

BRIDGsteel v2 – CHBDC Steel Girder Design

User's Manual

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1.0 INSTALLATION

1.1 Hardware Requirements

To successfully install BRIDGsteel, 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

BRIDGsteel 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 only, until the program is registered.
- The Excel files contain macros. The User will need to accept the macros in order 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 to operate the BRIDGframe program (included in Windows 7 and later). During the BRIDGframe 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.

3.0 NOTATION

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

A_{comp} – area of composite section using modular ratio

A'' – area of steel girder and deck reinforcing within effective deck width of design strip

dna or dNA – distance to neutral axis

E_r – modulus of elasticity for rebar

$FLS-P$ – composite positive moment stresses using live load case

$FLS-N$ – composite negative moment stresses using live load case

$FLS-P(2)$ – composite positive moment stresses using live load case

$FLS-N(2)$ – composite negative moment stresses using live load case

f_{gb} – stress in girder bottom

f_{gt} – stress in girder top

f_{rt} – stress in top rebar in deck

F_y' – $\phi_s F_y$

M_{fo} – factored moment of other loads (excludes dead and live loads)

$M_r CUST$ – moment resistance of plate girder I shapes

$M_r STD$ – moment resistance of standard rolled I shapes

NA – neutral axis

N/A – not applicable

NG – no / not good

$SLS-P$ – composite positive moment stresses using load cases

$SLS-N$ – composite negative moment stresses using load cases

$SLS-P(2)$ – composite positive moment stresses using load combinations

$SLS-N(2)$ – composite negative moment stresses using load combinations

$ULS-P 1\&2$ – composite positive M_r of class 1 & 2 sections using load cases

$ULS-P 1\&2(2)$ – composite positive M_r of class 1 & 2 sections using load combinations

$ULS-N 1\&2$ – composite negative M_r of class 1 & 2 sections using load cases

$ULS-N 1\&2(2)$ – composite negative M_r of class 1 & 2 sections using load combinations

$ULS-P 3\&4$ – composite positive M_r of class 3 & 4 sections using load cases

$ULS-P 3\&4(2)$ – composite positive M_r of class 3 & 4 sections using load combinations

$ULS-N 3\&4$ – composite negative M_r of class 3 & 4 sections using load cases

$ULS-N 3\&4(2)$ – composite negative M_r of class 3 & 4 sections using load combinations

w_d – uniform dead load

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4.0 INTRODUCTION

4.1 General

BRIDGsteel by Simplified Bridge Solutions Ltd. is a program that provides bridge 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 steel 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 BRIDGsteel 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

BRIDGsteel is a program that uses Microsoft Excel (output) and Visual Basic (input) for designing steel I 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 and Exceptional Loads presently 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 shear and shear connector requirements.

5.0 INPUT

5.1 General

The bridge structure is first modeled and analyzed using our BRIDGframe program. Upon completion of the analysis, the BRIDGframe model is saved and closed.

To begin using the BRIDGsteel program, the User is required to LOAD (see the LOAD buttons found on file tab of program) the BRIDGframe model into BRIDGsteel and then load the example BRIDGsteel file. (Appendix 4)

Input data is posted to the various Excel work sheets to be utilized by the program, by the selection of the 'Synchronize' button.

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

5.1.1 Sign Convention

All sign convention for load forces, shall be as per the BRIDGframe program where manual input of forces for load combination input is selected.

5.2 Input

The input sheet determines the force type and structure location relative to BRIDGframe for the design process.

5.3 Properties

The Properties tabs provide for the input of the steel girder and concrete deck properties and parameters.

5.3.1 Properties1

The Properties1 tab is used to input the composite parameters at the location being designed. Some property data such as the concrete deck Young's modulus is loaded from the BRIDGframe model. See the CHBDC cl.10.4.2 and cl.10.5.7.

5.3.2 Properties2

The Properties2 tab is used to input the composite cross-sectional properties at the location being designed.

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 rolled sections or custom 'I' girders are available for selection. To choose standard rolled sections select 'Input Symmetrical Girder Properties'. To choose a customized 'I' girder select 'Calculate Girder Properties'. This information is not imported from BRIDGframe in order to eliminate error that may occur by loading an incorrect section at a location containing a changing variable plate girder section.

The User must consider changes to the girder such as drill holes through the flanges or web which influence the girder geometric properties.

This tab also contains input required to establish the resistance of the girder during the construction stage or the naked girder. The unsupported length of the girder is typically that of the diaphragm spacing. The User may choose to enter factored moments within the girder; however this input is optional. If these factored moments are left blank, the program defaults the variable ' ω_2 ' to 1. The Factored Moments at Girder Left and Right End is positive for clockwise rotation and negative for counterclockwise rotation.

5.3.3 Properties3

The Properties3 tab is used to establish the effective contributing deck width for positive and negative moment regions as per cl.5.8.1. A 'Calculate' button has been provided to assist the User.

5.4 Loads

The User has the option of completing the design using load cases automatically imported from BRIDGframe or by manually generating load combinations using BRIDGframe and inputting the results into BRIDGsteel.

5.4.1 Loads 1

The Loads1 tab is used to input construction load factors and to select whether to perform the composite design using individual load cases or to use User established load combination results. Loads 1 also includes the load factors for dead and superimposed dead loads if load case input is selected.

