BRIDGframe v8 – CHBDC Bridge Analysis

User's Manual

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1.0 INSTALLATION

1.1 Hardware Requirements

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

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

1.2 Installation and Uninstall Program

BRIDGframe 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 analysis. Later analysis may utilize this workbook or other saved workbooks generated from the original Excel file.

- The application as received will require registration to enable full Analysis functionality. The program will run in demo mode until registered. See Appendix 1

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

- 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, unless defined as follows:

CANBAS – Canadian Bridge Analysis System

Constant – Constant or a single section property over a span length.

Deck – Top component of deck on girder superstructure. Distributes loads to girders.

Fixed – A support condition with no degrees of freedom. A condition allowing no rotation or translation.

Free – A support condition with no restraint of degrees of freedom. A condition allowing full rotation and translation.

Integral Abutment – A bridge with no expansion joints between the superstructure and abutment and includes a deep pile foundation integral with the abutment.

Integral Pier – A bridge with no expansion joints between the superstructure and pier and includes a deep pile foundation integral with the pier.

Member – a length within a span having constant section properties. The number of members per span may vary from one to seven.

Non-Integral – A bridge with a vertical expansion joint system between the substructure (ballast wall) and the superstructure.

Parabolic – A symmetrical slab structure with a parabolic soffit.

Pinned – A support condition restraining the translation degrees of freedom with allowance of full rotation degrees of freedom.

Rigid Frame Abutment – A bridge with no expansion joints between the superstructure and abutment and includes a footing foundation system at the base of the abutment.

Rigid Frame Pier – A bridge with no expansion joints between the superstructure and pier and includes a footing foundation system at the base of the pier.

Semi-Integral – A bridge with a horizontal expansion joint system between the substructure and a longitudinal component of the superstructure.

Slab - Superstructure consisting of slab only (no girders), spanning between substructures.

Substructure – as found on Combinations 1 and 2 tabs, refers to the abutments and piers if they are integral, and also refers to the Wingwalls / Barriers on Wingwalls.

Variable – changing sections over a span length.

3.0 NOTATION

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

DLA – dynamic load allowance
NA or na – neutral axis
dna – distance to neutral axis
E_p – Young's modulus of piles
hect. – hectagonal
I_p – moment of inertia of pile
K_h – modulus of horizontal subgrade reaction
L_c – critical pile length for lateral load
n_h – constant of horizontal subgrade reaction
Nmbr – number
oct. – octagonal
rnd. – round
sq. – square
t – age of concrete in days from initial girder casting to casting of deck for precast girders; or from release of prestessing for post tensioned structures
t1 – age of concrete in days from initial girder casting to placement on bearings
$t\zeta$ – age of concrete in days from initial casting to infinity (days)
UCL – uniform construction load, kN/m over width of bridge
UDL – uniform dead load, kN/m over width of bridge
UPL – uniform pedestrian load, kN/m
USDL – uniform superimposed dead load, kN/m over width of bridge
ULL – uniform lane load (portion of CL-W Lane Load), kN/m over width of bridge
UWL – uniform vertical wind load, kN/m over width of bridge
θ – girder end rotation due to eccentric prestressing force, radians

4.0 INTRODUCTION

4.1 General

BRIDGframe by Simplified Bridge Solutions Ltd. is a program that provides bridge modeling and analysis 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 most bridge structures being designed today. General or generic structural analysis programs tend not to provide the type of analysis required to design bridge structures, or if they are capable, it may not be without tedious effort on behalf of the User. Large bridge programs are expensive to operate and probably have too many non-applicable 'bells and whistles' for a typical bridge model. BRIDGframe, however, is clear and concise while easy to learn and understand.

4.2 Description

BRIDGframe is a program that uses Microsoft Excel (output) and Visual Basic (input) for two-dimensional modeling and analyzing slab bridges and deck on girder bridges for superstructure beam analysis and continuous frames.

The program analysis is for vertical Permanent and Transitory Loads, and longitudinal loads (braking and earthquake). Transverse or horizontal effect or loads and most Exceptional Loads presently do not form part of this program release.

Typical bridge types include continuous abutments and piers (rigid frames and integral abutments and piers), and non-continuous abutments (expansion jointed structures at abutments). The intent of this program is to utilize the Simplified Method of Analysis as per CHBDC 5.6 as applicable.

The bridge structure is modeled and analyzed by the program using its entire perpendicular width, and the results are reported in the Results Tables of the various load case worksheets. Analysis of the modeled structure is based on non-cracked section properties calculated by the program.

Net stress results for certain load cases, and in some locations, may indicate a reduction in the total stress effect. An example of such a condition would be the shrinkage of the deck relative to a steel girder. The resulting moment may cause tension stresses in the bottom of the girder; however, the axial stresses causing compression at the same location may result in a net compressive stress.

The maximum live load fraction (F_T) (CHBDC 5.6) for the governing interior and exterior girder is also calculated. The results for moments, shears, and axial FRACTIONS are reported on the FRACTIONS2 worksheet for the negative and positive regions for later use when generating Load Combinations. The User may edit the automatically generated live load fractions in the FRACTIONS2 worksheet via the Fractions tab if required.

Skew F_S fractions are included in the total Shear results (for deck-on-girder bridges only) shown on the individual load case worksheets for simplicity rather than applying the F_S fractions to a design strip as is the case with the F_T factor. Reactions reported on the worksheets have not been modified by the F_S factor.

The program does not include secondary effects of elastic length change of members.

For design of the bridge structural support components, Simplified Bridge Solutions Ltd. to date have also developed a series of design program tools, including prestressed composite girders, steel composite girders, abutment design, and retaining wall design. Other programs are in the works.

5.0 INPUT

5.1 General

Input data is posted to the various Loads worksheets, the DEFINE worksheet, or the FRACTIONS worksheet, to be utilized by the program by the selection of the 'Synchronize' button, as found on the Geometry 1 & 2, Properties 1, 2, & 3, and the Loads 6 tabs.

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

The program comes with an Excel example output file. To begin using the program, the User is required to LOAD (see LOAD button found on file tab of program) the example file and edit the file to suit a new bridge analysis. After running the program, the User may then save the Excel file to the location of choice. The User may copy the example file to a directory of choice prior to editing the file. (Appendix 1)

Upon Loading a current Excel version, older Excel files may be imported (Appendix 1).

The Input shall be that of the entire structure width including all Loads, Geometry and Properties unless noted otherwise.

The bridge should comply with the Simplified Method of Analysis as per the CHBDC. The bridge should be modeled assuming no skew of the substructure. However, for integral abutment bridges and rigid frames, the Designer may consider a more rigorous analysis to account for skew effects.

5.1.1 Sign Convention

All input, excluding Minimum Temperature below zero degrees as found on the Load 4 worksheet, shall be entered as positive values. The program assigns the proper sign convention for each load case as appropriate.

5.2 Geometry

The Geometry 1 & Geometry 2 tabs are for creating the layout of the structure frame for the Superstructure Construction Stage and the Bridge Completion Stage that can be viewed on the MODEL Worksheet for verification. These two Geometry worksheets are divided into four Tables of Input consisting of 'Superstructure,' 'Abutments,' 'Piers,' and 'Girders Over Piers During Construction.' Each superstructure span type and span length are input, and if applicable, the abutment and pier substructure heights and support conditions complete the frame.

For integral abutment analysis, where applicable, pile length is assumed based on the 'Equivalent Cantilever Method' as per fig. 13 of the Ministry of Transportation of Ontario – Integral Abutment Bridges Manual or as per Appendix 17.

Pile length may also be calculated using:

$L_c \cong 4\ (E_p{*}I_p/K_h)^{0.25}$ for soils with constant K_h (overly consolidate clay), and
$L_c \cong 4\ (E_p{*}I_p/n_h)^{0.2}$ for soils with a linear increasing K_h (granular soil and mormal consolidated clay)

Equivalent Cantilever Pile length = $L_c/2$ (+ 3.0m of loose top material such as sand if applicable).

The Superstructure Types designated in CHBDC 3.9.3 has been revised as follows: Type A – steel beam systems with composite steel decks; Type B – steel beam systems with composite concrete decks; Type C1 – precast concrete sections and prestressed non-monolithic concrete slabs or girders with composite concrete decks; Type C2 – plain reinforced monolithic concrete girders and deck systems (shored construction). Type C3 – post tensioned concrete systems is not fully supported for this program release version.

The Bridge Types (CHBDC 5.5) are designated as follows: Type A – Slab (no distribution slab); Type B – Voided Slab (no distribution slab); Type C – Concrete Deck-on-Girders (includes slabs with additional distribution slabs). Live Load fractions (F_T) reported by the program are only applicable to these Bridge Types. For other bridge types, the User may manually input the live load fractions by selecting 'manual' on the Analysis tab and then completing the input on the Fractions tab.

Where expansion joints are incorporated into the bridge structure, the related piers or abutments do not form part of the frame and therefore, are not part of the program analysis. Also, where expansion joints are applicable, the sum of all bearing shear stiffness or friction that may induce resistance forces at the underside of the superstructure can be input. The User may input the assumed bearing plate thickness that will be included in the calculation of the bearing-induced forces. Forces are applied at the underside of the girders (or shoe plates where applicable).

The User is required to select the degree of freedom conditions at the base of continuous abutment and pier supports. A pinned condition fixes the support in the vertical and horizontal directions with freedom to rotate. A fixed condition fixes the support in the vertical and horizontal directions and fixes the support from rotation. A free condition at the base of abutments may be selected for single span rigid frames and provides no restraint from movements or rotations. The option to select a free condition for spans greater than one (1) may be done by using the integral abutment option and making the stiffness of the piles extremely small.

For non-continuous abutments and piers, a fixed condition fixes the support in the vertical and horizontal directions. A free condition fixes the support in the vertical direction but provides no restraint in the horizontal direction. For fixed and free conditions, there is no restraint of rotation. For non-continuous abutments and piers, the program will allow for one support location to be fixed in the 'x' direction. The program will not allow fixity in non-continuous abutments and piers in the 'x' direction when integral or rigid frame abutments or piers form part of the model.

For non-integral abutments and piers, one joint must be fixed in the horizontal direction.

To model semi-integral abutment bridges with no fixity at any joints in the horizontal direction, see Appendix 12.

The User may select continuous or non-continuous girders over the pier supports to model either of the two girder conditions during the construction stage. For Type C2 Bridges the modeling of continuous or non-continuous girders over piers during construction is not relevant.

If the User is using the CL-W Truck as the only vehicle loading on the bridge, the User may choose to model the spans of the bridge by rounding the span length up to the nearest 0.15, 0.3m or 0.6m etc. The User may also choose to increment the length for an advancing vehicle to be divisible by, for example, 0.15, 0.3m, or 0.6m etc. The intent is to cause each axle to fall directly over a location being analyzed or to cause each axle to locate directly on top of a support during analysis, giving maximum load effect.

To simplify the input of a specific structure type, BRIDGframe includes an option to select a constant superstructure section over a span length, and a parabolic soffit for a slab span.

Tapered abutments are allowed for rigid frame bridges with a greater thickness at the top of the abutment.

Number of Spans Exceeding Three:

Using engineering judgment, the number of spans exceeding three can be modeled for a beam analysis.

Skew:

By providing a skew on the Geometry 2 tab, the program will calculate the F_S factor for deck-on-girder bridges as per CHBDC 5.6 and apply it to the shear of the individual load case results reported on worksheets. Input the non-skewed (perpendicular) length and thickness of the substructures. The program will make all necessary modifications if a skew value is entered.

5.3 Properties

Superstructure properties of each span are constant, variable, tapered slabs, or have a symmetrical parabolic slab throughout a span length. For variable plate girders, a tool for generating section properties can be found on the Properties 1 tab of the program.

To post properties (Properties 1) to one or a combination of spans, the User begins by clicking in the boxes on the left-hand side of the tab to set-up the Span Properties – Span Profile, and the Member Properties – Member Names or Lengths. Member Properties – Member Names or Lengths displayed in the colour crimson need to be synchronized. Member Properties – Member Names or Lengths displayed that contain a turquoise background are the active members to which the Section Properties will apply. Member Properties – Member Names or Lengths displayed that are of black text indicate that these members have been synchronized. The User may group all the members together that have the same section Member Properties – Member Names or Lengths properties to expedite the assignment of the section properties by clicking in the Member Properties – Member Names or Lengths box, selecting Modify from the Actions pop-up window, selecting to Change the member properties, and then selecting Current or Other to include this member with the predefined group. A Help button is available on the Properties 1 tab to assist the User. See Appendix 7.

Some properties must be constant over a bridge span. A light blue hue background rather than the typical white background represents these boxes. This is only applicable to Parabolic, Tapered, and Variable properties where more than one member makes up the span length. The value entered in row one of the member properties on Properties 1 will therefore be adopted for the remaining rows defining the member properties. The results of this input can be viewed on the DEFINE worksheet.

The program will only allow the User to post Properties for multiple spans if the span type as selected on the Geometry 1 worksheet is consistent with the property's selection. When modeling a superstructure consisting of a slab only (no girders), the properties found on the Properties 1 worksheet shall utilize the Girder input.

The abutment or pier geometry may consist of one or more components of either rectangular or circular cross-sectional properties. Where more than one component makes up an abutment or pier, the program assumes the properties of the individual components of the support are identical. The User inputs the Thickness and Width, or Radius of a single member of the supports, based on a non-skewed bridge. The program will make the necessary adjustment to account for skew.

Pile input is only used to model an integral abutment on a single row of piles. The preferred orientation of the piles is for the Y – Y axis of the pile to be perpendicular to the C/L of bridge alignment regardless of skew. See also the Steel Pile Design worksheet. For skewed abutments of integral abutment bridges, some of the moment in the pile will be due to displacement of the pile top and some will be from loads causing moment forces. These forces are being applied to the pile from two different angles. Piles placed with the Y – Y axis perpendicular to the C/L of bridge are influenced very little whether the abutment is skewed or not, and should require the least number of piles.

Abutment and piles are assumed to be distributed equally about the longitudinal C/L of structure.

The substructure properties are posted to the program using the 'Synchronize' button located on the Properties 2 worksheet.

Parabolic Soffit Slabs and Tapered Haunches:

The majority of parabolic slab soffit superstructures are symmetrical about the centerline of span. For such superstructures, BRIDGframe has simplified the input to just requiring the depth of the slab at the centerline of span or the apex of the parabola, and the depth of the slab at the ends. The program generates a true parabolic soffit slab and not a series of rectangular or tapered sections. Input of tapered slab haunches is similar with the exception that the length of haunch is required.

The program will not allow the User to define the slab properties (Properties 1) at the span ends prior to defining the slab properties at mid-span. The User must input and Synchronize the properties at mid-span to complete the slab depth, slab width, and f'_c which will be inherited as the properties at the ends of the span.

Tapered Abutments:

Input of Tapered Abutments in BRIDGframe is simplified by the requirement of only needing to designate the thickness of abutment at Top and Bottom. The program generates a true tapered member and not a series of rectangular or tapered sections.

For Abutments that are not tapered, it is only necessary to input the thickness of abutment at top. In the absence of a value at the bottom of abutment, the program assigns the same value to abutment bottom as input for the abutment top.

Variable Section Span:

To input a variable section the User must utilize the Action Box and select Modify. Through Modify the program will automatically set the last member of a span equal to the remaining length required.

The sequence of member numbers progresses from the left end of the span to the right. Therefore, member number one is always the left most member in the span.

Skew:

Substructure section properties on Properties 3 shall be entered assuming no skew. The program will make the necessary modifications to account for the skew.

5.4 Loads

To simplify input of repetitive data, multiple span bridges consisting of the same load conditions as span one of the structure, may generate the input for the remaining spans by utilizing the 'Input Generation' feature found on the Analyze tab.

5.4.1 Construction Loads CHBDC 3.6, 3.16

Construction Loads consist of the weight of the girders and deck along with any additional dead and live load specified by the designer. The deck load and additional dead and live load are a uniform distributed load over an entire span length. The program will automatically load spans to determine the maximum bending moment effect.

Using a separate Run, the User may utilize the Live (vehicle) Load consisting of moving point loads and the automated variable length udl lane load to establish more precise construction conditions.

Construction Loads are not applicable to shored construction.

5.4.2 Dead and Superimposed Dead Loads CHBDC 3.6

Dead Loads consist of the weight of the bridge superstructure materials supported by the non-shored naked girders. If the deck does not act composite with the girders, then all bridge materials are classified as Dead Loads. Superimposed Dead Loads is the weight of permanent bridge materials carried during shored construction or supported by the self-supporting composite superstructure.

Input the weight of all the members comprised of a particular load case. For example, if a bridge span has five girders, then the weight of the girders is for all five girders.

Dead Loads are not applicable to shored construction for continuous superstructures. For shored construction, enter all loads as Superimposed Dead Loads.

Parabolic and Tapered Soffit Slabs:

The User shall input the uniform weight of the slab based on the thinnest section of deck occurring at the center of the span. Input of the portion of deck below the soffit of slab at mid-span is not required. The program will calculate the loading from the parabolic or tapered portion of slab below the mid-span automatically.

Variable Section Span:

To intent of the variable option is primarily for modeling steel plate girders where the load from the girder may be modeled with relatively good accuracy using a constant uniform load pattern.

Wingwall Loads:

Wingwalls are assumed to be parallel with the C/L of bridge.

Wingwalls / Barriers on Wingwalls are applied as an equivalent vertical concentric load coupled with vertical moment. The forces are applied at the node between the top of abutment and end of the superstructure. Loading from the approach slab may be included within the vertical load portion; however, on the Combinations tabs 1 and 2, the load factor used is defaulted to Dead – Substructure. The wingwalls are assumed to be supported until the deck or slab is constructed, as such the forces are applied with the SIDL's on the frame. See Appendix 13.

5.4.3 Truck Loads CHBDC 3.8

The Truck Load input (Loads 2 and Loads 3 tabs) is for one of the following: i) 6 independent trucks with a maximum of 5 axles each, ii) Group 1 consisting of Case 1, 2 and 3, and Group 2 consisting of Case 4, 5 and 6, for 15 axles per group, and iii) one group consisting of Case 1 to 6 for a total of 30 axles. A single Truck Load will require two 'Case' inputs to represent the vehicle driving over the structure in either direction. This is accomplished by mirroring the axles and distance between axles of one load case to form the second load case. For i) and ii) above a vehicle travelling forward and a vehicle travelling backward (opposite direction) can be done in one run, however for iii) above, one run per vehicle in each direction would be required.

If the User chooses to eliminate any axle not contributing to the maximum load effect (Loads 2 tab), the program automatically models all axle combinations up to the actual number of axles used to generate the truck vehicle. Therefore, for example, assuming the Dynamic Load Allowance (DLA) (CHBDC 3.8.4.5) is the same for a four-axle truck as it is for a five-axle truck, and assuming the axle loads and spacing are equal where applicable for the two vehicles, it is not necessary to model a four-axle truck. Therefore, typically six Truck Load Cases are required for modeling the CHBDC truck: two 2-axle vehicles (axle 4 and 5), two 3-axle vehicles (axles 1, 2, and 3), and two 5-axle vehicles, to cover all possible axle combinations and DLA's.

The User is required to input the number of Design Lanes. The program will multiply the number of Design Lanes by the governing single Truck Load Case. The Live Load Results Tables do not include the Modification Factor for Multi-Lane Loading as per CHBDC table 3.5. These multi-lane load fractions are included in the Live Load Fractions found on the FRACTIONS2 worksheet.

All combinations of loaded lanes are expected from the results given from section 5 of the bridge code. Therefore, if 4 lanes can fit on the bridge platform, then the program is checking 1 to 4 lanes loaded. To satisfy cl.3.8.4.2.1 b) a separate run will need to be done setting the number of lanes to 2, if the number of lanes as per table 3.4 gives a W_e > 3.7m.

The advancement of the vehicle is defined in meter increments. The smaller the increments, the more accurate the results will be. Increments that are too small will cause the program to analyze the structure at a slower rate with possibly a negligible increase in accuracy of the results. For Truck Axle input, Axle No. 1 represents the axle furthest to the right of the Truck Load Case (vehicle) axle configuration (not as designated in the CHBDC). The program starts each vehicle with axle No. 1 at location x/L=0 of the superstructure or directly over the left abutment. Each vehicle is advanced left-to-right until the vehicle no longer loads the bridge structure.

Loading from the approach slab may be included within the vertical load portion of the Wingwall Loads; however, on the Combinations tabs 1 and 2, the load factor used is defaulted to Dead – Substructure.

The BCL truck contains a variable axle spacing. This vehicle is predefined by the program and is not editable.

5.4.4 Lane Load CHBDC 3.8

The Lane Load uses a percentage of the governing Truck Load Case results coupled with a uniformly distributed load. The program will automatically utilize only the portion of udl load over a span or combination of spans, which maximize the load effect.
Input of the uniformly distributed load is for a single lane only. The program will multiply the number of Design Lanes by the single lane uniformly distributed load.

DLA is not applied for Lane Loading (CHBDC 3.8.4.5)

5.4.5 Braking Load CHBDC 3.8.6

The Braking Load uses a longitudinal concentrated load and a longitudinal uniform load. Total braking force will be resisted at a Fixed Support, or for Continuous Abutments or Piers the braking force will be resisted by the soil pressure and the structure frame. For vehicles travelling right to left over the structure, the soil pressure involved in the resistance calculations will be that on the left abutment and vice versa for vehicles travelling left to right.

The loading is applied over the entire structure. For example, for vehicles travelling right to left, the concentrated load is applied at the left abutment location with the remaining uniform load applied over the structure length.

The braking force is part of Live Loads (Truck and Lane Loading). The braking force is applied along the C/L of bridge as is typical, therefore, no transverse eccentricity is assumed.

5.4.6 Pedestrian Load CHBDC 3.8.9

The User may enter the pedestrian load per linear metre. The same pedestrian load will be applied to spans. The program will automatically utilize only the portion of udl load over a span or combination of spans, which maximize the load effect.

5.4.7 Uniform Vertical Wind Load CHBDC 3.10

The User is required to input the Uniform Vertical Wind Load equal to Fv in kPa. The program multiplies the Wind pressure by the width of the superstructure or deck as input on Properties1 for a particular span to obtain the span's linear loading. Where a component such as an overhanging curb that is not being included in the width of superstructure or deck, the wind pressure may be adjusted as required to give the appropriate linear load.

5.4.8 Thermal Data for Superstructure CHBDC 3.9.4

Thermal data provides input for Thermal Gradient Load, Thermal Load from Expansion and Contraction of the Superstructure, Differential Thermal Load, and Soil Pressure. Thermal Gradient is the variance in material temperature over the depth of the superstructure section as defined in CHBDC 3.9.4.4. Thermal Load from Expansion and Contraction is, as implied, the expansion and contraction of the superstructure and is relative to the temperature at time of construction versus the design temperature. Differential Thermal Load is the load effect caused by a difference in thermal properties between the girders and the deck material types.

The User may choose to use the default coefficient of expansion/contraction values for steel and concrete as per the bridge code section 8 and 10 by checking the box to 'Use Default Values'. To run a model with no temperature effects the User will need to clear the check from the Use Default Value boxes and clear any coefficients in the boxes, as found on the Loads 4 tab.

See Appendix 16 for Differential Temperature

5.4.9 Soil Load CHBDC 3.5.2, C6.9

Soil Pressure is applicable to continuous abutment structures only and is due to soil backfill pressure against the abutment frame legs. The soil pressures on each end of the bridge will be multiplied by the load width and is typically equal to the width of the abutment supports. The height of the exterior soil pressure at each abutment is defaulted to equal the height input for the left and right abutment.

The height of interior soil is measured from the bottom of the concrete abutment for both rigid frames and integral abutments.

Where approach slabs are not used, the User can input the additional live load soil pressure from surcharge (CHBDC 6.9.5) found on the Load 4 tab and designated as 'Active Soil Pressure at Exterior Top' and 'Total At-rest Pressure at Exterior Top'. Live load surcharge will not be used during temperature contraction. The User may also use these boxes to input a surcharge load due to the difference in top of grade to the location of superstructure centroid, to account for the difference between the modeled height of backfill and the actual height of backfill but it will be conservatively taken as a live load; or simply use a conservative height of abutment.
For example, if the actual height of the left abutment is 4.0 m but the model uses a height of 3.7 m to the N.A. of the superstructure, the surcharge may be input as 1) Active = K x ht. x soil density = 0.33 x 0.3 x 21.3 = 2.1 kPa and 2) At-rest = 0.5 x 0.3 x 21.3 = 3.2 kPa.

The program assumes the resultant is at 1/3 the abutment height for the soil mass and 1/2 the abutment height for surcharge loads. Where backfill soil properties are not consistent or hydrostatic forces are present, the User shall adjust the properties of the soil to establish an equivalent loading.

The program calculates the earth pressure coefficients as per CHBDC C6.9 and figure C6.16 assuming loose sand (as per Integral Abutment Bridges report SO-96-01). Integral Abutment and Rigid Frame Abutments free at base assume a uniform movement over the entire abutment height, and restrained movement at base for Rigid Frame Abutments with pinned or fixed bases.

Earlier versions of BRIDGframe accounted for additional compaction of soil by increasing the starting pressure at At-rest by 15%. This has been removed and replaced with an overconsolidation ratio (OCR) and is entered on Loads 4.
The determination of starting At-rest pressure will be calculated using:
$K_O = (1 – \sin \phi) (OCR)^{\sin \phi}$
An OCR equal to 1.15 will not give a starting K_O of 15% greater than At-rest with no additional compaction. For example, a ϕ of 30^o to give a K_O of 15% greater than At-rest with no additional compaction, would require an OCR of 1.323. The User shall choose an OCR they are comfortable with, when representing the starting At-rest soil pressure.

See also 6.0 Analysis and 5.4.2 Wingwall Loads.

5.4.10 Deck Shrinkage and Concrete Girder Shrinkage CHBDC 3.9, 8.4.1.5

Deck Shrinkage or Differential Shrinkage is the difference between the shrinkage of the girders and the shrinkage of the cast-in-place concrete deck or is the shrinkage of the concrete deck relative to steel girders having no shrinkage. Differential Shrinkage is not applicable when the deck and girders are not composite, nor is Differential Shrinkage applicable when the girders and deck are poured monolithically, or if the Superstructure span is Type A. Differential Shrinkage strain for Type B Superstructure spans has different exposed surface areas at various stages. During initial shrinkage the soffit of the deck is covered with forming and the top of the deck is covered with curing material. The curing material is soon removed but not necessarily at the same time as the deck forms. And the time between construction of the deck and asphalt placement is difficult to determine. Differential Shrinkage strain for Type B Superstructure spans will be calculated from time of deck construction to infinity and the exposed surface area may be conservatively assumed as the actual deck surface. Using engineering judgment, the total load effects may be factored to determine the shrinkage load effects. Alternatively, engineering judgment may be used to adjust the constant exposed surface area at input. Or no adjustment can be made giving a conservative analysis.

Concrete Girder Shrinkage or Slab Shrinkage is the load effect from the shortening of the concrete superstructure specifically. The load effects from the shortening of the superstructure is the result of restraint conditions at the base of continuous abutment and pier bridges or are the result of the shear stiffness of the bearings for jointed bridge structures.

Forces analyzed by the program are calculated from time of deck or slab construction to infinity.

The User is required to input the Average Mean Relative Humidity as per CHBDC figure A3.1.3.

For deck on girder bridges, time of girder construction to time of placement of girders on bearings, and time of placement of girders to time of deck construction generally cannot be determined with high certainty at the time of design. Variables not only include the difference between the completed construction stages, but also the fact that typically only one girder at any one time is being constructed. The program input is based on the age of the girder at the time of deck pour in days (t) to infinity (tζ).

For post tensioned slabs, (t) represents the age of concrete to release of the prestressing.

The Shrinkage Correction Factor due to creep $(1-e^{-\psi(t,to)})/\psi$ for prestressed girders may be entered manually or calculated automatically by the program. The Shrinkage Correction Factor for creep of the deck of deck-on-girder bridges will be calculated automatically by the program.

The exposed surface area of girders is the surface area of one girder multiplied by the number of girders.

Parabolic Soffit Slabs:

The User shall input the average exposed surface area that would be relative to the varying depth of the slab over the span length.

See Appendix 16 for Differential Shrinkage.

5.4.11 Prestress Creep CHBDC 3.9, 8.4.1.6, 8.6.2.3

Prestress Creep is the load effect due to the creep of the concrete girders or slab from the Prestressing load in continuous abutments and piers, and continuous span bridges, and the load effects from the restraint caused by bearing stiffness.

The User is required to input 't (Days)' and 't1 (Days)' as required relative to the type of superstructure. For example, sixty days may pass from the time the girders are cast to the time the deck is cast, and fifteen days my pass from the time the girders are cast to the time the girders are placed on the bearings. Therefore, 't' = 60 and 't1' = 15. The Creep Correction Factor $(1-e^{-\psi(t,to)})$ will then be calculated automatically by the program or may be entered manually.

Alternatively, the User may input the Creep Correction Factor.

In lieu of 't' and 't1' being input, or the Creep Correction Factor being entered, the program will default the Creep Correction Factor to a value of 1.0.

Method A:

Unrestrained prestressing creep causes both horizontal and vertical deformations of the superstructure. The User is required to input the prestressing Fixed End Moments (FEMs) from all girders or the slab per span and for each applicable span and may also input the prestressing Corresponding Axial Force. The FEM's can be found on the DISPL worksheet of our BRIDGpretension program. Alternatively, tools for calculating FEMs can be found within Fig. 8.1.4 of the Metric Design Manual – Precast and Prestressed Concrete published by Canadian Prestressed Concrete Institute (CPCI) and figure DA 2-16 titled 'Fixed End Moments for Beams' from the Ontario Ministry of Transportation Structural Manual (FEM = $2EI\theta_{final}/L$). $E_{c,28}$ and I are for the composite section or slab, and final rotation is determined using the final prestress forces after all losses and the eccentricity of the prestressing using the composite section properties or the slab where applicable.

For deck on girder bridges, the intent is to calculate the effects from the time the deck is cast to create a composite superstructure, and to create a substructure that is integral or rigid when applicable. Forces developed during the time the naked girders are resting on the bearings are considered negligible and do not form part of the analysis.

For post tensioned slab bridges, the intent is to determine the effects from the time the prestressing is applied.

Load effects calculated by the program are from the restraint moments and axial shortening. Restraint moments do not impart additional deflection and rotation into the structure. To establish long-time prestress creep deformations the prestressed member instantaneous deflections and rotations should be increased as appropriate. See cl.C8.13

The properties of the superstructure span have been calculated using f'_{ci} at transfer when calculating deflection and rotation only. This is to coincide with CHBDC cl.8.13 for estimating long-term deflection and rotation so the User may utilize the long-term multipliers relative to the instantaneous or 'at transfer' time of loading.

Trial and error bridge analysis and prestressed girder or slab design may be performed to obtain final results.

Method B:

Some Designers do not agree with these additional moments mentioned in Method A created from creep effects or feel they are too difficult to estimate stages of construction and have too many property variables. Dead and Prestressed creep effects from moments is either ignored or creep is considered satisfied as follows.

An accepted method for analysis and design of semi-continuous prestressed girders with composite deck is to:

- Analyse each span separately as a simply supported beam for positive moment effects (Alternatively, Live Load moments may use partial continuity over supports relative to any partial continuity from some positive moment reinforcing being provided or closing of concrete cracking when Live Load is applied). See cl.8.19.4.2.
- Analyse as a semi-continuous superstructure for negative moment design and should include longitudinal creep effects
- Use provincial standard for moment connection between girders (these standards may not provide full positive moment restraint)

Also, refer to the National Highway Research Program, Report 322

5.4.12 Dead / Superimposed Dead Load Creep CHBDC 3.9, 8.4.1.6, 8.6.2.3

Load effects calculated by the program are from the Restraint Moments only. Restraint Moments do not impart additional deflection and rotation into the structure. To establish long-time creep deformations the member instantaneous deflections and rotations should be increased as appropriate. See cl.C8.13

5.4.13 Differential Settlement CHBDC 3.9, C6.6.3

Differential Settlement is the effect on a frame or continuous span bridge due to the differential settlement between adjacent supports in the longitudinal direction.
The User is required to input the differential settlement of each support beyond the expected settlement of the entire structure. Therefore, if the maximum any one support may settle is 25mm and the entire structure is expected to settle 15mm, then the differential settlement for any one support is 10mm which becomes the Maximum Settlement input value.

5.4.14 Earthquake CHBDC section 4

Seismic analysis is for Force-based Design.

BRIDGframe determines the effect on a structure due to movement and forces from an earthquake in either longitudinal direction.

For continuous abutments and/or piers, the effects are due to the frame stiffness in conjunction with the backfill spring stiffness, the resisting soil pressure at one end, and the applied soil pressure at the opposite end, as applicable. As the structure moves in either direction longitudinally, the reacting soil pressure increases to assist the frame stiffness in resisting this movement.

BRIDGframe calculates active soil pressure as per C4.6.4. The minimum K_{AE} value that BRIDGframe uses is defaulted to K_O if K_O is greater than K_{AE}. Additional soil pressure forces from earthquake loading can be added to the soil pressure (no temperature) results.

Passive soil resistance is calculated as per CHBDC C6.9 and figure C6.16, assuming loose sand (as per Integral Abutment Bridges report SO-96-01). Integral Abutment and Rigid Frame Abutments free at base assume a uniform movement over the entire abutment height, and restrained movement at base for Rigid Frame Abutments with pinned or fixed bases.

During seismic loading, additional earth pressure from seismic has been found to have a resultant acting above 1/3 the wall height, from the wall bottom. Initial static earth pressure remains at 1/3 the wall height. For cantilevered retaining wall type structures, it is common practice to apply the seismic resultant at mid-height (u.d.l. loading). This increases the cantilevered wall overturning moments. However, for integral abutment bridges, applying the soil pressure at ½ the wall height will decrease the load effects. BRIDGframe uses a resultant location of 1/3 the wall height from the wall bottom when applying the seismic portion of the soil pressure. The cantilevered retaining walls are also expected to be yielding or sliding structures, where an integral / rigid frame bridge is not necessarily, which may affect the location of the seismic portion of soil pressure. Also, refer to AASHTO.

When k_h has not been provided, the designer might choose to a value recommended by other sources.
When k_v has not been provided, the designer might choose to a value recommended by other sources or use 2/3 k_h.

Earthquake input data for Loads 7 may be found at:
https://earthquakescanada.nrcan.gc.ca/hazard-alea/zoning-zonage/NBCC2015maps-en.php#sa0.05
A link to the above website has been provided on the Loads 7 tab by clicking the Seismic Data button.

6.0 ANALYSIS

6.1 General

The program analysis is based on moment distribution using the stiffness method and the generation of Influence lines for all load effects.

For each load type involving length change of the superstructure, longitudinal loads, or for a non-symmetrical structure, the program runs sub-routines of progressive iterations to calculate the centroid of the structure for each condition based on the sum of the horizontal forces in each direction being equal.

Soil Pressures will automatically adjust during Soil Loading and Temperature effects by using non-linear soil pressure adjustments relative to the earth pressure coefficient for loose sand backfill (as per Integral Abutment Bridges report SO-96-01), to balance the structure during analysis. Pressure from surcharge loading during expansion is also automatically increased relative to the adjusted earth pressure coefficient during the balancing of the bridge frame forces subroutine. Where temperature effects are not part of the soil forces, the balancing of the structure will use only the soil pressure loading.

During a seismic event on a rigid frame or integral abutment bridge, the program uses the Average Horizontal Modulus of Subgrade Reaction on Abutments t determine the stiffness of the structure.

For each load case involving dynamic or pattern loading, the program removes any loading that does not contribute to the maximum load effect. For specific load cases, see OUTPUT.

Parabolic Soffit Slabs and Tapered Abutments:

As previously stated in Input, the program models a true parabolic soffit slab and tapered abutments rather than a series of rectangular or tapered sections.

6.2 Analyze

To analyze the model, open the Analyze tab and under 'Output Generation' complete the Divisions per Span/Support preference to be analyzed and then click the 'Run' button to start the Analysis calculations.

To interrupt an analysis in progress, place the cursor over the Excel worksheet and depress the 'F1' key on the keyboard. This will allow the User to pause or terminate an analysis.

If the BCL Truck was selected for the analysis, the program will take an extended period of time to complete the run. The recommended 'Increment Length for Advancing Vehicles' on the Loads 3 tab should be set to 1.2 to 1.5% of the total bridge length and a minimum of 0.3m for short length bridges and 1.2m for long length bridges. A further recommendation is to have a maximum 'Number of

Divisions per Span/Support' on the Analysis tab set to 10. These limits are to try and keep the analysis time to less than 1 hour.

During the analysis, the User may continue using their computer but must not open another Excel workbook.

The User may uncheck the "Output All" button to only write certain groups of worksheets.

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7.0 OUTPUT

7.1 General

The amount of output results, or number of divisions per span or support, is User defined on the Analyze tab under 'Output Generation.' Upon a completed run of the program, the User may request additional results located between a division by selecting the location using the 'Show Calculations for One Location' input table found on the Analysis tab and attaining the results for that location from the 'Calculation Tables' found on each Load Output worksheet.

Results for the superstructure are from left (location result = 0) to right, and for the abutments and piers from top (location result = 0) to bottom.

Geometric configuration or loading conditions cause horizontal displacements of a bridge frame. These displacements are significantly reduced or eliminated when soil backfill is included as a support of the frame. The program restrains the longitudinal movement of the superstructure within a frame to simulate the actual longitudinal movement that the bridge would move. Without this restraint, the distortion of the bridge frame would allow for redistribution of the moments and associated forces causing a margin of inaccuracy in the results.

Deflections are reported to one decimal place. Deflections less than 0.05mm will not be reported to equal zero but will be left blank in the output results.

Primary load output results are identified on the worksheets with uppercase letters. The breakdown of the truck or live load effect may be found on the lowercase letter worksheets.

Horizontal Reactions are reported at the support base. For integral abutments this reaction is relative to the base of the pile; for rigid frames this reaction is relative to the base of abutment; and for non-continuous abutments and/or piers this reaction is relative to the interface between the bearings and underside of girders.

Load case output results are that of the entire structure width modeled. Therefore, for example, to establish the forces per girder, the results must be distributed amongst the number of girders. Since deflections and rotations of the whole structure are relatively very close to that of the individual girder, distribution of these values is not applicable for load cases other than Live Load. For Live Load distribution, see 7.4.3. Distributing the Loads to a specific design strip is accomplished using the Combinations option; see 7.5.

Skew:

The individual load case output results provided in the worksheets include the skew factor F_S for deck-on-girder bridges only. Prior to the 2019 code, the Fs was applied to both interior and exterior design strips. For this reason, the Fs was included in the total results shown on each worksheet. The code now requests the Fs to apply only to the exterior design strip. However, for simplicity, BRIDGframe will continue to apply the Fs to the total result therefore when using the Combinations tabs and worksheets the exterior design strip will be correct and contain the Fs and the interior design strip will be conservative and contain the Fs.

7.1.1 Sign Convention

7.1.1.1 Moments

Negative Moments produce tension stresses on 1) top of superstructure, 2) left side of left abutment, 3) right side of right abutment, 4) right side of left pier, and 5) right side of right pier. Positive Moments produce tension stresses on 1) bottom of superstructure, 2) right side of left abutment, 3) left side of right abutment, 4) left side of left pier, and 5) left side of right pier.

7.1.1.2 Shear

Shear forces causing diagonal cracking through the second and fourth quadrant, are reported as negative shear forces.

7.1.1.3 Axial

Axial forces causing tension in a member are reported as negative axial forces.

7.1.1.4 Deflection/Displacement

Negative deflection or displacement represents downward movement from an initial position prior to loading.

7.1.1.5 Vertical Reactions

A negative vertical reaction represents a downward force.

7.1.1.6 Horizontal Reactions

A negative horizontal reaction represents a force acting to the left.

7.1.1.7 Rotation

A negative rotation represents a counterclockwise movement.

7.2 Geometry

A line diagram of the bridge span lengths and support heights along with support and joint conditions may be viewed on the Model worksheet for both the bridge construction stage and the bridge completion stage.

Input geometry data may be viewed on the DEFINE and FRACTIONS2 worksheets.

7.3 Properties

Direct input and calculated properties of the bridge structure may be viewed on the DEFINE worksheet.

7.4 Loads

Direct input and calculated loads and parameters may be viewed on the DEFINE worksheet.

7.4.1 Construction Loads

The program assumes the bridge deck (Case #2) may be poured over any span or combination of spans. BRIDGframe will automatically neglect the deck load or specified live uniform load (Case #4) on a span that reduces the load effect on the structure at a given location. The specified additional dead load (Case #3) will be applied regardless of if it reduces the load effect on the structure at a given location.

7.4.2 Dead and Superimposed Dead Load (SDL)

The program calculates the weight of the abutments and piers (excluding piles) when they form part of the bridge frame and includes these values in a table as part of the Dead Loads output results.

The weight of the abutments and piers are calculated assuming they are normal to the centerline of the bridge. For skewed abutments and piers, the reported weights must be adjusted to account for the skew lengths.

Dead Load and SDL instantaneous deflections and rotations are reported. For Type C1 Superstructures, the rotations and deflections from the Girder are calculated relative to the prestressed girder modulus of elasticity at prestressing transfer. For all other Loads the final modulus of elasticity is used. To obtain final results the User must increase the reported deflection and rotation values relative to the long-term multipliers as per CHBDC C8.13.3.3. The User may choose to use the Long-term multiplier for Type B - composite steel girder bridges that have been calculated relative to 3n for SDL and are reported on the SDL worksheet starting on cell S4.

Parabolic Soffit Slabs:

The portion of slab below the slab soffit at the center of span is reported in the tables on the SIDL worksheet. The load is represented on the Combinations tab under Superimposed Dead – Haunch.

Wingwall Loads:

Wingwalls / Barriers on Wingwalls are reported on the SIDL2 worksheet. For rigid frames, the wingwall load results will be that of reactions only; for integral abutment bridges the load results will be that due to the forces as applied and distributed throughout the frame. The wingwalls are assumed to be supported until the deck or slab is constructed, as such the forces are that of a SIDL applied to the frame.

7.4.3 Live Load (Truck Loads and Lane Loads)

From the Loads 2 tab, if the User selected (option 1) to model 6 trucks of 5 axles each the results are reported for each vehicle or Case 1 to 6. If the User selected (option 2) to model 2 groups or trucks of up to 15 axles the results are reported as Case 1 and Case 4. And if the User selected (option 3) to model a 30 axle configuration the results are reported as Case 1.

The starting Truck location for each case or group is with axle one directly over the left abutment. The truck advances until the last axle for each case has advanced beyond the total length of the structure.

During the analysis of each truck load case, the program automatically drops any axle that is not contributing to the maximum load effect at a specific location, if selected as such on the Loads 2 tab. For establishing load effect from the uniform portion of the lane load; any uniform lane load over a specific span that is not contributing to the maximum load effect is automatically dropped from the analysis.

The User may choose to fix the vehicle(s) at a specific location on the bridge. Input in metres is the distance from the left support.

The Live and Live 2 worksheet contains a summary prepared by the program of the maximum load effect caused by the Truck Loads verses the Lane Loads, and just the Truck Loads respectively.

The Live Load Results reflect the number of design lanes on the bridge structure.

The FRACTIONS2 worksheet contains the Live Load Fractions. These fractions include the Multi-Lane Loading Modification Factor as per CHBDC Table 3.5. These fractions are to be multiplied by the LIVE and LIVE2 results (excluding deflection and rotation) to obtain the load effects for: 1) Type C Bridge – Concrete Deck on Girder, per interior and exterior girder, and 2) Type A and B Bridge – Slab Bridge, per metre of width, as per CHBDC 5.7.1.3.1.0. The distribution of the Live Load using the fractions on the FRACTIONS2 worksheet results can be done automatically using the Combinations option, see 7.5.

The inflection points as per FIG. 5.1 of the code for L_e of the abutments was not used as per the bridge code for the program. The negative moments for the superstructure at the abutments will be less than actual when using part 5. To assist in compensating for this, BRIDGframe calculates L_e of the abutments by using the inflection point from the top if abutment caused by the soil pressure with no temperature acting. This creates a larger F_T factor.

The Live Load positive moments over the support regions and negative moments over the mid-span region have not been calculated in the FRACTIONS2 worksheet.

The inflection points for both integral abutments and rigid frames use the values of an integral abutment as modeled by the Ministry of Transportation of Ontario CANBAS program. Therefore, at the structure ends the negative moment contribution length is 0.15 x the adjacent span length and for positive moments the contribution length is 0.10 x the adjacent span length. The contribution length over the piers is as per the CHBDC figure A5.1.1. Mid-span contribution lengths will be calculated using the remaining length (e.g., 1.0 - 0.1 - 0.2 = 0.7) for end spans of multiple span bridges.

As per cl.5.7.1.2.2.2(a), D_{VE} max. will be taken as 3.00.

7.4.4 Braking Load

The program applies the braking load in both longitudinal directions over the bridge structure entire length. For integral or rigid frame abutments, the program determines the required amount of additional soil pressure required to resist the braking load, depending on direction of load application.

Braking forces assume no changes to interior soil pressure beyond that already given in the Soil worksheet results. The program, for simplicity, also assumes no decrease in the soil pressure against the abutment that is moving away from the backfill, since movement would be minimal.

The Braking Load is part of Live Load (Truck and Lane Loading). The braking force results is along the C/L of bridge as is typical, therefore, no transverse eccentricity is assumed.

7.4.5 Pedestrian Load

The program automatically any load per span not contributing to the maximum load effect.

7.4.6 Uniform Vertical Wind Load

The program uses load patterning conforming to CHBDC 3.10.1.5 and determines the greatest governing load effect from all possible combinations. The program reports the load effect assuming the wind force is applied in either an upward or downward directional force.

7.4.7 Differential Thermal Load

Differential Thermal Load output is the forces resulting from different thermal properties between the girders and the deck. Application of this load case is typically for Type B superstructures consisting of steel girders with a composite concrete deck system unless different coefficients of expansion and contraction are specified between the deck and girders of the other Types of superstructures.

Force effects are generated using the contributing area, modulus of elasticity, and coefficient of expansion/contraction, of the girders verses the deck.

There are different theories used in the application of this load. One theory is to apply the Differential Thermal force generated and applying this force to the top of the naked girder. This theory also involves a varying strain developed relative to the unrestrained deck top and the girder restricted deck soffit. Another theory is to determine the force generated by a uniform strain and applying this force at the center depth of the deck on the composite section. This program uses the latter theory.

Differential Temperature effects due to different coefficients of expansion/contraction between the deck and girders create an axial force in the girders and an equal but opposite axial force in the deck. This equal but opposite force will remain as such for simply supported girders but will be each influenced differently for continuous girders or frames. Axial forces are reported in two adjacent columns on the DTEMP worksheet, one for the girder and one for the deck. Axial force in the deck due to thermal differences between the deck and girder is only used in design of deck rebar for expansion of the girder causing tension in the deck, although it is reported in BRIDGframe for all conditions.

See Appendix 16 for Differential Temperature.

7.4.8 Thermal Gradient

Thermal Gradient is the load effect on the structure due to a variance in material temperature over the depth of the applicable superstructure section.

Thermal Gradient causes vertical deformations only and not forces in unrestrained members. Forces are induced into the continuous members due to their restraint conditions.

For simplicity, reduction or increase in effective temperature as per fig. 3.5 of the CHBDC will be based on the average depth within a span length.

7.4.9 Thermal Expansion and Contraction of Superstructure

Thermal Load from Expansion and Contraction is the load effect on the structure due to the shortening or lengthening of the superstructure through expansion and contraction. Forces are induced due to continuity of the bridge frame and support conditions, or through bearing stiffness for non-continuous abutment and pier bridge structures.

For simplicity, reduction or increase in effective temperature as per fig. 3.5 of the CHBDC will be based on the average depth within a span length.

Note: Temperature effects for frame structures are included in the soils results

7.4.10 Soil Pressure

Soil Pressure is the load effect on a continuous abutment structure due to soil backfill pressure against the abutment frame legs. Soil pressure is not applied to the pile foundation portion of an integral abutment bridge.

Horizontal Soil Springs:

BRIDGframe does not use compression only horizontal springs along the abutment height since this would only complicate the model generation. It is also difficult to accurately model interaction between the soil and the structure model using horizontal soil springs. Soil springs are generally assumed to be linear although soil does not react linearly. When the User chooses to model a frame that uses compression only horizontal springs along the height of abutment, the stiffness of the spring can only be approximated since the actual movement is unknown and is also not constant. Furthermore, geotechnical engineers generally do not have full confidence in defining soil spring values.

Rather than soil springs, BRIDGframe will automatically adjust the soil pressure during Soil Loading and Temperature effects by using non-linear soil pressure adjustments relative to the earth pressure coefficient as per the MTO Integral Abutment Manual and CHBDC Fig. C6.27, to balance the structure during analysis. The adjustment of the earth pressure coefficient is also relative to the surcharge load that is probably not automatically calculated using a program utilizing soil springs.

Exterior Soil Pressure:

The program assumes At-rest soil pressure at the Effective Construction Temperature as entered on the Loads 4 tab. During Thermal Expansion of the Superstructure, the program calculates the Passive pressure increasing relative to the expansive movement of the superstructure.

During Thermal Contraction of the Superstructure, the Soil Pressure modeled is between At-rest and Active pressure, depending on the amount the abutment moves away from the backfill material.

The program also calculates the effective soil pressure behind each abutment with no temperature effects to be used in the applicable limit state condition.

Live load surcharge is not used during Thermal Contraction.

Interior Soil Pressure:

Interior soil pressure is more difficult to define since there typically are fewer controls placed on the material that may be used, and the construction methods. Where construction is adjacent to a watercourse, the backfill material may be that of a large loose stone material such as smooth river stone. Under drier conditions the backfill may be that of imported granular or native material. The material type may change during construction, and furthermore, compaction of the material is questionable or unlikely. Erosion and settlement of the material is also likely to occur. Relying on interior soil pressure to resist the 'free' base of a rigid frame is questionable, however, if such is the case, at best the soil pressure resistance that would probably be achieved is At-rest conditions, however, Active conditions would probably be more realistic. To achieve Passive conditions, the movement required would probably cause failure at the abutment and superstructure connection.

The program does not use a varying soil pressure based on the movement similar to that of exterior soil pressure. Due to the many variables and an unclear starting pressure, the program uses constant interior soil pressures.

During Thermal Expansion of the Superstructure, the program uses a constant Active soil pressure. During Thermal Contraction of the Superstructure, the program uses a constant At-rest soil pressure.

Note: Temperature effects for frame structures are included in the soils results

Where the user wants to exceed or decrease the above conditions, the backfill material density can be adjusted to obtain the necessary load, or the width of the applied soil load can be adjusted.

7.4.11 Differential Shrinkage Load

Differential Shrinkage Load output is the forces resulting in the difference between the shrinkage of the deck and the shrinkage of the girders. Differential Shrinkage may imply shrinkage of the girder exists; however, for the purpose of this load case, Differential Shrinkage will also represent the shrinkage between the concrete deck and a steel girder having no shrinkage.

Force effects are generated using the contributing area and modulus of elasticity of the girders verses the deck.

There are different theories used in the application of this load. One theory is to apply the Differential Shrinkage force generated by the deck and applying this force to the top of the naked girder. Another theory is to determine the force generated by a uniform strain and applying this force at the center depth of the deck on the composite section. This program uses the latter theory.

Differential Shrinkage effects due to different shrinkage strains between the deck and girders create an axial force in the girders and an equal but opposite axial force in the deck. This equal but opposite force will remain as such for simply supported girders but will be each influenced differently for continuous girders or frames. Axial forces are reported in two adjacent columns on the DSHR worksheet, one for the girder and one for the deck. .

The Differential Shrinkage Force of the deck will be adjusted by a Shrinkage Correction Factor due to creep.

See Appendix 16 for Differential Shrinkage.

7.4.12 Shrinkage Load

Shrinkage output is the load effect from the shortening of the superstructure and is applicable to Type C structures only. Forces are induced due to continuity of the bridge frame support conditions, or through bearing stiffness for non-continuous abutment and pier bridge structures.

7.4.13 Prestress Creep CHBDC 8.4, 8.6

Prestress Creep is the effect from the 'restraint' moments induced due to the creep shortening of the superstructure length and the creep rotation due to eccentric prestress loading.

Prestressing causes vertical and horizontal deformation only and not forces in unrestrained members.

Forces from prestressed girders are induced into continuous members due to their restraint conditions calculated after deck placement. Restraint conditions include frame action from continuous frames or shear stiffness from bearings in non-continuous abutments and pier bridges.

7.4.14 Dead and Superimposed Dead Load Creep CHBDC 8.4, 8.6

Dead and Superimposed Dead Load Creep (herein referred to as Dead Load Creep) is the effect from the Restraint Moments induced due to the differential creep over the depth of the superstructure section and is considered for Superstructure Span Type C1 only. Deck creep of steel composite girders is addressed during the design phase of the composite section.

The program calculates the applicable Dead Load bending moment at each mid-span and induces this force into the span ends for distribution throughout the bridge frame (CHBDC C8.6.2.6).

The program uses the same Creep Correction Factor ($1-e^{-\psi(t,to)}$) as that used for Prestress Creep.

7.4.15 Differential Settlement

The program calculates the maximum load effect from all possible combinations of support settlement. Any support settlement that decreases the load effect at any reported location is removed from that specific location analysis.

The force effects are generated from moment distribution only and assume no horizontal movement at the base of the substructures. Soil pressure, approach slabs, etc., are assumed to also fix the superstructure from longitudinal displacement beyond the original location of the superstructure prior to settlement occurring. Any secondary elastic effects such as superstructure length change do not form part of the analysis.

7.4.16 Earthquake

Earthquake output is the load effect from additional soil pressure as applicable for continuous abutment bridges and requires the inclusion of the SOIL (no temperature) effects to establish the total soil pressure effects. Output results for continuous abutment bridges will reflect the minimum longitudinal displacement location when the total soil pressure first reaches full passive resistance or less. Where piers are continuous with the superstructure, but the abutments are non-continuous, the earthquake output is the load effects from the resisting frame only. In the case of non-continuous abutments and piers the output is not written.

Earthquake forces assume no changes to interior soil pressure beyond that already given in the Soil (no temperature) worksheet results.

The weight of the structure uses the superstructure dead and superimposed dead loads only, for integral abutment and rigid frame bridges (the abutment against the soil acting in passive resistance is not included in the structures weight). The stiffness of the frame is calculated based on the displacement caused by the weight of the structure and the backfill soil springs applied to the high fill side.

7.5 Fractions

The Fractions tab will populate automatically or allow for User defined fraction values by way of selection by the User on the Analysis tab. The selection of 'Auto' will have the program determine the live load fractions automatically. The selection of Auto / Manual will show the values the program calculates automatically but them allow the User to manually override the automated values. And the Manual option goes straight to manual input by the User. See Appendix 10.

7.6 Load Combination

Using the Combinations 1 tab (Appendix 11), the program allows the User to generate a Load Combination from the Load Cases after Analysis of the structure.

The Combinations 2 tab is for developing maximum and minimum envelopes. The program automatically compares related (e.g., all ULS) combinations in conjunction with utilizing the maximum and minimum individual load case fractions to report maximum and minimum force envelopes. Winter and summer conditions are automatically kept separate during the envelope generation. For 'K' or Transitory Loads, Temperature Expansion and Contraction, and Differential Temperature, will always be included in the summation of all forces. Shrinkage and Differential Shrinkage, and ΣCreep Loads will be included if chosen by the User. Thermal Gradient forces will be automatically eliminated from the summation if they decrease the net force effects, as there is no guarantee of the magnitude of these forces.

The User may choose to distribute the Static Load Cases equally amongst the girders. Therefore, if a bridge has four girders the amplification factor would be 0.25. Or the User may distribute loads equally amongst the girders by selecting 'Divide Amongst Girders.

The User may choose to distribute the LIVE or LIVE2 Load Cases to the appropriate girder (interior or exterior) as per the Live Load Amplification Fractions given on the FRACTIONS2 worksheet. Note: the governing design for positive live load moments will fall within the mid-span region, therefore, for simplicity, all positive moments including those over the supports will utilize the load amplification factor at throughout the mid-span region. Likewise, the governing design for negative live load moments will be at the support location. Similarly, and also for simplicity, all negative moments will utilize the load amplification factor at the support and carry this factor throughout the mid-span region.

Braking load is distributed as part of the 'Remaining Load Cases'.

Pedestrian load is automatically included in the Live Load results and is distributed as part of the 'Remaining Load Cases'. Pedestrian load will be included as part of SLS1, ULS1, ULS2, and ULS3.

The table consisting of vertical reactions and rotations provide two results at pier locations or x/L = 1 or 2. The first row of values at a pier location utilize the amplification fractions and/or number of girders in the span to the left of the pier and the second row of values utilize the amplification fractions and/or the number of girders in the span to the right of the pier.

To generate Load Combinations that include distribution of live load for bridge types other than A, B and C as per Table 5.1, the User may edit the FRACTIONS2 tables to account for the bridge type being analyzed, after completion of the structure analysis. In order for manually entered amplification fractions to not be overwritten during proceeding model analysis, the User must have selected 'Manual' in the Geometry 3 tab.

Load distribution for a rigid or integral support, or for a slab superstructure, may be distributed per meter width. Therefore, for a ten meter wide structure a distribution factor of 0.10 might be chosen.

If the User chooses to save the output for each of the load combinations generated, rather than overwriting it, the User may generate a load combination and then copy and rename the combination worksheet using the Excel commands.

For superimposed dead loads the haunch option represents the portion of slab below the slab soffit at the center of span.

For simplicity, the sum of the rotations on the Combination and Combination 2 worksheet is based on the entire structure; no load amplification or distribution has been applied.

Construction loads presently are not included in the Combination tab. Construction load effects can be viewed on the Construction worksheet.

Note: the FRACTIONS2 worksheet in Excel contains the Multi-Lane load modification factor as per the CHBDC Table 3.5. On the Combination 1 and Combination 2 tab, the User has the option of using or excluding the Multi-Lane load modification factor from the results, regardless of the factor already being included in the amplification fractions in the tables on the FRACTIONS2 worksheet.

On the Combination and Combination 2 tab, the Braking Load will be automatically included in the Live Load values. On the Combination 2 tab, where the Braking Force does not in increase the Live Load effects, it will be automatically neglected to simulate no braking taking place on the structure. The braking will always use the ULS load factors of the code regardless of what load factor values are used in the Combinations tabs.

To include weight of abutments and piers, and effects from the wingwall loading, The User must select 'Dead' on the Combinations tabs and select 'Substructure' with a load factor.

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8.0 Printing

Printing of Excel worksheets is done by selection of each load case result as found on the program Analysis 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 tabs, the User may: i) press 'Ctrl,' 'Alt' and 'Prt Sc' simultaneously when on the tab 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.

The 'Get Confirmation' is defaulted to active when the Select All button is clicked. This option requests the User to verify the printing of each worksheet. Un-checking of the 'Get Confirmation' would remove practical control methods of the User to end the print operation when multiple worksheets are selected for printing. The User must select the 'Get Confirmation' manually if the individual print options are also selected manually.

Selection of 'Print Cover Pages' will print a cover page for each of the load case output worksheets.

Printing of the Load Combination Tables is done on the VB Combination Tab by selecting the Print button and then selecting the result tables from the excel combination worksheets to print.

9.0 Troubleshooting

If the User does not Load a compatible Excel file, an Error will appear. Probable Resolution: Load a compatible Excel spreadsheet that was received with the program or download and use the Example Excel file from the website.

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. Further configuration of the firewall may be required to allow BRIDGframe.exe and BRIDGframeUpdater.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 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

The maximum number of variable sections (members) within a span length is set at seven.

Type C3 – post tensioned concrete systems (shored construction) is not fully supported for this program release version.

The intent of this program is to utilize the Simplified Method of Analysis as per CHBDC 5.6 and 5.7 as applicable. Simple beam theory / stiffness method is used to analyze the bridge behavior.

Transverse loads do not form part of this program.

Soil springs along a foundation height do not form part of this program. BRIDGframe automatically adjusts the earth pressure coefficient during temperature effects and soil interaction.

Number of spans is presently limited to three for direct input although bridges with more than three spans can be modeled.

Piers and piles comprising of individual members must be of the same section properties and have the same global neutral axis location. Offsetting individual members is not supported. Multiple members are lumped to obtain a single element for analysis.

Tapered Abutments for rigid frames limit the thickness of abutment at Top to be equal to or no greater than 3x the abutment thickness at bottom.

Parabolic Soffit Slab Superstructures limit the depth of the deck at ends to be equal to or no greater than 3x the deck depth at center of span. The Parabolic Soffit Slab must be symmetrical.

Generation of User defined Load types are not supported. Load types are predefined.

Presently, only uniform loads over a span length are supported for load cases such as dead and superimposed dead loads. Since the truck loading can model up to 30 axles it should be possible to use this input to model most any vertical load shape.

Not all Superstructure and Bridge Types are supported. See 5.2 Geometry.

The program does not include effects of elastic length change of members except for prestressing horizontal forces causing shortening.

Units of measurement for Input and Output are fixed.

Superelevation and sloping bridge profiles does not form part of the program analysis.

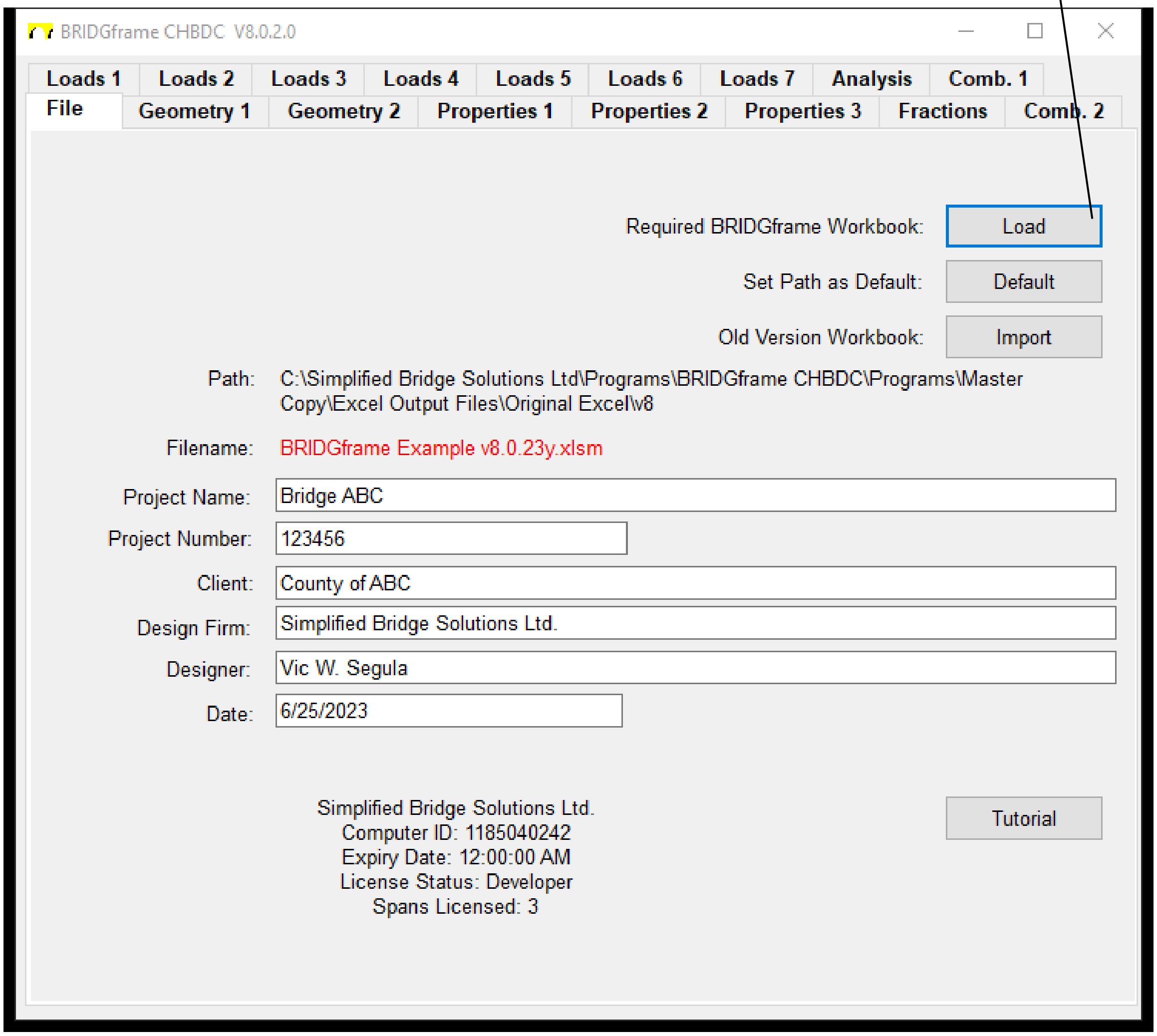
Effects of frictional forces between backfill and abutments does not form part of the program analysis.

Direction of traffic is parallel to direction of horizontal alignment.

The maximum number of vehicle axles per vehicle or axle group that may be entered is thirty.

APPENDIX 1 – FILE TAB

BRIDGframe worksheet Load button



- Load: load the BRIDGframe Excel file to be used in analysis
- 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 (not visible): this button provides a link to the web site

APPENDIX 2 - PROGRAM FEATURES

BRIDGframe
2D bridge analysis software

- conformance with the Canadian Highway Bridge Design Code CAN/CSA-S6-19
- simple and minimal tabular input of structure model and loads for continuous beam, rigid and integral abutment, and integral pier analysis
- named bridge member components rather than numerically identified members
- simplified and automatic generation of support conditions
- one step input to generate tapered abutments and parabolic symmetrical soffit slabs
- simple generation of composite section properties
- drop-down menus of standard steel and precast concrete sections
- only one model required for all load conditions and construction stages
- automatic generation of soil pressure relative to temperature expansion and contraction, and due to distortion of non-symmetrical structures. Soil pressure is non-linear and relative to actual non-linear soil pressure conditions and not modeled as linear springs.
- automatic generation of horizontal reactions at superstructure level to simulate restraint of frame provided by backfill behind abutments
- automatic patterning of loads, such as construction, wind, and differential settlement
- automatic application of all loads
- all loads input as positive values except temperature below zero
- pre-designated load cases that may be edited
- User-requested automatic generation of second and/or third span properties and loads, to match first span input
- If selected, truck axle loads not contributing to the maximum load effect are automatically eliminated from the analysis
- Automatic determination of contributing length of udl loading per span for lane and pedestrian load
- automatic generation of governing live load effect (truck loads vs. lane loads)
- differential shrinkage and differential temperature effect between the girders and deck
- restraint moment load effect from prestressing creep, dead load creep, and shrinkage effect
- braking and longitudinal earthquake load included
- output of results is left to right for superstructure and top to bottom for substructure, not dictated by order of input typical of general structural programs
- User can obtain results at any location on structure without reanalyzing
- live load moment, shear, and axial amplification fractions automatically generated for Type A, B, C (slab on girder as per Table 5.3), and D (with continuity of transverse flexural rigidity across the cross-section) bridge types as per Table 5.1. Manual input of amplification fractions allowed for other bridge types.
- amplification fractions for governing interior and exterior girders in positive and negative regions of continuous frames
- combination of load cases includes amplification of Live Load to exterior and interior girder

- one step max / min load combination results
- output is very clearly defined
- output is in Microsoft Excel, making it very accessible for viewing and generating graphical output

APPENDIX 3 - SOFTWARE LICENSING AGREEMENT AND INSTALLATION

BRIDGframe
Software Licensing Agreement

By installing the BRIDGframe 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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BRIDGframe
Installation

Design parameters and calculation results for bridge analysis are stored in Excel workbooks, one workbook per analysis. BRIDGframe 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.

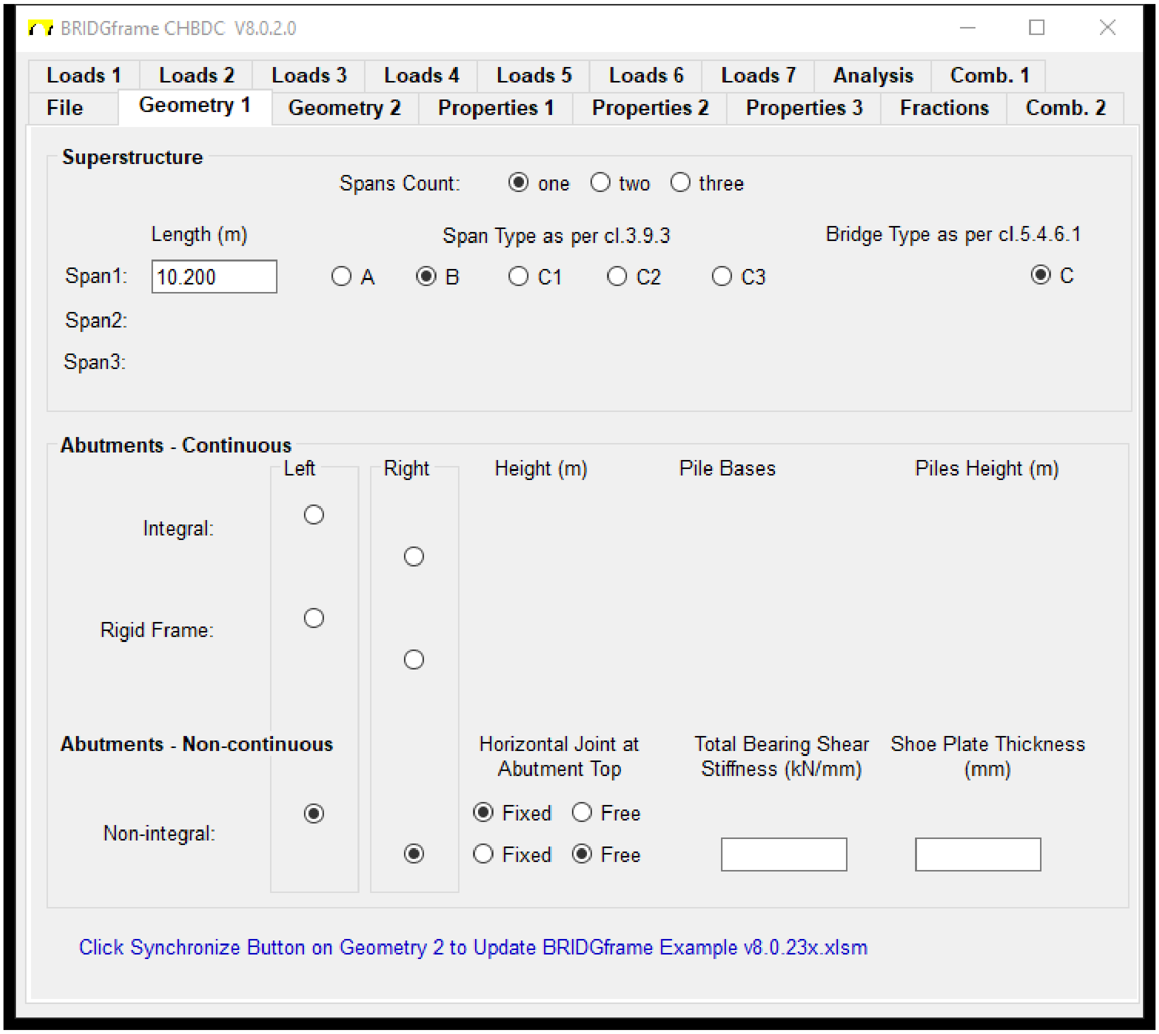
Certain advanced features are disabled until the application is registered. BRIDGframe will run in Demo mode until it is registered.

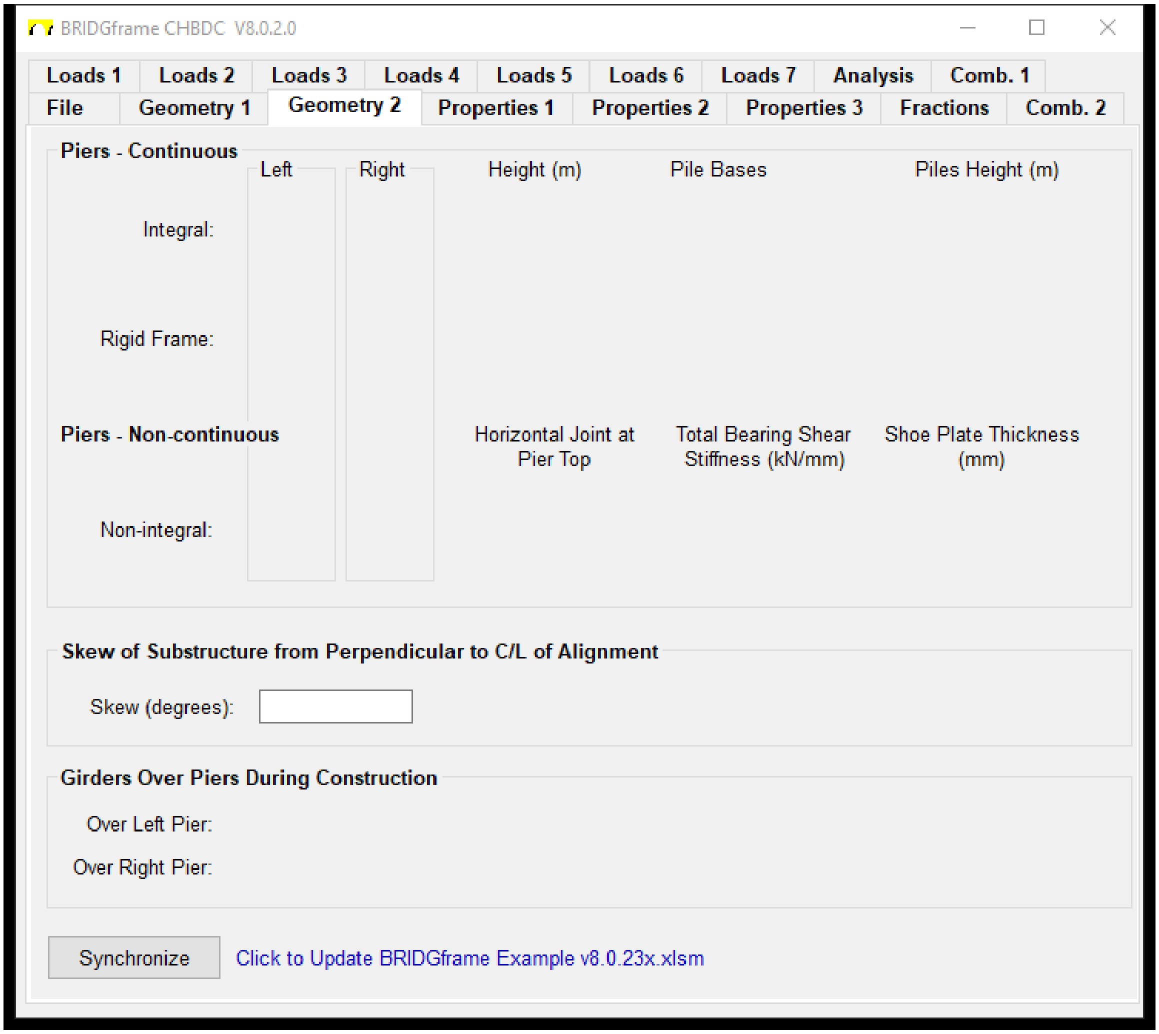
APPENDIX 4 – SIMPLY SUPPORTED STEEL GIRDERS

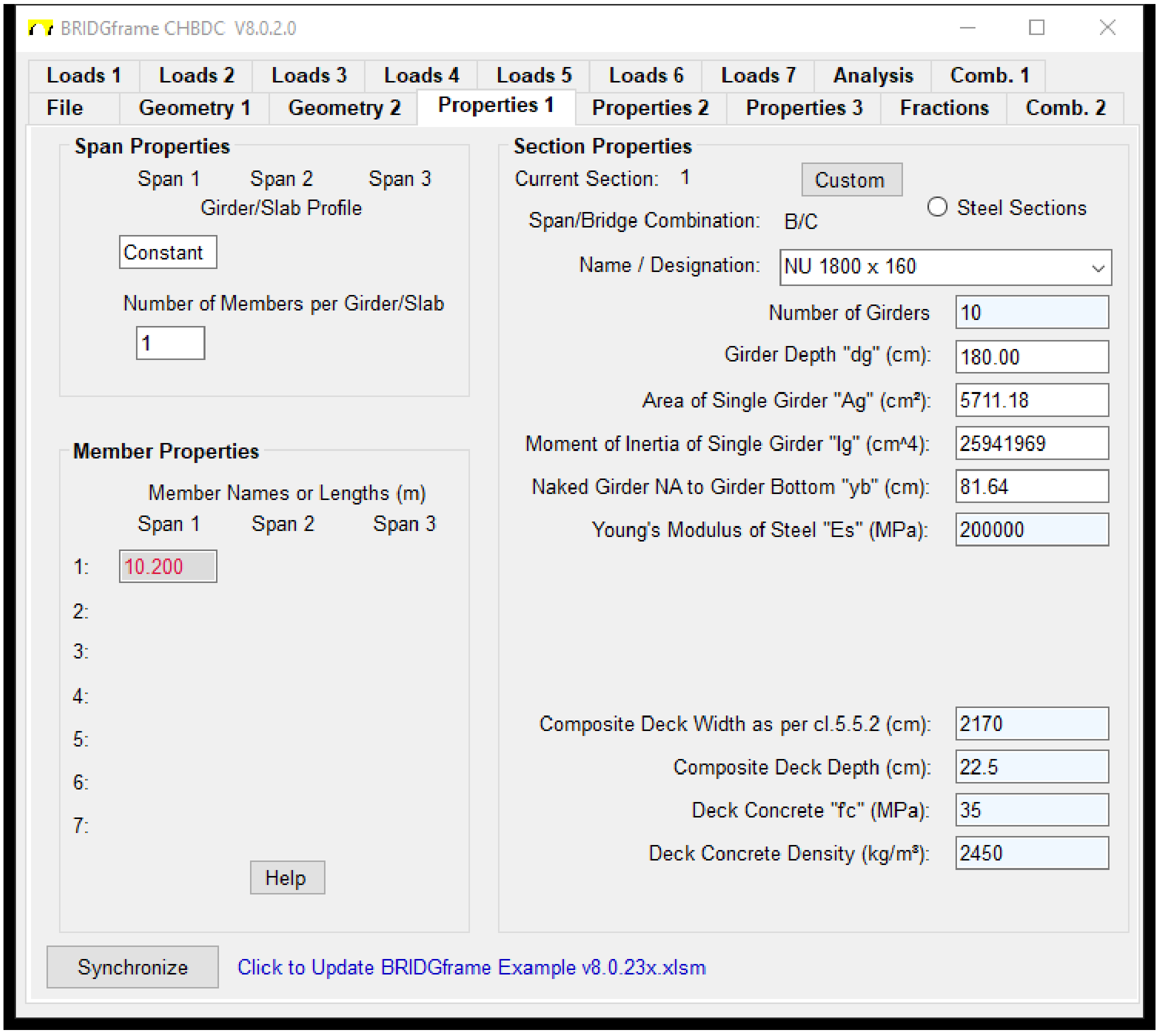
Bridge Geometry

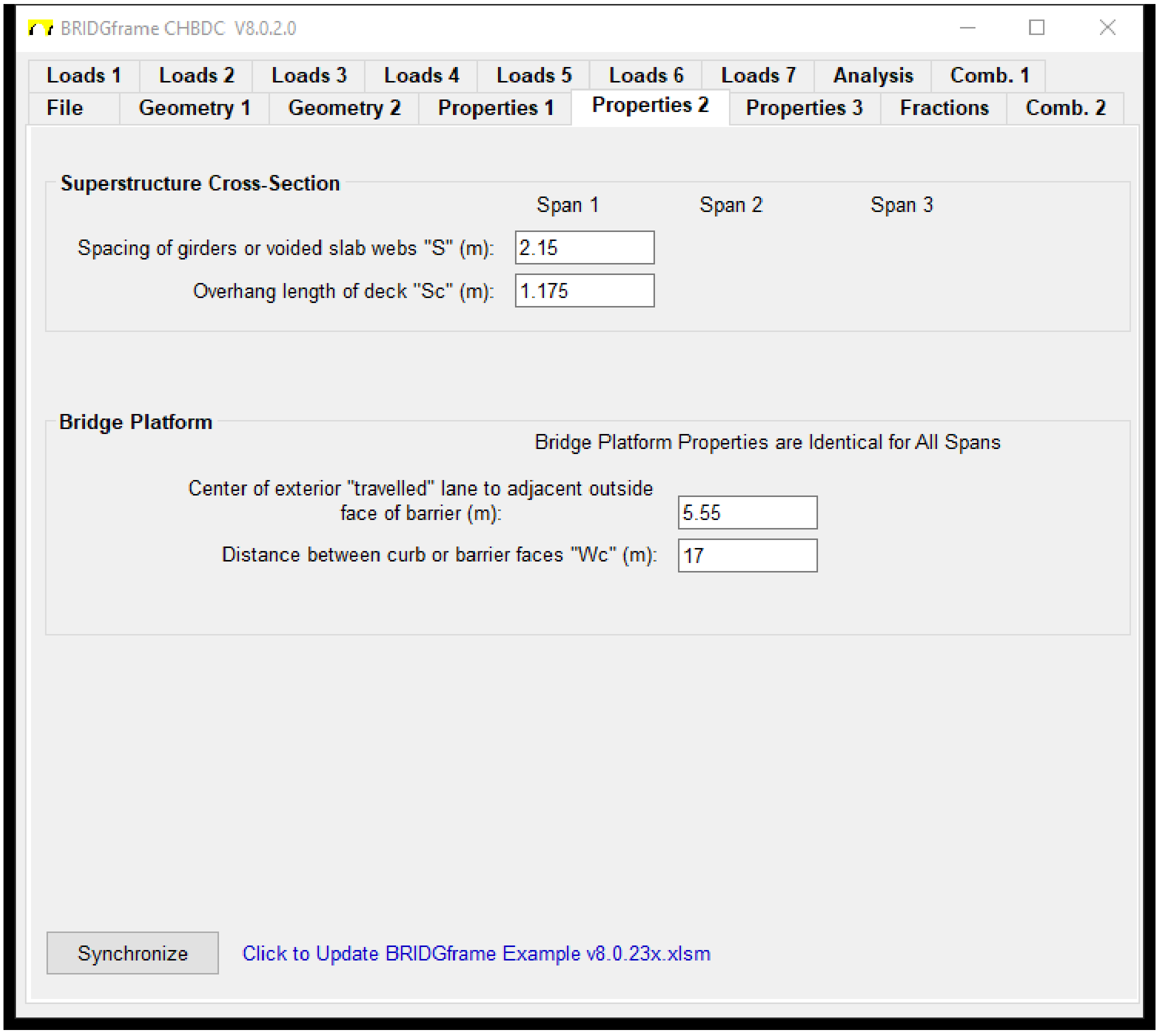
Structure Type:	Simply supported concrete composite deck with steel girders
Spans:	1 span at 10.2 m
Deck:	5.6 m total width x 225 mm thick (32 kN/m). 5.0 m barrier inside face to barrier inside face. 1 travelled lane at 3.0 m. 2 side clearances at 1.0 m. 1 design lane. 90mm asphalt and waterproofing (10.2 kN/m).
Barriers:	Parapet wall 250 mm (11.0 kN/m)
Girders:	5 – W310 x 79 spaced at 1.15 m (4.6 kN/m)
Abutments:	N/A
Shoe plates:	assume 20 mm thickness
Bearings:	assume shear stiffness/bearing = 3.0 kN/mm (15.0 kN/mm)

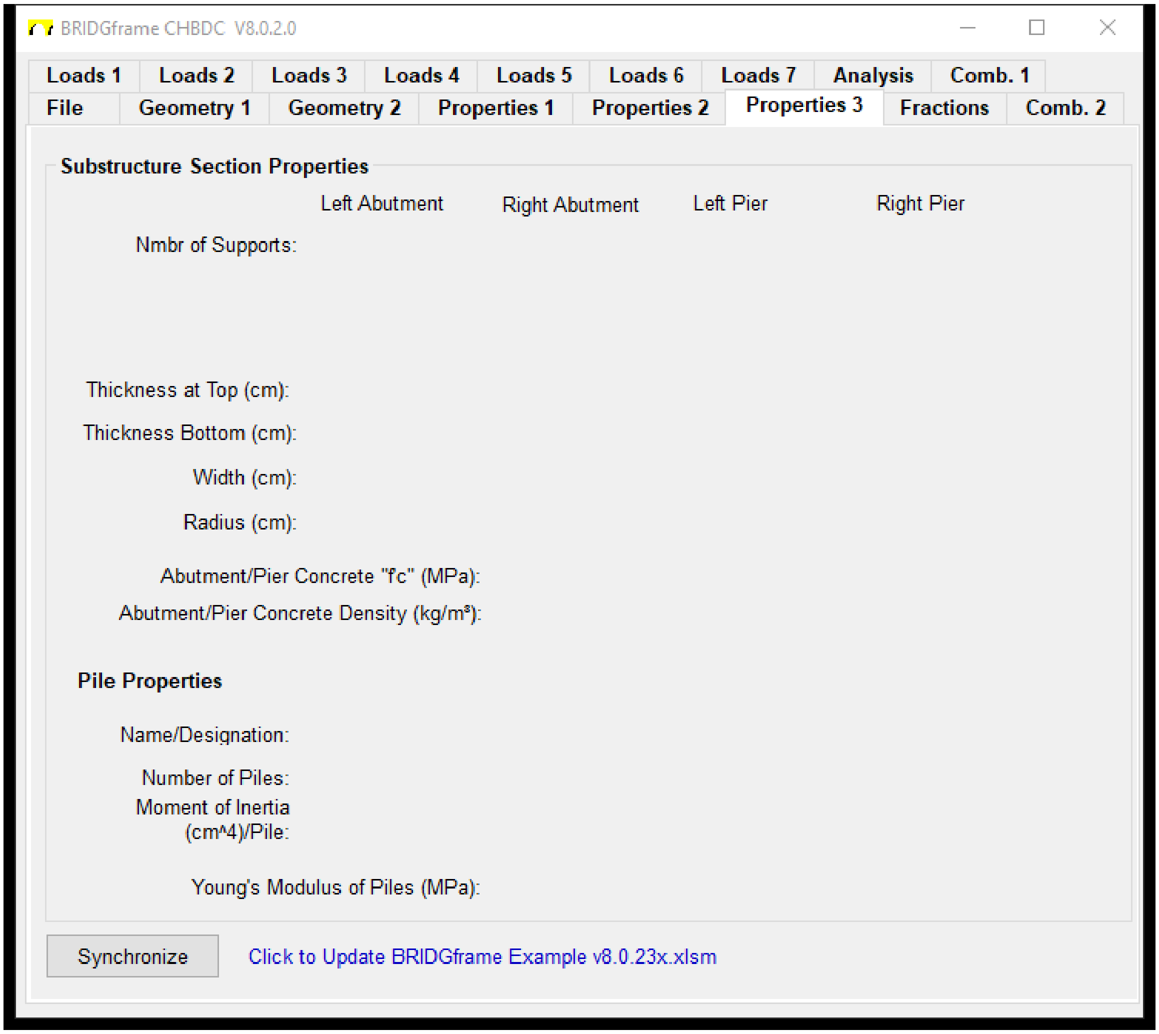
Note: Non-integral model provided. If semi-integral model required, input may be done as per Appendix 12.

