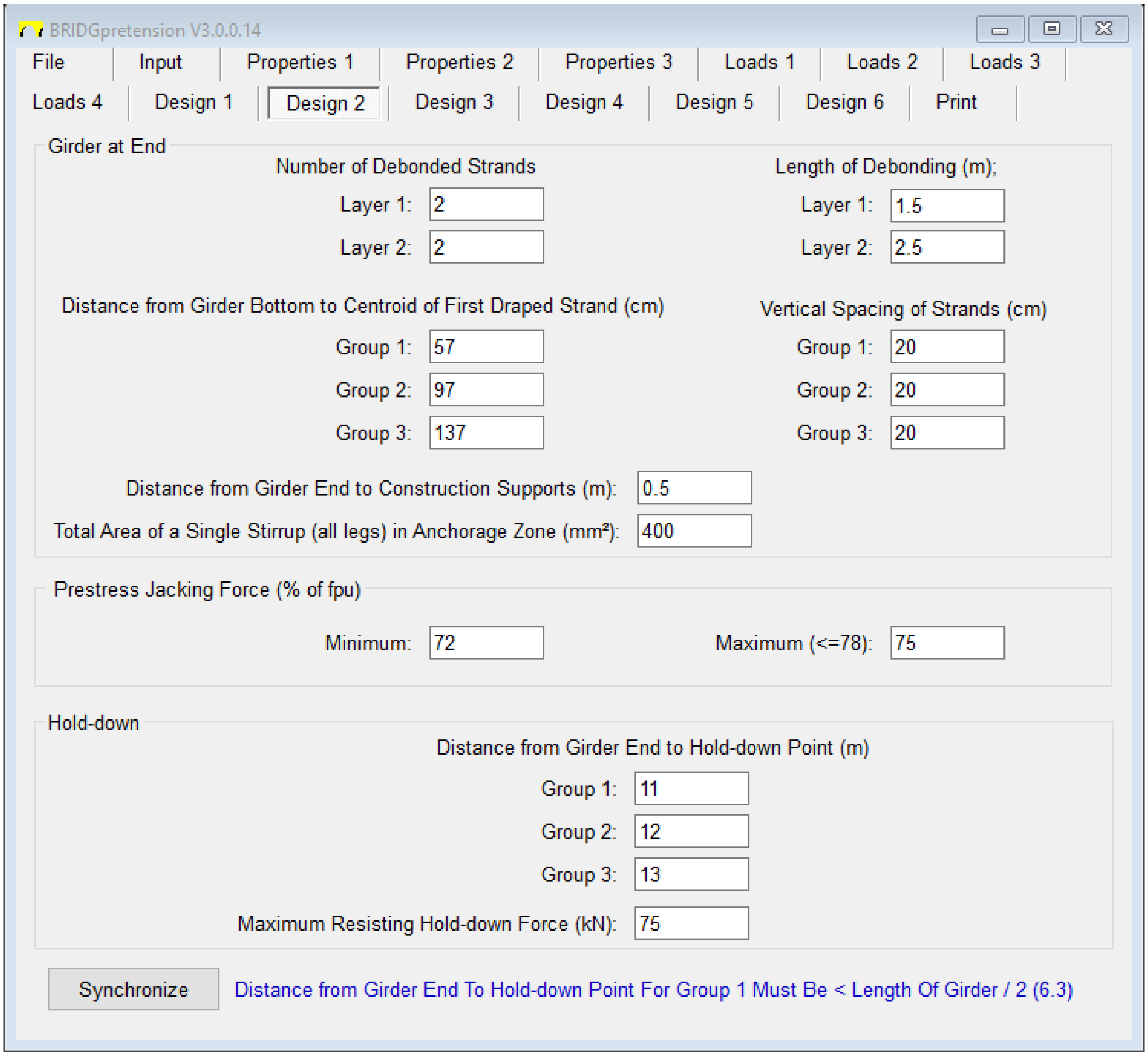


- if load case results are imported from BRIDGframe, they are populated into the Total Superstructure Forces group box