Design using Load Cases is automated to load all individual loadings from BRIDGframe and develop the necessary limit state combinations. Input is simplified although there is more output involved.

Design using load combinations requires the User to spend more time obtaining BRIDGsteel input values from BRIDGframe and has a greater possibility of error if the User does not generate the governing load combination condition correctly. It does, however, result in less BRIDGsteel output. If generating load combination values from BRIDGframe, do not include any Axial in Deck values from the DSHR or DTEMP worksheets.

If the User chooses to design using load cases, the loads that will be imported into BRIDGsteel from BRIDGframe will be that of the x/L location selected on the Input tab. If the User chooses to design using load combinations, the x/L location selected on the Input tab will not be relevant and the User must manually enter the required load combination data.

5.4.2 Loads 2

The Loads2 tab is used to input the remaining load case factors for the Live (truck), all 'K', wind, settlement and soil force effects when designing using load cases. Loads 2 will also be utilized if load combination is selected on the Loads 1 tab.

For design using load combinations, 'Remaining Loads' is User defined. It may mean an individual load case or the summation of multiple load case results. Remaining Load would mean any load or loads that are not being accounted for. For SLS, dead and sidl is already being accounted for and would not establish part of the Remaining Load. For ULS, dead and live is already being accounted for and would therefore not establish part of the Remaining Load.

For Soil with inclusive temperature effects, BRIDGsteel will automatically use the maximum or minimum load factor that causes the maximum load effect at the location being designed.

6.0 DESIGN

ULS-N 1&2 and ULS-N 3&4 designs are relative to the x/L location as selected on the INPUT tab. ULS-N 1&2 (2) and ULS-N 3&4 (2) is design by using load combination values manually entered by the User and is not related to the x/L location.

The Design tabs contain additional input requirements for moment and shear design calculations and vibration.

Design in negative moment regions is assumed to contain shear connectors.

6.1 Design 1

ULS: The Design 1 tab is used to input optional compression and tension design when doing moment design. This input was included if a User has chosen to design to cl.10.9.4. Although integral abutment or rigid frame bridge structures generate axial forces in the superstructure, generally these forces are not significant enough to utilize this input into the program.

FLS: The User shall select the applicable Detail Category in accordance with Table 10.4, Table 10.7 and Figure 10.6. For example, at connection plates the detail category may be B at the bottom of bottom flange and top of top flange, and the detail category may be C1 at the top of bottom flange and bottom of top flange, where the welding takes place.

SLS2: Vibration as per cl.3.4.4 is also included on the Design 1 tab but is only visible when designing for Positive Bending Moments.

6.2 Design 2

The Design 2 tab contains additional input to complete the Shear design. If Shear was not selected on the Input tab, this page will appear blank.

Connector material property is as per cl.10.4.7.

7.0 OUTPUT

7.1 General

The amount of output results is dependent on the number of x/L locations designed for, and whether the User has chosen to design using load cases or load combinations.

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

7.2 Results

The force type and location are specified on the input tab. Only the results relative to the input tab selection will be visible at any one time.

7.2.1 Info

The Info work sheet contains the general data required to be utilized by most of the design sheets. Much of this information is imported from the BRIDGframe file and much of it will have been previously entered in the Excel file.

7.2.2 M_r STD, M_r CUST, and V_r

The naked girder moment resistance for class 1, 2 and 3 sections, and the naked girder shear resistance are provided as per cl.10.10.2.3, 10.10.2.4, and 10.10.5 respectively.

7.2.3 SECT-P and SECT-N

The positive moment region section properties are calculated using the effective width of deck "ew" as per cl.5.8.2

The negative moment region section properties are calculated using the area of longitudinal deck reinforcing within the effective width of deck "ew" as per cl.5.8.1. The section properties will consist of the steel girder and deck reinforcing only; no deck concrete will be used to establish the negative moment region properties.

For both SECT-P and SECT-N, the section properties are calculated for both the exterior and interior girder.

7.2.4 CONSTR

The program checks the capacity of the girder for moment and shear during the construction stage using data imported from BRIDGframe. The data imported from BRIDGframe is relative to the x/L location selected on the INPUT tab.

7.2.5 LIVE, DEAD-SIDL, K, SOIL, WIND, DSETT

LIVE: The live load used in BRIDGsteel is relative to the x/L location selected on the INPUT tab. The live load amplification factors for distribution of forces to the exterior and interior girder are imported from BRIDGframe and loaded into the INFO work sheet to be utilized by the live load calculations. ULS, SLS and FLS values are established for moments and axial loads (live load shear is performed on the shear sheets). This sheet is not applicable if the User chooses to design using load combinations.

DEAD-SIDL, K, SOIL, WIND, DSETT: The primary function of these sheets are to accept the force values imported from BRIDGframe and determine the forces per girder for the different limit state conditions as applicable. Some of the load cases will include the stress results at critical section locations. The distribution of these forces is fixed as equal amongst the girders.