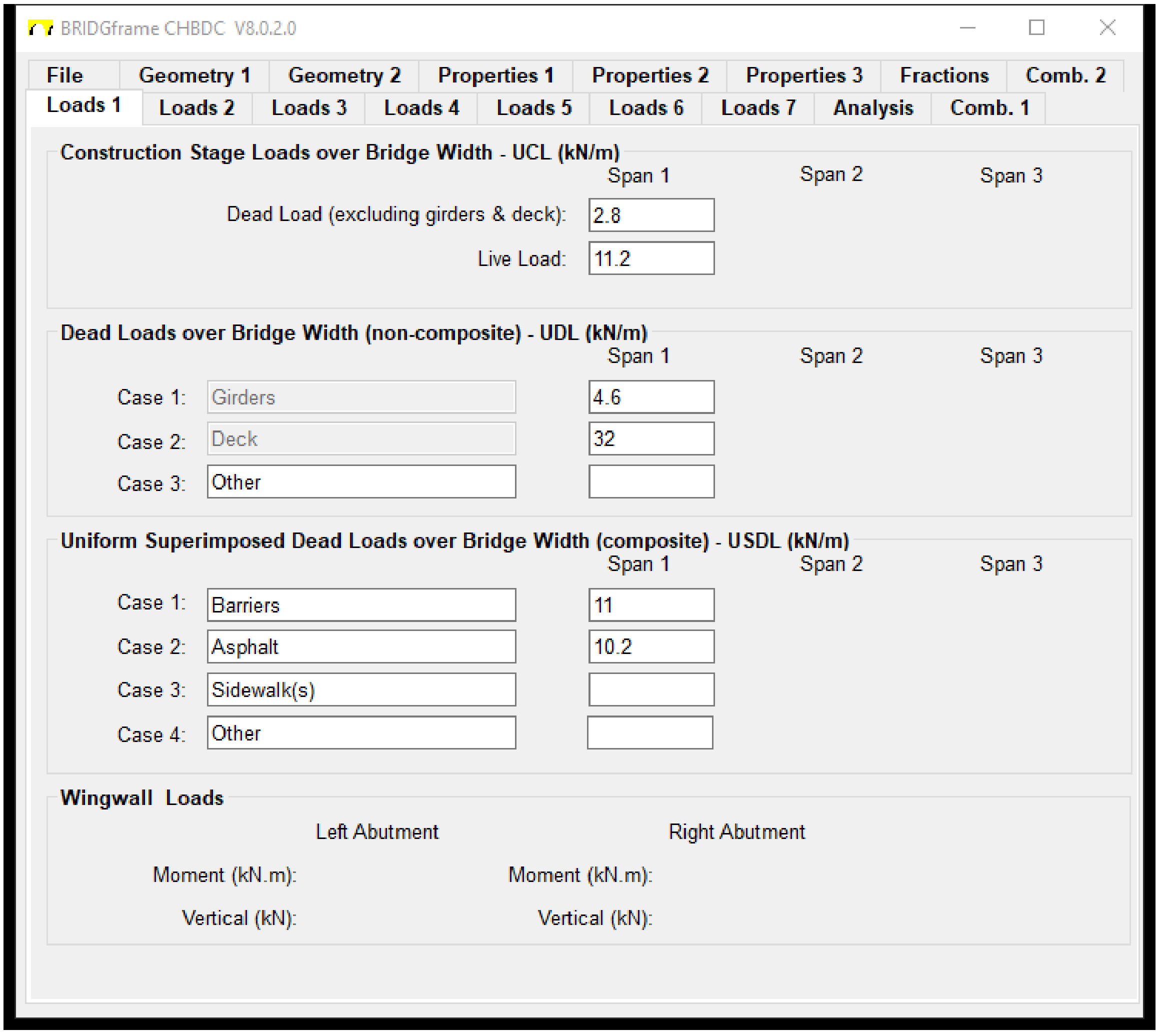

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Superstructure
Spans Count:
one
two
three
Length (m)
Span Type as per cl.3.9.3
Bridge Type as per cl.5.4.6.1
Span1:
10.200
A
B
C1
C2
C3
C
Span2:
Span3:
Abutments - Continuous
Left
Right
Height (m)
Pile Bases
Piles Height (m)
Integral:
Rigid Frame:
Abutments - Non-continuous
Horizontal Joint at Abutment Top
Total Bearing Shear Stiffness (kN/mm)
Shoe Plate Thickness (mm)
Non-integral:
Fixed
Free
Fixed
Free
Click Synchronize Button on Geometry 2 to Update BRIDGframe Example v8.0.23x.xlsm

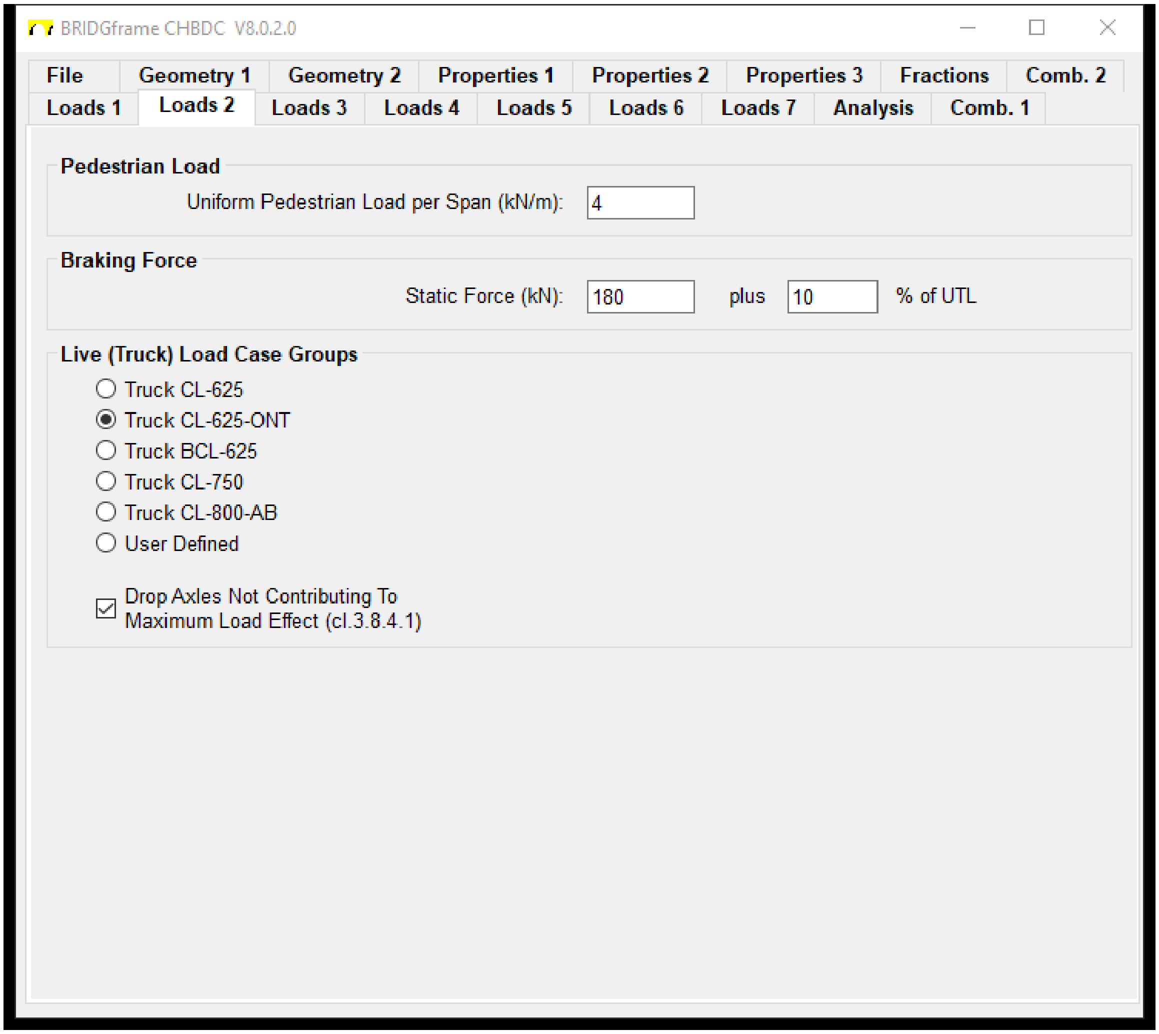

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Piers - Continuous
Left
Right
Height (m)
Pile Bases
Piles Height (m)
Integral:
Rigid Frame:
Piers - Non-continuous
Horizontal Joint at Pier Top
Total Bearing Shear Stiffness (kN/mm)
Shoe Plate Thickness (mm)
Non-integral:
Skew of Substructure from Perpendicular to C/L of Alignment
Skew (degrees):
Girders Over Piers During Construction
Over Left Pier:
Over Right Pier:
Synchronize
Click to Update BRIDGframe Example v8.0.23x.xlsm

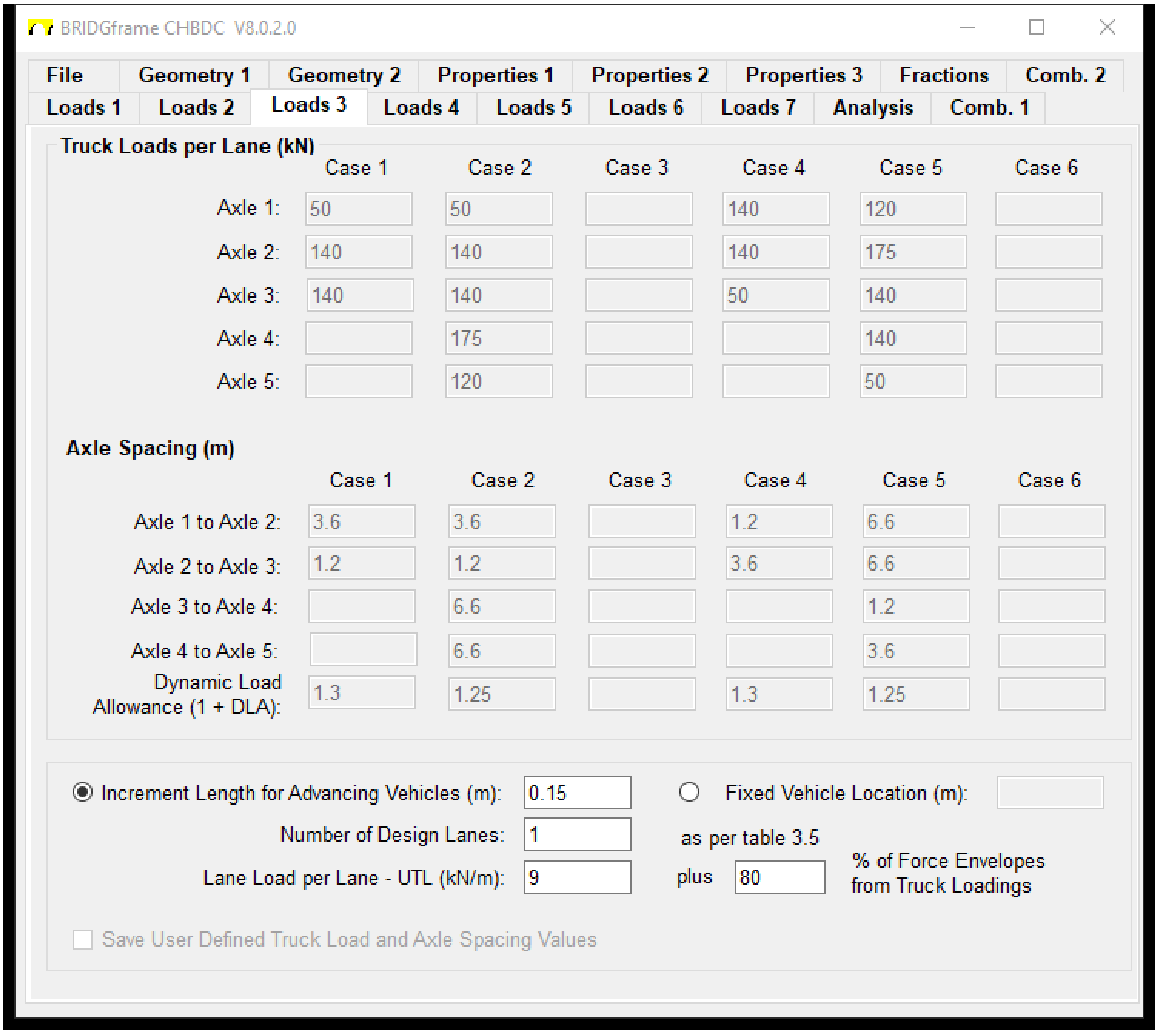

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Span Properties
Span 1
Span 2
Span 3
Girder/Slab Profile
Constant
Number of Members per Girder/Slab
1
Member Properties
Member Names or Lengths (m)
Span 1
Span 2
Span 3
1: 10.200
2:
3:
4:
5:
6:
7:
Help
Section Properties
Current Section: 1
Custom
Steel Sections
Span/Bridge Combination: B/C
Name / Designation: NU 1800 x 160
Number of Girders 10
Girder Depth "dg" (cm): 180.00
Area of Single Girder "Ag" (cm²): 5711.18
Moment of Inertia of Single Girder "Ig" (cm^4): 25941969
Naked Girder NA to Girder Bottom "yb" (cm): 81.64
Young's Modulus of Steel "Es" (MPa): 200000
Composite Deck Width as per cl.5.5.2 (cm): 2170
Composite Deck Depth (cm): 22.5
Deck Concrete "fc" (MPa): 35
Deck Concrete Density (kg/m³): 2450
Synchronize
Click to Update BRIDGframe Example v8.0.23x.xlsm

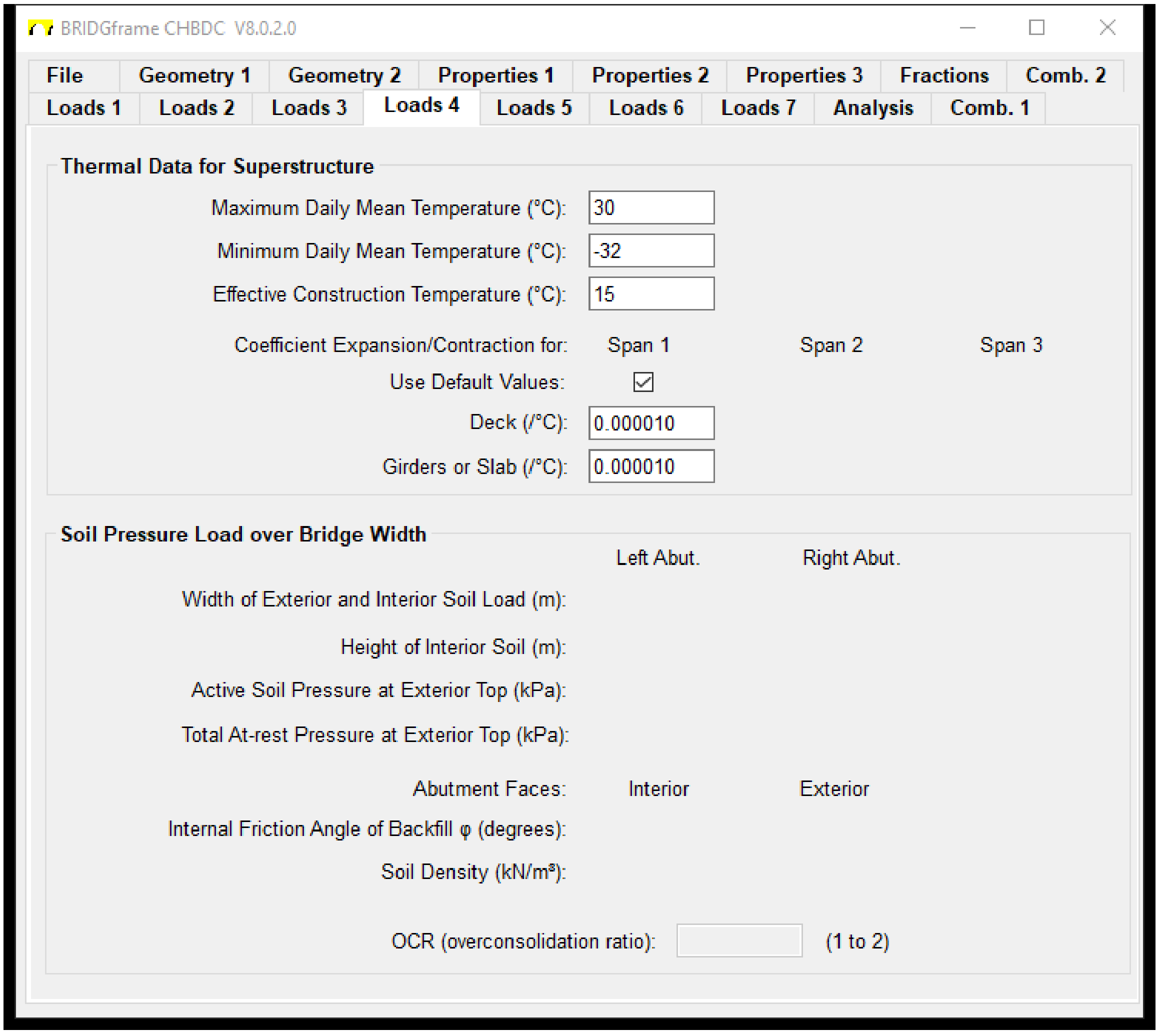

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Superstructure Cross-Section
Span 1
Span 2
Span 3
Spacing of girders or voided slab webs "S" (m):
2.15
Overhang length of deck "Sc" (m):
1.175
Bridge Platform
Bridge Platform Properties are Identical for All Spans
Center of exterior "travelled" lane to adjacent outside face of barrier (m):
5.55
Distance between curb or barrier faces "Wc" (m):
17
Synchronize
Click to Update BRIDGframe Example v8.0.23x.xlsm

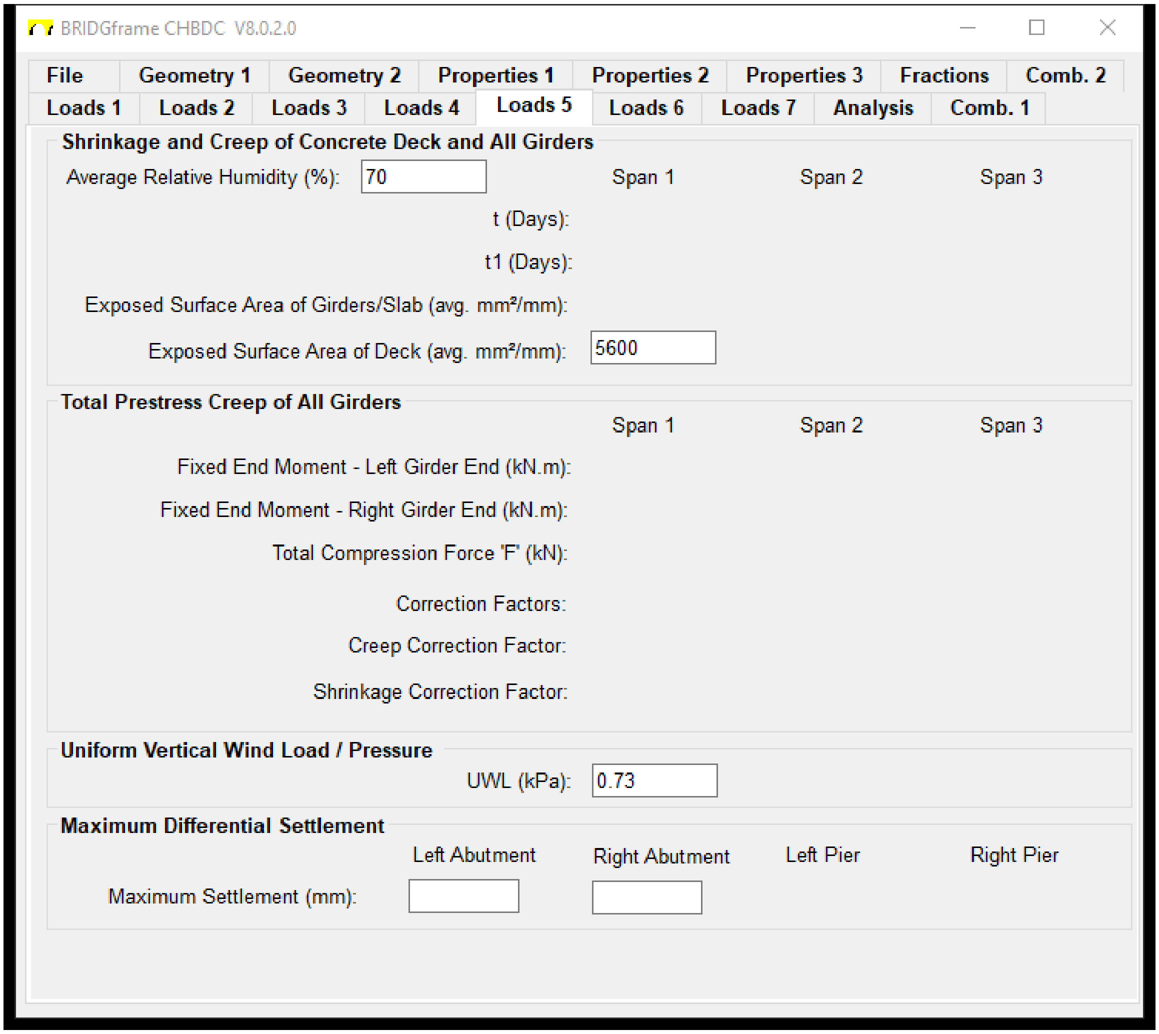

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Substructure Section Properties
Left Abutment
Right Abutment
Left Pier
Right Pier
Nmbr of Supports:
Thickness at Top (cm):
Thickness Bottom (cm):
Width (cm):
Radius (cm):
Abutment/Pier Concrete "f'c" (MPa):
Abutment/Pier Concrete Density (kg/m³):
Pile Properties
Name/Designation:
Number of Piles:
Moment of Inertia (cm^4)/Pile:
Young's Modulus of Piles (MPa):
Synchronize
Click to Update BRIDGframe Example v8.0.23x.xlsm

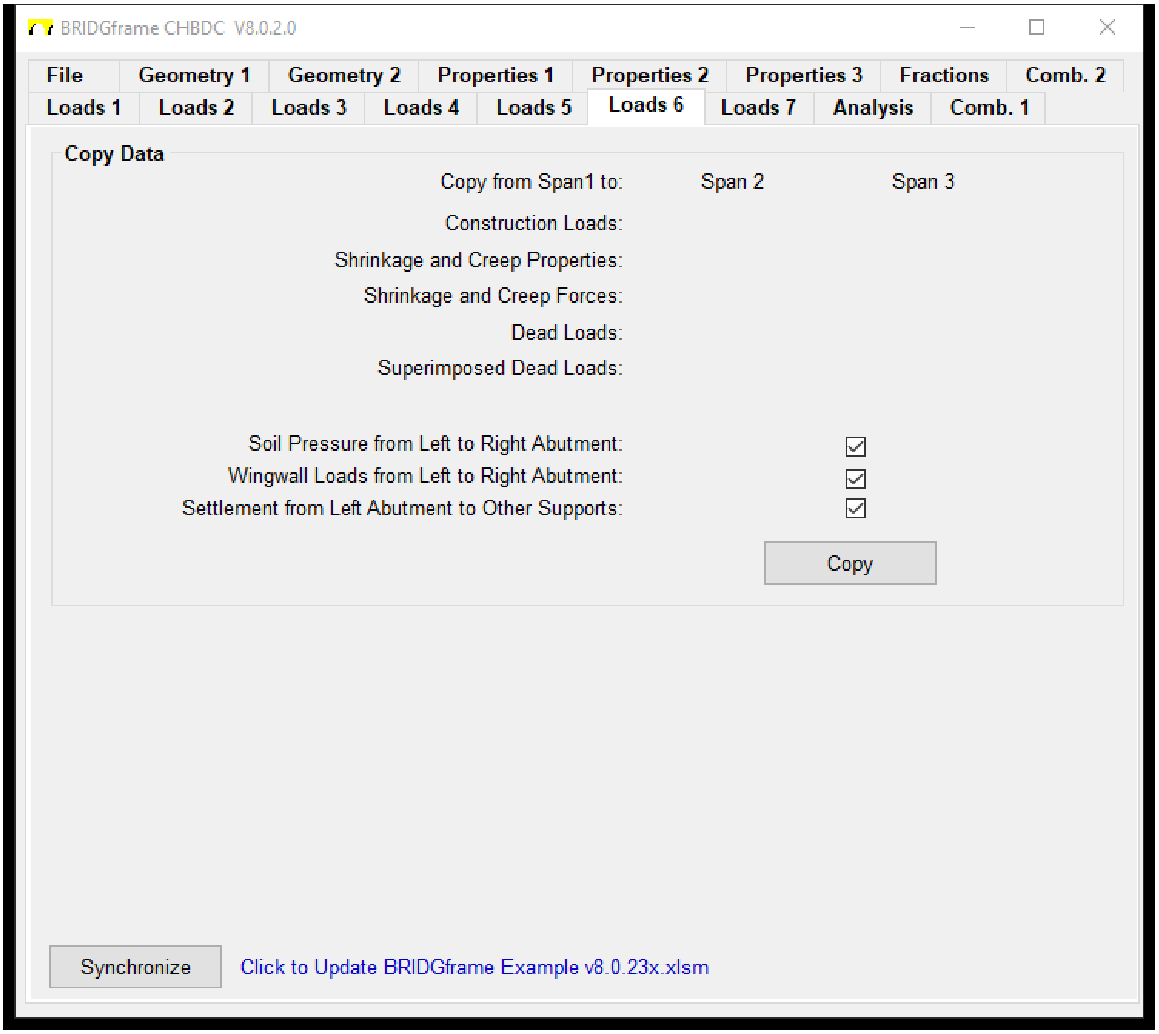

BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Construction Stage Loads over Bridge Width - UCL (kN/m)
Span 1
Span 2
Span 3
Dead Load (excluding girders & deck):
2.8
Live Load:
11.2
Dead Loads over Bridge Width (non-composite) - UDL (kN/m)
Span 1
Span 2
Span 3
Case 1:
Girders
4.6
Case 2:
Deck
32
Case 3:
Other
Uniform Superimposed Dead Loads over Bridge Width (composite) - USDL (kN/m)
Span 1
Span 2
Span 3
Case 1:
Barriers
11
Case 2:
Asphalt
10.2
Case 3:
Sidewalk(s)
Case 4:
Other
Wingwall Loads
Left Abutment
Right Abutment
Moment (kN.m):
Vertical (kN):
Moment (kN.m):
Vertical (kN):

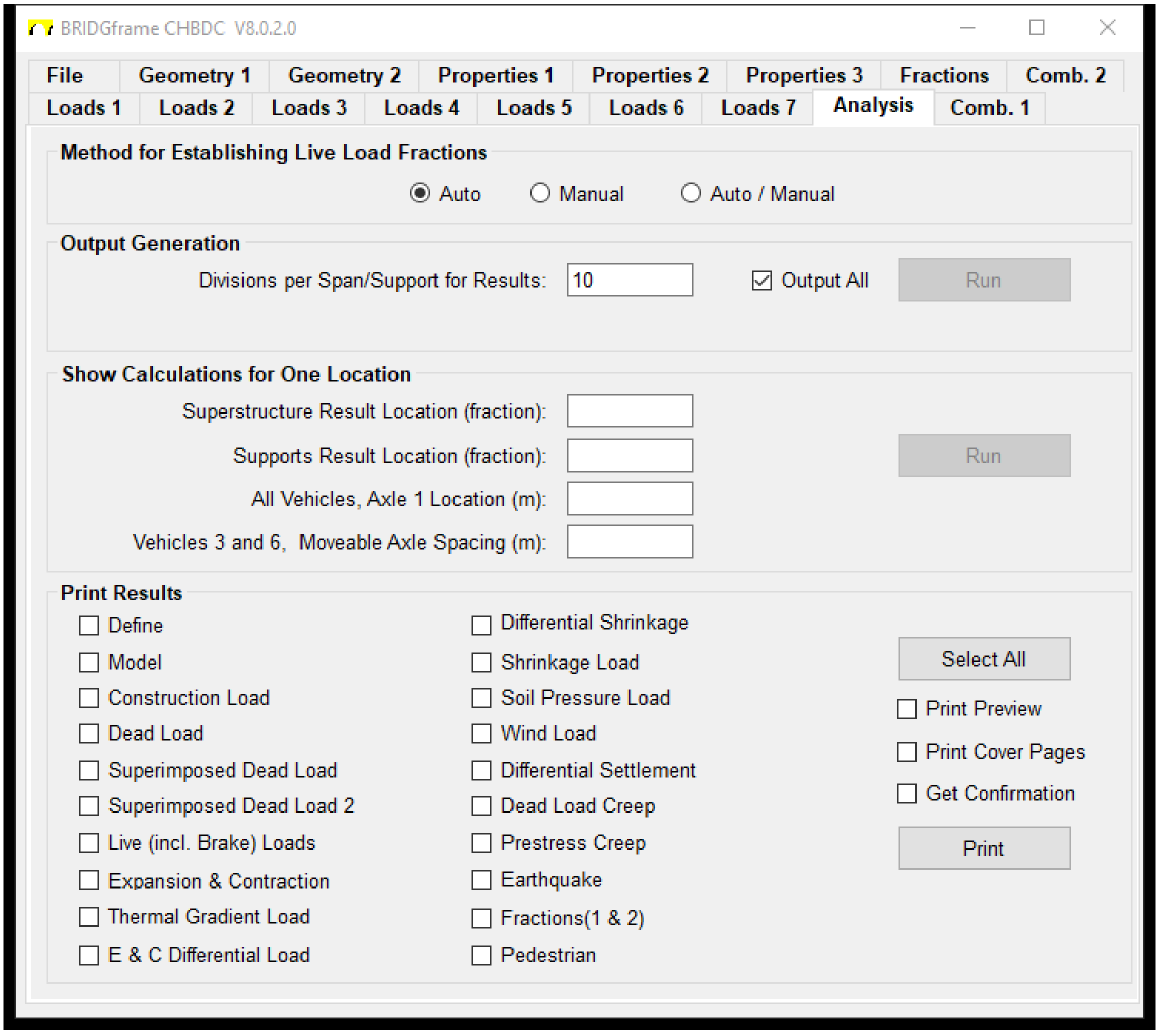

BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Pedestrian Load
Uniform Pedestrian Load per Span (kN/m): 4
Braking Force
Static Force (kN): 180 plus 10 % of UTL
Live (Truck) Load Case Groups
Truck CL-625
Truck CL-625-ONT
Truck BCL-625
Truck CL-750
Truck CL-800-AB
User Defined
Drop Axles Not Contributing To Maximum Load Effect (cl.3.8.4.1)


BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Truck Loads per Lane (kN)
Case 1 Case 2 Case 3 Case 4 Case 5 Case 6
Axle 1: 50 50 140 120
Axle 2: 140 140 140 175
Axle 3: 140 140 50 140
Axle 4: 175 140
Axle 5: 120 50
Axle Spacing (m)
Case 1 Case 2 Case 3 Case 4 Case 5 Case 6
Axle 1 to Axle 2: 3.6 3.6 1.2 6.6
Axle 2 to Axle 3: 1.2 1.2 3.6 6.6
Axle 3 to Axle 4: 6.6 1.2
Axle 4 to Axle 5: 6.6 3.6
Dynamic Load Allowance (1 + DLA): 1.3 1.25 1.3 1.25
Increment Length for Advancing Vehicles (m): 0.15
Fixed Vehicle Location (m):
Number of Design Lanes: 1
as per table 3.5
Lane Load per Lane - UTL (kN/m): 9
plus 80
% of Force Envelopes from Truck Loadings
Save User Defined Truck Load and Axle Spacing Values


BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Thermal Data for Superstructure
Maximum Daily Mean Temperature (°C): 30
Minimum Daily Mean Temperature (°C): -32
Effective Construction Temperature (°C): 15
Coefficient Expansion/Contraction for: Span 1 Span 2 Span 3
Use Default Values:
Deck (/°C): 0.000010
Girders or Slab (/°C): 0.000010
Soil Pressure Load over Bridge Width
Left Abut. Right Abut.
Width of Exterior and Interior Soil Load (m):
Height of Interior Soil (m):
Active Soil Pressure at Exterior Top (kPa):
Total At-rest Pressure at Exterior Top (kPa):
Abutment Faces: Interior Exterior
Internal Friction Angle of Backfill φ (degrees):
Soil Density (kN/m³):
OCR (overconsolidation ratio): (1 to 2)


BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Shrinkage and Creep of Concrete Deck and All Girders
Average Relative Humidity (%):
70
Span 1
Span 2
Span 3
t (Days):
t1 (Days):
Exposed Surface Area of Girders/Slab (avg. mm²/mm):
Exposed Surface Area of Deck (avg. mm²/mm):
5600
Total Prestress Creep of All Girders
Span 1
Span 2
Span 3
Fixed End Moment - Left Girder End (kN.m):
Fixed End Moment - Right Girder End (kN.m):
Total Compression Force 'F' (kN):
Correction Factors:
Creep Correction Factor:
Shrinkage Correction Factor:
Uniform Vertical Wind Load / Pressure
UWL (kPa):
0.73
Maximum Differential Settlement
Left Abutment
Right Abutment
Left Pier
Right Pier
Maximum Settlement (mm):

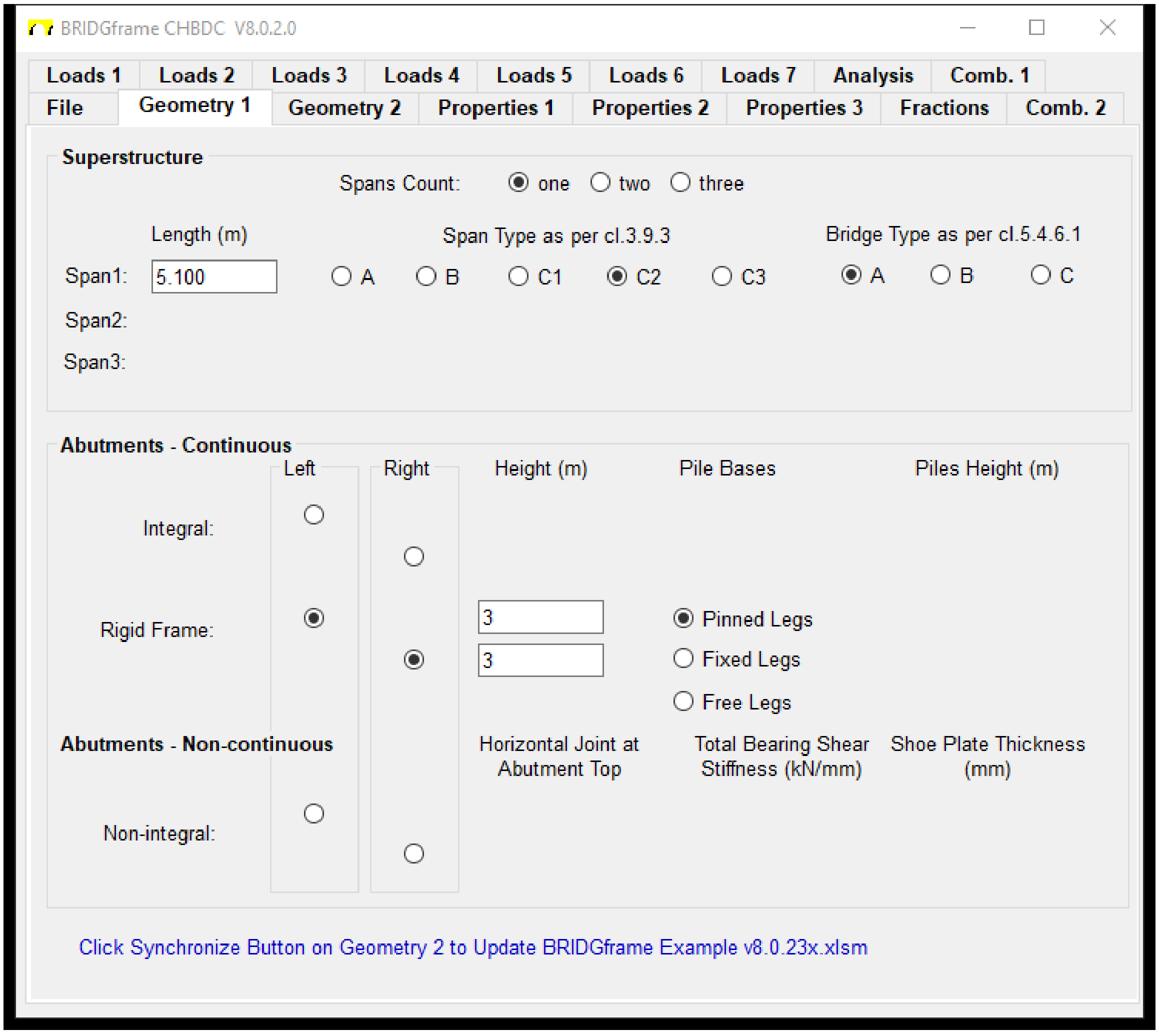

BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Copy Data
Copy from Span1 to:
Span 2
Span 3
Construction Loads:
Shrinkage and Creep Properties:
Shrinkage and Creep Forces:
Dead Loads:
Superimposed Dead Loads:
Soil Pressure from Left to Right Abutment:
Wingwall Loads from Left to Right Abutment:
Settlement from Left Abutment to Other Supports:
Copy
Synchronize
Click to Update BRIDGframe Example v8.0.23x.xlsm

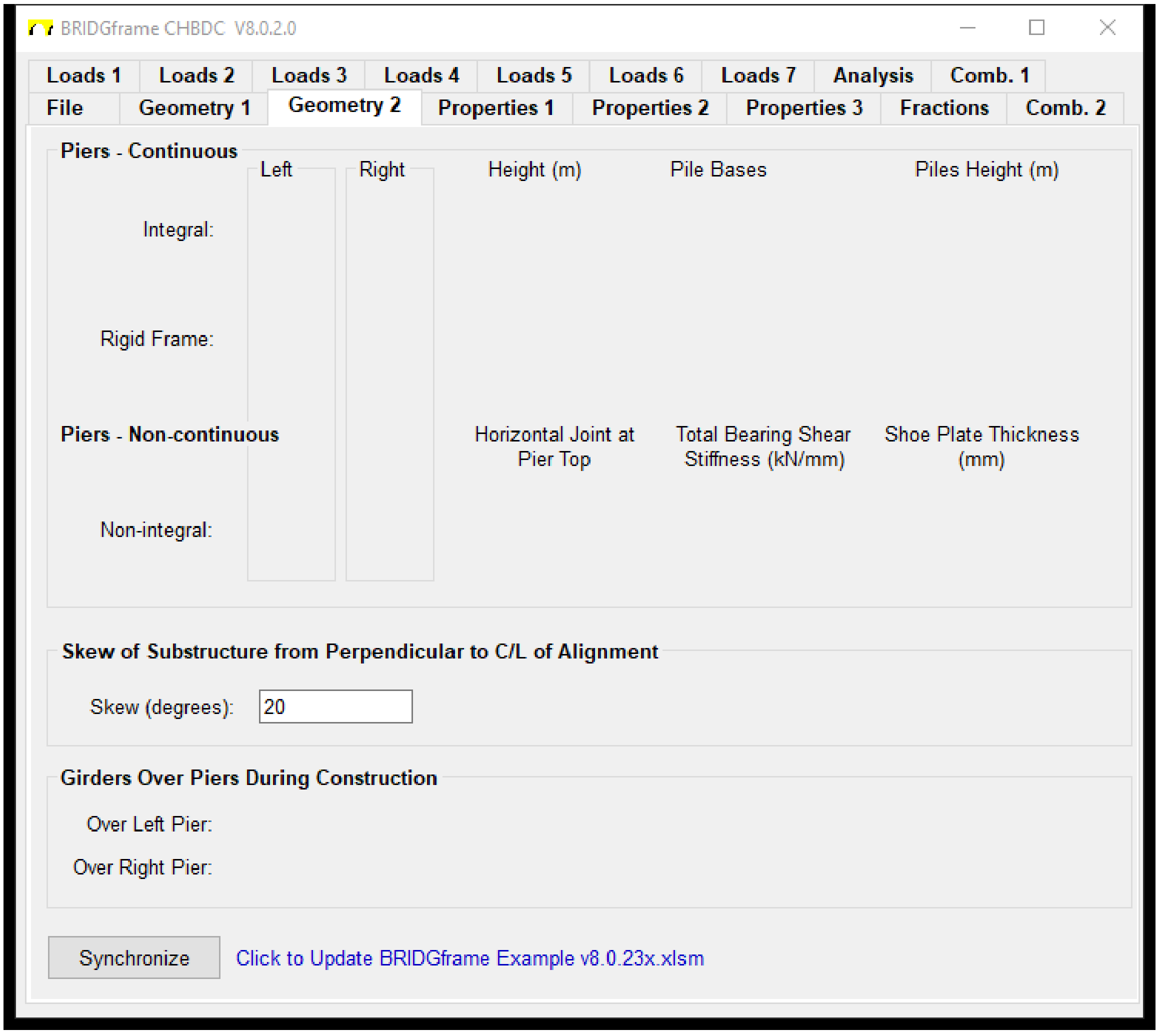

BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Method for Establishing Live Load Fractions
Auto
Manual
Auto / Manual
Output Generation
Divisions per Span/Support for Results:
10
Output All
Run
Show Calculations for One Location
Superstructure Result Location (fraction):
Supports Result Location (fraction):
All Vehicles, Axle 1 Location (m):
Vehicles 3 and 6, Moveable Axle Spacing (m):
Run
Print Results
Define
Model
Construction Load
Dead Load
Superimposed Dead Load
Superimposed Dead Load 2
Live (incl. Brake) Loads
Expansion & Contraction
Thermal Gradient Load
E & C Differential Load
Differential Shrinkage
Shrinkage Load
Soil Pressure Load
Wind Load
Differential Settlement
Dead Load Creep
Prestress Creep
Earthquake
Fractions(1 & 2)
Pedestrian
Select All
Print Preview
Print Cover Pages
Get Confirmation
Print

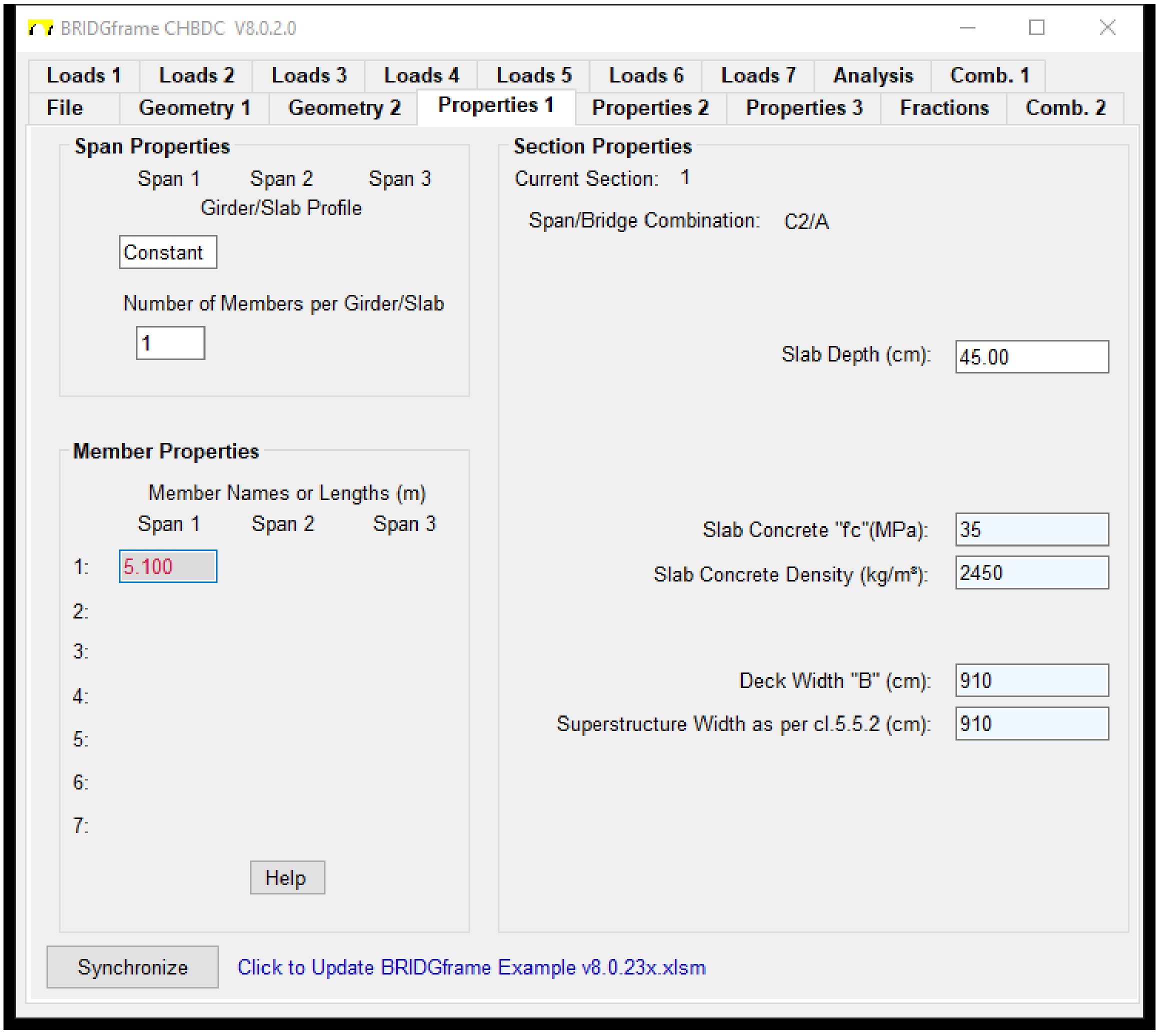
APPENDIX 4 – CONCRETE RIGID FRAME (SKEWED)

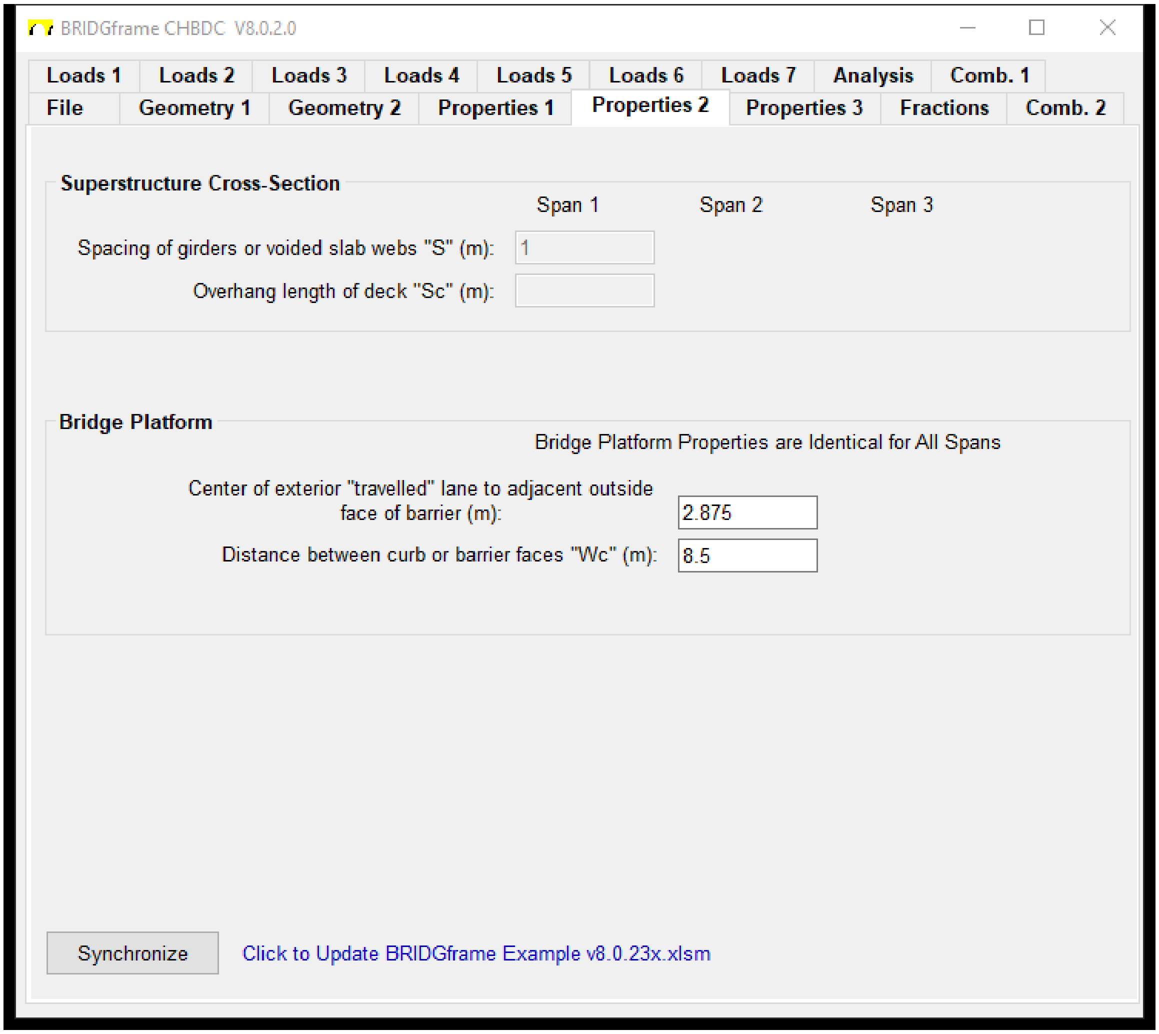
Bridge Geometry

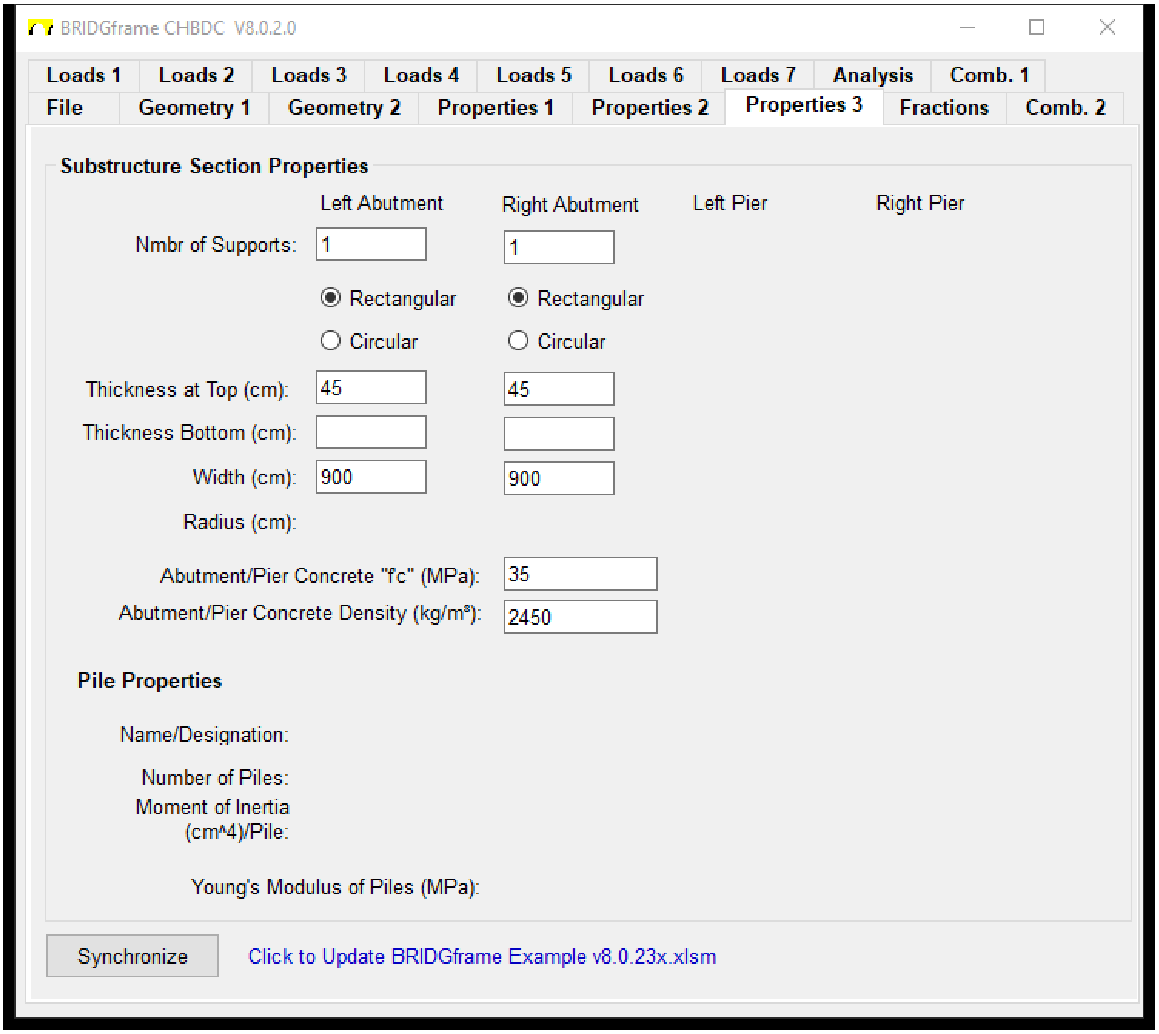
Structure Type:	Rigid frame with structural slab spanning between abutments
Spans:	1 span at 5.0 m
Deck:	9.1 m total width x 450 mm thick (99 kN/m). Deck is shored during construction 8.5 m barrier inside face to barrier inside face. 2 travelled lanes at 3.25 m. 2 side clearances at 1.0 m. 2 design lanes. 90mm asphalt and waterproofing (17.2 kN/m).
Barriers:	Parapet wall 250 mm (11.0 kN/m)
Girders:	None
Abutments:	3.0 m high x 0.45 m thick x 9.0 m wide (non-skewed width)
Piles:	None
Wingwalls:	Two wingwalls loading per abutment (includes barriers on wingwalls) See Appendix 13. Vertical (gravity load) (354 kN) Moment (863 kN.m)
Skew:	20 degrees Weight of abutments will be modified by the program to suit skewed width. The skew factor 'F_S' is not automatically applied to this type of structure

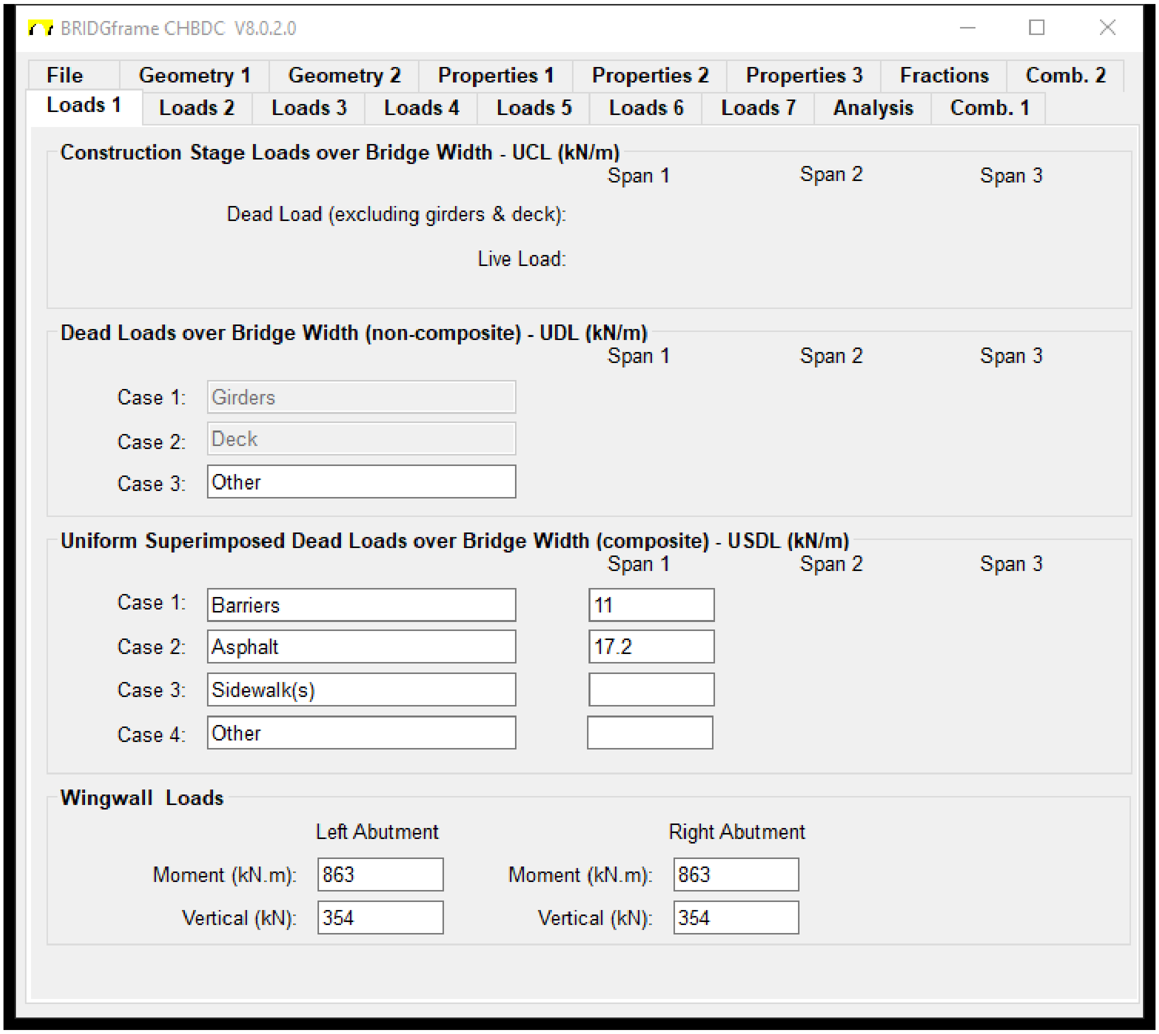

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Superstructure
Spans Count:
one
two
three
Length (m)
Span Type as per cl.3.9.3
Bridge Type as per cl.5.4.6.1
Span1:
5.100
A
B
C1
C2
C3
A
B
C
Span2:
Span3:
Abutments - Continuous
Left
Right
Height (m)
Pile Bases
Piles Height (m)
Integral:
Rigid Frame:
3
3
Pinned Legs
Fixed Legs
Free Legs
Abutments - Non-continuous
Horizontal Joint at Abutment Top
Total Bearing Shear Stiffness (kN/mm)
Shoe Plate Thickness (mm)
Non-integral:
Click Synchronize Button on Geometry 2 to Update BRIDGframe Example v8.0.23x.xlsm

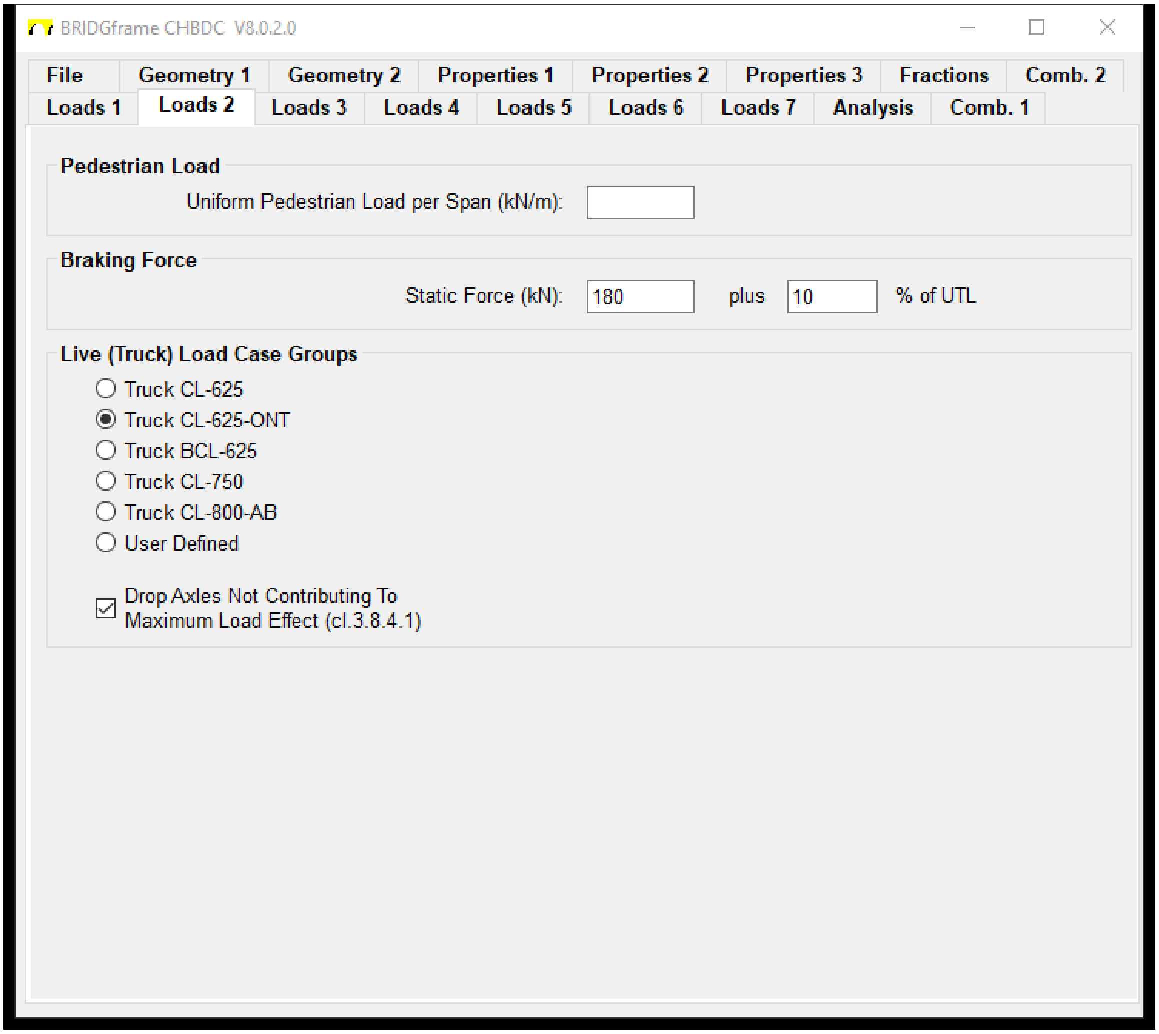

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Piers - Continuous
Left
Right
Height (m)
Pile Bases
Piles Height (m)
Integral:
Rigid Frame:
Piers - Non-continuous
Horizontal Joint at Pier Top
Total Bearing Shear Stiffness (kN/mm)
Shoe Plate Thickness (mm)
Non-integral:
Skew of Substructure from Perpendicular to C/L of Alignment
Skew (degrees):
20
Girders Over Piers During Construction
Over Left Pier:
Over Right Pier:
Synchronize
Click to Update BRIDGframe Example v8.0.23x.xlsm

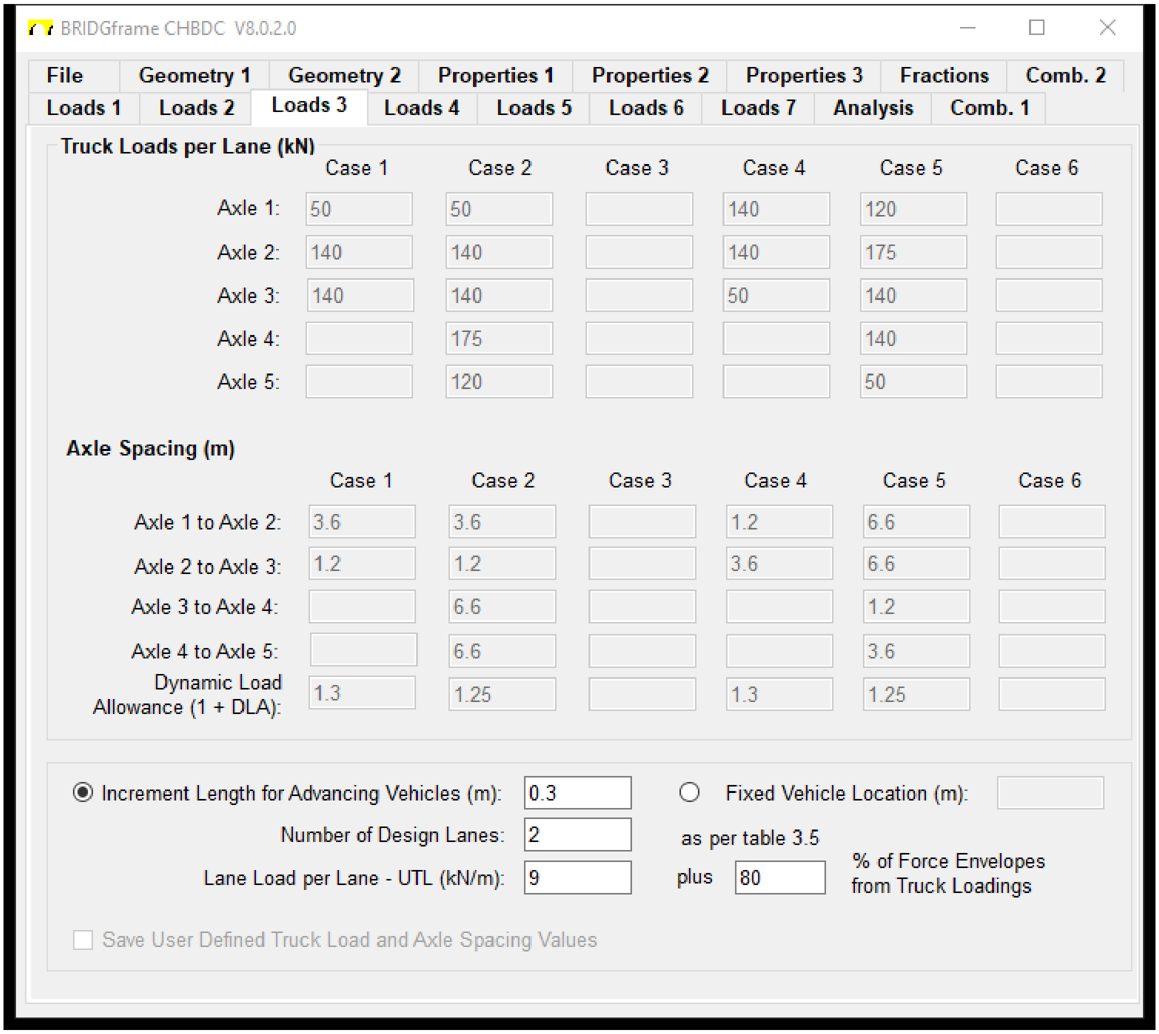

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Span Properties
Span 1 Span 2 Span 3
Girder/Slab Profile
Constant
Number of Members per Girder/Slab
1
Member Properties
Member Names or Lengths (m)
Span 1 Span 2 Span 3
1: 5.100
2:
3:
4:
5:
6:
7:
Help
Section Properties
Current Section: 1
Span/Bridge Combination: C2/A
Slab Depth (cm): 45.00
Slab Concrete "f'c"(MPa): 35
Slab Concrete Density (kg/m³): 2450
Deck Width "B" (cm): 910
Superstructure Width as per cl.5.5.2 (cm): 910
Synchronize
Click to Update BRIDGframe Example v8.0.23x.xlsm


BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Superstructure Cross-Section
Span 1
Span 2
Span 3
Spacing of girders or voided slab webs "S" (m):
1
Overhang length of deck "Sc" (m):
Bridge Platform
Bridge Platform Properties are Identical for All Spans
Center of exterior "travelled" lane to adjacent outside face of barrier (m):
2.875
Distance between curb or barrier faces "Wc" (m):
8.5
Synchronize
Click to Update BRIDGframe Example v8.0.23x.xlsm


BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Substructure Section Properties
Left Abutment
Right Abutment
Left Pier
Right Pier
Nmbr of Supports:
1
1
Rectangular
Rectangular
Circular
Circular
Thickness at Top (cm):
45
45
Thickness Bottom (cm):
Width (cm):
900
900
Radius (cm):
Abutment/Pier Concrete "f'c" (MPa):
35
Abutment/Pier Concrete Density (kg/m³):
2450
Pile Properties
Name/Designation:
Number of Piles:
Moment of Inertia (cm^4)/Pile:
Young's Modulus of Piles (MPa):
Synchronize
Click to Update BRIDGframe Example v8.0.23x.xlsm


BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Construction Stage Loads over Bridge Width - UCL (kN/m)
Span 1
Span 2
Span 3
Dead Load (excluding girders & deck):
Live Load:
Dead Loads over Bridge Width (non-composite) - UDL (kN/m)
Span 1
Span 2
Span 3
Case 1:
Girders
Case 2:
Deck
Case 3:
Other
Uniform Superimposed Dead Loads over Bridge Width (composite) - USDL (kN/m)
Span 1
Span 2
Span 3
Case 1:
Barriers
11
Case 2:
Asphalt
17.2
Case 3:
Sidewalk(s)
Case 4:
Other
Wingwall Loads
Left Abutment
Right Abutment
Moment (kN.m):
863
Moment (kN.m):
863
Vertical (kN):
354
Vertical (kN):
354


BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Pedestrian Load
Uniform Pedestrian Load per Span (kN/m):
Braking Force
Static Force (kN): 180 plus 10 % of UTL
Live (Truck) Load Case Groups
Truck CL-625
Truck CL-625-ONT
Truck BCL-625
Truck CL-750
Truck CL-800-AB
User Defined
Drop Axles Not Contributing To
Maximum Load Effect (cl.3.8.4.1)



BRIDGframe CHBDC V8.0.2.0

File | Geometry 1 | Geometry 2 | Properties 1 | Properties 2 | Properties 3 | Fractions | Comb. 2
Loads 1 | Loads 2 | Loads 3 | Loads 4 | Loads 5 | Loads 6 | Loads 7 | Analysis | Comb. 1

Truck Loads per Lane (kN)

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Axle 1:	50	50		140	120	
Axle 2:	140	140		140	175	
Axle 3:	140	140		50	140	
Axle 4:		175			140	
Axle 5:		120			50	

Axle Spacing (m)

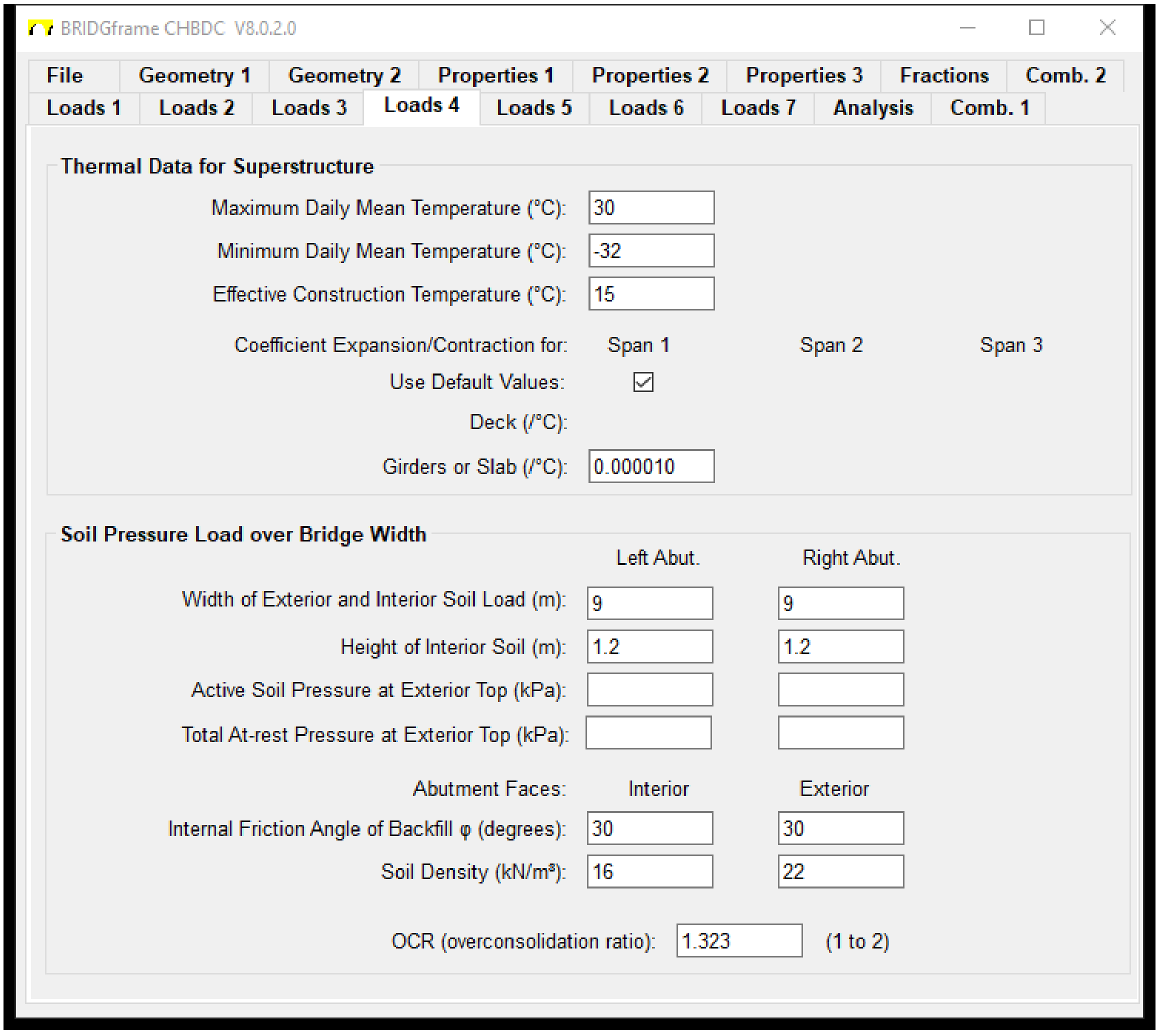
	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Axle 1 to Axle 2:	3.6	3.6		1.2	6.6	
Axle 2 to Axle 3:	1.2	1.2		3.6	6.6	
Axle 3 to Axle 4:		6.6			1.2	
Axle 4 to Axle 5:		6.6			3.6	
Dynamic Load Allowance (1 + DLA):	1.3	1.25		1.3	1.25	

(●) Increment Length for Advancing Vehicles (m): 0.3 ( ) Fixed Vehicle Location (m):

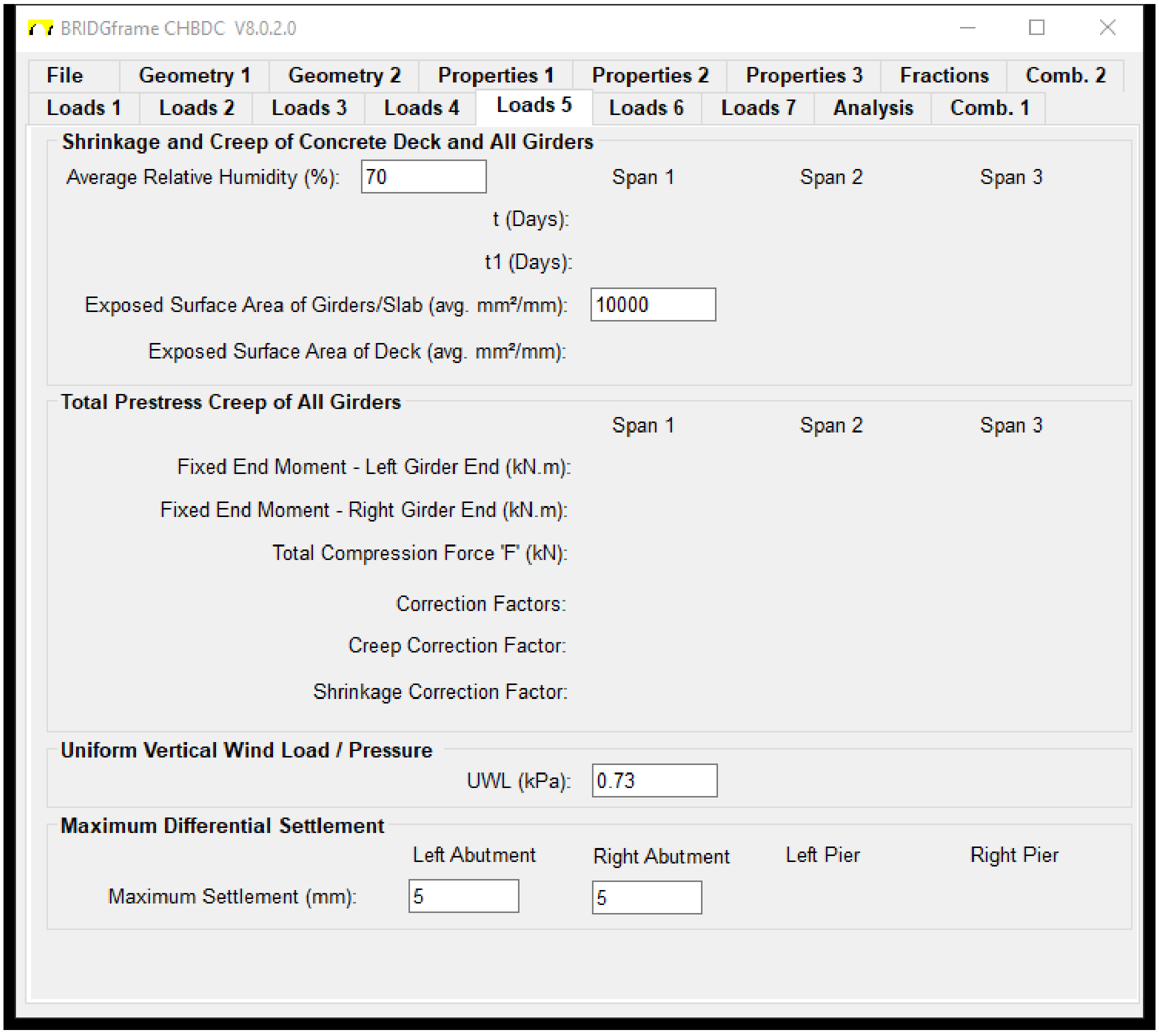
Number of Design Lanes: 2 as per table 3.5

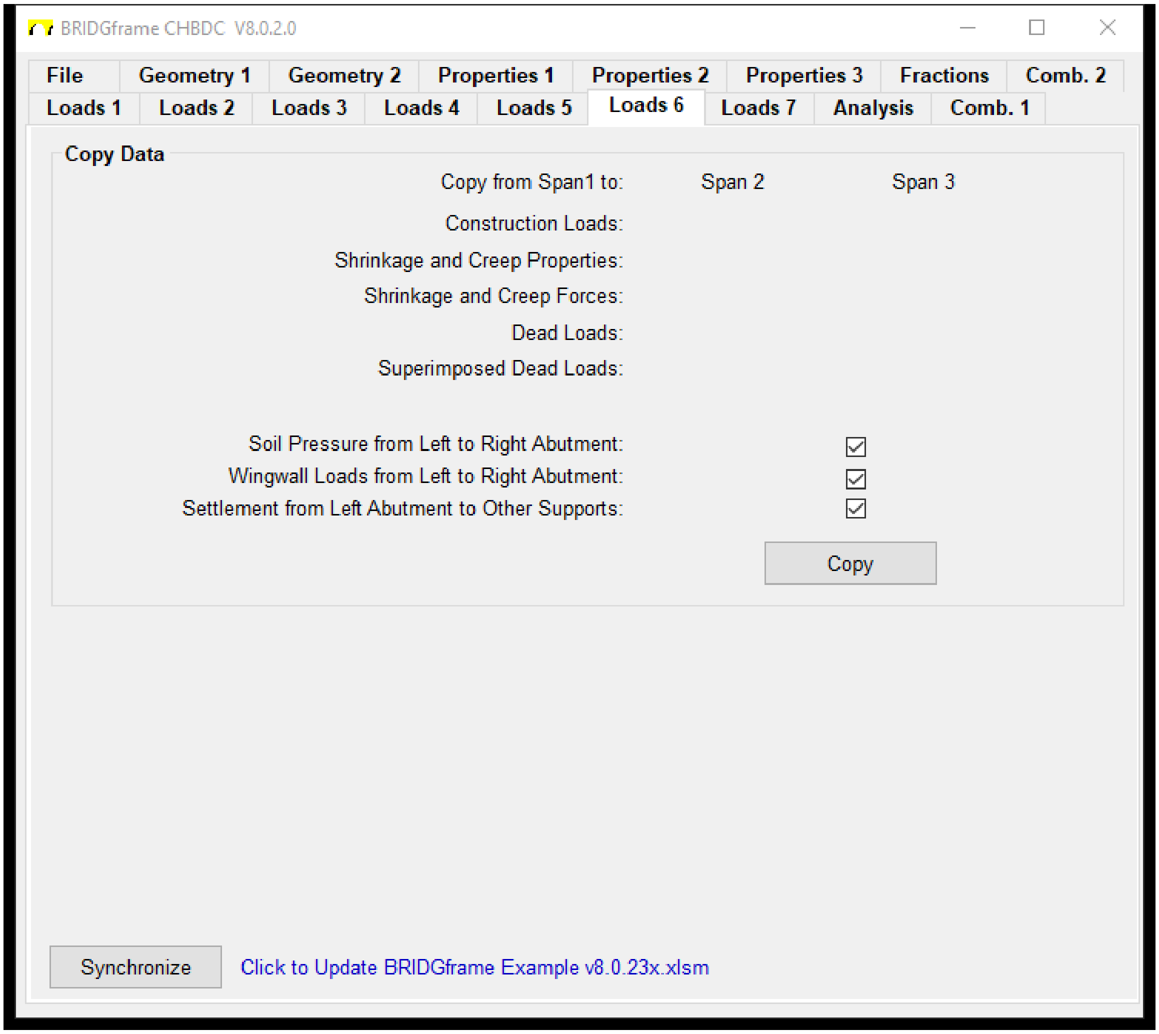
Lane Load per Lane - UTL (kN/m): 9 plus 80 % of Force Envelopes from Truck Loadings

☐ Save User Defined Truck Load and Axle Spacing Values

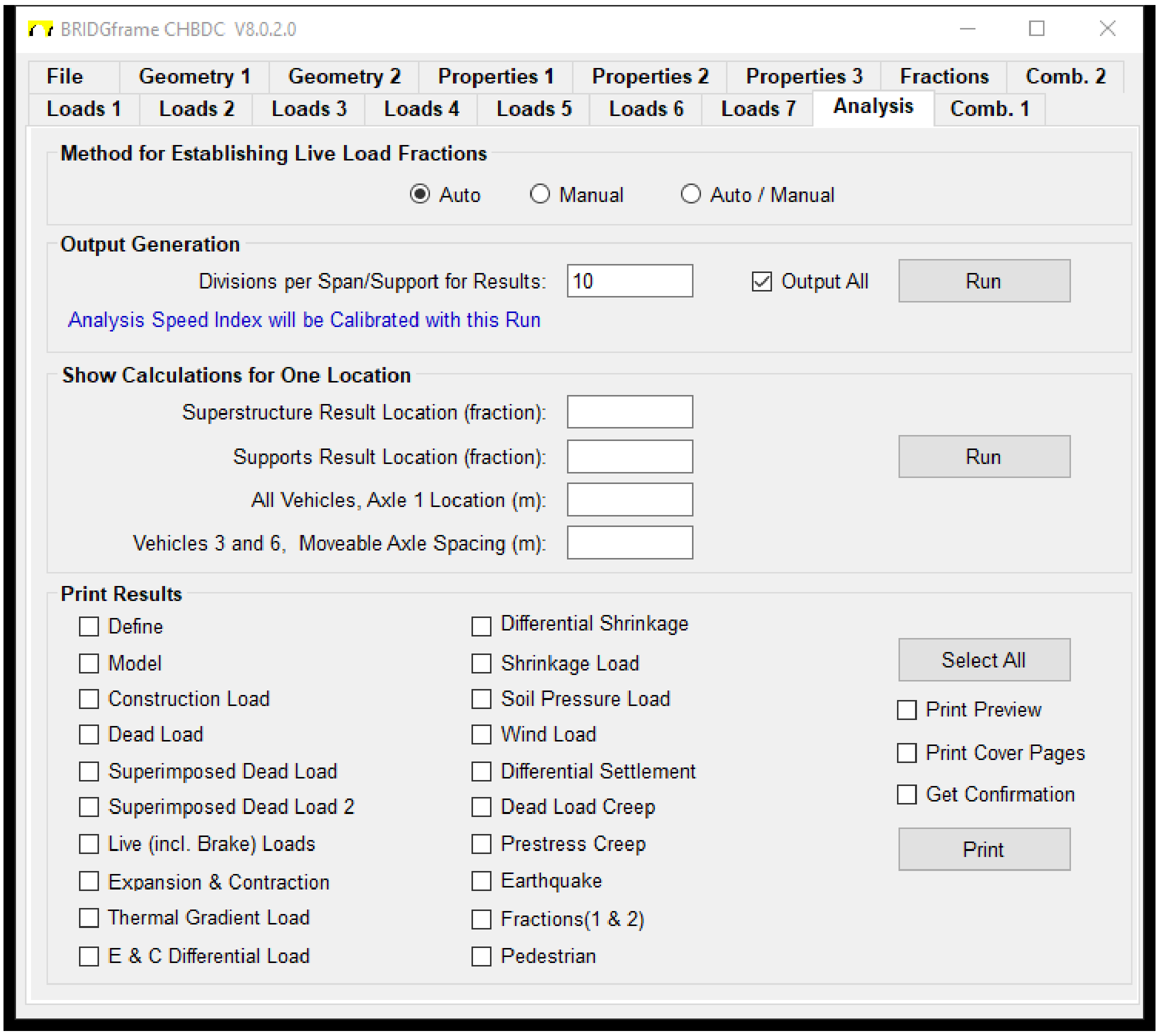


- Active Soil Pressure at Exterior Top and Total At-rest Pressure at Exterior Top may be included. See paragraph 2 of 5.4.9 and Appendix 4 – Concrete Rigid Parabolic Soffit, Loads 4 screen print.
- Although interior soil pressure has been input, it will have negligible impact on the results and may be left blank.


BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Shrinkage and Creep of Concrete Deck and All Girders
Average Relative Humidity (%): 70
Span 1
Span 2
Span 3
t (Days):
t1 (Days):
Exposed Surface Area of Girders/Slab (avg. mm²/mm): 10000
Exposed Surface Area of Deck (avg. mm²/mm):
Total Prestress Creep of All Girders
Span 1
Span 2
Span 3
Fixed End Moment - Left Girder End (kN.m):
Fixed End Moment - Right Girder End (kN.m):
Total Compression Force 'F' (kN):
Correction Factors:
Creep Correction Factor:
Shrinkage Correction Factor:
Uniform Vertical Wind Load / Pressure
UWL (kPa): 0.73
Maximum Differential Settlement
Left Abutment
Right Abutment
Left Pier
Right Pier
Maximum Settlement (mm): 5 5


BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Copy Data
Copy from Span1 to:
Span 2
Span 3
Construction Loads:
Shrinkage and Creep Properties:
Shrinkage and Creep Forces:
Dead Loads:
Superimposed Dead Loads:
Soil Pressure from Left to Right Abutment:
Wingwall Loads from Left to Right Abutment:
Settlement from Left Abutment to Other Supports:
Copy
Synchronize
Click to Update BRIDGframe Example v8.0.23x.xlsm

Loads 7: See Appendix 17.



APPENDIX 4 – CONCRETE RIGID FRAME PARABOLIC SOFFIT

Bridge Geometry

Structure Type: Rigid frame with symmetrical parabolic structural slab spanning between tapered abutments

Spans: 1 span at 16.2 m

Deck: 9.1 m total width x 400 mm thick at C/L and 1000 mm thick at ends (88 kN/m). Note: Input UDL of deck at C/L of span. Program calculates load and load effects of slab haunch automatically. See SIDL program results.
Deck is shored during construction
8.5 m barrier inside face to barrier inside face.
2 travelled lanes at 3.25 m.
2 side clearances at 1.0 m.
2 design lanes.
90mm asphalt and waterproofing (17.2 kN/m).

Barriers: Parapet wall 250 mm (11.0 kN/m)

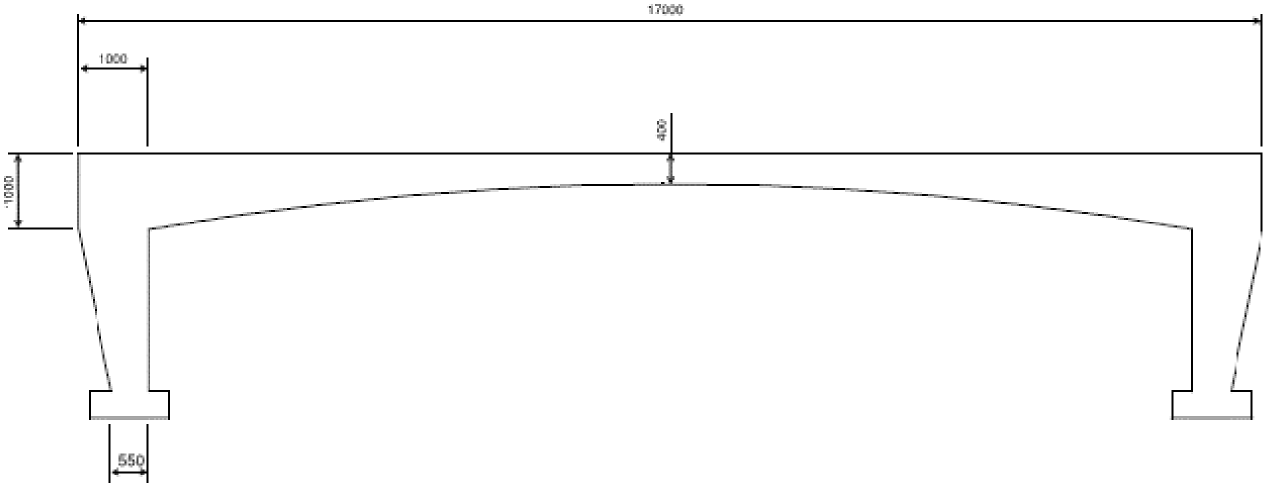
Girders: None

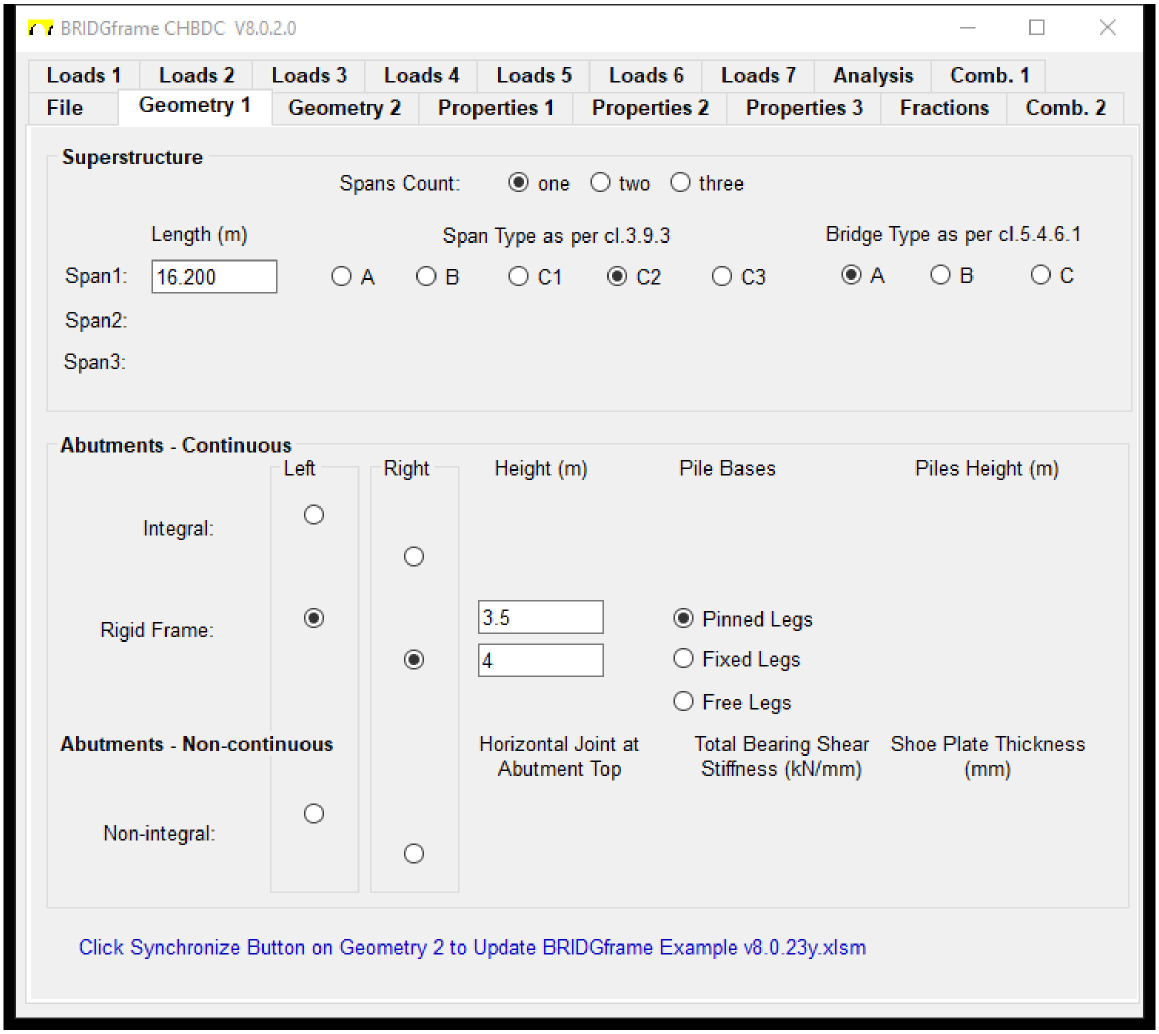
Abutments: 3.5 m and 4.0 m high x 1.00 m thick at top and 0.55 m thick at bottom x 9.0 m wide

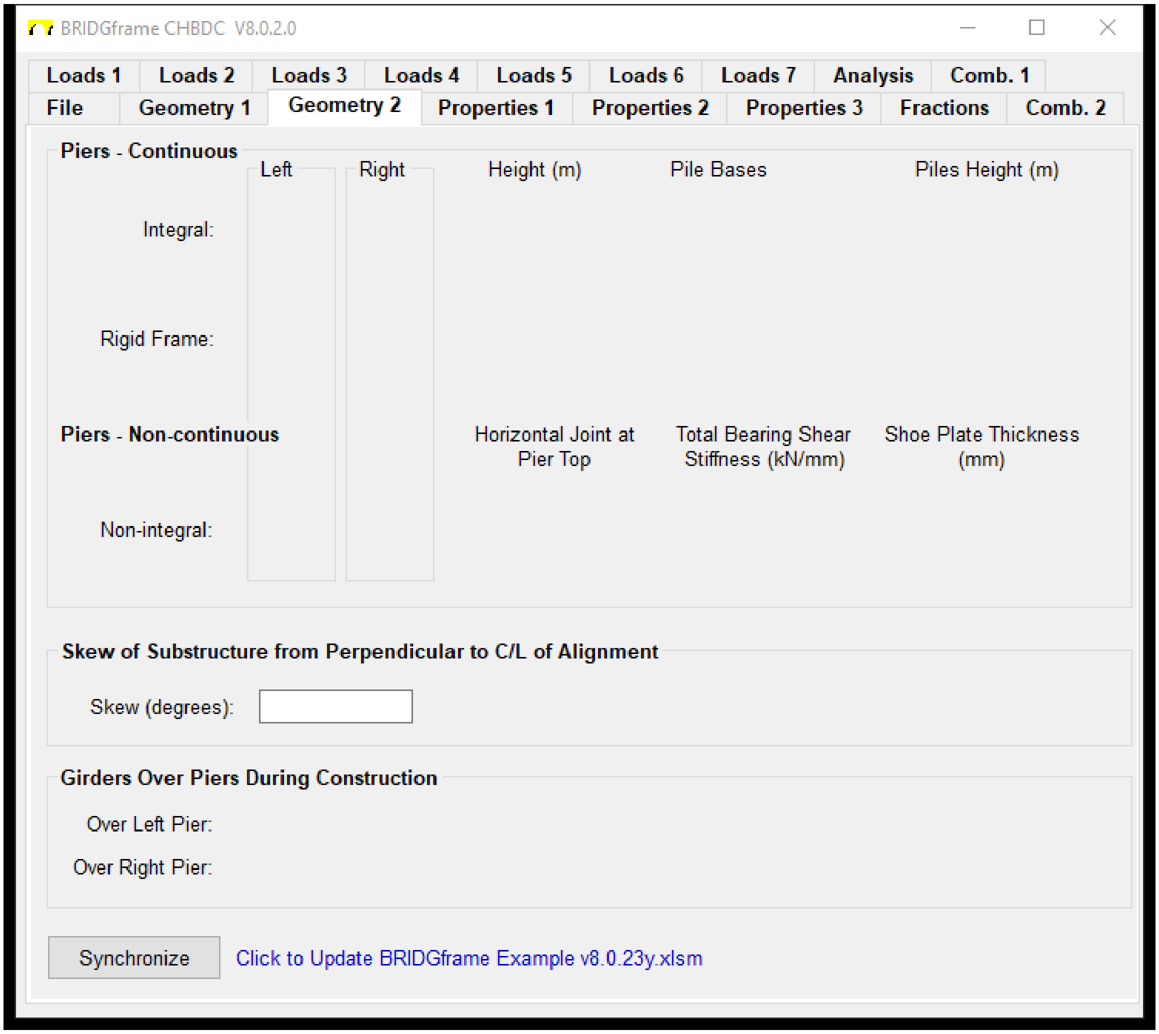
Piles: None

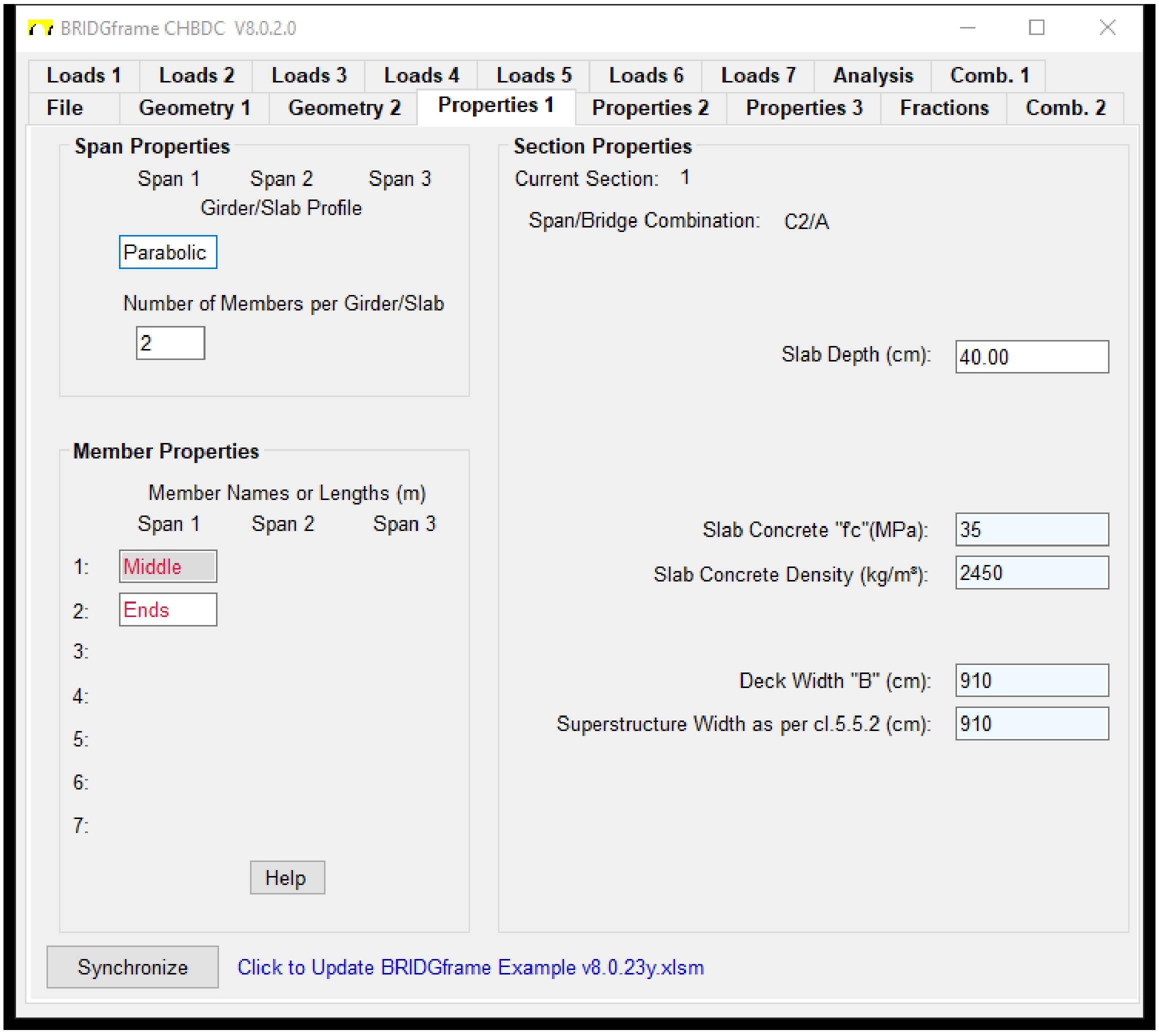
Wingwalls: Two wingwalls loading per abutment (includes barriers on wingwalls) See Appendix 13.