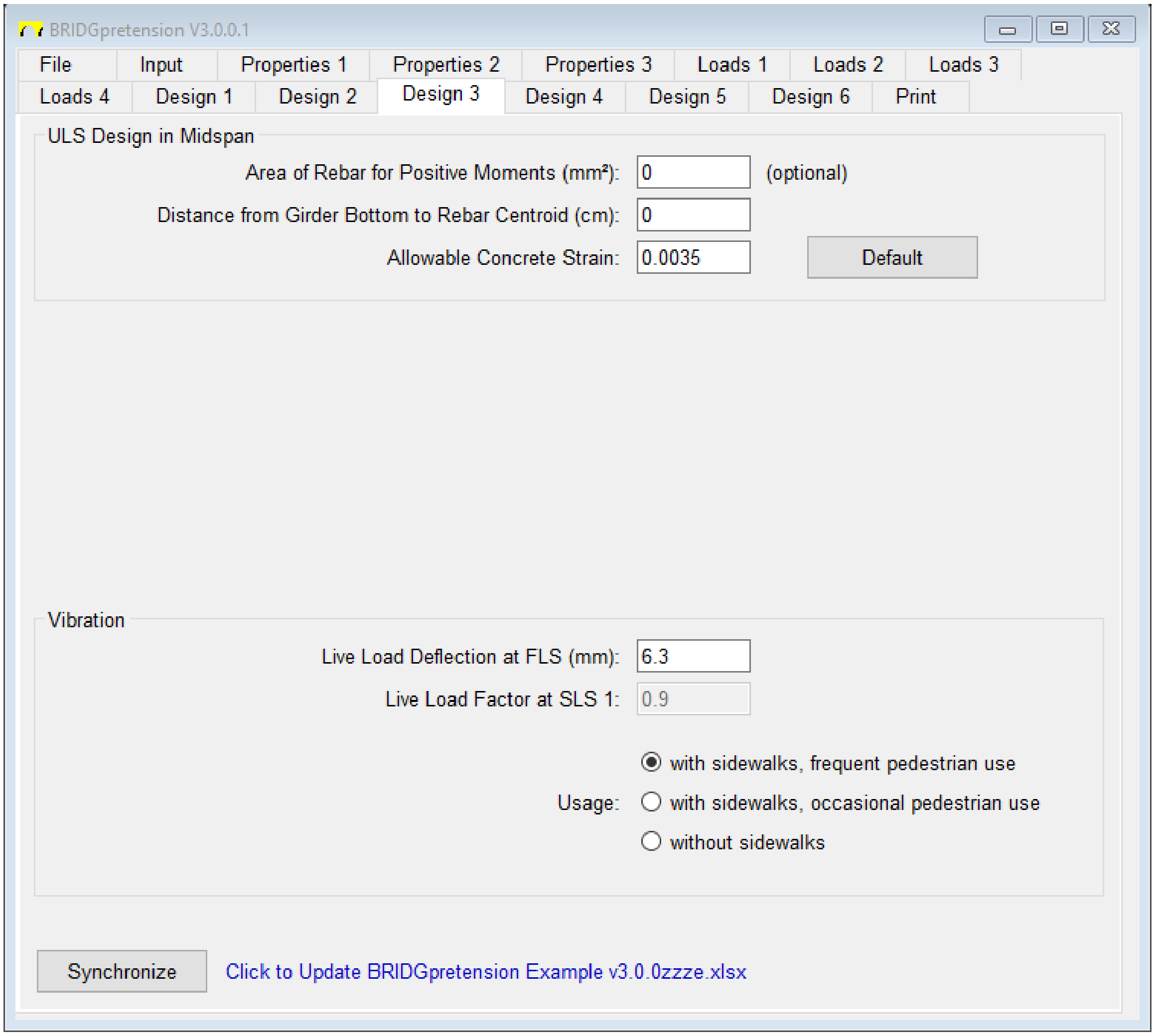

BRIDGpretension V3.0.0.1
Loads 4 Design 1 Design 2 Design 3 Design 4 Design 5 Design 6 Print
File Input Properties 1 Properties 2 Properties 3 Loads 1 Loads 2 Loads 3
Total Superstructure Forces (cont'd)
Live:
Positive Moment (kN.m)
Corresponding Shear Left (kN) Right (kN)
Corresp. Axial (kN)
SLS/ULS truck/lane: 15619.5 288.1 125.7 632.9
FLS truck: 15619.5 288.1 125.7 632.9
braking: 0.0 0.0 0.0
pedestrian: 0.0 0.0 0.0 0.0
Negative Moment (kN.m)
Corresponding Shear Left (kN) Right (kN)
Corresp. Axial (kN)
SLS/ULS truck/lane: 0.0 0.0 0.0 0.0
FLS truck: 0.0 0.0 0.0 632.9
braking: -113.9 -16.3 -43.3
pedestrian: 0.0 0.0 0.0 0.0
Positive Shear (kN)
Corresponding Moment (kN.m) Axial (kN)
Negative Shear (kN)
Corresponding Moment (kN.m) Axial (kN)
SLS/ULS truck/lane: 885.1 12894.1 494.2 -1116.5 13772.0 557.1
FLS truck: 885.1 12894.1 494.2 -1116.5 13772.0 557.1
braking: 28.9 -110.7 -43.3 -29.0 -110.7 -43.3
pedestrian: 0.0 0.0 0.0 0.0 0.0 0.0
Synchronize
Click to Update BRIDGpretension Example v3.0.0zzze.xlsx

