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 develope 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 is 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. Deck reinforcing is not included in the positive moment region section property calculations.

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 however is not added to the distributed amount of Axial force from frame action. This is addressed more fully in the BRIDGframe manual. 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.