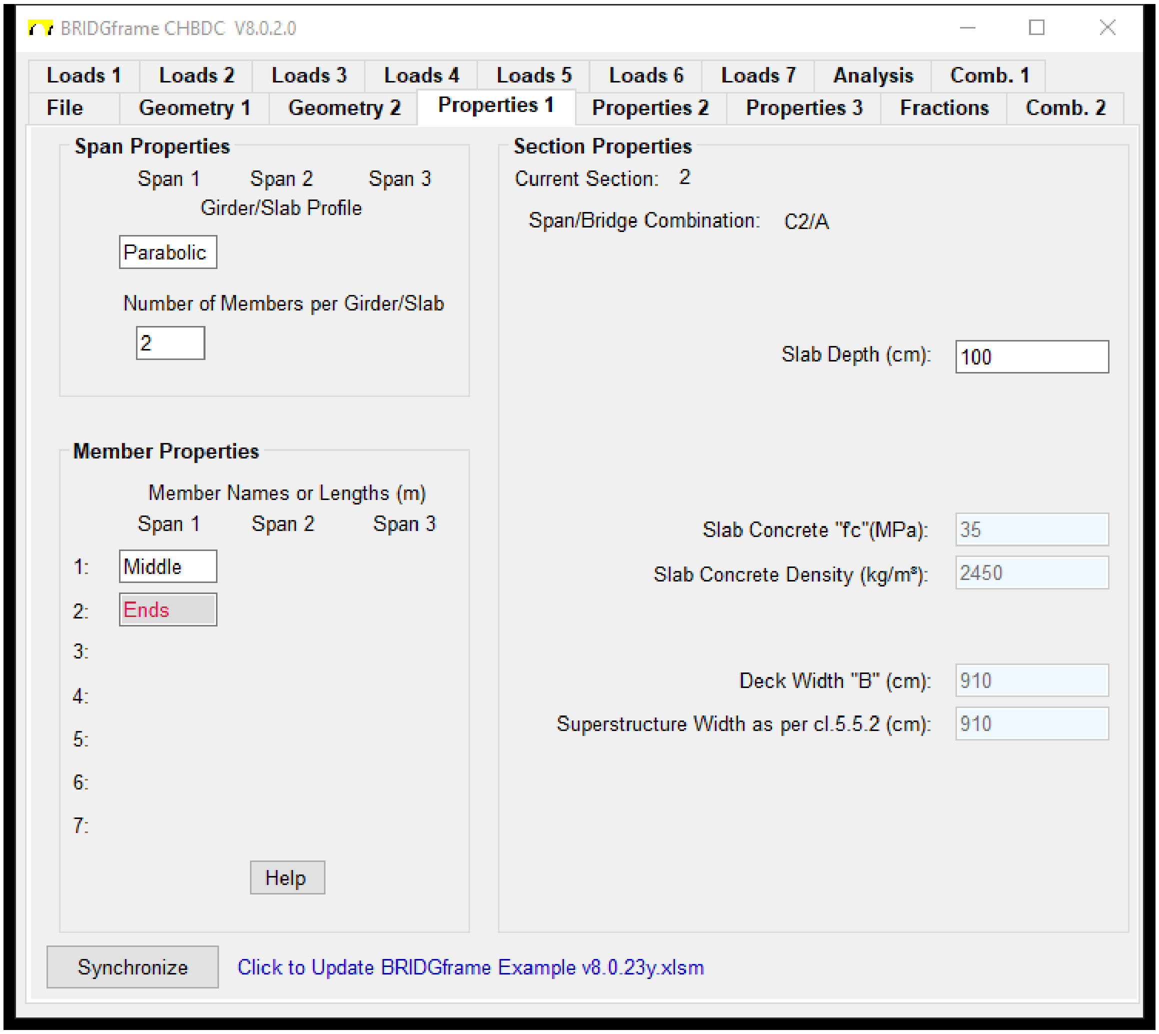
Vertical (gravity load) (354 kN)
Moment (863 kN.m)

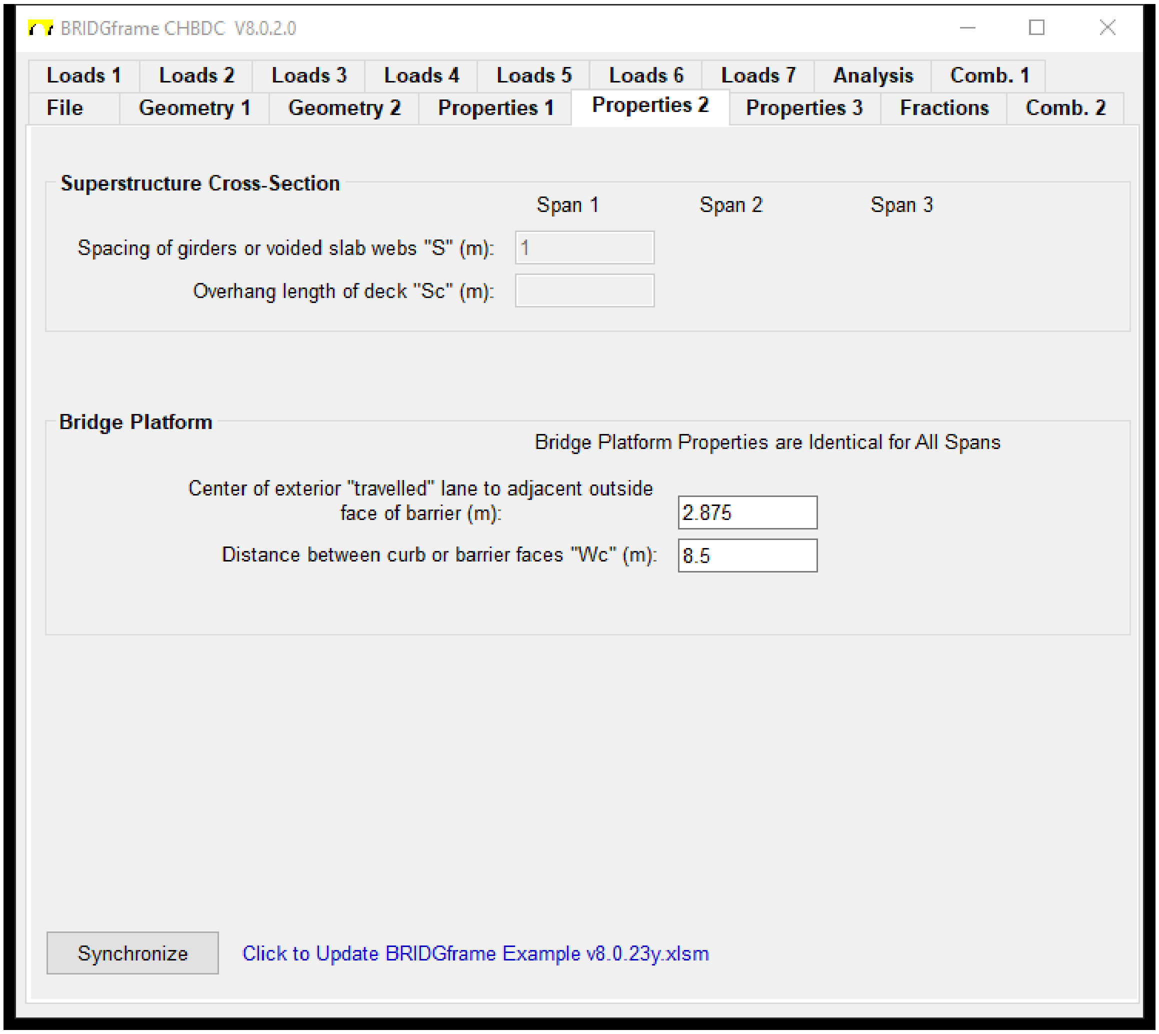

17000
1000
400
1000
550

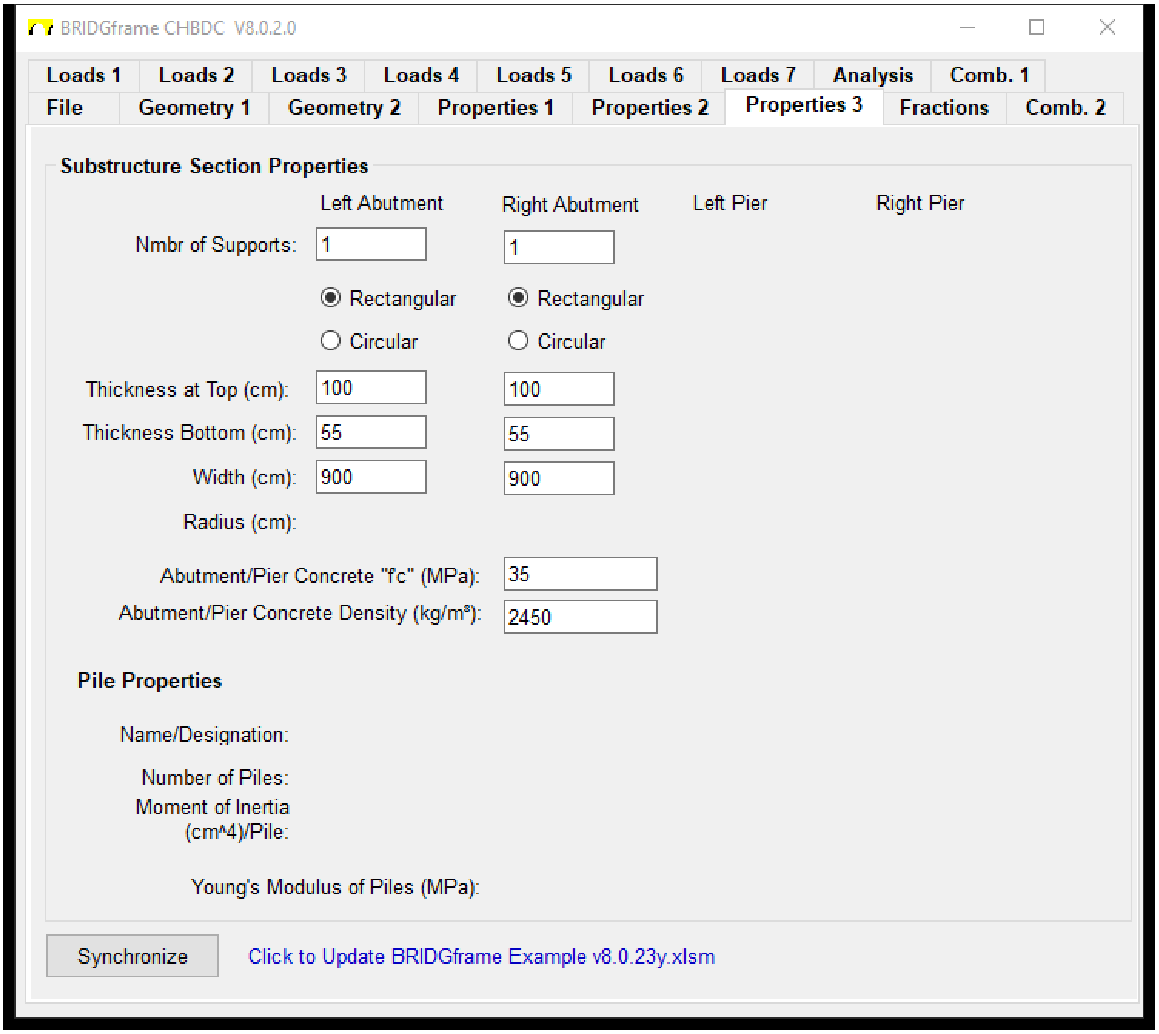

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Superstructure
Spans Count:
one
two
three
Length (m)
Span Type as per cl.3.9.3
Bridge Type as per cl.5.4.6.1
Span1:
16.200
A
B
C1
C2
C3
A
B
C
Span2:
Span3:
Abutments - Continuous
Left
Right
Height (m)
Pile Bases
Piles Height (m)
Integral:
Rigid Frame:
3.5
4
Pinned Legs
Fixed Legs
Free Legs
Abutments - Non-continuous
Horizontal Joint at Abutment Top
Total Bearing Shear Stiffness (kN/mm)
Shoe Plate Thickness (mm)
Non-integral:
Click Synchronize Button on Geometry 2 to Update BRIDGframe Example v8.0.23y.xlsm

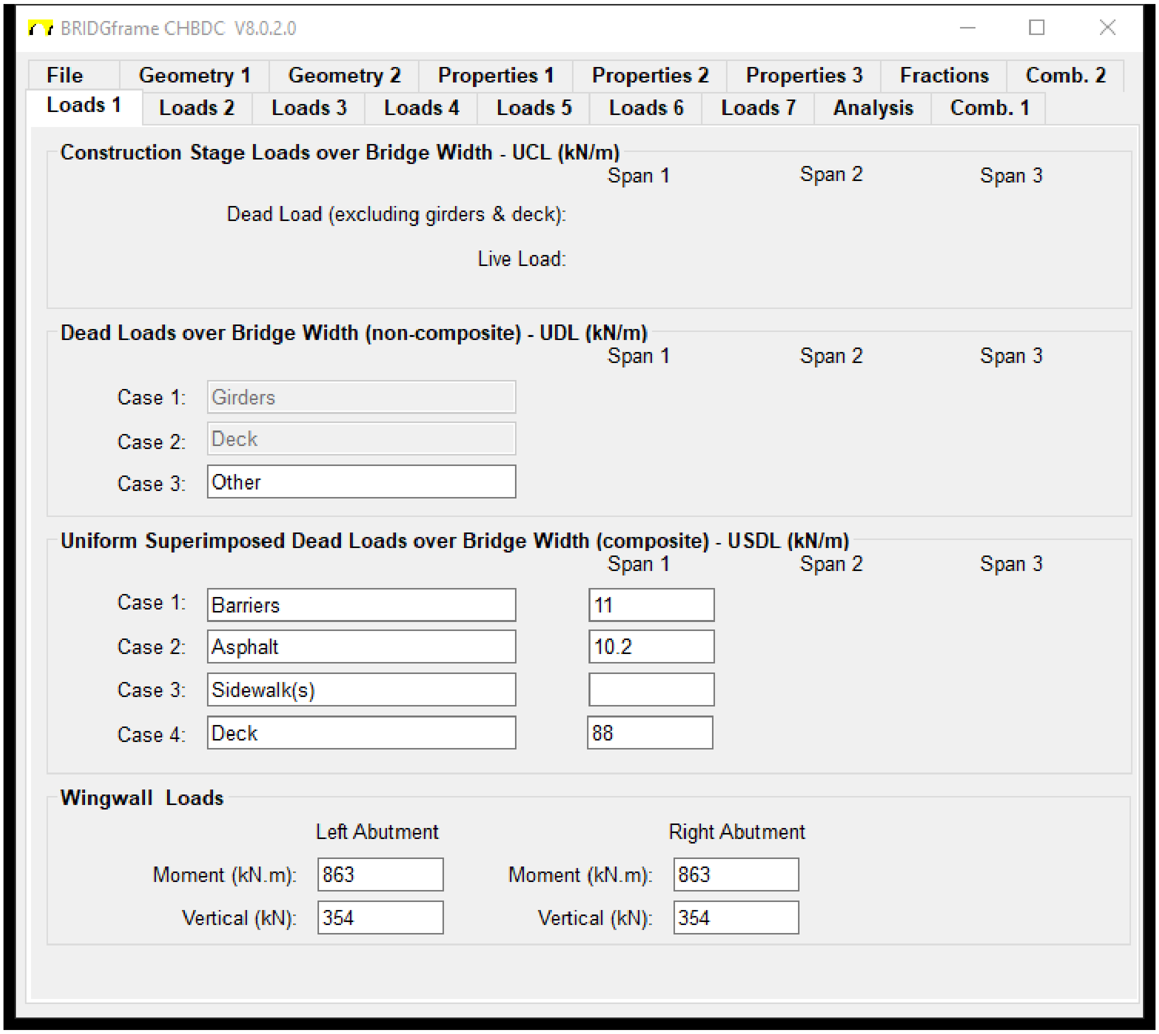

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Piers - Continuous
Left
Right
Height (m)
Pile Bases
Piles Height (m)
Integral:
Rigid Frame:
Piers - Non-continuous
Horizontal Joint at Pier Top
Total Bearing Shear Stiffness (kN/mm)
Shoe Plate Thickness (mm)
Non-integral:
Skew of Substructure from Perpendicular to C/L of Alignment
Skew (degrees):
Girders Over Piers During Construction
Over Left Pier:
Over Right Pier:
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm

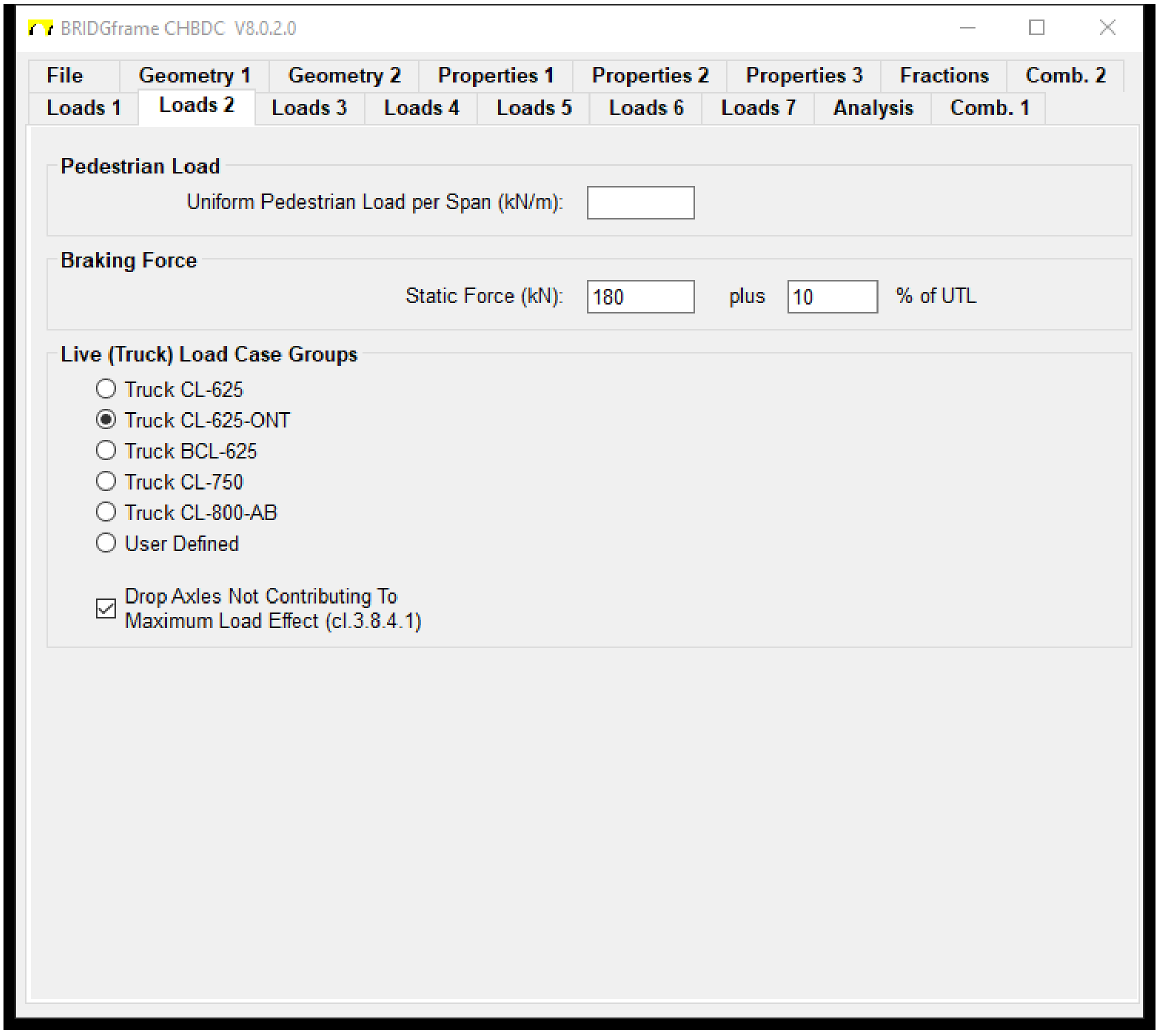

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Span Properties
Span 1 Span 2 Span 3
Girder/Slab Profile
Parabolic
Number of Members per Girder/Slab
2
Member Properties
Member Names or Lengths (m)
Span 1 Span 2 Span 3
1: Middle
2: Ends
3:
4:
5:
6:
7:
Help
Section Properties
Current Section: 1
Span/Bridge Combination: C2/A
Slab Depth (cm): 40.00
Slab Concrete "f'c"(MPa): 35
Slab Concrete Density (kg/m³): 2450
Deck Width "B" (cm): 910
Superstructure Width as per cl.5.5.2 (cm): 910
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm

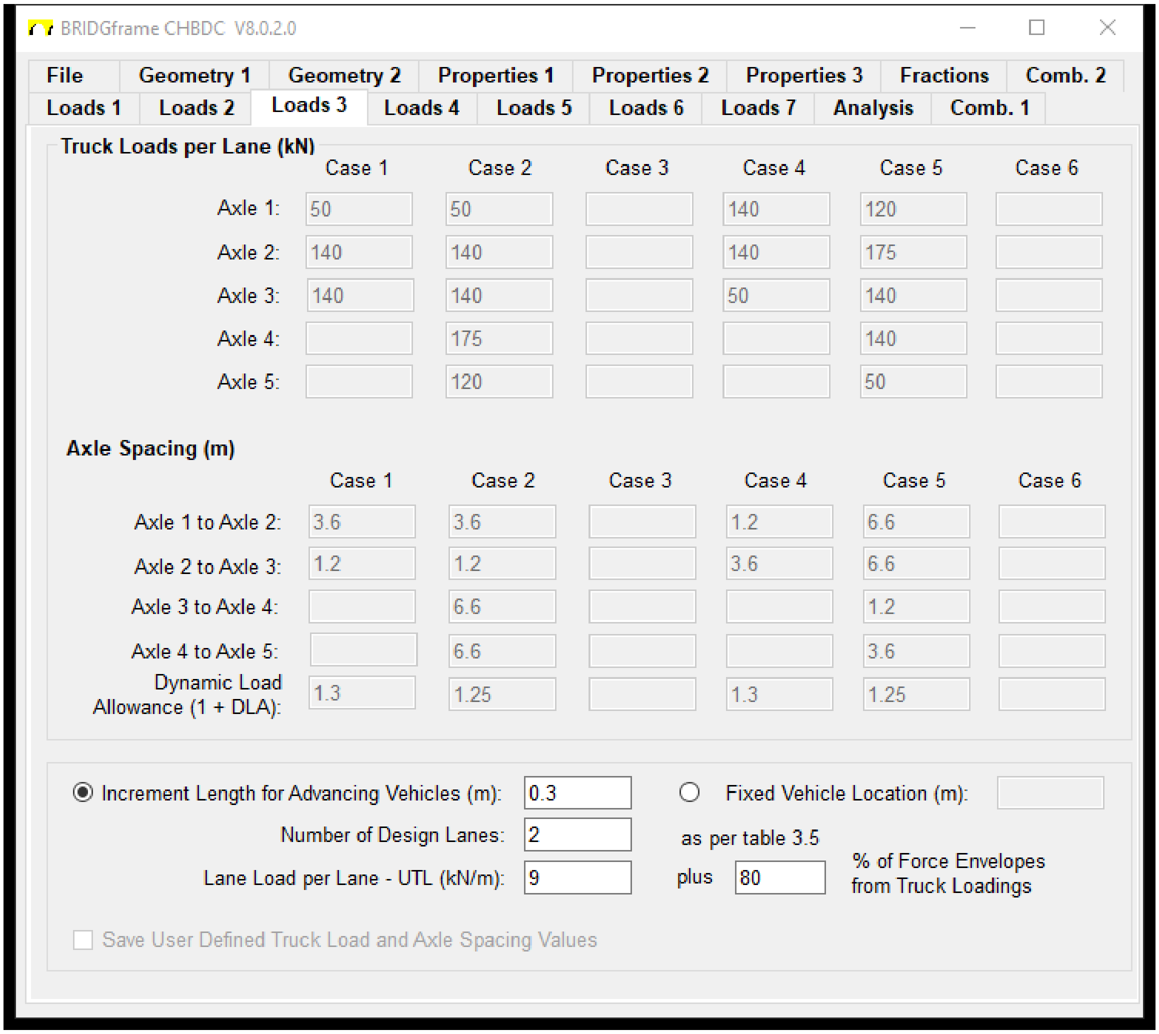

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Span Properties
Span 1
Span 2
Span 3
Girder/Slab Profile
Parabolic
Number of Members per Girder/Slab
2
Member Properties
Member Names or Lengths (m)
Span 1
Span 2
Span 3
1: Middle
2: Ends
3:
4:
5:
6:
7:
Help
Section Properties
Current Section: 2
Span/Bridge Combination: C2/A
Slab Depth (cm): 100
Slab Concrete "f'c"(MPa): 35
Slab Concrete Density (kg/m³): 2450
Deck Width "B" (cm): 910
Superstructure Width as per cl.5.5.2 (cm): 910
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm

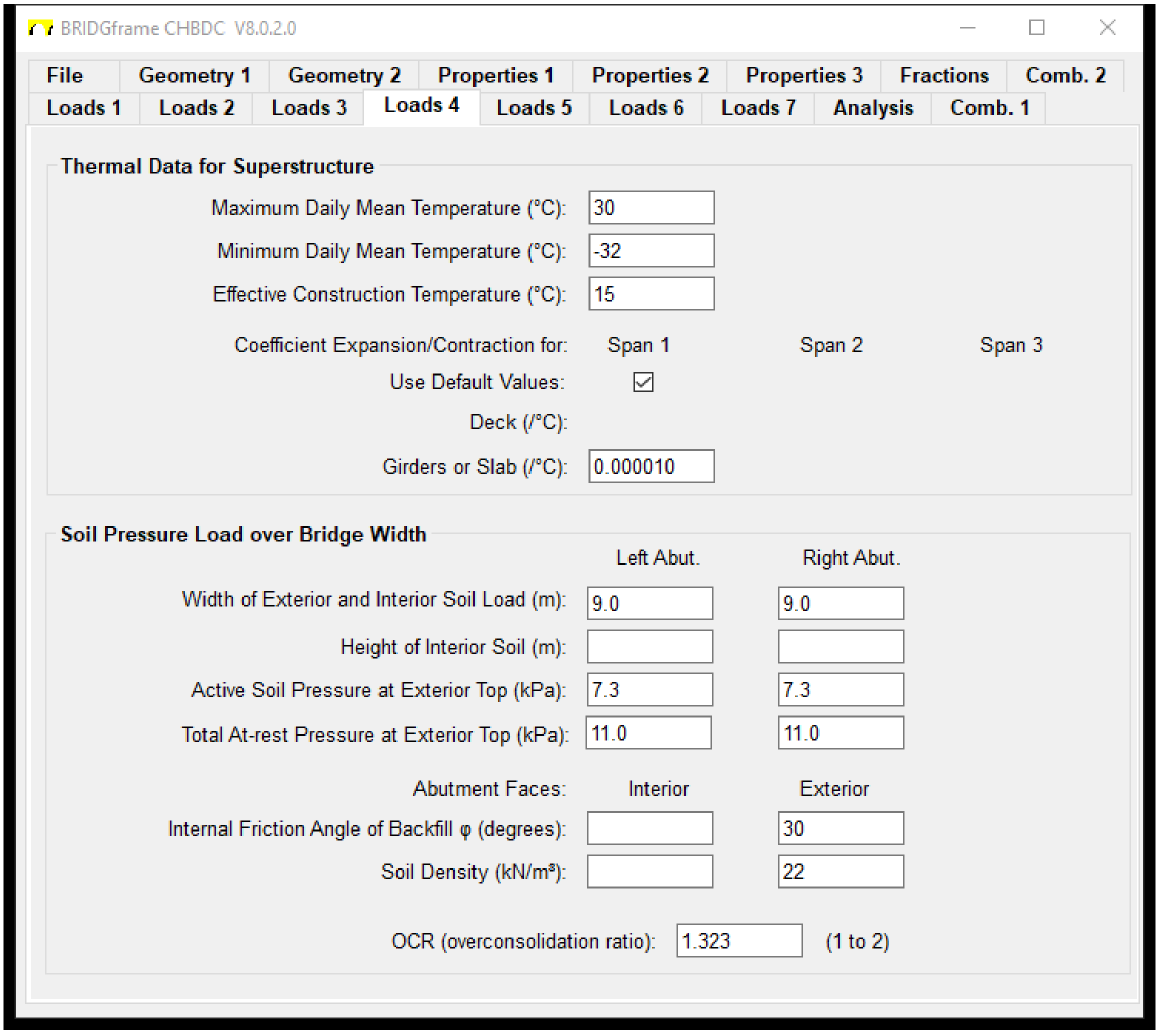

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Superstructure Cross-Section
Span 1
Span 2
Span 3
Spacing of girders or voided slab webs "S" (m):
1
Overhang length of deck "Sc" (m):
Bridge Platform
Bridge Platform Properties are Identical for All Spans
Center of exterior "travelled" lane to adjacent outside face of barrier (m):
2.875
Distance between curb or barrier faces "Wc" (m):
8.5
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm


BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Substructure Section Properties
Left Abutment
Right Abutment
Left Pier
Right Pier
Nmbr of Supports:
1
1
Rectangular
Rectangular
Circular
Circular
Thickness at Top (cm):
100
100
Thickness Bottom (cm):
55
55
Width (cm):
900
900
Radius (cm):
Abutment/Pier Concrete "f'c" (MPa):
35
Abutment/Pier Concrete Density (kg/m³):
2450
Pile Properties
Name/Designation:
Number of Piles:
Moment of Inertia (cm^4)/Pile:
Young's Modulus of Piles (MPa):
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm


BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Construction Stage Loads over Bridge Width - UCL (kN/m)
Span 1
Span 2
Span 3
Dead Load (excluding girders & deck):
Live Load:
Dead Loads over Bridge Width (non-composite) - UDL (kN/m)
Span 1
Span 2
Span 3
Case 1:
Girders
Case 2:
Deck
Case 3:
Other
Uniform Superimposed Dead Loads over Bridge Width (composite) - USDL (kN/m)
Span 1
Span 2
Span 3
Case 1:
Barriers
11
Case 2:
Asphalt
10.2
Case 3:
Sidewalk(s)
Case 4:
Deck
88
Wingwall Loads
Left Abutment
Right Abutment
Moment (kN.m):
863
Moment (kN.m):
863
Vertical (kN):
354
Vertical (kN):
354

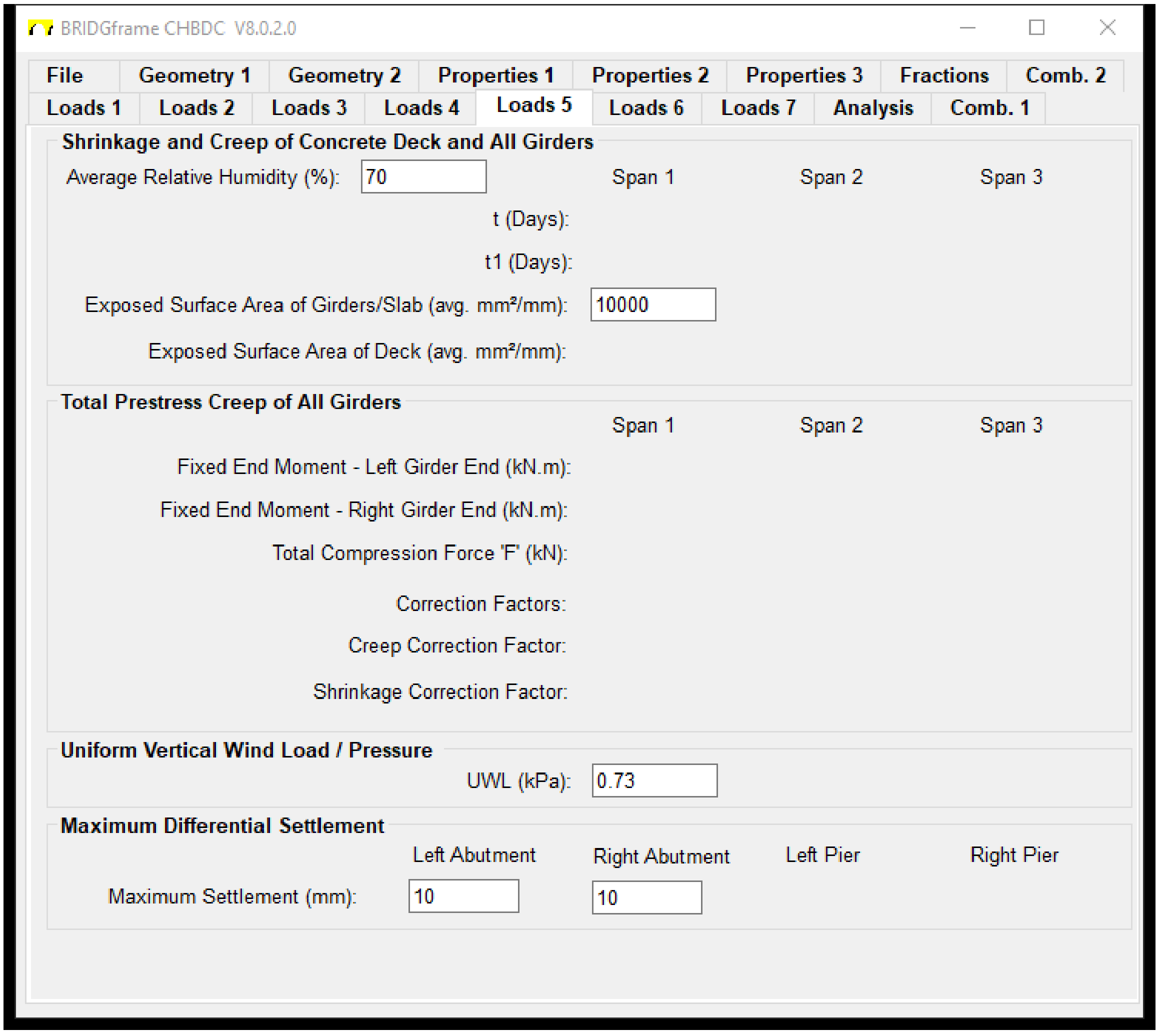

BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Pedestrian Load
Uniform Pedestrian Load per Span (kN/m):
Braking Force
Static Force (kN):
180
plus
10
% of UTL
Live (Truck) Load Case Groups
Truck CL-625
Truck CL-625-ONT
Truck BCL-625
Truck CL-750
Truck CL-800-AB
User Defined
Drop Axles Not Contributing To
Maximum Load Effect (cl.3.8.4.1)

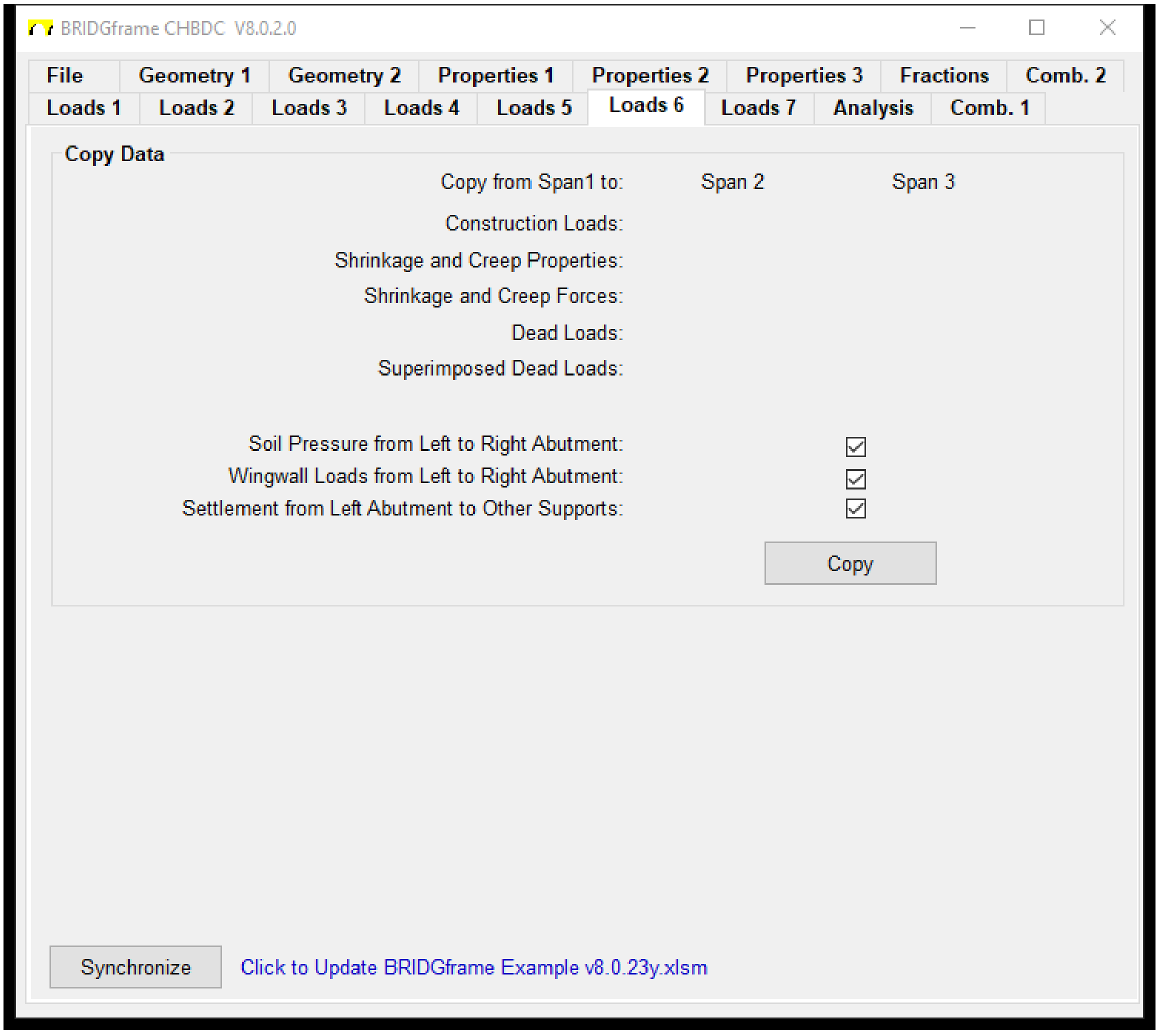

BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Truck Loads per Lane (kN)
Case 1 Case 2 Case 3 Case 4 Case 5 Case 6
Axle 1: 50 50 140 120
Axle 2: 140 140 140 175
Axle 3: 140 140 50 140
Axle 4: 175 140
Axle 5: 120 50
Axle Spacing (m)
Case 1 Case 2 Case 3 Case 4 Case 5 Case 6
Axle 1 to Axle 2: 3.6 3.6 1.2 6.6
Axle 2 to Axle 3: 1.2 1.2 3.6 6.6
Axle 3 to Axle 4: 6.6 1.2
Axle 4 to Axle 5: 6.6 3.6
Dynamic Load Allowance (1 + DLA): 1.3 1.25 1.3 1.25
Increment Length for Advancing Vehicles (m): 0.3
Fixed Vehicle Location (m):
Number of Design Lanes: 2
as per table 3.5
Lane Load per Lane - UTL (kN/m): 9
plus 80
% of Force Envelopes from Truck Loadings
Save User Defined Truck Load and Axle Spacing Values



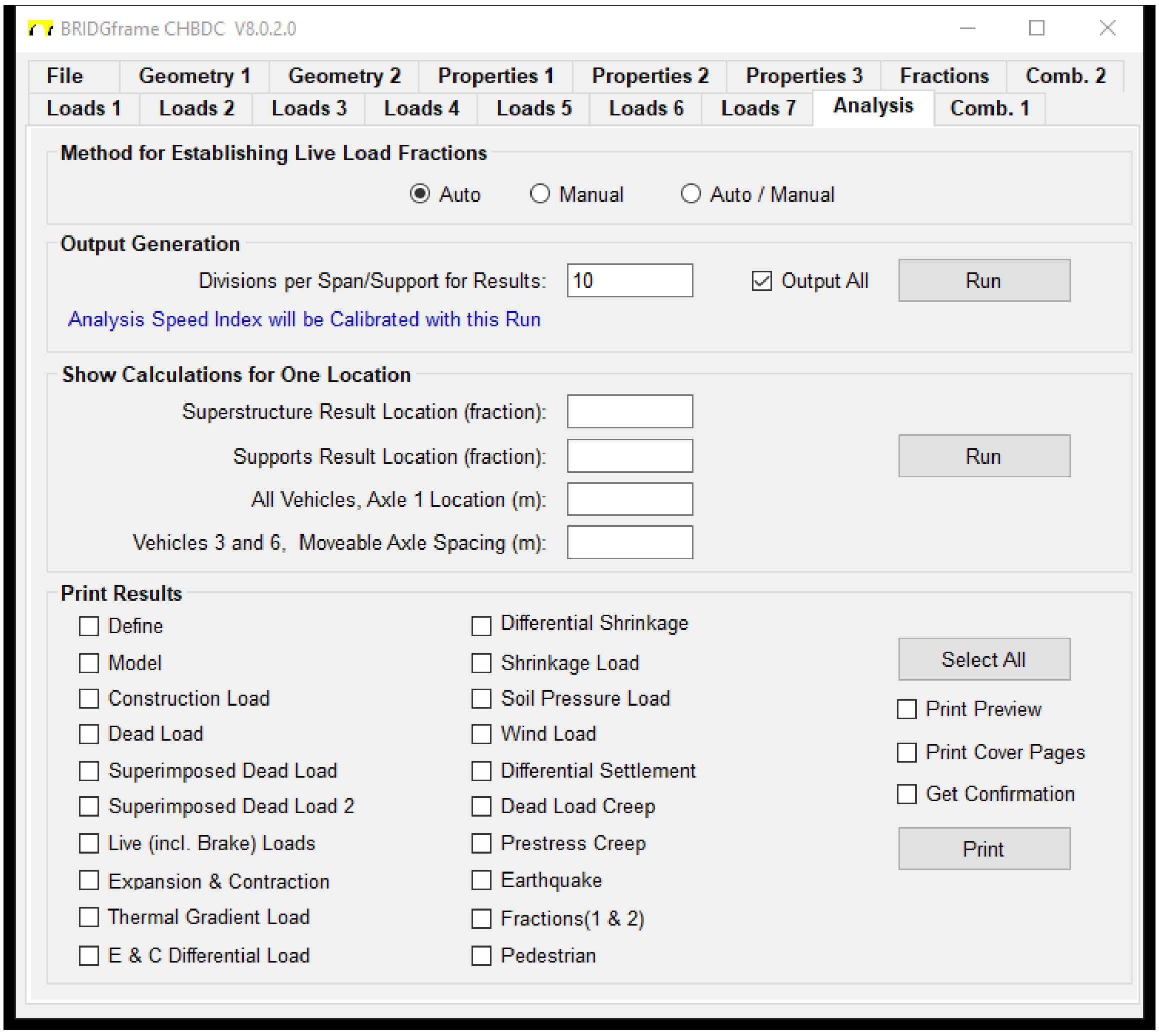
- The distance between the superstructure NA and grade is 0.2 m and since no approach slabs will be used the live load surcharge will be taken as an equivalent soil surcharge of 0.8 m. For simplicity, the 0.2 m will be assumed as a live load. Therefore (0.2 + 0.8) x 22.0 = 22.0 kPa.
  Active Soil Pressure at Exterior Top = 22.0 x 0.33 = 7.3 kPa
  Total At-rest Pressure at Exterior Top = 22.0 x 0.50 = 11.0 kPa

  Note: if approach slabs were present the total depth of soil surcharge would have been 0.2 m. Alternatively, a conservative height of abutment could be used and no soil pressure input.


BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Shrinkage and Creep of Concrete Deck and All Girders
Average Relative Humidity (%):
70
Span 1
Span 2
Span 3
t (Days):
t1 (Days):
Exposed Surface Area of Girders/Slab (avg. mm²/mm):
10000
Exposed Surface Area of Deck (avg. mm²/mm):
Total Prestress Creep of All Girders
Span 1
Span 2
Span 3
Fixed End Moment - Left Girder End (kN.m):
Fixed End Moment - Right Girder End (kN.m):
Total Compression Force 'F' (kN):
Correction Factors:
Creep Correction Factor:
Shrinkage Correction Factor:
Uniform Vertical Wind Load / Pressure
UWL (kPa):
0.73
Maximum Differential Settlement
Left Abutment
Right Abutment
Left Pier
Right Pier
Maximum Settlement (mm):
10
10


BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Copy Data
Copy from Span1 to:
Span 2
Span 3
Construction Loads:
Shrinkage and Creep Properties:
Shrinkage and Creep Forces:
Dead Loads:
Superimposed Dead Loads:
Soil Pressure from Left to Right Abutment:
Wingwall Loads from Left to Right Abutment:
Settlement from Left Abutment to Other Supports:
Copy
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm

Loads 7: See Appendix 17.



APPENDIX 4 – CONCRETE RIGID FRAME PARABOLIC BEAMS

Bridge Geometry

Structure Type: Rigid frame with symmetrical parabolic beams spanning between tapered abutments

Spans: 1 span at 21.3 m

Deck: 9.1 m total width x 180 mm thick (39.3 kN/m).
Deck and beams are shored during construction
8.5 m barrier inside face to barrier inside face.
2 travelled lanes at 3.25 m.
2 side clearances at 1.0 m.
2 design lanes.
90mm asphalt and waterproofing (17.2 kN/m).

Barriers: Parapet walls 250 mm wide (10.5 kN/m)

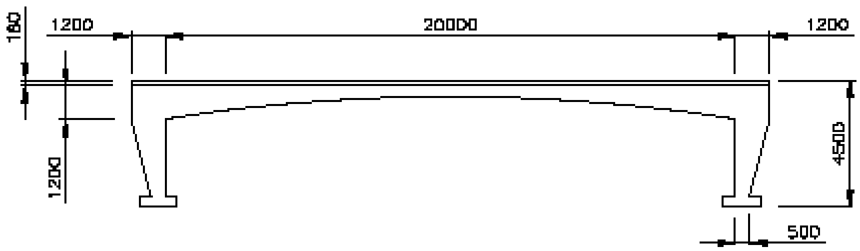
Beams: 4 – 1000mm wide. Height varies from 1200 at ends to 400 at C/L of span.

Abutments: 4.1 m high x 1.20 m thick at top and 0.50 m thick at bottom x 9.0 m wide

Piles: None

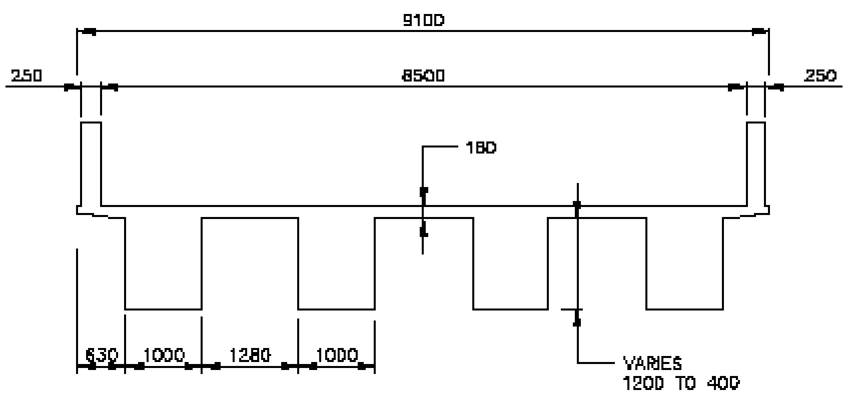
Wingwalls: Two wingwalls loading per abutment (includes barriers on wingwalls)
See Appendix 13.

Vertical (gravity load) (354 kN)
Moment (863 kN.m)



ELEVATION

SCALE: 1 : 200



SECTION

SCALE: 1 : 75

This structure is modeled using two runs for analysis (Run 1 and Run 2).

Run 1 model: For all load cases except effects of beam haunch weight.

In Run 1, the superstructure will be modeled as a variable beam consisting of seven members per beam length.

1. Divide half of the beam (half parabola) into four segments or members.
    a. first member to be (600 half of abutment width plus 550) = 1150 mm
    b. second member to be 1400 mm
    c. third member to be 3800 mm
    d. and fourth member to be 4300 mm

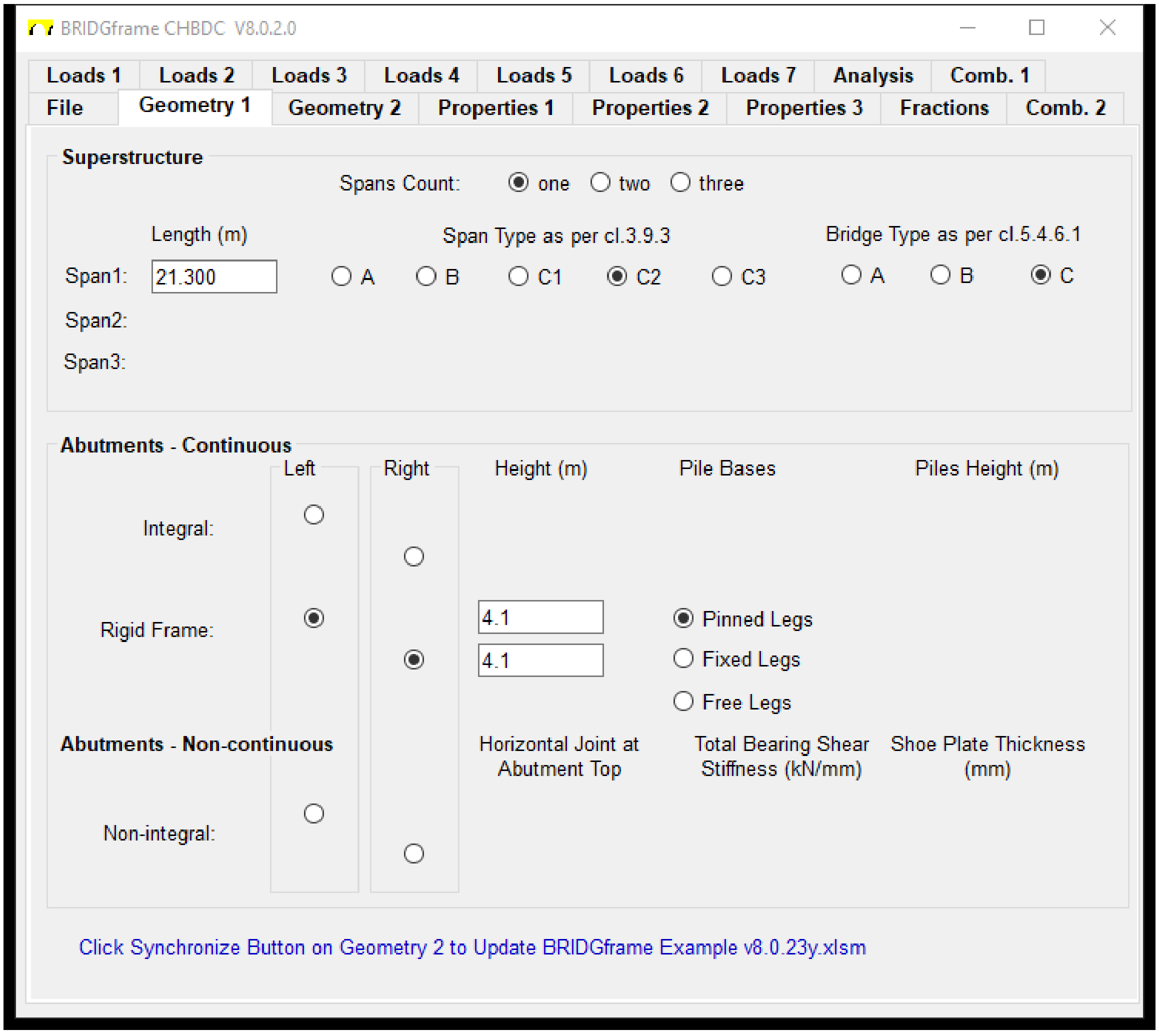
Given the equation of the parabolic curve as $y = 4f / L^2 * (L-x)\ x$
where y = vertical height of curve at x
f = height to apex = 1200 – 400 = 800 mm
L = span = 21300 mm
x = horizontal distance from start of curve

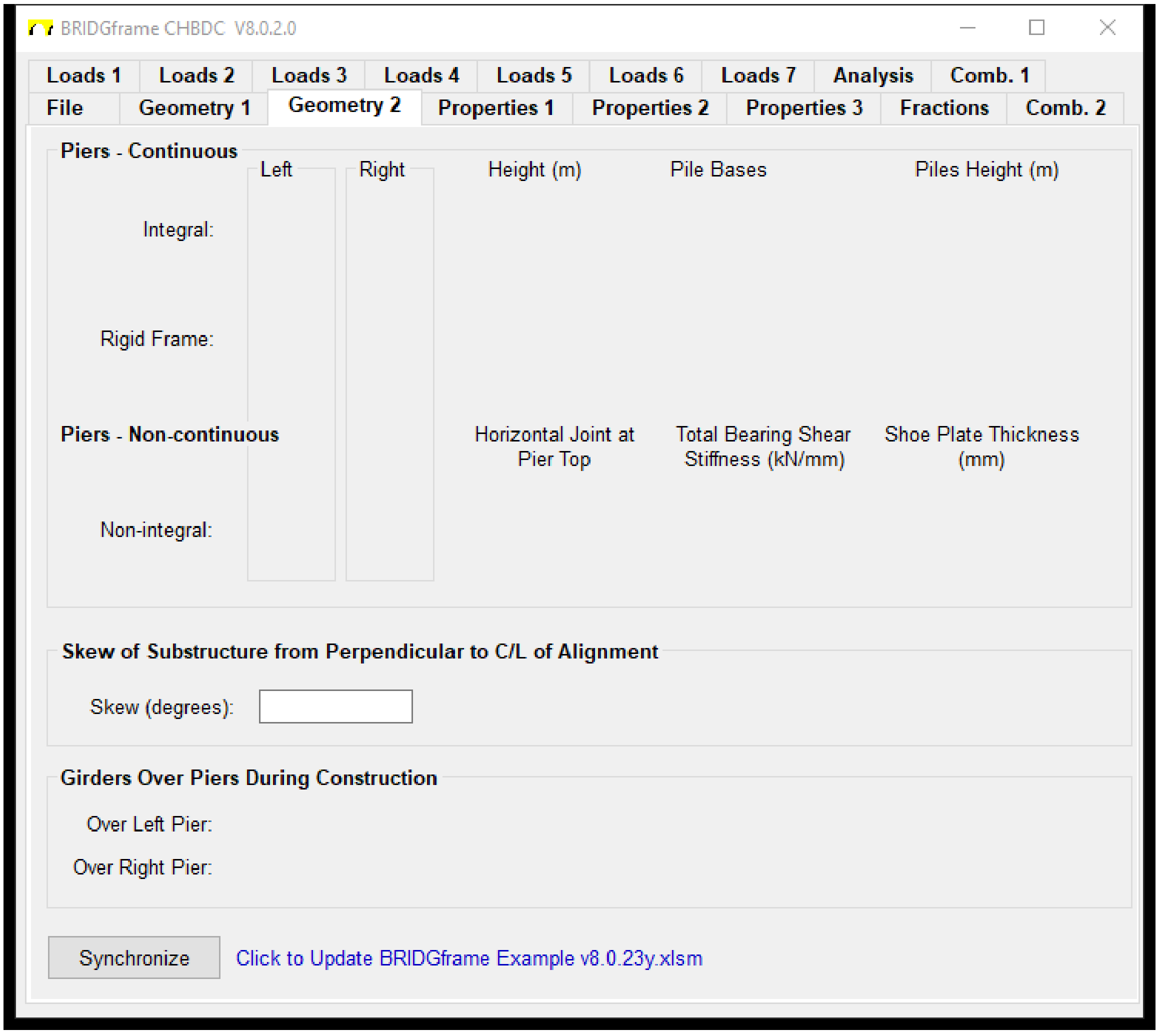
1st member: 1150 * 25% = 287.5 mm = x
y = 4.3 cm
beam depth = 120 – 4.3 = 115.7 cm
$A = 100 * 115.7 = 11570\ cm^2$
$I = 100 * 115.7^3 / 12 = 12906807\ cm^4$
$Y_b = 115.7 / 2 = 57.85$ cm

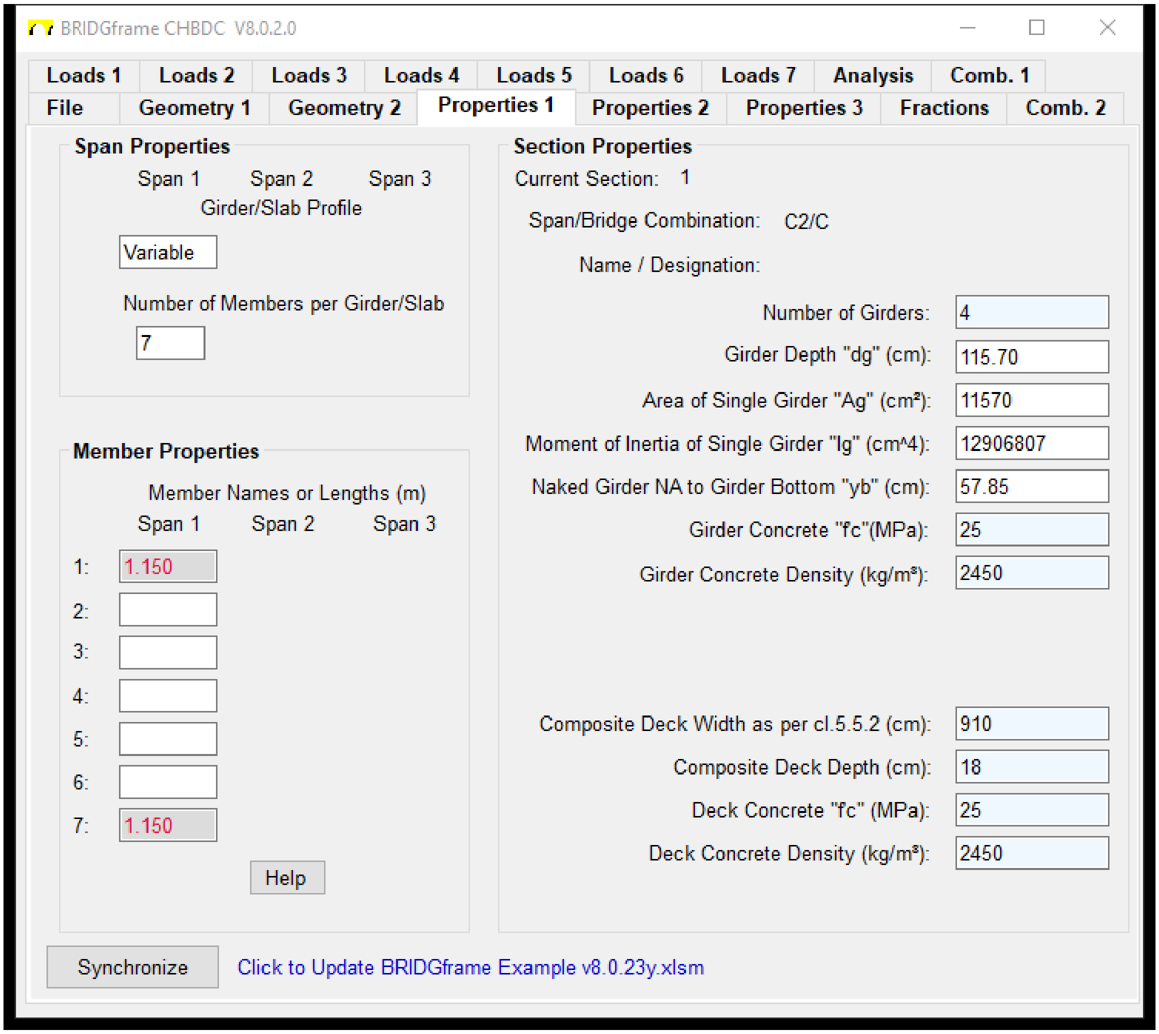
2nd member: 1400 * 25% + 1150 = 1500 mm = x
y = 20.9 cm
beam depth = 120 – 20.9 = 99.1 cm
$A = 100 * 99.1 = 9910\ cm^2$
$I = 100 * 99.1^3 / 12 = 8110352\ cm^4$
$Y_b = 99.1 / 2 = 49.55$ cm

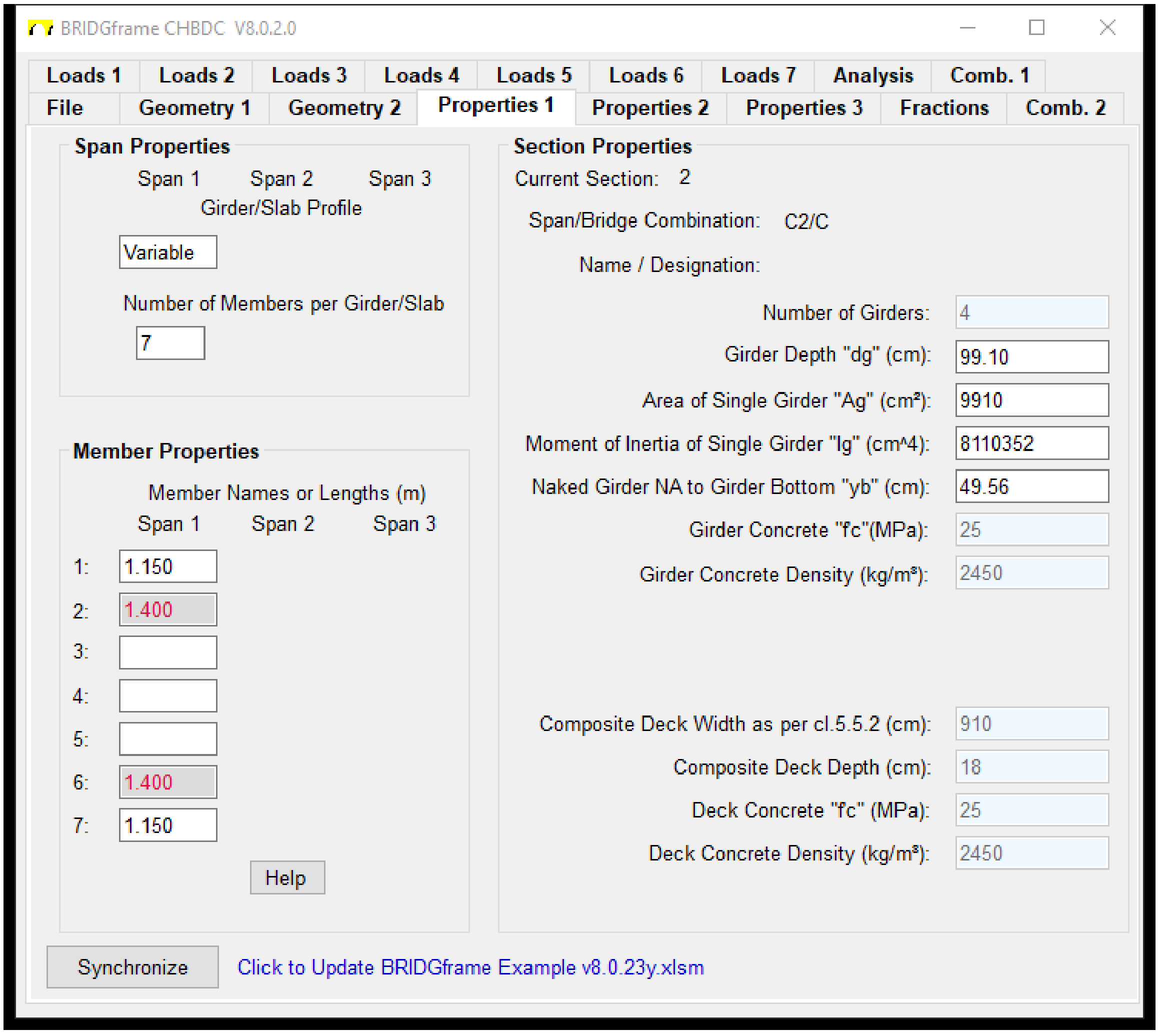
3rd member: 3800 * 25% + 1150 + 1400 = 3500 mm = x
y = 43.9 cm
beam depth = 120 – 43.9 = 76.1 cm
$A = 100 * 76.1 = 7610\ cm^2$
$I = 100 * 76.1^3 / 12 = 3672592\ cm^4$
$Y_b = 76.1 / 2 = 38.05$ cm

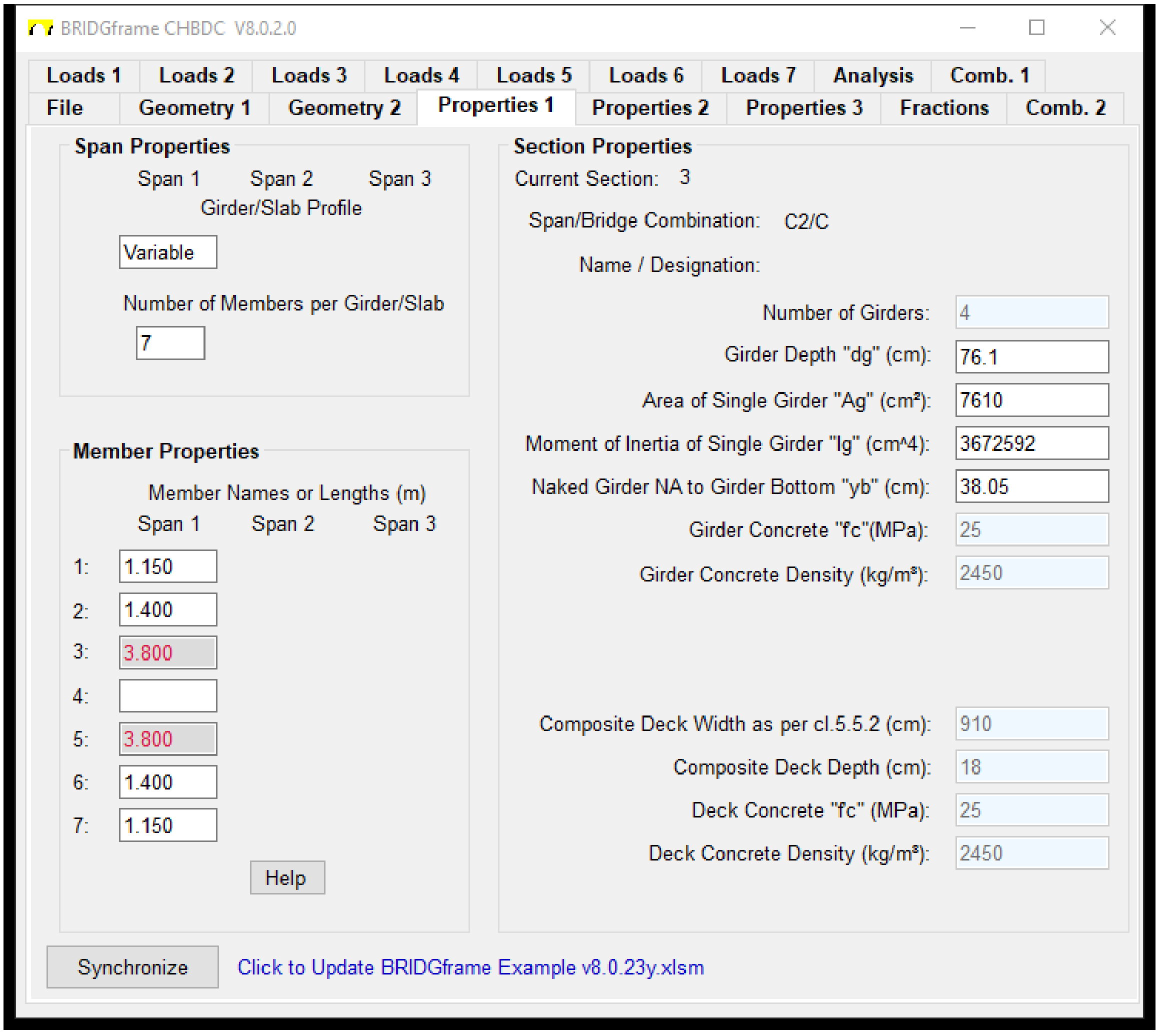
4th member: 4300 * 25% + 1150 + 1400 + 3800 = 7425 mm = x
y = 72.7 cm
beam depth = 120 – 72.7 = 47.3 cm
$A = 100 * 47.3 = 4730\ cm^2$
$I = 100 * 47.3^3 / 12 = 881865\ cm^4$
$Y_b = 47.3 / 2 = 23.65$ cm

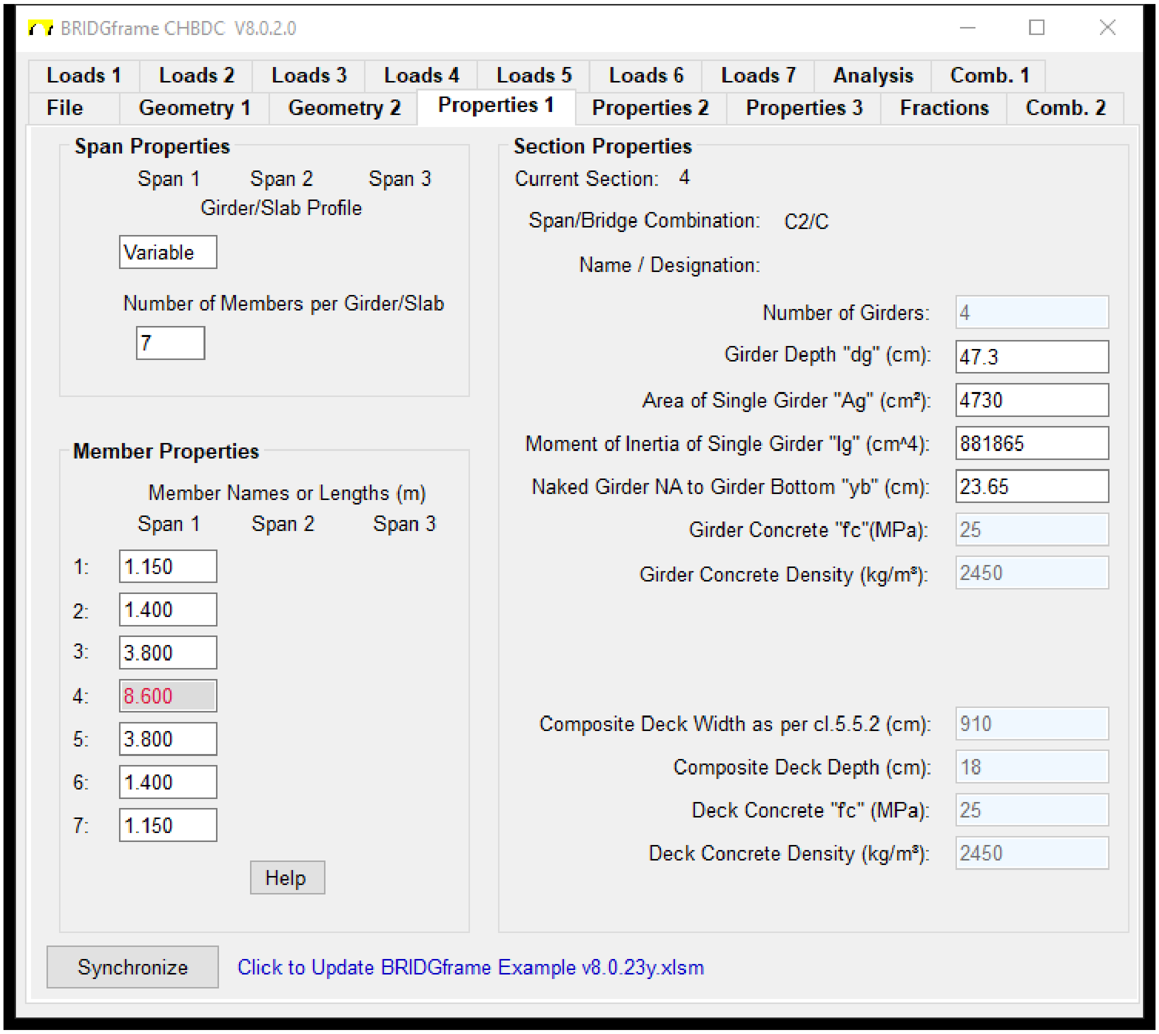

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Superstructure
Spans Count:
one
two
three
Length (m)
Span Type as per cl.3.9.3
Bridge Type as per cl.5.4.6.1
Span1:
21.300
A
B
C1
C2
C3
A
B
C
Span2:
Span3:
Abutments - Continuous
Left
Right
Height (m)
Pile Bases
Piles Height (m)
Integral:
Rigid Frame:
4.1
4.1
Pinned Legs
Fixed Legs
Free Legs
Abutments - Non-continuous
Horizontal Joint at Abutment Top
Total Bearing Shear Stiffness (kN/mm)
Shoe Plate Thickness (mm)
Non-integral:
Click Synchronize Button on Geometry 2 to Update BRIDGframe Example v8.0.23y.xlsm

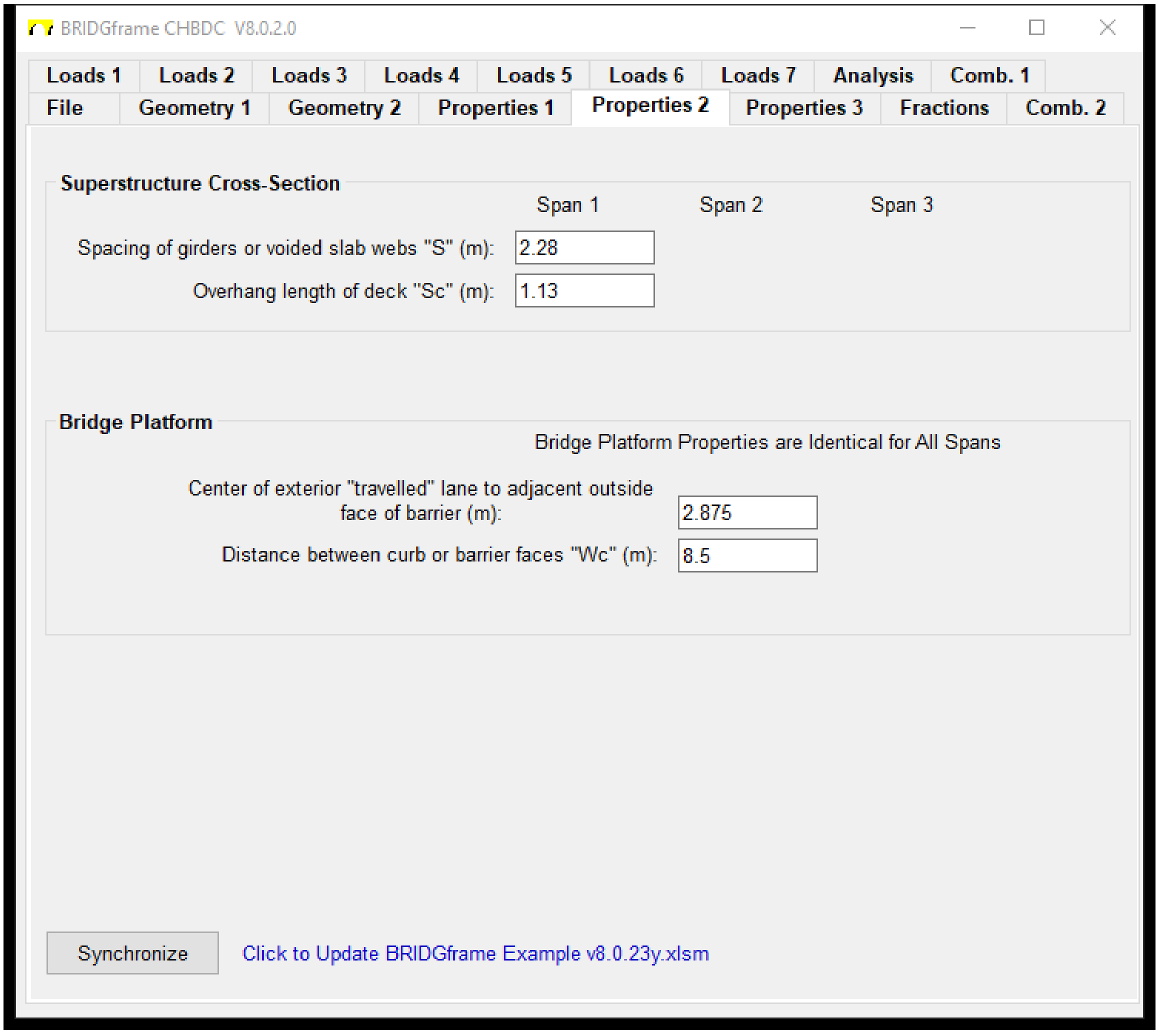

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Piers - Continuous
Left
Right
Height (m)
Pile Bases
Piles Height (m)
Integral:
Rigid Frame:
Piers - Non-continuous
Horizontal Joint at Pier Top
Total Bearing Shear Stiffness (kN/mm)
Shoe Plate Thickness (mm)
Non-integral:
Skew of Substructure from Perpendicular to C/L of Alignment
Skew (degrees):
Girders Over Piers During Construction
Over Left Pier:
Over Right Pier:
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm

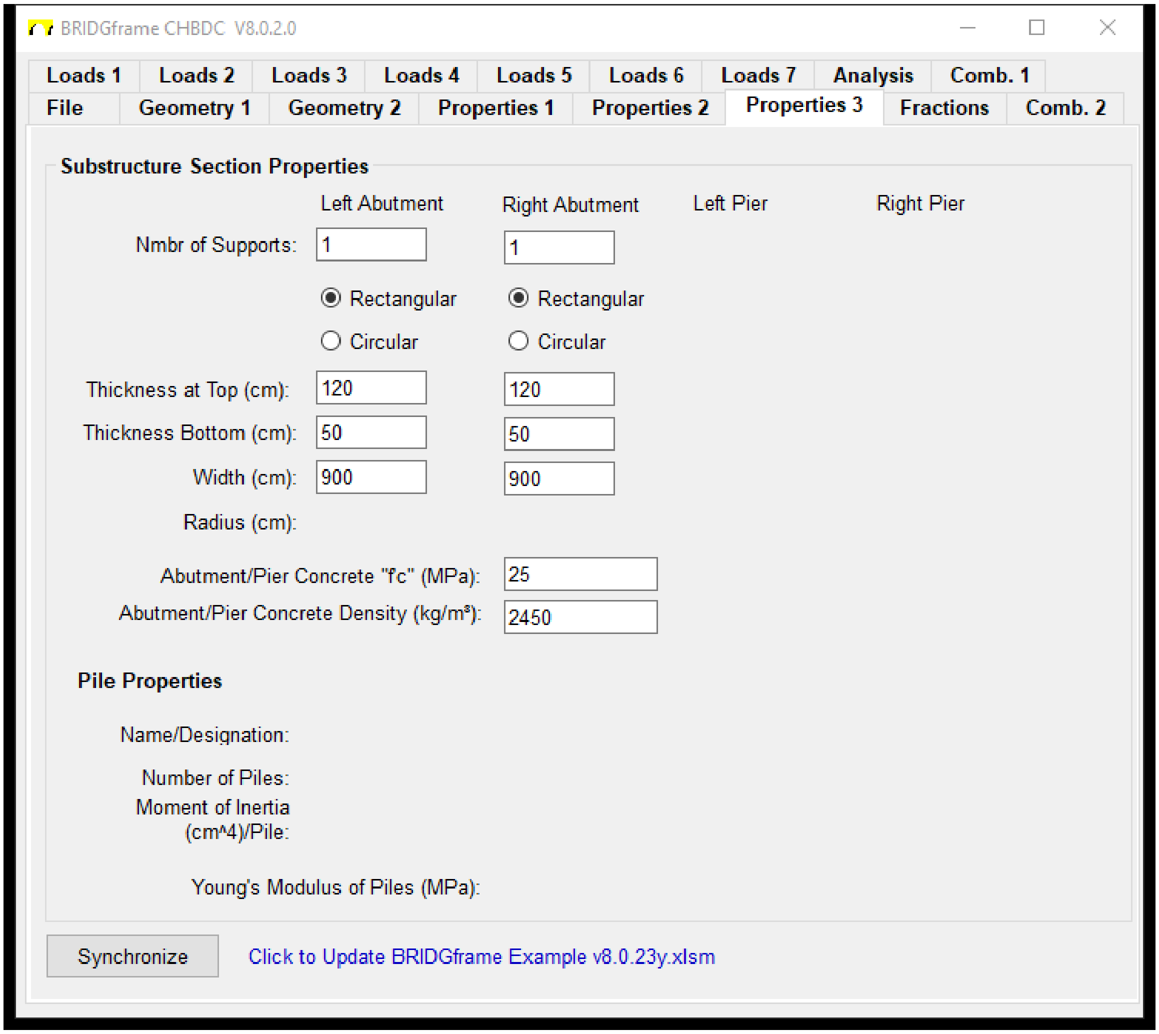

BRIDGframe CHBDC V8.0.2.0
Loads 1 | Loads 2 | Loads 3 | Loads 4 | Loads 5 | Loads 6 | Loads 7 | Analysis | Comb. 1
File | Geometry 1 | Geometry 2 | Properties 1 | Properties 2 | Properties 3 | Fractions | Comb. 2
Span Properties
Span 1 Span 2 Span 3
Girder/Slab Profile
Variable
Number of Members per Girder/Slab
7
Member Properties
Member Names or Lengths (m)
Span 1 Span 2 Span 3
1: 1.150
2:
3:
4:
5:
6:
7: 1.150
Help
Section Properties
Current Section: 1
Span/Bridge Combination: C2/C
Name / Designation:
Number of Girders: 4
Girder Depth "dg" (cm): 115.70
Area of Single Girder "Ag" (cm²): 11570
Moment of Inertia of Single Girder "Ig" (cm^4): 12906807
Naked Girder NA to Girder Bottom "yb" (cm): 57.85
Girder Concrete "fc"(MPa): 25
Girder Concrete Density (kg/m³): 2450
Composite Deck Width as per cl.5.5.2 (cm): 910
Composite Deck Depth (cm): 18
Deck Concrete "fc" (MPa): 25
Deck Concrete Density (kg/m³): 2450
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm

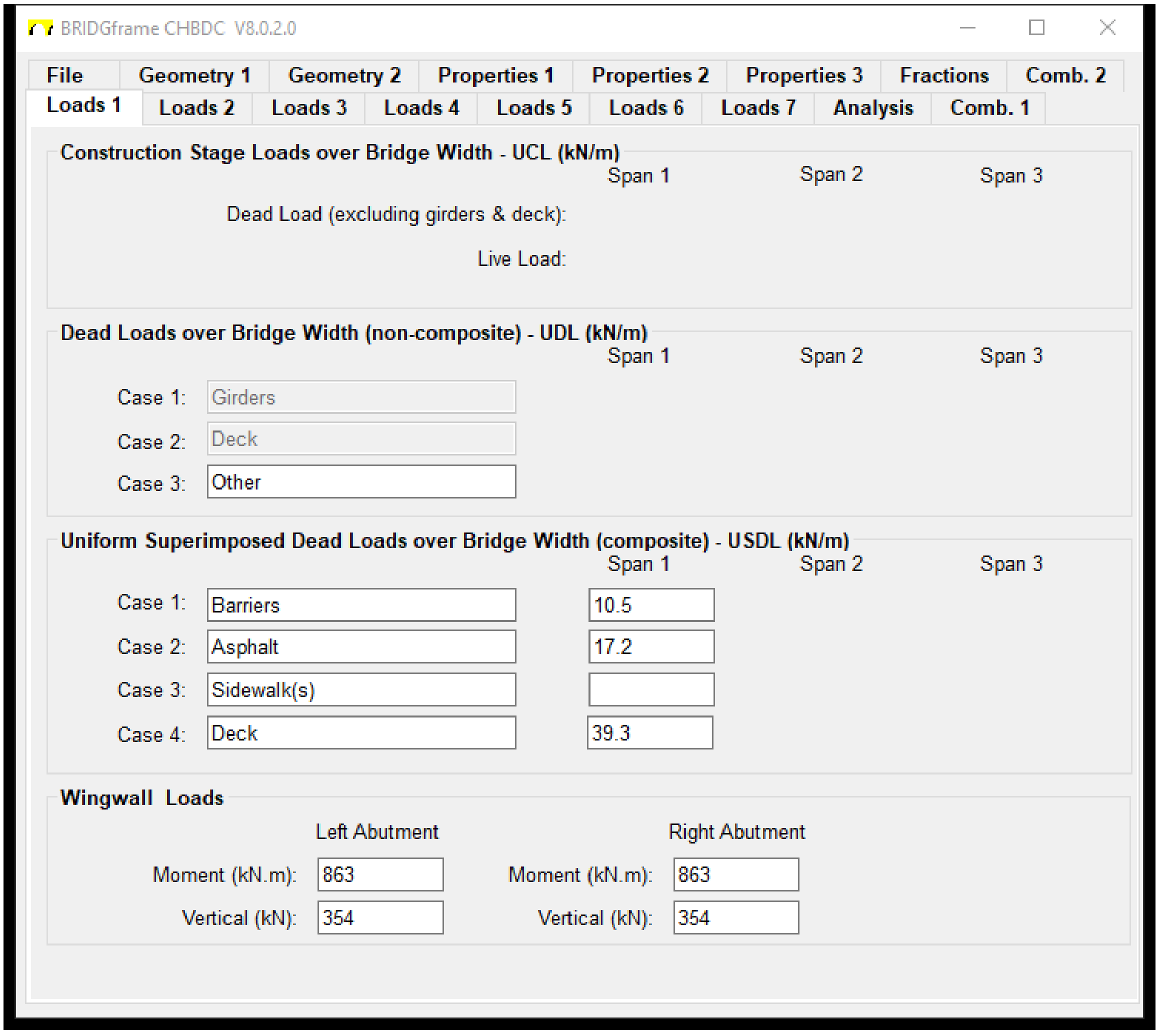

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Span Properties
Span 1
Span 2
Span 3
Girder/Slab Profile
Variable
Number of Members per Girder/Slab
7
Member Properties
Member Names or Lengths (m)
Span 1
Span 2
Span 3
1: 1.150
2: 1.400
3:
4:
5:
6: 1.400
7: 1.150
Help
Section Properties
Current Section: 2
Span/Bridge Combination: C2/C
Name / Designation:
Number of Girders: 4
Girder Depth "dg" (cm): 99.10
Area of Single Girder "Ag" (cm²): 9910
Moment of Inertia of Single Girder "Ig" (cm^4): 8110352
Naked Girder NA to Girder Bottom "yb" (cm): 49.56
Girder Concrete "f'c"(MPa): 25
Girder Concrete Density (kg/m³): 2450
Composite Deck Width as per cl.5.5.2 (cm): 910
Composite Deck Depth (cm): 18
Deck Concrete "f'c" (MPa): 25
Deck Concrete Density (kg/m³): 2450
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm

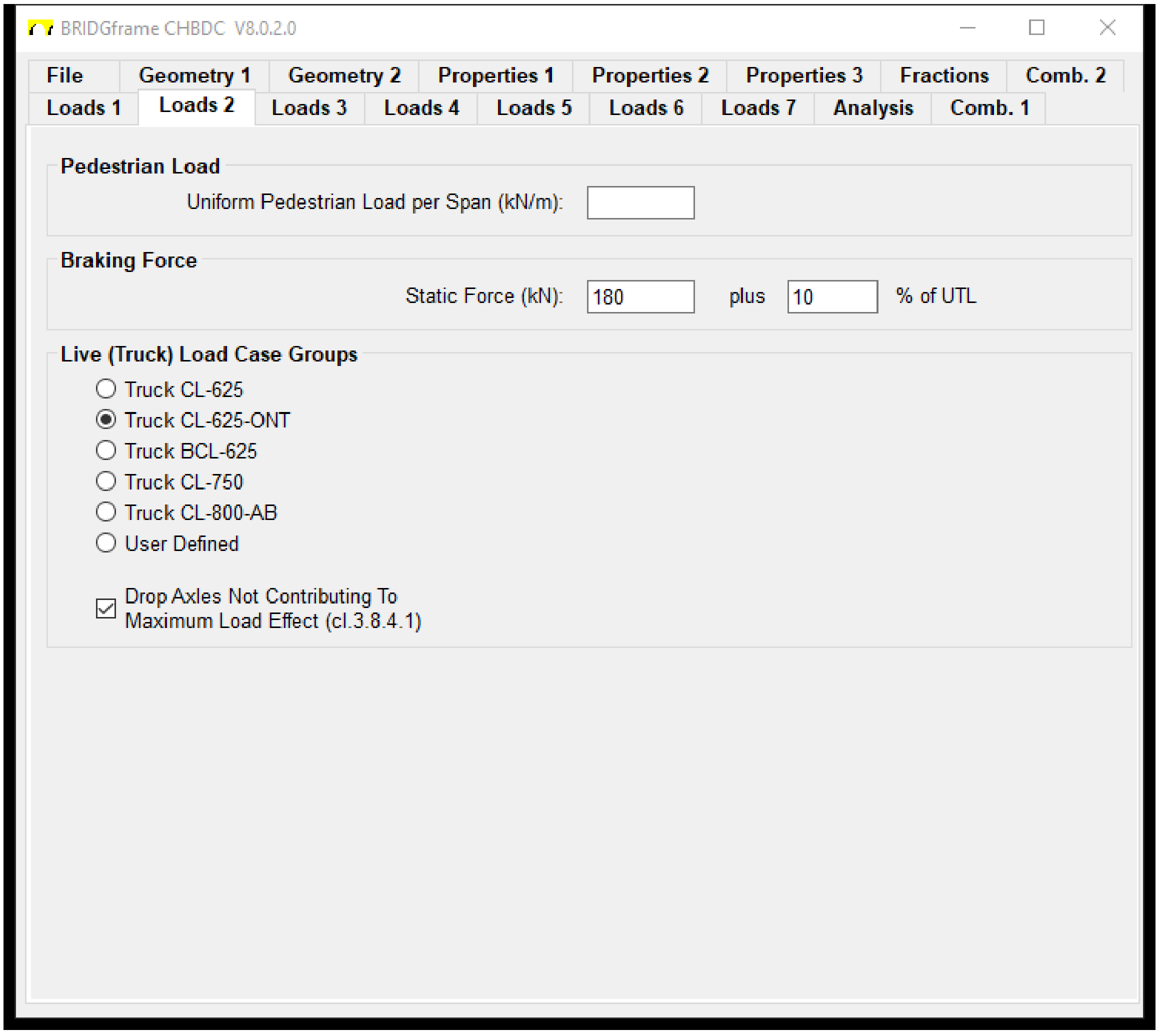

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Span Properties
Span 1 Span 2 Span 3
Girder/Slab Profile
Variable
Number of Members per Girder/Slab
7
Member Properties
Member Names or Lengths (m)
Span 1 Span 2 Span 3
1: 1.150
2: 1.400
3: 3.800
4:
5: 3.800
6: 1.400
7: 1.150
Help
Section Properties
Current Section: 3
Span/Bridge Combination: C2/C
Name / Designation:
Number of Girders: 4
Girder Depth "dg" (cm): 76.1
Area of Single Girder "Ag" (cm²): 7610
Moment of Inertia of Single Girder "Ig" (cm^4): 3672592
Naked Girder NA to Girder Bottom "yb" (cm): 38.05
Girder Concrete "f'c"(MPa): 25
Girder Concrete Density (kg/m³): 2450
Composite Deck Width as per cl.5.5.2 (cm): 910
Composite Deck Depth (cm): 18
Deck Concrete "f'c" (MPa): 25
Deck Concrete Density (kg/m³): 2450
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm

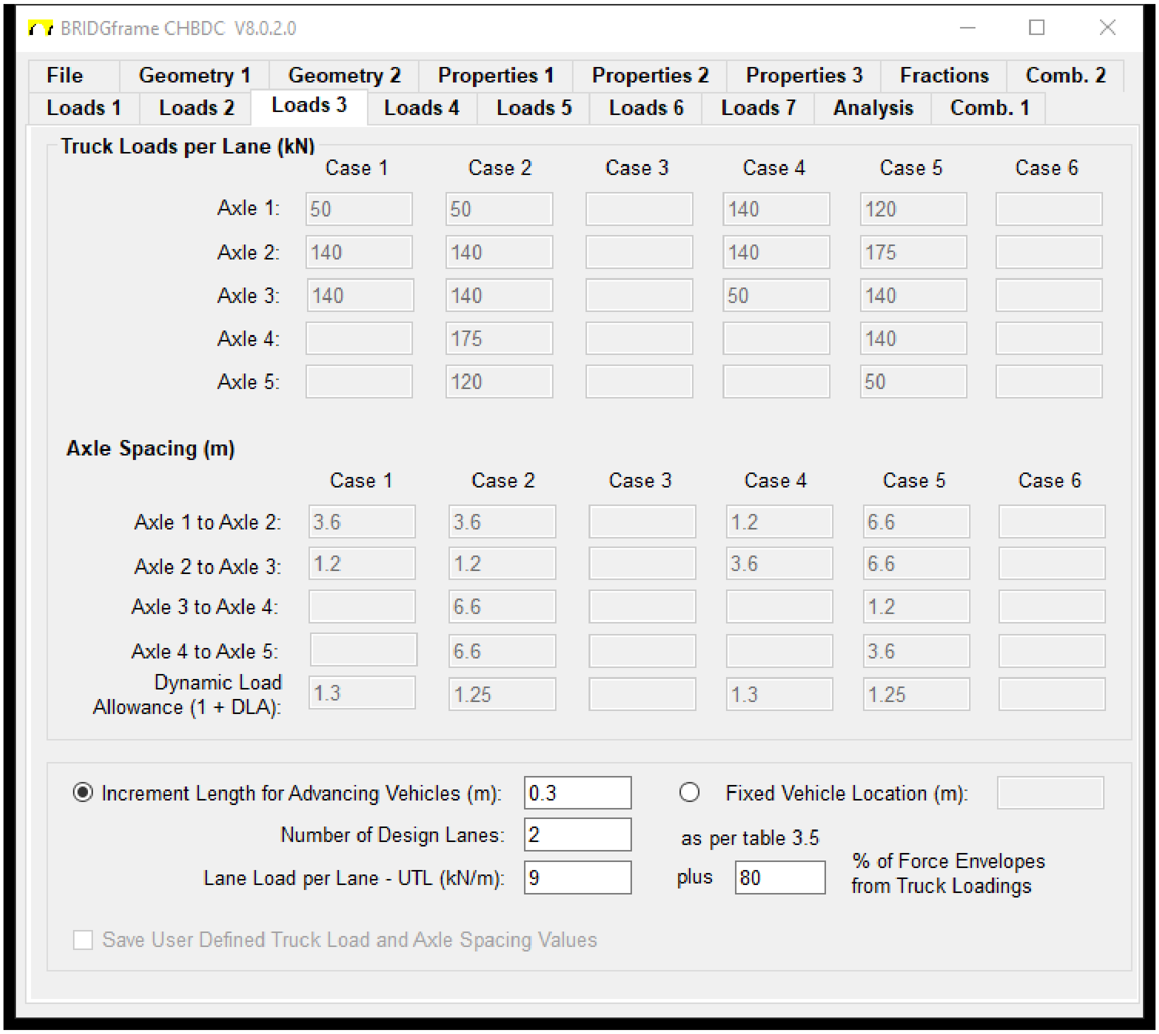

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Span Properties
Span 1
Span 2
Span 3
Girder/Slab Profile
Variable
Number of Members per Girder/Slab
7
Member Properties
Member Names or Lengths (m)
Span 1
Span 2
Span 3
1: 1.150
2: 1.400
3: 3.800
4: 8.600
5: 3.800
6: 1.400
7: 1.150
Help
Section Properties
Current Section: 4
Span/Bridge Combination: C2/C
Name / Designation:
Number of Girders: 4
Girder Depth "dg" (cm): 47.3
Area of Single Girder "Ag" (cm²): 4730
Moment of Inertia of Single Girder "Ig" (cm^4): 881865
Naked Girder NA to Girder Bottom "yb" (cm): 23.65
Girder Concrete "f'c"(MPa): 25
Girder Concrete Density (kg/m³): 2450
Composite Deck Width as per cl.5.5.2 (cm): 910
Composite Deck Depth (cm): 18
Deck Concrete "f'c" (MPa): 25
Deck Concrete Density (kg/m³): 2450
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm

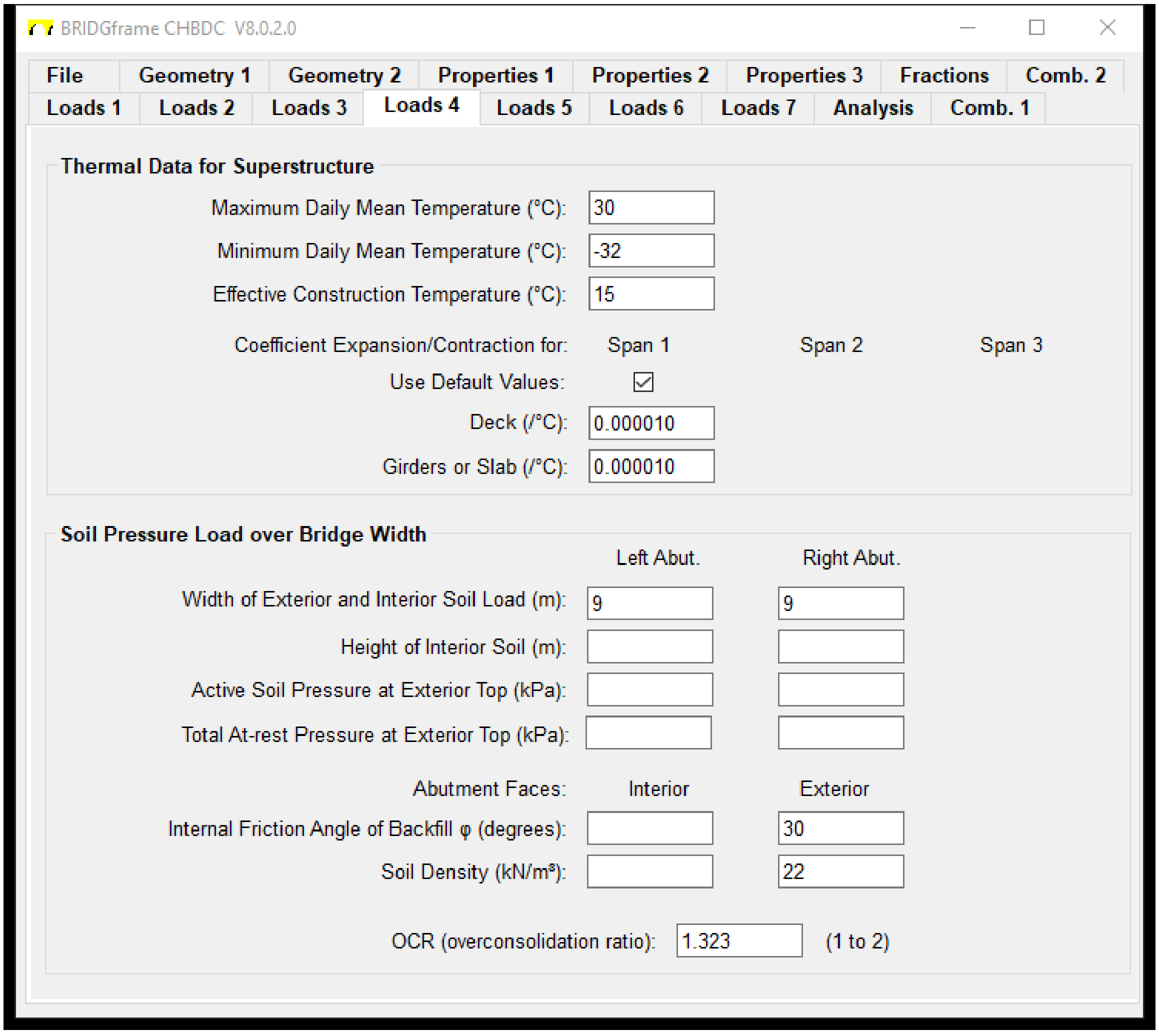

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Superstructure Cross-Section
Span 1
Span 2
Span 3
Spacing of girders or voided slab webs "S" (m):
2.28
Overhang length of deck "Sc" (m):
1.13
Bridge Platform
Bridge Platform Properties are Identical for All Spans
Center of exterior "travelled" lane to adjacent outside face of barrier (m):
2.875
Distance between curb or barrier faces "Wc" (m):
8.5
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm


BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Substructure Section Properties
Left Abutment
Right Abutment
Left Pier
Right Pier
Nmbr of Supports:
1
1
Rectangular
Rectangular
Circular
Circular
Thickness at Top (cm):
120
120
Thickness Bottom (cm):
50
50
Width (cm):
900
900
Radius (cm):
Abutment/Pier Concrete "f'c" (MPa):
25
Abutment/Pier Concrete Density (kg/m³):
2450
Pile Properties
Name/Designation:
Number of Piles:
Moment of Inertia (cm^4)/Pile:
Young's Modulus of Piles (MPa):
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm

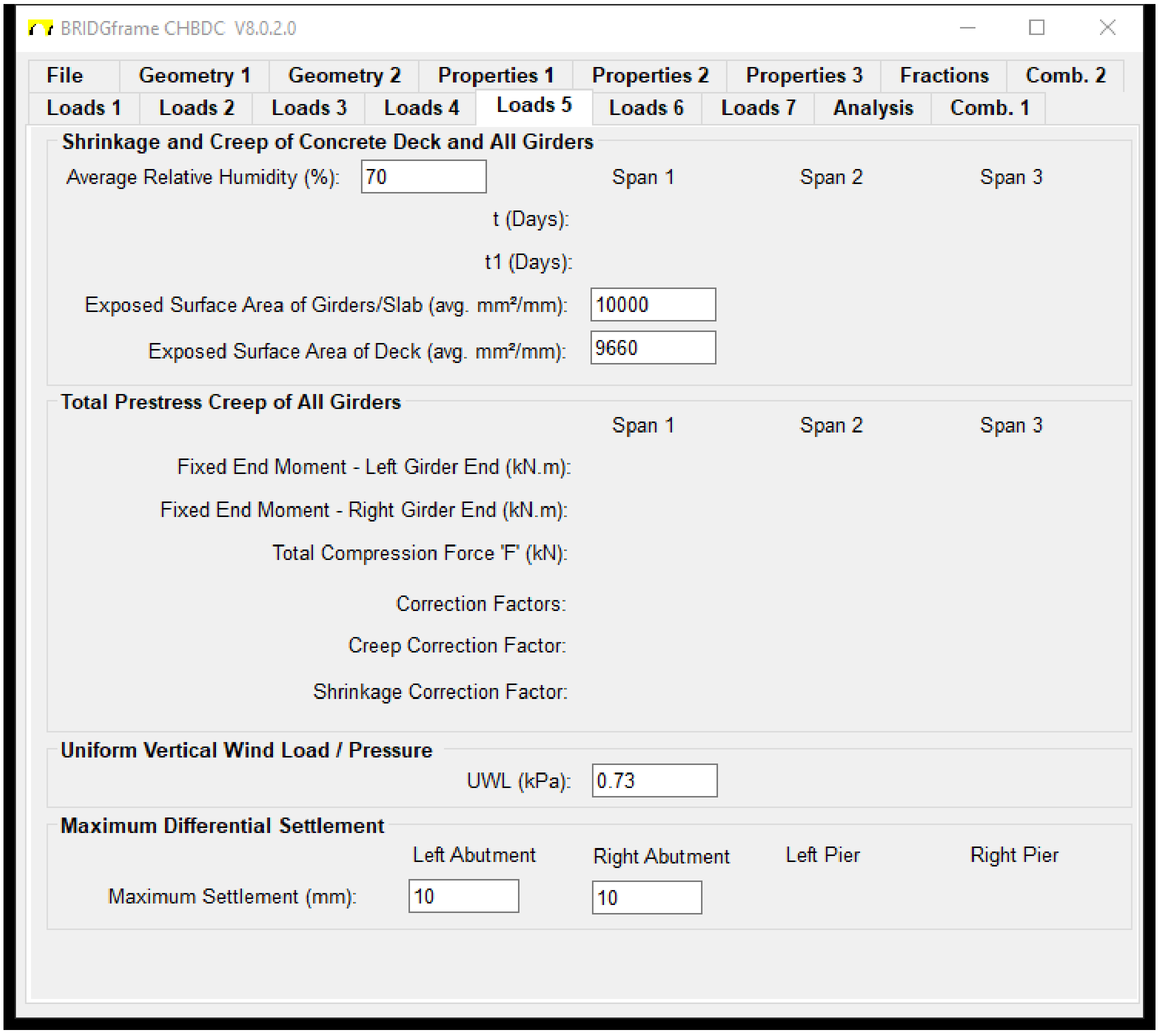

BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Construction Stage Loads over Bridge Width - UCL (kN/m)
Span 1
Span 2
Span 3
Dead Load (excluding girders & deck):
Live Load:
Dead Loads over Bridge Width (non-composite) - UDL (kN/m)
Span 1
Span 2
Span 3
Case 1:
Girders
Case 2:
Deck
Case 3:
Other
Uniform Superimposed Dead Loads over Bridge Width (composite) - USDL (kN/m)
Span 1
Span 2
Span 3
Case 1:
Barriers
10.5
Case 2:
Asphalt
17.2
Case 3:
Sidewalk(s)
Case 4:
Deck
39.3
Wingwall Loads
Left Abutment
Right Abutment
Moment (kN.m):
863
Moment (kN.m):
863
Vertical (kN):
354
Vertical (kN):
354

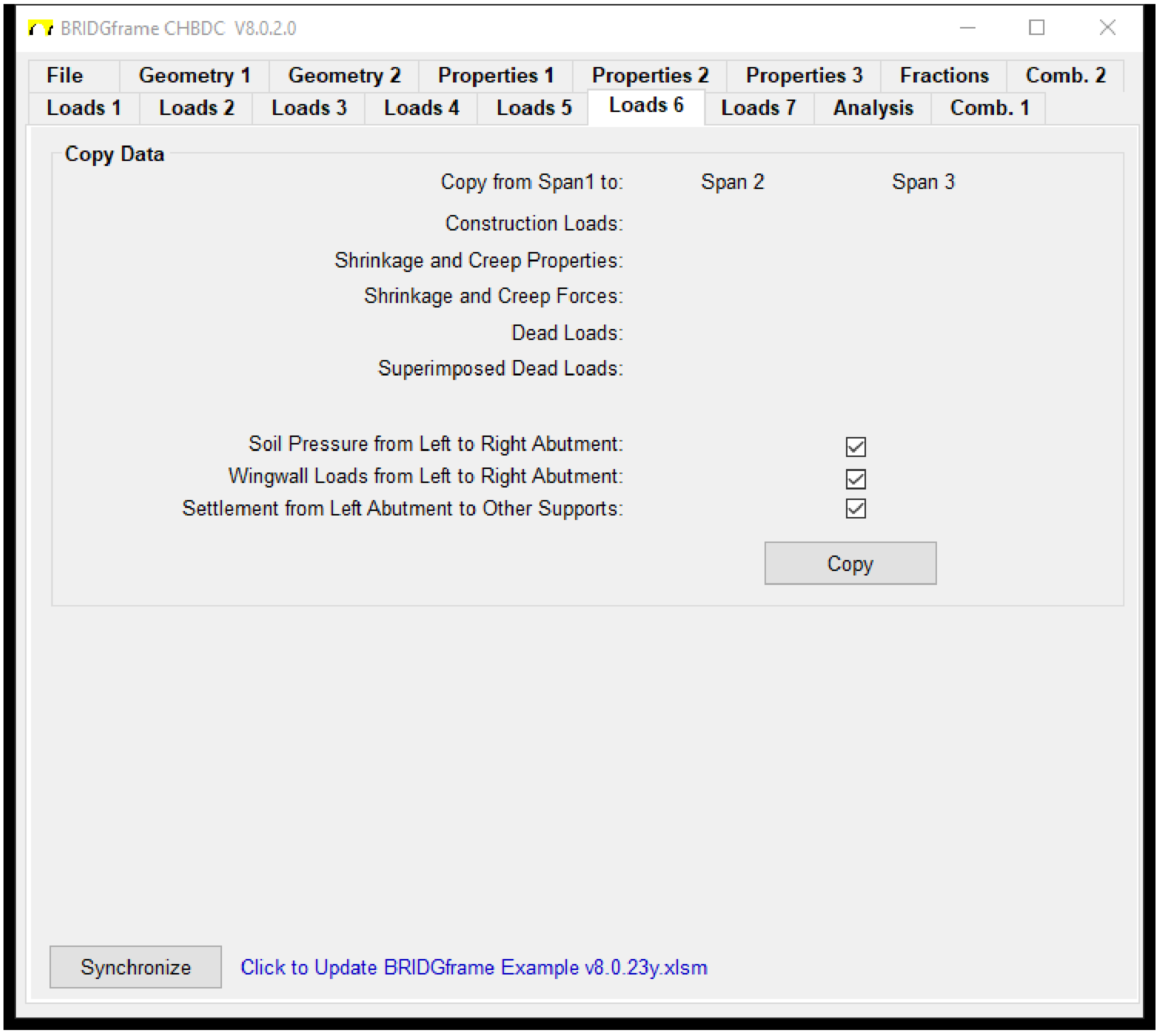

BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Pedestrian Load
Uniform Pedestrian Load per Span (kN/m):
Braking Force
Static Force (kN):
180
plus
10
% of UTL
Live (Truck) Load Case Groups
Truck CL-625
Truck CL-625-ONT
Truck BCL-625
Truck CL-750
Truck CL-800-AB
User Defined
Drop Axles Not Contributing To
Maximum Load Effect (cl.3.8.4.1)


BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Truck Loads per Lane (kN)
Case 1 Case 2 Case 3 Case 4 Case 5 Case 6
Axle 1: 50 50 140 120
Axle 2: 140 140 140 175
Axle 3: 140 140 50 140
Axle 4: 175 140
Axle 5: 120 50
Axle Spacing (m)
Case 1 Case 2 Case 3 Case 4 Case 5 Case 6
Axle 1 to Axle 2: 3.6 3.6 1.2 6.6
Axle 2 to Axle 3: 1.2 1.2 3.6 6.6
Axle 3 to Axle 4: 6.6 1.2
Axle 4 to Axle 5: 6.6 3.6
Dynamic Load Allowance (1 + DLA): 1.3 1.25 1.3 1.25
Increment Length for Advancing Vehicles (m): 0.3
Fixed Vehicle Location (m):
Number of Design Lanes: 2
as per table 3.5
Lane Load per Lane - UTL (kN/m): 9
plus 80 % of Force Envelopes from Truck Loadings
Save User Defined Truck Load and Axle Spacing Values

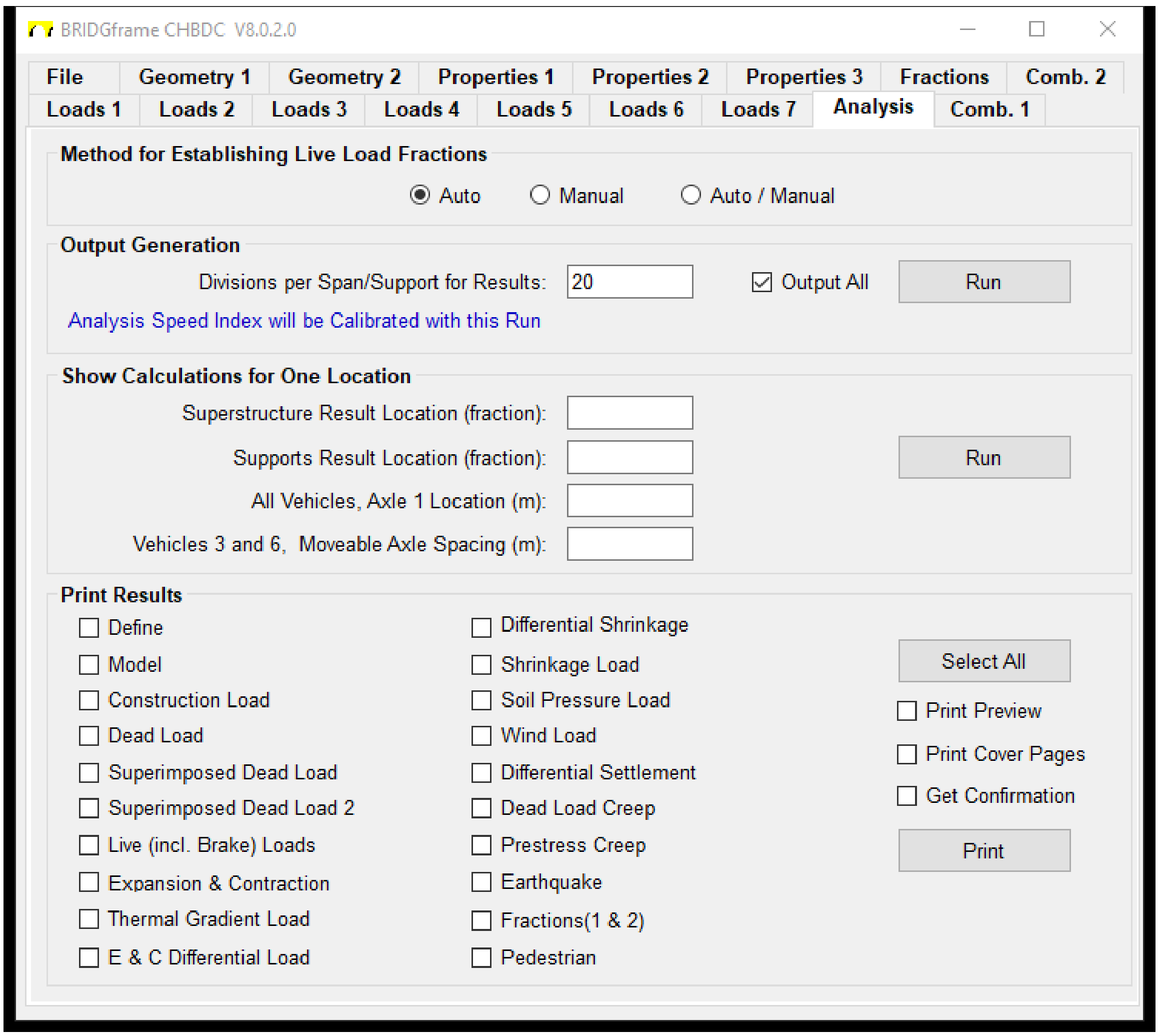


- Active Soil Pressure at Exterior Top and Total At-rest Pressure at Exterior Top may be included. See paragraph 2 of 5.4.9 and Appendix 4 – Concrete Rigid Parabolic Soffit, Loads 4 screen print.


BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Shrinkage and Creep of Concrete Deck and All Girders
Average Relative Humidity (%): 70
Span 1
Span 2
Span 3
t (Days):
t1 (Days):
Exposed Surface Area of Girders/Slab (avg. mm²/mm): 10000
Exposed Surface Area of Deck (avg. mm²/mm): 9660
Total Prestress Creep of All Girders
Span 1
Span 2
Span 3
Fixed End Moment - Left Girder End (kN.m):
Fixed End Moment - Right Girder End (kN.m):
Total Compression Force 'F' (kN):
Correction Factors:
Creep Correction Factor:
Shrinkage Correction Factor:
Uniform Vertical Wind Load / Pressure
UWL (kPa): 0.73
Maximum Differential Settlement
Left Abutment
Right Abutment
Left Pier
Right Pier
Maximum Settlement (mm): 10
10


BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Copy Data
Copy from Span1 to:
Span 2
Span 3
Construction Loads:
Shrinkage and Creep Properties:
Shrinkage and Creep Forces:
Dead Loads:
Superimposed Dead Loads:
Soil Pressure from Left to Right Abutment:
Wingwall Loads from Left to Right Abutment:
Settlement from Left Abutment to Other Supports:
Copy
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm

Loads 7: See Appendix 17.



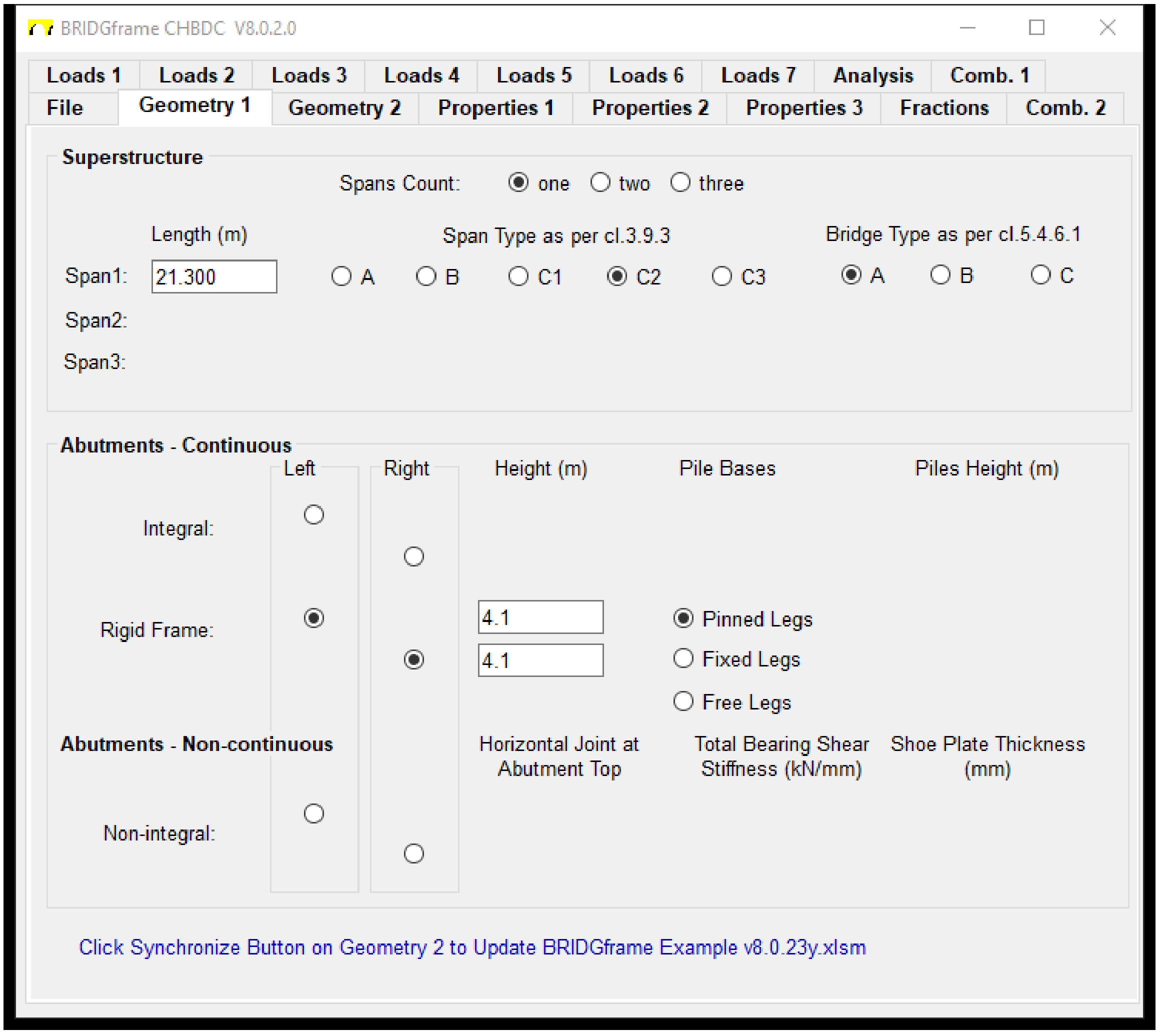
Run 2 model: For weight of beam effects only.

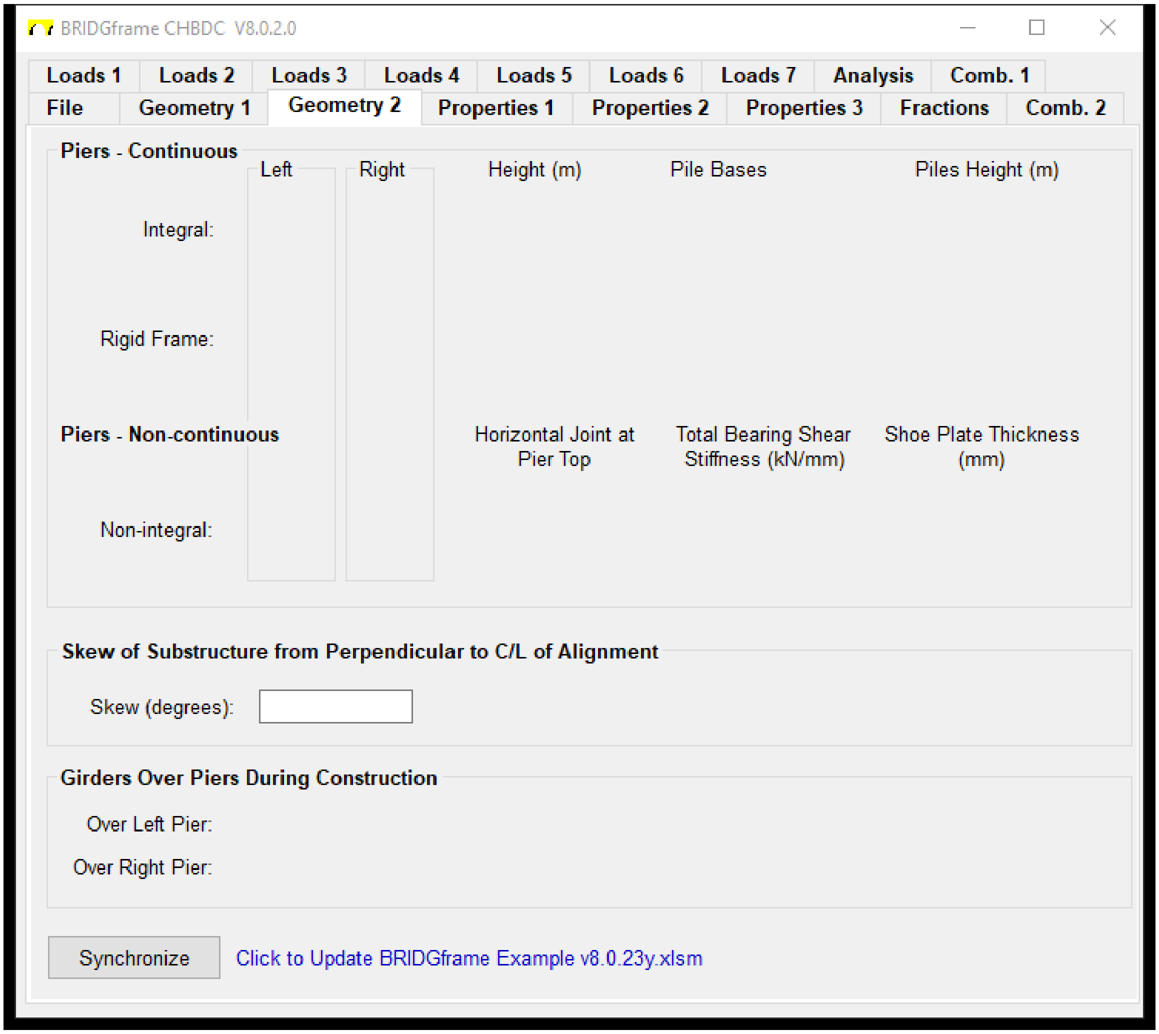
In Run 2, the superstructure will be modeled as a parabolic slab.

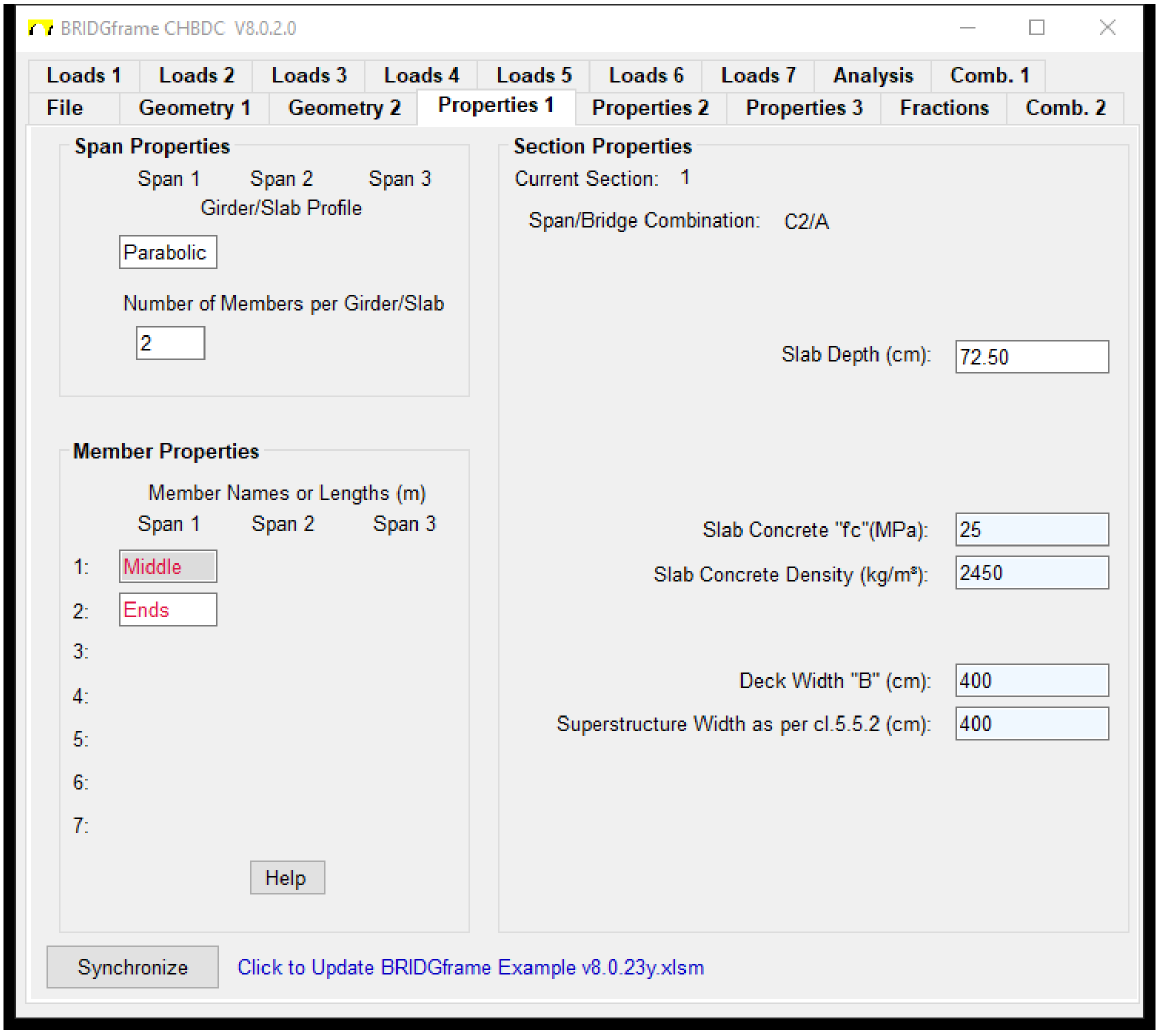
The objective of this Run is to model a parabolic superstructure using the same stiffness as that of Run 1. The 'K' or stiffness of the superstructure from Run 1 is 1.5047 * 10^{12}.

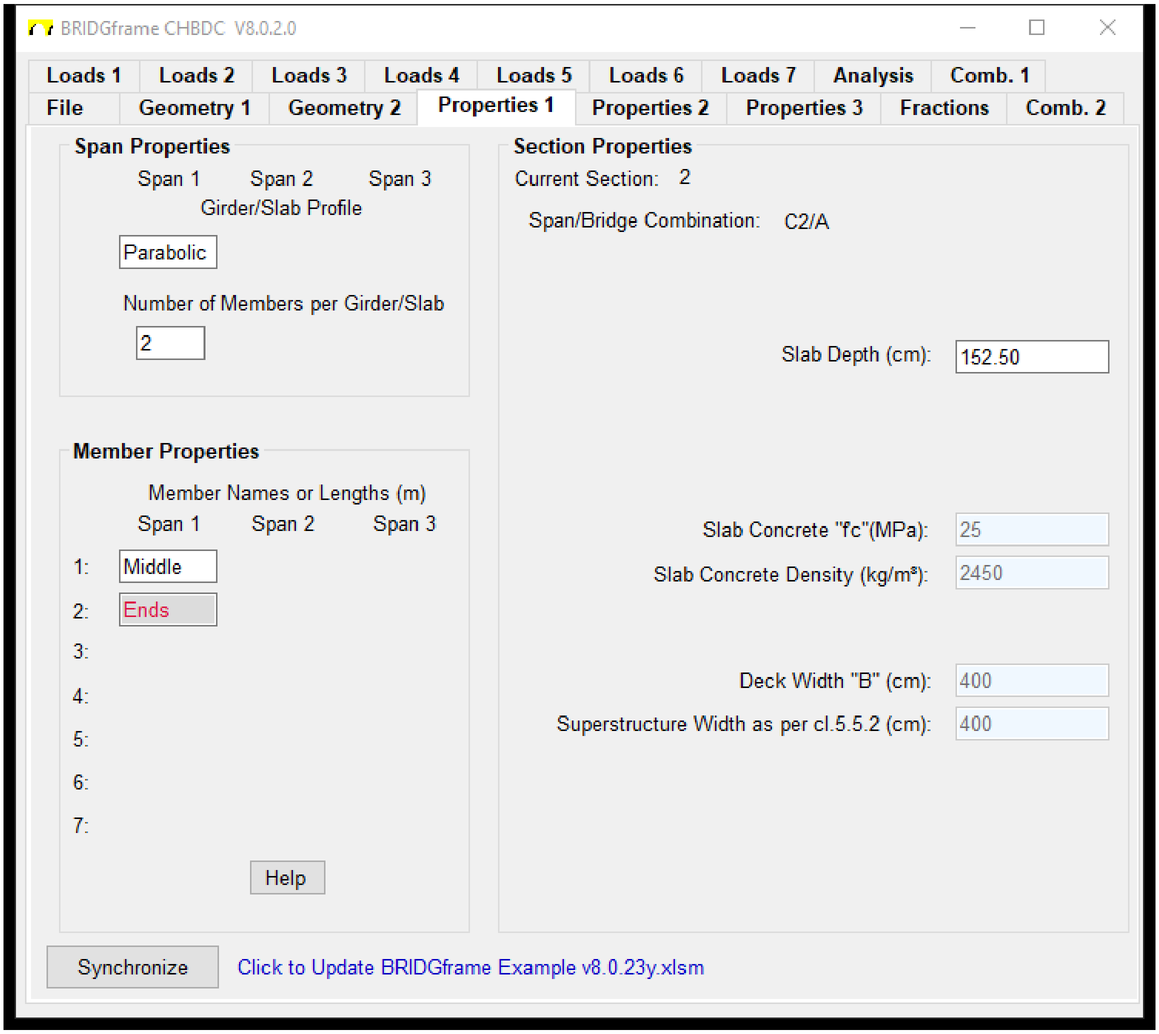
1. weight of actual beams above beam soffit at C/L of span =
   4 x 1.0 x 0.4 x 24 = 38.4 kN/m
2. since the weight of the portion of slab (or beam) below the apex of the parabola is calculated automatically, there is no need to enter a load pattern to account for this.
3. assume a slab depth at ends = 152.5 cm and a slab depth at C / L of span = 72.5 cm. Note: the height of the apex must remain constant at 80 cm.
4. assume a slab width or superstructure width = 4 beams * 100 = 400 cm
5. synchronize all preceding tabs up to and including the Properties 1 tab. After synchronizing the Properties 1 tab, check the Model worksheet of Excel to verify the 'K' values of the superstructure are close to that of Run 1. The 'K' of the superstructure for Run 2 using the above dimensions is 1.5010 * 10^{12} which approximately equals the 'K' value of Run 1, therefore the Run 2 model is correct.
6. to distribute the weight of the slab haunch equally into the individual beams, use an amplification factor of 1 / 4 beams = 0.25 on the Combinations tab.
7. also, on the Combinations tab run only the Beam and the Haunch of the Superimposed Dead Loads.

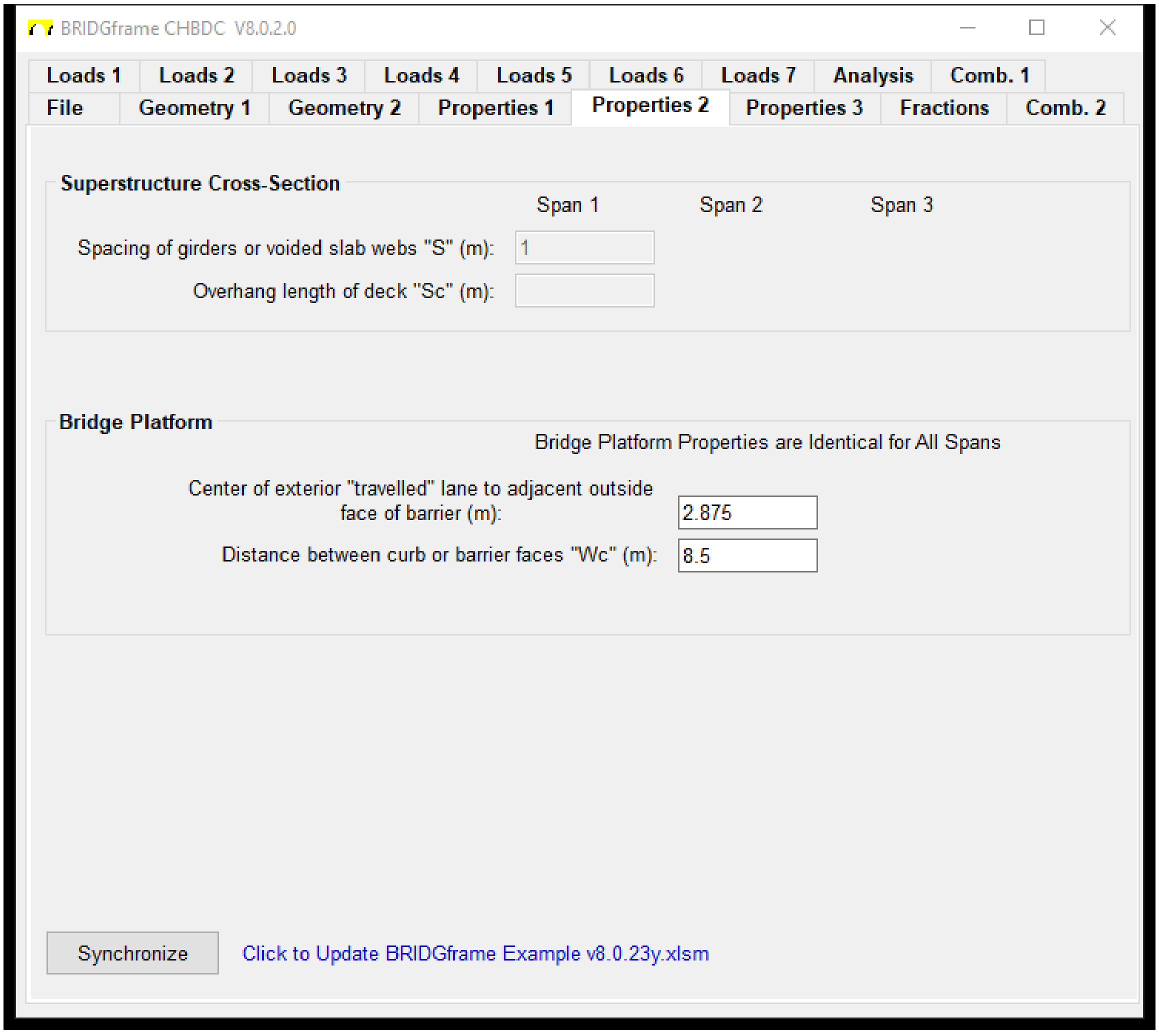
To obtain final force effects sum the results from Run 1 and Run 2.

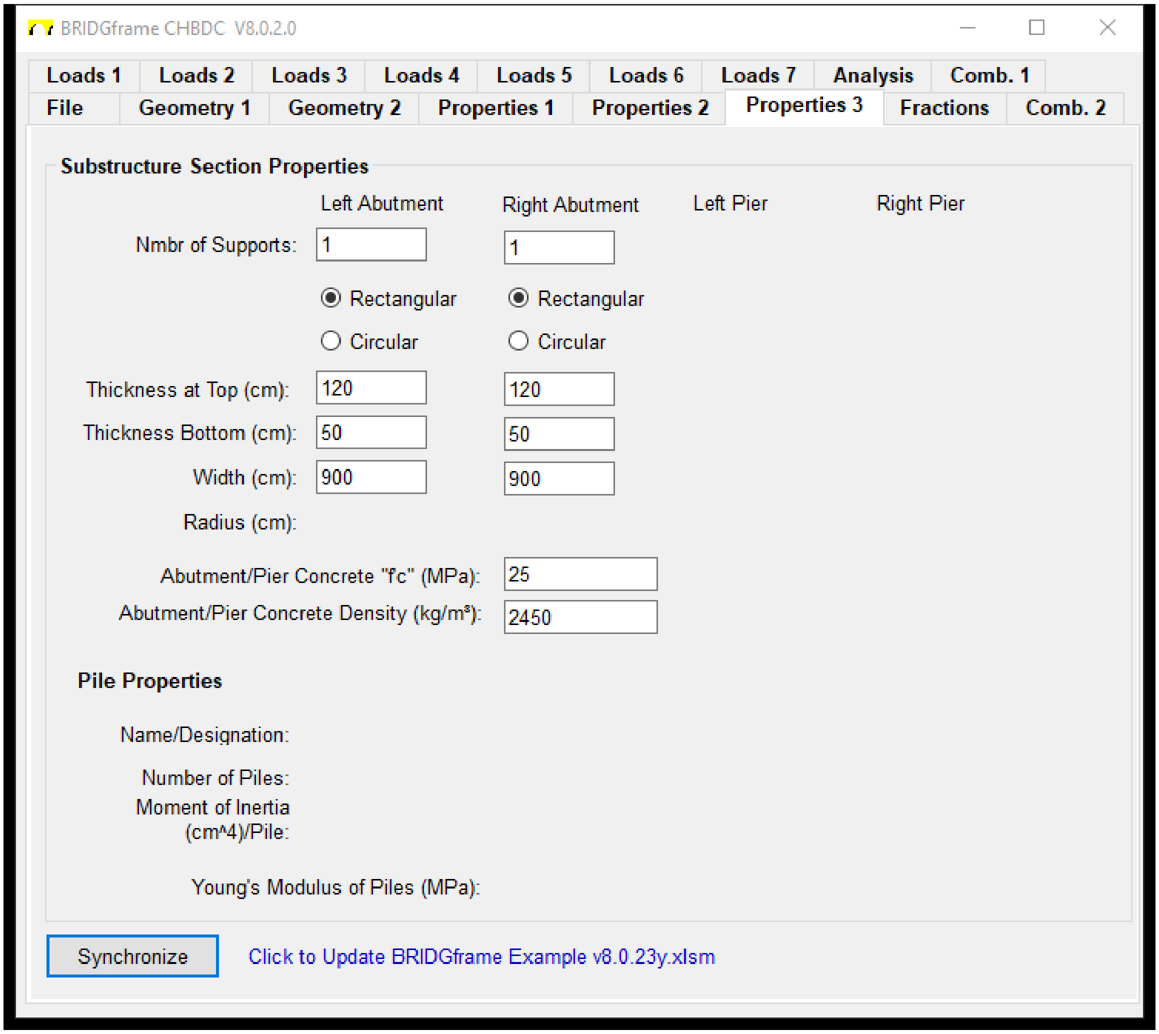

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Superstructure
Spans Count:
one
two
three
Length (m)
Span Type as per cl.3.9.3
Bridge Type as per cl.5.4.6.1
Span1:
21.300
A
B
C1
C2
C3
A
B
C
Span2:
Span3:
Abutments - Continuous
Left
Right
Height (m)
Pile Bases
Piles Height (m)
Integral:
Rigid Frame:
4.1
4.1
Pinned Legs
Fixed Legs
Free Legs
Abutments - Non-continuous
Horizontal Joint at Abutment Top
Total Bearing Shear Stiffness (kN/mm)
Shoe Plate Thickness (mm)
Non-integral:
Click Synchronize Button on Geometry 2 to Update BRIDGframe Example v8.0.23y.xlsm

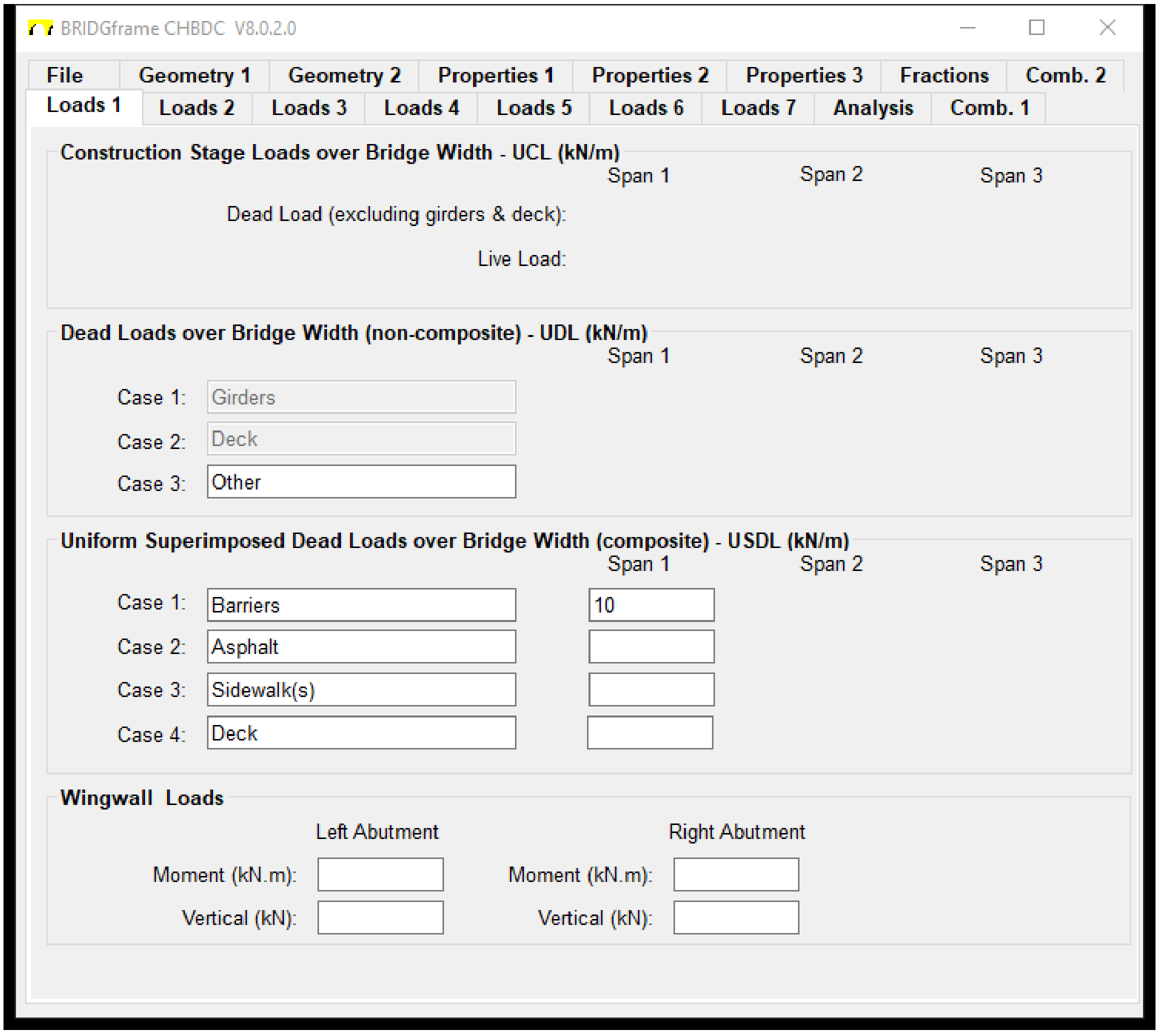

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Piers - Continuous
Left
Right
Height (m)
Pile Bases
Piles Height (m)
Integral:
Rigid Frame:
Piers - Non-continuous
Horizontal Joint at Pier Top
Total Bearing Shear Stiffness (kN/mm)
Shoe Plate Thickness (mm)
Non-integral:
Skew of Substructure from Perpendicular to C/L of Alignment
Skew (degrees):
Girders Over Piers During Construction
Over Left Pier:
Over Right Pier:
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm


BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Span Properties
Span 1 Span 2 Span 3
Girder/Slab Profile
Parabolic
Number of Members per Girder/Slab
2
Member Properties
Member Names or Lengths (m)
Span 1 Span 2 Span 3
1: Middle
2: Ends
3:
4:
5:
6:
7:
Help
Section Properties
Current Section: 1
Span/Bridge Combination: C2/A
Slab Depth (cm): 72.50
Slab Concrete "f'c"(MPa): 25
Slab Concrete Density (kg/m³): 2450
Deck Width "B" (cm): 400
Superstructure Width as per cl.5.5.2 (cm): 400
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm

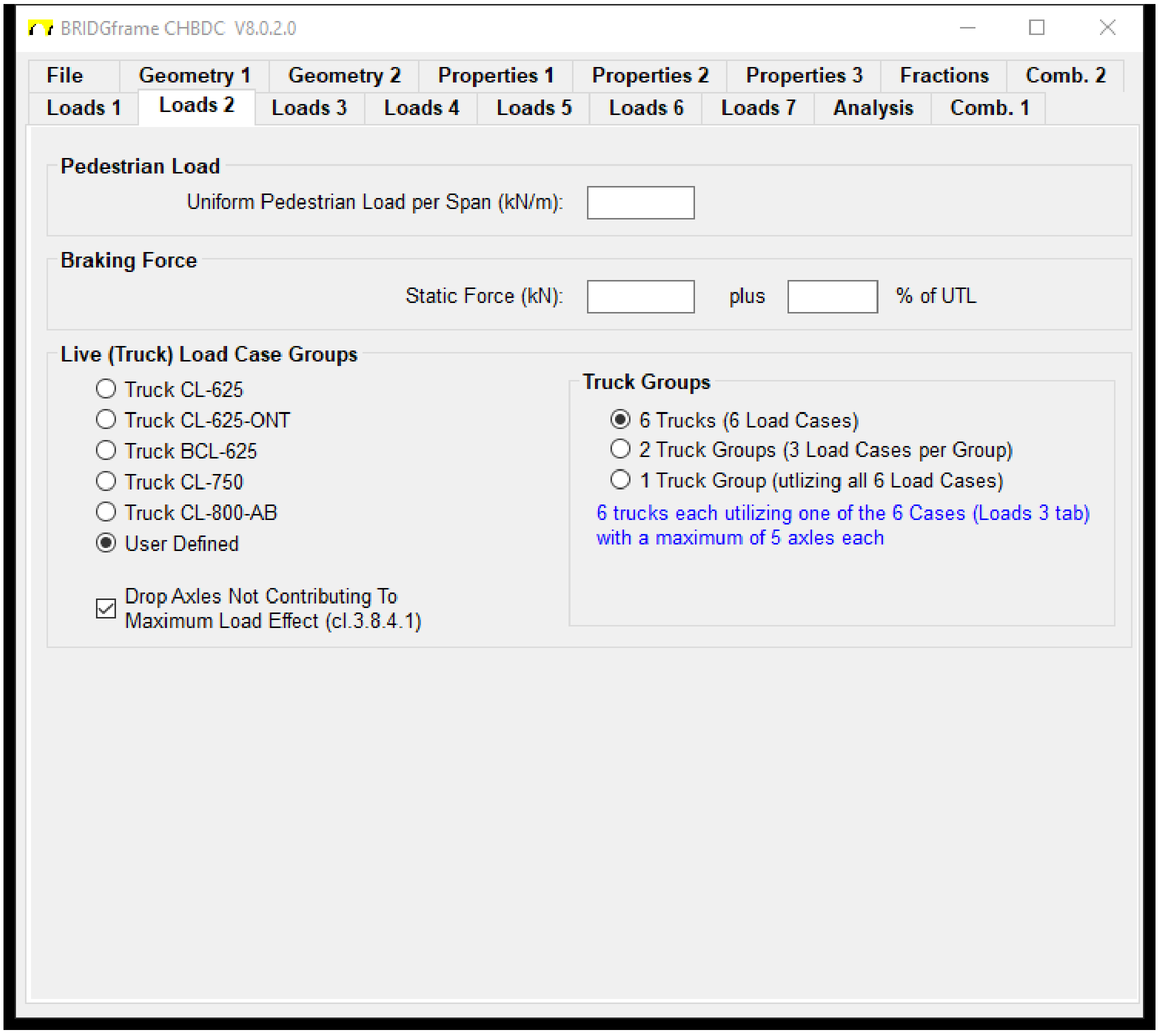

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Span Properties
Span 1
Span 2
Span 3
Girder/Slab Profile
Parabolic
Number of Members per Girder/Slab
2
Member Properties
Member Names or Lengths (m)
Span 1
Span 2
Span 3
1:
Middle
2:
Ends
3:
4:
5:
6:
7:
Help
Section Properties
Current Section: 2
Span/Bridge Combination: C2/A
Slab Depth (cm):
152.50
Slab Concrete "f'c"(MPa):
25
Slab Concrete Density (kg/m³):
2450
Deck Width "B" (cm):
400
Superstructure Width as per cl.5.5.2 (cm):
400
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm

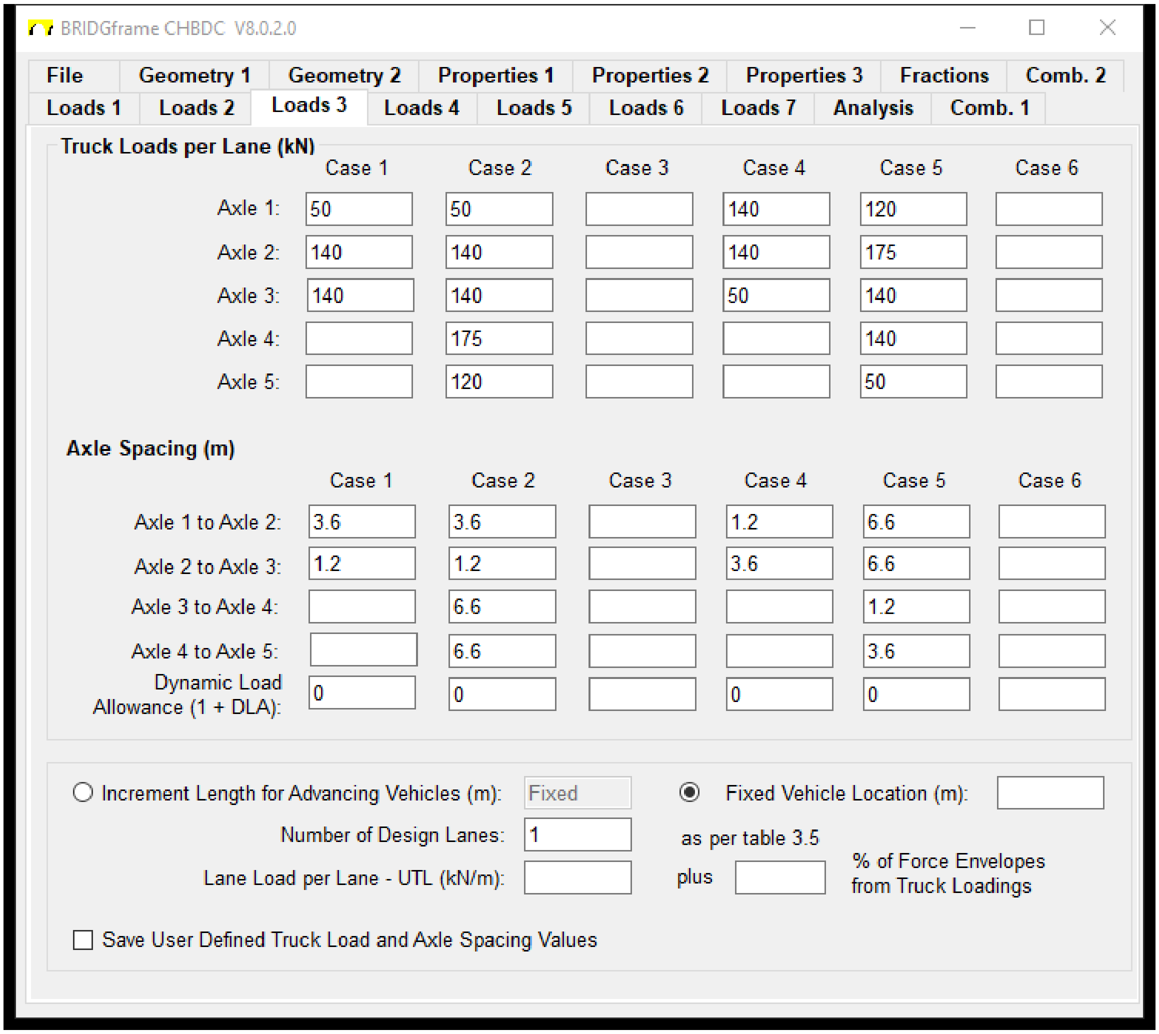

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Superstructure Cross-Section
Span 1
Span 2
Span 3
Spacing of girders or voided slab webs "S" (m):
1
Overhang length of deck "Sc" (m):
Bridge Platform
Bridge Platform Properties are Identical for All Spans
Center of exterior "travelled" lane to adjacent outside face of barrier (m):
2.875
Distance between curb or barrier faces "Wc" (m):
8.5
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm

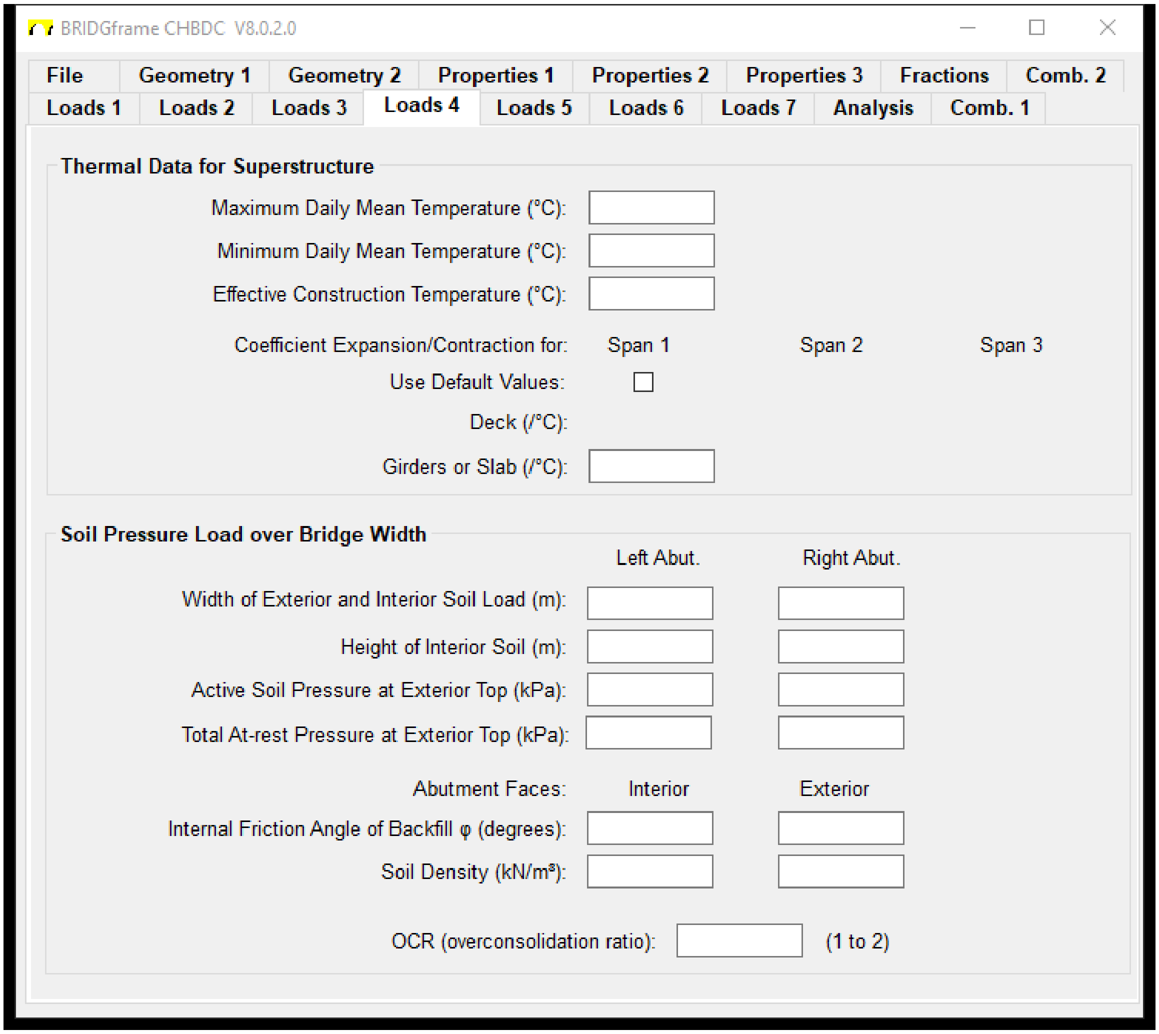

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Substructure Section Properties
Left Abutment
Right Abutment
Left Pier
Right Pier
Nmbr of Supports:
1
1
Rectangular
Rectangular
Circular
Circular
Thickness at Top (cm):
120
120
Thickness Bottom (cm):
50
50
Width (cm):
900
900
Radius (cm):
Abutment/Pier Concrete "f'c" (MPa):
25
Abutment/Pier Concrete Density (kg/m³):
2450
Pile Properties
Name/Designation:
Number of Piles:
Moment of Inertia (cm^4)/Pile:
Young's Modulus of Piles (MPa):
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm

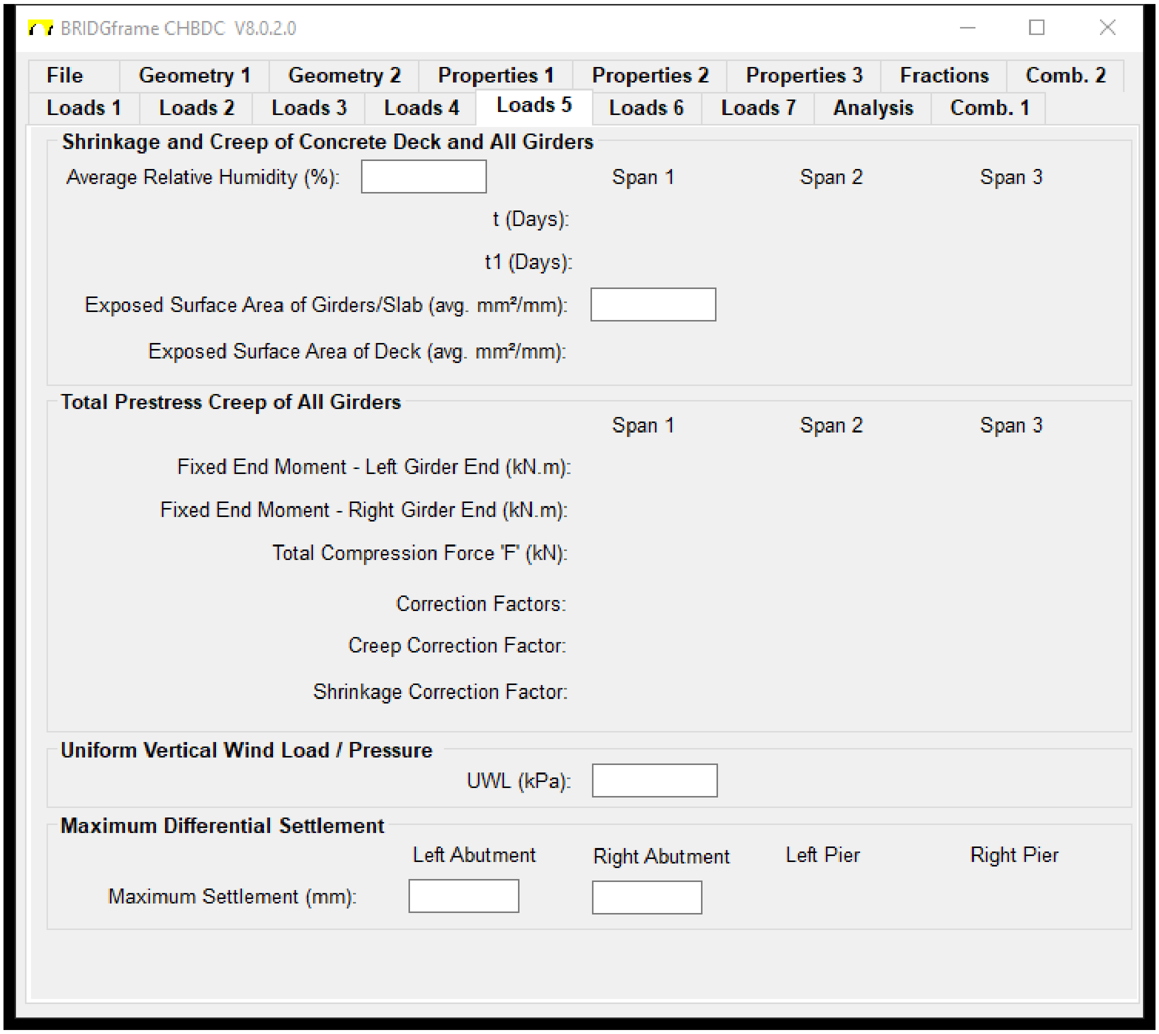


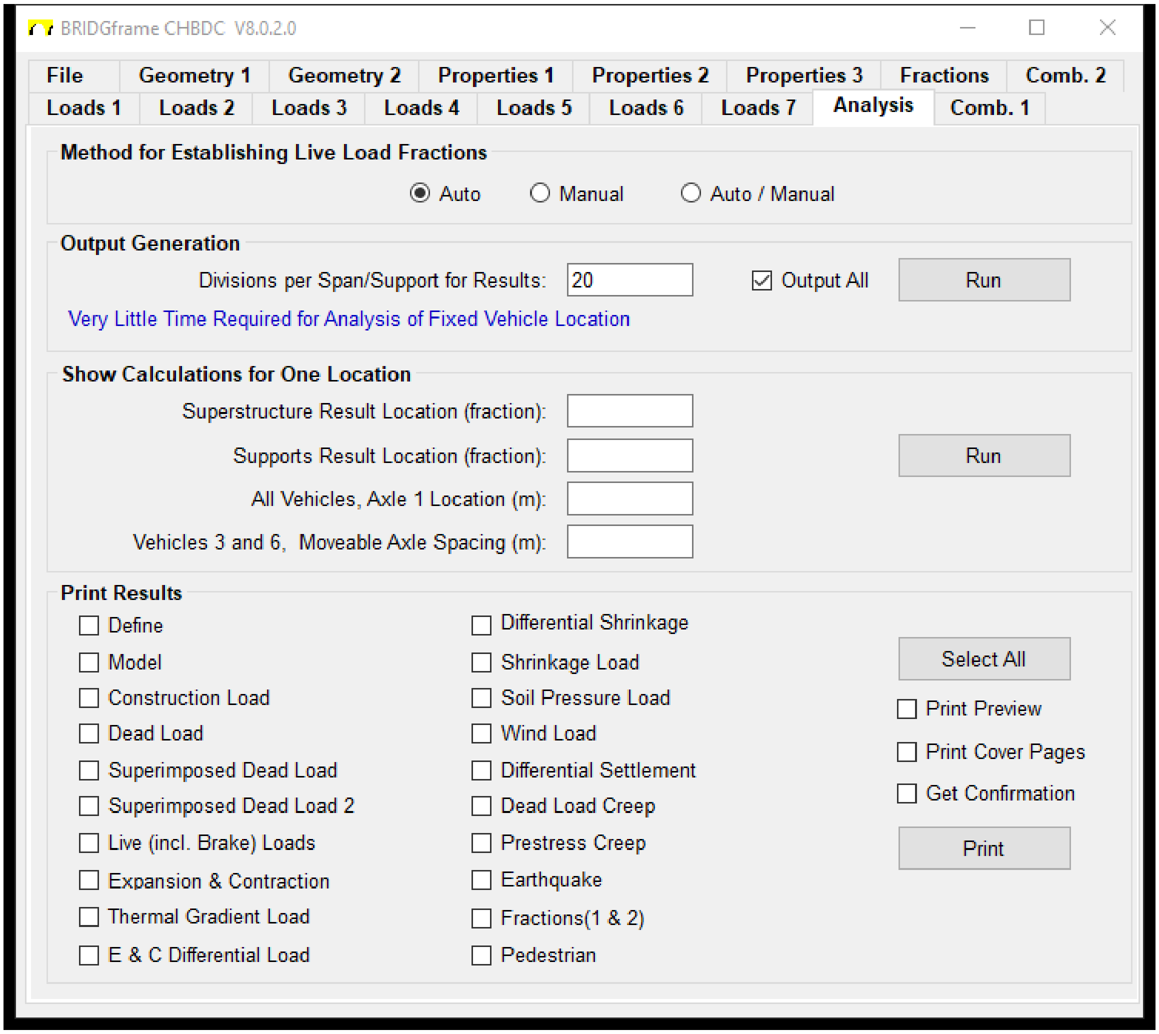
- input a value in the superimposed dead loads to enable the program to calculate inflection points.

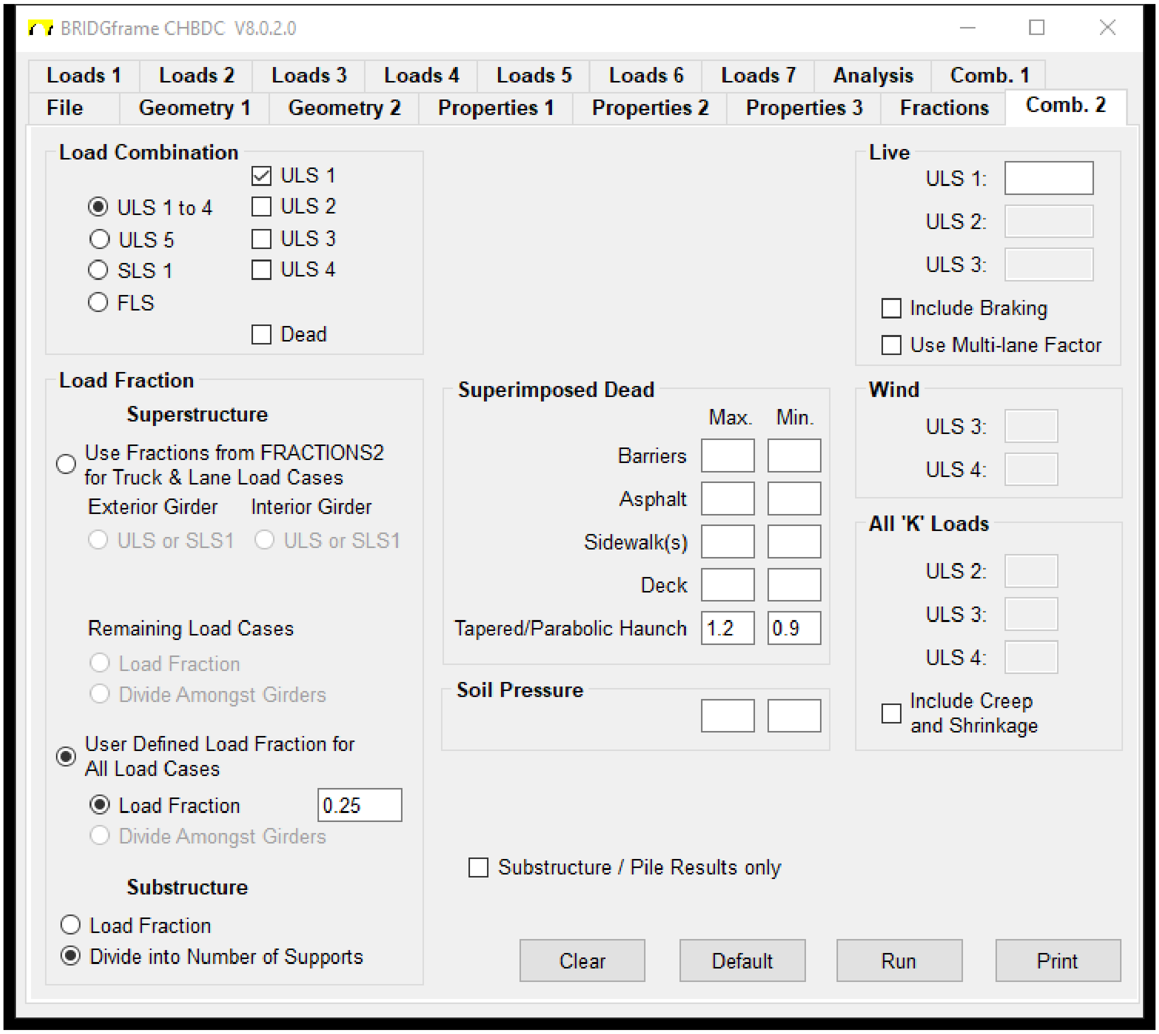

BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Pedestrian Load
Uniform Pedestrian Load per Span (kN/m):
Braking Force
Static Force (kN):
plus
% of UTL
Live (Truck) Load Case Groups
Truck CL-625
Truck CL-625-ONT
Truck BCL-625
Truck CL-750
Truck CL-800-AB
User Defined
Drop Axles Not Contributing To Maximum Load Effect (cl.3.8.4.1)
Truck Groups
6 Trucks (6 Load Cases)
2 Truck Groups (3 Load Cases per Group)
1 Truck Group (utlizing all 6 Load Cases)
6 trucks each utilizing one of the 6 Cases (Loads 3 tab) with a maximum of 5 axles each


BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Truck Loads per Lane (kN)
Case 1
Case 2
Case 3
Case 4
Case 5
Case 6
Axle 1:
50
50
140
120
Axle 2:
140
140
140
175
Axle 3:
140
140
50
140
Axle 4:
175
140
Axle 5:
120
50
Axle Spacing (m)
Case 1
Case 2
Case 3
Case 4
Case 5
Case 6
Axle 1 to Axle 2:
3.6
3.6
1.2
6.6
Axle 2 to Axle 3:
1.2
1.2
3.6
6.6
Axle 3 to Axle 4:
6.6
1.2
Axle 4 to Axle 5:
6.6
3.6
Dynamic Load Allowance (1 + DLA):
0
0
0
0
Increment Length for Advancing Vehicles (m):
Fixed
Fixed Vehicle Location (m):
Number of Design Lanes:
1
as per table 3.5
Lane Load per Lane - UTL (kN/m):
plus
% of Force Envelopes from Truck Loadings
Save User Defined Truck Load and Axle Spacing Values


BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Thermal Data for Superstructure
Maximum Daily Mean Temperature (°C):
Minimum Daily Mean Temperature (°C):
Effective Construction Temperature (°C):
Coefficient Expansion/Contraction for:
Span 1
Span 2
Span 3
Use Default Values:
Deck (/°C):
Girders or Slab (/°C):
Soil Pressure Load over Bridge Width
Left Abut.
Right Abut.
Width of Exterior and Interior Soil Load (m):
Height of Interior Soil (m):
Active Soil Pressure at Exterior Top (kPa):
Total At-rest Pressure at Exterior Top (kPa):
Abutment Faces:
Interior
Exterior
Internal Friction Angle of Backfill φ (degrees):
Soil Density (kN/m³):
OCR (overconsolidation ratio):
(1 to 2)


BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Shrinkage and Creep of Concrete Deck and All Girders
Average Relative Humidity (%):
Span 1
Span 2
Span 3
t (Days):
t1 (Days):
Exposed Surface Area of Girders/Slab (avg. mm²/mm):
Exposed Surface Area of Deck (avg. mm²/mm):
Total Prestress Creep of All Girders
Span 1
Span 2
Span 3
Fixed End Moment - Left Girder End (kN.m):
Fixed End Moment - Right Girder End (kN.m):
Total Compression Force 'F' (kN):
Correction Factors:
Creep Correction Factor:
Shrinkage Correction Factor:
Uniform Vertical Wind Load / Pressure
UWL (kPa):
Maximum Differential Settlement
Left Abutment
Right Abutment
Left Pier
Right Pier
Maximum Settlement (mm):

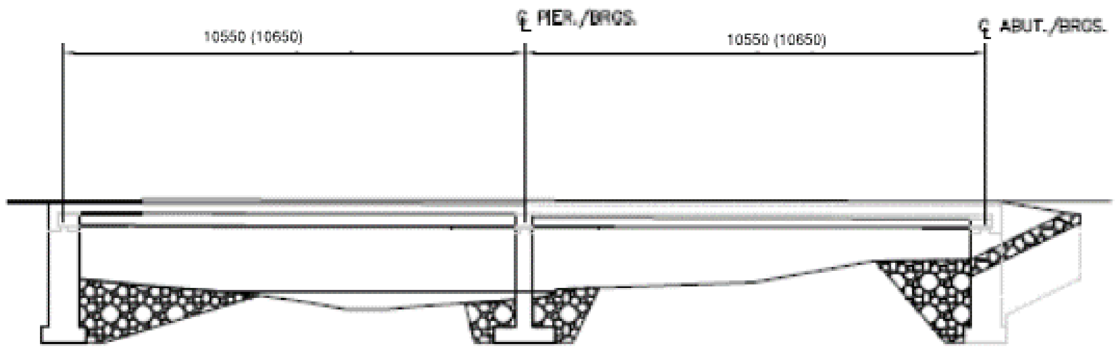

BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Method for Establishing Live Load Fractions
Auto
Manual
Auto / Manual
Output Generation
Divisions per Span/Support for Results:
20
Output All
Run
Very Little Time Required for Analysis of Fixed Vehicle Location
Show Calculations for One Location
Superstructure Result Location (fraction):
Supports Result Location (fraction):
All Vehicles, Axle 1 Location (m):
Vehicles 3 and 6, Moveable Axle Spacing (m):
Run
Print Results
Define
Model
Construction Load
Dead Load
Superimposed Dead Load
Superimposed Dead Load 2
Live (incl. Brake) Loads
Expansion & Contraction
Thermal Gradient Load
E & C Differential Load
Differential Shrinkage
Shrinkage Load
Soil Pressure Load
Wind Load
Differential Settlement
Dead Load Creep
Prestress Creep
Earthquake
Fractions(1 & 2)
Pedestrian
Select All
Print Preview
Print Cover Pages
Get Confirmation
Print

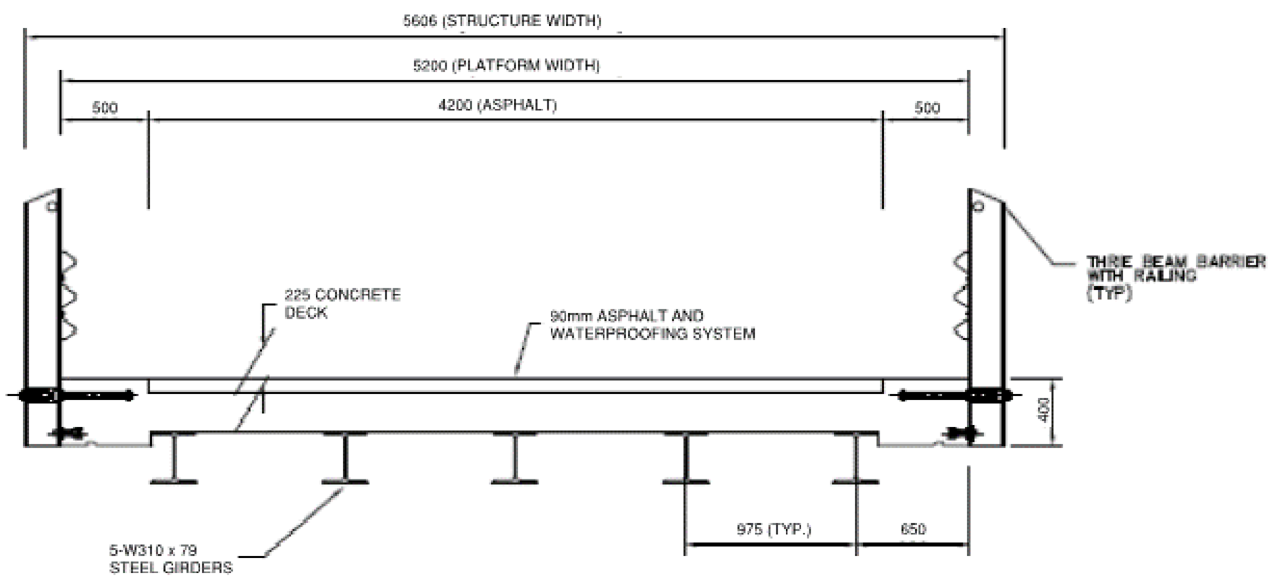

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Load Combination
ULS 1 to 4
ULS 5
SLS 1
FLS
ULS 1
ULS 2
ULS 3
ULS 4
Dead
Live
ULS 1:
ULS 2:
ULS 3:
Include Braking
Use Multi-lane Factor
Load Fraction
Superstructure
Use Fractions from FRACTIONS2 for Truck & Lane Load Cases
Exterior Girder
Interior Girder
ULS or SLS1
ULS or SLS1
Remaining Load Cases
Load Fraction
Divide Amongst Girders
User Defined Load Fraction for All Load Cases
Load Fraction
0.25
Divide Amongst Girders
Substructure
Load Fraction
Divide into Number of Supports
Superimposed Dead
Max.
Min.
Barriers
Asphalt
Sidewalk(s)
Deck
Tapered/Parabolic Haunch
1.2
0.9
Soil Pressure
Wind
ULS 3:
ULS 4:
All 'K' Loads
ULS 2:
ULS 3:
ULS 4:
Include Creep and Shrinkage
Substructure / Pile Results only
Clear
Default
Run
Print

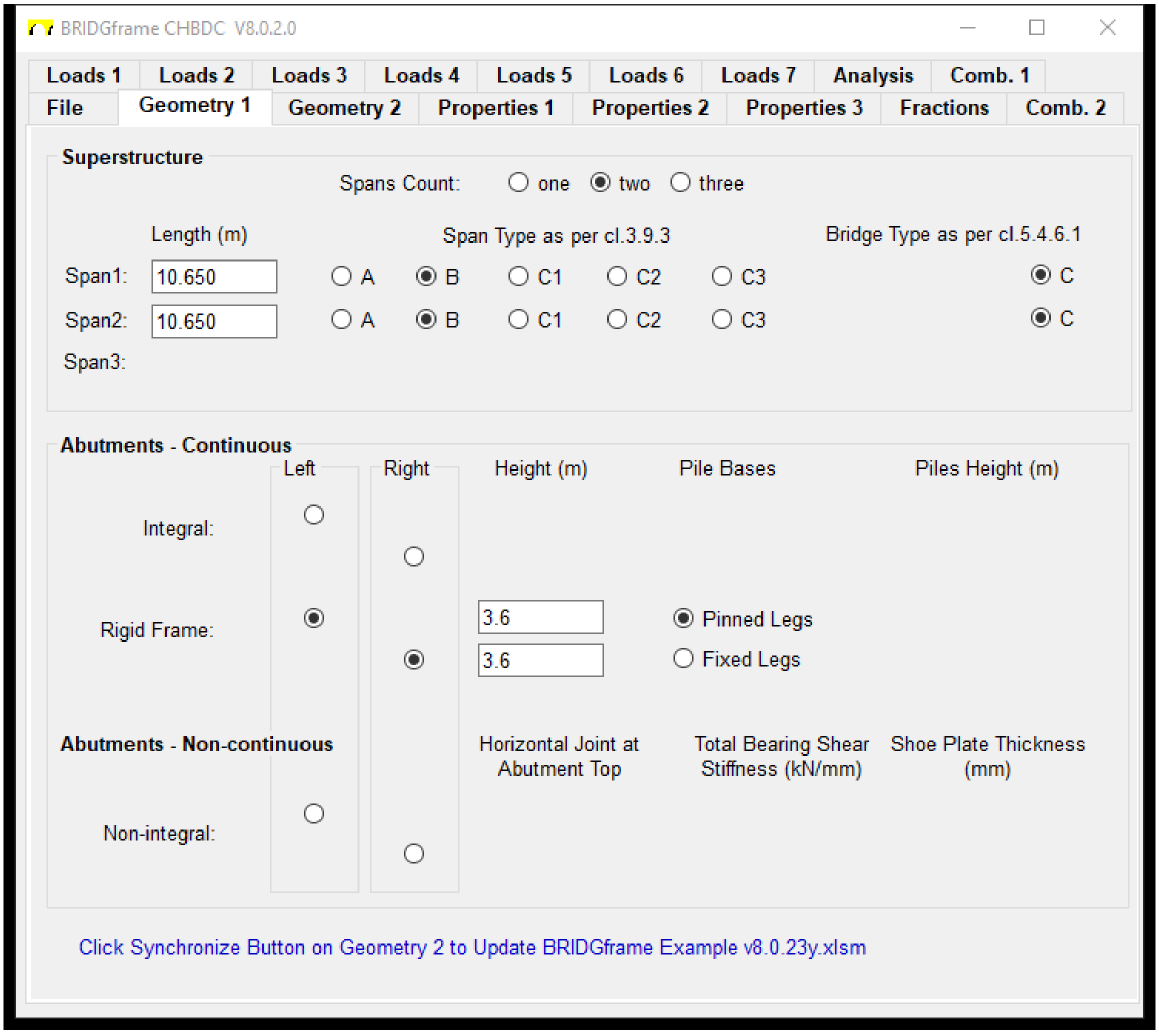
APPENDIX 4 – RIGID FRAME 2 SPAN STEEL GIRDER (SKEWED)

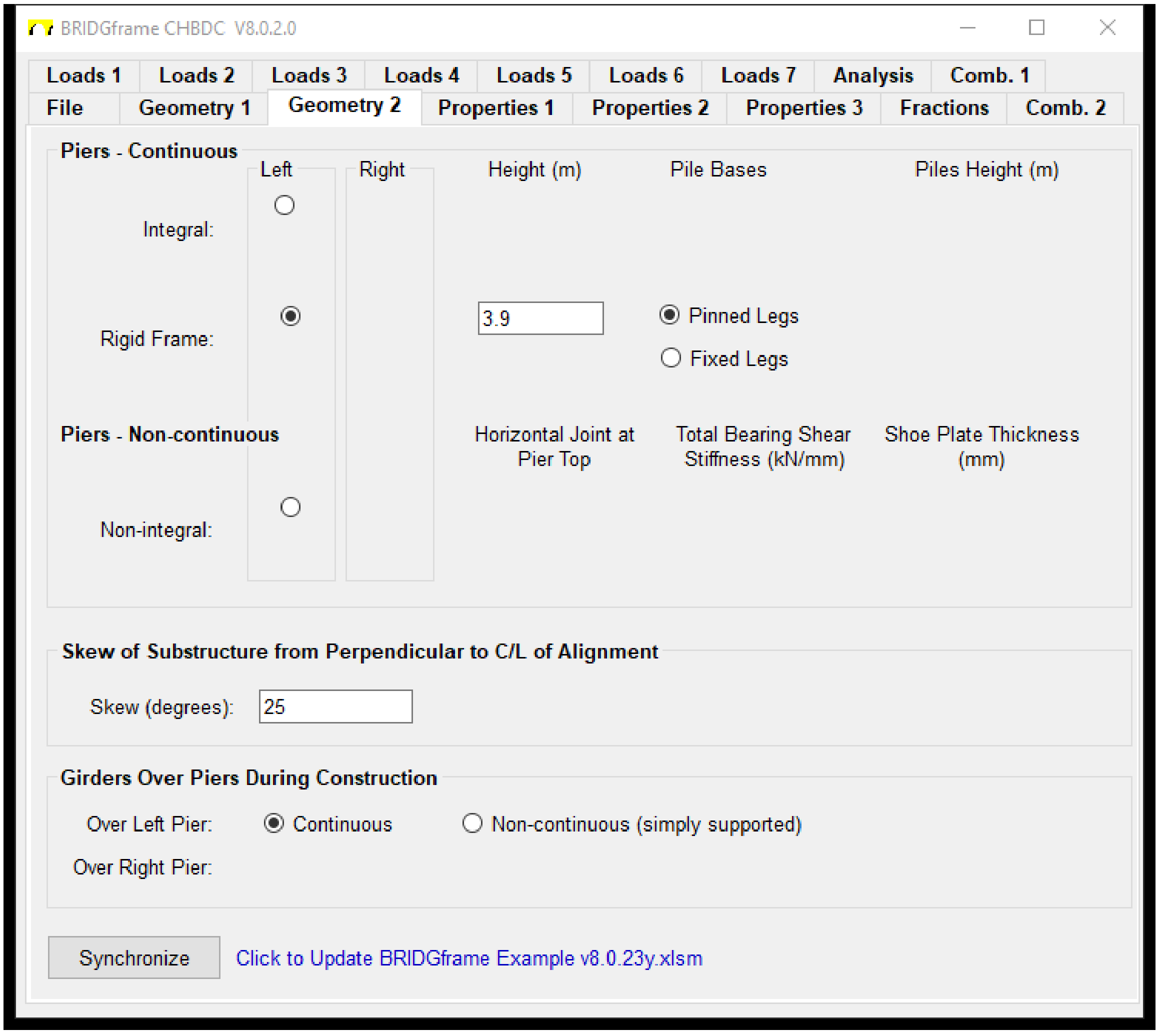
Bridge Geometry

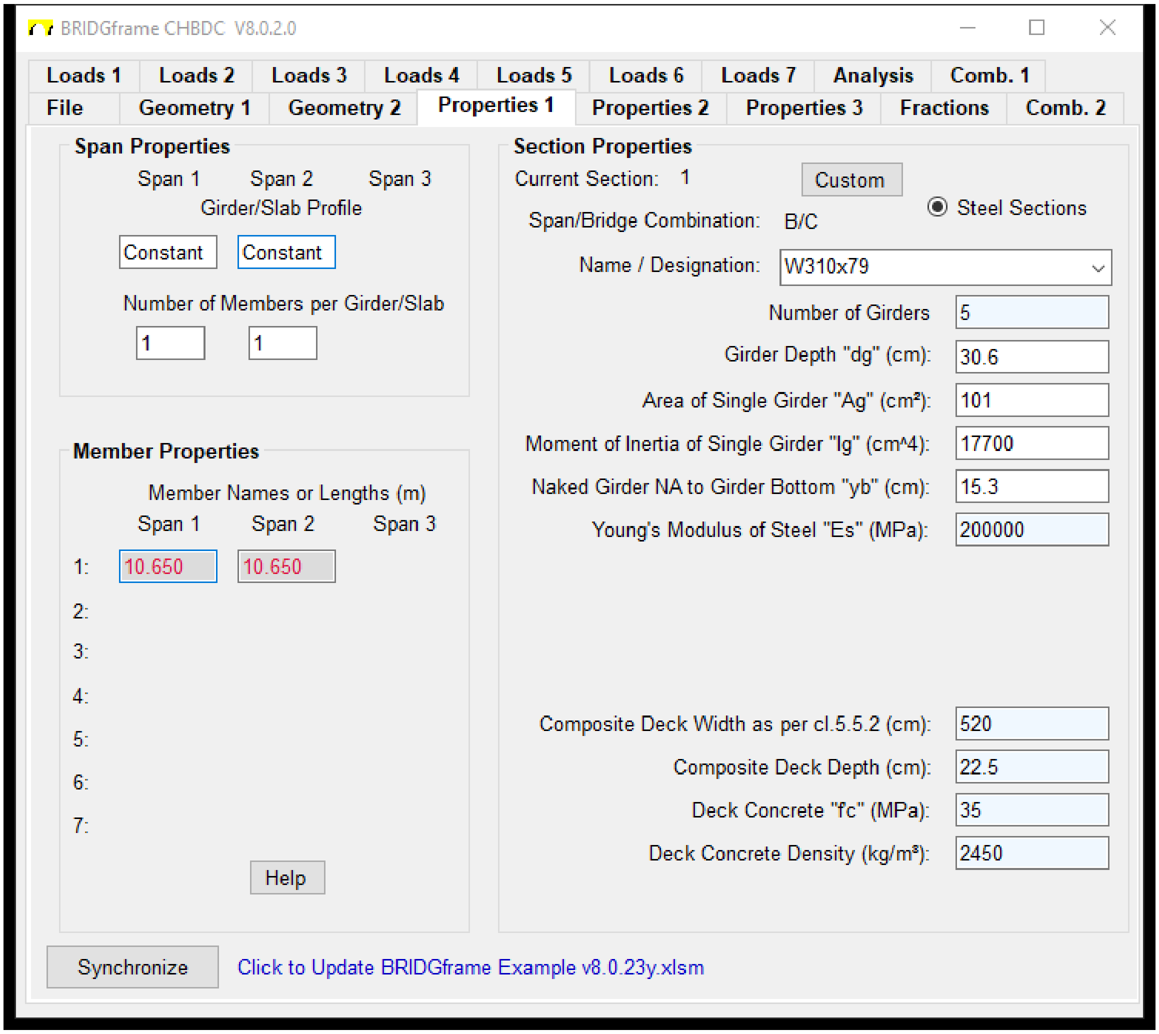
Structure Type:	Rigid frame abutments and pier. Concrete composite deck with continuous span steel girders.
Spans:	2 spans of 10.65 m
Deck:	5.20 m total width x 225 mm thick (29 kN/m). 5.03 m barrier inside face to barrier inside face. 1 travelled lane at 3.0 m. 2 side clearances at 0.42 m 1 design lane. 650 mm overhang from centerline of exterior girder to edge of deck. 90mm asphalt and waterproofing (8.5 kN/m).
Barriers:	Thrie beam (say 1.0 kN/m)
Girders:	5 – W310 x 79 spaced at 0.975 m (5.0 kN/m)
Abutments:	3.6 m high x 0.6 m thick x 5.1 m wide (non-skewed width)
Piers	3.9 m high x 0.4 m thick x 5.1 m wide (non-skewed width)
Piles:	None
Wingwalls:	Two wingwalls loading per abutment (includes barriers on wingwalls) Vertical (gravity load) (354 kN) Moment (863 kN.m)
Skew:	25 degrees Weight of abutments and piers will be modified by the program to suit skewed width. The skew factor 'F_S' is automatically applied to the shear of the structure to 0.25 x span length from each side of each support.