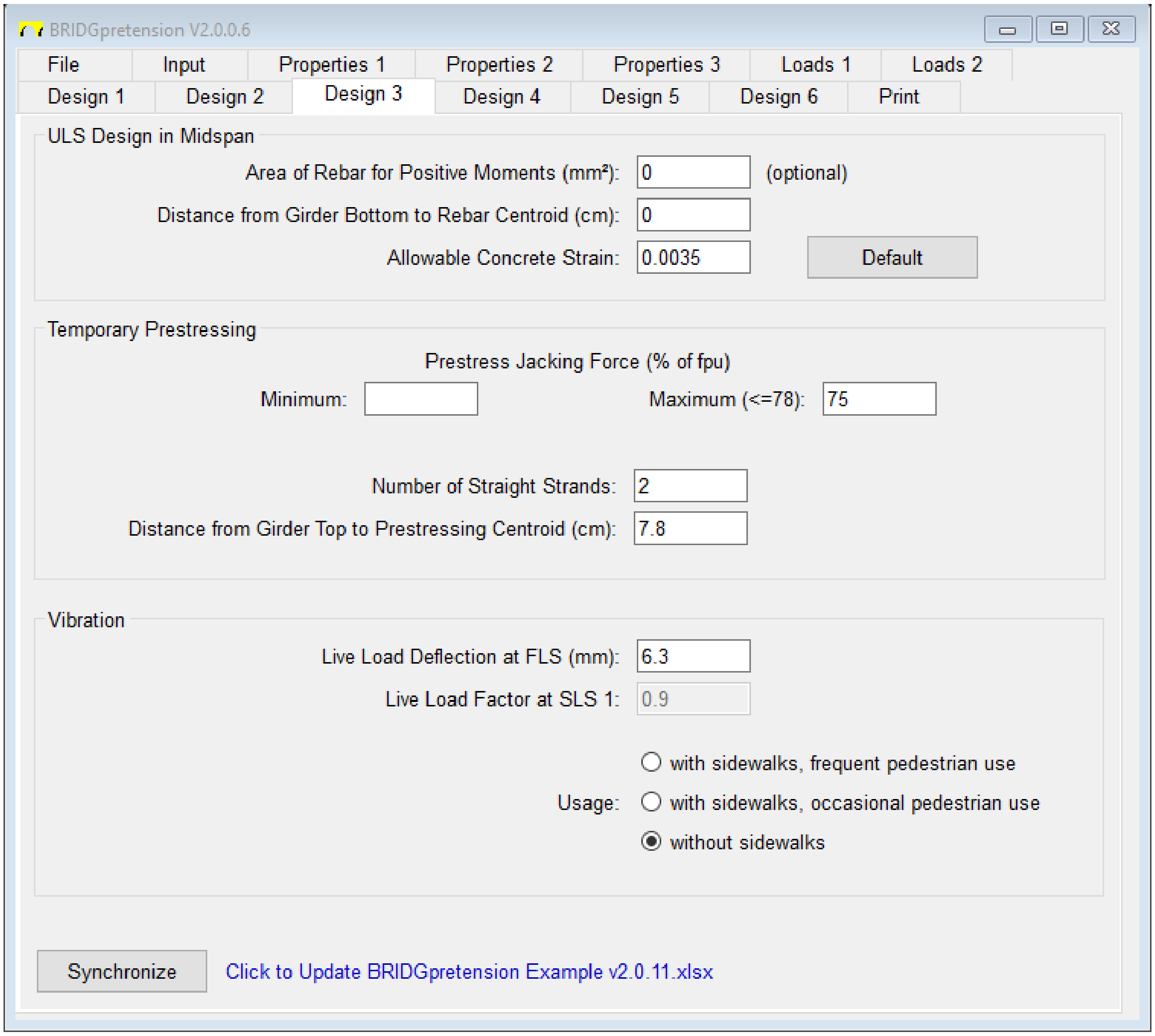

BRIDGpretension V3.0.0.1
File | Input | Properties 1 | Properties 2 | Properties 3 | Loads 1 | Loads 2 | Loads 3
Loads 4 | Design 1 | Design 2 | Design 3 | Design 4 | Design 5 | Design 6 | Print
Total Superstructure Forces (cont'd)
Corresponding
Moment (kN.m) | Shear (kN) | Axial (kN)
K: Thermal Expansion: 0.0 | 0.0 | 0.0
Thermal Contraction: 0.0 | 0.0 | 0.0
Thermal Gradient (summer): 2852.3 | -5.0 | -392.9
Thermal Gradient (winter-pos.): 1426.1 | -2.5 | -196.4
Thermal Gradient (winter-neg.): -1426.1 | 2.5 | 200.2
Dead Load Creep: -8759.9 | 15.3 | 1230.0
Prestress Creep: 16156.6 | -27.6 | -2248.8
Axial in Girders (kN) | Axial in Deck (kN)
Shrinkage: 1892.4 | -2.5 | -294.1
Differential Shrinkage: 2894.6 | 2.7 | 213.6 | 7706.5 | -7706.5
Soil: with Temperature Exp.: -6256.0 | -2.2 | 3151.9
with Temperature Contr.: 1701.3 | -21.6 | 433.1
without Temperature: -3990.5 | 9.5 | 2448.0
Corresponding
Shear (kN) | Moment (kN.m) | Axial (kN)
Wind: Downward Pressure: 1849.6 | -21.8 | 78.2 | -21.8 | 1849.6 | 78.2
Upward Pressure: -1849.6 | 21.8 | -78.2 | 21.8 | -1849.6 | -78.2
Differential Settlement: Pos. Moment: 164.3 | 84.7 | 347.1
Neg. Moment: -164.3 | -84.7 | 346.0
Synchronize
Click to Update BRIDGpretension Example v3.0.0zzze.xlsx