7.2.6 DTEMP, DSHR

The Axial force reported in BRIDGframe comprises of three components. The first being that in the entire superstructure due to frame action, the second and third being that in the girder and deck due to the Driving force from the net length change between the deck and girder. A distributed amount of Axial force from frame action is added to the length change Axial force in the girder to get the total girder axial. The length change Axial force from DSHR is not added to the distributed amount of Axial force from frame action, although it is for DTEMP. This is addressed more fully in the BRIDGframe manual, Appendix 14. The driving axial forces are considered at SLS only.

7.2.7 VIBR

Vibration limitations are calculated as per cl.3.4.4. Imported BRIDGframe values for calculating the superstructure vibration are relative to the x/L location selected on the INPUT tab.

7.2.8 SLS-P, SLS-N, SLS-P (2), SLS-N (2)

SLS-P, SLS-N: SLS-P provides a stress check at the composite section properties critical locations in the positive bending moment region. SLS-N provides a stress check at the composite section properties critical locations in the negative bending moment region. Some loads are considered "Transitory Loads" and are isolated during this design process. Where a transitory load creates a net stress that decreases the total stress effect, that load case is removed from the design. Note; as this does not form part of the CHBDC, the result is reported as a percentage of the steel yield strength for the purpose of providing information to the User only, and not a condition to be met. The purpose of providing the stress design using transitory loads was to primarily provide the User with an indication of the total effects from a frame structure. A stress check as per cl.10.11.4 is provided but has been modified to include axial forces that occur from primarily a frame structure.

SLS-P (2), SLS-N (2): these sheets provide a stress check as per cl.10.11.4 if the User has chosen to design using load combinations rather than by load cases. The results in accordance with cl.10.11.4 have been modified to include axial forces from primarily a frame structure.

7.2.9 ULS-P 1&2, ULS-P 3&4, ULS-P 1&2 (2), ULS -P 3&4 (2)

ULS-P 1&2 and ULS-P 3&4 designs are relative to the x/L location as selected on the INPUT tab. ULS-P 1&2 (2) and ULS-P 3&4 (2) is design by using load combination values manually entered by the User and is unrelated to the x/L location.

ULS-P 1&2 and ULS-P3&4: provides a positive moment strength design for the composite exterior girder and interior girder design strip of a class 1 and 2 section or a class 3 and 4 section as per cl.10.11.5.2 or 10.11.6.2 respectively, using imported load cases from BRIDGframe.

ULS-P 1&2 (2) and ULS-P 3&4 (2): provides positive moment strength design for the composite exterior girder and interior girder design strip of a class 1 and 2 section or a class 3 section as per cl.10.11.5.2 or 10.11.6.2 respectively, using load combination results manually input by the User.

7.2.10 ULS-N 1&2, ULS-N 3, ULS-N 1&2 (2), ULS-N 3&4 (2)

ULS-N 1&2 and ULS-N 3&4 designs are relative to the x/L location as selected on the INPUT tab. ULS-N 1&2 (2) and ULS-N 3&4 (2) is design by using load combination values manually entered by the User and is unrelated to the x/L location.

ULS-N 1&2 and ULS-N 3&4: provides a negative moment strength design for the composite exterior girder and interior girder design strip of a class 1 and 2 section or a class 3 section as per cl.10.11.5.3 or 10.11.6.3 respectively, using imported load cases from BRIDGframe.

ULS-N 1&2 (2) and ULS-N 3&4 (2): provides a negative moment strength design for the composite exterior girder and interior girder design strip of a class 1 and 2 section or a class 3 section as per cl.10.11.5.3 or 10.11.6.3 respectively, using load combination results manually input by the User.

7.2.11 FLS-P, FLS-N

Imported BRIDGframe values for FLS-P and FLS-N are relative to the x/L location selected on the INPUT tab

FLS-P, FLS-N: provides a live load stress range fatigue design for the composite exterior girder and interior girder design strip as per cl.10.17 using the imported live load case from the BRIDGframe LIVE2 work sheet.

Fatigue design is not done when using the load combinations option on the Loads 1 tab.

7.2.12 SHEAR

The Shear work sheet provides design for the shear capacity of the steel girder section and the shear connectors or studs. The shear capacity of the girder is a strength design check at ULS as per cl.10.10.5.2 and utilizes maximum moment and corresponding shear or maximum shear and corresponding moment. The shear connector design is that of ULS and FLS as per cl.10.11.8.3 and 10.17 respectively.

Imported BRIDGframe values for performing the shear design calculations are relative to the x/L location selected on the INPUT tab.

7.2.13 SHEAR (2) and Vf Mf (2)

Shear (2): The Shear (2) work sheet is for design using load combinations manually input by the User and provides shear connector design to that of ULS and FLS as per cl.10.11.8.3 and 10.17 respectively.

Vf Mf (2): The Vf Mf (2) work sheet is for design using load combinations manually input by the User and provides design for the shear capacity of the steel girder section. The shear capacity of the girder is a strength design check at ULS as per cl.10.10.5.2 and utilizes maximum moment and corresponding shear or maximum shear and corresponding moment.

8.0 Printing

Printing of Excel sheets is done by selection of each work sheet as found on the program 'Print' sheet. 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.

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 BRIDGframe and BRIDGsteel spreadsheets 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 BRIDGsteel.exe and BRIDGsteelUpdater.exe to access the internet.