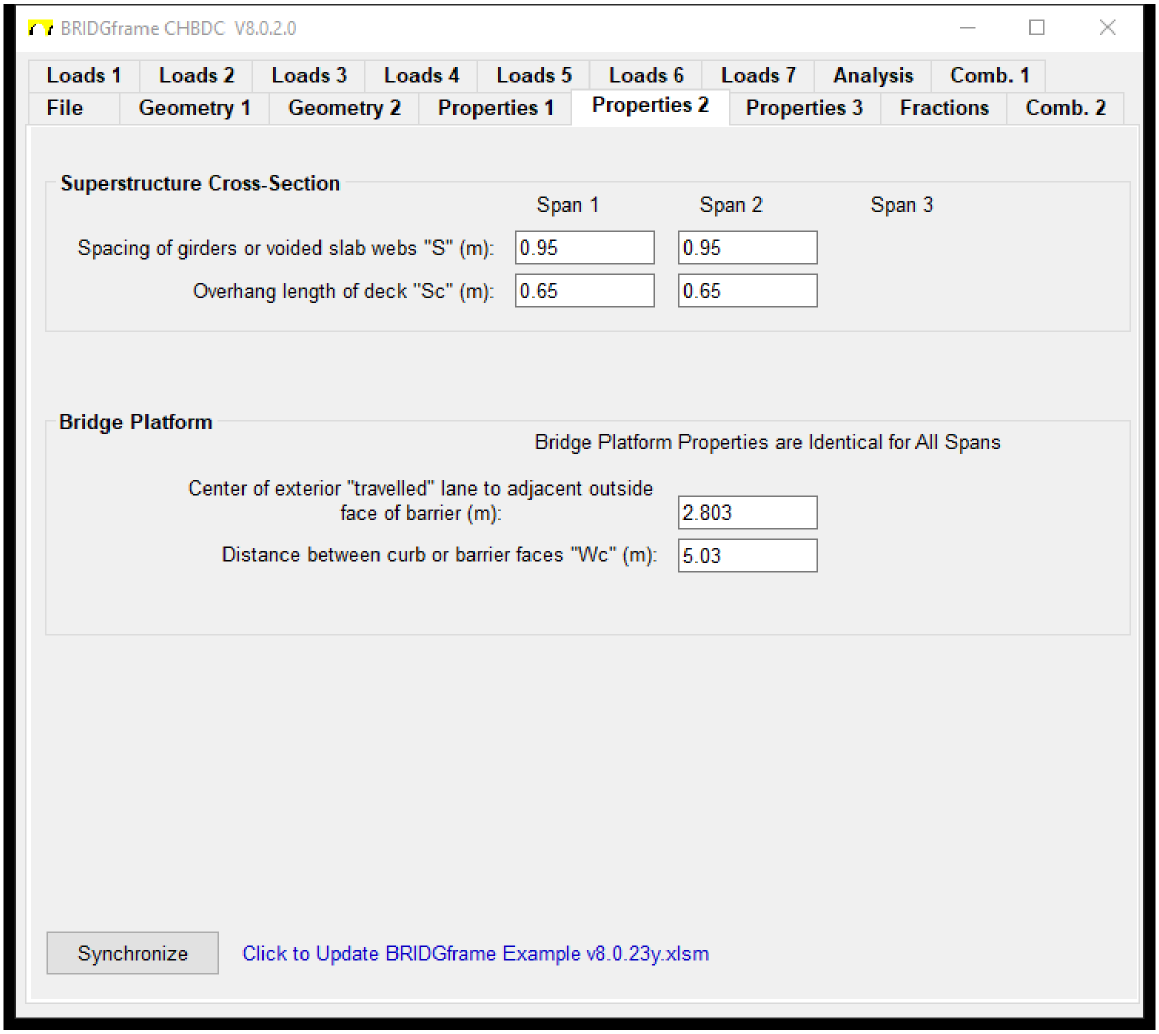

℄ PIER./BRGS.
℄ ABUT./BRGS.
10550 (10650)
10550 (10650)


5606 (STRUCTURE WIDTH)
5200 (PLATFORM WIDTH)
500
4200 (ASPHALT)
500
THRIE BEAM BARRIER WITH RAILING (TYP)
225 CONCRETE DECK
90mm ASPHALT AND WATERPROOFING SYSTEM
400
975 (TYP.)
650
5-W310 x 79 STEEL GIRDERS


BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Superstructure
Spans Count: one two three
Length (m)
Span Type as per cl.3.9.3
Bridge Type as per cl.5.4.6.1
Span1: 10.650 A B C1 C2 C3 C
Span2: 10.650 A B C1 C2 C3 C
Span3:
Abutments - Continuous
Left
Right
Height (m)
Pile Bases
Piles Height (m)
Integral:
Rigid Frame:
3.6
3.6
Pinned Legs
Fixed Legs
Abutments - Non-continuous
Horizontal Joint at Abutment Top
Total Bearing Shear Stiffness (kN/mm)
Shoe Plate Thickness (mm)
Non-integral:
Click Synchronize Button on Geometry 2 to Update BRIDGframe Example v8.0.23y.xlsm


BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Piers - Continuous
Left
Right
Height (m)
Pile Bases
Piles Height (m)
Integral:
Rigid Frame:
3.9
Pinned Legs
Fixed Legs
Piers - Non-continuous
Horizontal Joint at Pier Top
Total Bearing Shear Stiffness (kN/mm)
Shoe Plate Thickness (mm)
Non-integral:
Skew of Substructure from Perpendicular to C/L of Alignment
Skew (degrees):
25
Girders Over Piers During Construction
Over Left Pier:
Continuous
Non-continuous (simply supported)
Over Right Pier:
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm


BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Span Properties
Span 1
Span 2
Span 3
Girder/Slab Profile
Constant
Constant
Number of Members per Girder/Slab
1
1
Member Properties
Member Names or Lengths (m)
Span 1
Span 2
Span 3
1:
10.650
10.650
2:
3:
4:
5:
6:
7:
Help
Section Properties
Current Section: 1
Custom
Steel Sections
Span/Bridge Combination: B/C
Name / Designation: W310x79
Number of Girders 5
Girder Depth "dg" (cm): 30.6
Area of Single Girder "Ag" (cm²): 101
Moment of Inertia of Single Girder "Ig" (cm^4): 17700
Naked Girder NA to Girder Bottom "yb" (cm): 15.3
Young's Modulus of Steel "Es" (MPa): 200000
Composite Deck Width as per cl.5.5.2 (cm): 520
Composite Deck Depth (cm): 22.5
Deck Concrete "fc" (MPa): 35
Deck Concrete Density (kg/m³): 2450
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm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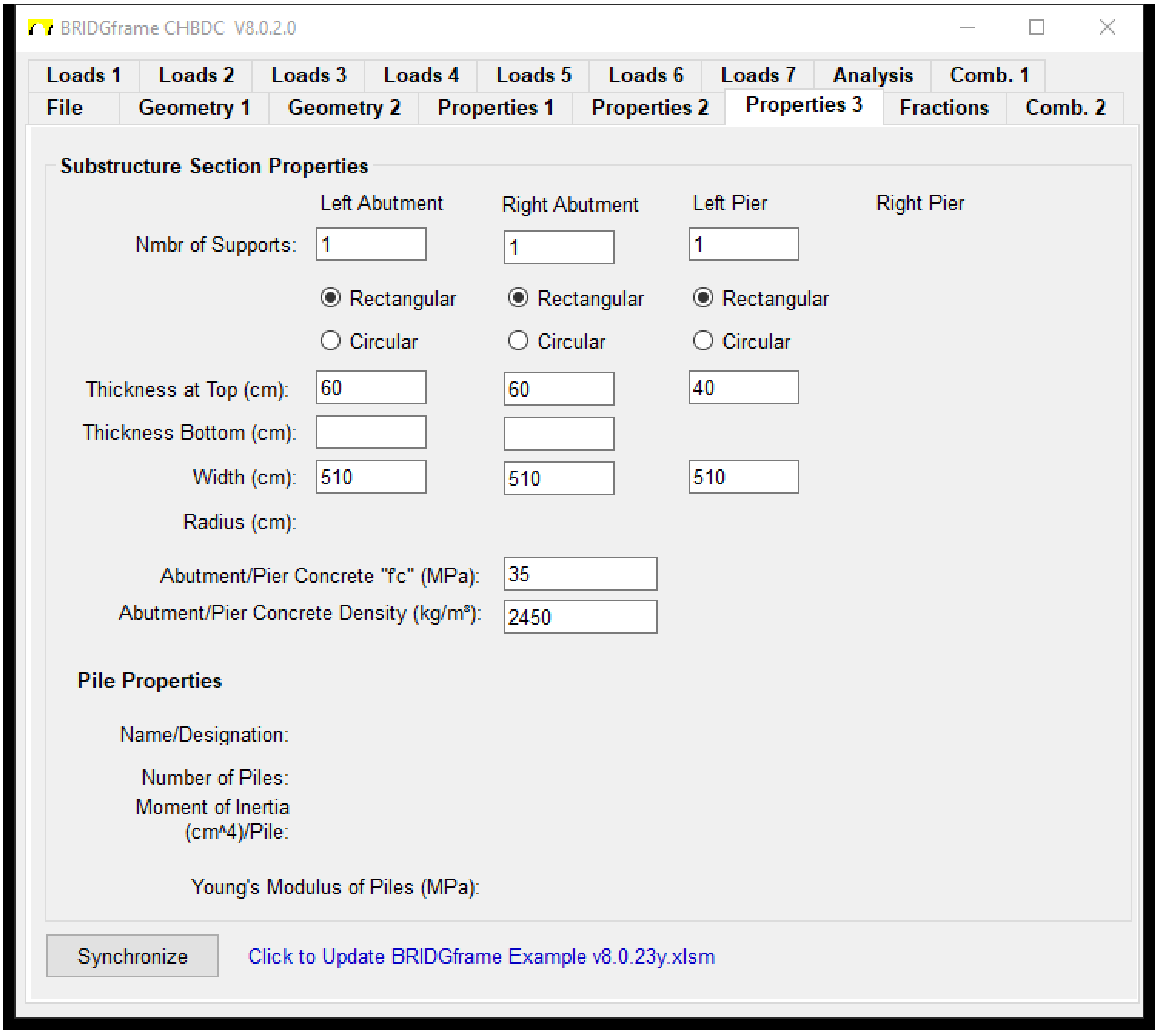
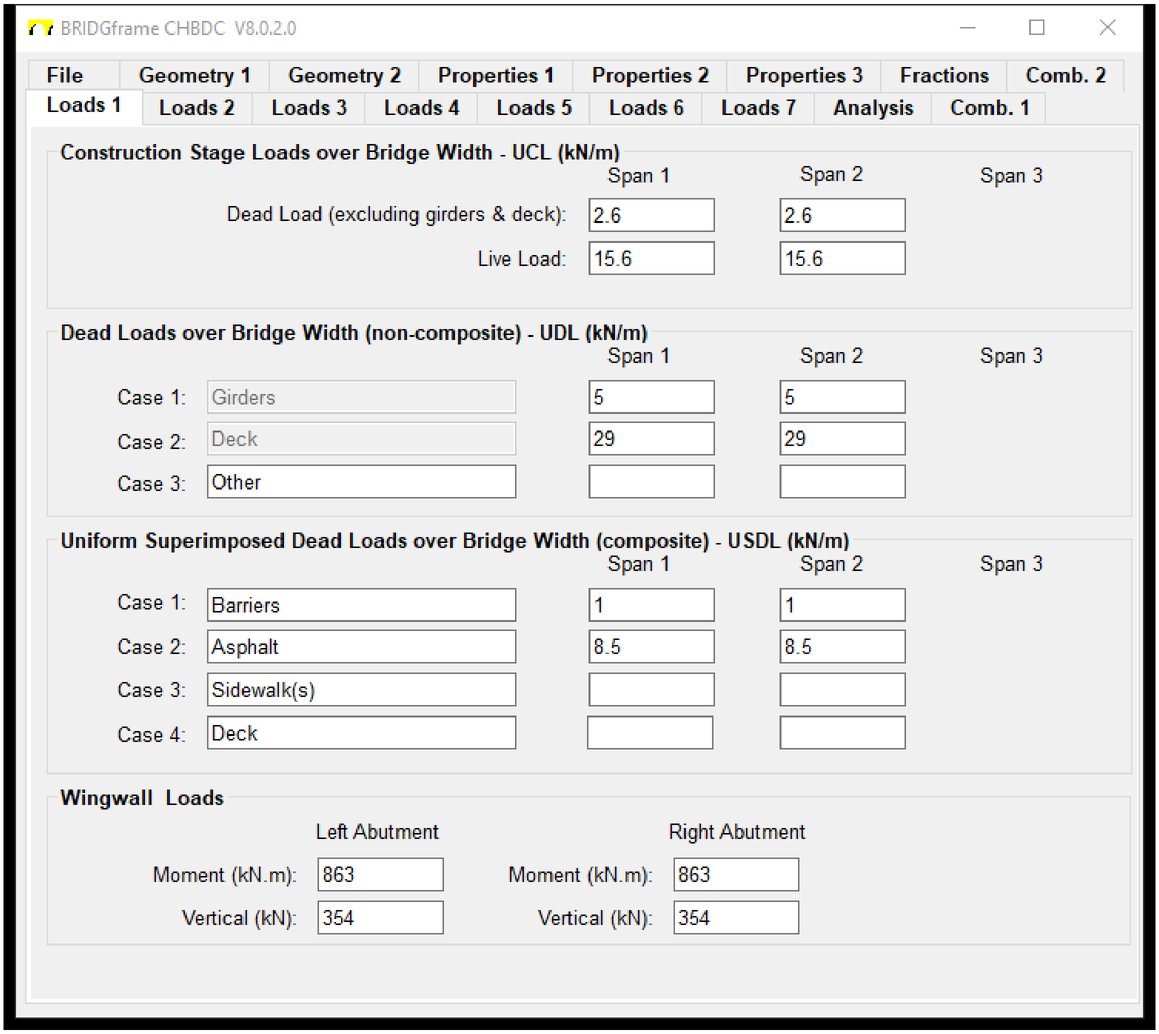
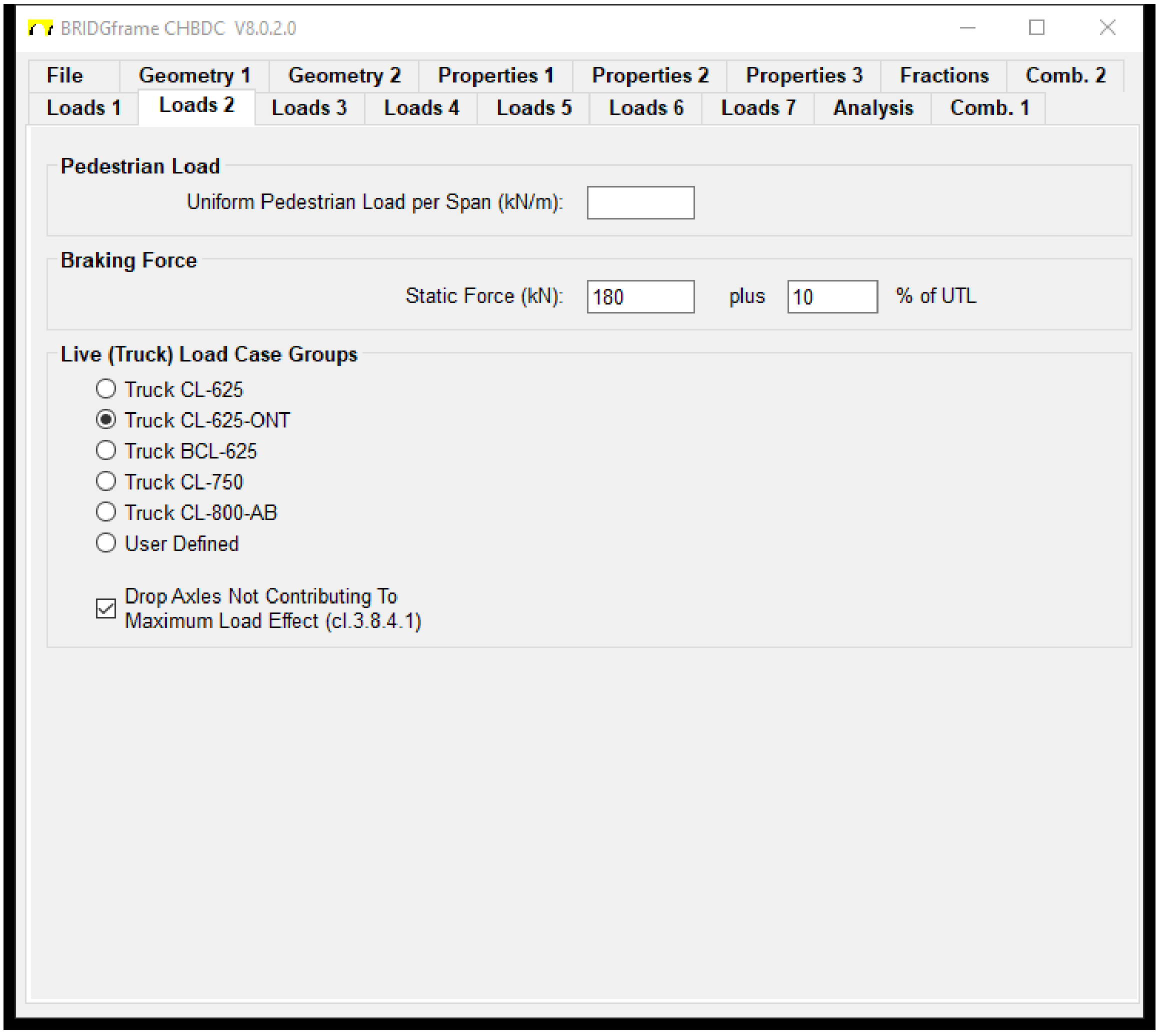
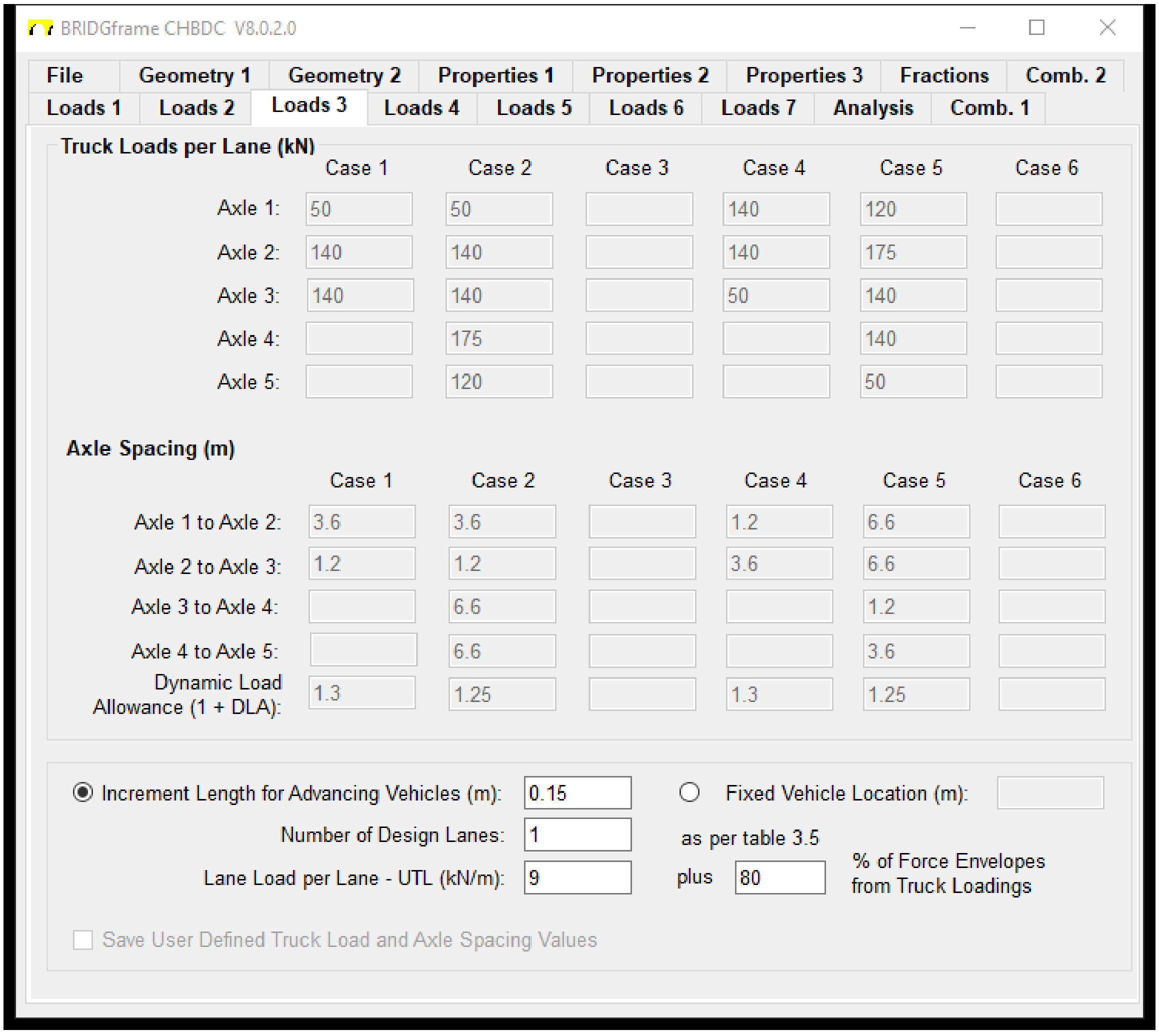
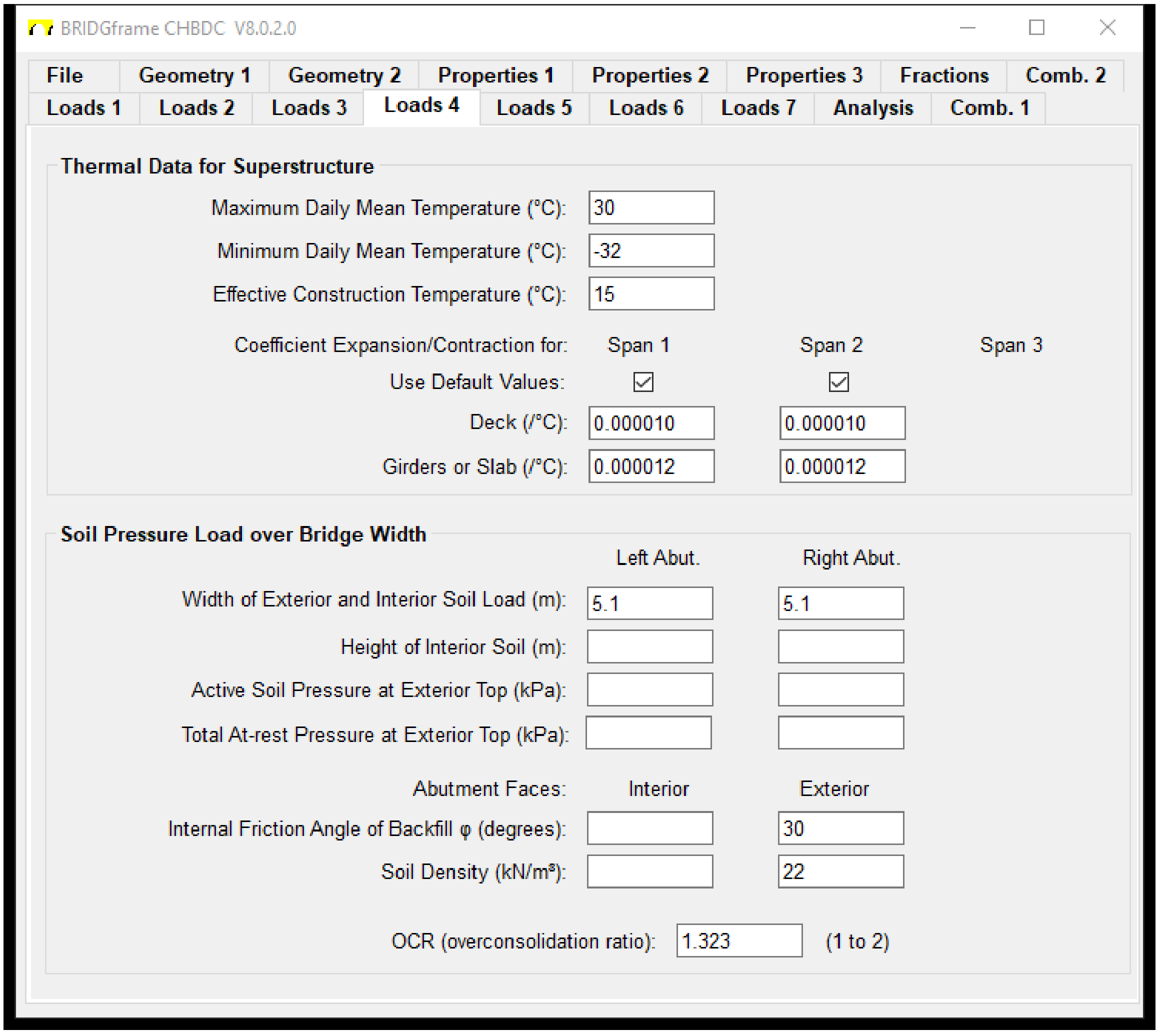
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Superstructure Cross-Section
Span 1
Span 2
Span 3
Spacing of girders or voided slab webs "S" (m):
0.95
0.95
Overhang length of deck "Sc" (m):
0.65
0.65
Bridge Platform
Bridge Platform Properties are Identical for All Spans
Center of exterior "travelled" lane to adjacent outside face of barrier (m):
2.803
Distance between curb or barrier faces "Wc" (m):
5.03
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm


BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Substructure Section Properties
Left Abutment
Right Abutment
Left Pier
Right Pier
Nmbr of Supports:
1
1
1
Rectangular
Rectangular
Rectangular
Circular
Circular
Circular
Thickness at Top (cm):
60
60
40
Thickness Bottom (cm):
Width (cm):
510
510
510
Radius (cm):
Abutment/Pier Concrete "f'c" (MPa):
35
Abutment/Pier Concrete Density (kg/m³):
2450
Pile Properties
Name/Designation:
Number of Piles:
Moment of Inertia (cm^4)/Pile:
Young's Modulus of Piles (MPa):
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm

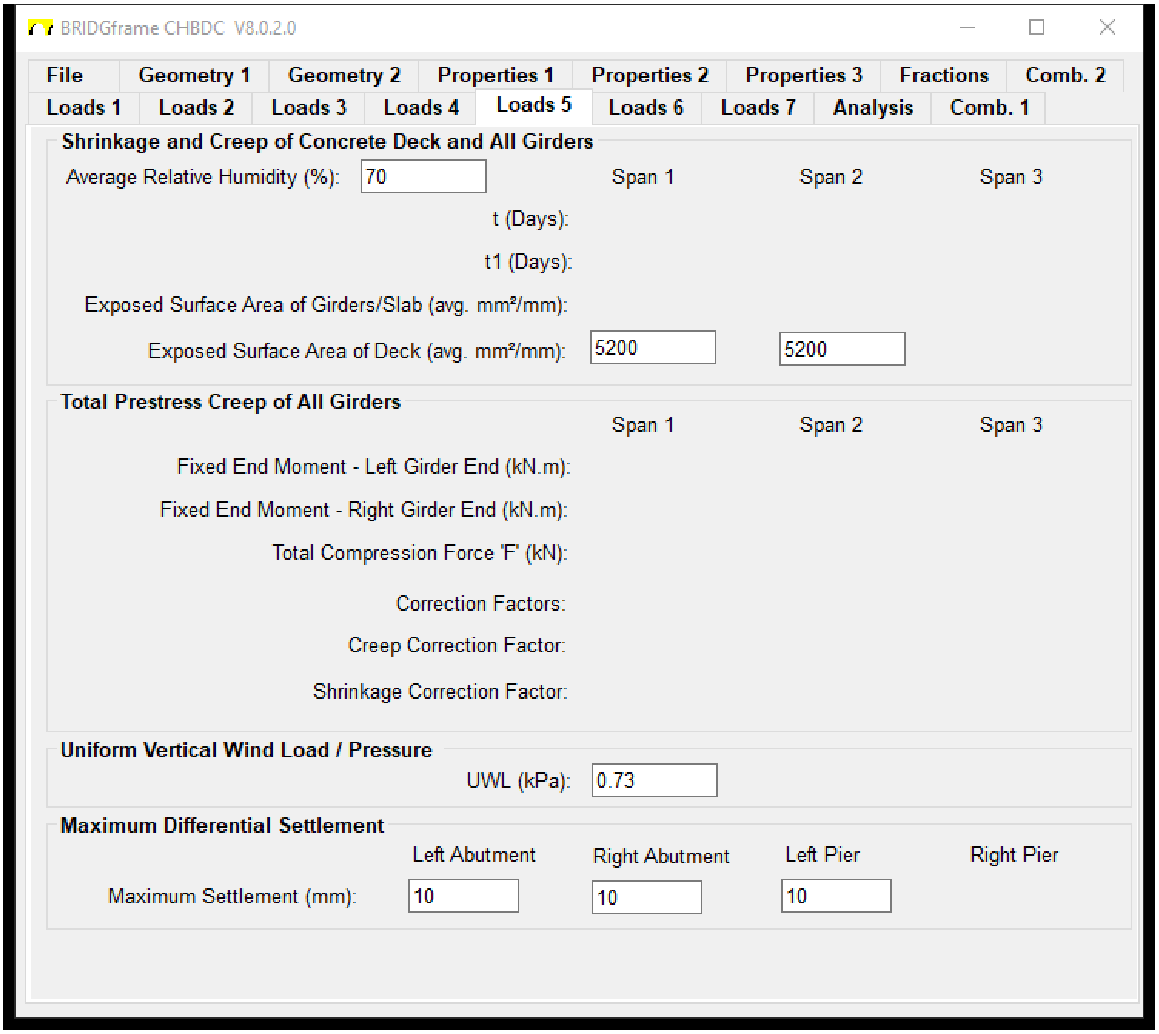

BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Construction Stage Loads over Bridge Width - UCL (kN/m)
Span 1
Span 2
Span 3
Dead Load (excluding girders & deck):
2.6
2.6
Live Load:
15.6
15.6
Dead Loads over Bridge Width (non-composite) - UDL (kN/m)
Span 1
Span 2
Span 3
Case 1:
Girders
5
5
Case 2:
Deck
29
29
Case 3:
Other
Uniform Superimposed Dead Loads over Bridge Width (composite) - USDL (kN/m)
Span 1
Span 2
Span 3
Case 1:
Barriers
1
1
Case 2:
Asphalt
8.5
8.5
Case 3:
Sidewalk(s)
Case 4:
Deck
Wingwall Loads
Left Abutment
Right Abutment
Moment (kN.m):
863
Moment (kN.m):
863
Vertical (kN):
354
Vertical (kN):
354

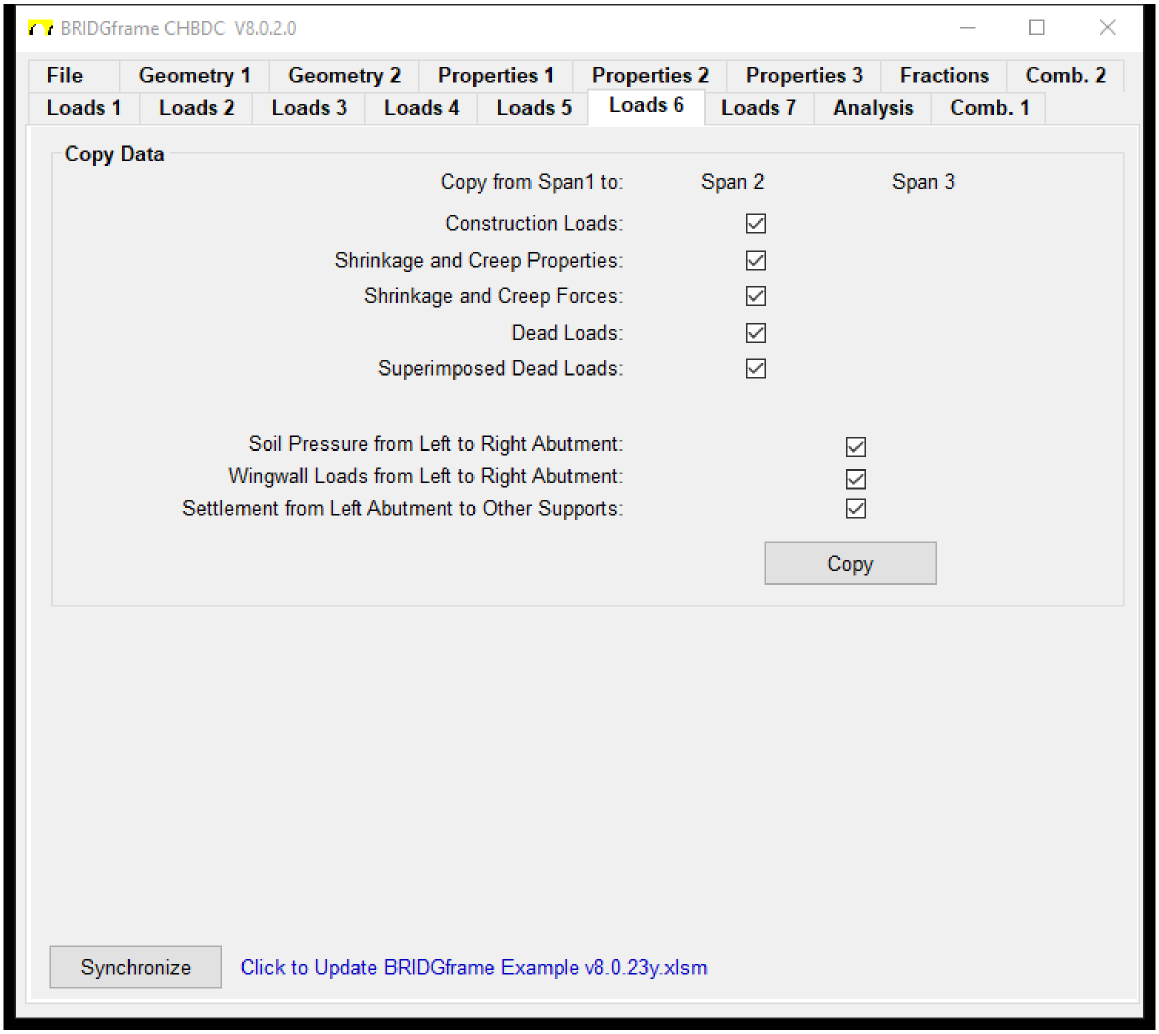

BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Pedestrian Load
Uniform Pedestrian Load per Span (kN/m):
Braking Force
Static Force (kN): 180 plus 10 % of UTL
Live (Truck) Load Case Groups
Truck CL-625
Truck CL-625-ONT
Truck BCL-625
Truck CL-750
Truck CL-800-AB
User Defined
Drop Axles Not Contributing To
Maximum Load Effect (cl.3.8.4.1)


BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Truck Loads per Lane (kN)
Case 1 Case 2 Case 3 Case 4 Case 5 Case 6
Axle 1: 50 50 140 120
Axle 2: 140 140 140 175
Axle 3: 140 140 50 140
Axle 4: 175 140
Axle 5: 120 50
Axle Spacing (m)
Case 1 Case 2 Case 3 Case 4 Case 5 Case 6
Axle 1 to Axle 2: 3.6 3.6 1.2 6.6
Axle 2 to Axle 3: 1.2 1.2 3.6 6.6
Axle 3 to Axle 4: 6.6 1.2
Axle 4 to Axle 5: 6.6 3.6
Dynamic Load Allowance (1 + DLA): 1.3 1.25 1.3 1.25
Increment Length for Advancing Vehicles (m): 0.15
Fixed Vehicle Location (m):
Number of Design Lanes: 1
as per table 3.5
Lane Load per Lane - UTL (kN/m): 9
plus 80
% of Force Envelopes from Truck Loadings
Save User Defined Truck Load and Axle Spacing Values

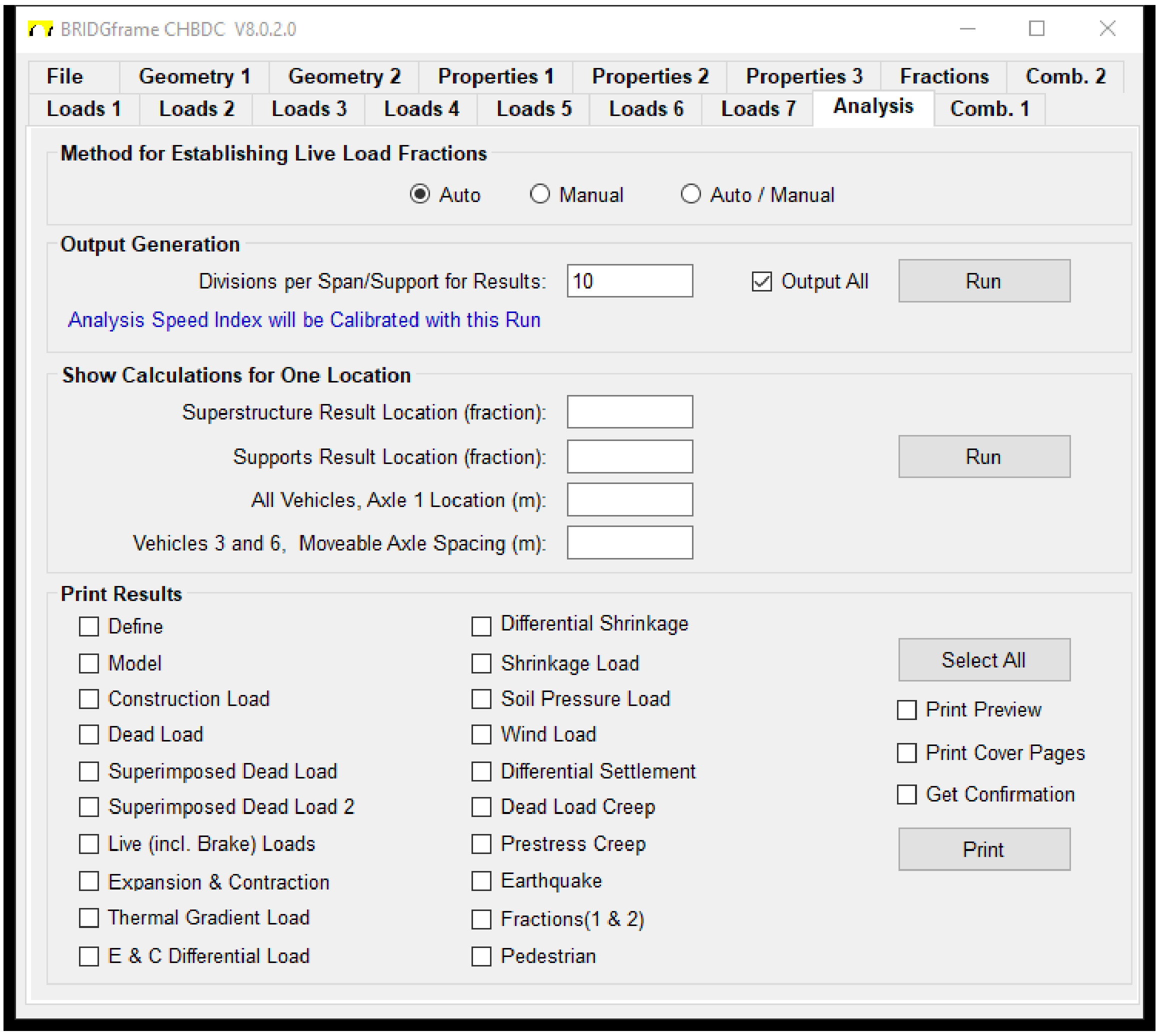


- Active Soil Pressure at Exterior Top and Total At-rest Pressure at Exterior Top may be included. See paragraph 2 of 5.4.9 and Appendix 4 – Concrete Rigid Parabolic Soffit, Loads 4 screen print.


BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Shrinkage and Creep of Concrete Deck and All Girders
Average Relative Humidity (%): 70
Span 1
Span 2
Span 3
t (Days):
t1 (Days):
Exposed Surface Area of Girders/Slab (avg. mm²/mm):
Exposed Surface Area of Deck (avg. mm²/mm): 5200 5200
Total Prestress Creep of All Girders
Span 1
Span 2
Span 3
Fixed End Moment - Left Girder End (kN.m):
Fixed End Moment - Right Girder End (kN.m):
Total Compression Force 'F' (kN):
Correction Factors:
Creep Correction Factor:
Shrinkage Correction Factor:
Uniform Vertical Wind Load / Pressure
UWL (kPa): 0.73
Maximum Differential Settlement
Left Abutment
Right Abutment
Left Pier
Right Pier
Maximum Settlement (mm): 10 10 10


BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Copy Data
Copy from Span1 to:
Span 2
Span 3
Construction Loads:
Shrinkage and Creep Properties:
Shrinkage and Creep Forces:
Dead Loads:
Superimposed Dead Loads:
Soil Pressure from Left to Right Abutment:
Wingwall Loads from Left to Right Abutment:
Settlement from Left Abutment to Other Supports:
Copy
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm

Loads 7: See Appendix 17.



APPENDIX 4 – 2 SPAN STEEL PLATE GIRDERS

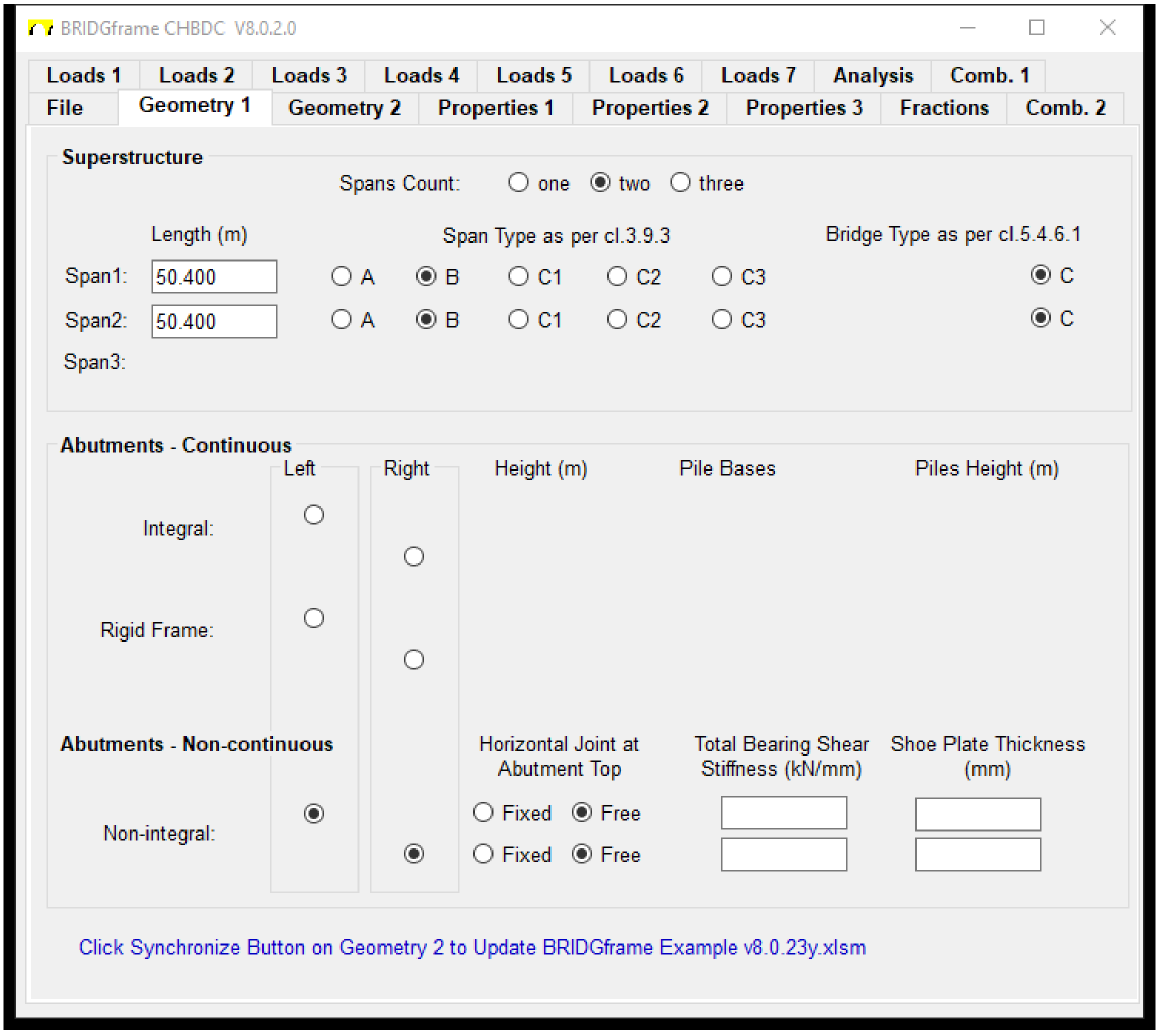
Bridge Geometry

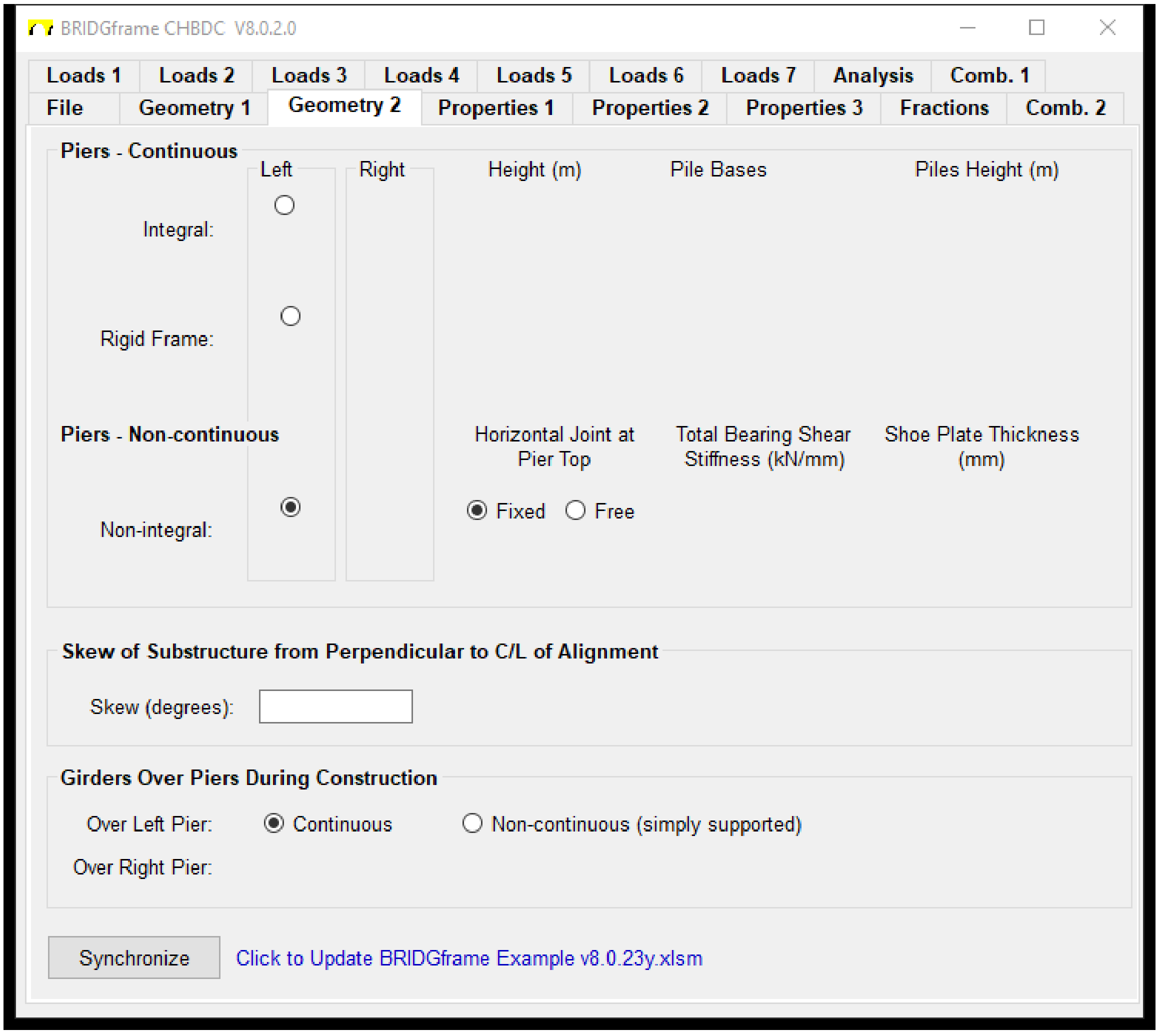
Structure Type:	Continuous steel plate girders of variable section properties with concrete composite deck. Pinned at abutments.
Spans:	2 spans of 50.4 m
Deck:	26.2 m total width x 225 mm thick (145 kN/m). 25.11 m barrier inside face to barrier inside face. 5 travelled lanes at 3.65 m. 2 side clearances at 3.43 m. 7 design lanes. 1375 mm overhang from centerline of exterior girder to edge of deck. 90mm asphalt and waterproofing (55 kN/m).
Barriers:	NewJersey Barriers 495 mm at base (14 kN/m)
Girders:	8 – Steel Plate Girders at 3.35 m (1370 x 12.7 mm web) Use the Custom button to generate required member properties.

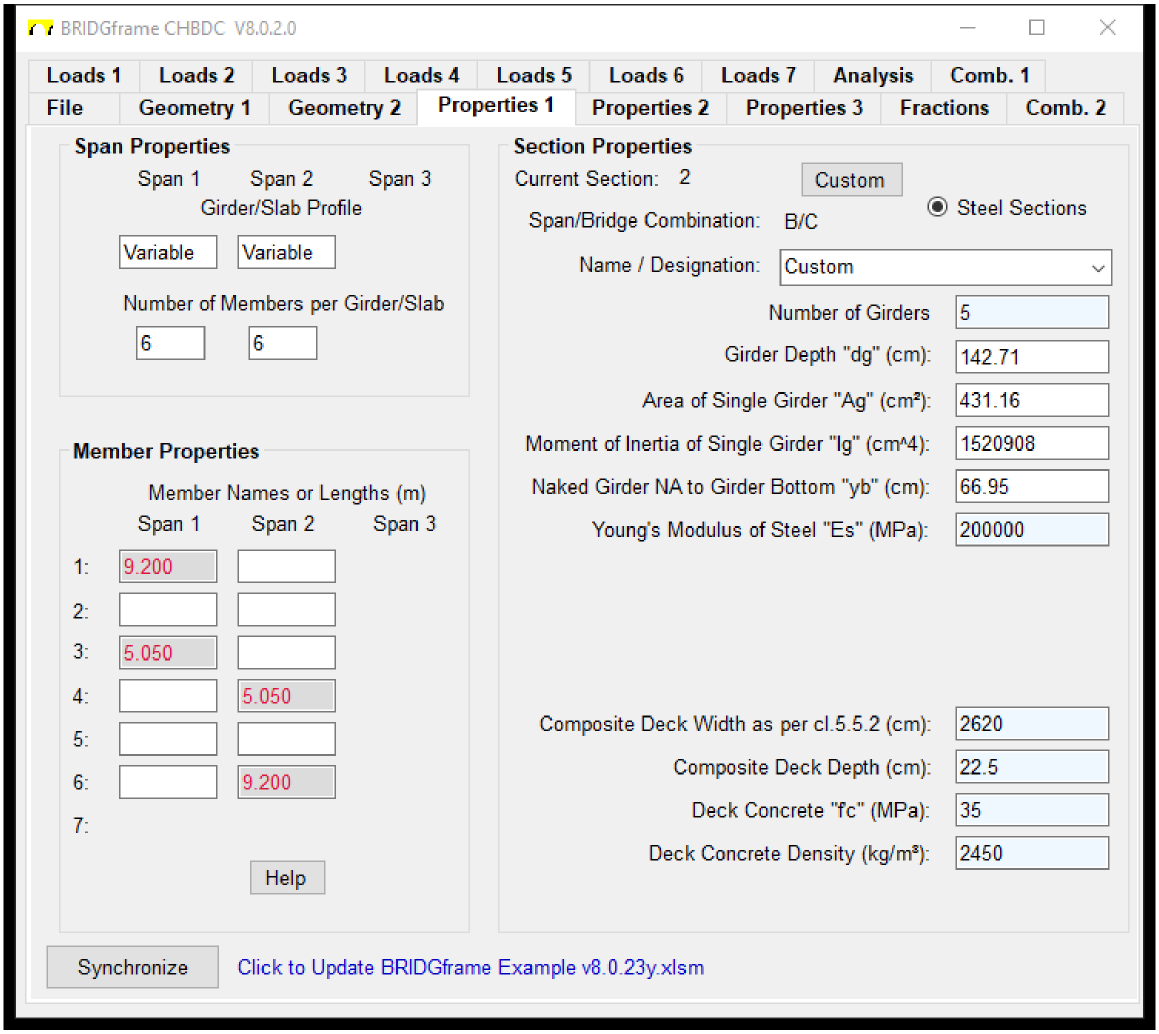
Assumed girder section properties:

from C/L Bearing to 9.2 m: 9.2m total length	top pl. 450 x 25.4 mm bott. pl. 450 x 31.75 mm Area = 431.16 cm^2
from 9.2 to 29.7 m: 20.5 total length	top pl. 450 x 25.4 mm bott. pl. 450 x 57.15 mm Area = 545.46 cm^2
from 29.7 to 34.75 m: 5.05 total length	top pl. 450 x 25.4 mm bott. pl. 450 x 31.75 mm Area = 431.16 cm^2
from 34.75 to 40.5 m: 5.75 total length	top pl. 600 x 25.4 mm bott. pl. 600 x 25.4 mm Area = 478.79 cm^2
from 40.5 to 46.5 m: 6.0 total length	top pl. 600 x 50.8 mm bott. pl. 600 x 50.8 mm Area = 783.59 cm^2
from 46.5 to 50.4 m: 3.9 total length	top pl. 600 x 70.0 mm bott. pl. 600 x 70.0 mm Area = 1013.99 cm^2

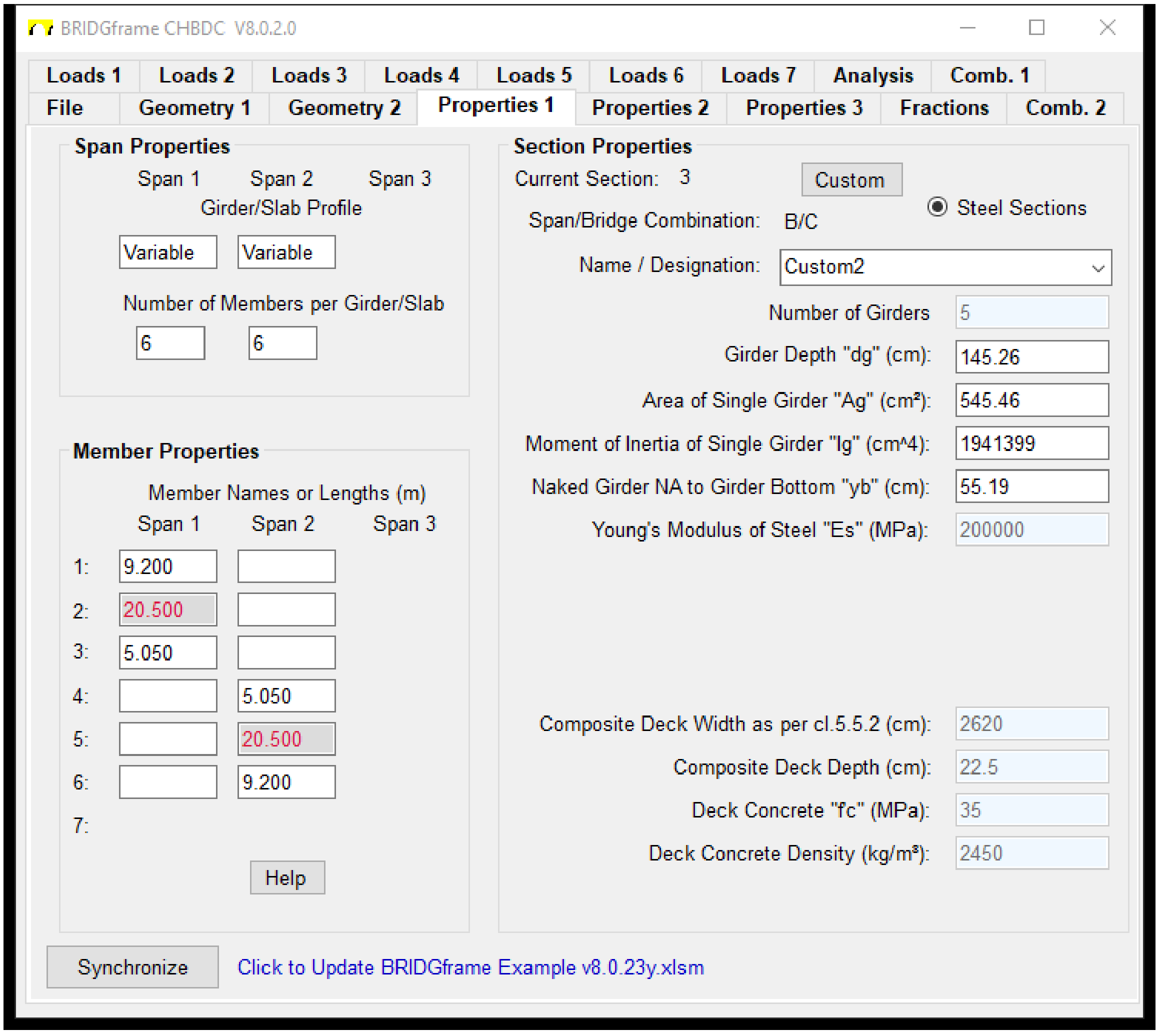
Average Area from assumed section properties = 570.14 cm^2
Therefore, assume a constant udl weight = 8 x 0.05714 x 77kN/m^3 = say 40 kN/m

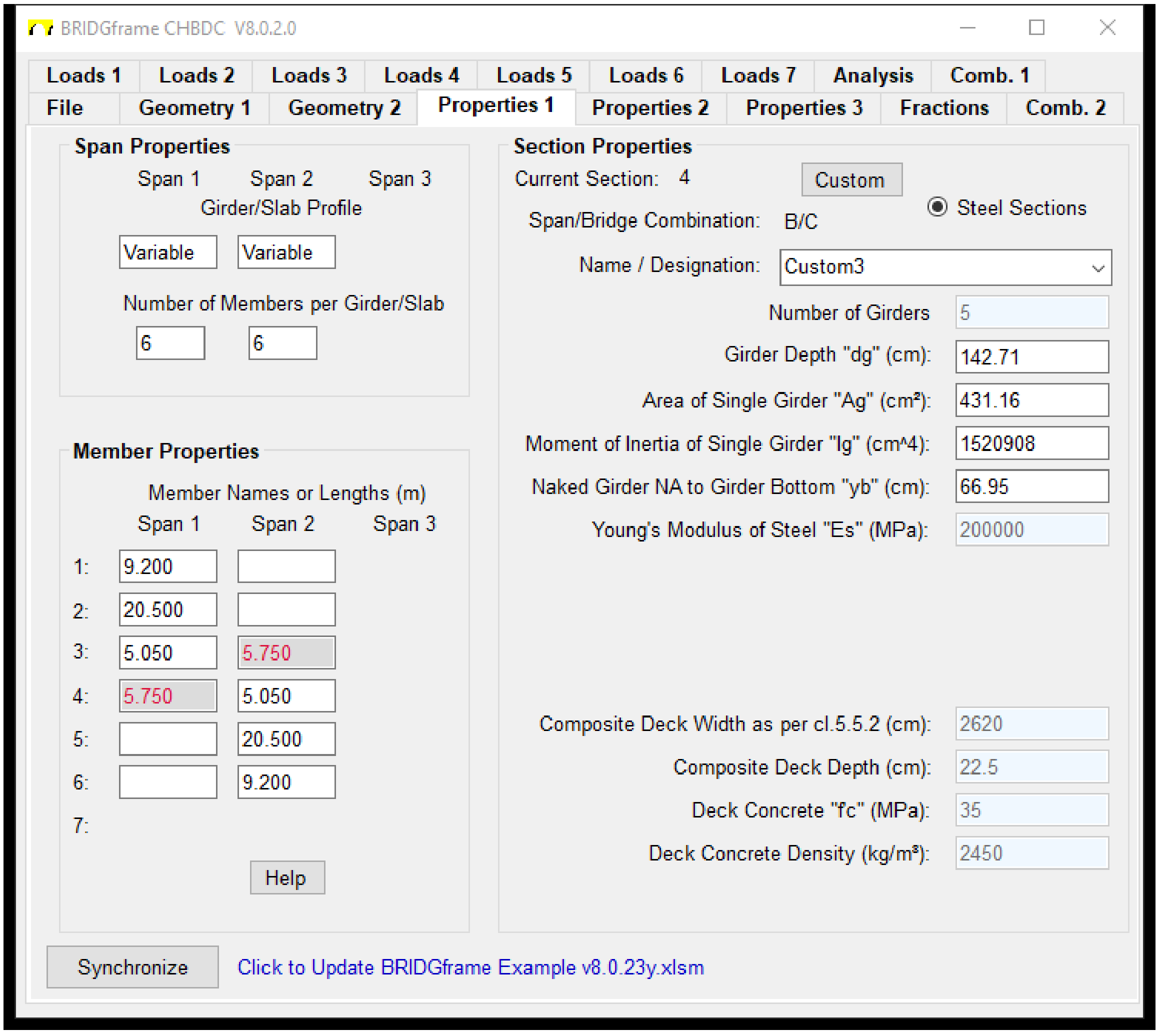

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Superstructure
Spans Count:
one
two
three
Length (m)
Span Type as per cl.3.9.3
Bridge Type as per cl.5.4.6.1
Span1:
50.400
A
B
C1
C2
C3
C
Span2:
50.400
A
B
C1
C2
C3
C
Span3:
Abutments - Continuous
Left
Right
Height (m)
Pile Bases
Piles Height (m)
Integral:
Rigid Frame:
Abutments - Non-continuous
Horizontal Joint at Abutment Top
Total Bearing Shear Stiffness (kN/mm)
Shoe Plate Thickness (mm)
Non-integral:
Fixed
Free
Fixed
Free
Click Synchronize Button on Geometry 2 to Update BRIDGframe Example v8.0.23y.xlsm

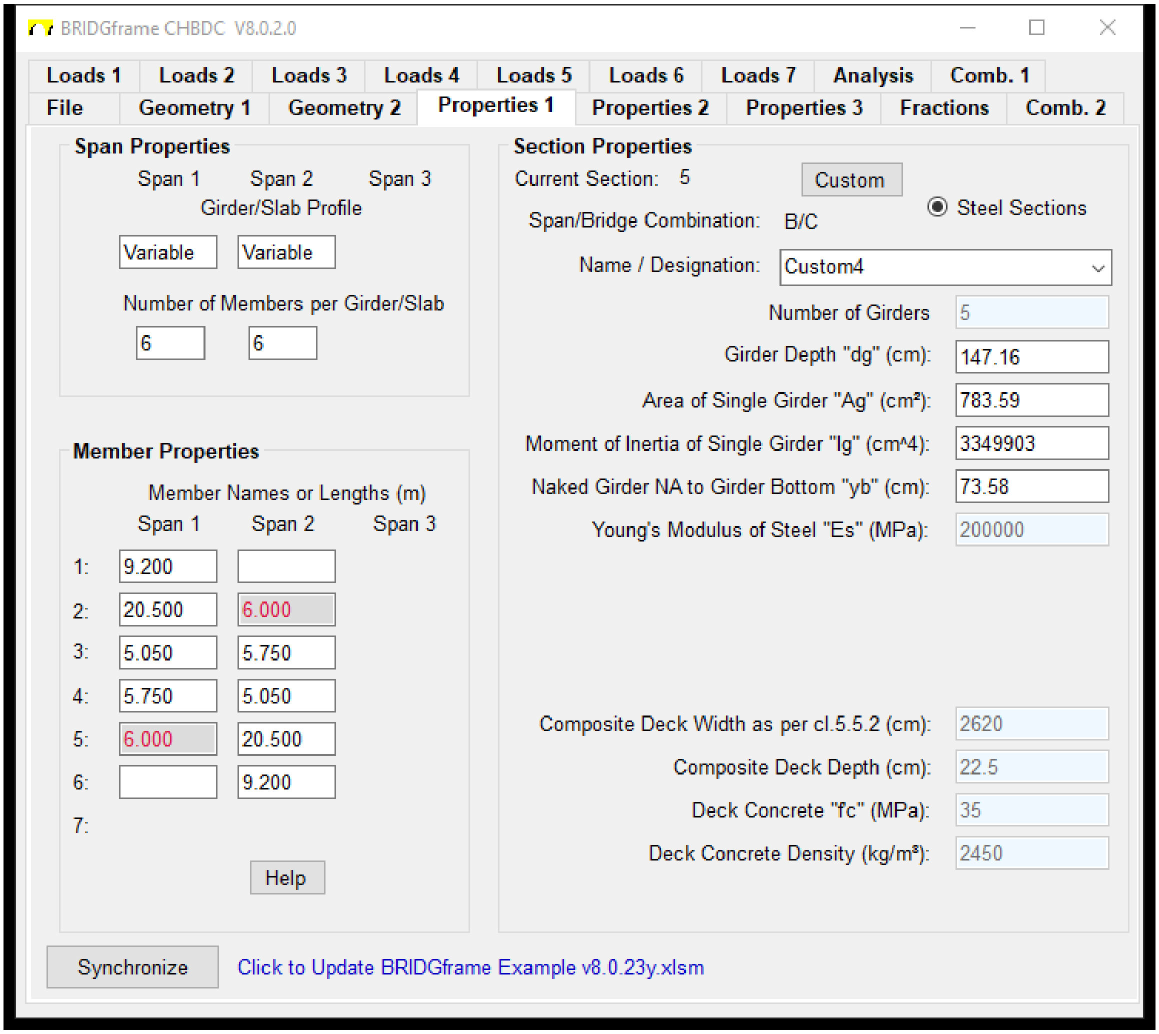

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Piers - Continuous
Left
Right
Height (m)
Pile Bases
Piles Height (m)
Integral:
Rigid Frame:
Piers - Non-continuous
Horizontal Joint at Pier Top
Total Bearing Shear Stiffness (kN/mm)
Shoe Plate Thickness (mm)
Fixed
Free
Non-integral:
Skew of Substructure from Perpendicular to C/L of Alignment
Skew (degrees):
Girders Over Piers During Construction
Over Left Pier:
Continuous
Non-continuous (simply supported)
Over Right Pier:
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm

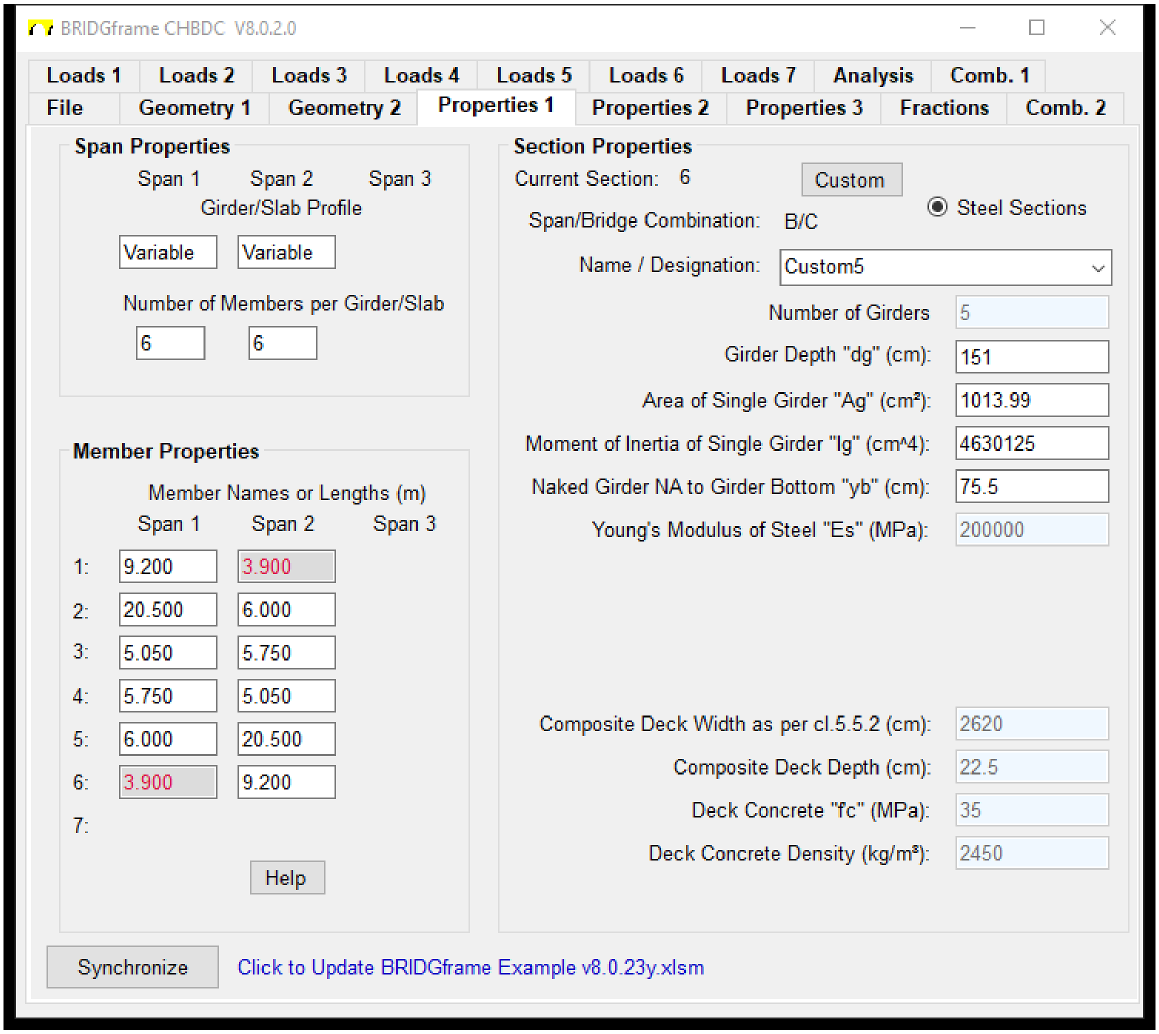


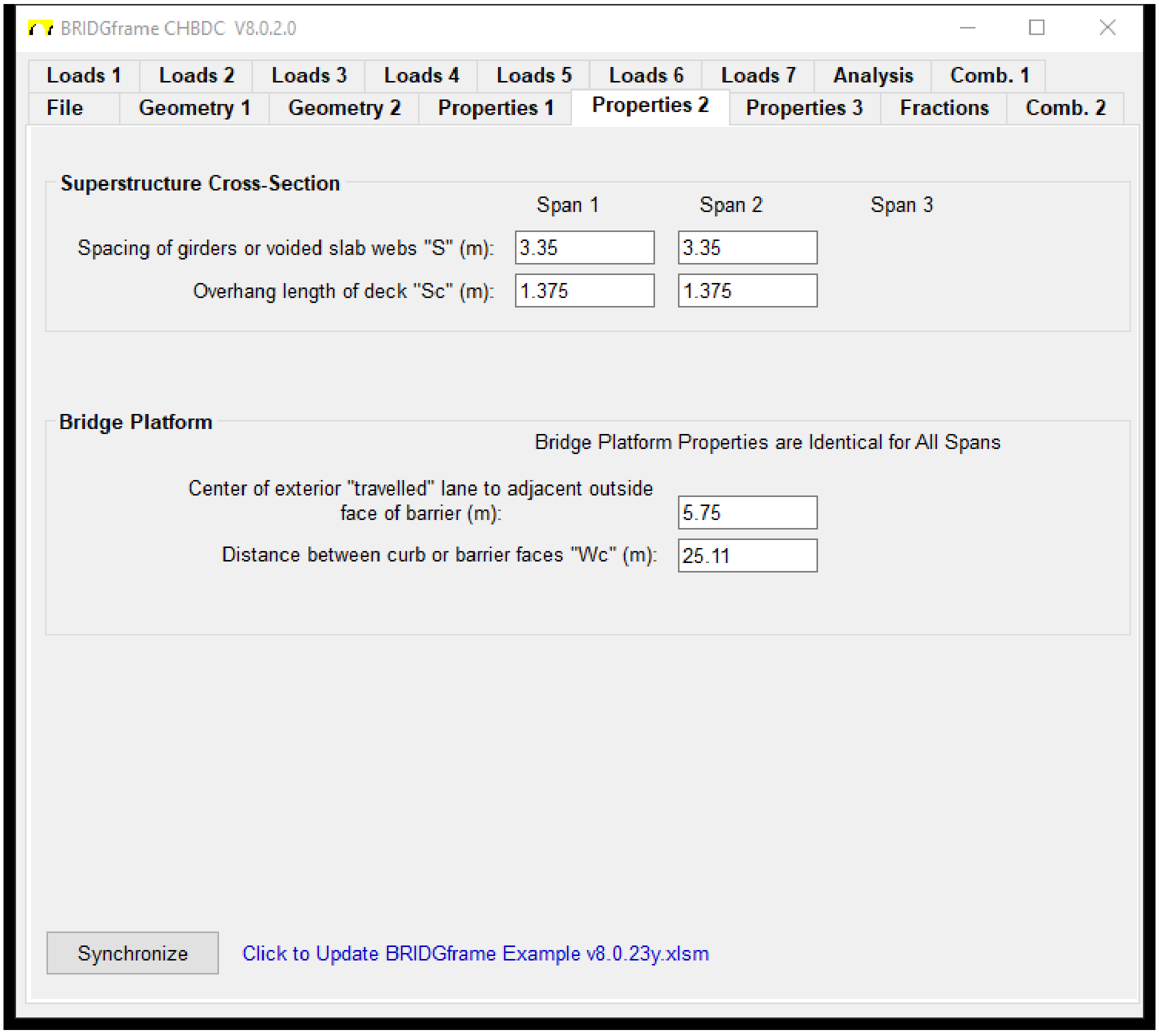
When more than one element has the same section properties, the elements can be grouped prior to synchronizing. First one element is selected and assigned properties.
Hover your cursor over another element box and click your left mouse button to open the Modify Properties popup and select Current. Repeat until all elements are included in the group of same section properties. (see Appendix 7)

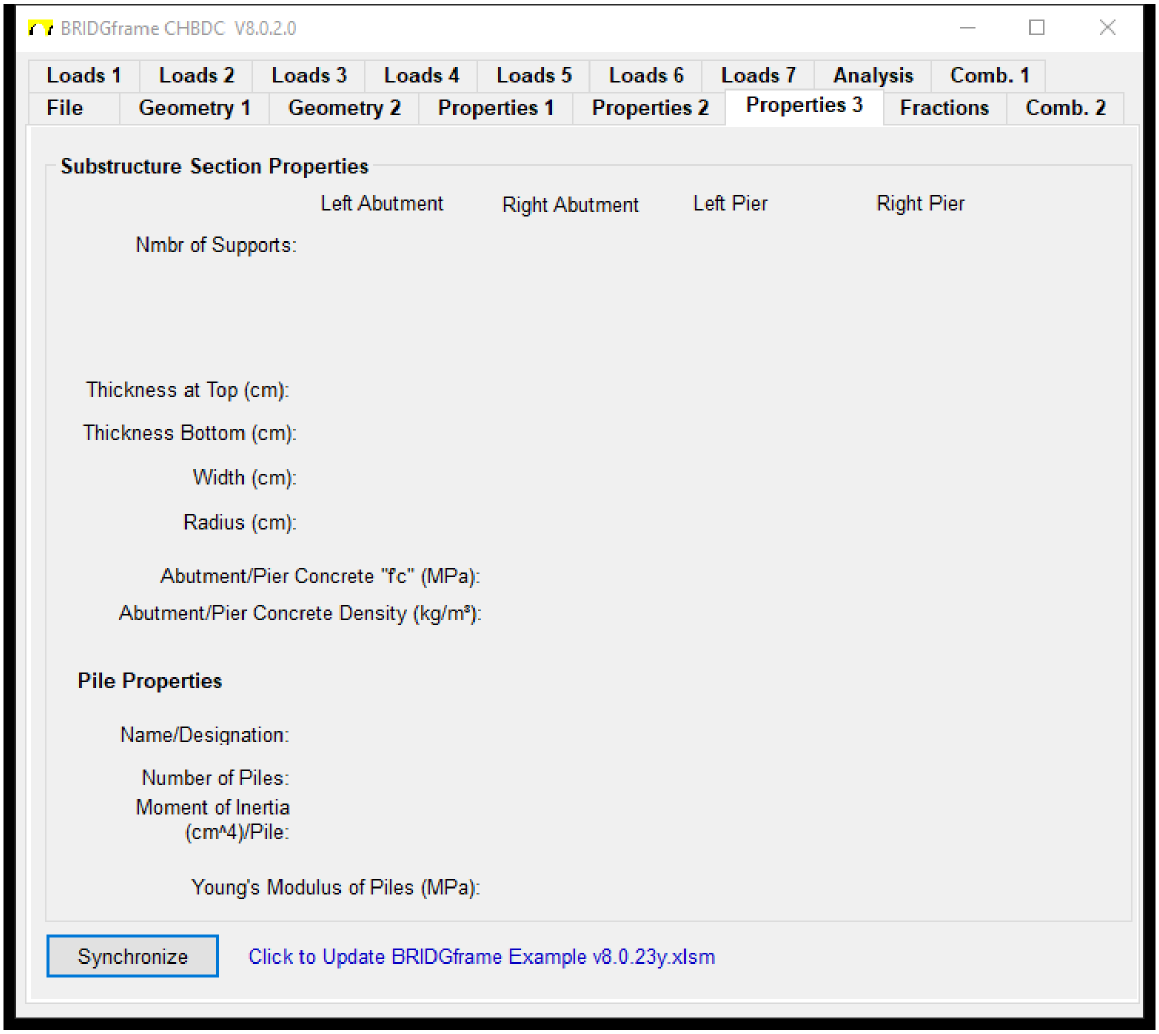

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Span Properties
Span 1
Span 2
Span 3
Girder/Slab Profile
Variable
Variable
Number of Members per Girder/Slab
6
6
Member Properties
Member Names or Lengths (m)
Span 1
Span 2
Span 3
1: 9.200
2: 20.500
3: 5.050
4: 5.050
5: 20.500
6: 9.200
7:
Help
Section Properties
Current Section: 3
Custom
Steel Sections
Span/Bridge Combination: B/C
Name / Designation: Custom2
Number of Girders 5
Girder Depth "dg" (cm): 145.26
Area of Single Girder "Ag" (cm²): 545.46
Moment of Inertia of Single Girder "Ig" (cm^4): 1941399
Naked Girder NA to Girder Bottom "yb" (cm): 55.19
Young's Modulus of Steel "Es" (MPa): 200000
Composite Deck Width as per cl.5.5.2 (cm): 2620
Composite Deck Depth (cm): 22.5
Deck Concrete "fc" (MPa): 35
Deck Concrete Density (kg/m³): 2450
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm

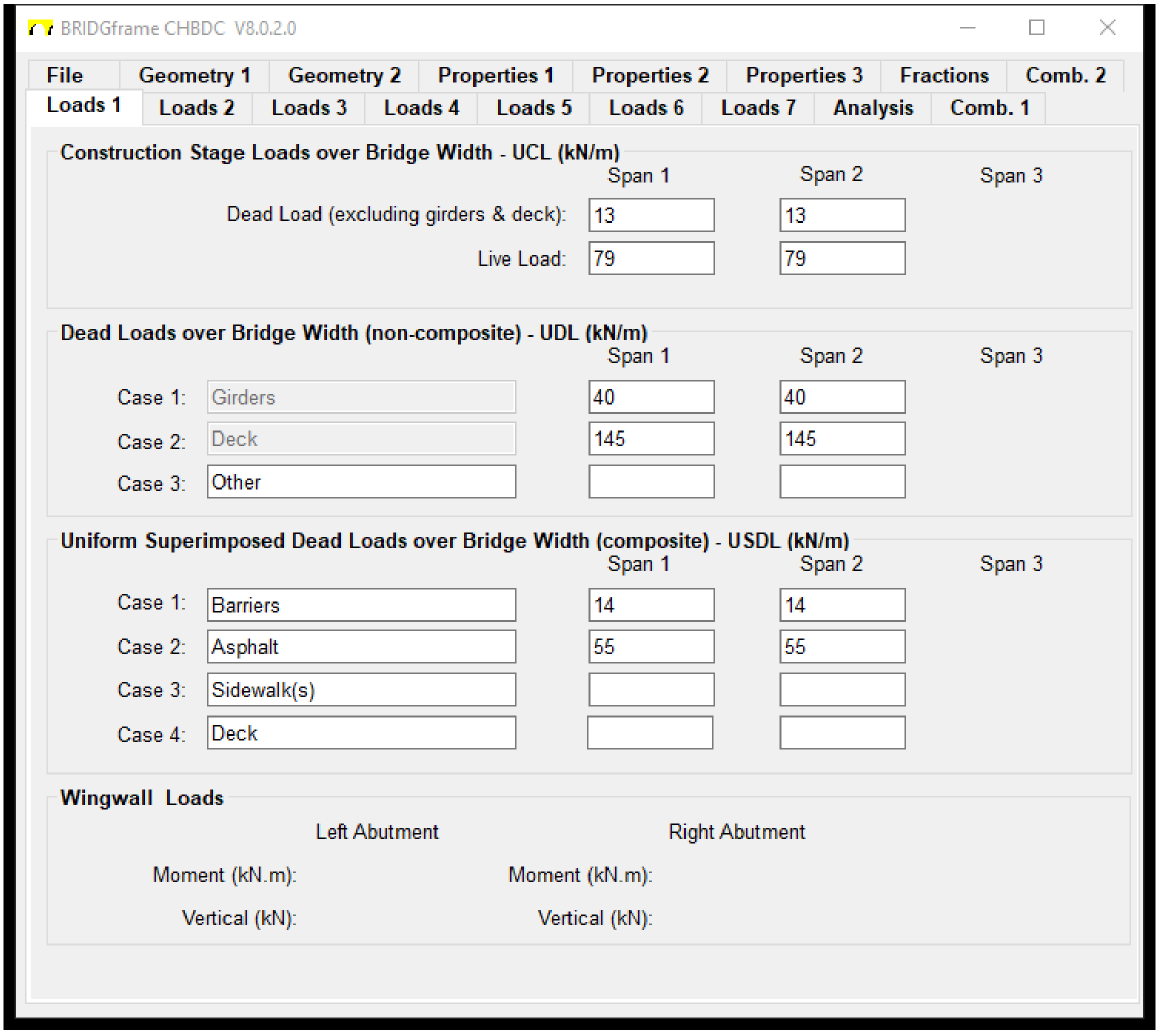

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Span Properties
Span 1
Span 2
Span 3
Girder/Slab Profile
Variable
Variable
Number of Members per Girder/Slab
6
6
Member Properties
Member Names or Lengths (m)
Span 1
Span 2
Span 3
1: 9.200
2: 20.500
3: 5.050 5.750
4: 5.750 5.050
5: 20.500
6: 9.200
7:
Help
Section Properties
Current Section: 4
Custom
Steel Sections
Span/Bridge Combination: B/C
Name / Designation: Custom3
Number of Girders 5
Girder Depth "dg" (cm): 142.71
Area of Single Girder "Ag" (cm²): 431.16
Moment of Inertia of Single Girder "Ig" (cm^4): 1520908
Naked Girder NA to Girder Bottom "yb" (cm): 66.95
Young's Modulus of Steel "Es" (MPa): 200000
Composite Deck Width as per cl.5.5.2 (cm): 2620
Composite Deck Depth (cm): 22.5
Deck Concrete "fc" (MPa): 35
Deck Concrete Density (kg/m³): 2450
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm

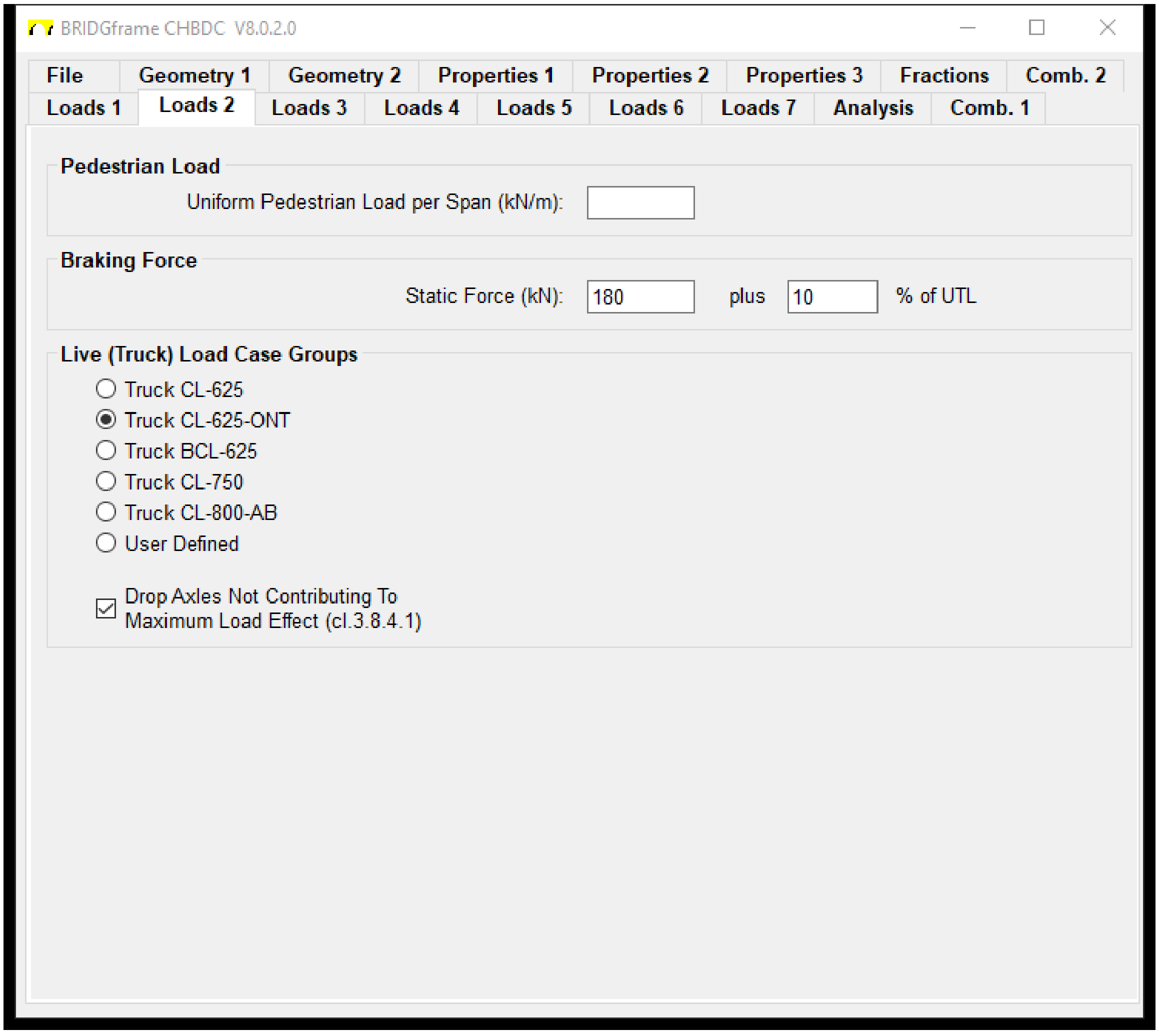

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Span Properties
Span 1
Span 2
Span 3
Girder/Slab Profile
Variable
Variable
Number of Members per Girder/Slab
6
6
Member Properties
Member Names or Lengths (m)
Span 1
Span 2
Span 3
1: 9.200
2: 20.500 6.000
3: 5.050 5.750
4: 5.750 5.050
5: 6.000 20.500
6: 9.200
7:
Help
Section Properties
Current Section: 5
Custom
Steel Sections
Span/Bridge Combination: B/C
Name / Designation: Custom4
Number of Girders 5
Girder Depth "dg" (cm): 147.16
Area of Single Girder "Ag" (cm²): 783.59
Moment of Inertia of Single Girder "Ig" (cm^4): 3349903
Naked Girder NA to Girder Bottom "yb" (cm): 73.58
Young's Modulus of Steel "Es" (MPa): 200000
Composite Deck Width as per cl.5.5.2 (cm): 2620
Composite Deck Depth (cm): 22.5
Deck Concrete "fc" (MPa): 35
Deck Concrete Density (kg/m³): 2450
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm

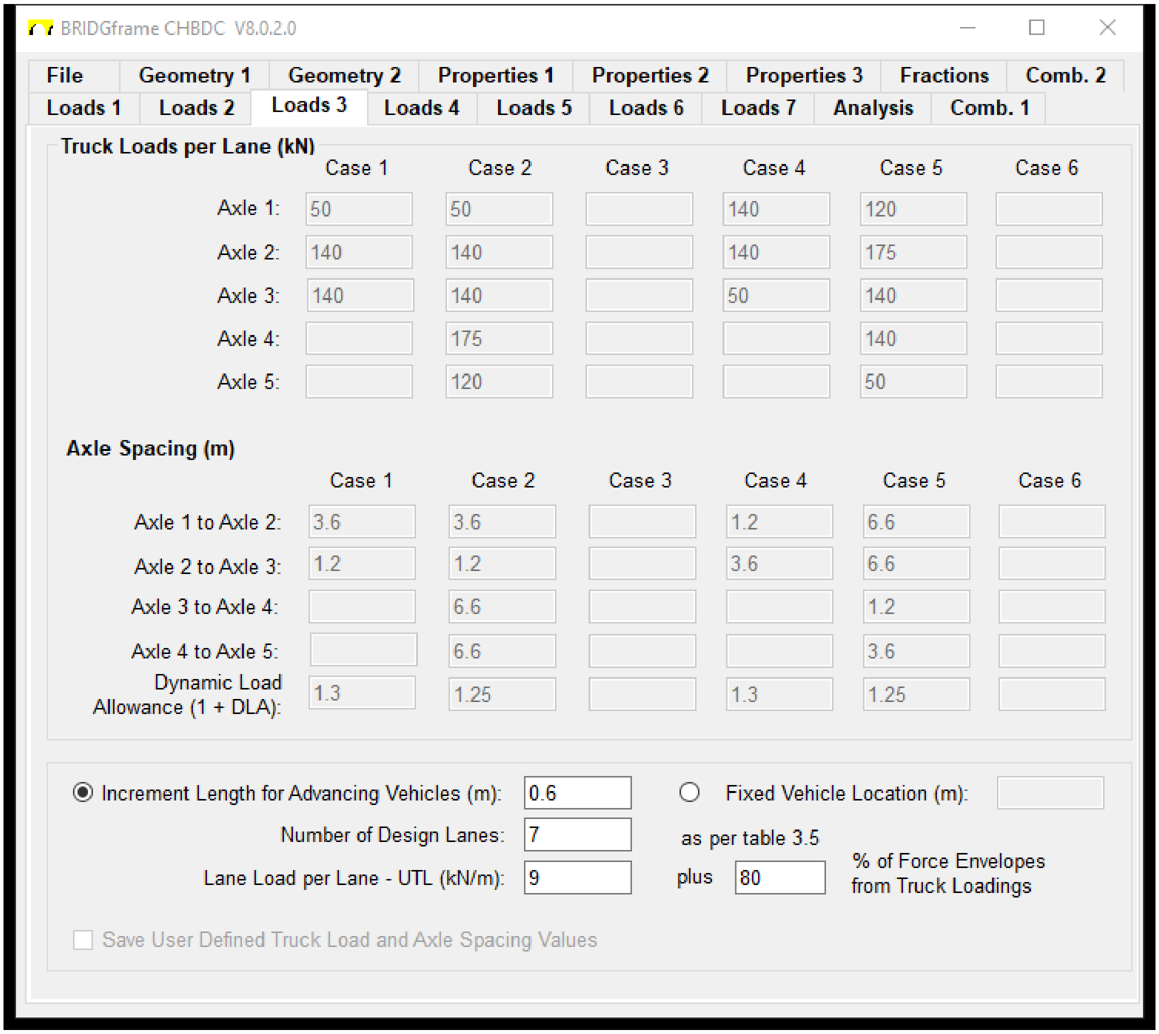

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Span Properties
Span 1 Span 2 Span 3
Girder/Slab Profile
Variable Variable
Number of Members per Girder/Slab
6 6
Member Properties
Member Names or Lengths (m)
Span 1 Span 2 Span 3
1: 9.200 3.900
2: 20.500 6.000
3: 5.050 5.750
4: 5.750 5.050
5: 6.000 20.500
6: 3.900 9.200
7:
Help
Section Properties
Current Section: 6
Custom
Steel Sections
Span/Bridge Combination: B/C
Name / Designation: Custom5
Number of Girders 5
Girder Depth "dg" (cm): 151
Area of Single Girder "Ag" (cm²): 1013.99
Moment of Inertia of Single Girder "Ig" (cm^4): 4630125
Naked Girder NA to Girder Bottom "yb" (cm): 75.5
Young's Modulus of Steel "Es" (MPa): 200000
Composite Deck Width as per cl.5.5.2 (cm): 2620
Composite Deck Depth (cm): 22.5
Deck Concrete "f'c" (MPa): 35
Deck Concrete Density (kg/m³): 2450
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm

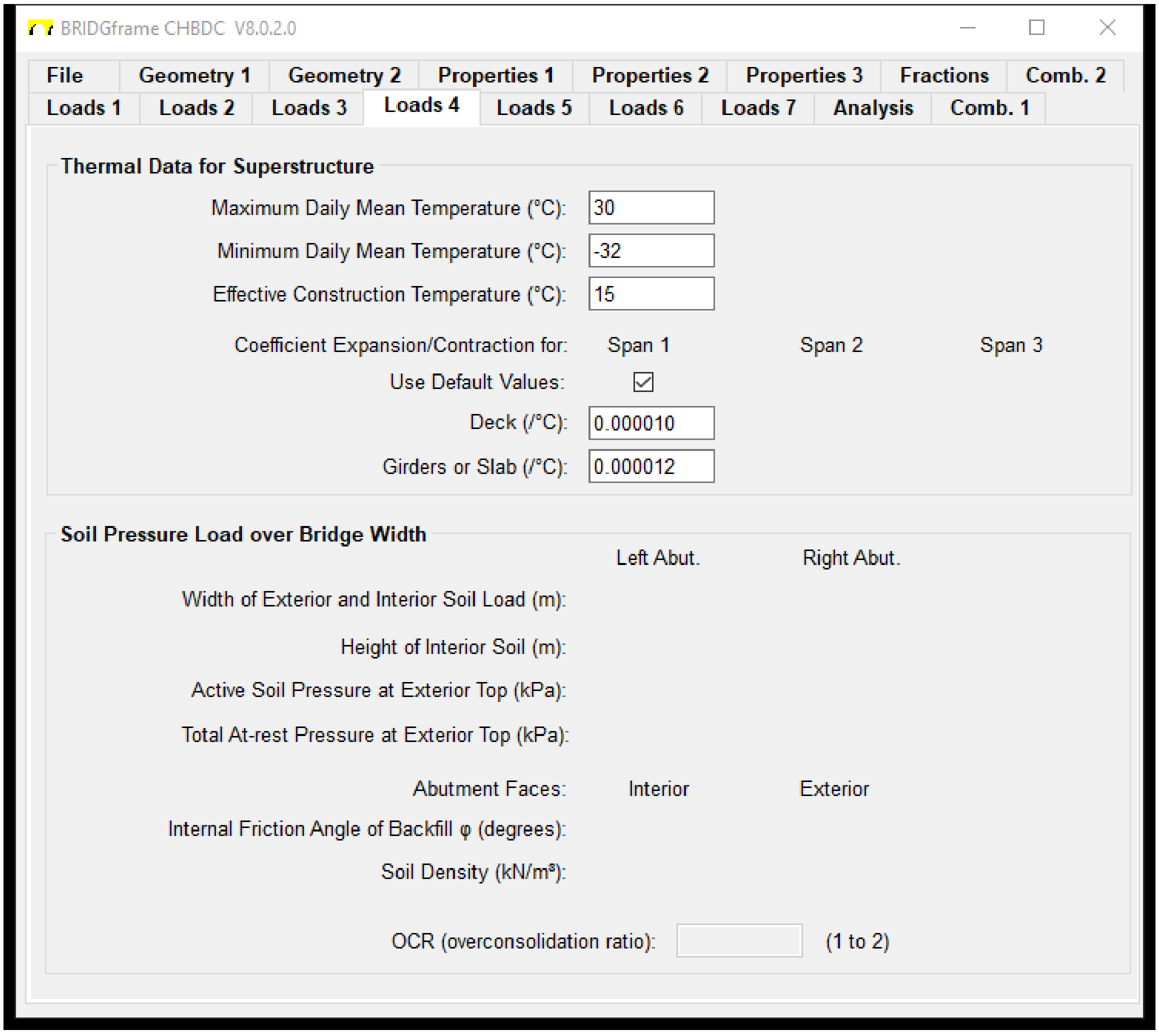

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Superstructure Cross-Section
Span 1
Span 2
Span 3
Spacing of girders or voided slab webs "S" (m):
3.35
3.35
Overhang length of deck "Sc" (m):
1.375
1.375
Bridge Platform
Bridge Platform Properties are Identical for All Spans
Center of exterior "travelled" lane to adjacent outside face of barrier (m):
5.75
Distance between curb or barrier faces "Wc" (m):
25.11
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm

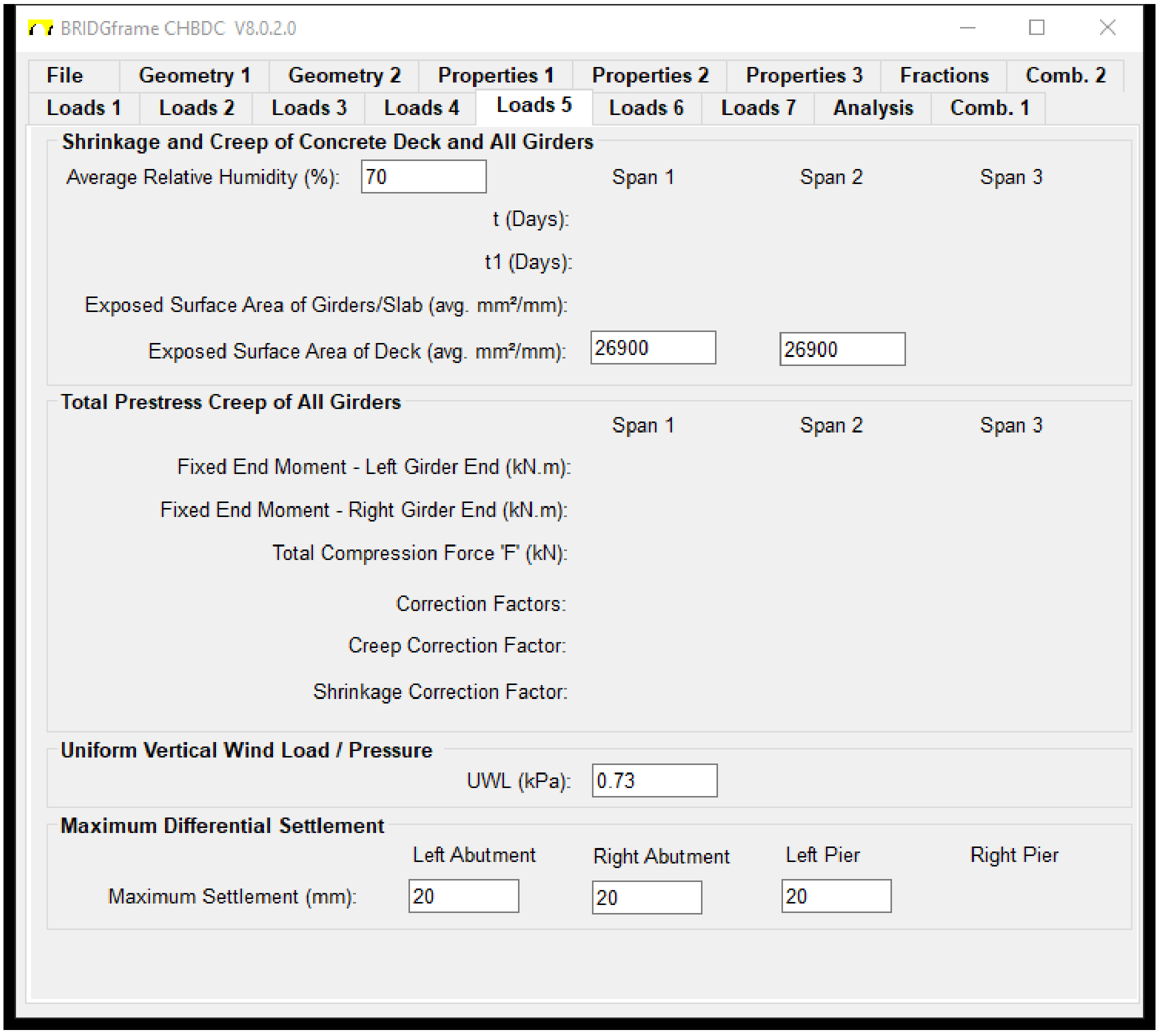

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Substructure Section Properties
Left Abutment
Right Abutment
Left Pier
Right Pier
Nmbr of Supports:
Thickness at Top (cm):
Thickness Bottom (cm):
Width (cm):
Radius (cm):
Abutment/Pier Concrete "f'c" (MPa):
Abutment/Pier Concrete Density (kg/m³):
Pile Properties
Name/Designation:
Number of Piles:
Moment of Inertia (cm^4)/Pile:
Young's Modulus of Piles (MPa):
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm

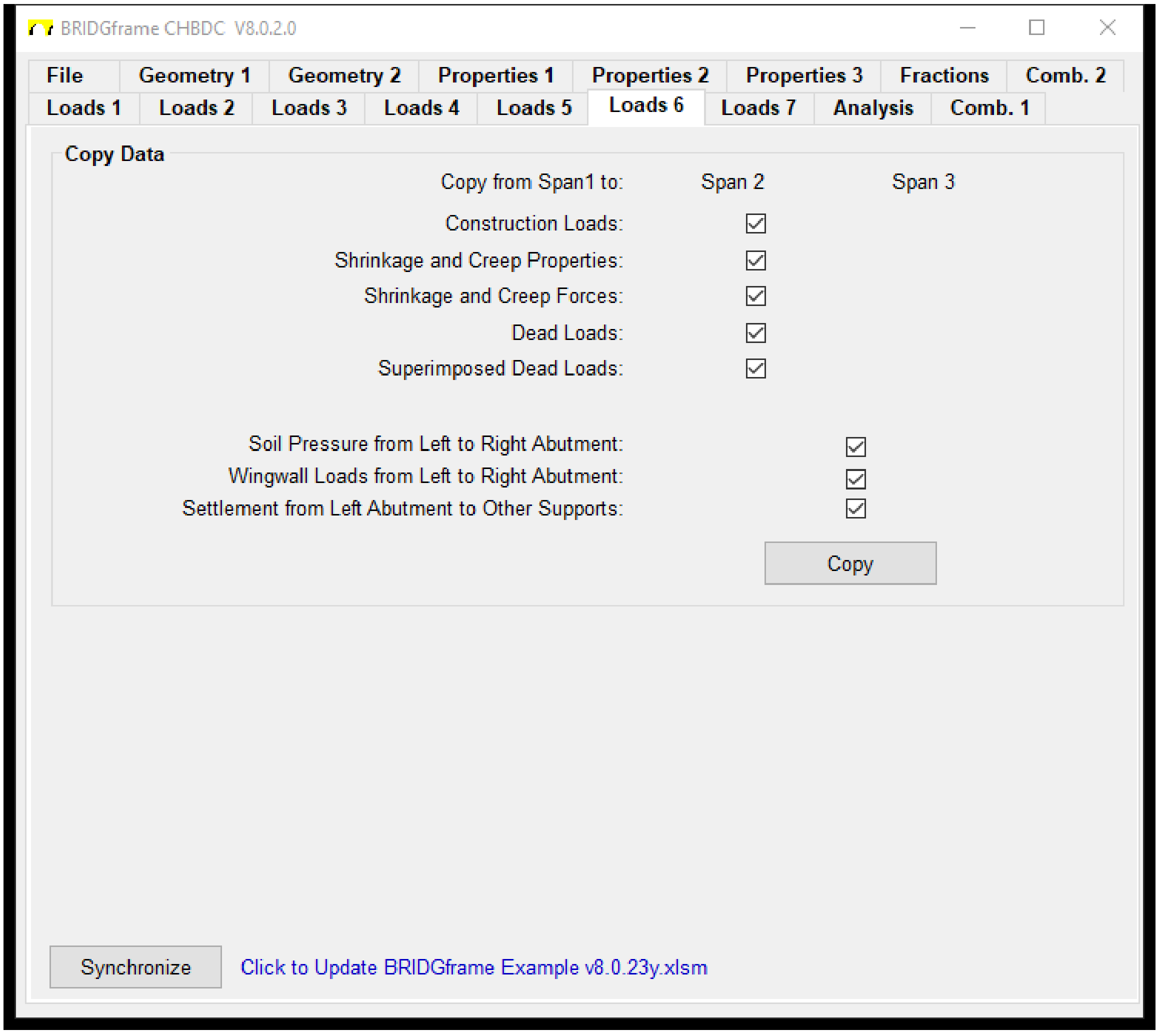

BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Construction Stage Loads over Bridge Width - UCL (kN/m)
Span 1
Span 2
Span 3
Dead Load (excluding girders & deck):
13
13
Live Load:
79
79
Dead Loads over Bridge Width (non-composite) - UDL (kN/m)
Span 1
Span 2
Span 3
Case 1:
Girders
40
40
Case 2:
Deck
145
145
Case 3:
Other
Uniform Superimposed Dead Loads over Bridge Width (composite) - USDL (kN/m)
Span 1
Span 2
Span 3
Case 1:
Barriers
14
14
Case 2:
Asphalt
55
55
Case 3:
Sidewalk(s)
Case 4:
Deck
Wingwall Loads
Left Abutment
Right Abutment
Moment (kN.m):
Moment (kN.m):
Vertical (kN):
Vertical (kN):

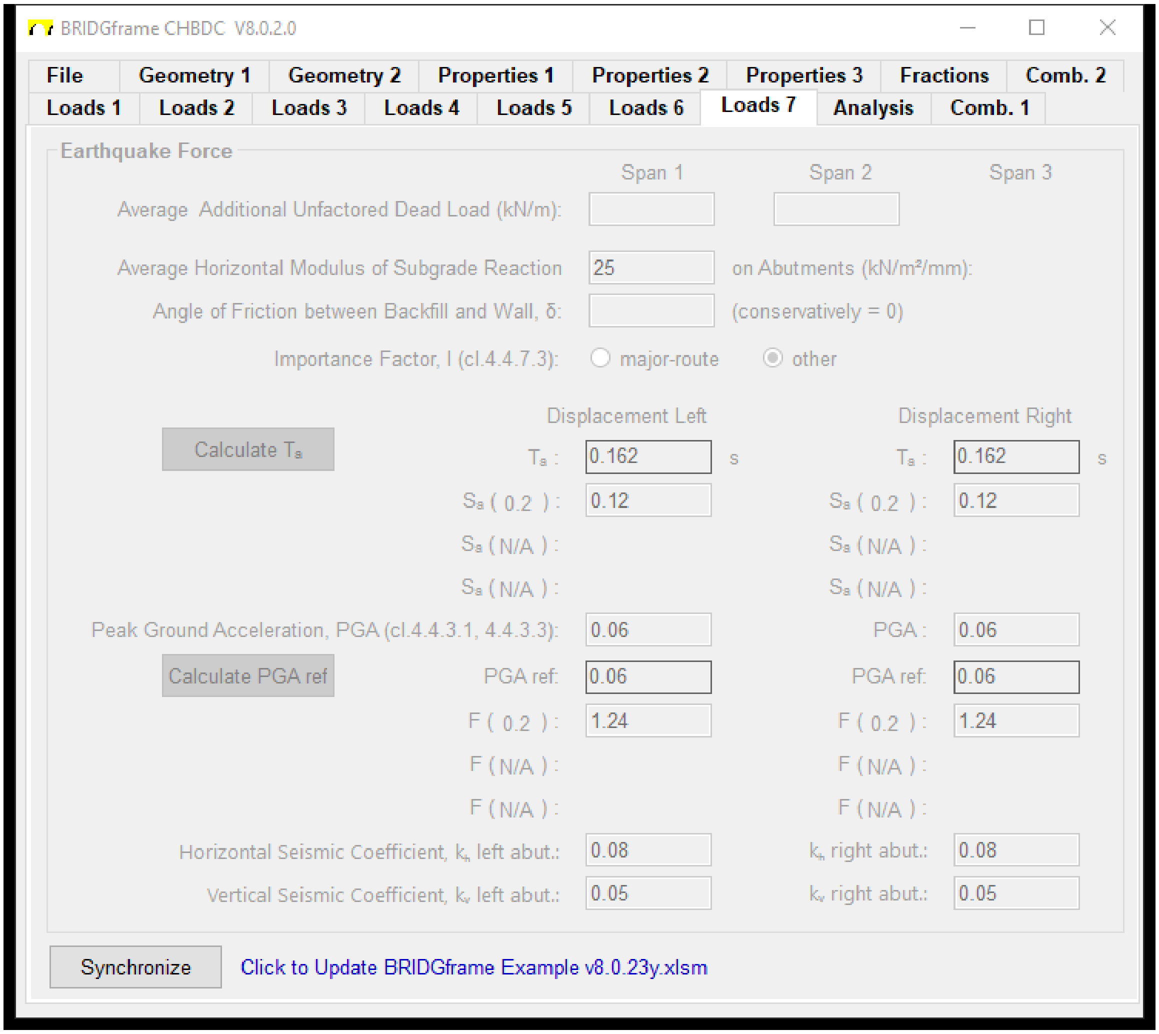

BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Pedestrian Load
Uniform Pedestrian Load per Span (kN/m):
Braking Force
Static Force (kN):
180
plus
10
% of UTL
Live (Truck) Load Case Groups
Truck CL-625
Truck CL-625-ONT
Truck BCL-625
Truck CL-750
Truck CL-800-AB
User Defined
Drop Axles Not Contributing To
Maximum Load Effect (cl.3.8.4.1)

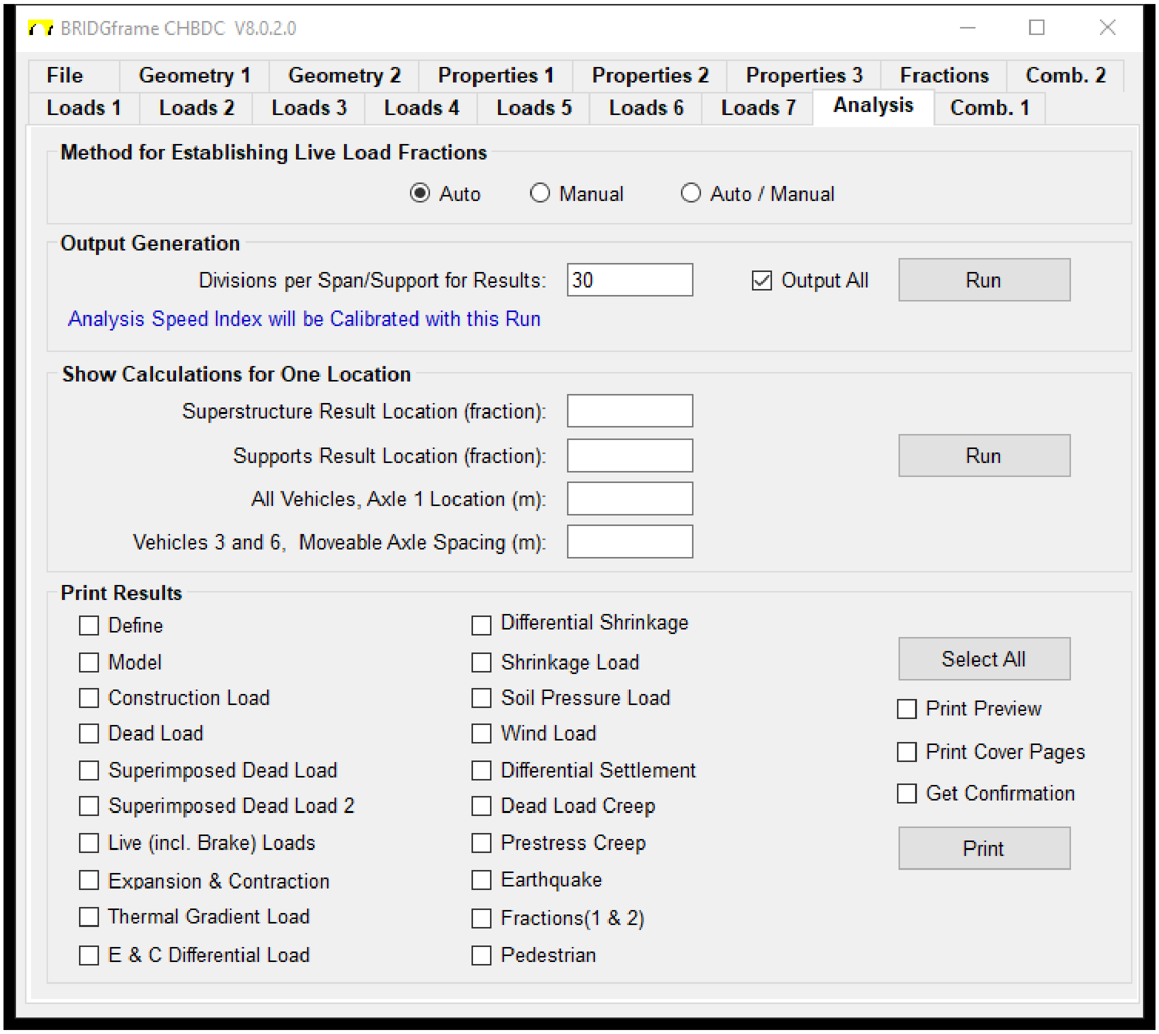

BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Truck Loads per Lane (kN)
Case 1 Case 2 Case 3 Case 4 Case 5 Case 6
Axle 1: 50 50 140 120
Axle 2: 140 140 140 175
Axle 3: 140 140 50 140
Axle 4: 175 140
Axle 5: 120 50
Axle Spacing (m)
Case 1 Case 2 Case 3 Case 4 Case 5 Case 6
Axle 1 to Axle 2: 3.6 3.6 1.2 6.6
Axle 2 to Axle 3: 1.2 1.2 3.6 6.6
Axle 3 to Axle 4: 6.6 1.2
Axle 4 to Axle 5: 6.6 3.6
Dynamic Load Allowance (1 + DLA): 1.3 1.25 1.3 1.25
Increment Length for Advancing Vehicles (m): 0.6
Fixed Vehicle Location (m):
Number of Design Lanes: 7
as per table 3.5
Lane Load per Lane - UTL (kN/m): 9
plus 80
% of Force Envelopes from Truck Loadings
Save User Defined Truck Load and Axle Spacing Values


BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Thermal Data for Superstructure
Maximum Daily Mean Temperature (°C):
30
Minimum Daily Mean Temperature (°C):
-32
Effective Construction Temperature (°C):
15
Coefficient Expansion/Contraction for:
Span 1
Span 2
Span 3
Use Default Values:
Deck (/°C):
0.000010
Girders or Slab (/°C):
0.000012
Soil Pressure Load over Bridge Width
Left Abut.
Right Abut.
Width of Exterior and Interior Soil Load (m):
Height of Interior Soil (m):
Active Soil Pressure at Exterior Top (kPa):
Total At-rest Pressure at Exterior Top (kPa):
Abutment Faces:
Interior
Exterior
Internal Friction Angle of Backfill φ (degrees):
Soil Density (kN/m³):
OCR (overconsolidation ratio):
(1 to 2)


BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Shrinkage and Creep of Concrete Deck and All Girders
Average Relative Humidity (%):
70
Span 1
Span 2
Span 3
t (Days):
t1 (Days):
Exposed Surface Area of Girders/Slab (avg. mm²/mm):
Exposed Surface Area of Deck (avg. mm²/mm):
26900
26900
Total Prestress Creep of All Girders
Span 1
Span 2
Span 3
Fixed End Moment - Left Girder End (kN.m):
Fixed End Moment - Right Girder End (kN.m):
Total Compression Force 'F' (kN):
Correction Factors:
Creep Correction Factor:
Shrinkage Correction Factor:
Uniform Vertical Wind Load / Pressure
UWL (kPa):
0.73
Maximum Differential Settlement
Left Abutment
Right Abutment
Left Pier
Right Pier
Maximum Settlement (mm):
20
20
20


BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Copy Data
Copy from Span1 to:
Span 2
Span 3
Construction Loads:
Shrinkage and Creep Properties:
Shrinkage and Creep Forces:
Dead Loads:
Superimposed Dead Loads:
Soil Pressure from Left to Right Abutment:
Wingwall Loads from Left to Right Abutment:
Settlement from Left Abutment to Other Supports:
Copy
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm


BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Earthquake Force
Span 1
Span 2
Span 3
Average Additional Unfactored Dead Load (kN/m):
Average Horizontal Modulus of Subgrade Reaction
25
on Abutments (kN/m²/mm):
Angle of Friction between Backfill and Wall, δ:
(conservatively = 0)
Importance Factor, I (cl.4.4.7.3):
major-route
other
Displacement Left
Displacement Right
Calculate Ts
Ts :
0.162
s
Sa (0.2) :
0.12
Sa (N/A) :
Sa (N/A) :
Peak Ground Acceleration, PGA (cl.4.4.3.1, 4.4.3.3):
0.06
PGA :
Calculate PGA ref
PGA ref:
F (0.2) :
1.24
F (N/A) :
F (N/A) :
Horizontal Seismic Coefficient, kh left abut.:
0.08
kh right abut.:
Vertical Seismic Coefficient, kv left abut.:
0.05
kv right abut.:
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm


BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Method for Establishing Live Load Fractions
Auto
Manual
Auto / Manual
Output Generation
Divisions per Span/Support for Results:
30
Output All
Run
Analysis Speed Index will be Calibrated with this Run
Show Calculations for One Location
Superstructure Result Location (fraction):
Supports Result Location (fraction):
Run
All Vehicles, Axle 1 Location (m):
Vehicles 3 and 6, Moveable Axle Spacing (m):
Print Results
Define
Differential Shrinkage
Model
Shrinkage Load
Select All
Construction Load
Soil Pressure Load
Print Preview
Dead Load
Wind Load
Print Cover Pages
Superimposed Dead Load
Differential Settlement
Get Confirmation
Superimposed Dead Load 2
Dead Load Creep
Live (incl. Brake) Loads
Prestress Creep
Print
Expansion & Contraction
Earthquake
Thermal Gradient Load
Fractions(1 & 2)
E & C Differential Load
Pedestrian

APPENDIX 4 – 3 SPAN INTEGRAL ABUTMENT PRESTRESSED GIRDERS

Bridge Geometry

Structure Type: Integral abutments with horizontal joint at pier top.
Concrete composite deck with simple span prestressed girders
for dead load made continuous.