BRIDGpretension V3.0.0.14
File
Input
Properties 1
Properties 2
Properties 3
Loads 1
Loads 2
Loads 3
Loads 4
Design 1
Design 2
Design 3
Design 4
Design 5
Design 6
Print
Girder at Midspan
Strand Diameter (mm): 15.2
Area of Strand (mm²): 140
Number of Straight Strands
Layer 1: 12
Layer 2: 10
Layer 3: 4
Number of Draped Strands
Group 1: 4
Group 2: 4
Group 3: 4
Distance from Girder Bottom to Centroid of:
Straight Strands (cm)
Layer 1: 7
Layer 2: 12
Layer 3: 17
First Draped Strand in Group (cm)
Group 1: 7
Group 2: 17
Group 3: 27
Vertical Spacing of Draped Strands (cm)
RH as per cl.8.7.4.3.2 70
Group 1: 5
Group 2: 5
Group 3: 5
Synchronize
ERROR on STR MID Worksheet Ignored

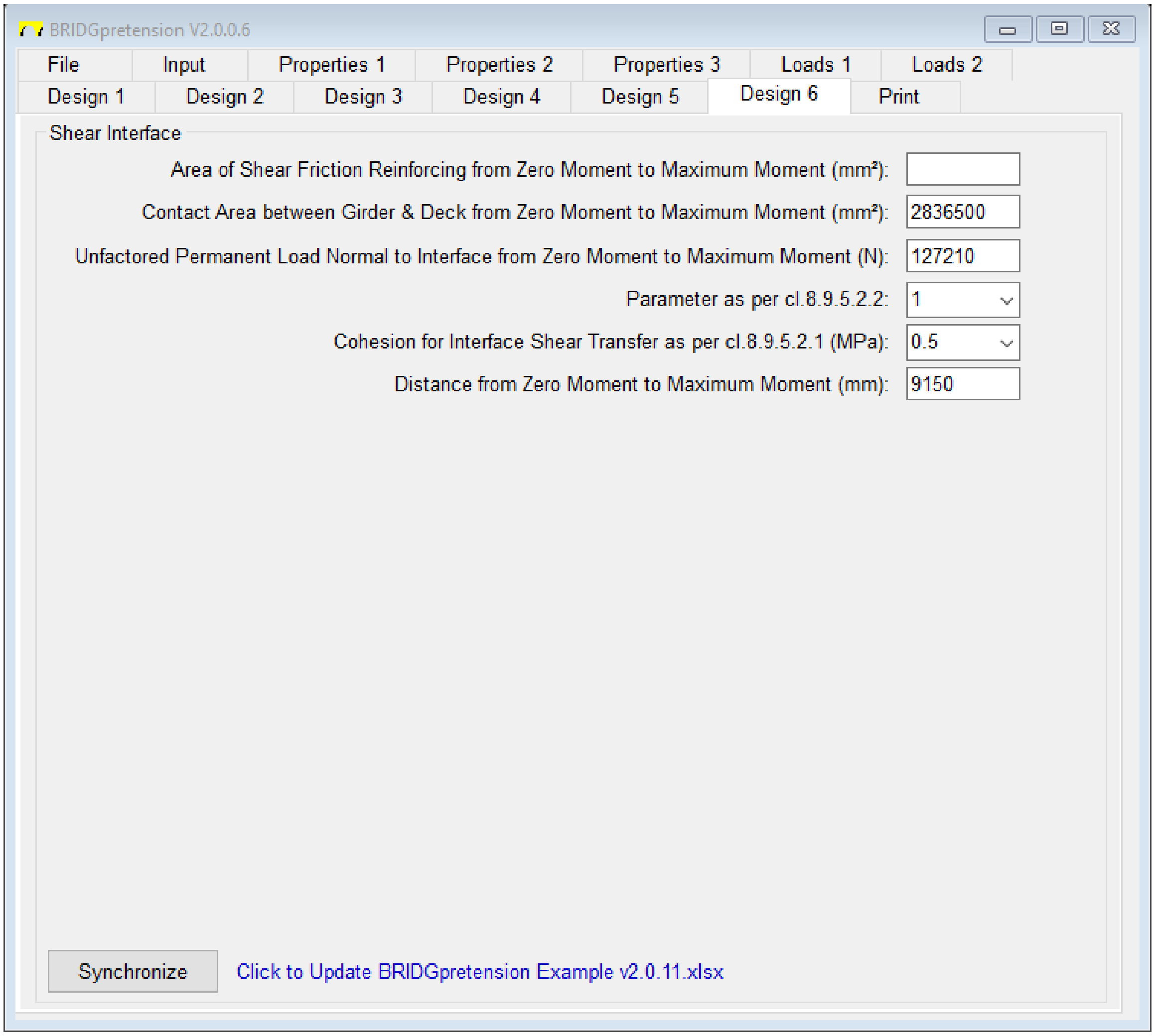


- if the Minimum Prestressing Jacking Force is left blank, the program will start at 0% jacking force when looking for the minimum required jacking force
- if for example, 70 was entered for the minimum required jacking force, the program will start at 70% when looking for the minimum required jacking force
- the User may choose a value greater than the minimum jacking force found by the program
- Number of debonded strands may start at zero. The program will indicate an error if debonded strands are required.
- Enter the strand layout at the girder end and the strand group hold-down locations; program assumes girder is symmetrical
- The Distance to the Construction Supports is primarily a fabrication design issue however consideration is provided to assist in confirming constructability