If the appearance of the program is not as per the screen prints shown in the Appendix 4 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 analyse. Probable Resolution: Macros have not been allowed to run. Program requires Excel 2007 or later (2007 not recommended). 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

Stiffeners do not form part of this program.

Longitudinal shear does not form part of this program.

Steel girder shapes other than "I" girders are not fully supported.

Horizontal curvature of bridge is limited to A5.1.3.2.

Supported load cases are those generated in BRIDGframe.

Distortion does not form part of this program.

Splices and connections do not form part of this program.

Openings in girder flanges and/or web, or changes in the deck slab are not part of the input of this program and therefore require User generated data input.

Note: above limitations may be removed in future updates.

APPENDIX 1 - PROGRAM FEATURES

BRIDGsteel
composite steel girder design software

- conformance with the Canadian Highway Bridge Design Code CAN/CSA-S6-19
- simple and minimal tabular input
- automatic importing of data from BRIDGframe analysis program
- design of positive and negative moment regions, shear / shear connectors, and vibration
- SLS, ULS and FLS design
- naked girder and composite girder design
- drop-down menus of standard steel sections
- customized plate girder building tool
- 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

APPENDIX 2 - SOFTWARE LICENSING AGREEMENT AND INSTALLATION

BRIDGsteel Software Licensing Agreement

By installing the BRIDGsteel 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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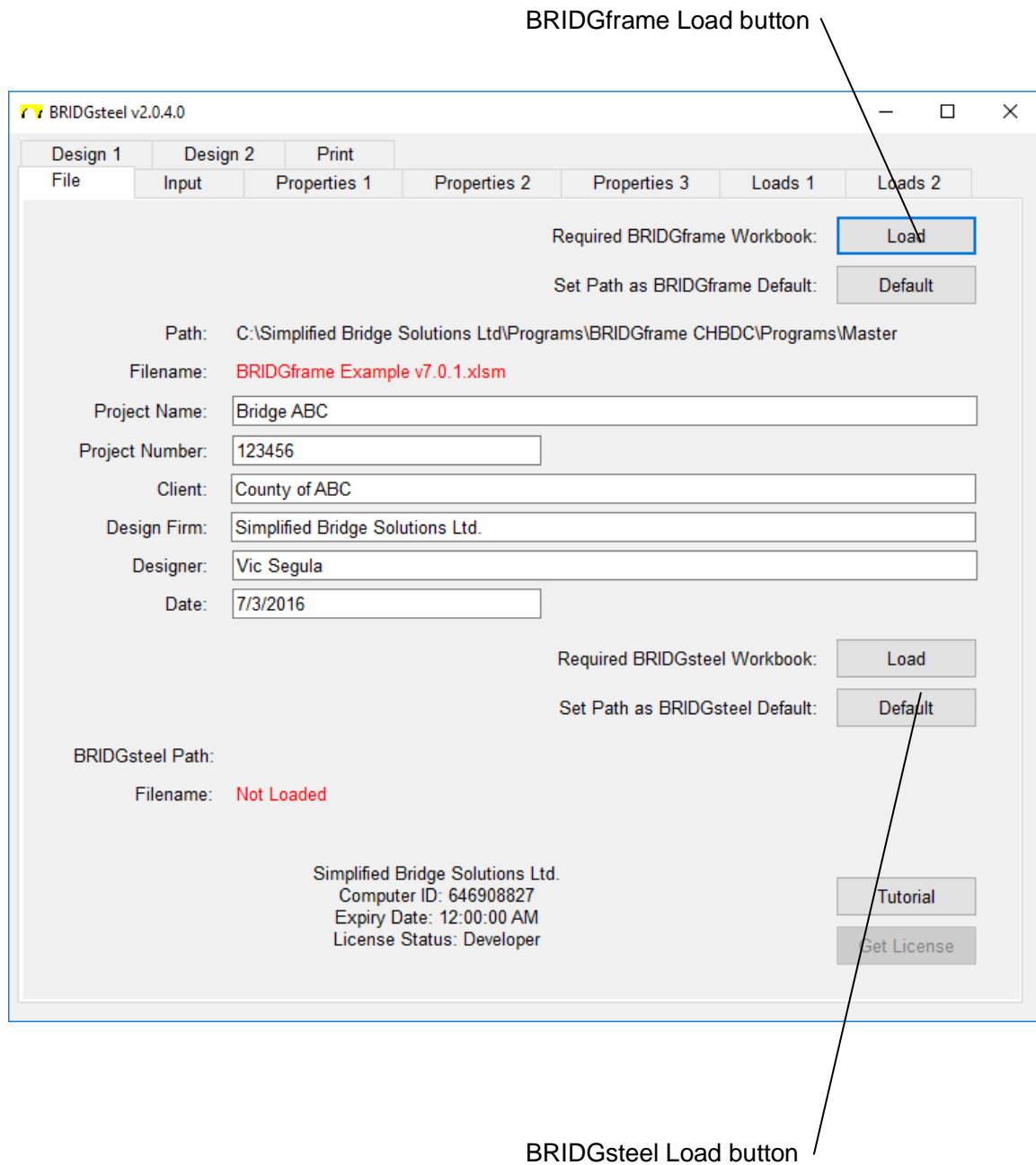
BRIDGsteel Installation

Design parameters and calculation results for composite girder designs are stored in Excel workbooks, one workbook per design. BRIDGsteel 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 analysis. Later analysis may utilize this workbook or other saved workbooks generated from the original Excel file. All files are available for download directly from our website.