Spans: 3 spans; 2 end spans of 24.0 m and center span of 33.0 m

Deck: 11.445 m total width x 225 mm thick (65 kN/m).
9.10 m barrier inside face to curb face of sidewalk.
2 travelled lanes at 3.25 m.
2 side clearances at 1.30 m.
2 design lanes.
1073 mm overhang from centerline of exterior girder to edge of deck.
90mm asphalt and waterproofing (19 kN/m).
1.8 m x 270 mm sidewalk (11.7 kN/m)
Sidewalk load: p=5.0 – s/30
5.0 – (2 x 24 + 33) / 30 = 2.3 kPa
1.5m sidewalk x 2.3 x 80% = 2.8 kN/m

Barriers: 1 - NewJersey Barrier 495 mm at base (6.7 kN/m), 1 – Parapet Wall (5.5 kN/m)

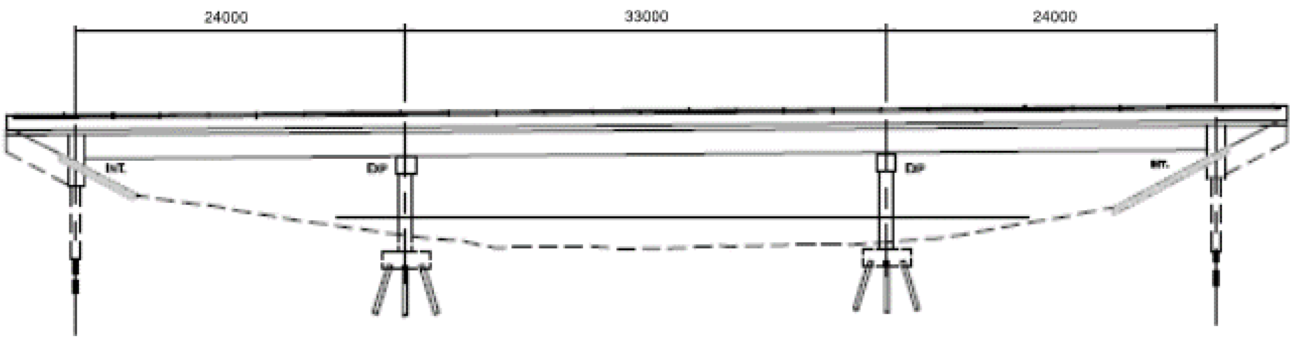
Girders: 5 – CPCI 1600 spaced at 2.3 m (65 kN/m)

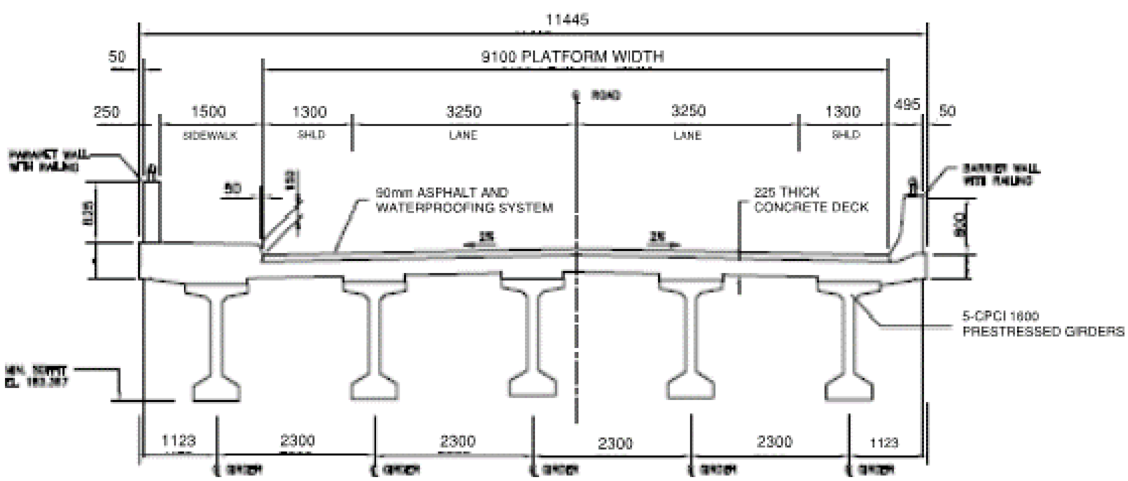
Abutments: 3.0 m high x 1.2 m thick x 11.345 m wide

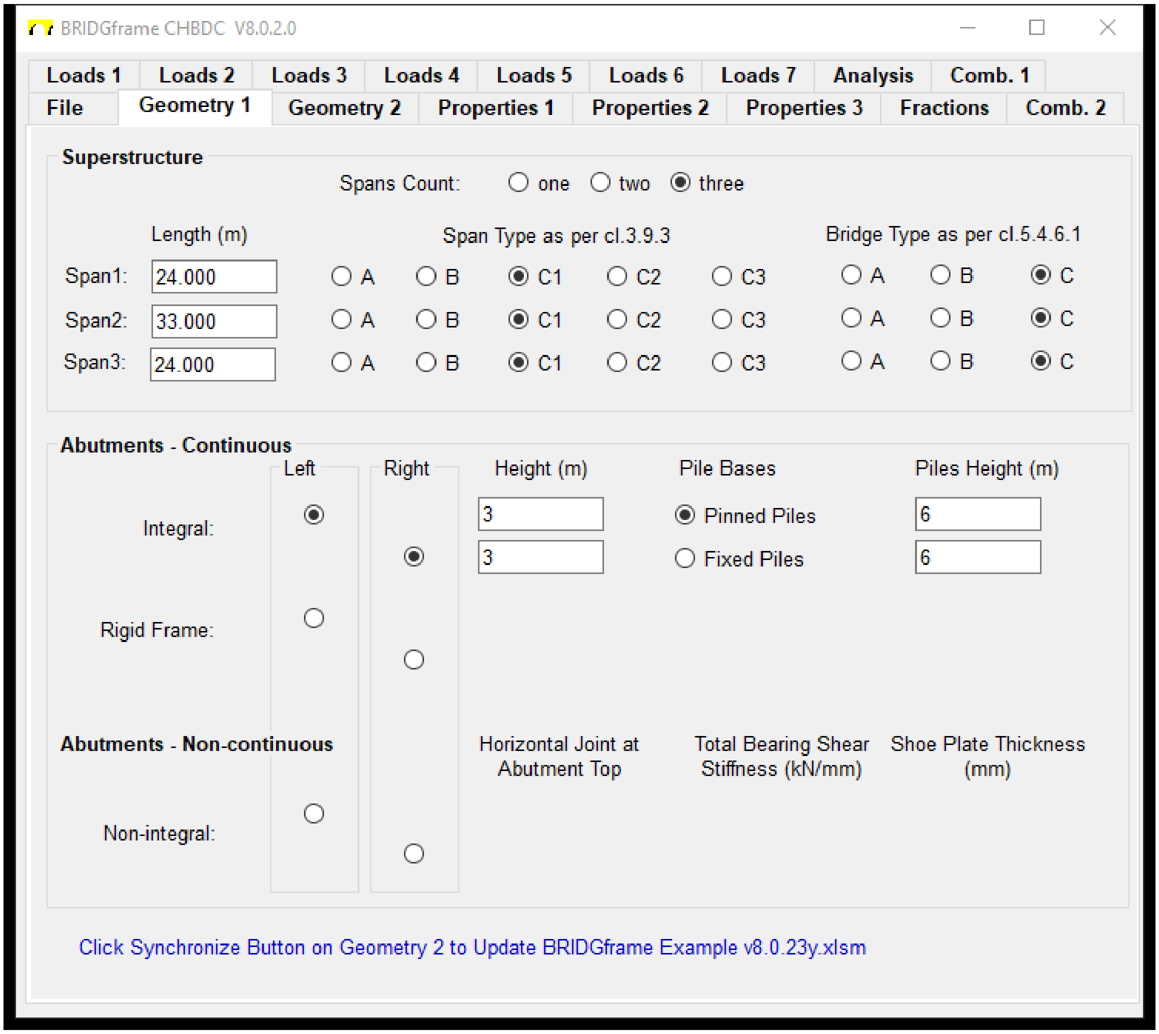
Piles: 7 – HP310 x 110 in strong direction, Ix
6.0 m from underside of abutment to fixed base of model.
Number of piles may be assumed for initial program analysis. Sum loadings on piles after initial run and adjust number of piles accordingly.

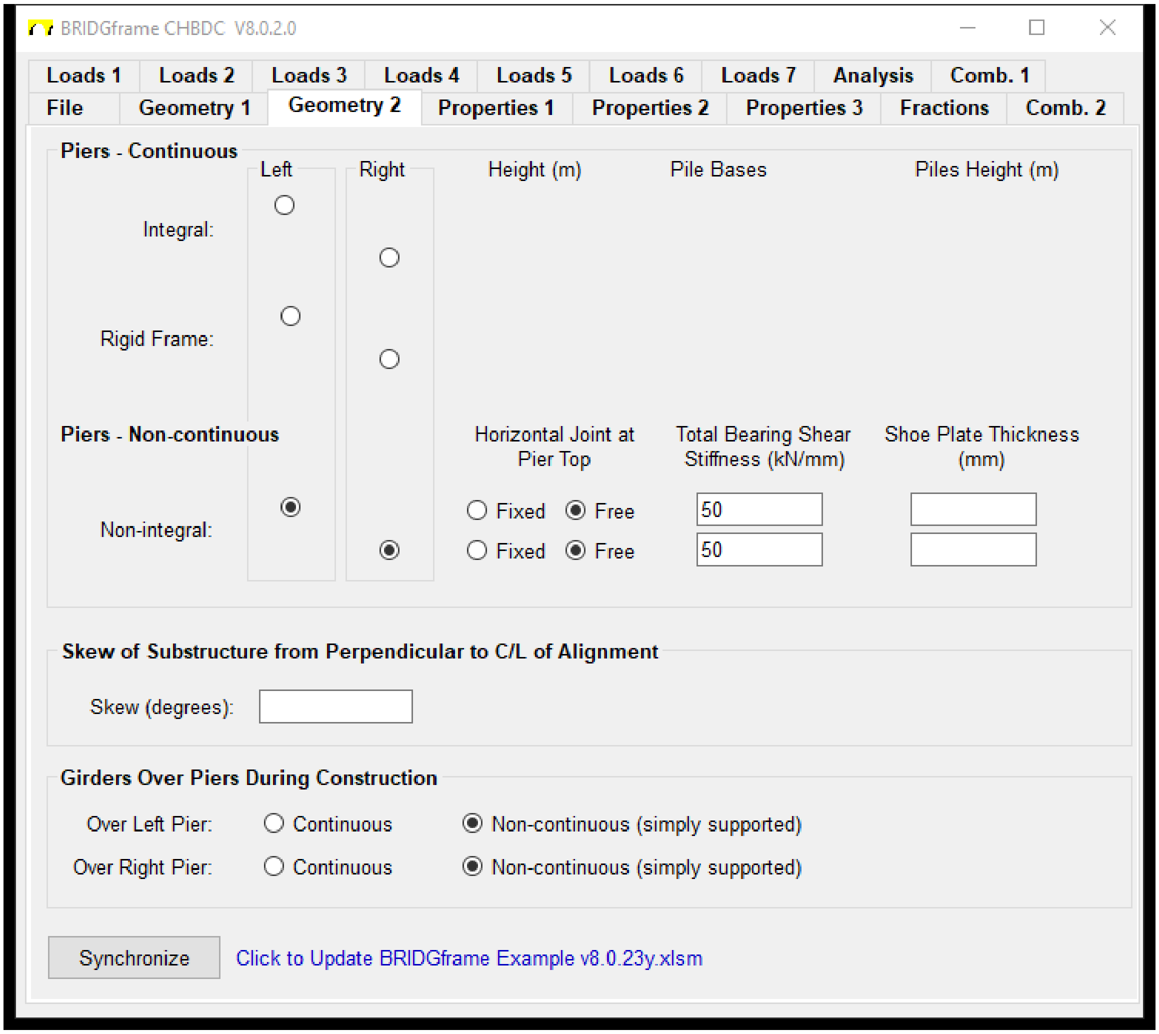
Wingwalls: Two wingwalls loading per abutment (includes barriers on wingwalls)
See Appendix 13.

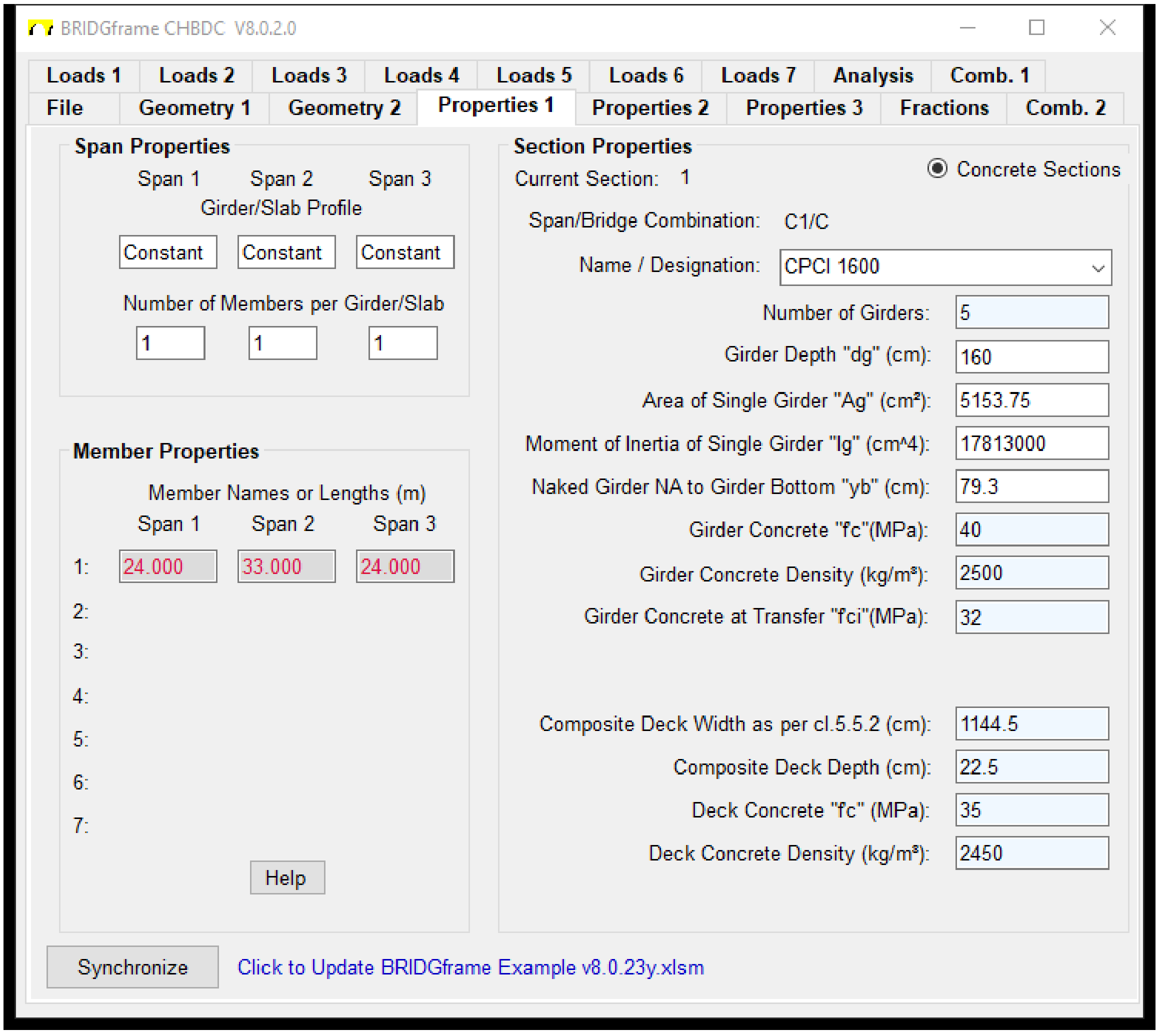
Vertical (gravity load) (354 kN)
Moment (863 kN.m)


24000
33000
24000
INT.
EXP
EXP
INT.

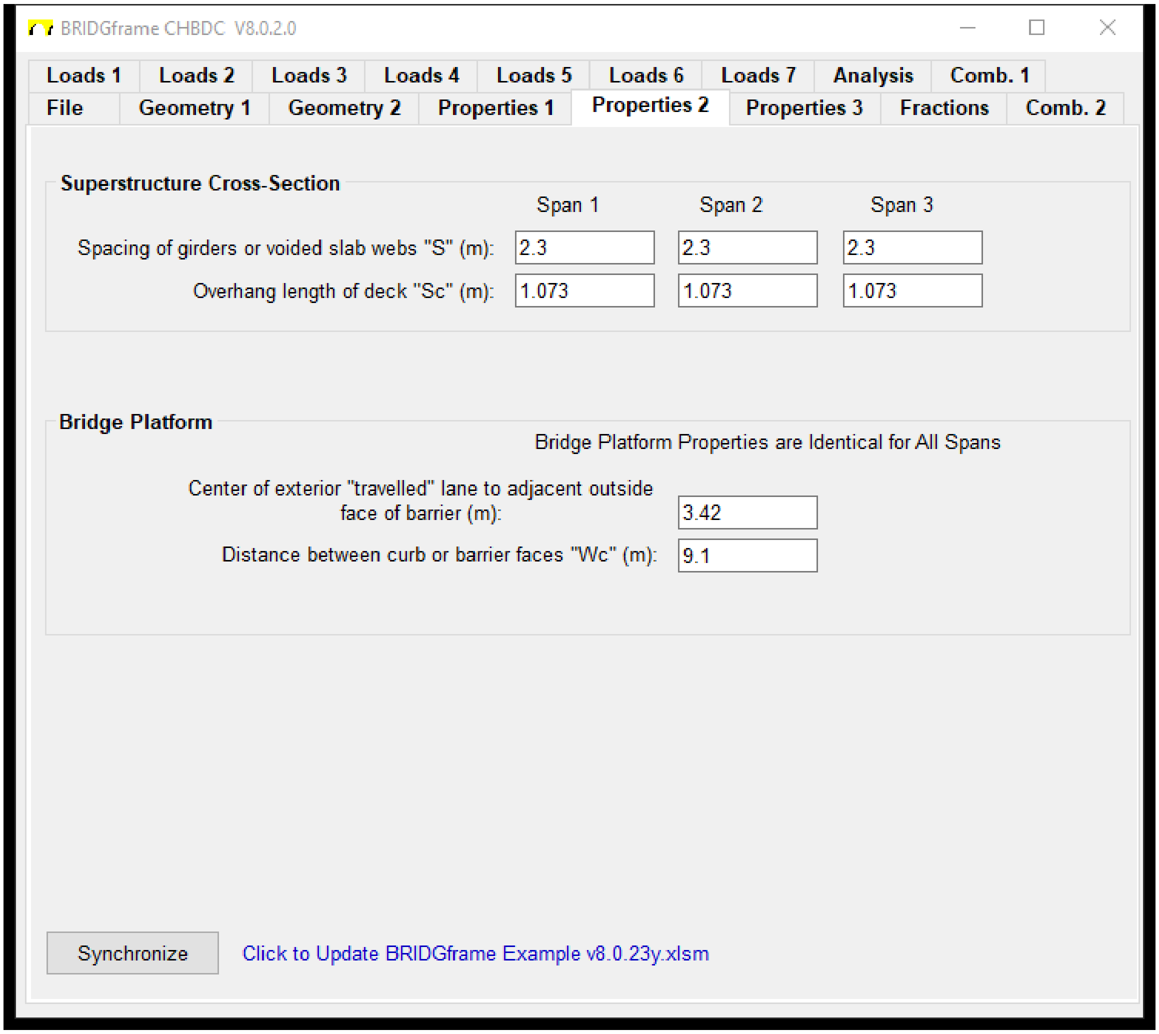

11445
9100 PLATFORM WIDTH
50
250
1500
SIDEWALK
1300
SHLD
3250
LANE
3250
LANE
1300
SHLD
495
50
90mm ASPHALT AND
WATERPROOFING SYSTEM
225 THICK
CONCRETE DECK
5-CPCI 1600
PRESTRESSED GIRDERS
835
800
50
2%
2%
1123
2300
2300
2300
2300
1123

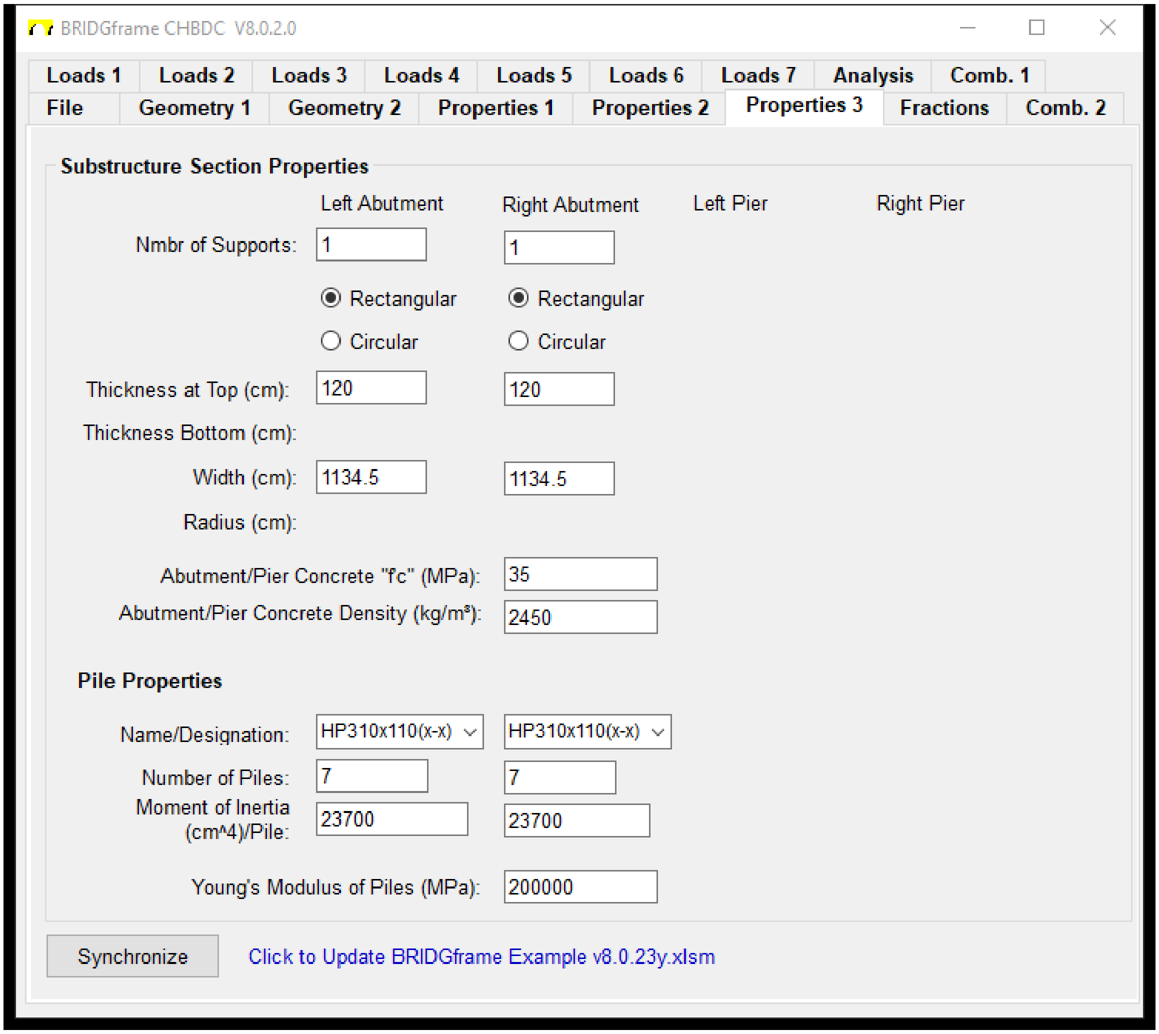

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Superstructure
Spans Count: one two three
Length (m)
Span Type as per cl.3.9.3
Bridge Type as per cl.5.4.6.1
Span1: 24.000 A B C1 C2 C3 A B C
Span2: 33.000 A B C1 C2 C3 A B C
Span3: 24.000 A B C1 C2 C3 A B C
Abutments - Continuous
Left
Right
Height (m)
Pile Bases
Piles Height (m)
Integral:
3
3
Pinned Piles
Fixed Piles
6
6
Rigid Frame:
Abutments - Non-continuous
Horizontal Joint at Abutment Top
Total Bearing Shear Stiffness (kN/mm)
Shoe Plate Thickness (mm)
Non-integral:
Click Synchronize Button on Geometry 2 to Update BRIDGframe Example v8.0.23y.xlsm

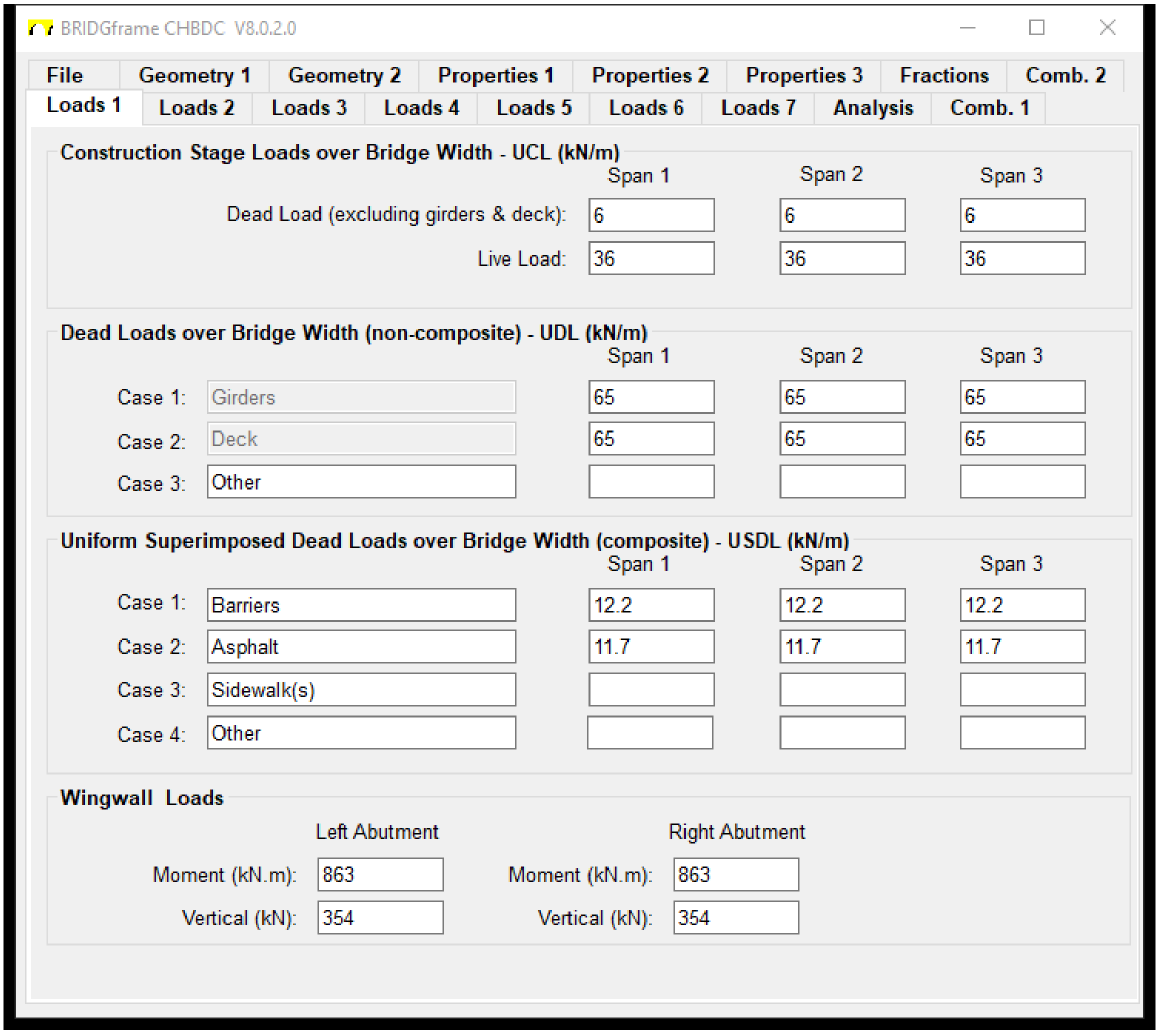

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Piers - Continuous
Left
Right
Height (m)
Pile Bases
Piles Height (m)
Integral:
Rigid Frame:
Piers - Non-continuous
Horizontal Joint at Pier Top
Total Bearing Shear Stiffness (kN/mm)
Shoe Plate Thickness (mm)
Non-integral:
Fixed
Free
50
Fixed
Free
50
Skew of Substructure from Perpendicular to C/L of Alignment
Skew (degrees):
Girders Over Piers During Construction
Over Left Pier:
Continuous
Non-continuous (simply supported)
Over Right Pier:
Continuous
Non-continuous (simply supported)
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm

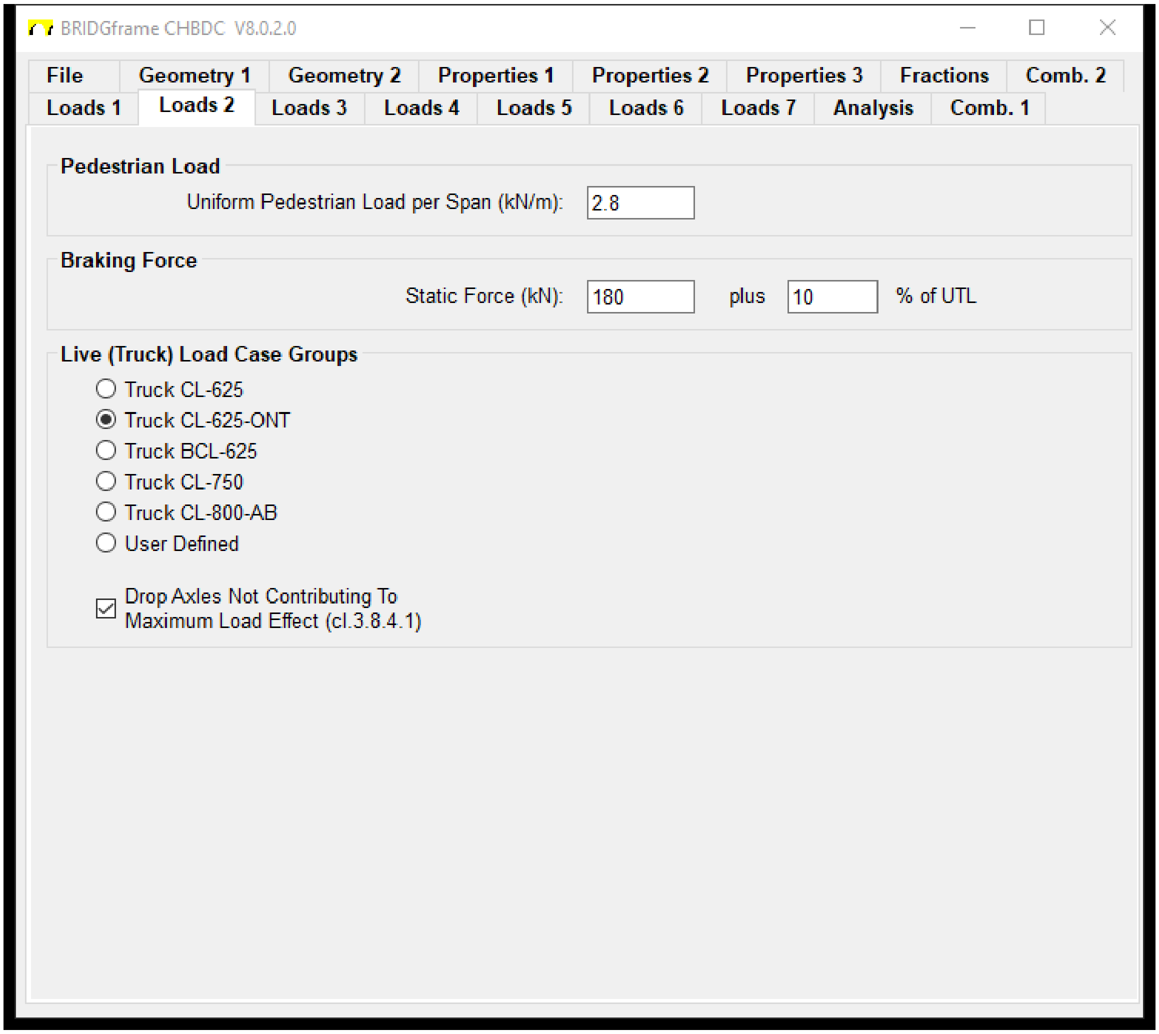


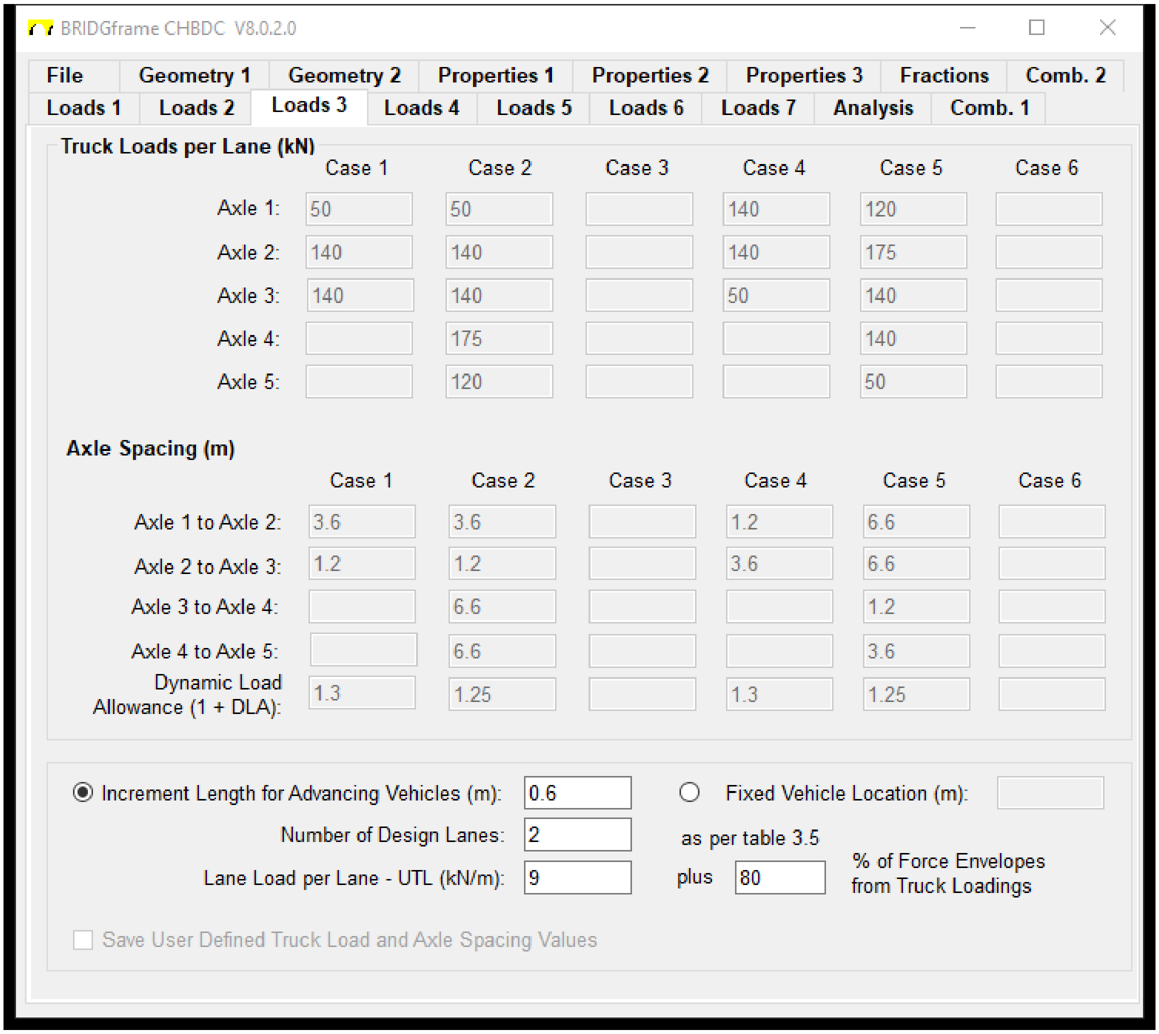
- Use the Actions pop up, select Modify, and select the Current radio button to group all member properties boxes to that of one selection

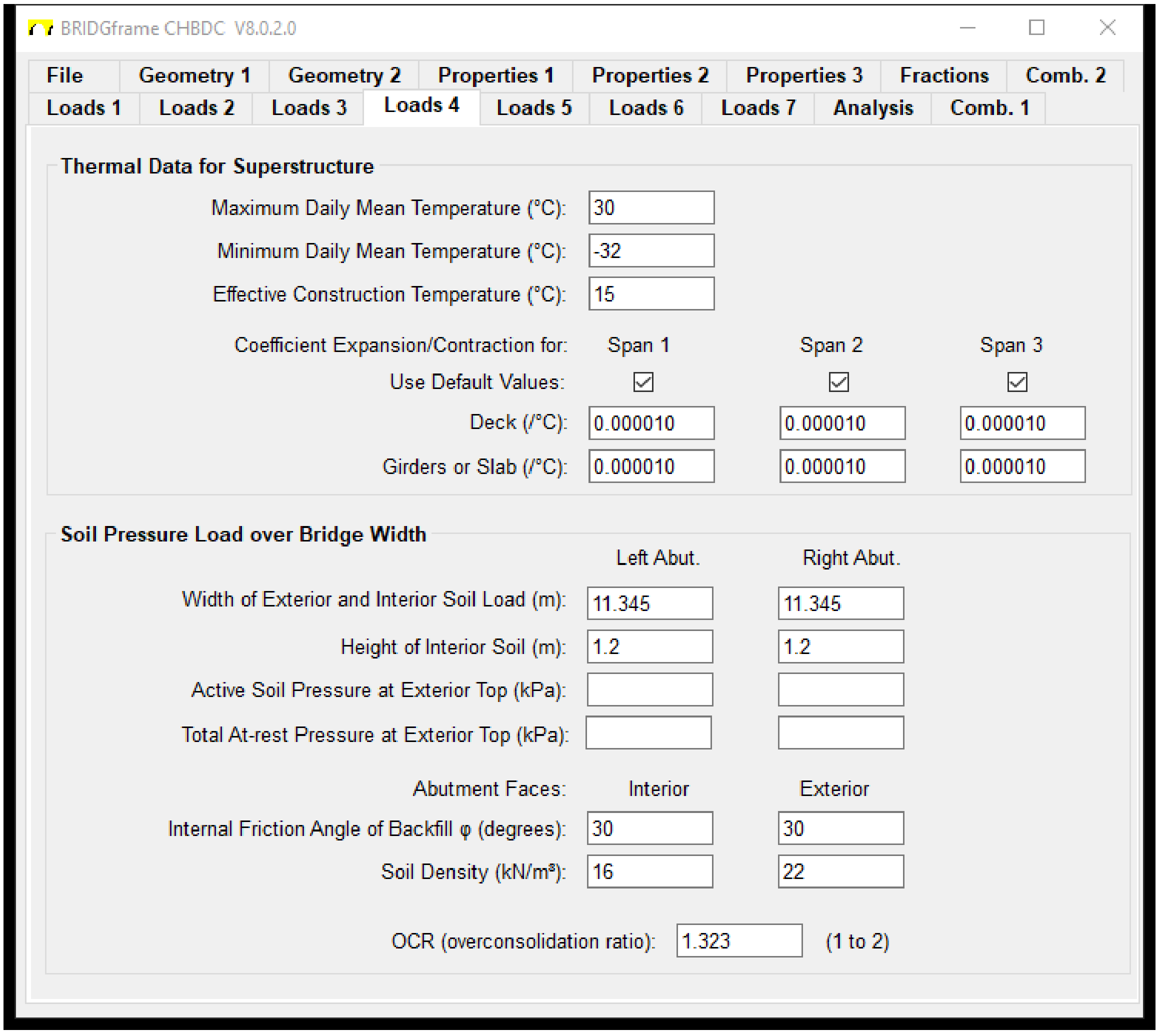

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Superstructure Cross-Section
Span 1
Span 2
Span 3
Spacing of girders or voided slab webs "S" (m):
2.3
2.3
2.3
Overhang length of deck "Sc" (m):
1.073
1.073
1.073
Bridge Platform
Bridge Platform Properties are Identical for All Spans
Center of exterior "travelled" lane to adjacent outside face of barrier (m):
3.42
Distance between curb or barrier faces "Wc" (m):
9.1
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm


BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Substructure Section Properties
Left Abutment
Right Abutment
Left Pier
Right Pier
Nmbr of Supports:
1
1
Rectangular
Rectangular
Circular
Circular
Thickness at Top (cm):
120
120
Thickness Bottom (cm):
Width (cm):
1134.5
1134.5
Radius (cm):
Abutment/Pier Concrete "f'c" (MPa):
35
Abutment/Pier Concrete Density (kg/m³):
2450
Pile Properties
Name/Designation:
HP310x110(x-x)
HP310x110(x-x)
Number of Piles:
7
7
Moment of Inertia (cm^4)/Pile:
23700
23700
Young's Modulus of Piles (MPa):
200000
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm

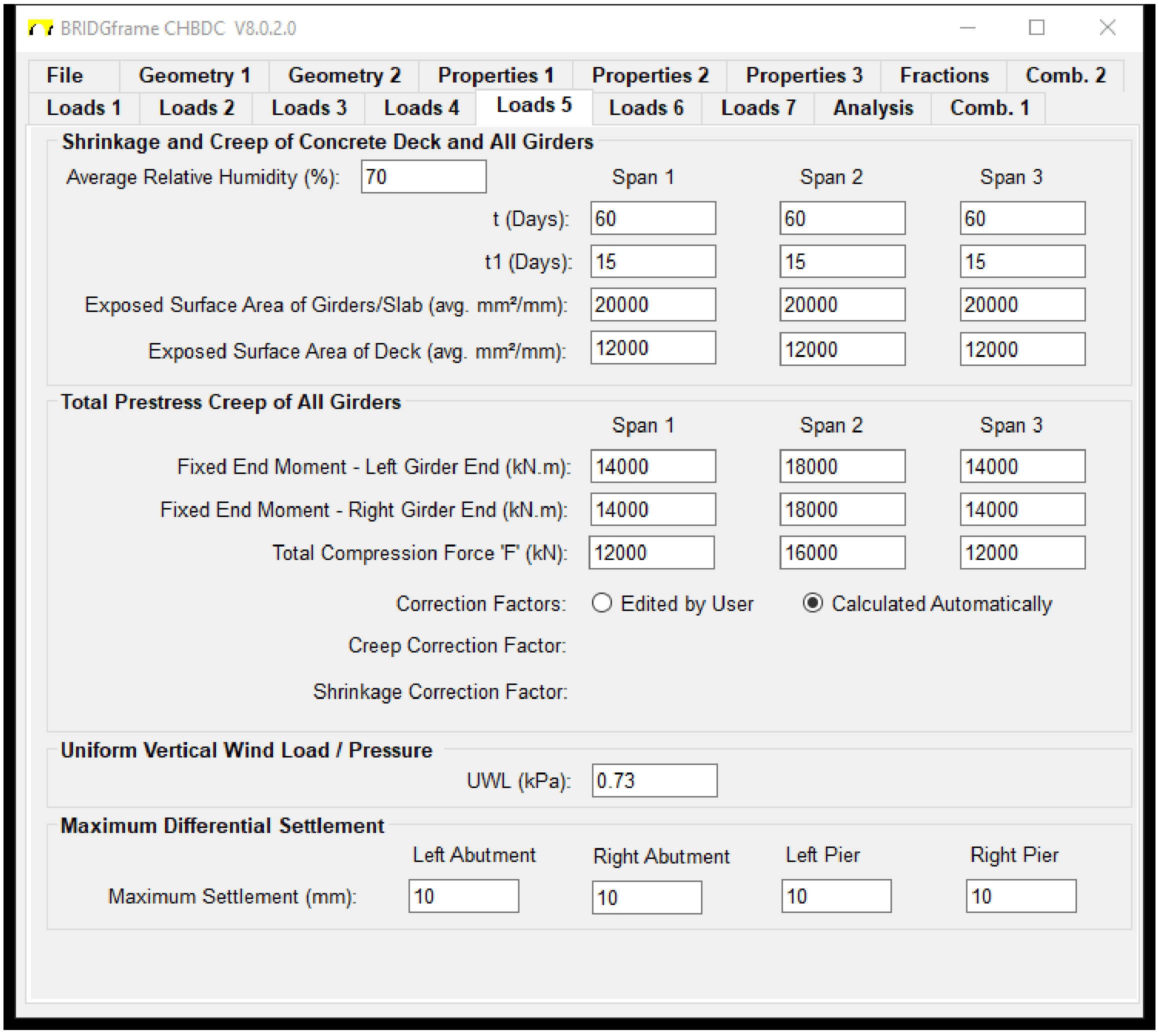

BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Construction Stage Loads over Bridge Width - UCL (kN/m)
Span 1
Span 2
Span 3
Dead Load (excluding girders & deck): 6 6 6
Live Load: 36 36 36
Dead Loads over Bridge Width (non-composite) - UDL (kN/m)
Span 1
Span 2
Span 3
Case 1: Girders 65 65 65
Case 2: Deck 65 65 65
Case 3: Other
Uniform Superimposed Dead Loads over Bridge Width (composite) - USDL (kN/m)
Span 1
Span 2
Span 3
Case 1: Barriers 12.2 12.2 12.2
Case 2: Asphalt 11.7 11.7 11.7
Case 3: Sidewalk(s)
Case 4: Other
Wingwall Loads
Left Abutment
Right Abutment
Moment (kN.m): 863
Vertical (kN): 354
Moment (kN.m): 863
Vertical (kN): 354


BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Pedestrian Load
Uniform Pedestrian Load per Span (kN/m):
2.8
Braking Force
Static Force (kN):
180
plus
10
% of UTL
Live (Truck) Load Case Groups
Truck CL-625
Truck CL-625-ONT
Truck BCL-625
Truck CL-750
Truck CL-800-AB
User Defined
Drop Axles Not Contributing To Maximum Load Effect (cl.3.8.4.1)

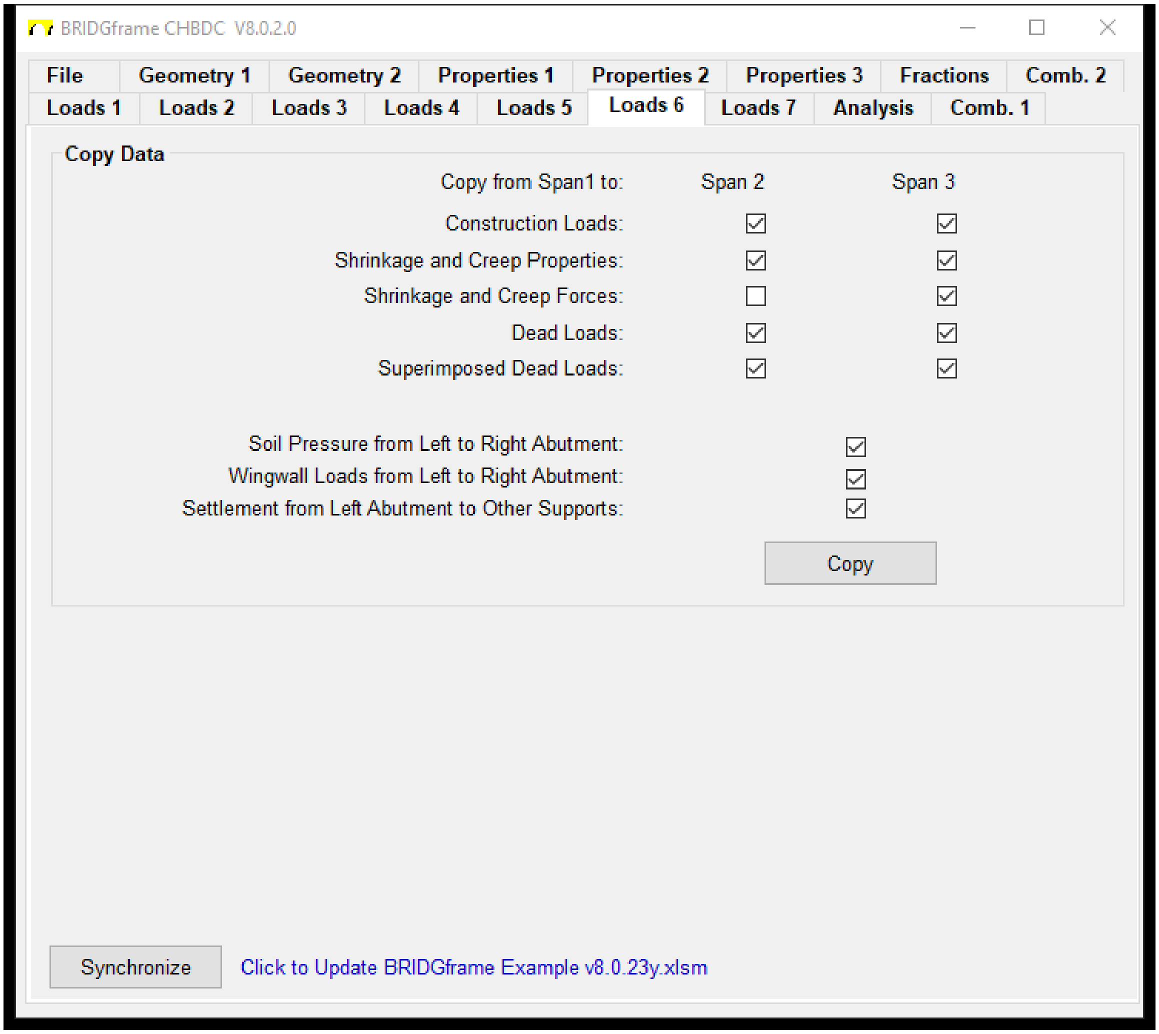

BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Truck Loads per Lane (kN)
Case 1
Case 2
Case 3
Case 4
Case 5
Case 6
Axle 1: 50 50 140 120
Axle 2: 140 140 140 175
Axle 3: 140 140 50 140
Axle 4: 175 140
Axle 5: 120 50
Axle Spacing (m)
Case 1
Case 2
Case 3
Case 4
Case 5
Case 6
Axle 1 to Axle 2: 3.6 3.6 1.2 6.6
Axle 2 to Axle 3: 1.2 1.2 3.6 6.6
Axle 3 to Axle 4: 6.6 1.2
Axle 4 to Axle 5: 6.6 3.6
Dynamic Load Allowance (1 + DLA): 1.3 1.25 1.3 1.25
Increment Length for Advancing Vehicles (m): 0.6
Fixed Vehicle Location (m):
Number of Design Lanes: 2
as per table 3.5
Lane Load per Lane - UTL (kN/m): 9
plus 80
% of Force Envelopes from Truck Loadings
Save User Defined Truck Load and Axle Spacing Values



- Active Soil Pressure at Exterior Top and Total At-rest Pressure at Exterior Top may be included. See paragraph 2 of 5.4.9 and Appendix 4 – Concrete Rigid Parabolic Soffit, Loads 4 screen print

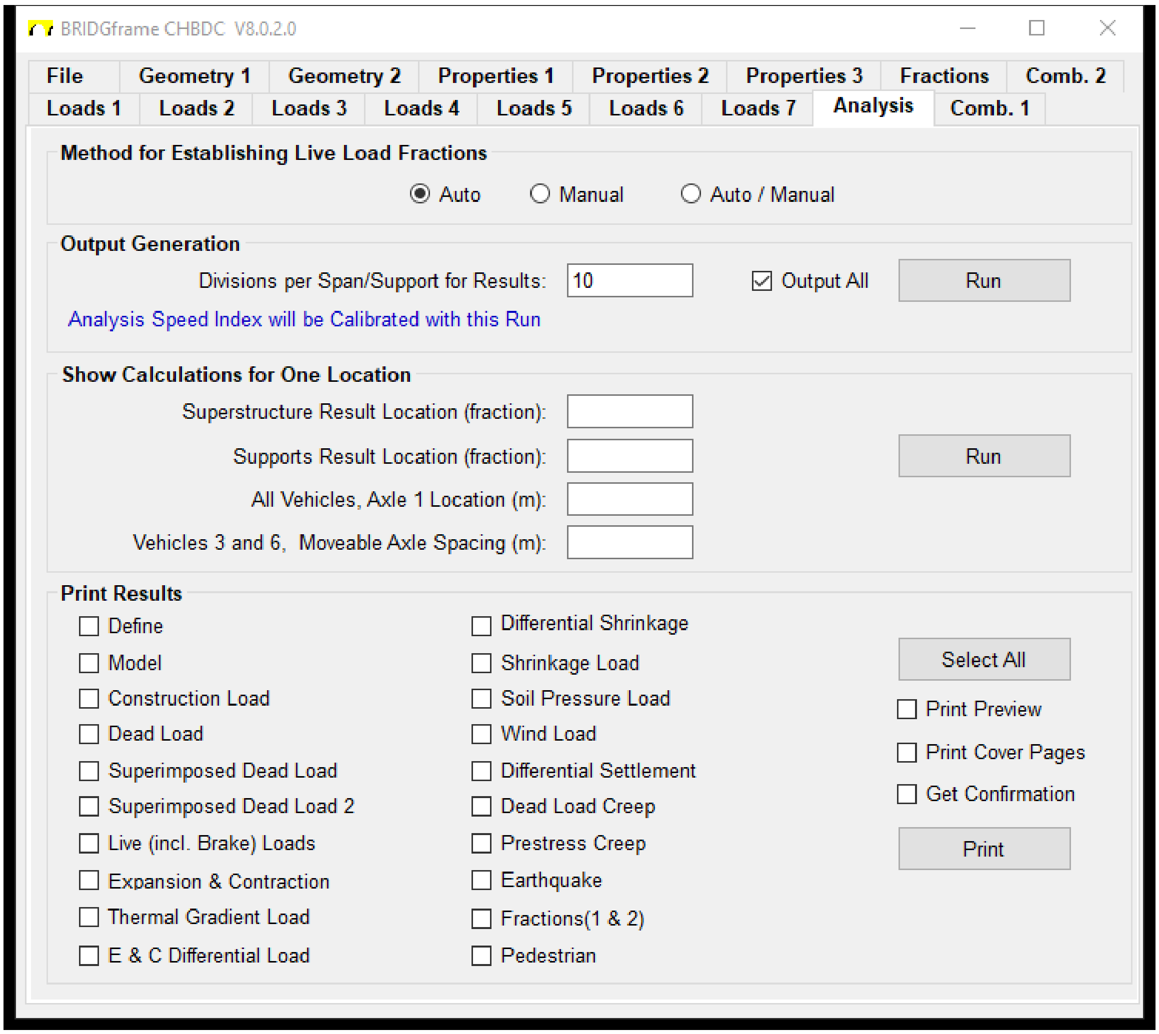


- Creep effects entered as per Method A of 5.4.11
- Creep correction factor may be calculated automatically by the program or manually entered by the User
- Also refer to Method B of 5.4.11



- Shrinkage and Creep Forces were not copied from Span 1 to Span 2.

Loads 7: See Appendix 17.



APPENDIX 4 – SIDE-BY-SIDE PRESTRESSED BOX GIRDERS

Bridge Geometry

Structure Type: Simply supported side-by-side prestressed box girders with composite distribution slab

Spans: 1 span at 27.35 m (use 27.45 m)

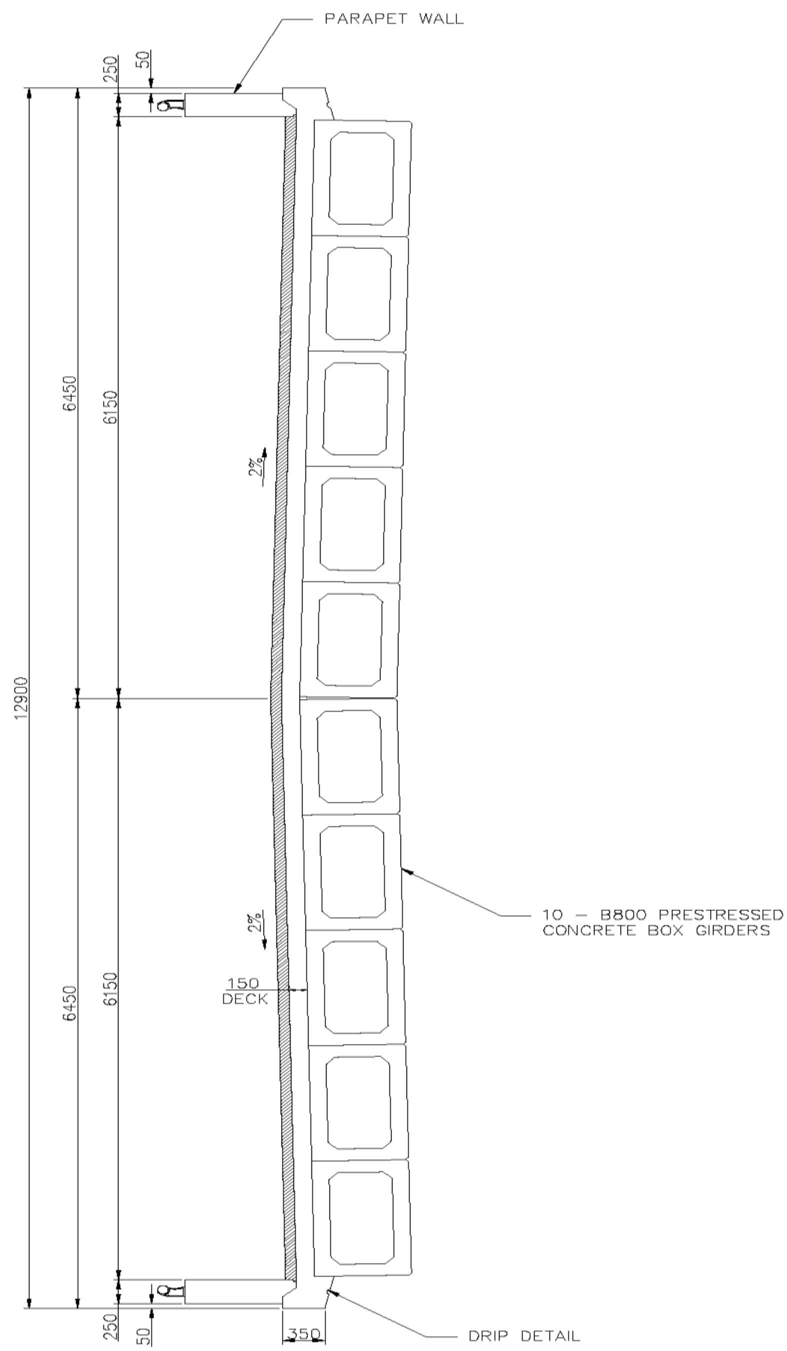
Deck: 12.9 m total width x 150 mm thick (48.8 kN/m).
12.3 m barrier inside face to barrier inside face.
2 travelled lanes at 3.65 m.
2 side clearances at 2.5 m.
2 or 3 design lanes at 6.15m or 4.1m respectively.
90mm asphalt and waterproofing (24.9 kN/m).

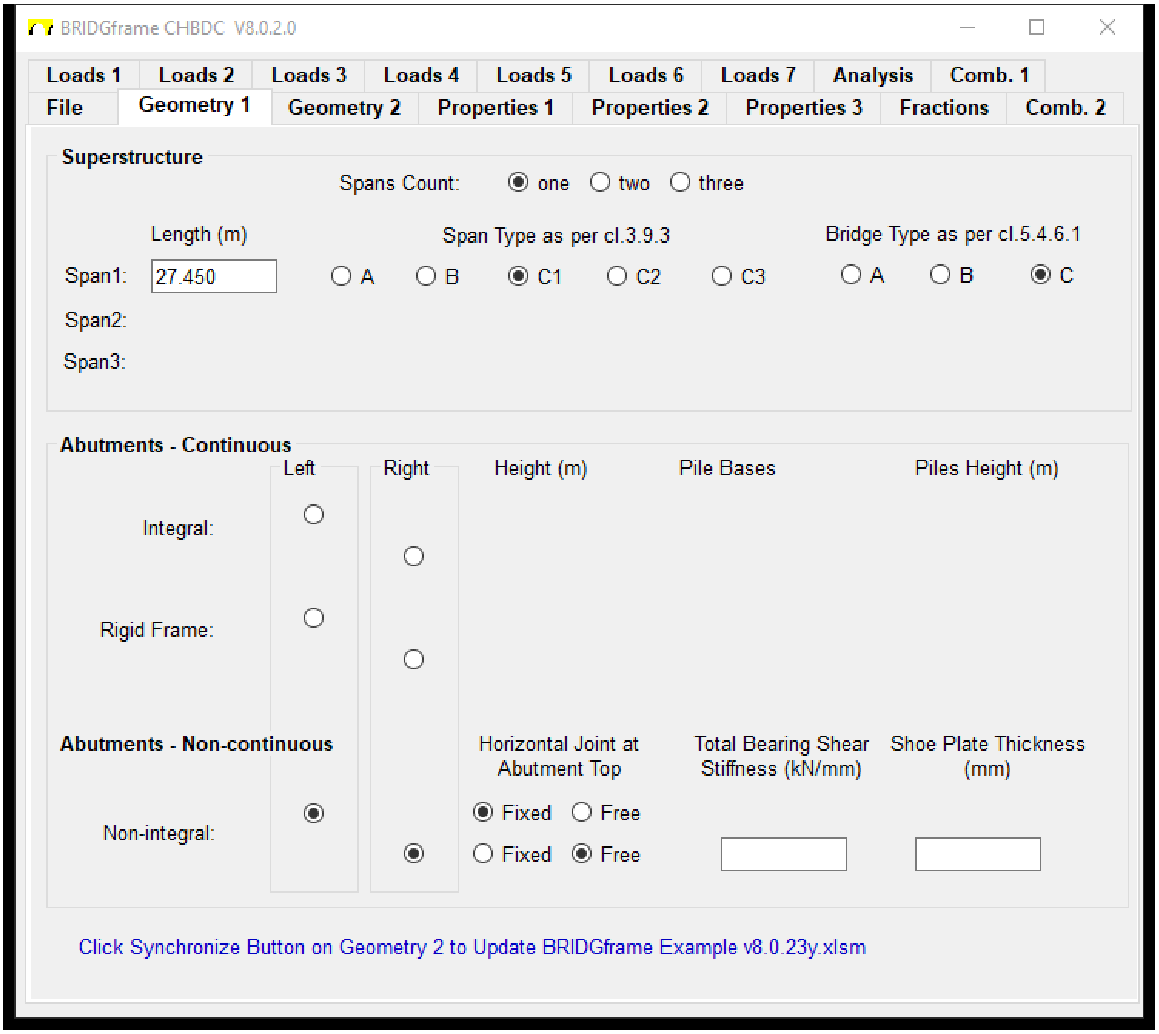
Barriers: Parapet walls 250 mm wide (10.8 kN/m)

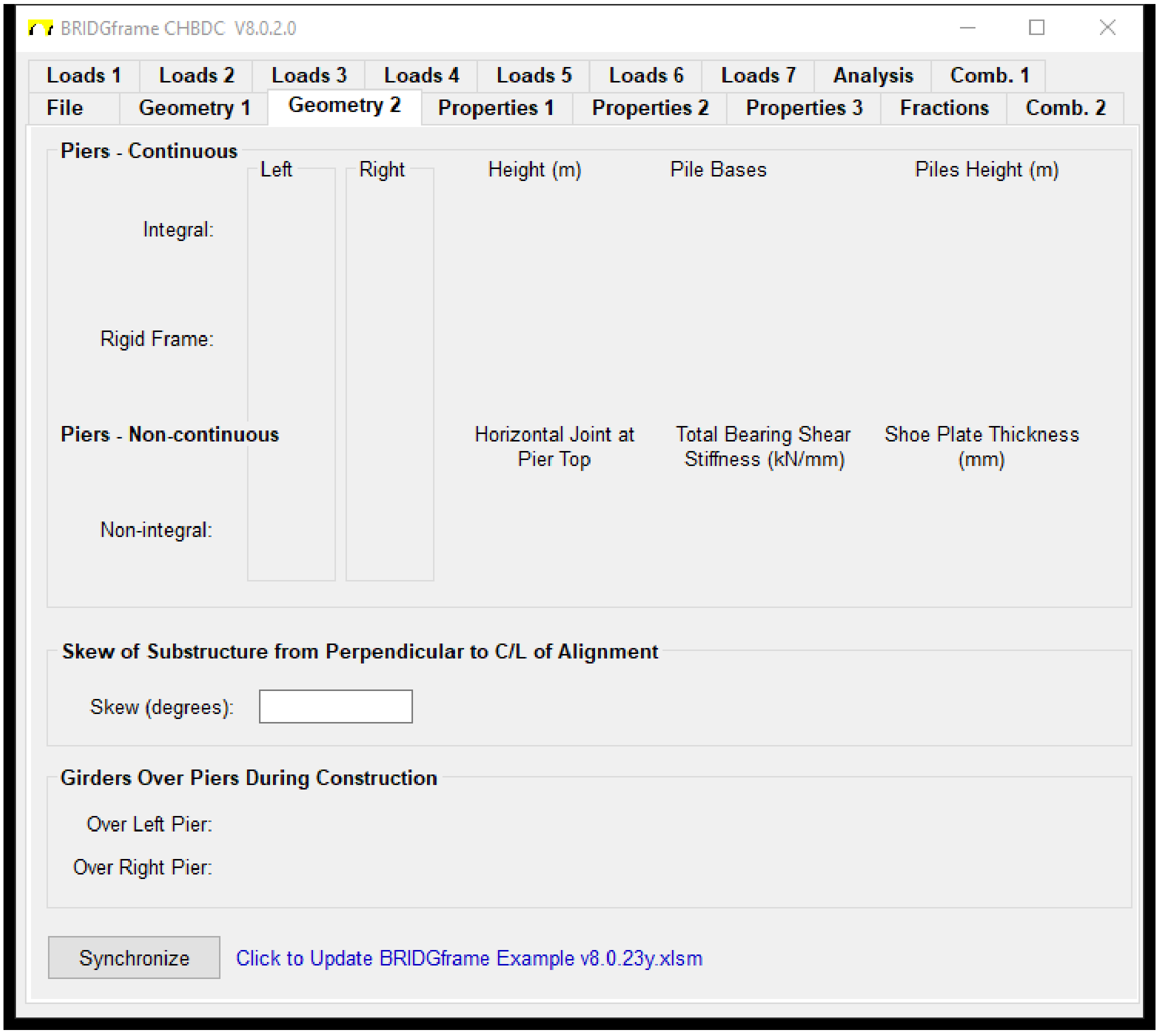
Beams: 10 – B 800, 1220 mm wide (118.3 kN/m)

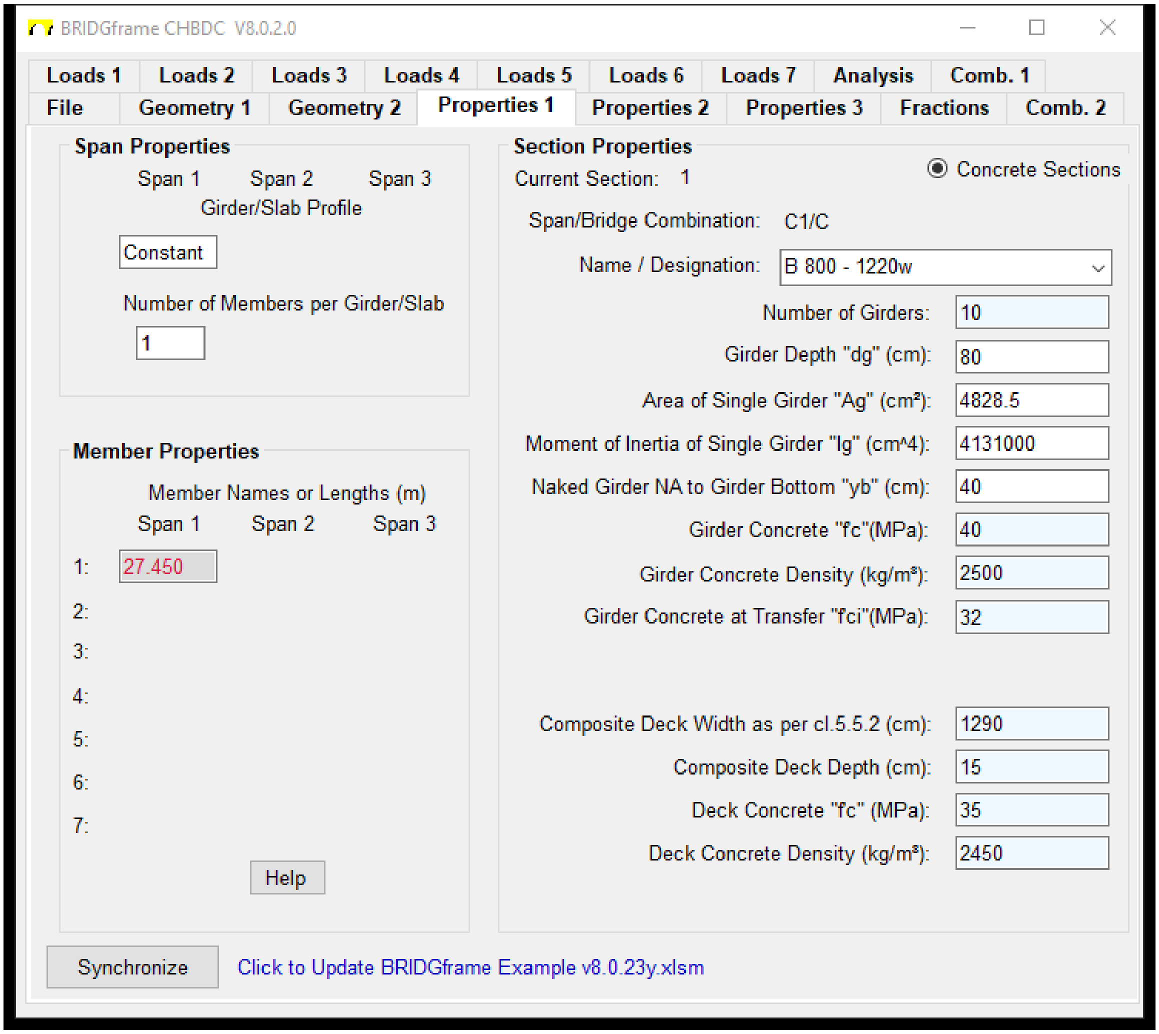
Note: 3 lane model governed over 2 lane model, therefore use 3 – 3.35 m lanes and 2 – 1.125 m side clearances (assumed).

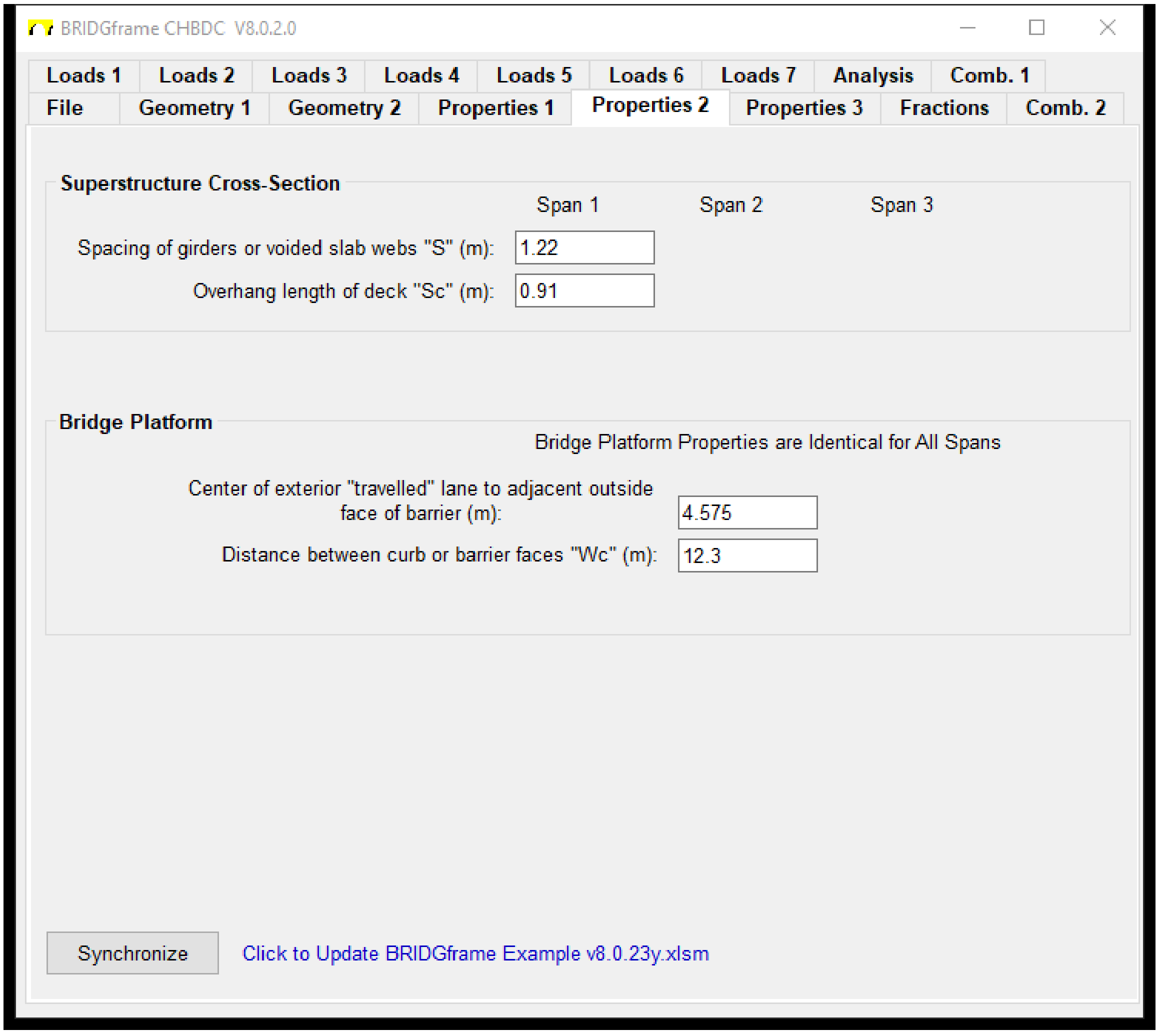
Note: Non-integral model provided. If semi-integral model required, input may be done as per Appendix 12.

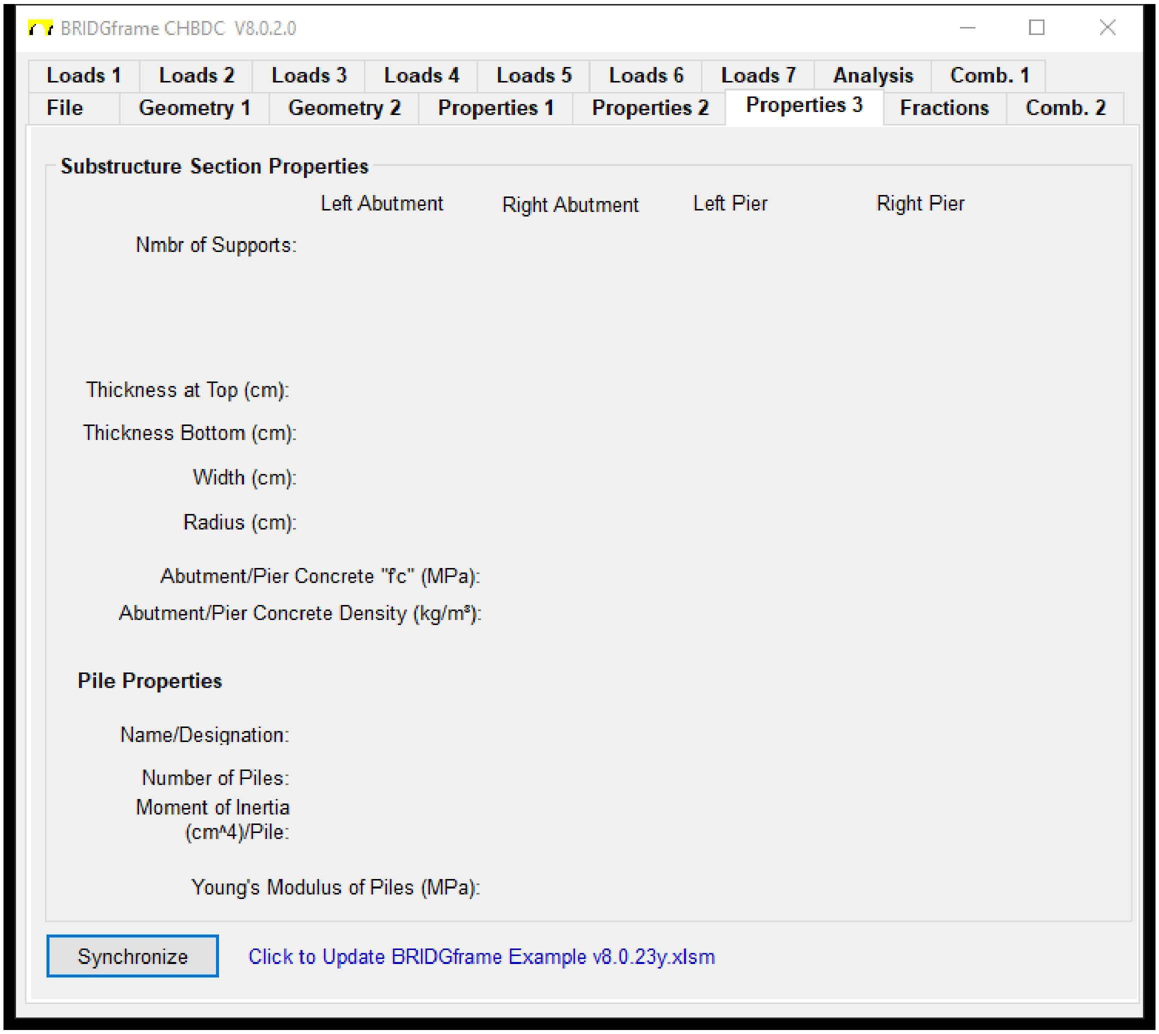

PARAPET WALL
250
50
6450
6150
12900
2%
2%
150
DECK
10 – B800 PRESTRESSED
CONCRETE BOX GIRDERS
350
DRIP DETAIL

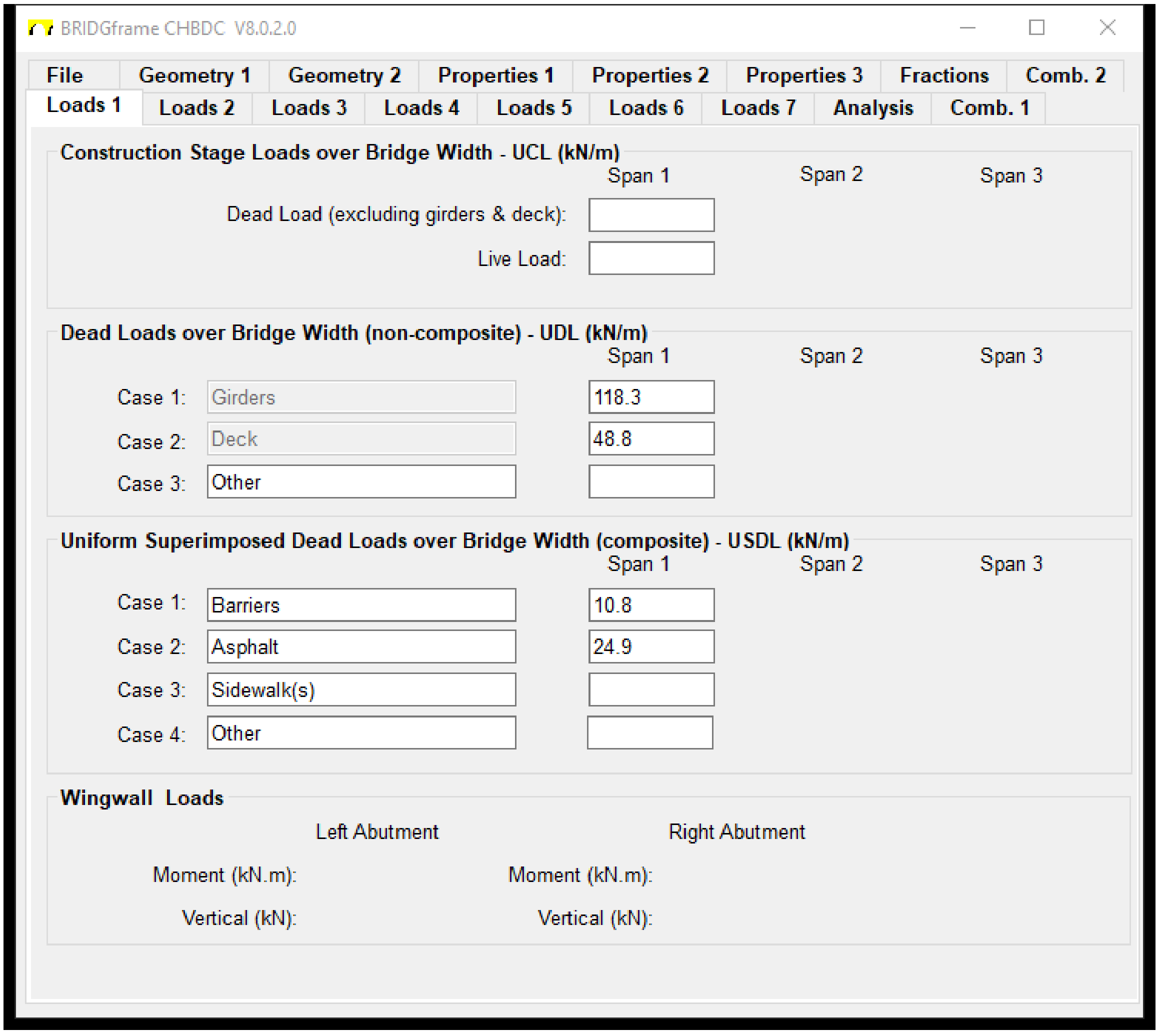

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Superstructure
Spans Count:
one
two
three
Length (m)
Span Type as per cl.3.9.3
Bridge Type as per cl.5.4.6.1
Span1:
27.450
A
B
C1
C2
C3
A
B
C
Span2:
Span3:
Abutments - Continuous
Left
Right
Height (m)
Pile Bases
Piles Height (m)
Integral:
Rigid Frame:
Abutments - Non-continuous
Horizontal Joint at Abutment Top
Total Bearing Shear Stiffness (kN/mm)
Shoe Plate Thickness (mm)
Non-integral:
Fixed
Free
Fixed
Free
Click Synchronize Button on Geometry 2 to Update BRIDGframe Example v8.0.23y.xlsm

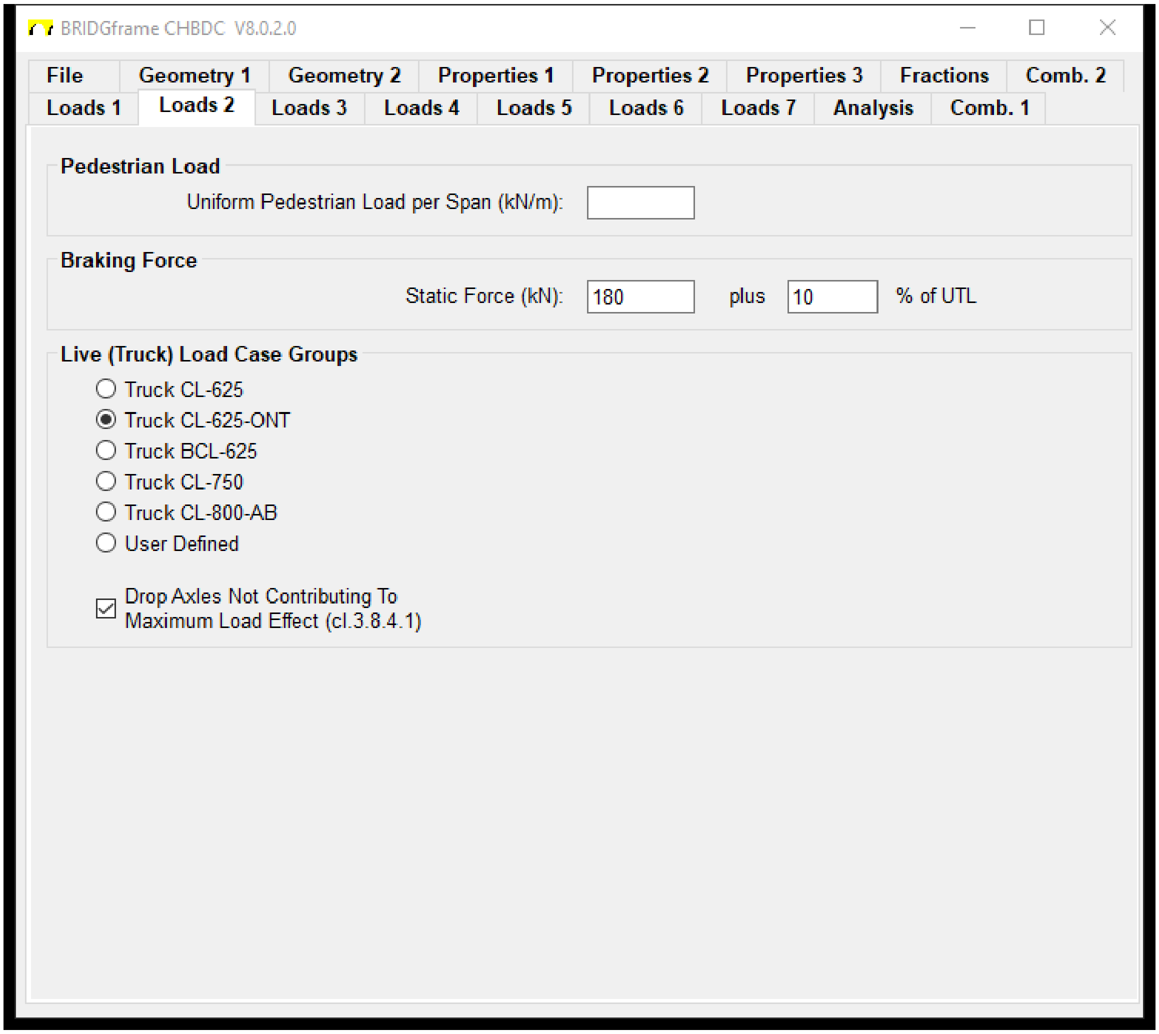

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Piers - Continuous
Left
Right
Height (m)
Pile Bases
Piles Height (m)
Integral:
Rigid Frame:
Piers - Non-continuous
Horizontal Joint at Pier Top
Total Bearing Shear Stiffness (kN/mm)
Shoe Plate Thickness (mm)
Non-integral:
Skew of Substructure from Perpendicular to C/L of Alignment
Skew (degrees):
Girders Over Piers During Construction
Over Left Pier:
Over Right Pier:
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm

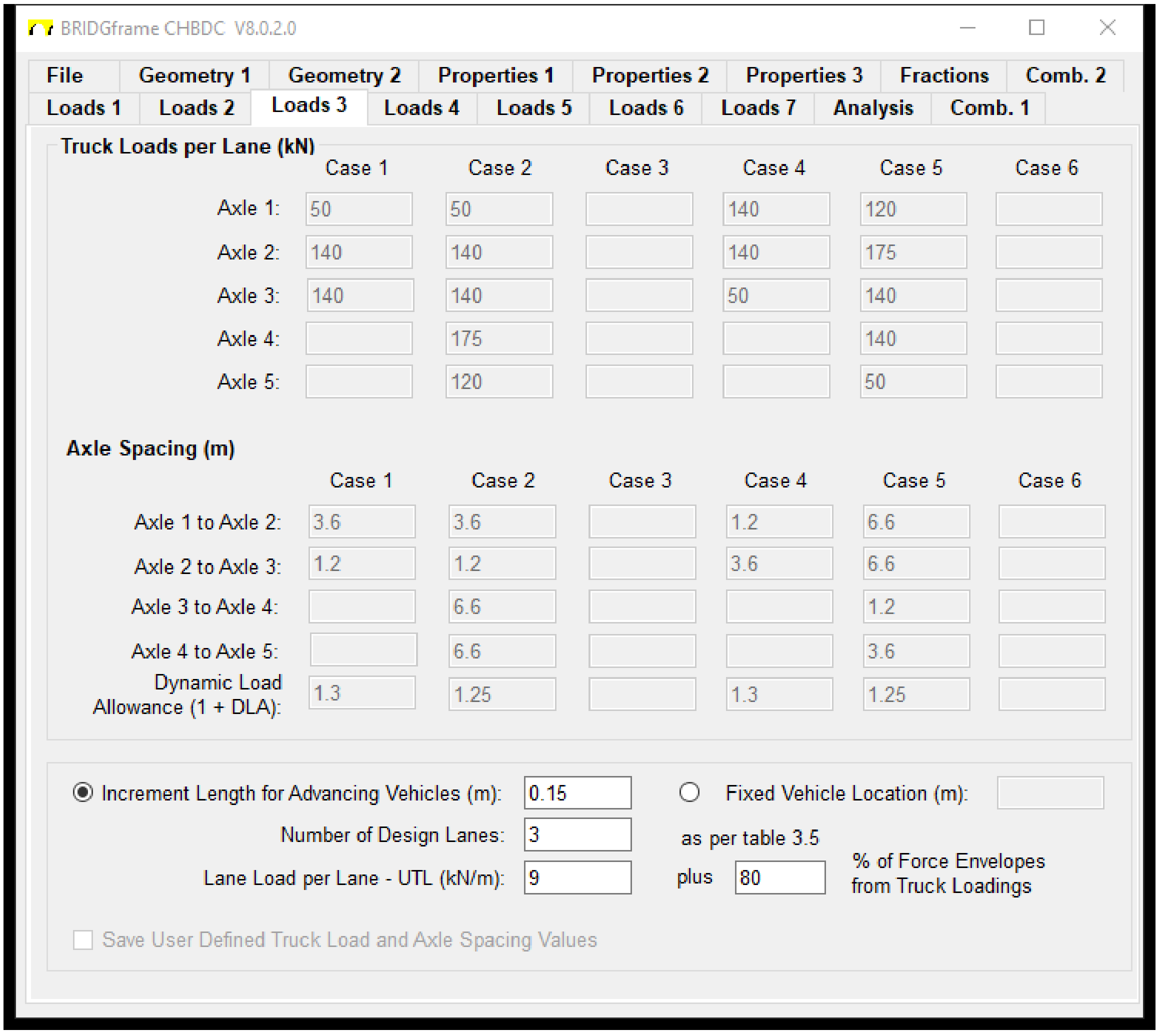

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Span Properties
Span 1 Span 2 Span 3
Girder/Slab Profile
Constant
Number of Members per Girder/Slab
1
Member Properties
Member Names or Lengths (m)
Span 1 Span 2 Span 3
1: 27.450
2:
3:
4:
5:
6:
7:
Help
Section Properties
Current Section: 1
Concrete Sections
Span/Bridge Combination: C1/C
Name / Designation: B 800 - 1220w
Number of Girders: 10
Girder Depth "dg" (cm): 80
Area of Single Girder "Ag" (cm²): 4828.5
Moment of Inertia of Single Girder "Ig" (cm^4): 4131000
Naked Girder NA to Girder Bottom "yb" (cm): 40
Girder Concrete "f'c"(MPa): 40
Girder Concrete Density (kg/m³): 2500
Girder Concrete at Transfer "f'ci"(MPa): 32
Composite Deck Width as per cl.5.5.2 (cm): 1290
Composite Deck Depth (cm): 15
Deck Concrete "f'c" (MPa): 35
Deck Concrete Density (kg/m³): 2450
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm

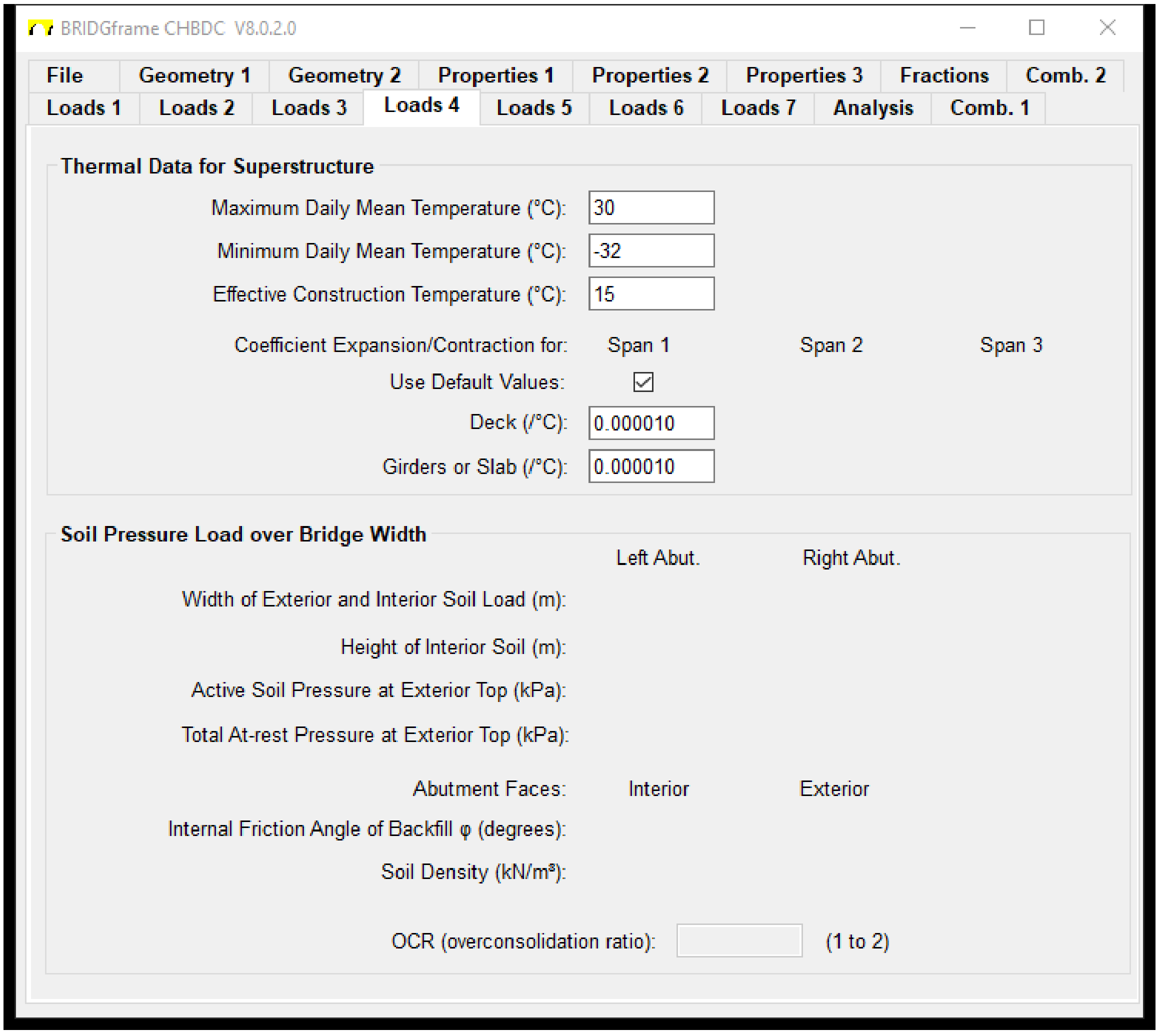

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Superstructure Cross-Section
Span 1
Span 2
Span 3
Spacing of girders or voided slab webs "S" (m):
1.22
Overhang length of deck "Sc" (m):
0.91
Bridge Platform
Bridge Platform Properties are Identical for All Spans
Center of exterior "travelled" lane to adjacent outside face of barrier (m):
4.575
Distance between curb or barrier faces "Wc" (m):
12.3
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm

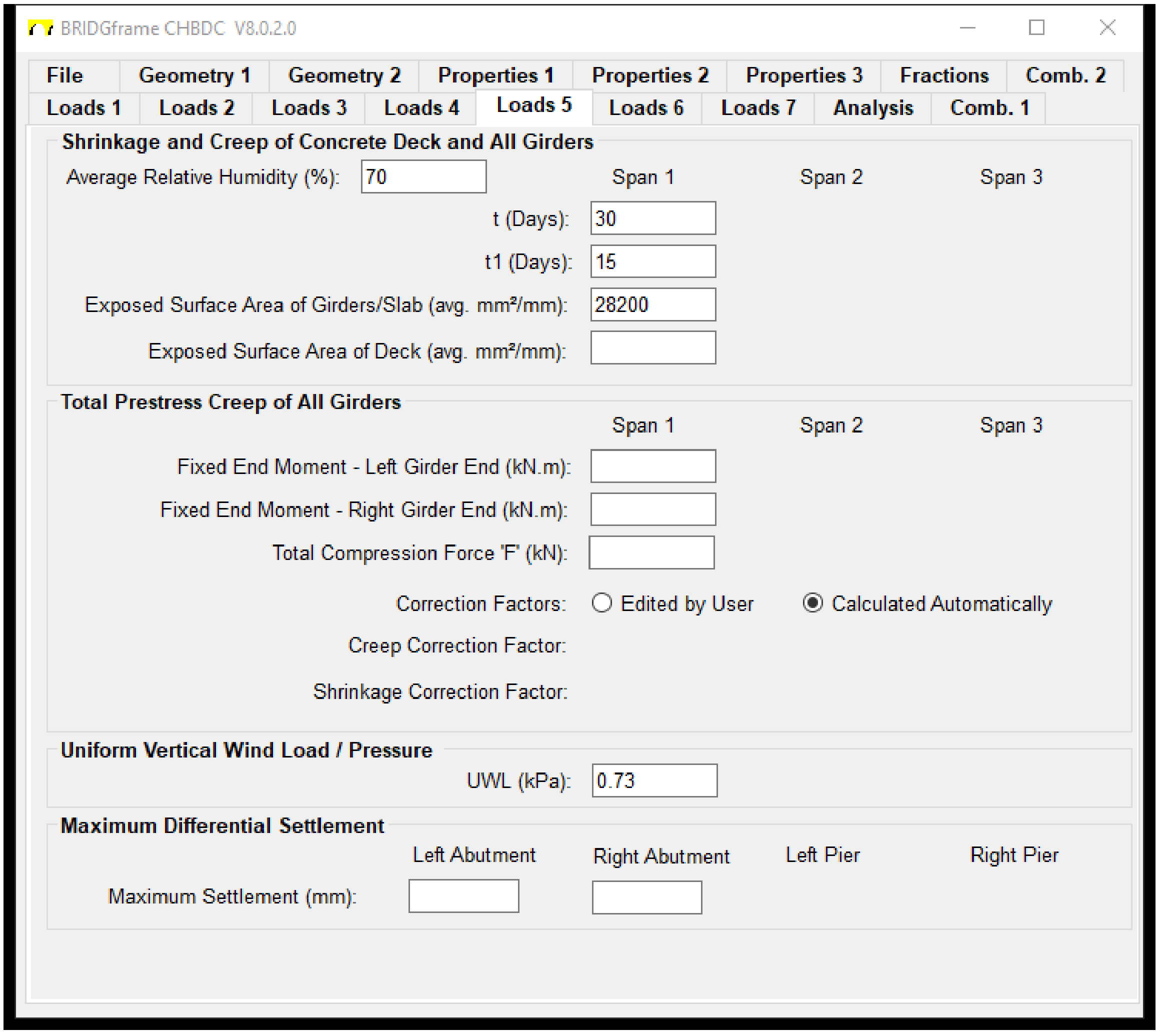

BRIDGframe CHBDC V8.0.2.0
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Substructure Section Properties
Left Abutment
Right Abutment
Left Pier
Right Pier
Nmbr of Supports:
Thickness at Top (cm):
Thickness Bottom (cm):
Width (cm):
Radius (cm):
Abutment/Pier Concrete "f'c" (MPa):
Abutment/Pier Concrete Density (kg/m³):
Pile Properties
Name/Designation:
Number of Piles:
Moment of Inertia (cm^4)/Pile:
Young's Modulus of Piles (MPa):
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm

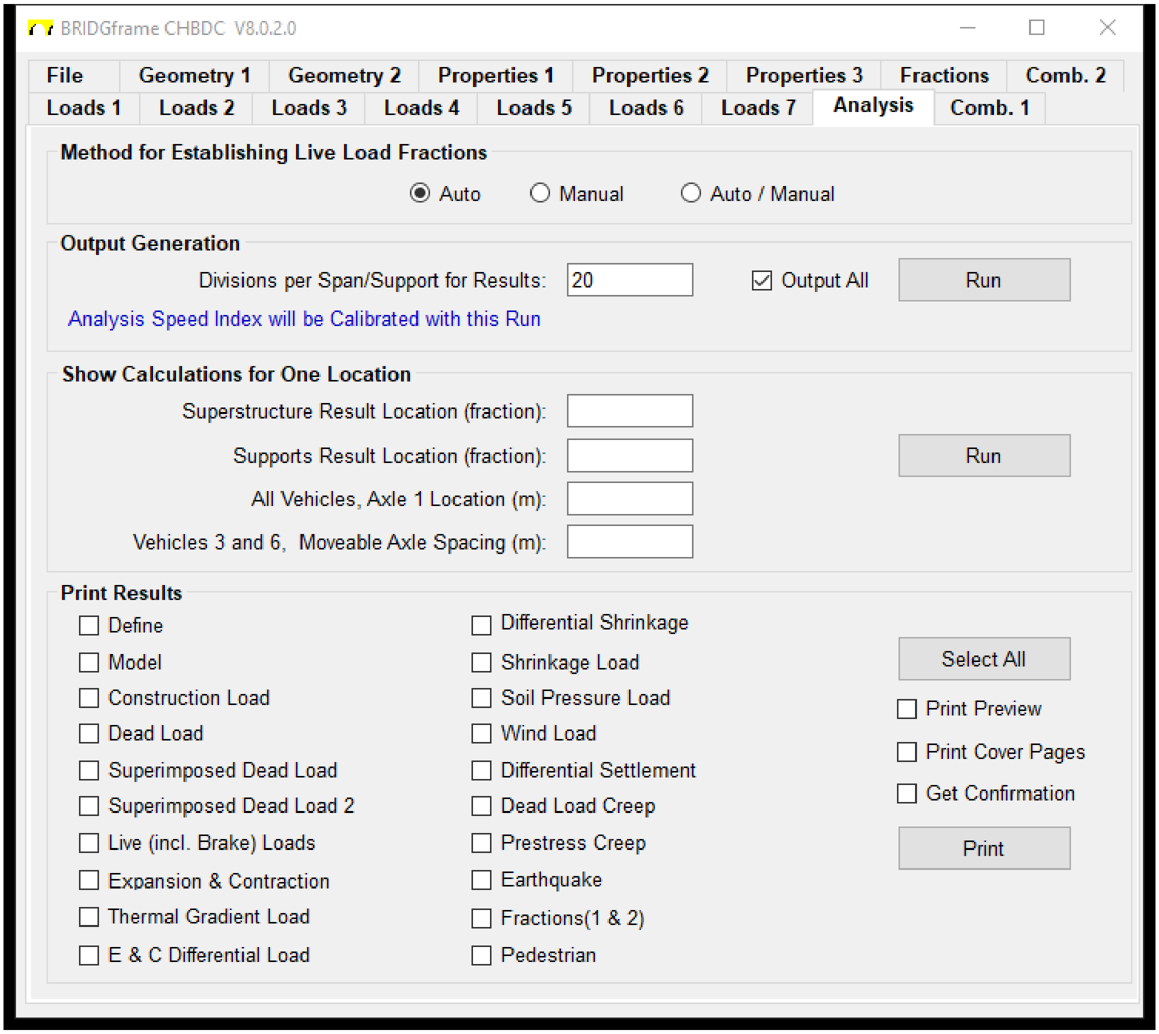

BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Construction Stage Loads over Bridge Width - UCL (kN/m)
Span 1
Span 2
Span 3
Dead Load (excluding girders & deck):
Live Load:
Dead Loads over Bridge Width (non-composite) - UDL (kN/m)
Span 1
Span 2
Span 3
Case 1: Girders 118.3
Case 2: Deck 48.8
Case 3: Other
Uniform Superimposed Dead Loads over Bridge Width (composite) - USDL (kN/m)
Span 1
Span 2
Span 3
Case 1: Barriers 10.8
Case 2: Asphalt 24.9
Case 3: Sidewalk(s)
Case 4: Other
Wingwall Loads
Left Abutment
Right Abutment
Moment (kN.m):
Vertical (kN):
Moment (kN.m):
Vertical (kN):


BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Pedestrian Load
Uniform Pedestrian Load per Span (kN/m):
Braking Force
Static Force (kN):
180
plus
10
% of UTL
Live (Truck) Load Case Groups
Truck CL-625
Truck CL-625-ONT
Truck BCL-625
Truck CL-750
Truck CL-800-AB
User Defined
Drop Axles Not Contributing To
Maximum Load Effect (cl.3.8.4.1)


BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Truck Loads per Lane (kN)
Case 1
Case 2
Case 3
Case 4
Case 5
Case 6
Axle 1: 50 50 140 120
Axle 2: 140 140 140 175
Axle 3: 140 140 50 140
Axle 4: 175 140
Axle 5: 120 50
Axle Spacing (m)
Case 1
Case 2
Case 3
Case 4
Case 5
Case 6
Axle 1 to Axle 2: 3.6 3.6 1.2 6.6
Axle 2 to Axle 3: 1.2 1.2 3.6 6.6
Axle 3 to Axle 4: 6.6 1.2
Axle 4 to Axle 5: 6.6 3.6
Dynamic Load Allowance (1 + DLA): 1.3 1.25 1.3 1.25
Increment Length for Advancing Vehicles (m): 0.15
Fixed Vehicle Location (m):
Number of Design Lanes: 3
as per table 3.5
Lane Load per Lane - UTL (kN/m): 9
plus 80
% of Force Envelopes from Truck Loadings
Save User Defined Truck Load and Axle Spacing Values


BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Thermal Data for Superstructure
Maximum Daily Mean Temperature (°C): 30
Minimum Daily Mean Temperature (°C): -32
Effective Construction Temperature (°C): 15
Coefficient Expansion/Contraction for: Span 1 Span 2 Span 3
Use Default Values:
Deck (/°C): 0.000010
Girders or Slab (/°C): 0.000010
Soil Pressure Load over Bridge Width
Left Abut. Right Abut.
Width of Exterior and Interior Soil Load (m):
Height of Interior Soil (m):
Active Soil Pressure at Exterior Top (kPa):
Total At-rest Pressure at Exterior Top (kPa):
Abutment Faces: Interior Exterior
Internal Friction Angle of Backfill φ (degrees):
Soil Density (kN/m³):
OCR (overconsolidation ratio): (1 to 2)


BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Shrinkage and Creep of Concrete Deck and All Girders
Average Relative Humidity (%): 70
Span 1
Span 2
Span 3
t (Days): 30
t1 (Days): 15
Exposed Surface Area of Girders/Slab (avg. mm²/mm): 28200
Exposed Surface Area of Deck (avg. mm²/mm):
Total Prestress Creep of All Girders
Span 1
Span 2
Span 3
Fixed End Moment - Left Girder End (kN.m):
Fixed End Moment - Right Girder End (kN.m):
Total Compression Force 'F' (kN):
Correction Factors:
Edited by User
Calculated Automatically
Creep Correction Factor:
Shrinkage Correction Factor:
Uniform Vertical Wind Load / Pressure
UWL (kPa): 0.73
Maximum Differential Settlement
Left Abutment
Right Abutment
Left Pier
Right Pier
Maximum Settlement (mm):



- If 'Show Calculations for One Location' is greyed out, Synchronize the last tab to activate this group box.

APPENDIX 5 – PRECAST RIGID FRAME WITH DISTRIBUTION SLAB (FOR FOOTING DESIGN)

Bridge Geometry

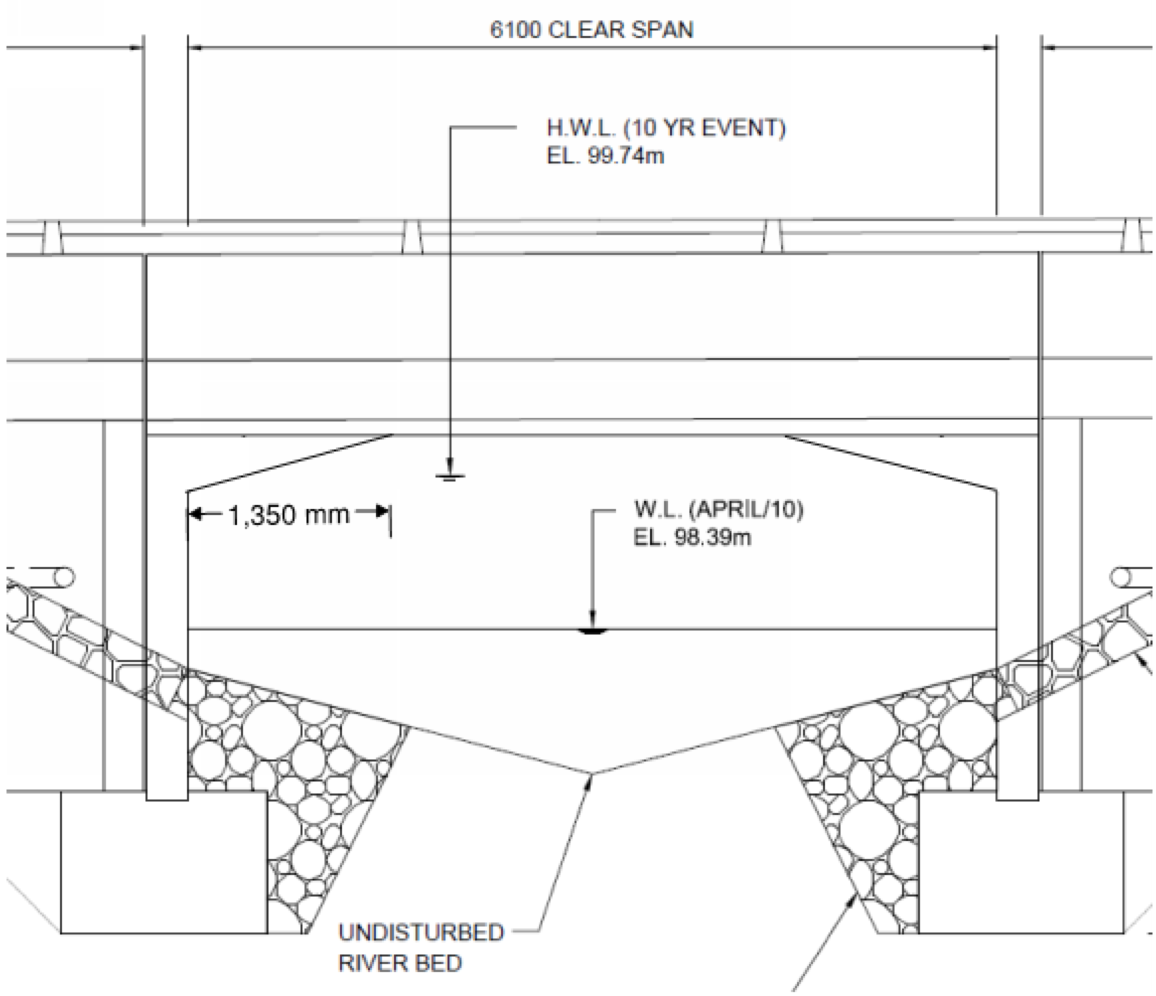
Structure Type:	Precast rigid frame single span with non-composite distribution deck slab
Spans:	1 – 6.1 m clear span
Deck:	9.0 m total width x 330 mm thick deck at mid-span and 450 thick deck at ends, (73 kN/m). Haunch length is 1350mm. 9.6 m total width x 190 mm avg cast-in-place non-composite distribution slab (47.0 kN/m) 9.0 m barrier inside face to barrier inside face. 2 travelled lanes at 3.25 m. 2 side clearances at 1.125 m. 2 design lanes. 90mm asphalt and waterproofing (19 kN/m).
Barriers:	Parapet walls 250 mm wide (12 kN/m)
Abutment:	u/s of abutment to u/s of precast deck slab at mid-span = 2.75 m 350mm thick

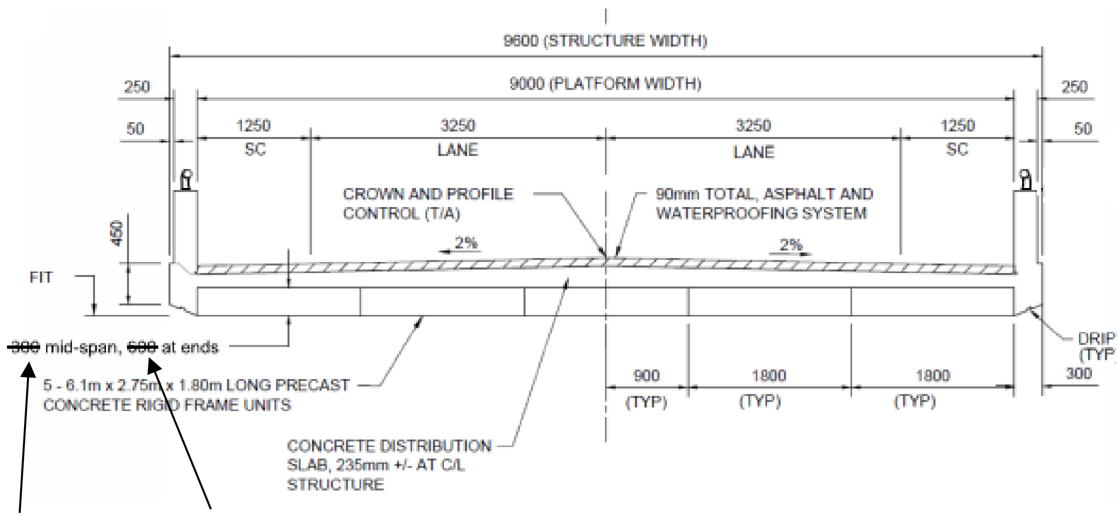
Use a span to C/L of abutments rounded to 6.45m.
Distance between inside face of wingwalls = 9.0 m which is the width of soil pressure load.

For footing design, use only Dead, SIDL, Live, and Soil Pressure.
For example, Differential settlement would be used for design of the frame only,
K loads would not cause continuous movement in any direction, etc.

Run 1 model: using self weight, distribution slab weight, and soil pressure (no surchanrge)
Run 2 model: using SIDL, live load, and live/soil surcharge

If assuming no composite action, all loads can be applied in Run 1.


6100 CLEAR SPAN
H.W.L. (10 YR EVENT)
EL. 99.74m
1,350 mm
W.L. (APRIL/10)
EL. 98.39m
UNDISTURBED
RIVER BED



330 450

Average depth of distribution slab = 190mm
Leg thickness = 350mm

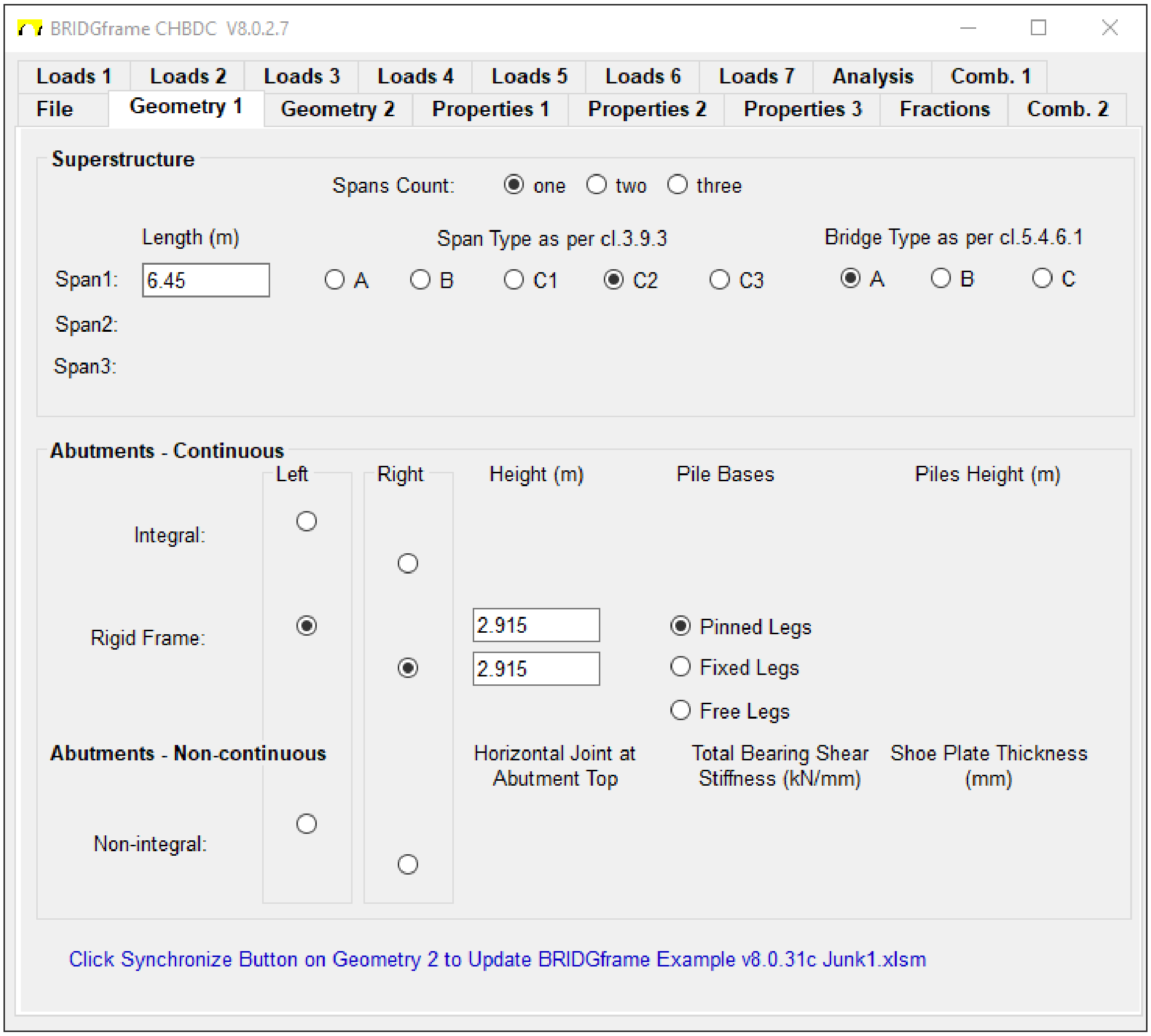
Run 1: Deck is 330 at mid-span and 450 inside face of frame leg (abutment)

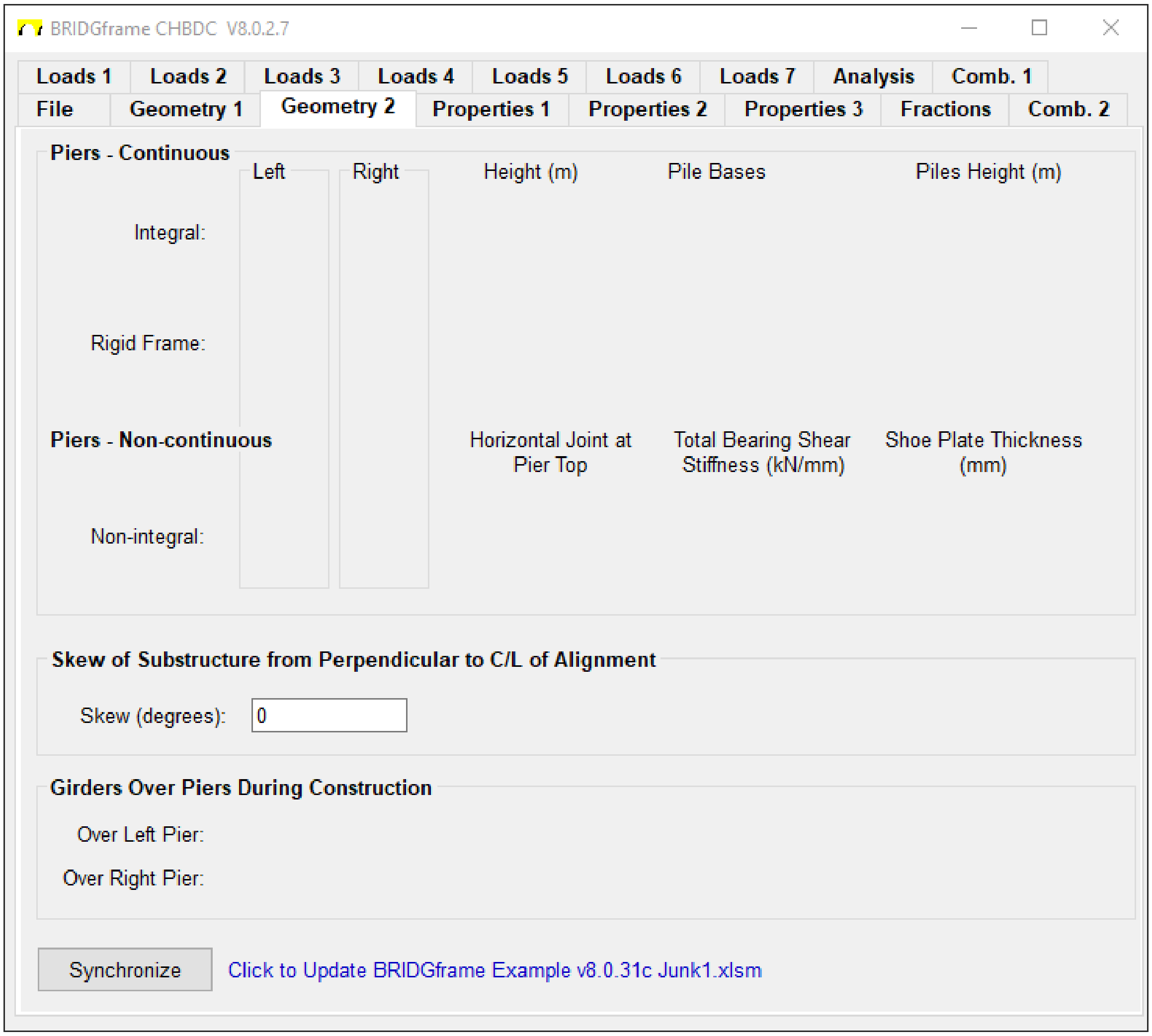
Since the model will go to the C/L of abutment, the deck end thickness can be adjusted. (450-330)/1350 x 350/2 = 16mm
Use a deck end thickness of 466mm.
Use an abutment height of 2.75 + 0.330/2 = 2.915m

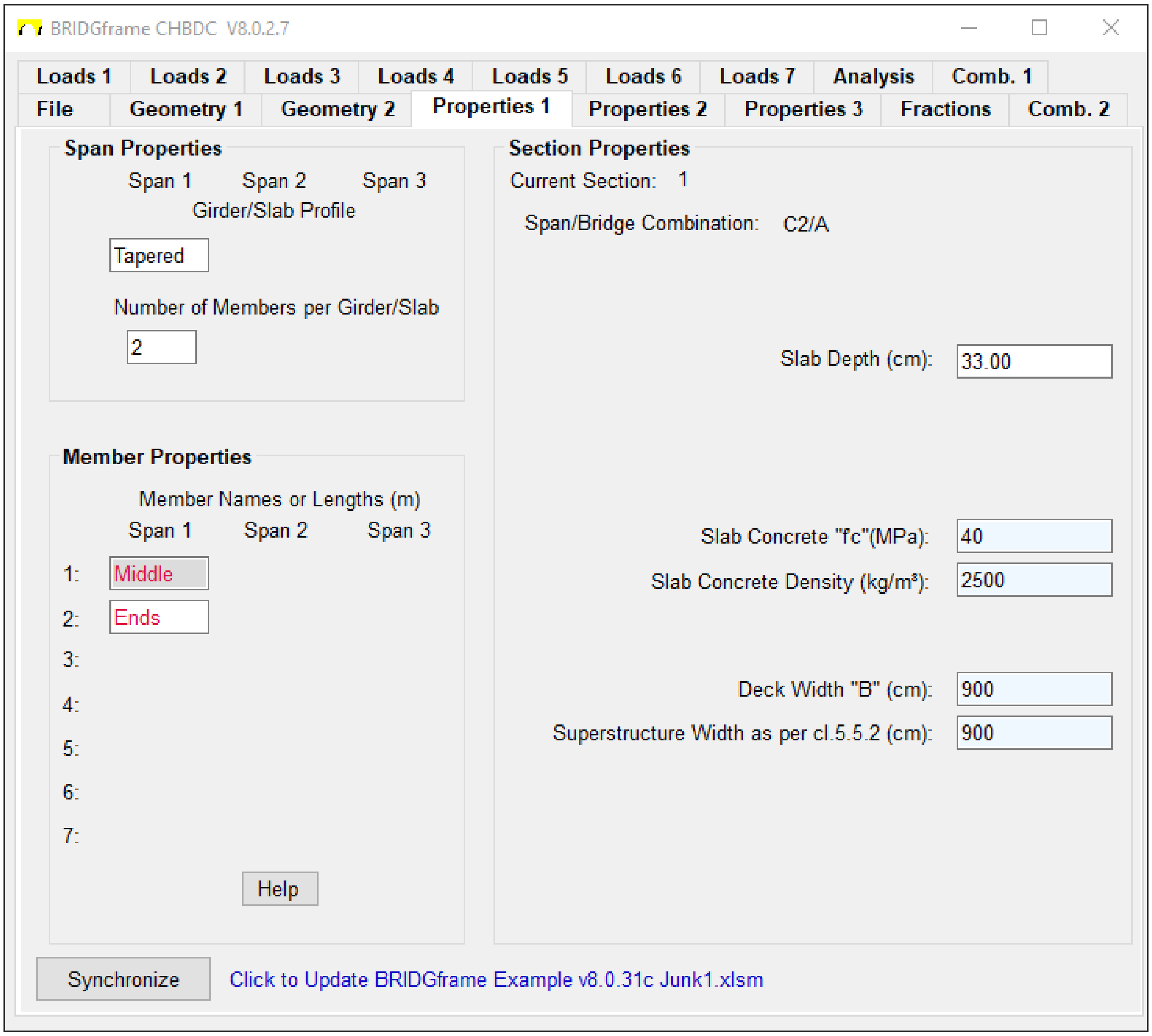
Run 2: Deck is 520 at mid-span and 656 at C/L of abutment
Use an abutment height of 2.75 + 0.520/2 = 3.01m

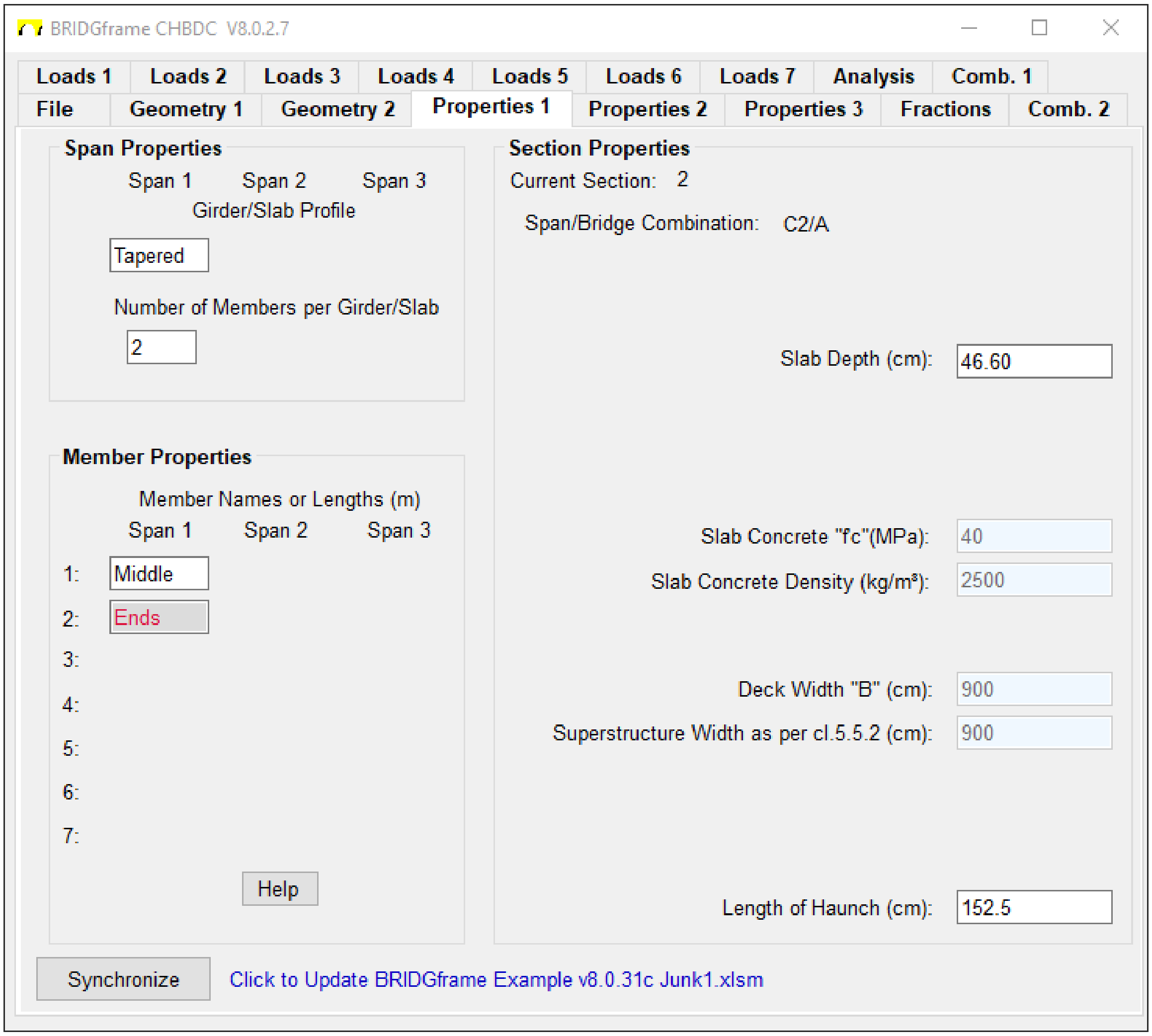
Length of deck haunch = 1350 + 350/2 = 1525mm = 152.5cm

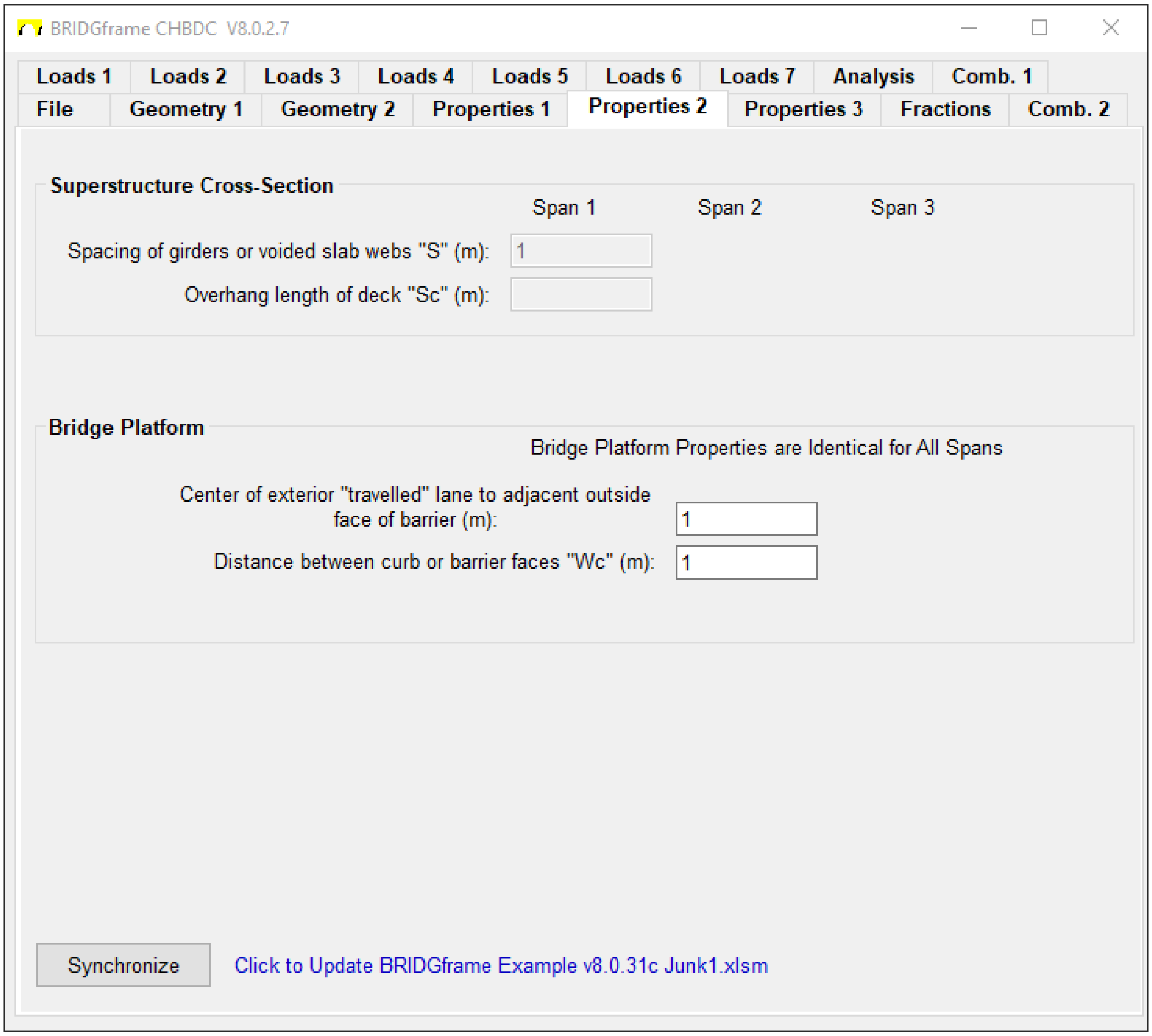
Run 1:


BRIDGframe CHBDC V8.0.2.7
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Superstructure
Spans Count:
one
two
three
Length (m)
Span Type as per cl.3.9.3
Bridge Type as per cl.5.4.6.1
Span1:
6.45
A
B
C1
C2
C3
A
B
C
Span2:
Span3:
Abutments - Continuous
Left
Right
Height (m)
Pile Bases
Piles Height (m)
Integral:
Rigid Frame:
2.915
2.915
Pinned Legs
Fixed Legs
Free Legs
Abutments - Non-continuous
Horizontal Joint at Abutment Top
Total Bearing Shear Stiffness (kN/mm)
Shoe Plate Thickness (mm)
Non-integral:
Click Synchronize Button on Geometry 2 to Update BRIDGframe Example v8.0.31c Junk1.xlsm

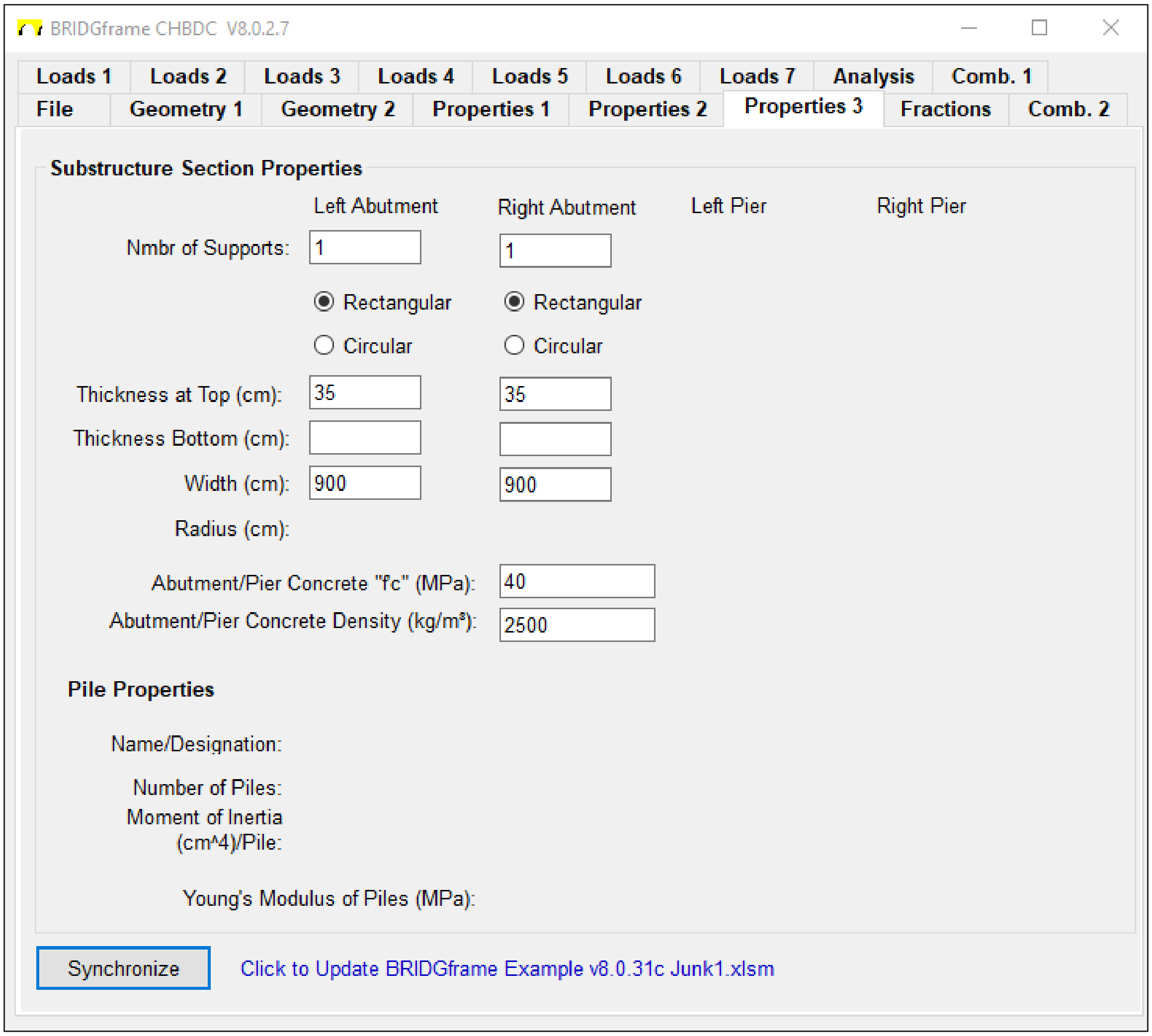

BRIDGframe CHBDC V8.0.2.7
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Piers - Continuous
Left
Right
Height (m)
Pile Bases
Piles Height (m)
Integral:
Rigid Frame:
Piers - Non-continuous
Horizontal Joint at Pier Top
Total Bearing Shear Stiffness (kN/mm)
Shoe Plate Thickness (mm)
Non-integral:
Skew of Substructure from Perpendicular to C/L of Alignment
Skew (degrees):
0
Girders Over Piers During Construction
Over Left Pier:
Over Right Pier:
Synchronize
Click to Update BRIDGframe Example v8.0.31c Junk1.xlsm

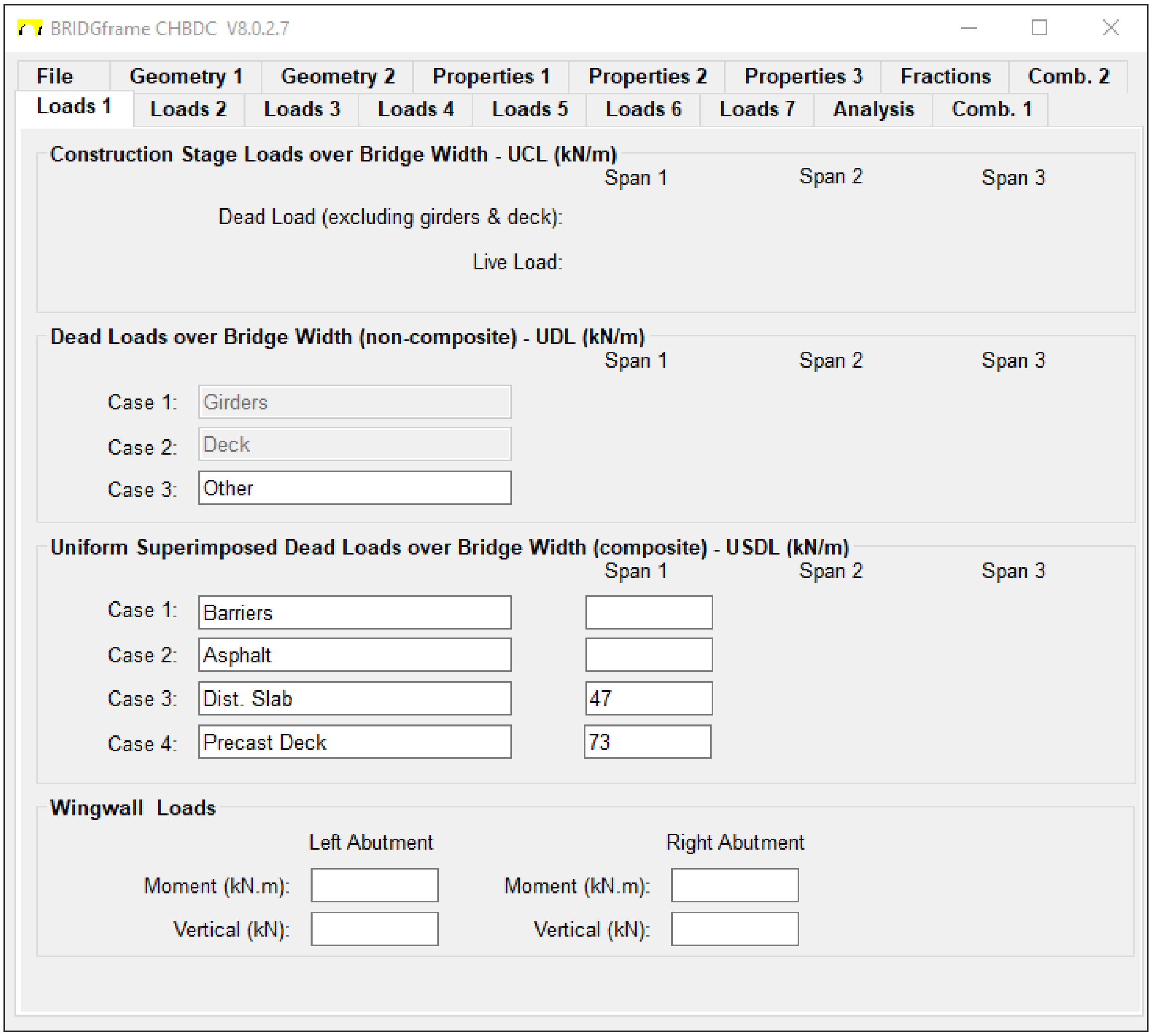

BRIDGframe CHBDC V8.0.2.7
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Span Properties
Span 1
Span 2
Span 3
Girder/Slab Profile
Tapered
Number of Members per Girder/Slab
2
Member Properties
Member Names or Lengths (m)
Span 1
Span 2
Span 3
1:
Middle
2:
Ends
3:
4:
5:
6:
7:
Help
Section Properties
Current Section: 1
Span/Bridge Combination: C2/A
Slab Depth (cm):
33.00
Slab Concrete "f'c"(MPa):
40
Slab Concrete Density (kg/m³):
2500
Deck Width "B" (cm):
900
Superstructure Width as per cl.5.5.2 (cm):
900
Synchronize
Click to Update BRIDGframe Example v8.0.31c Junk1.xlsm


BRIDGframe CHBDC V8.0.2.7
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Span Properties
Span 1
Span 2
Span 3
Girder/Slab Profile
Tapered
Number of Members per Girder/Slab
2
Section Properties
Current Section: 2
Span/Bridge Combination: C2/A
Slab Depth (cm): 46.60
Member Properties
Member Names or Lengths (m)
Span 1
Span 2
Span 3
1: Middle
2: Ends
3:
4:
5:
6:
7:
Help
Slab Concrete "f'c"(MPa): 40
Slab Concrete Density (kg/m³): 2500
Deck Width "B" (cm): 900
Superstructure Width as per cl.5.5.2 (cm): 900
Length of Haunch (cm): 152.5
Synchronize
Click to Update BRIDGframe Example v8.0.31c Junk1.xlsm



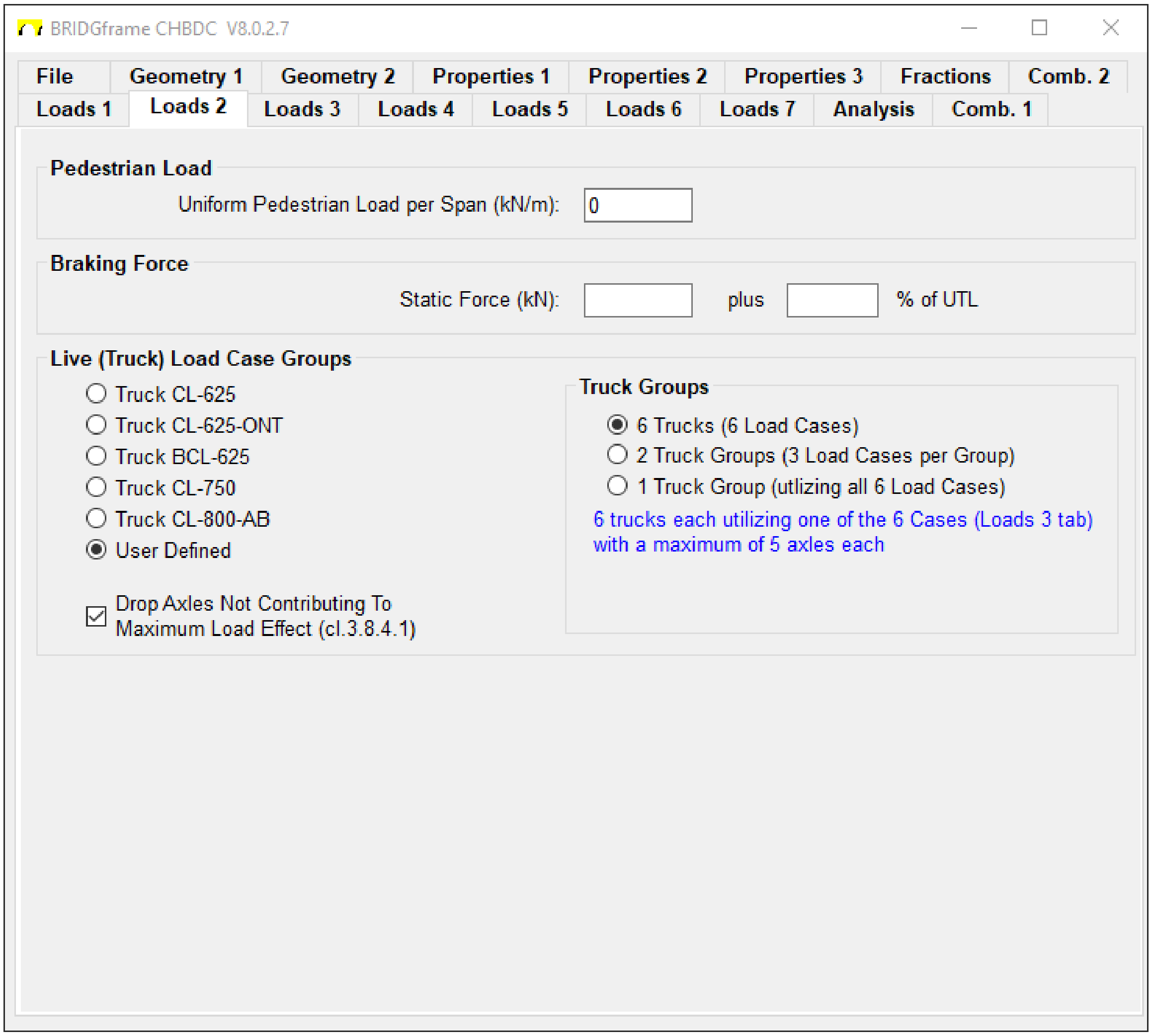
Input boxes may be defaulted to '1' as this information is not required for footing design.

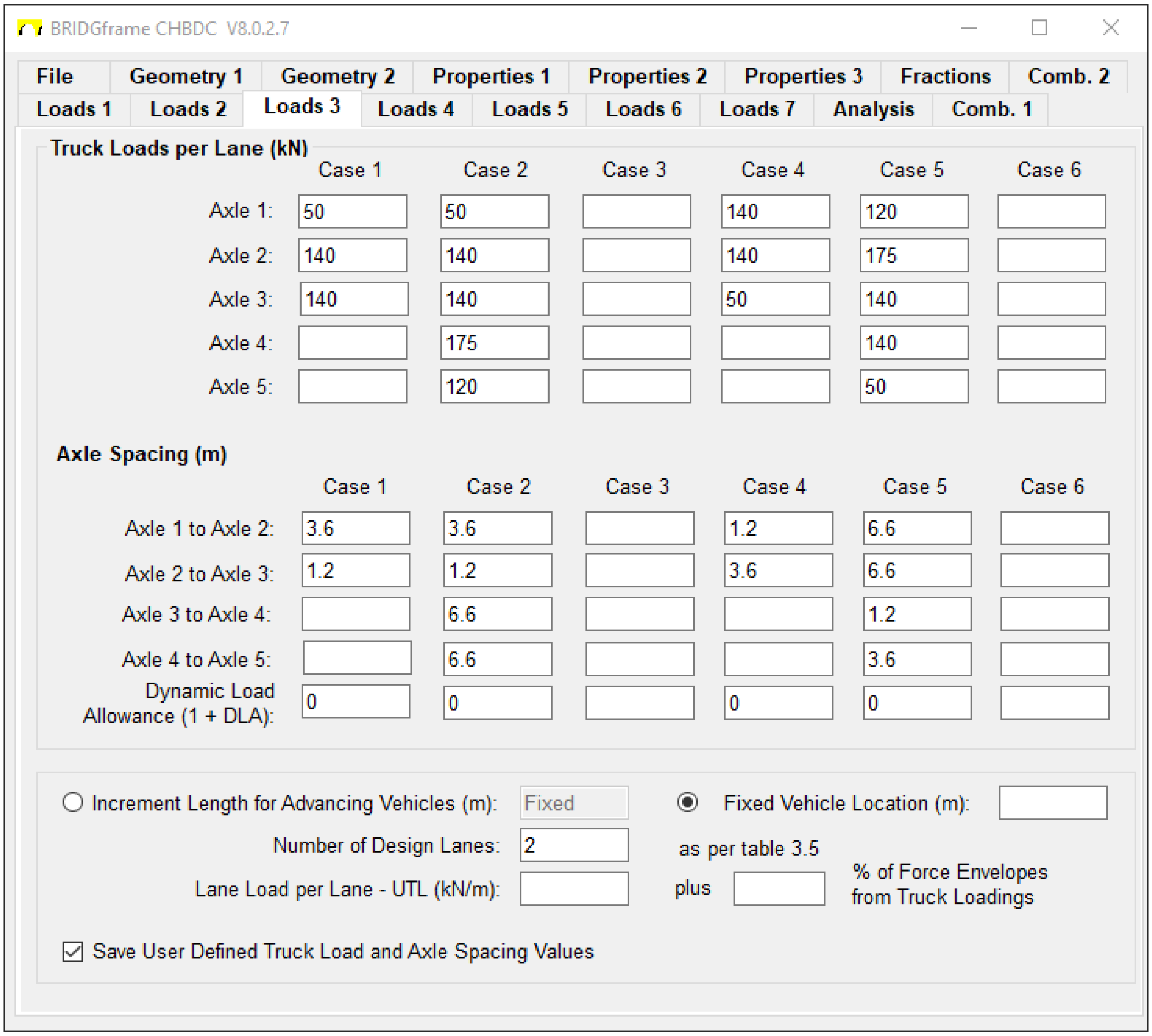

BRIDGframe CHBDC V8.0.2.7
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Substructure Section Properties
Left Abutment
Right Abutment
Left Pier
Right Pier
Nmbr of Supports:
1
1
Rectangular
Rectangular
Circular
Circular
Thickness at Top (cm):
35
35
Thickness Bottom (cm):
Width (cm):
900
900
Radius (cm):
Abutment/Pier Concrete "f'c" (MPa):
40
Abutment/Pier Concrete Density (kg/m³):
2500
Pile Properties
Name/Designation:
Number of Piles:
Moment of Inertia (cm^4)/Pile:
Young's Modulus of Piles (MPa):
Synchronize
Click to Update BRIDGframe Example v8.0.31c Junk1.xlsm

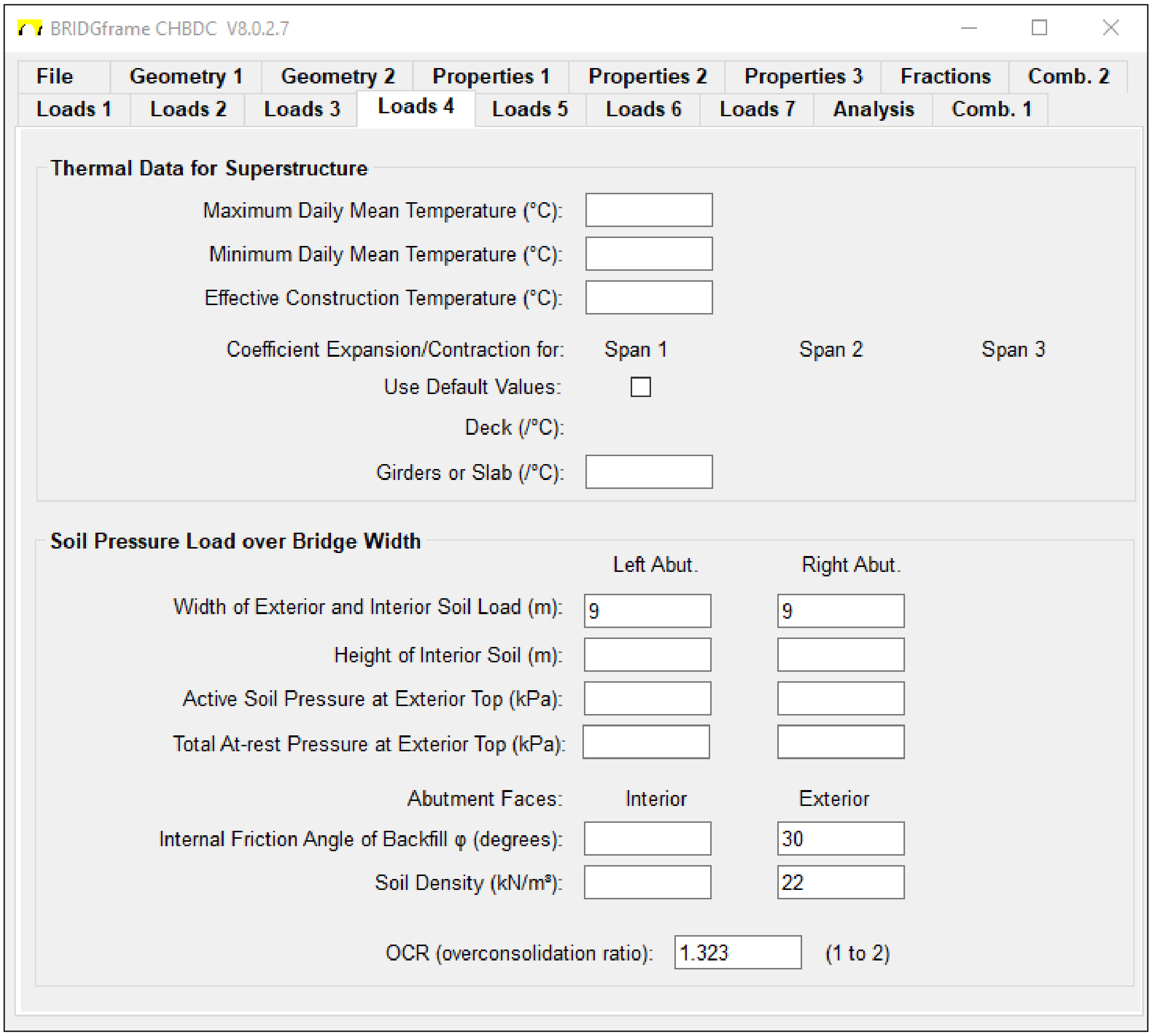


The weight of the precast superstructure is based on the thickness at mid-span.
0.33 x 9.0 x 24.5 kN/m^3 = 73 kN/m

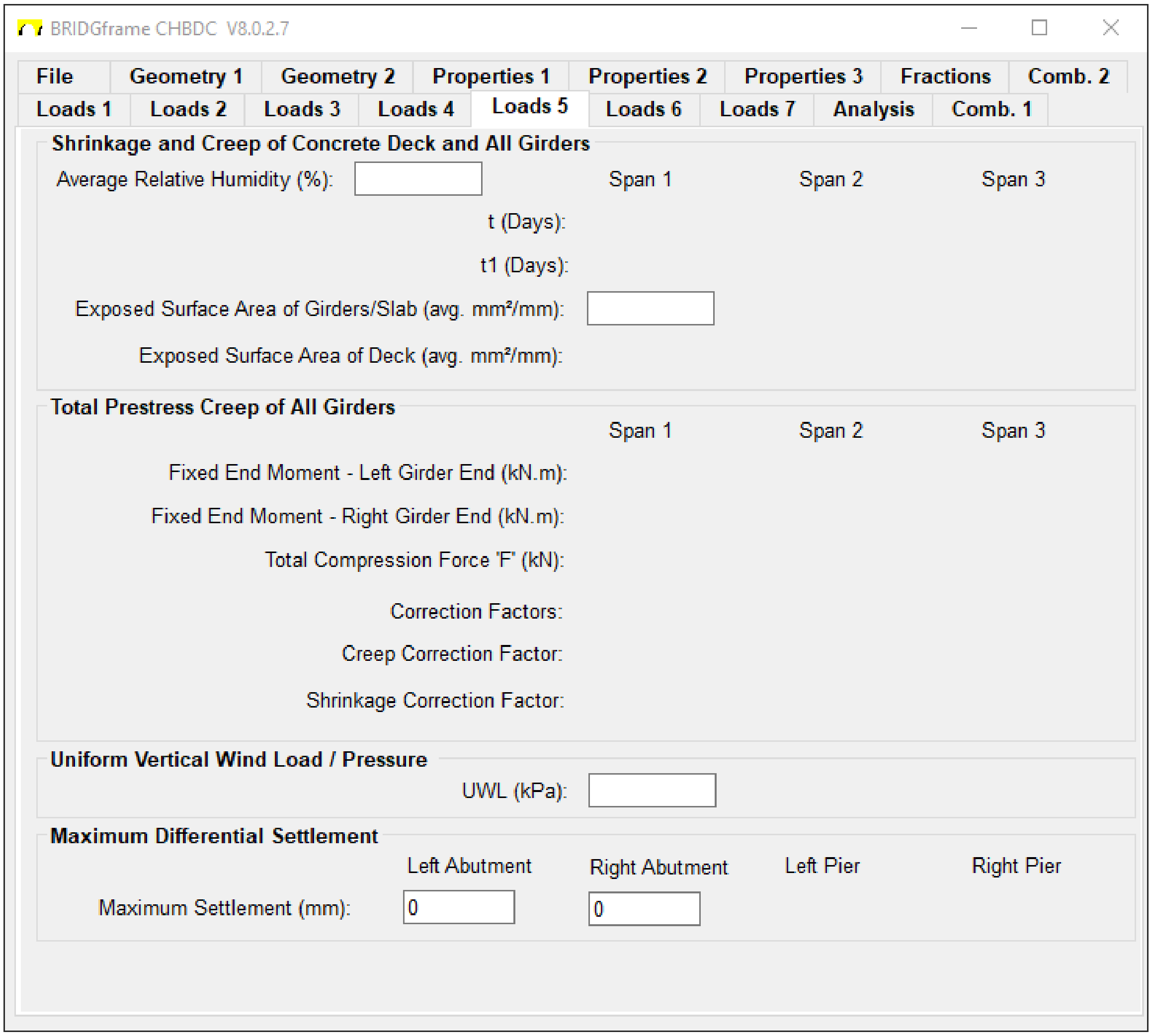
The weight of the distribution slab = 0.19 x 9.6 x 24 kN/m^3 = use 47.0 kN/m to account for edge thickening.

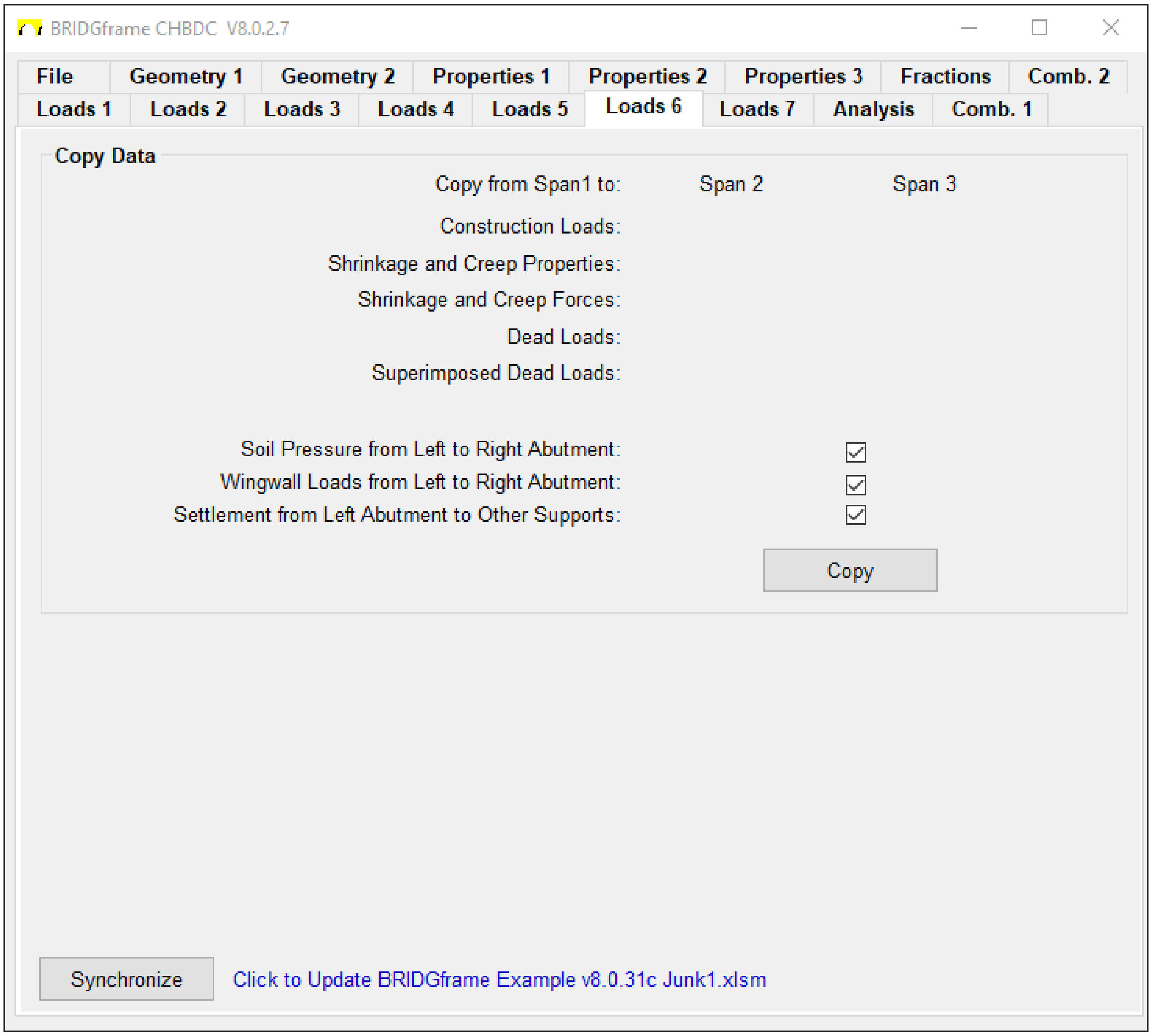

BRIDGframe CHBDC V8.0.2.7
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Pedestrian Load
Uniform Pedestrian Load per Span (kN/m):
0
Braking Force
Static Force (kN):
plus
% of UTL
Live (Truck) Load Case Groups
Truck CL-625
Truck CL-625-ONT
Truck BCL-625
Truck CL-750
Truck CL-800-AB
User Defined
Drop Axles Not Contributing To Maximum Load Effect (cl.3.8.4.1)
Truck Groups
6 Trucks (6 Load Cases)
2 Truck Groups (3 Load Cases per Group)
1 Truck Group (utlizing all 6 Load Cases)
6 trucks each utilizing one of the 6 Cases (Loads 3 tab) with a maximum of 5 axles each

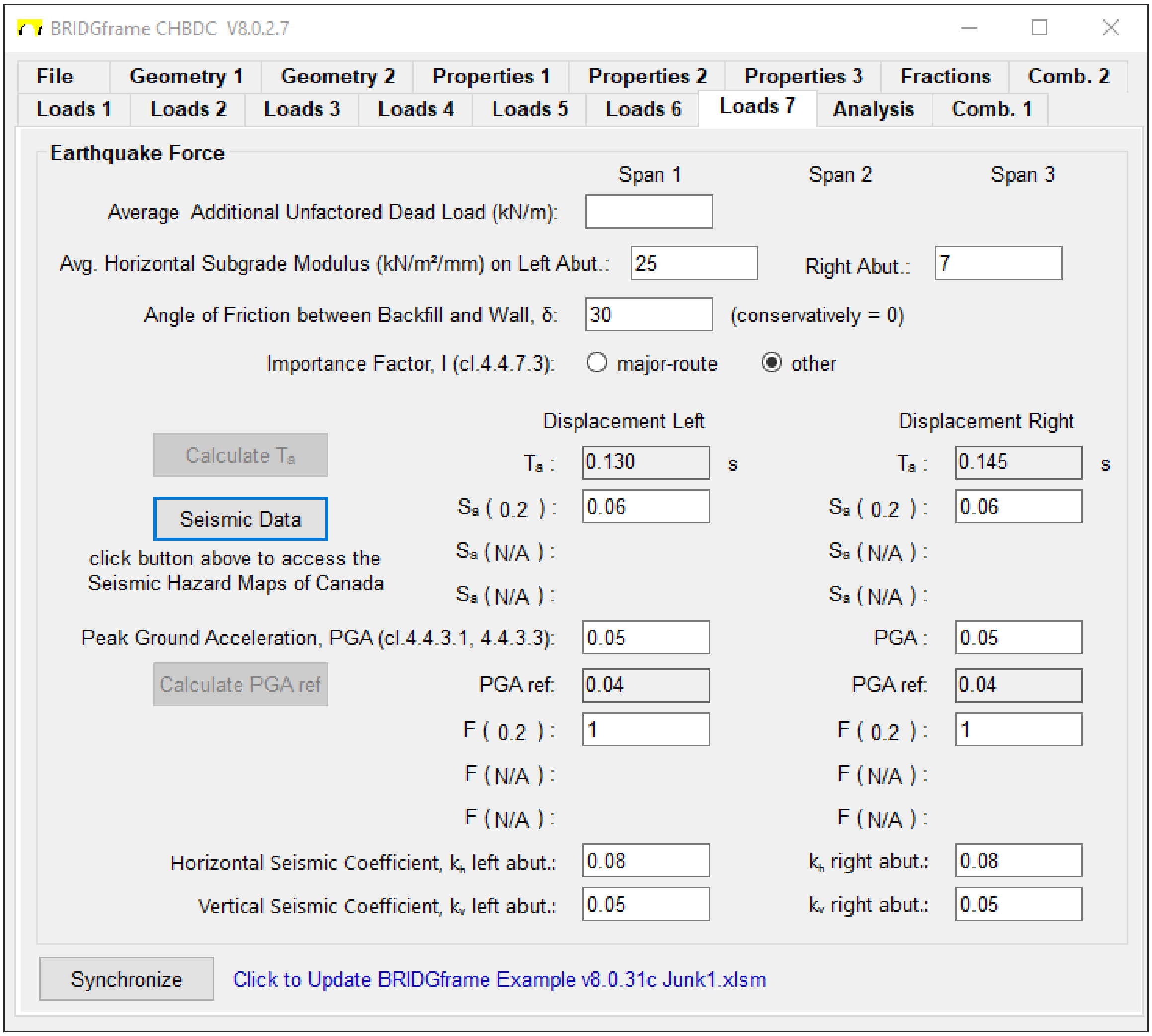

BRIDGframe CHBDC V8.0.2.7
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Truck Loads per Lane (kN)
Case 1
Case 2
Case 3
Case 4
Case 5
Case 6
Axle 1:
50
50
140
120
Axle 2:
140
140
140
175
Axle 3:
140
140
50
140
Axle 4:
175
140
Axle 5:
120
50
Axle Spacing (m)
Case 1
Case 2
Case 3
Case 4
Case 5
Case 6
Axle 1 to Axle 2:
3.6
3.6
1.2
6.6
Axle 2 to Axle 3:
1.2
1.2
3.6
6.6
Axle 3 to Axle 4:
6.6
1.2
Axle 4 to Axle 5:
6.6
3.6
Dynamic Load Allowance (1 + DLA):
0
0
0
0
Increment Length for Advancing Vehicles (m):
Fixed
Fixed Vehicle Location (m):
Number of Design Lanes:
2
as per table 3.5
Lane Load per Lane - UTL (kN/m):
plus
% of Force Envelopes from Truck Loadings
Save User Defined Truck Load and Axle Spacing Values



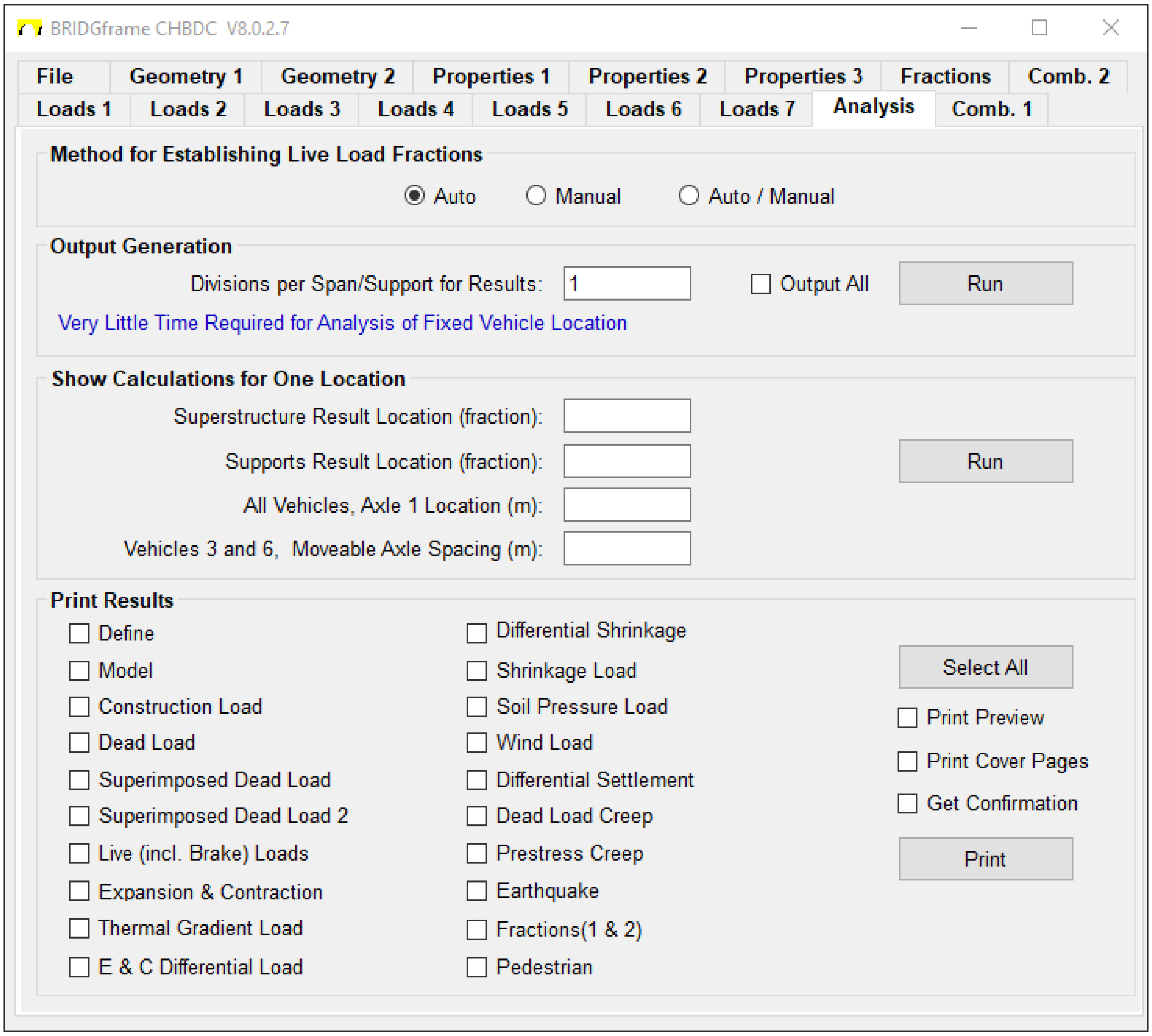
Interior soil pressure has been ignored.


BRIDGframe CHBDC V8.0.2.7
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Shrinkage and Creep of Concrete Deck and All Girders
Average Relative Humidity (%):
Span 1
Span 2
Span 3
t (Days):
t1 (Days):
Exposed Surface Area of Girders/Slab (avg. mm²/mm):
Exposed Surface Area of Deck (avg. mm²/mm):
Total Prestress Creep of All Girders
Span 1
Span 2
Span 3
Fixed End Moment - Left Girder End (kN.m):
Fixed End Moment - Right Girder End (kN.m):
Total Compression Force 'F' (kN):
Correction Factors:
Creep Correction Factor:
Shrinkage Correction Factor:
Uniform Vertical Wind Load / Pressure
UWL (kPa):
Maximum Differential Settlement
Left Abutment
Right Abutment
Left Pier
Right Pier
Maximum Settlement (mm):
0
0


BRIDGframe CHBDC V8.0.2.7
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Copy Data
Copy from Span1 to:
Span 2
Span 3
Construction Loads:
Shrinkage and Creep Properties:
Shrinkage and Creep Forces:
Dead Loads:
Superimposed Dead Loads:
Soil Pressure from Left to Right Abutment:
Wingwall Loads from Left to Right Abutment:
Settlement from Left Abutment to Other Supports:
Copy
Synchronize
Click to Update BRIDGframe Example v8.0.31c Junk1.xlsm

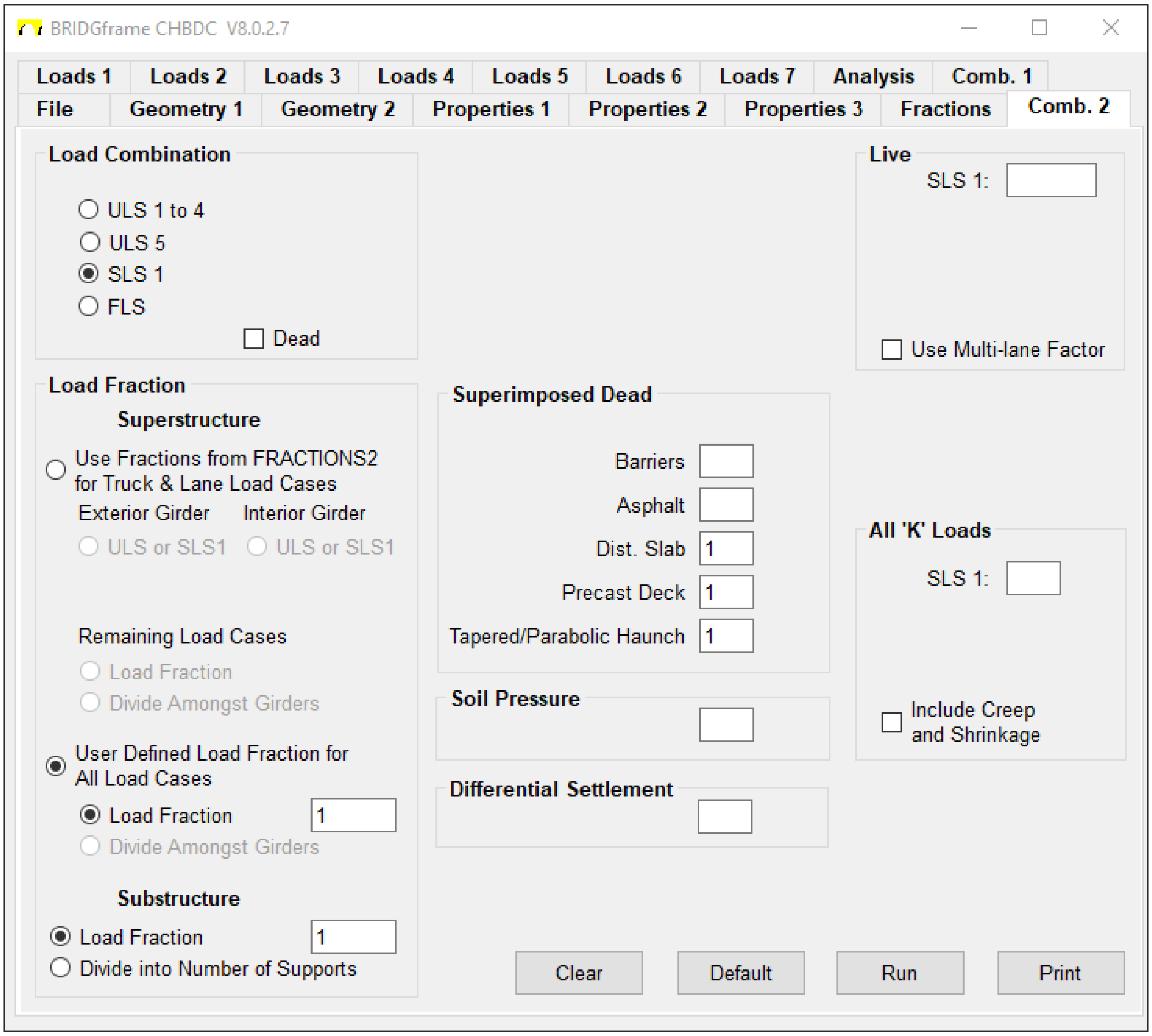


Loads 7 must be completed to advance to Analysis. Earthquake results will not be used therefore the values input are irrelevant. Assume input values to allow the tab to be Synchronized.



Only one division is required since results at the supports is all that's required.

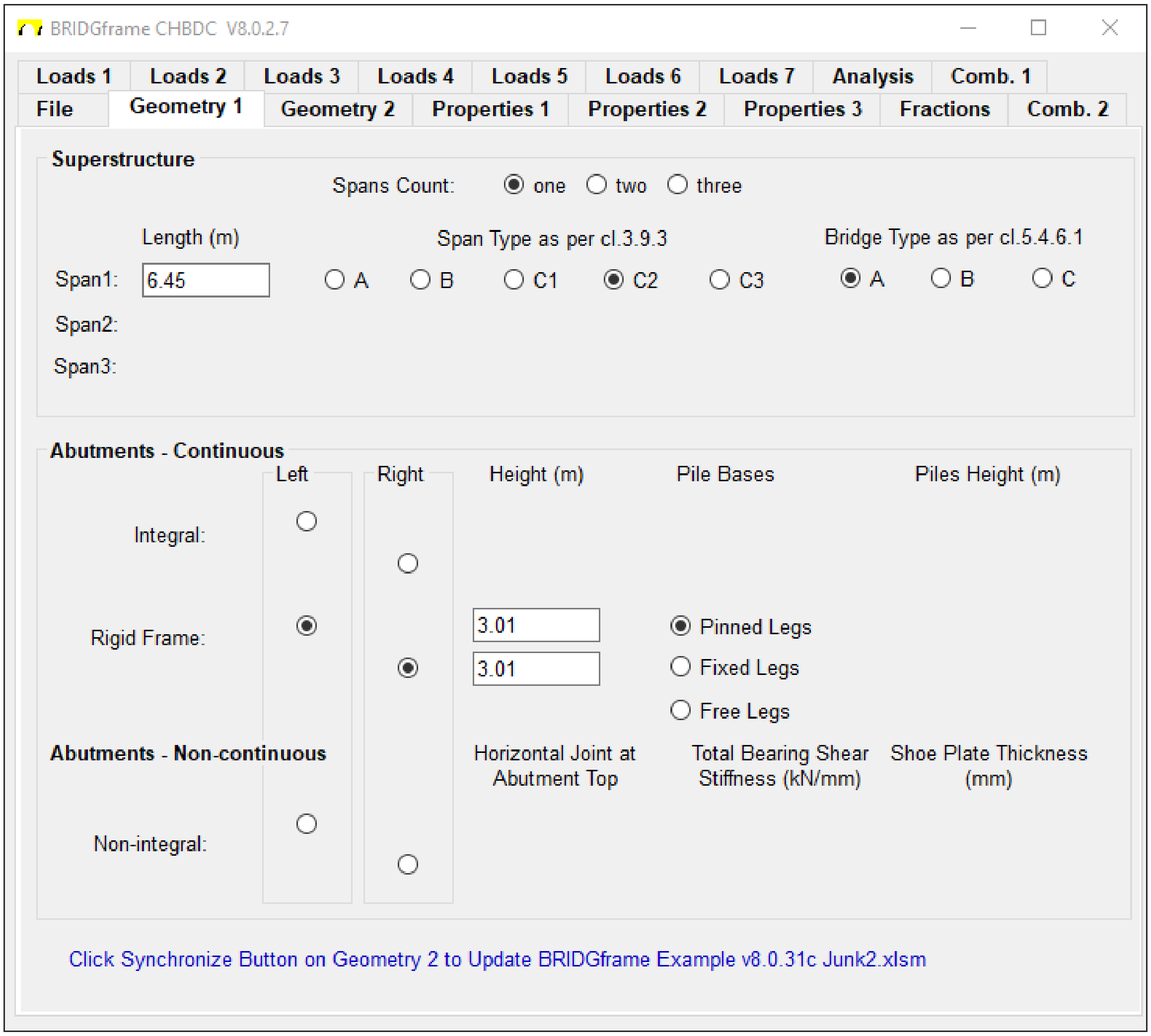
Output results for SIDL and SOIL.

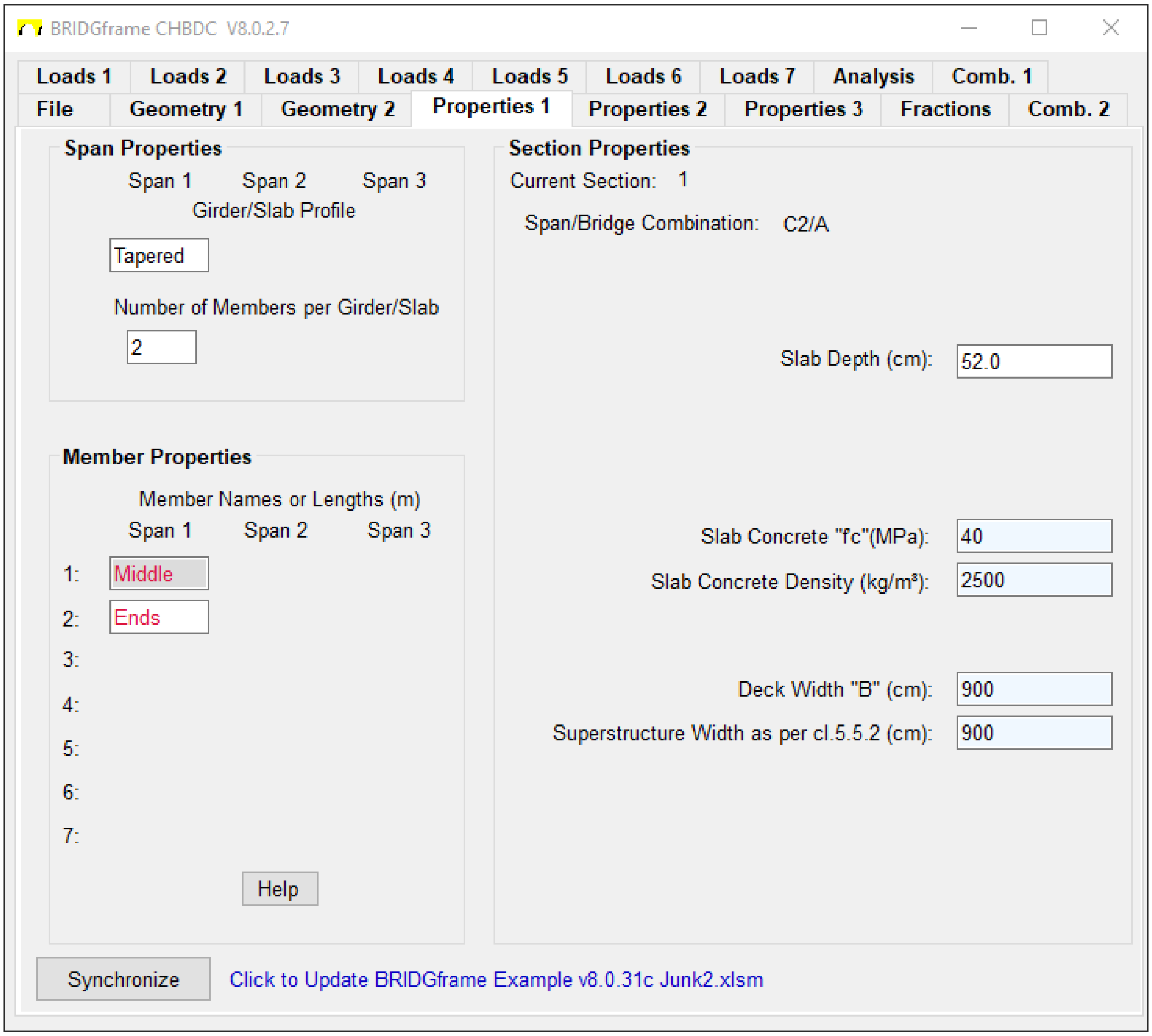


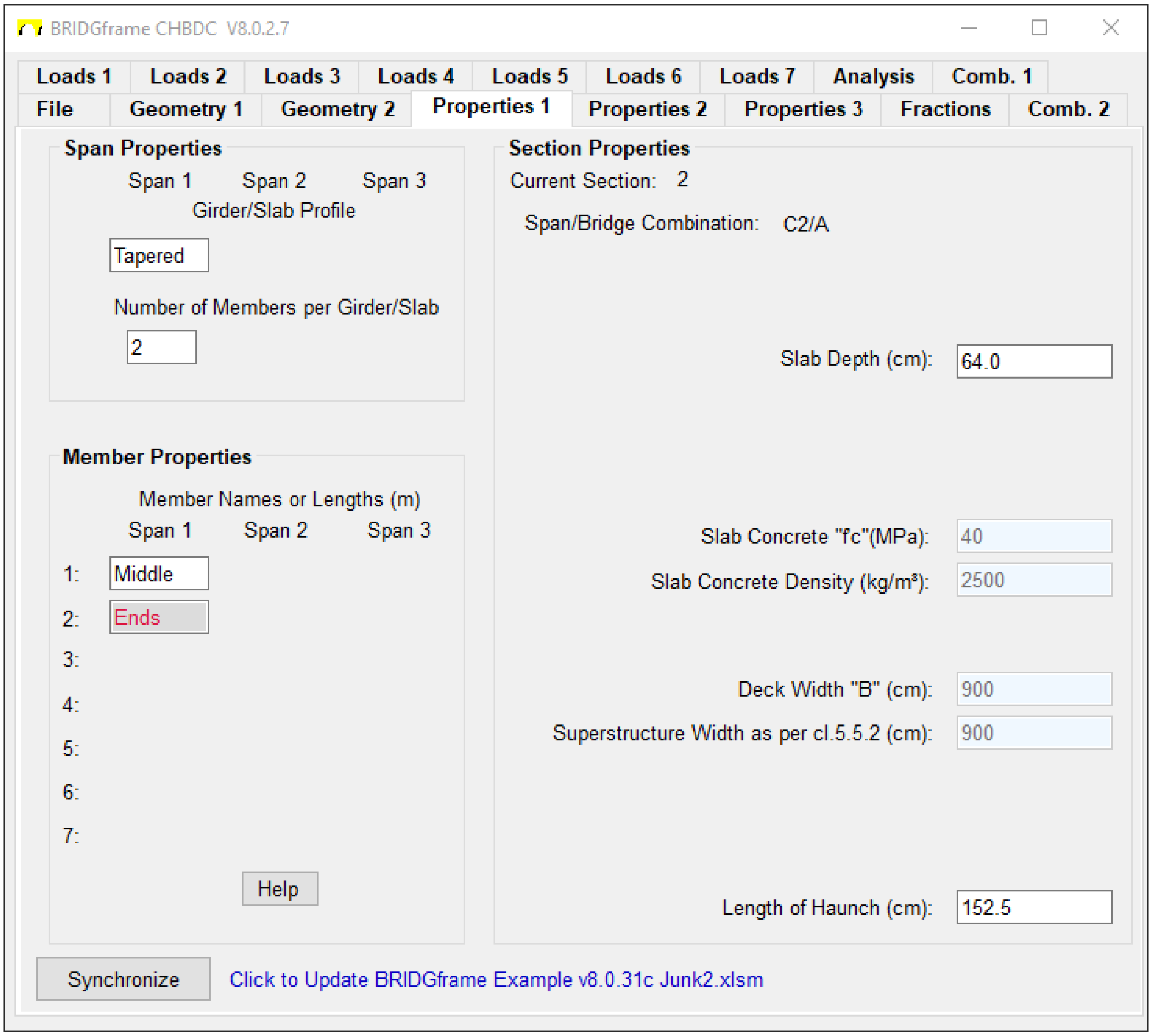
Run 1 SIDL output example using Comb. 2
Include Tapered/Parabolic Haunch here.