BRIDGpretension V3.0.0.1
File
Input
Properties 1
Properties 2
Properties 3
Loads 1
Loads 2
Loads 3
Loads 4
Design 1
Design 2
Design 3
Design 4
Design 5
Design 6
Print
ULS Design in Midspan
Area of Rebar for Positive Moments (mm²):
0
(optional)
Distance from Girder Bottom to Rebar Centroid (cm):
0
Allowable Concrete Strain:
0.0035
Default
Vibration
Live Load Deflection at FLS (mm):
6.3
Live Load Factor at SLS 1:
0.9
Usage:
with sidewalks, frequent pedestrian use
with sidewalks, occasional pedestrian use
without sidewalks
Synchronize
Click to Update BRIDGpretension Example v3.0.0zzze.xlsx



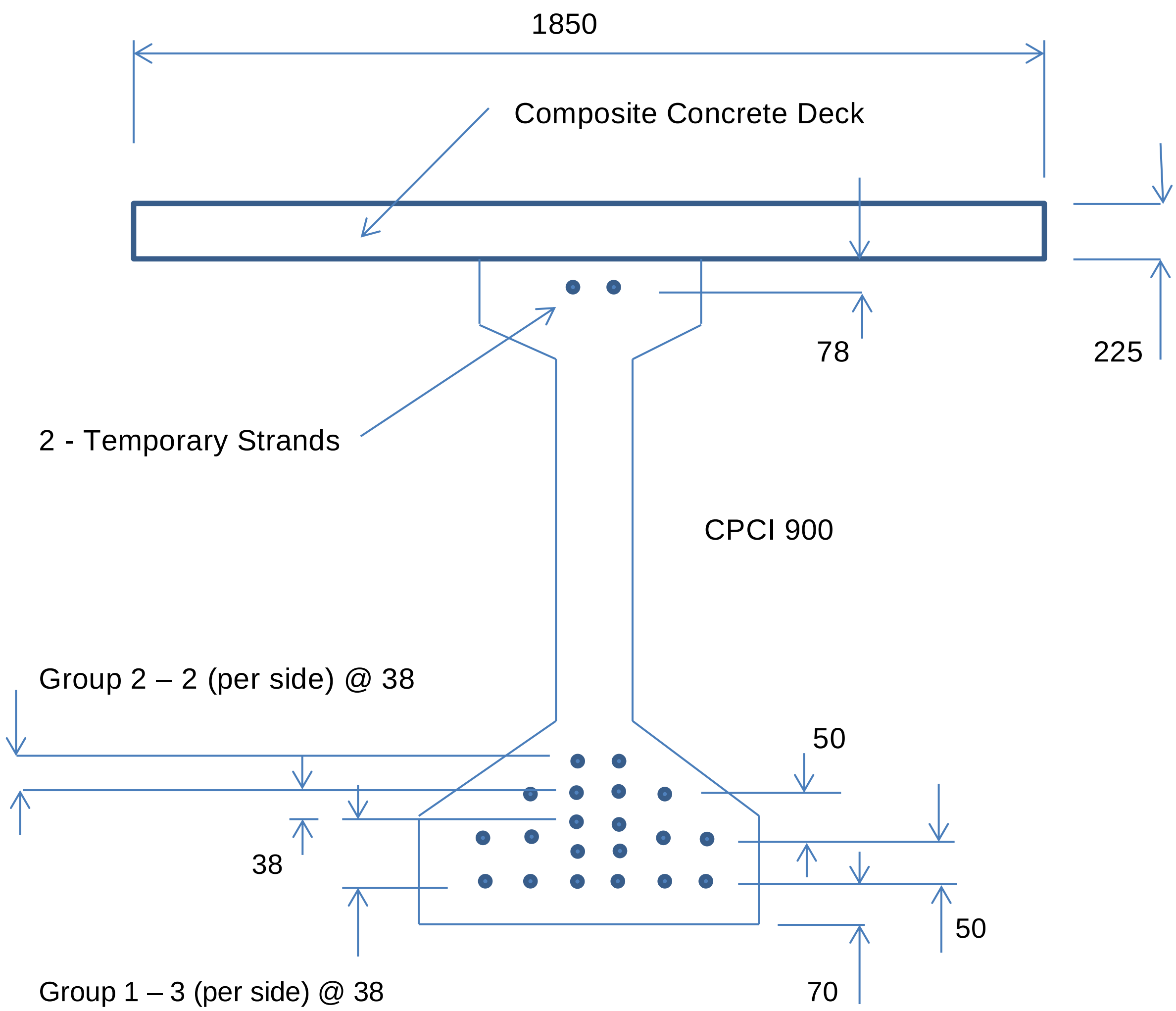
- the Temporary Prestressing box will be visible if temporary prestressing is applicable
- the program will automatically calculate the minimum required jacking force required; the User may use the minimum calculated or override the calculated minimum with a User defined minimum. It is typical to use the same jacking force for both the temporary and permanent prestressing.
- the program will never use less than the Minimum Jacking Force input when starting the automated process of finding the minimum jacking force required