Certain advanced features are disabled until the application is registered.

BRIDGsteel will run in Demo mode only, if User is not licensed.

APPENDIX 3 – FILE TAB (PROJECT SET-UP AND PROGRAM REGISTRATION)



- 1) select BRIDGframe file to be used in design
- 2) following step 1, select BRIDGsteel file to be used for design

After Loading the BRIDGframe and/or the BRIDGsteel file, the 'Default' button may be selected for each. This will have the program open the directories to these file locations when reopening up the program at later start-ups.

Input project particulars.

APPENDIX 3 – INPUT TAB

BRIDGsteel v2.0.4.0

Design 1 Design 2 Print

File Input Properties 1 Properties 2 Properties 3 Loads 1 Loads 2

Design For Moment:

Positive ☒

Negative ☐

Design for Shear and Connectors ☐

Design Location:

Span: 1

x/L (from 0 to 1.0): 0.500

Synchronize Click Synchronize Button to Update BRIDGsteel Example v2.0.30t.xlsx

- select force to design for and general location for negative moment region
- select exact location of superstructure (i.e. Mid-point of span one shown) to design for (applicable to load case design only)

APPENDIX 3 – PROPERTIES 1 TAB

BRIDGsteel v2.0.5.1

Loads 3 | Design 1 | Design 2 | Print

File | Input | Properties 1 | Properties 2 | Properties 3 | Loads 1 | Loads 2

Materials:

Steel Resistance Factor " ϕ_s ":	<input type="text" value="0.95"/>	
Concrete Resistance Factor " ϕ_c ":	<input type="text" value="0.75"/>	
Rebar Resistance Factor " ϕ_r ":	<input type="text" value="0.9"/>	
Shear Stud Resistance Factor " ϕ_{sc} ":	<input type="text" value="0.85"/>	
Young's Modulus of Steel Girder " E_s " (MPa):	<input type="text" value="200000"/>	
Shear Modulus of Steel Girder " G_s " (MPa):	<input type="text" value="77000"/>	
Yield Strength of Steel " F_y " (MPa):	<input type="text" value="345"/>	
Young's Modulus of Concrete Deck " E_c " (MPa):	<input type="text" value="27000"/>	<input type="checkbox"/>
Deck Concrete Strength " f_c " (MPa):	<input type="text" value="30"/>	<input type="checkbox"/>
Deck Concrete Density (kg/m ³):	<input type="text" value="2400"/>	<input type="checkbox"/>
Yield Strength of Deck Rebar " f_y " (MPa):	<input type="text" value="400"/>	

Import Import Items Checked from the BRIDGframe Workbook

Synchronize Click Synchronize Button to Update BRIDGsteel Example v2.0.52.xlsx

Check the available boxes if wanting to use the same properties as that of the BRIDGframe file, the click Import

APPENDIX 3 – PROPERTIES 2 TAB

BRIDGsteel v2.0.4.0

Design 1 Design 2 Print

File Input Properties 1 Properties 2 Properties 3 Loads 1 Loads 2

Section - Naked Girder:

Input Symmetrical Girder Properties ☒ Calculate Girder Properties ☐

Girder Section: W610x91 Girder Section:

Section Depth (mm): 598 Web Height (mm):

Flanges Width (mm): 227 Web Thickness (mm):

Flanges Thickness (mm): 12.7 Top Flange Width (mm):

Web Thickness (mm): 9.7 Top Flange Thickness (mm):

A (mm²): 11500 Bottom Flange Width (mm):

Ix (*10⁶ mm⁴): 657 Bottom Flange Thickness (mm):

Iy (*10⁶ mm⁴): 24.8 Height of Haunch (mm):

Cw (*10⁹ mm⁶): 2120

J (*1000 mm⁴): 531

Elastic Section Modulus (mm³): 2200000

Plastic Section Modulus (mm³): 2520000

Height of Haunch (mm): 0

Unsupported Length of Girder (mm): 3900

Mmax, max. abs. factored moment magnitude (kN.m): 0

Ma, factored moment at one-quarter point (kN.m): 0

Mb, factored moment at midpoint (kN.m): 0

Mc, factored moment at three-quarters point (kN.m): 0

Synchronize Click Synchronize Button to Update BRIDGsteel Example v2.0.30t.xlsx

- symmetrical girder property tab format shown
- standard rolled “I” girder shapes
- naked girder factored moments at girder ends or between ends is manually input by the User. This information is optional.