- the program will calculate the minimum Area of Shear Friction required

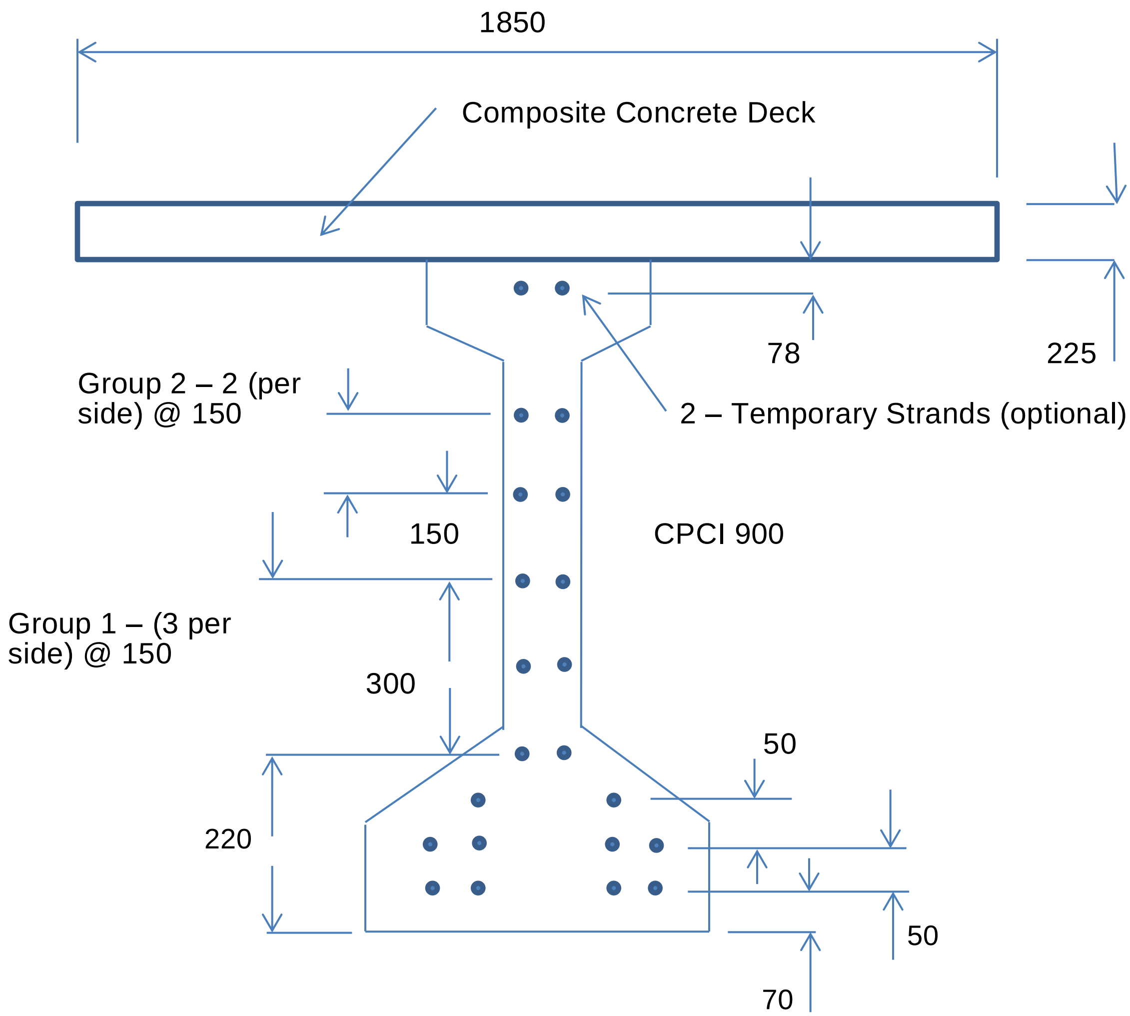
APPENDIX 4 – PRESTRESSING STRAND LAYOUT

Pretension Input Example:



Girder at Midspan

- number of straight strands Layer 1 = 4, Layer 2 = 4, and Layer 3 = 2
- number of draped strands Group 1 = 6, and Group 2 = 4
- distance from girder bottom to centroid of Layer 1 = 7, Layer 2 = 12, and Layer 3 = 17
- distance from girder bottom to centroid of first draped strand in Group 1 = 7, Group 2 = 18.4



Girder at Ends

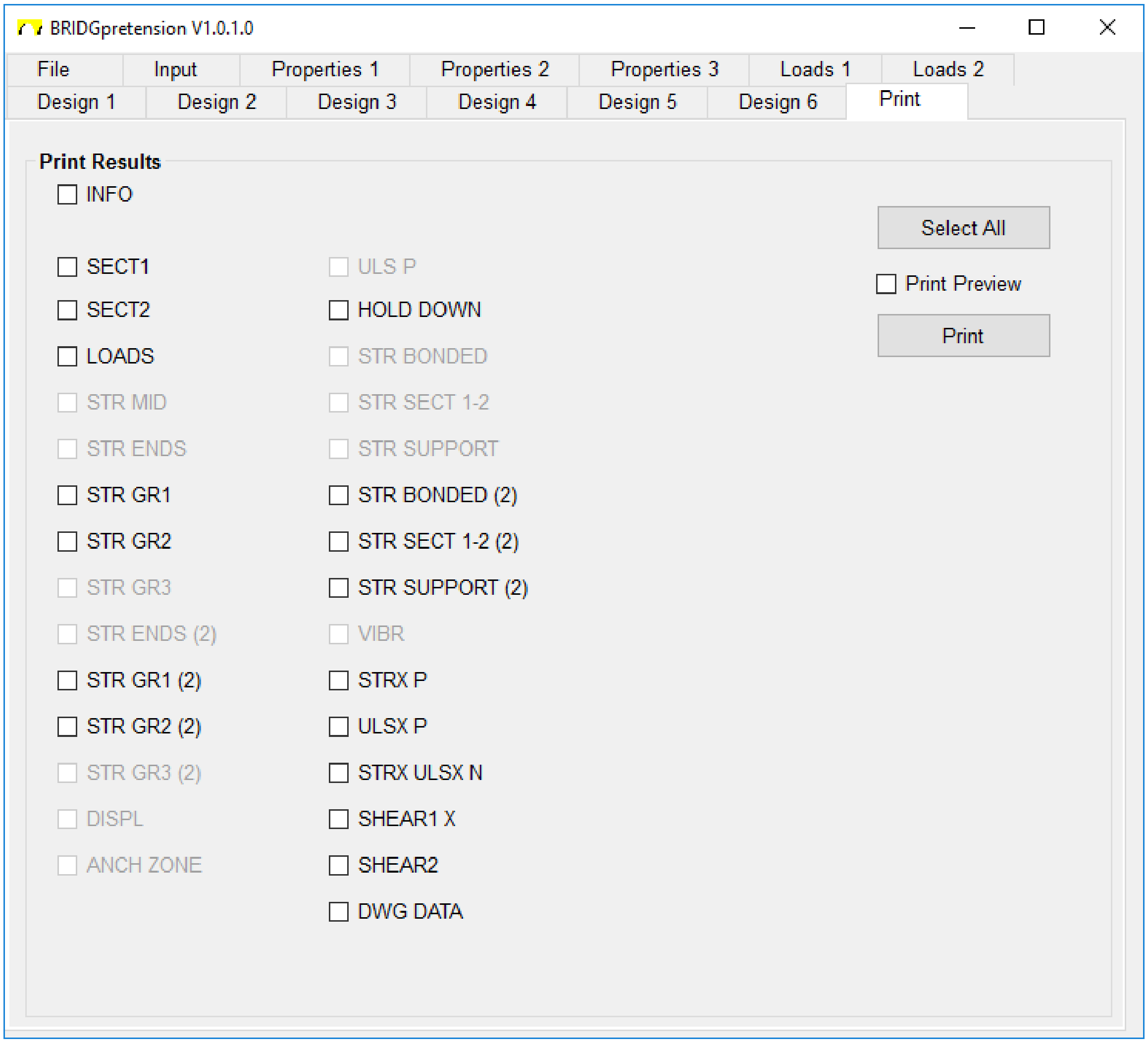
Note: Best practice is for the Designer to avoid having the draped strands interfere with the stirrup reinforcing, more specifically at the girder ends. Therefore, attention should be given to the draped strands profile relative to the enclosing stirrup bars.

Preferably the spacing between groups at the end of the girder to be 100mm min.

If holes through the web at the end of the girder are required, provide a spacing of strand rows of 150mm to accommodate the hole in between strand rows.

BRIDGpretension allows for 3 Layers of Straight Strands to be input. If a girder has more than 3 layers, then input more than one layer as a single layer and input the distance from the Girder Bottom to Centroid of First Draped Strand in the Group as the centroid of the multi-layer group.

APPENDIX 5 – PRINT TAB

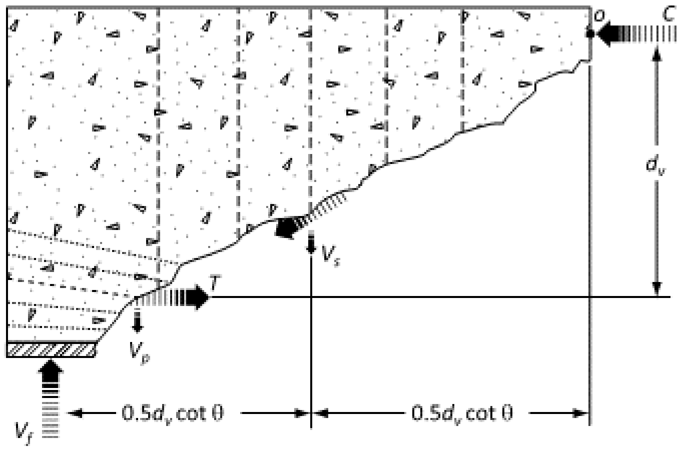


- only active / visible tabs in the Excel spreadsheet are available for print

APPENDIX 6 – SHEAR DESIGN

Maximum stirrup requirements occur at d_v as per cl.8.9.3.1.
Longitudinal reinforcing to accompany the maximum stirrup requirements to cl.8.9.3.12.

Figure C8.15
Free-body diagram of end region of beam
(See Clause C8.9.3.12.)