BRIDGsteel v2.0.4.0

Design 1 Design 2 Print

File Input Properties 1 Properties 2 Properties 3 Loads 1 Loads 2

Section - Naked Girder: Input Symmetrical Girder Properties ☐
Calculate Girder Properties ☒

Girder Section: Custom 1

Section Depth (mm): Web Height (mm): 600

Flanges Width (mm): Web Thickness (mm): 12.7

Flanges Thickness (mm): Top Flange Width (mm): 325

Web Thickness (mm): Top Flange Thickness (mm): 16

A (mm²): Bottom Flange Width (mm): 400

I_x (*10⁶ mm⁴): Bottom Flange Thickness (mm): 25

I_y (*10⁶ mm⁴): Height of Haunch (mm):

C_w (*10⁹ mm⁶):

J (*1000 mm⁴):

Elastic Section Modulus (mm³):

Plastic Section Modulus (mm³):

Height of Haunch (mm):

Unsupported Length of Girder (mm): 3900

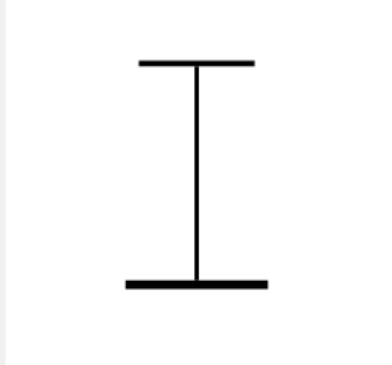
M_{max}, max. abs. factored moment magnitude (kN.m): 0

M_a, factored moment at one-quarter point (kN.m): 0

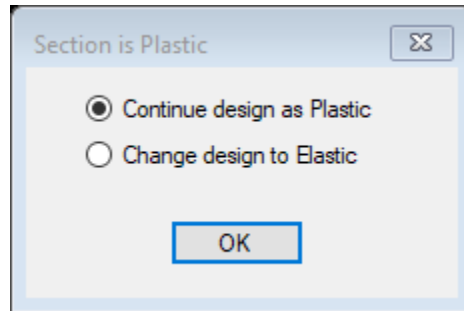
M_b, factored moment at midpoint (kN.m): 0

M_c, factored moment at three-quarters point (kN.m): 0

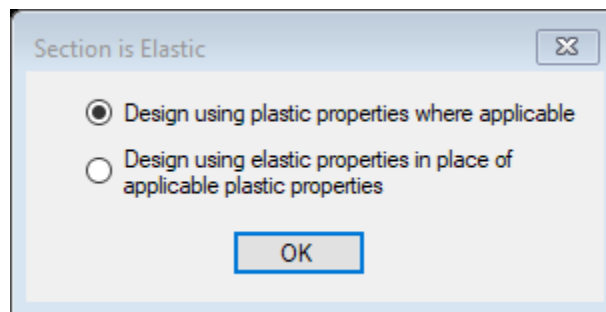
Synchronize Click Synchronize Button to Update BRIDGsteel Example v2.0.30t.xlsx



- custom format tab shown
- generates custom plate “I” girders



- The above box will open when synchronizing the Properties 2 worksheet if the section is class 1 or 2.



- The above box will open when synchronizing the Properties 2 worksheet if the section is class 3 or 4.

APPENDIX 3 – PROPERTIES 3 TAB

BRIDGsteel v2.0.5.1

Loads 3 Design 1 Design 2 Print
File Input Properties 1 Properties 2 **Properties 3** Loads 1 Loads 2

Section - Composite Girder:

Effective Deck Width:

B Interior (m): B Exterior (m):

Deck Rebar

	Girder	
	Exterior	Interior
Top Rebar:		
Average Area/Bar (mm²):	<input type="text" value="200"/>	<input type="text" value="200"/>
Rebar Spacing (mm):	<input type="text" value="300"/>	<input type="text" value="300"/>
Deck Top to Top Rebar Centres (mm):	<input type="text" value="94"/>	<input type="text" value="94"/>
Diameter of Rebar in Deck Top (mm):	<input type="text" value="16"/> ▼	
Top Rebar Is Epoxy Coated	<input type="checkbox"/>	
Category of Exposure:	<input type="radio"/> A <input checked="" type="radio"/> B	
Bottom Rebar:		
Average Area/Bar (mm²):	<input type="text" value="200"/>	<input type="text" value="200"/>
Rebar Spacing (mm):	<input type="text" value="300"/>	<input type="text" value="300"/>
Deck Top to Bottom Rebar Centres (mm):	<input type="text" value="151"/>	<input type="text" value="151"/>

 [Click Synchronize Button to Update BRIDGsteel Example v2.0.52.xlsx](#)

- effective deck width of composite girder design strip may be manually entered or automatically calculated

APPENDIX 3 – LOADS 1 TAB

BRIDGsteel v2.0.5.1

Loads 3 | Design 1 | Design 2 | Print | Loads 1 | Loads 2

File | Input | Properties 1 | Properties 2 | Properties 3

ULS Load Factors - Construction Loading:

Dead (excl. structure): Girders:

Live: Deck:

Design Completed Structure Using: ☒ Load Cases ☐ Load Combinations

ULS Load Factors - Completed Structure Loading:

Dead Loads

	Max	Min
Case 1: Girders	<input type="text" value="1.1"/>	<input type="text"/>
Case 2: Deck	<input type="text" value="1.2"/>	<input type="text"/>
Case 3: Other	<input type="text"/>	<input type="text"/>

Design Using Max or Min ☒ ☐

Uniform Superimposed Dead Loads

	Max	Min
Case 1: Barriers	<input type="text" value="1.2"/>	<input type="text"/>
Case 2: Asphalt	<input type="text" value="1.5"/>	<input type="text"/>
Case 3: Sidewalk(s)	<input type="text"/>	<input type="text"/>
Case 4: Other	<input type="text"/>	<input type="text"/>

Include Wingwall Forces ☐

Design Using Max or Min ☒ ☐

Synchronize [Click Synchronize Button to Update BRIDGsteel Example v2.0.52.xlsx](#)

- design using load cases imported from BRIDGframe

BRIDGsteel v2.0.5.1

Loads 3 Design 1 Design 2 Print

File Input Properties 1 Properties 2 Properties 3 **Loads 1** Loads 2

ULS Load Factors - Construction Loading:

Dead (excl. structure): Girders:

Live: Deck:

Design Completed Structure Using: ☐ Load Cases ☒ Load Combinations

 [Click Synchronize Button to Update BRIDGsteel Example v2.0.52.xlsx](#)

- design using load combinations
- requires values generated outside of BRIDGsteel

APPENDIX 3 – LOADS 2 TAB

BRIDGsteel v2.0.5.1

Loads 3 Design 1 Design 2 Print

File Input Properties 1 Properties 2 Properties 3 Loads 1 Loads 2

Load Factors:

	SLS1	ULS1	ULS2	ULS3	ULS4
Live (truck / brake / ped):	0.9	1.7	1.6	1.4	
all 'K' (excl. temp. for frames):	0.8		1.15	1.0	1.25
Wind:				0.45	1.40
Settlement:	1.00				
Include Soil Forces in SLS and ULS design <input checked="" type="checkbox"/>					
Soil (incl. temp.):				ULS Max	ULS Min
				1.25	0.80

Click Synchronize Button on Loads 3 to Update BRIDGsteel Example v2.0.52.xlsx

- design using load cases imported from BRIDGframe

BRIDGsteel v2.0.4.0

Design 1 Design 2 Print

File Input Properties 1 Properties 2 Properties 3 Loads 1 Loads 2

Design Using Load Combinations (forces per girder or design strip):

		Exterior	Interior
SLS:	Dead Loads Moment (kN.m):	<input type="text"/>	<input type="text"/>
	SIDL Moment (kN.m):	<input type="text"/>	<input type="text"/>
	SIDL Axial (kN):	<input type="text"/>	<input type="text"/>
	Remaining Loads Moment (kN.m):	<input type="text"/>	<input type="text"/>
	Remaining Loads Axial (kN):	<input type="text"/>	<input type="text"/>
ULS:	Remaining Loads Axial in Deck (kN):	<input type="text"/>	<input type="text"/>
	Dead Loads Moment (kN.m):	<input type="text"/>	<input type="text"/>
	Live Load Moment (kN.m):	<input type="text"/>	<input type="text"/>
	Live Load Axial (kN):	<input type="text"/>	<input type="text"/>
	Remaining Loads Moment (kN.m):	<input type="text"/>	<input type="text"/>
	Remaining Loads Axial (kN):	<input type="text"/>	<input type="text"/>

Synchronize [Click Synchronize Button to Update BRIDGsteel Example v2.0.30t.xlsx](#)

- design using load combinations
- requires values generated outside of BRIDGsteel to be manually input

APPENDIX 4 – LOADS 3 TAB

BRIDGsteel v2.0.5.1

File Input Properties 1 Properties 2 Properties 3 Loads 1 Loads 2

Loads 3 Design 1 Design 2 Print

Design Shear Using Load Combinations:

	Exterior	Interior
ULS		
Dead Loads Shear (kN):	<input type="text"/>	<input type="text"/>
Corresponding Dead Loads Moment (kN.m):	<input type="text"/>	<input type="text"/>
Live Load Shear (kN):	<input type="text"/>	<input type="text"/>
Corresponding Live Load Moment (kN.m):	<input type="text"/>	<input type="text"/>
Live Load Moment (kN.m):	<input type="text"/>	<input type="text"/>
Corresponding Live Load Shear (kN):	<input type="text"/>	<input type="text"/>
Remaining Loads Shear (kN):	<input type="text"/>	<input type="text"/>
Corresponding Remaining Loads Moment (kN.m):	<input type="text"/>	<input type="text"/>
Remaining Loads Moment (kN.m):	<input type="text"/>	<input type="text"/>
Corresponding Remaining Loads Shear (kN):	<input type="text"/>	<input type="text"/>
FLS:		
Live Load Shear Range (kN):	<input type="text"/>	<input type="text"/>

Synchronize Click Synchronize Button to Update BRIDGsteel Example v2.0.52u.xlsx

- design using load combinations
- requires values generated outside of BRIDGsteel to be manually input

APPENDIX 5 – DESIGN 1 TAB

BRIDGsteel v2.0.5.1

File Input Properties 1 Properties 2 Properties 3 Loads 1 Loads 2
Loads 3 Design 1 Design 2 Print

Moment Design: Include Compression and Tension in ULS Resistance Design: ☒

ULS (cl. 10.8, 10.9, 10.10)