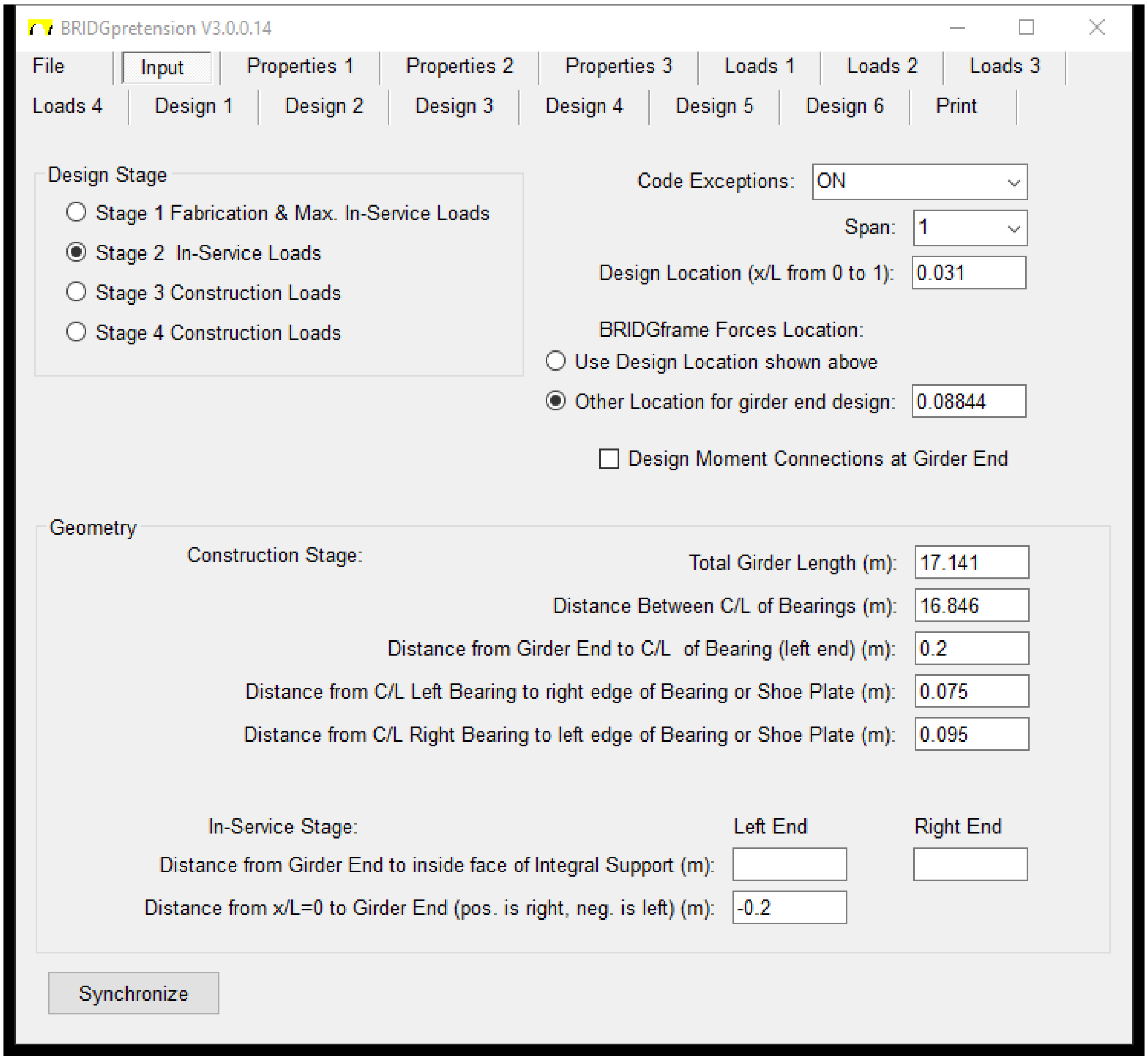


Design to cl.8.9.3.2:

When values are imported into BRIDGpretension from BRIDGframe, they are for a specific location.

If the Design Location in BRIDGpretension is input to correspond with o above (d_V cot θ from V_f), then the program is also going to use the prestressing at that location and not the prestressing at the inside face of the bearing plate as shown.
To use the forces at point o with the prestressing at the inside face of bearing plate, the User shall select Design Location at the inside face of bearing plate, and select Deso and import the corresponding BRIDGframe forces. The User shall then redefine the design location as the inside face of bearing plate without importing the BRIDGframe forces.
This will establish the correct forces and the correct prestressing, more specifically, the correct developed length of the prestressing.

Distance to point o = 0.08844 and distance to inside face of bearing plate = 0.031, both from x/L = 0 in BRIDGframe.



Note: the above would also apply whenever the prestressing is changing within the length d_v cot θ, therefore generally towards the ends of the girder where there are debonded strands or within the transfer length of prestressing.

APPENDIX 7 – ULS DESIGN

For ULS design, only rectangular shapes will be used. Therefore, any triangular shapes shown below will not be included in the design. Also, circular voids will be converted into square voids with the diameters equal to the square width and height. This should have little if any impact on the ULS capacity as the compression block depth may not be affected.