	Exterior	Interior
Compressive Resistance of Composite Section (kN):	<input type="text"/>	<input type="text"/>
Tension Resistance of Composite Section (kN):	<input type="text"/>	<input type="text"/>

Unsupported Length (typically span of bridge) (m):

ϕ_1 (cl. 10.9.4.3):

FLS (cl. 10.17)

Is the ADTT a known value?: ☐ ADTT (Table 10.6): y (years): C_L :

Section Location	Detail Category as per Table 10.4
top of top flange:	<input type="text" value="C"/>
bottom of top flange:	<input type="text" value="B"/>
top of bottom flange:	<input type="text" value="B"/>
bottom of bottom flange:	<input type="text" value="B"/>
web:	<input type="text" value="C1"/>

SLS 2 - Vibration (cl. 3.4.4)

SLS 2 Load Factor:

☐ with sidewalks - frequent pedestrian use
☐ with sidewalks - occasional pedestrian use
☒ without sidewalks

Synchronize [Click Synchronize Button to Update BRIDGsteel Example v2.0.52.xlsx](#)

- If User chooses to include compression and tension in ULS design, required data is to be provided by and manually entered by the User. Typically, this box is never checked.

Note: tension & compression resistance is dependent on the amount of force that can be developed within the member.

APPENDIX 6 – DESIGN 2 TAB

The screenshot shows the BRIDGsteel v2.0.4.0 software window. The 'Design 2' tab is active, displaying the 'Shear' design section. The interface includes a menu bar (File, Input, Properties 1, Properties 2, Properties 3, Loads 1, Loads 2) and a toolbar (Design 1, Design 2, Print). The main area contains the following fields and options:

- Connector Properties:**
 - Area "Asc" (mm²): 380
 - Fu (MPa): 450
 - Diameter (mm): 22
- Number of Connectors per Row:**
 - Exterior Girder: 2
 - Interior Girder: 2
- Shear of Web (transverse web stiffeners):**
 - Provide Stiffeners: ☐
 - Stiffener Spacing (mm):
- Is Tension Field Anchored or N/A:**
 - ☒ yes
 - ☐ tension field not anchored

At the bottom, there is a link: "Click Synchronize Button to Update BRIDGsteel Example v2.0.30t.xlsx" and a "Synchronize" button.

- for shear design as selected on the INPUT tab
- 'Synchronize All' may be used to synchronize all at once rather than re-synchronizing each sheet where applicable. More specifically, it allows the User to make one change in the Input on one of the tabs and go straight to Synchronize All.

The screenshot shows the BRIDGsteel v2.0.4.0 application window. The top menu bar includes 'File', 'Input', 'Properties 1', 'Properties 2', 'Properties 3', 'Loads 1', and 'Loads 2'. Below the menu bar, there are sub-tabs for 'Design 1', 'Design 2', and 'Print'. The main content area is titled 'Class 4 Data' and contains the following text and input fields:

Naked Girder as per cl.10.10.3.4 or 10.10.4.1:

- top flange is class:
- bottom flange is class:
- web is class:
- h/w as per cl.10.10.3.4 (mm):

(as per 10.10.3.4 - 10.11.7.3.1 - 10.10.4.3)

Moment Resistance Reduction Factor:
(use 1.0 for no reduction)

A 'Synchronize' button is located at the bottom left of the 'Class 4 Data' section.

- if design for moments was selected on the INPUT tab and the class of section is 4 for custom plate girders, this sheet provides data and input for the reduction factor relative to the stiffeners that may be required

APPENDIX 7 – PRINT TAB

BRIDGsteel v2.0.4.0

File Input Properties 1 Properties 2 Properties 3 Loads 1 Loads 2

Design 1 Design 2 Print

Print Results

<input type="checkbox"/> Title	<input type="checkbox"/> SLS-P	<input type="checkbox"/> SLS-P (2)
<input type="checkbox"/> INFO	<input type="checkbox"/> ULS-P 1&2	<input type="checkbox"/> ULS-P 1&2 (2)
<input type="checkbox"/> Mr STD	<input type="checkbox"/> ULS-P 3&4	<input type="checkbox"/> ULS-P 3&4 (2)
<input type="checkbox"/> Mr CUST		
<input type="checkbox"/> Vr		
<input type="checkbox"/> SECT-N	<input type="checkbox"/> SLS-N	<input type="checkbox"/> SLS-N (2)
<input type="checkbox"/> SECT-P	<input type="checkbox"/> ULS-N 1&2	<input type="checkbox"/> ULS-N 1&2 (2)
<input type="checkbox"/> CONSTR	<input type="checkbox"/> ULS-N 3&4	<input type="checkbox"/> ULS-N 3&4 (2)
<input type="checkbox"/> DEAD-SIDL	<input type="checkbox"/> FLS	<input type="checkbox"/> Vf Mf (2)
<input type="checkbox"/> LIVE	<input type="checkbox"/> SHEAR	<input type="checkbox"/> SHEAR (2)
<input type="checkbox"/> K		
<input type="checkbox"/> SOIL		
<input type="checkbox"/> WIND		
<input type="checkbox"/> DSETT		
<input type="checkbox"/> VIBR		

Select None

Select All

☐ Print Preview

Print

Synchronize All

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