Run 2:

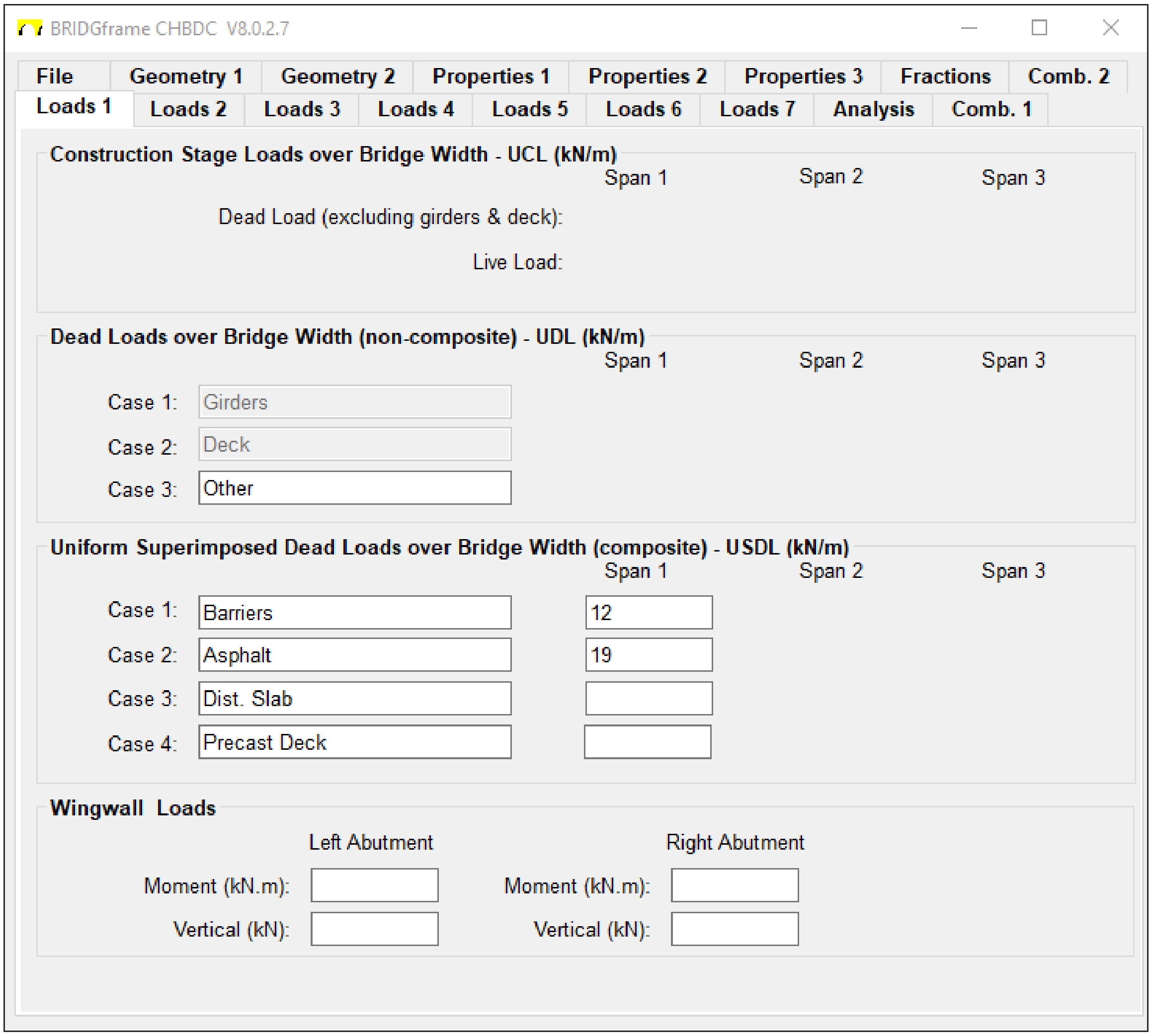
Tabs not shown below match that of Run 1.

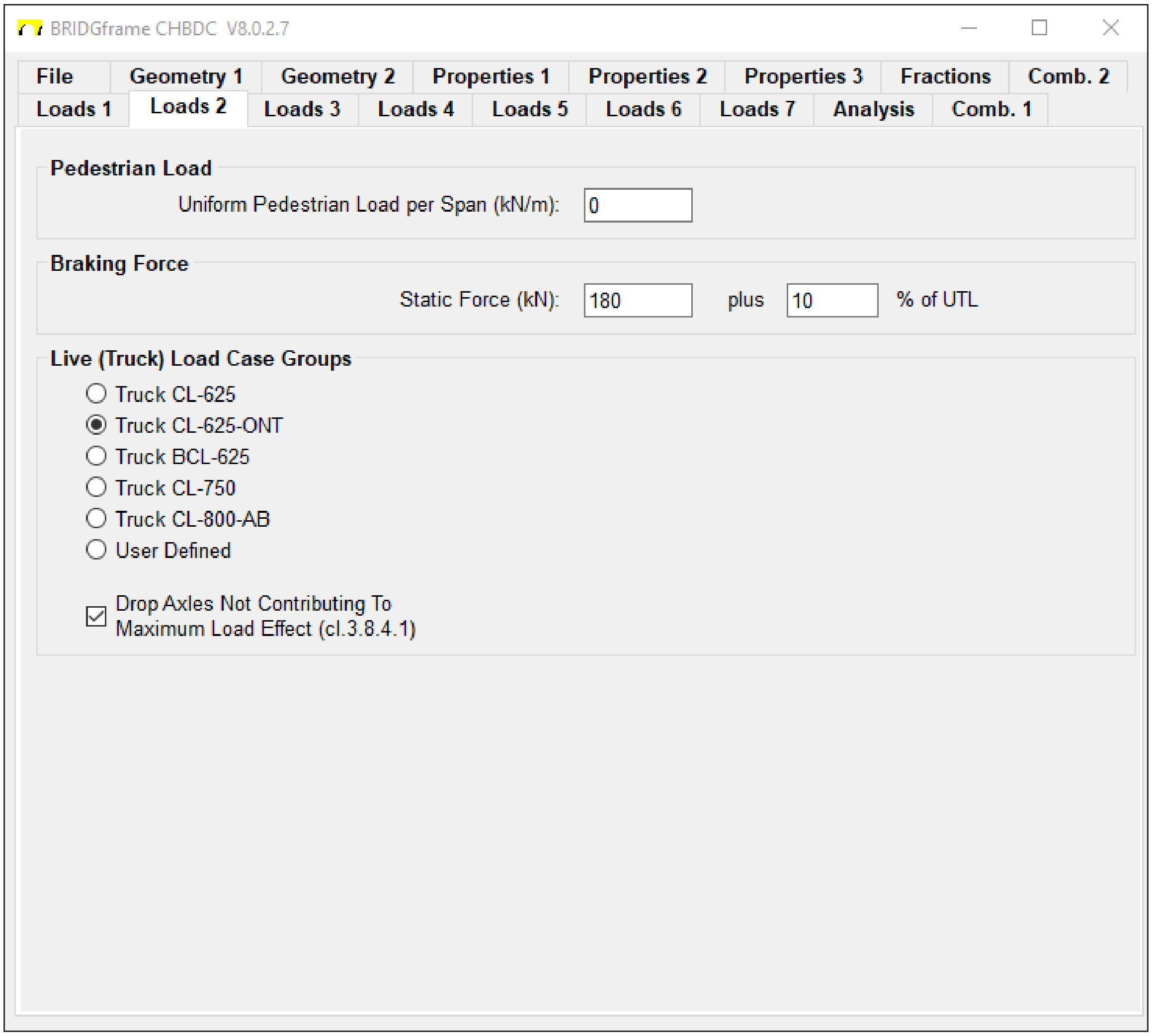


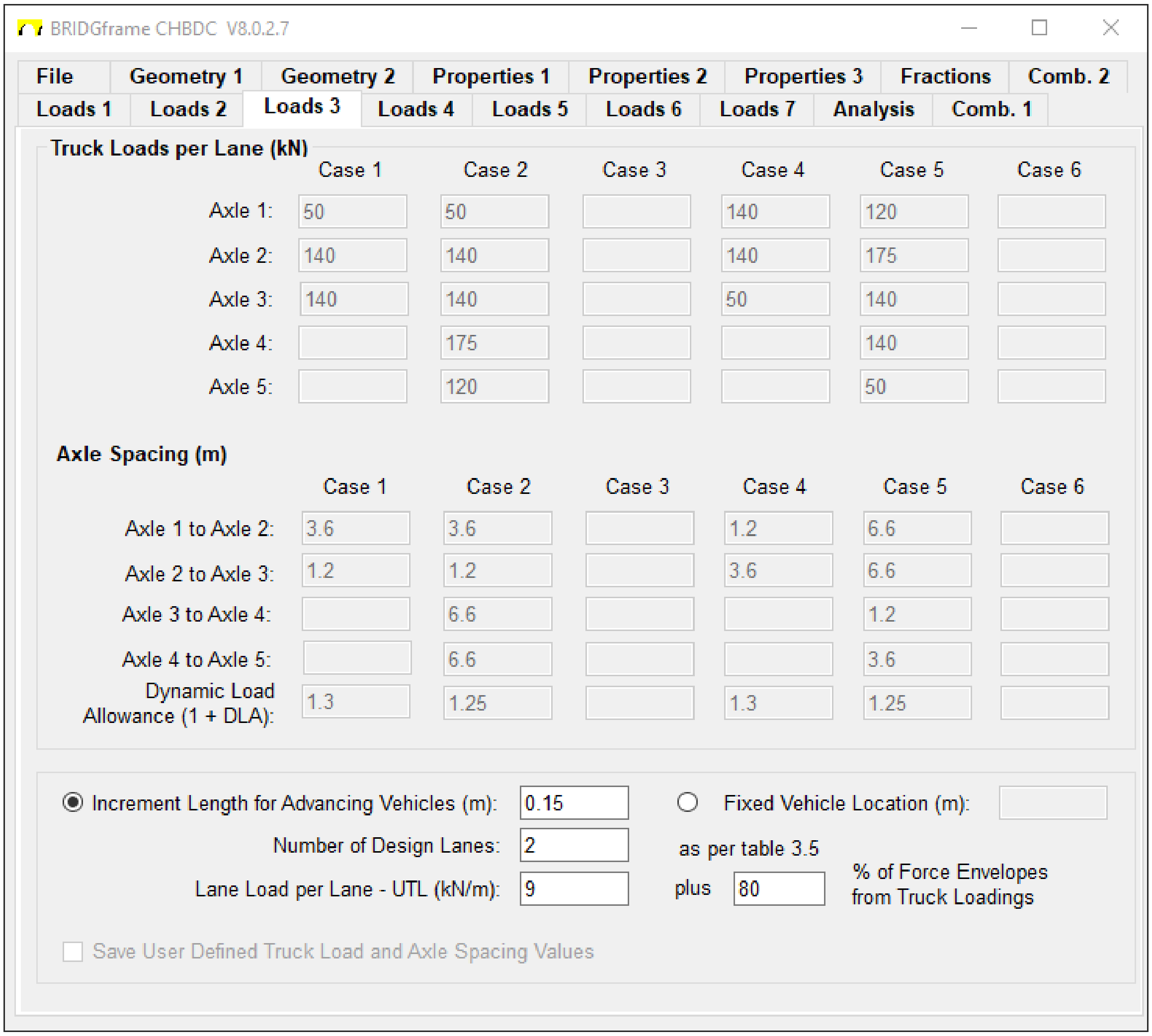

BRIDGframe CHBDC V8.0.2.7
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Span Properties
Span 1
Span 2
Span 3
Girder/Slab Profile
Tapered
Number of Members per Girder/Slab
2
Member Properties
Member Names or Lengths (m)
Span 1
Span 2
Span 3
1:
Middle
2:
Ends
3:
4:
5:
6:
7:
Help
Section Properties
Current Section: 1
Span/Bridge Combination: C2/A
Slab Depth (cm): 52.0
Slab Concrete "f'c"(MPa): 40
Slab Concrete Density (kg/m³): 2500
Deck Width "B" (cm): 900
Superstructure Width as per cl.5.5.2 (cm): 900
Synchronize
Click to Update BRIDGframe Example v8.0.31c Junk2.xlsm

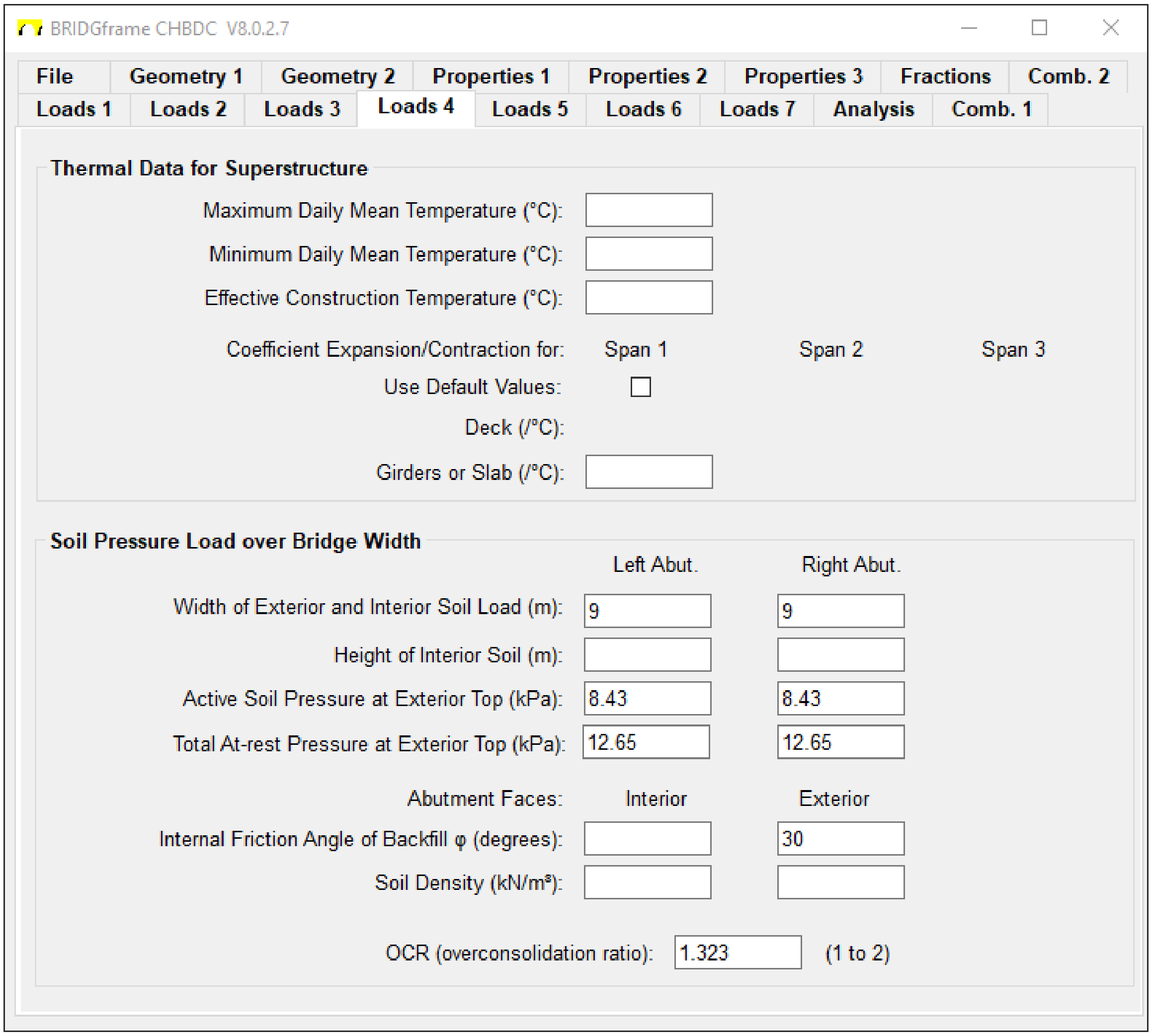


The distribution slab and the precast units might have different densities which would give different modulus of elasticities. For simplicity, ignore differences as the impact on results will be negligible.


BRIDGframe CHBDC V8.0.2.7
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Construction Stage Loads over Bridge Width - UCL (kN/m)
Span 1
Span 2
Span 3
Dead Load (excluding girders & deck):
Live Load:
Dead Loads over Bridge Width (non-composite) - UDL (kN/m)
Span 1
Span 2
Span 3
Case 1:
Girders
Case 2:
Deck
Case 3:
Other
Uniform Superimposed Dead Loads over Bridge Width (composite) - USDL (kN/m)
Span 1
Span 2
Span 3
Case 1:
Barriers
12
Case 2:
Asphalt
19
Case 3:
Dist. Slab
Case 4:
Precast Deck
Wingwall Loads
Left Abutment
Right Abutment
Moment (kN.m):
Vertical (kN):
Moment (kN.m):
Vertical (kN):


BRIDGframe CHBDC V8.0.2.7
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Pedestrian Load
Uniform Pedestrian Load per Span (kN/m):
0
Braking Force
Static Force (kN):
180
plus
10
% of UTL
Live (Truck) Load Case Groups
Truck CL-625
Truck CL-625-ONT
Truck BCL-625
Truck CL-750
Truck CL-800-AB
User Defined
Drop Axles Not Contributing To
Maximum Load Effect (cl.3.8.4.1)

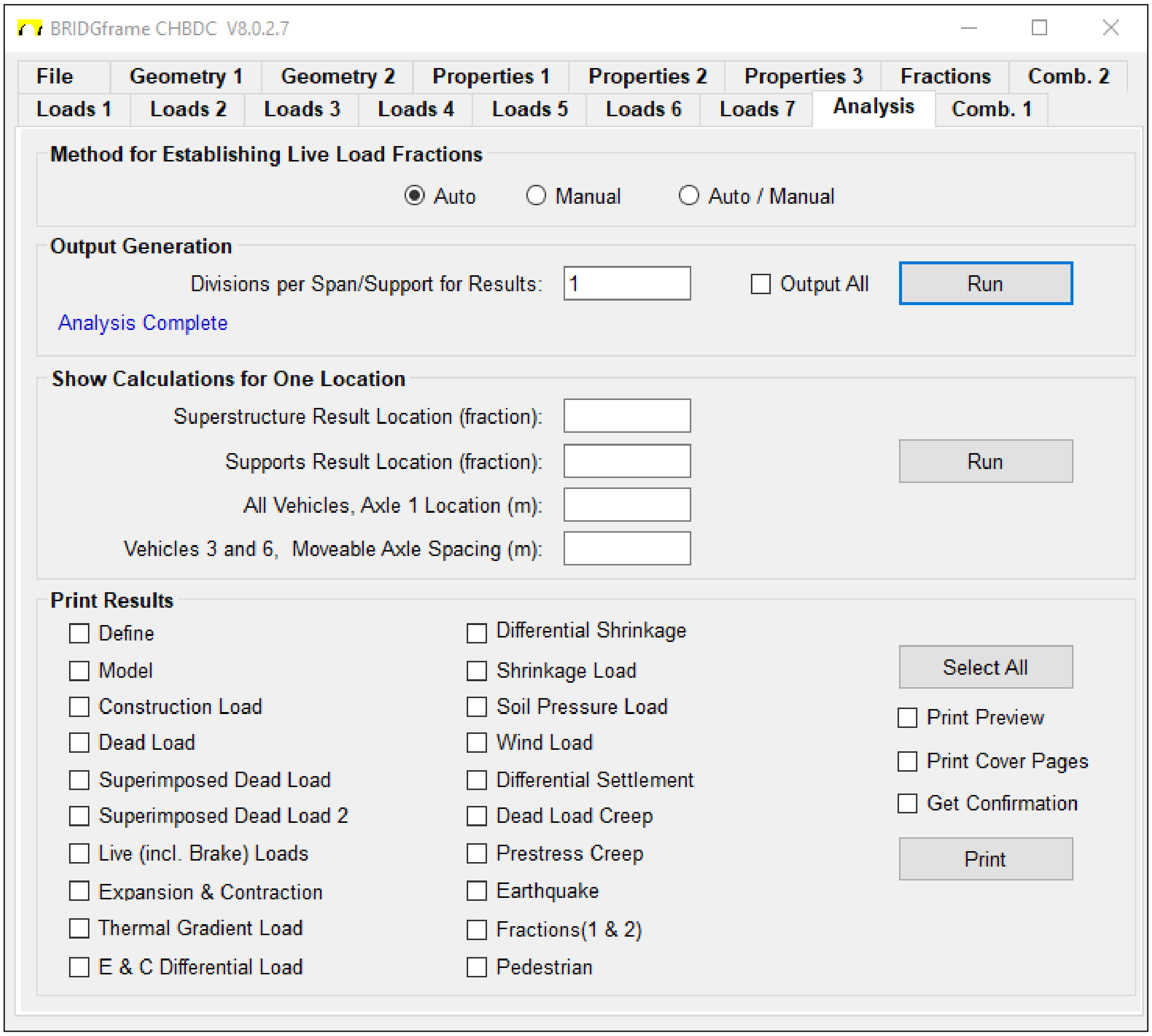

BRIDGframe CHBDC V8.0.2.7
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Truck Loads per Lane (kN)
Case 1
Case 2
Case 3
Case 4
Case 5
Case 6
Axle 1: 50 50 140 120
Axle 2: 140 140 140 175
Axle 3: 140 140 50 140
Axle 4: 175 140
Axle 5: 120 50
Axle Spacing (m)
Case 1
Case 2
Case 3
Case 4
Case 5
Case 6
Axle 1 to Axle 2: 3.6 3.6 1.2 6.6
Axle 2 to Axle 3: 1.2 1.2 3.6 6.6
Axle 3 to Axle 4: 6.6 1.2
Axle 4 to Axle 5: 6.6 3.6
Dynamic Load Allowance (1 + DLA): 1.3 1.25 1.3 1.25
Increment Length for Advancing Vehicles (m): 0.15
Fixed Vehicle Location (m):
Number of Design Lanes: 2
as per table 3.5
Lane Load per Lane - UTL (kN/m): 9
plus 80
% of Force Envelopes from Truck Loadings
Save User Defined Truck Load and Axle Spacing Values



If there are no approach slabs, there will be live load surcharge on the road approaches. This equates to soil fill of 0.8m. There is also an additional soil surcharge load from the T/road to the neutral axis of the superstructure that equates to 0.09 (asphalt) + 0.52 (precast + distribution slab) / 2 = 0.35m. The additional sol surcharge = 1.15m.
The soil surcharge is assumed to be part of the live load surcharge for simplicity.

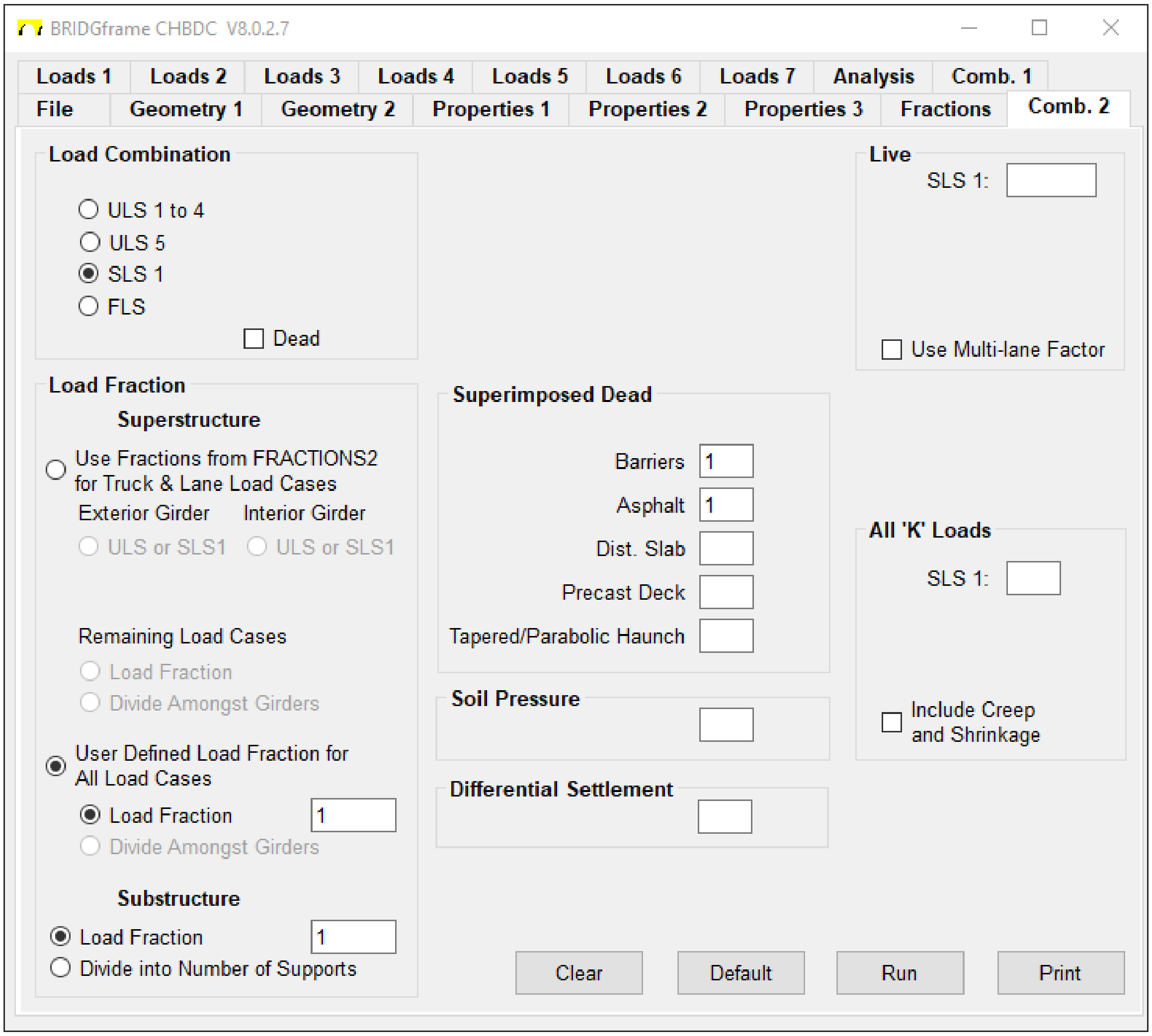
Active pressure from surcharge = 0.333 x 22 x 1.15 = 8.43 kPa
At-rest pressure from surcharge = 0.5 x 22 x 1.15 = 12.65 kPa

These pressures will be adjusted by the program for the OCR when required by the program.



Only one division is required since results at the supports is all that's required.

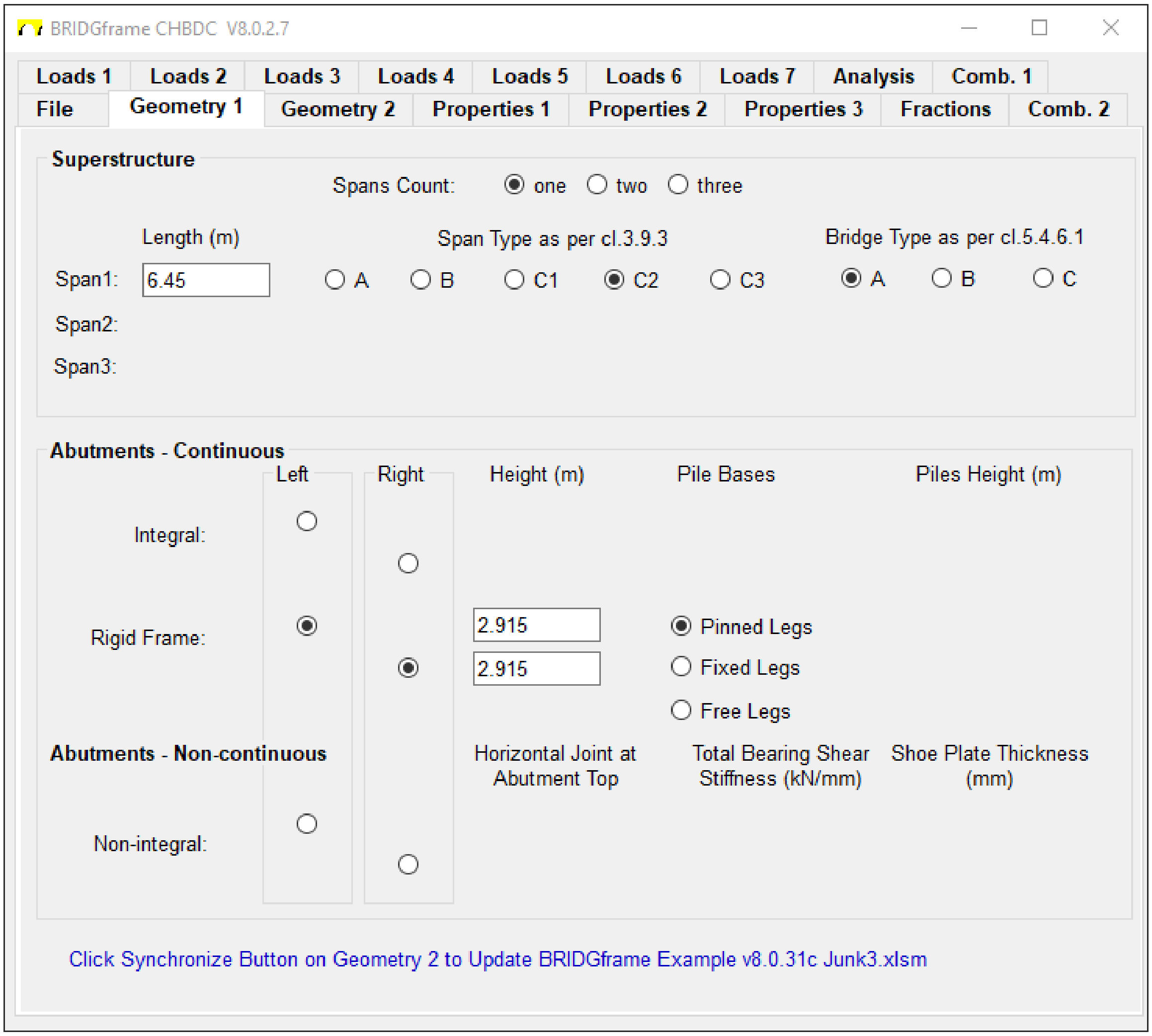
Output results for LIVE, SIDL, and SOIL.

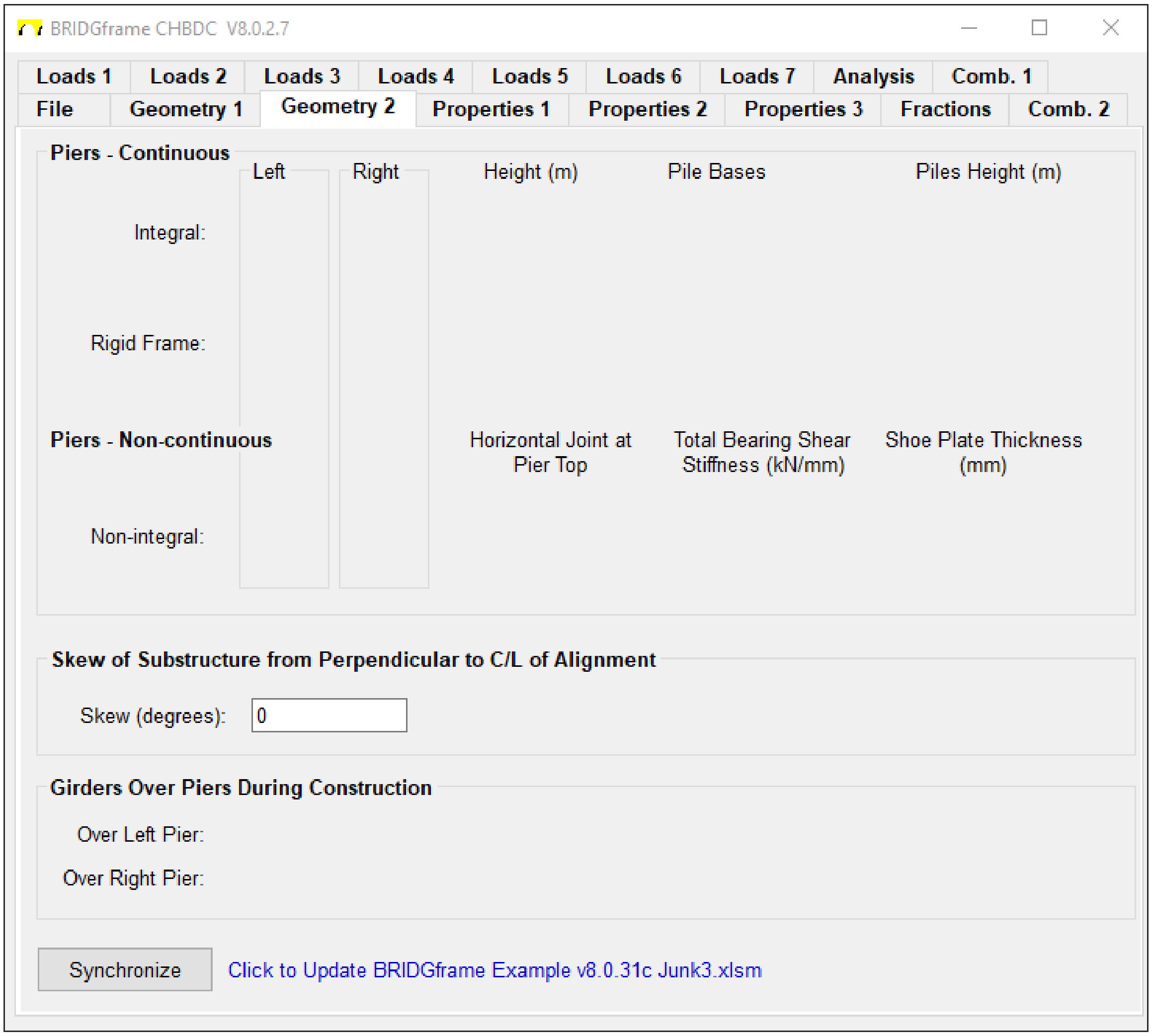


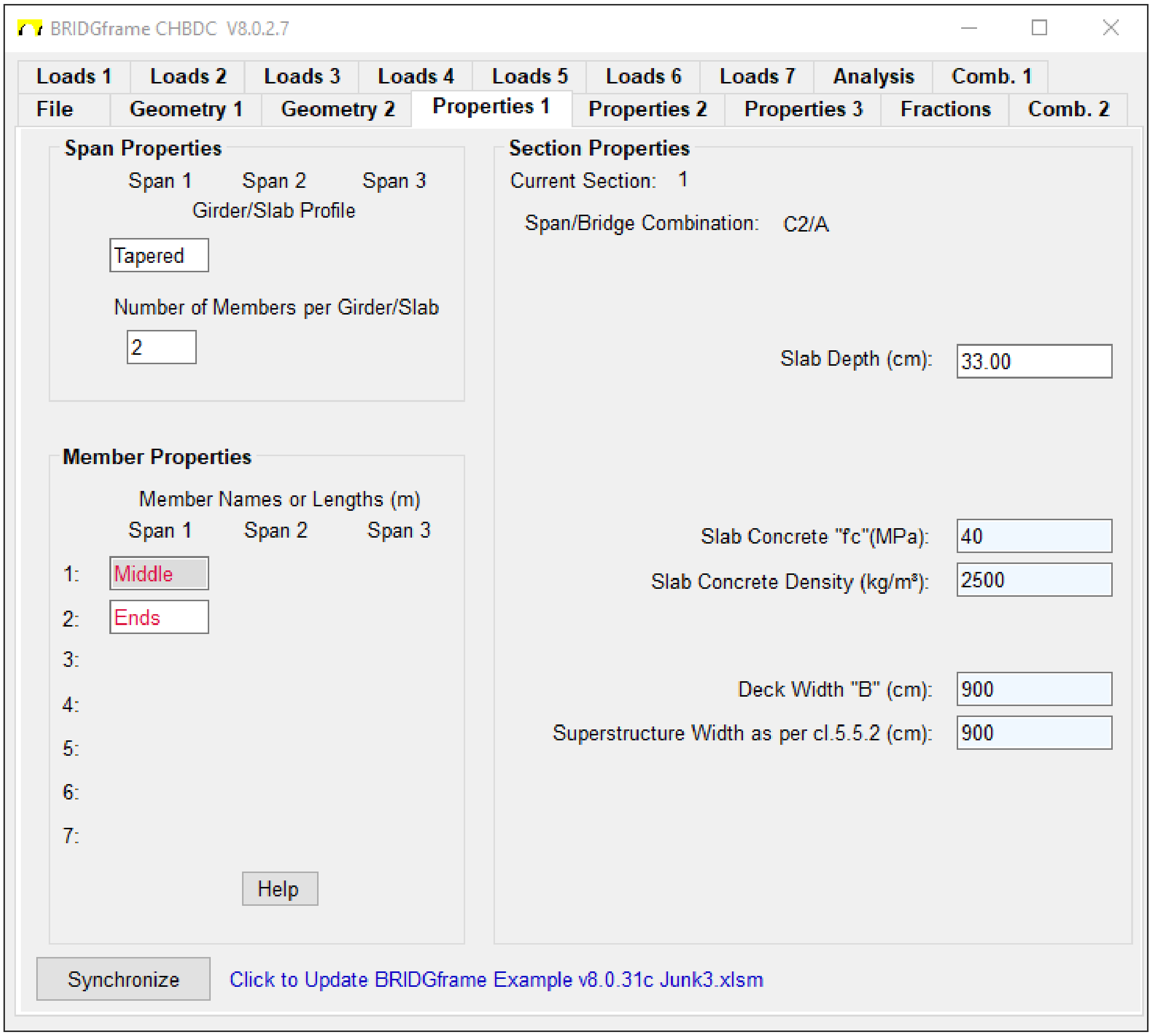
Run 2 SIDL output example using Comb. 2

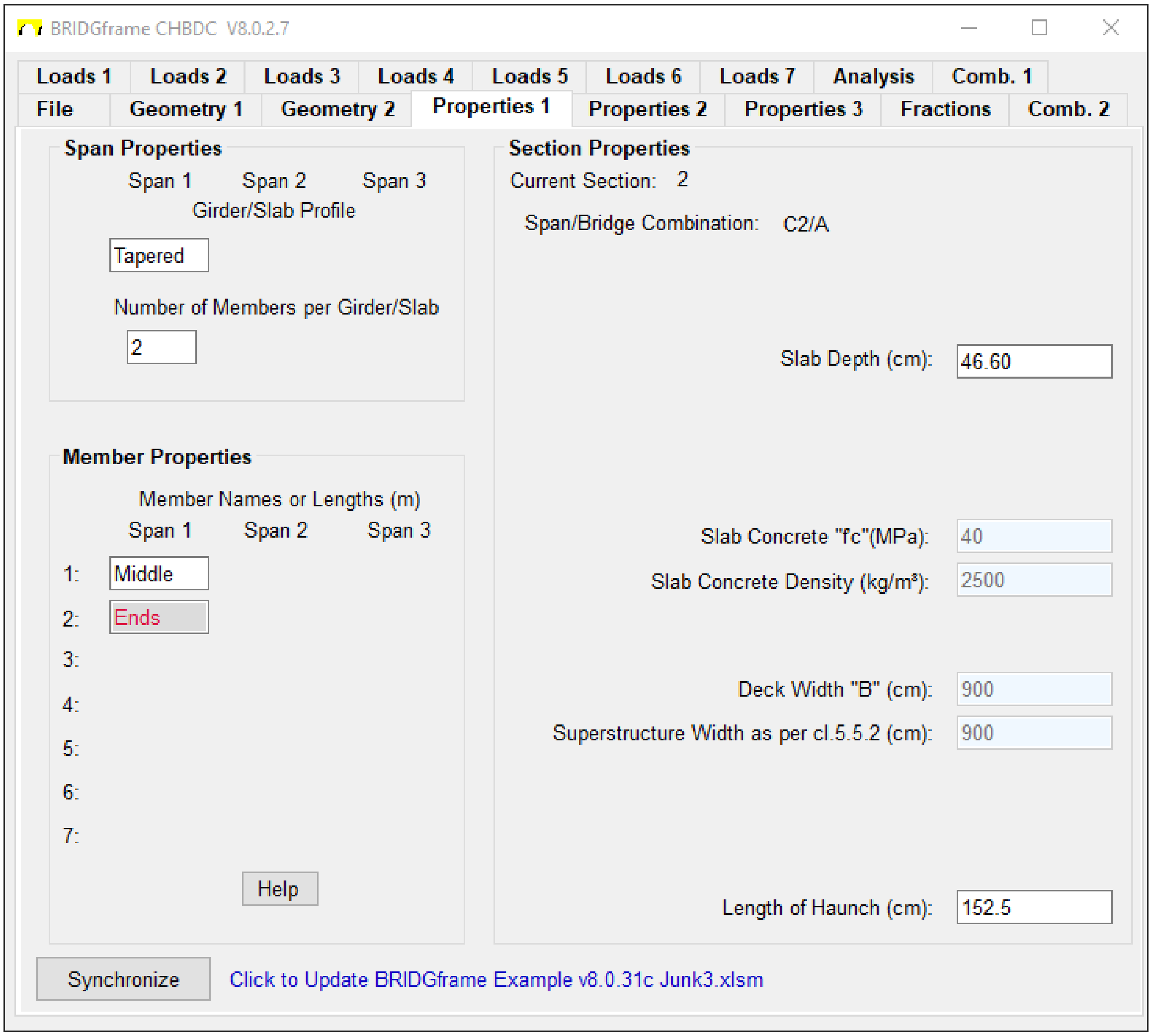
Upon completion of Run 1 and Run 2, add the results together for total load effects.

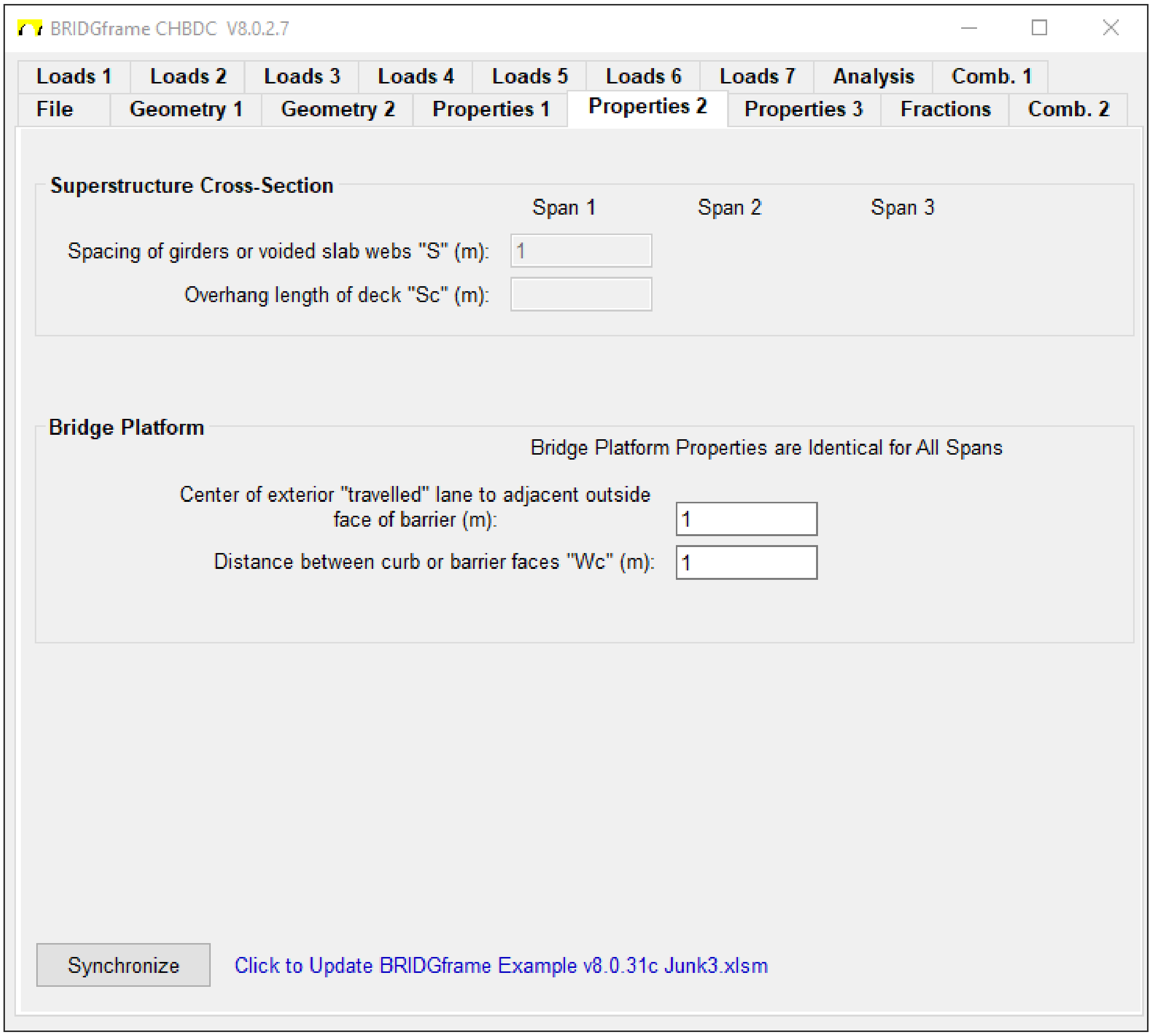
If distribution slab is not acting composite with the precast units:

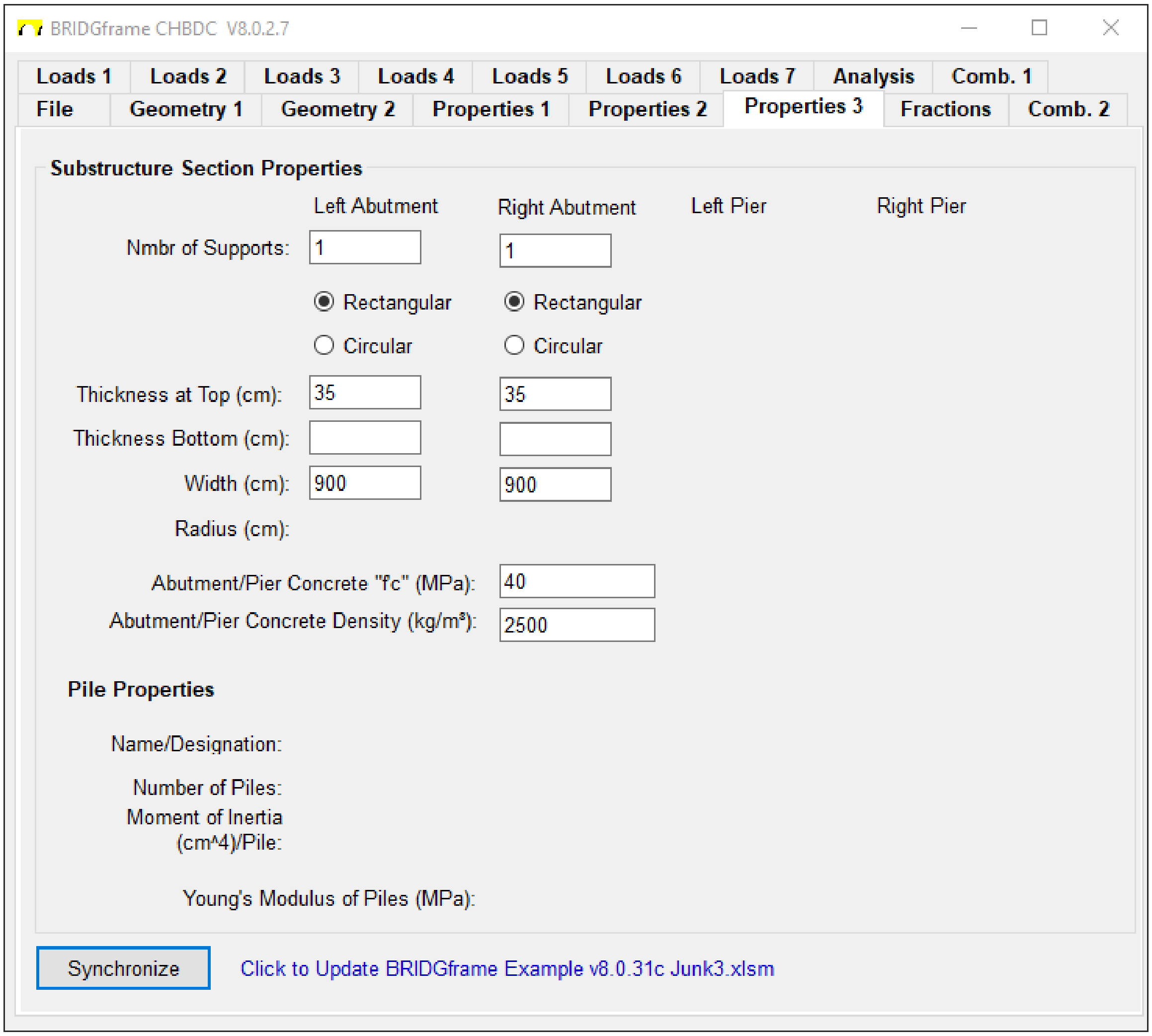


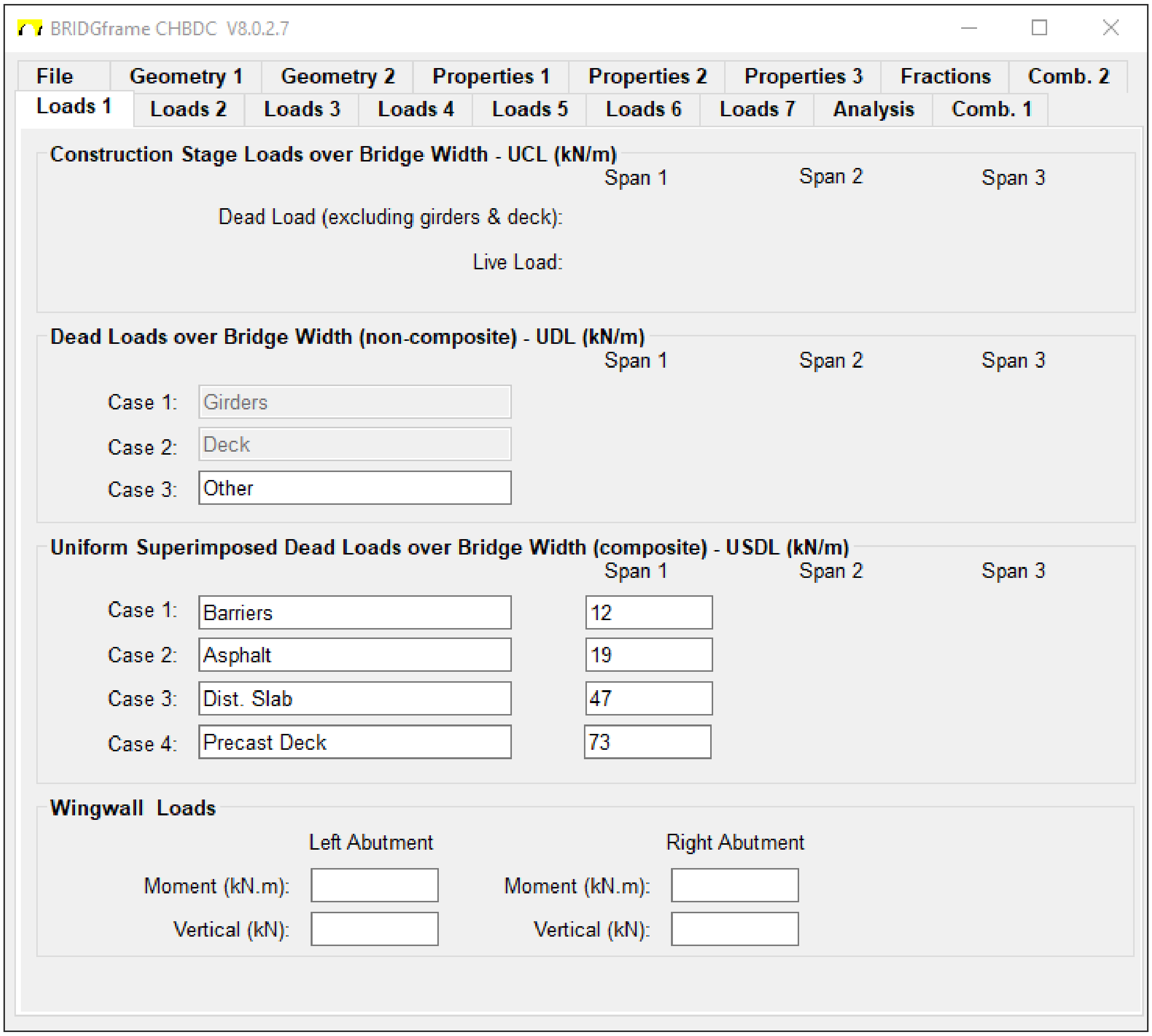

BRIDGframe CHBDC V8.0.2.7
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Piers - Continuous
Left
Right
Height (m)
Pile Bases
Piles Height (m)
Integral:
Rigid Frame:
Piers - Non-continuous
Horizontal Joint at Pier Top
Total Bearing Shear Stiffness (kN/mm)
Shoe Plate Thickness (mm)
Non-integral:
Skew of Substructure from Perpendicular to C/L of Alignment
Skew (degrees):
0
Girders Over Piers During Construction
Over Left Pier:
Over Right Pier:
Synchronize
Click to Update BRIDGframe Example v8.0.31c Junk3.xlsm

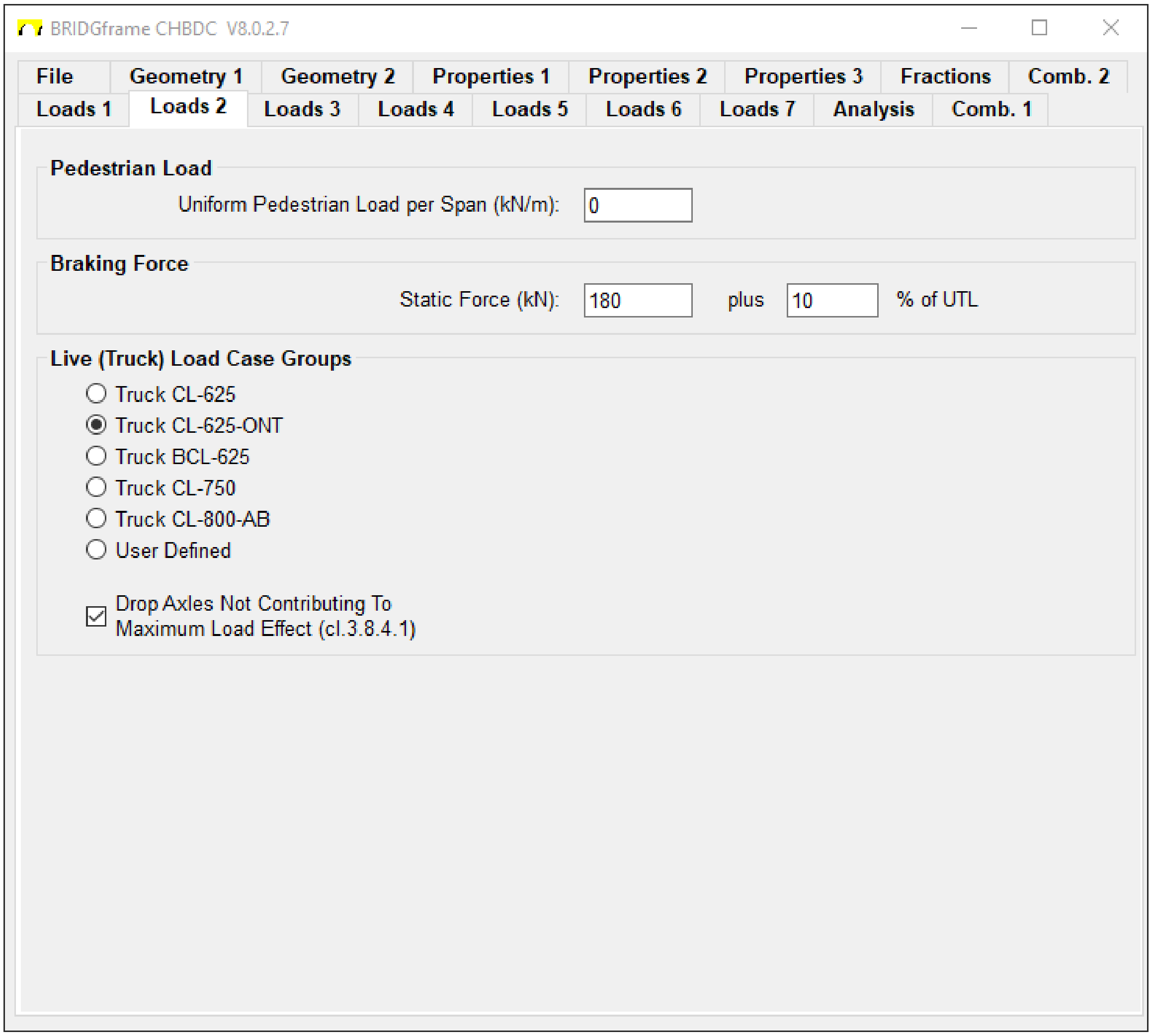

BRIDGframe CHBDC V8.0.2.7
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Span Properties
Span 1
Span 2
Span 3
Girder/Slab Profile
Tapered
Number of Members per Girder/Slab
2
Member Properties
Member Names or Lengths (m)
Span 1
Span 2
Span 3
1:
Middle
2:
Ends
3:
4:
5:
6:
7:
Help
Section Properties
Current Section: 1
Span/Bridge Combination: C2/A
Slab Depth (cm): 33.00
Slab Concrete "f'c"(MPa): 40
Slab Concrete Density (kg/m³): 2500
Deck Width "B" (cm): 900
Superstructure Width as per cl.5.5.2 (cm): 900
Synchronize
Click to Update BRIDGframe Example v8.0.31c Junk3.xlsm

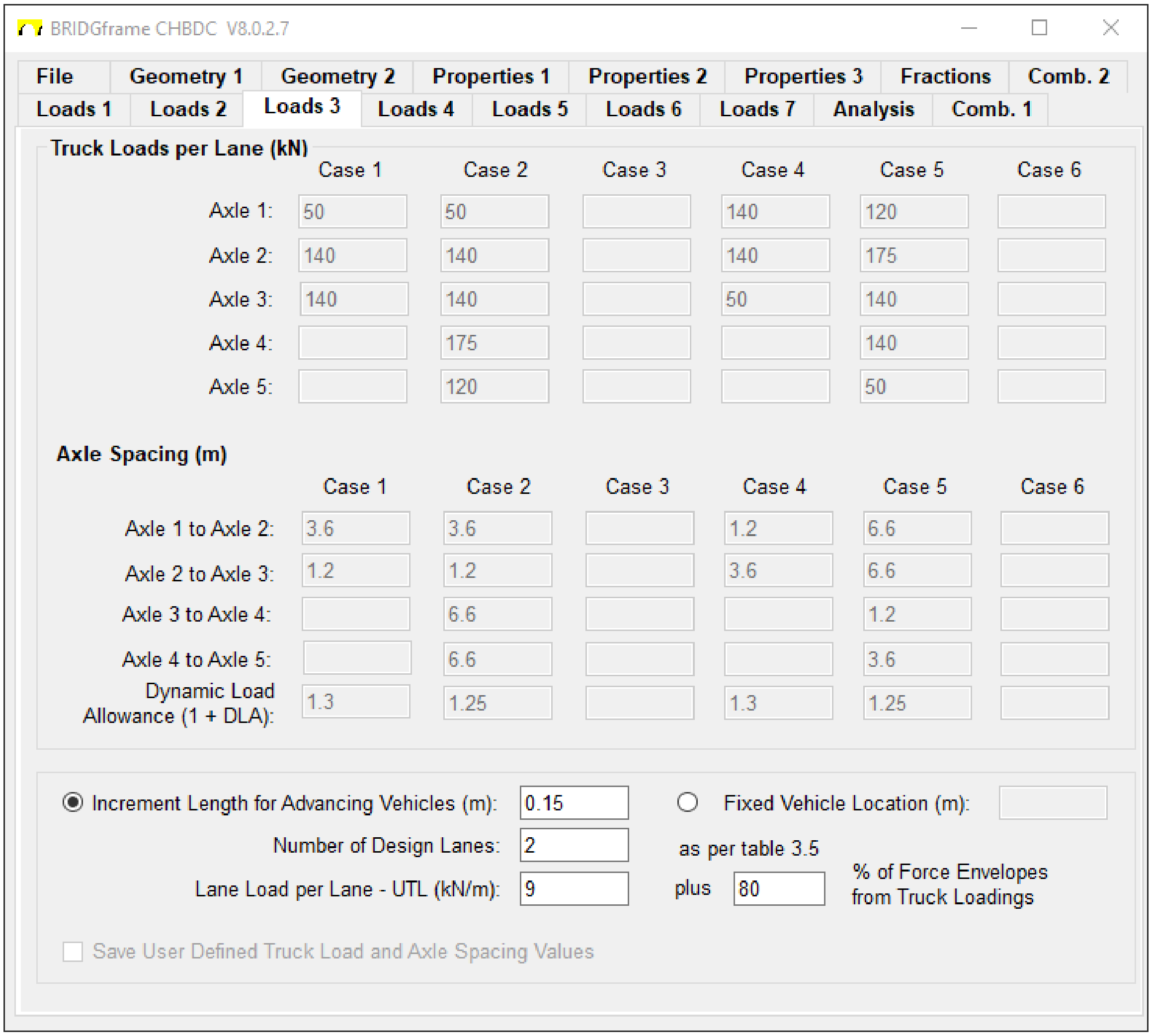

BRIDGframe CHBDC V8.0.2.7
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Span Properties
Span 1
Span 2
Span 3
Girder/Slab Profile
Tapered
Number of Members per Girder/Slab
2
Member Properties
Member Names or Lengths (m)
Span 1
Span 2
Span 3
1: Middle
2: Ends
3:
4:
5:
6:
7:
Help
Section Properties
Current Section: 2
Span/Bridge Combination: C2/A
Slab Depth (cm): 46.60
Slab Concrete "f'c"(MPa): 40
Slab Concrete Density (kg/m³): 2500
Deck Width "B" (cm): 900
Superstructure Width as per cl.5.5.2 (cm): 900
Length of Haunch (cm): 152.5
Synchronize
Click to Update BRIDGframe Example v8.0.31c Junk3.xlsm

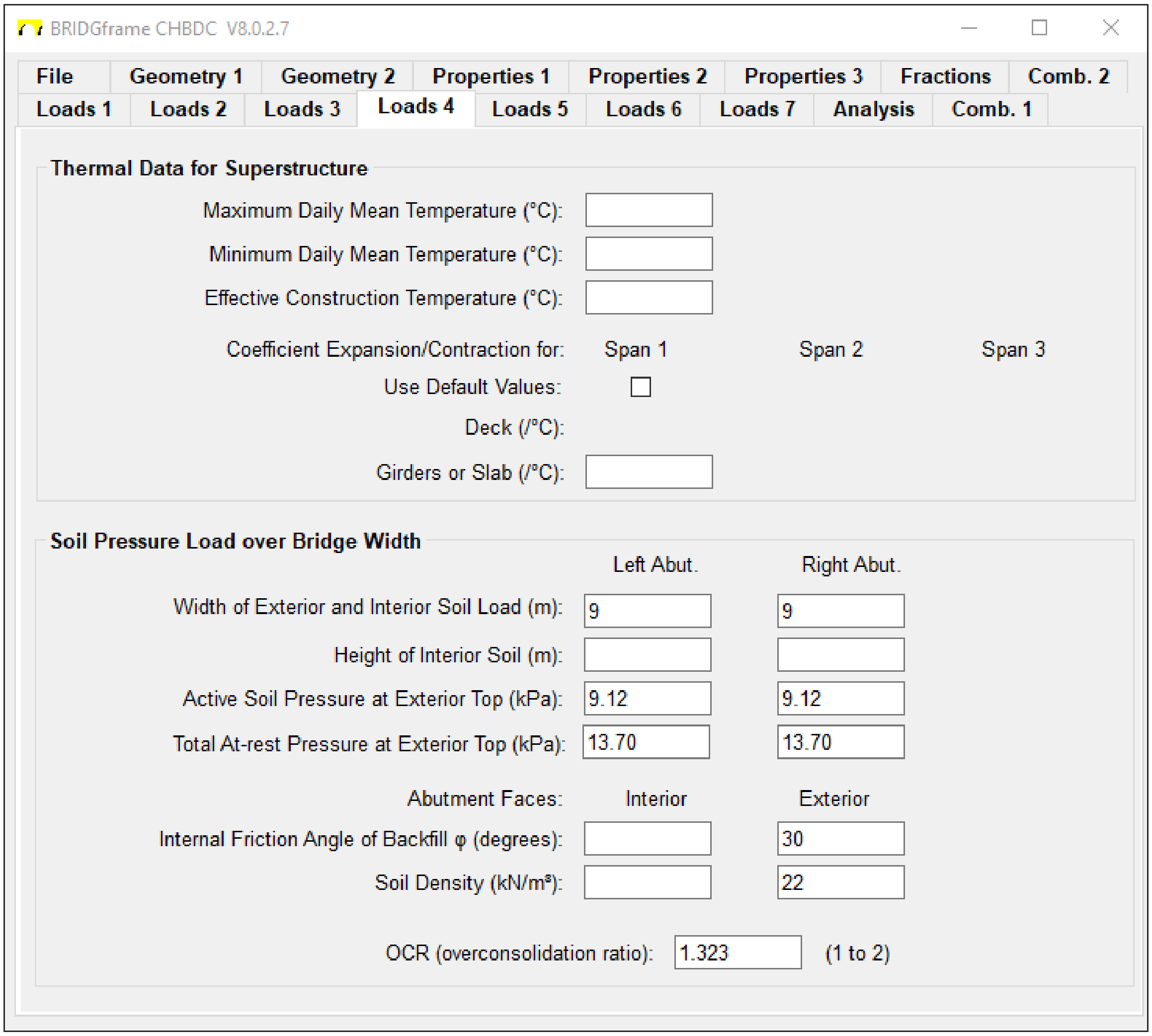

BRIDGframe CHBDC V8.0.2.7
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Superstructure Cross-Section
Span 1
Span 2
Span 3
Spacing of girders or voided slab webs "S" (m):
1
Overhang length of deck "Sc" (m):
Bridge Platform
Bridge Platform Properties are Identical for All Spans
Center of exterior "travelled" lane to adjacent outside face of barrier (m):
1
Distance between curb or barrier faces "Wc" (m):
1
Synchronize
Click to Update BRIDGframe Example v8.0.31c Junk3.xlsm


BRIDGframe CHBDC V8.0.2.7
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Substructure Section Properties
Left Abutment
Right Abutment
Left Pier
Right Pier
Nmbr of Supports:
1
1
Rectangular
Rectangular
Circular
Circular
Thickness at Top (cm):
35
35
Thickness Bottom (cm):
Width (cm):
900
900
Radius (cm):
Abutment/Pier Concrete "f'c" (MPa):
40
Abutment/Pier Concrete Density (kg/m³):
2500
Pile Properties
Name/Designation:
Number of Piles:
Moment of Inertia (cm^4)/Pile:
Young's Modulus of Piles (MPa):
Synchronize
Click to Update BRIDGframe Example v8.0.31c Junk3.xlsm


BRIDGframe CHBDC V8.0.2.7
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Construction Stage Loads over Bridge Width - UCL (kN/m)
Span 1
Span 2
Span 3
Dead Load (excluding girders & deck):
Live Load:
Dead Loads over Bridge Width (non-composite) - UDL (kN/m)
Span 1
Span 2
Span 3
Case 1:
Girders
Case 2:
Deck
Case 3:
Other
Uniform Superimposed Dead Loads over Bridge Width (composite) - USDL (kN/m)
Span 1
Span 2
Span 3
Case 1:
Barriers
12
Case 2:
Asphalt
19
Case 3:
Dist. Slab
47
Case 4:
Precast Deck
73
Wingwall Loads
Left Abutment
Right Abutment
Moment (kN.m):
Vertical (kN):
Moment (kN.m):
Vertical (kN):


BRIDGframe CHBDC V8.0.2.7
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Pedestrian Load
Uniform Pedestrian Load per Span (kN/m):
0
Braking Force
Static Force (kN):
180
plus
10
% of UTL
Live (Truck) Load Case Groups
Truck CL-625
Truck CL-625-ONT
Truck BCL-625
Truck CL-750
Truck CL-800-AB
User Defined
Drop Axles Not Contributing To
Maximum Load Effect (cl.3.8.4.1)

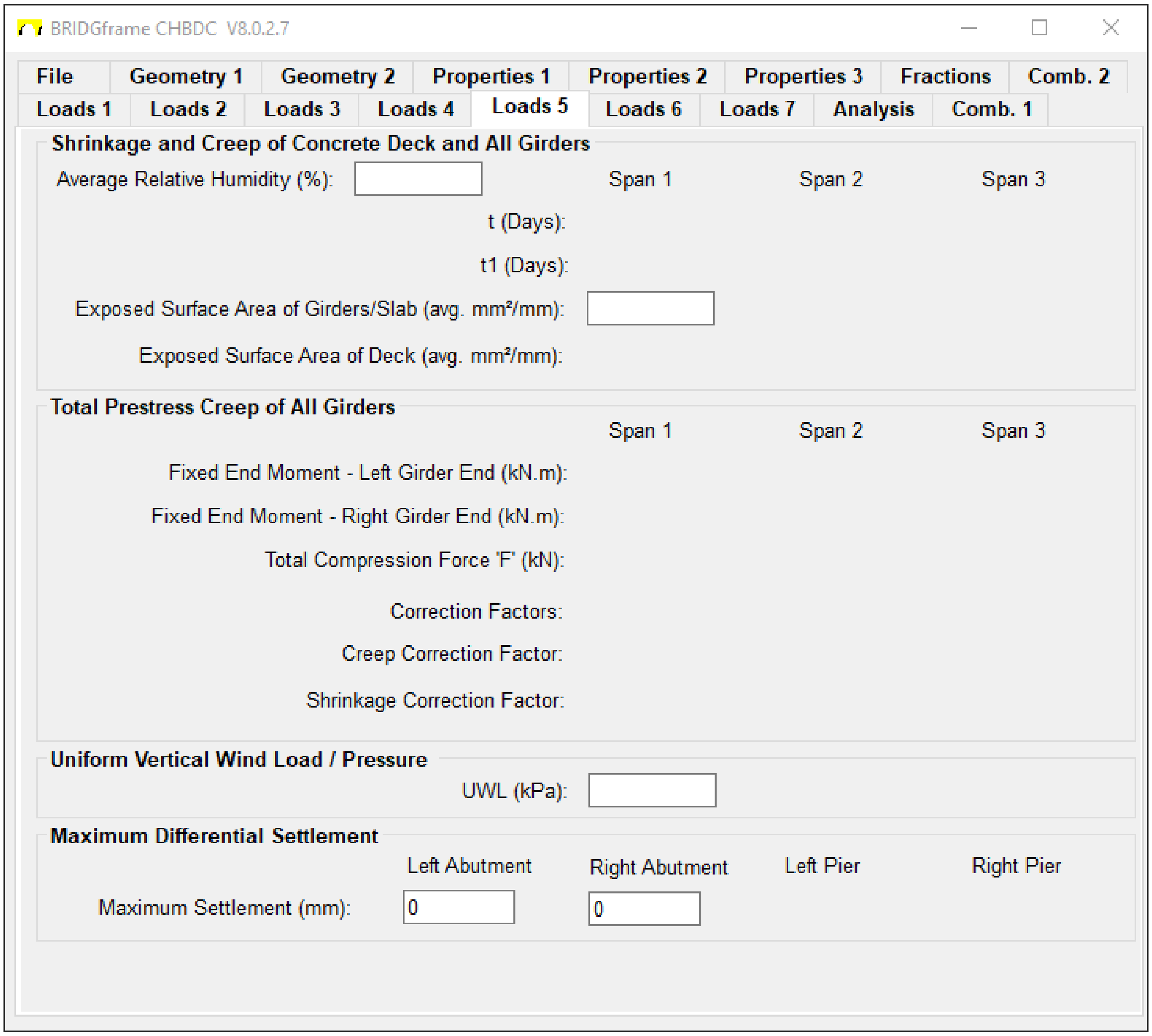

BRIDGframe CHBDC V8.0.2.7
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Truck Loads per Lane (kN)
Case 1 Case 2 Case 3 Case 4 Case 5 Case 6
Axle 1: 50 50 140 120
Axle 2: 140 140 140 175
Axle 3: 140 140 50 140
Axle 4: 175 140
Axle 5: 120 50
Axle Spacing (m)
Case 1 Case 2 Case 3 Case 4 Case 5 Case 6
Axle 1 to Axle 2: 3.6 3.6 1.2 6.6
Axle 2 to Axle 3: 1.2 1.2 3.6 6.6
Axle 3 to Axle 4: 6.6 1.2
Axle 4 to Axle 5: 6.6 3.6
Dynamic Load Allowance (1 + DLA): 1.3 1.25 1.3 1.25
Increment Length for Advancing Vehicles (m): 0.15
Fixed Vehicle Location (m):
Number of Design Lanes: 2
as per table 3.5
Lane Load per Lane - UTL (kN/m): 9
plus 80
% of Force Envelopes from Truck Loadings
Save User Defined Truck Load and Axle Spacing Values

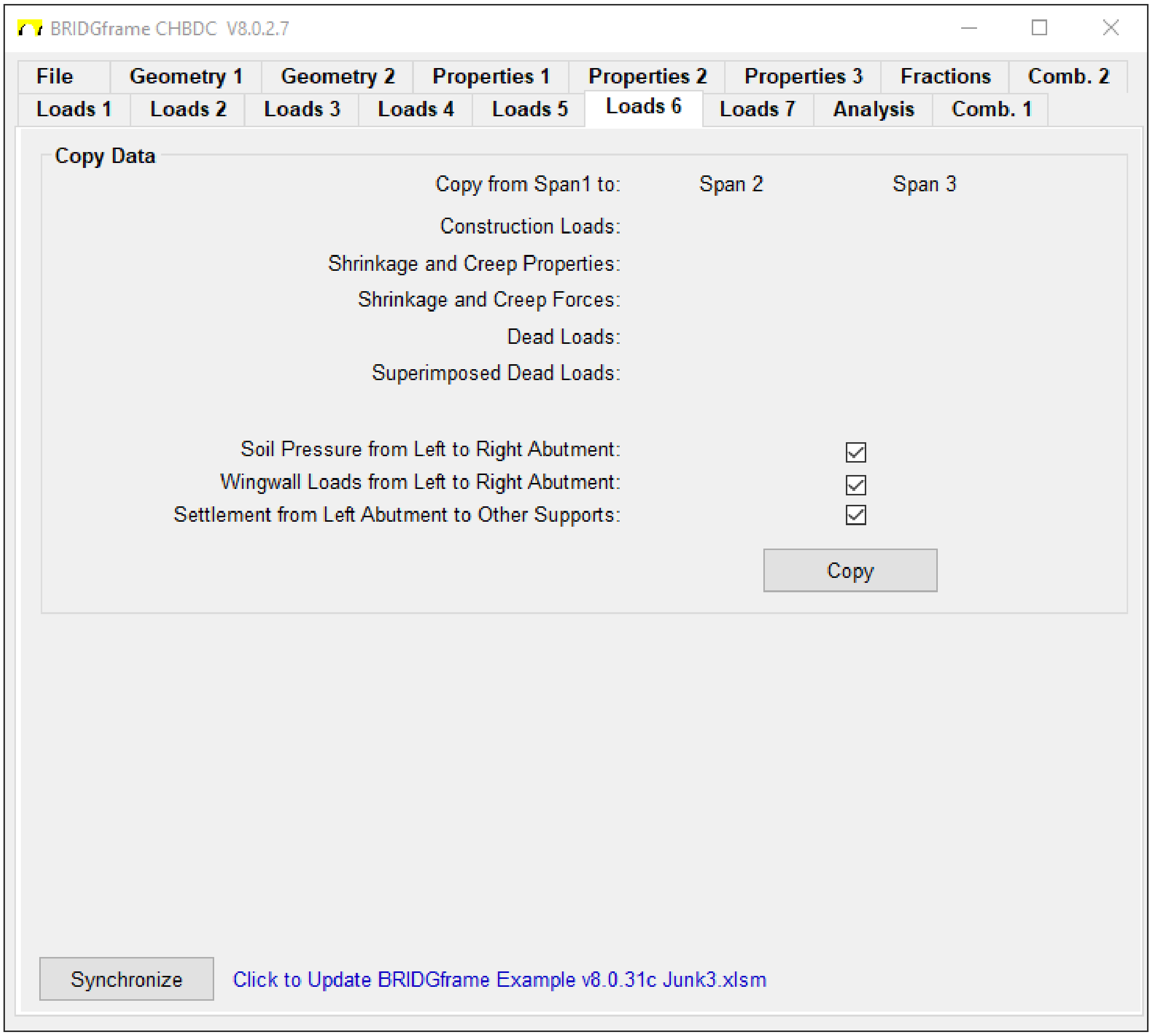


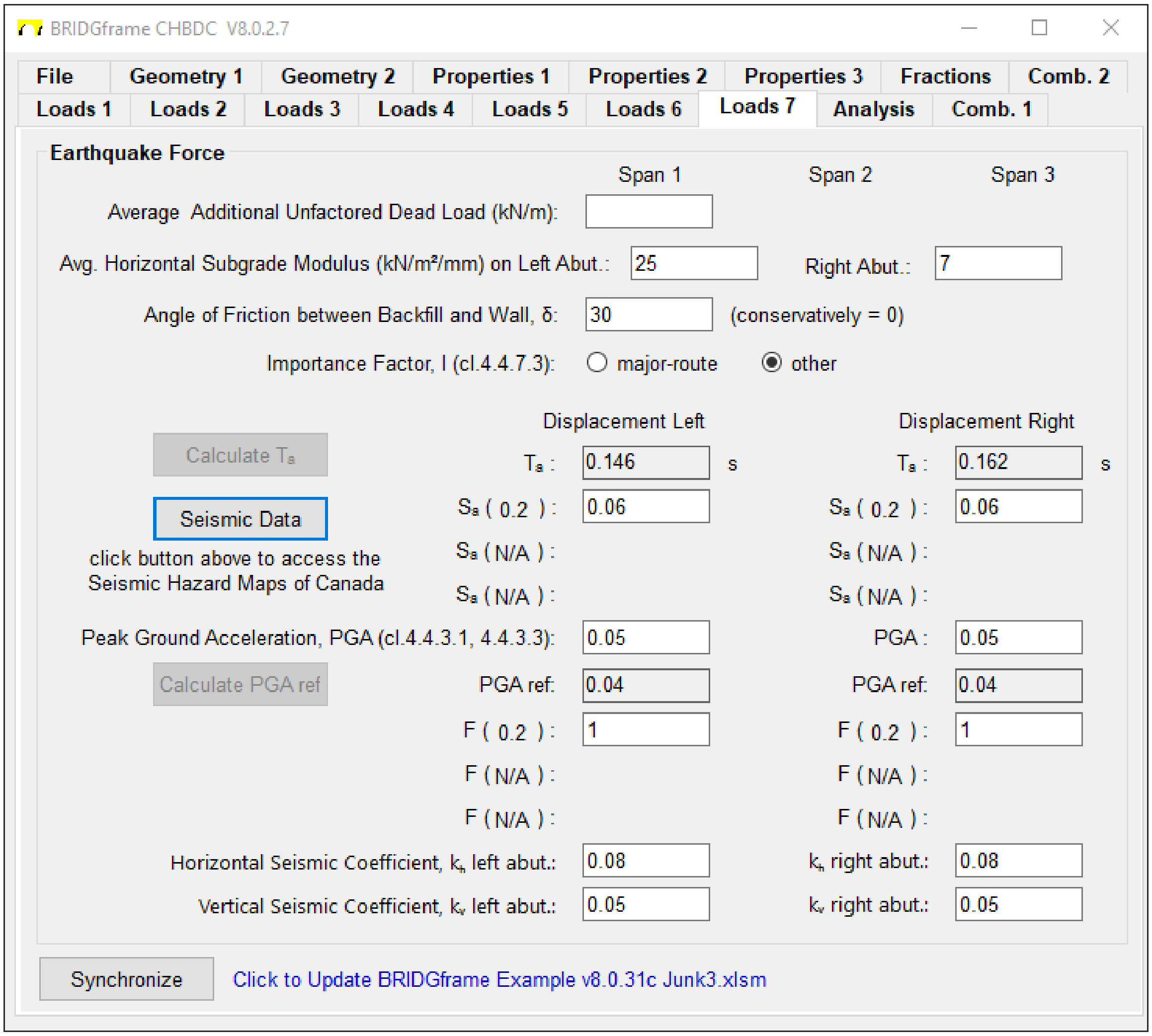
If there are no approach slabs, there will be live load surcharge on the road approaches. This equates to soil fill of 0.8m. There is also an additional soil surcharge load from the T/road to the neutral axis of the superstructure that equates to 0.09 (asphalt) + 0.19 (distribution slab) + 0.33 (precast) / 2 = 0.445m. The additional sol surcharge = 1.245m. The soil surcharge is assumed to be part of the live load surcharge for simplicity.

Active pressure from surcharge = 0.333 x 22 x 1.245 = 9.12 kPa
At-rest pressure from surcharge = 0.5 x 22 x 1.245 = 13.70 kPa

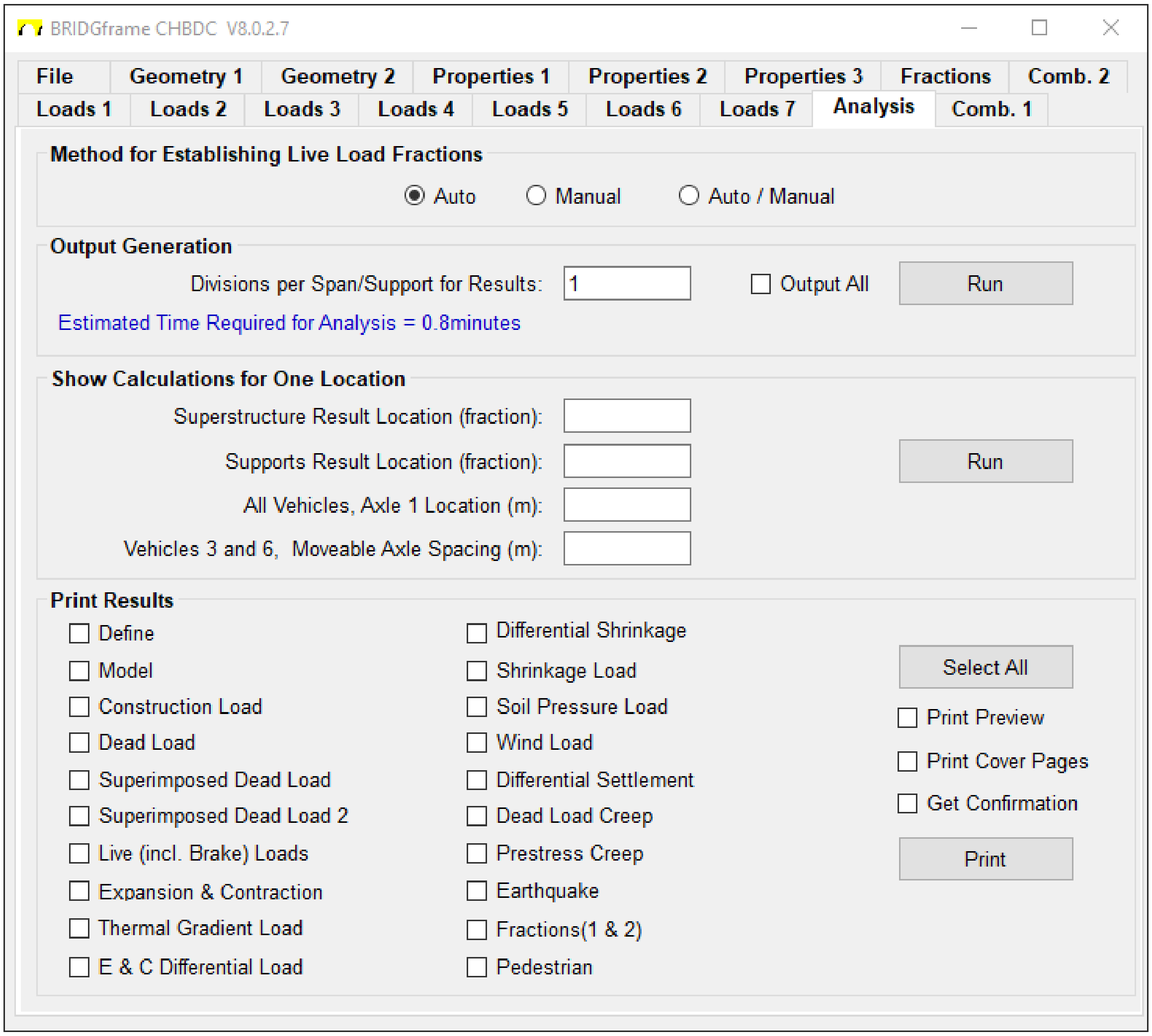
These pressures will be adjusted by the program for the OCR when required by the program.


BRIDGframe CHBDC V8.0.2.7
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Shrinkage and Creep of Concrete Deck and All Girders
Average Relative Humidity (%):
Span 1
Span 2
Span 3
t (Days):
t1 (Days):
Exposed Surface Area of Girders/Slab (avg. mm²/mm):
Exposed Surface Area of Deck (avg. mm²/mm):
Total Prestress Creep of All Girders
Span 1
Span 2
Span 3
Fixed End Moment - Left Girder End (kN.m):
Fixed End Moment - Right Girder End (kN.m):
Total Compression Force 'F' (kN):
Correction Factors:
Creep Correction Factor:
Shrinkage Correction Factor:
Uniform Vertical Wind Load / Pressure
UWL (kPa):
Maximum Differential Settlement
Left Abutment
Right Abutment
Left Pier
Right Pier
Maximum Settlement (mm):
0
0


BRIDGframe CHBDC V8.0.2.7
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Copy Data
Copy from Span1 to:
Span 2
Span 3
Construction Loads:
Shrinkage and Creep Properties:
Shrinkage and Creep Forces:
Dead Loads:
Superimposed Dead Loads:
Soil Pressure from Left to Right Abutment:
Wingwall Loads from Left to Right Abutment:
Settlement from Left Abutment to Other Supports:
Copy
Synchronize
Click to Update BRIDGframe Example v8.0.31c Junk3.xlsm



Loads 7 must be completed to advance to Analysis. Earthquake results will not be used therefore the values input are irrelevant. Assume input values to allow the tab to be Synchronized.



Only one division is required since results at the supports is all that's required.

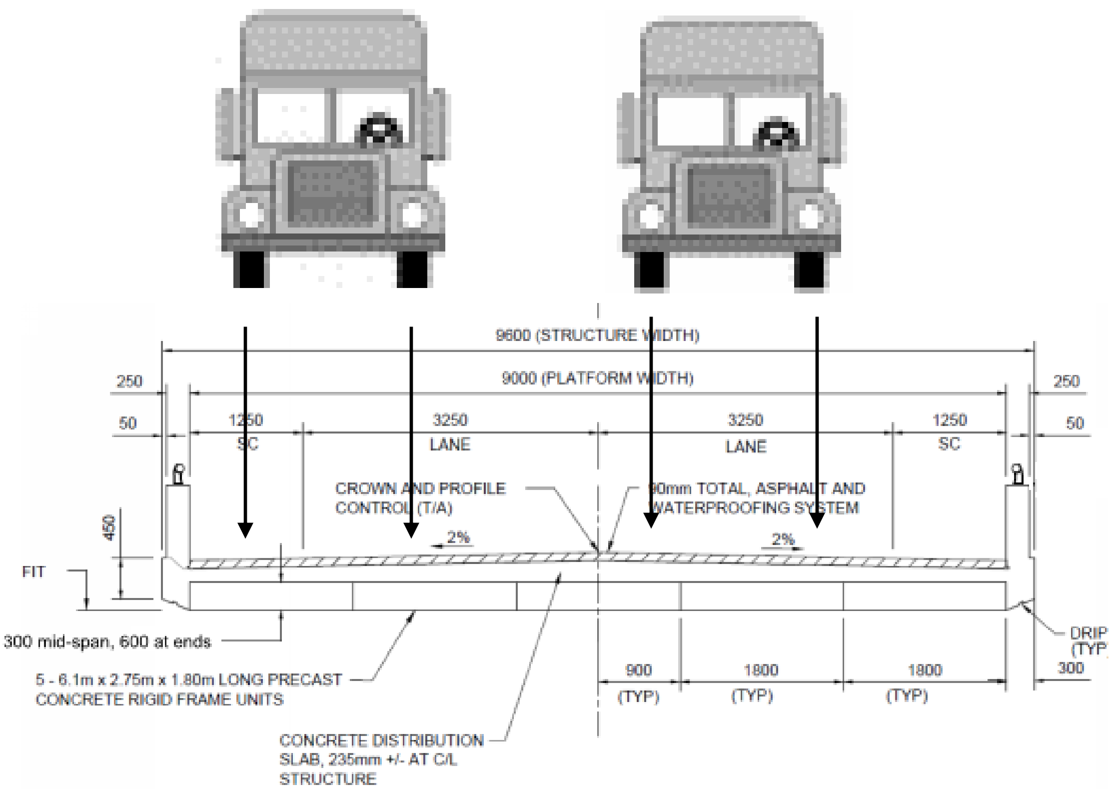
Output results for SIDL, LIVE, BRAKING and SOIL.

Use engineering judgement regarding the use or magnitude of the BRAKING force.

Distribution of Live Load on Footing:

There are various methods for applying the live load to the footing. Below is an example of an acceptable method.

The bridge consists of two lanes. The vehicle in the left lane can be located 0.6m from the inside face of barrier to the first line of wheel loads. The vehicle in the right lane can be located 0.6m from the C/L of bridge (the edge of its lane).

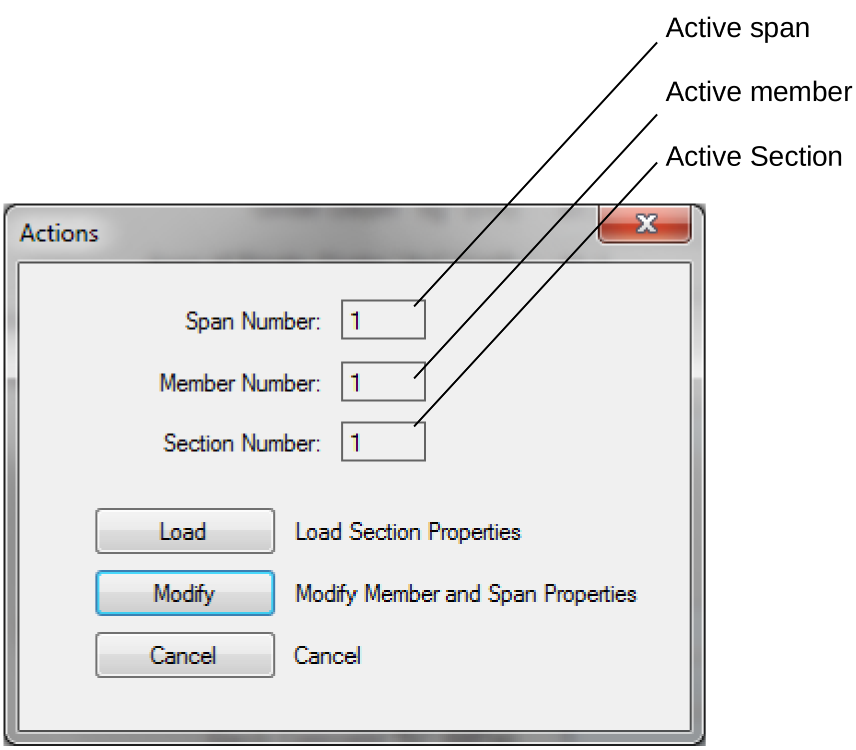


The live load after applying the multi-lane factor can be applied as a concentric load on a footing that is (0.25 + 0.6 + 1.8 + 2.1 + 0.6 + 1.8 + 0.6 + 0.25) = 8.0m long. The 1.8 m represents the distance between wheel lines.

Another method might be to use the entire footing length and apply the truck or trucks as an eccentric load on the footing length.

APPENDIX 6 – ACTIONS DIALOGUE WINDOW

Popup on Properties 1 tab if User hovers over an input box for Members Properties and clicks left mouse button.



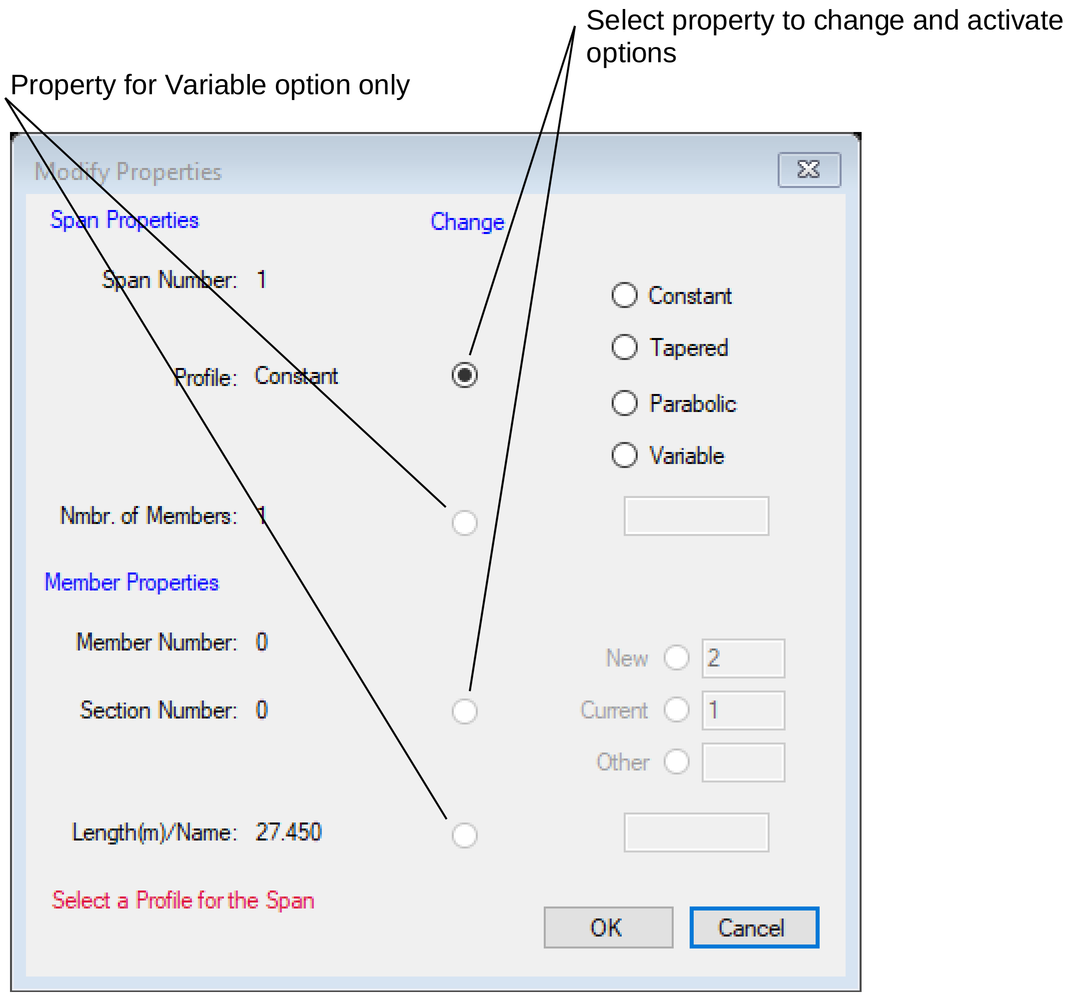
Load: Loads saved section properties or makes member Active

Modify: Opens the Modify Properties Window

Cancel: Closes the window and cancels the operation

APPENDIX 7 – MODIFY PROPERTIES DIALOGUE WINDOW

Popup on Properties 1 tab if User hovers over an input box for Span Properties and clicks left mouse button.

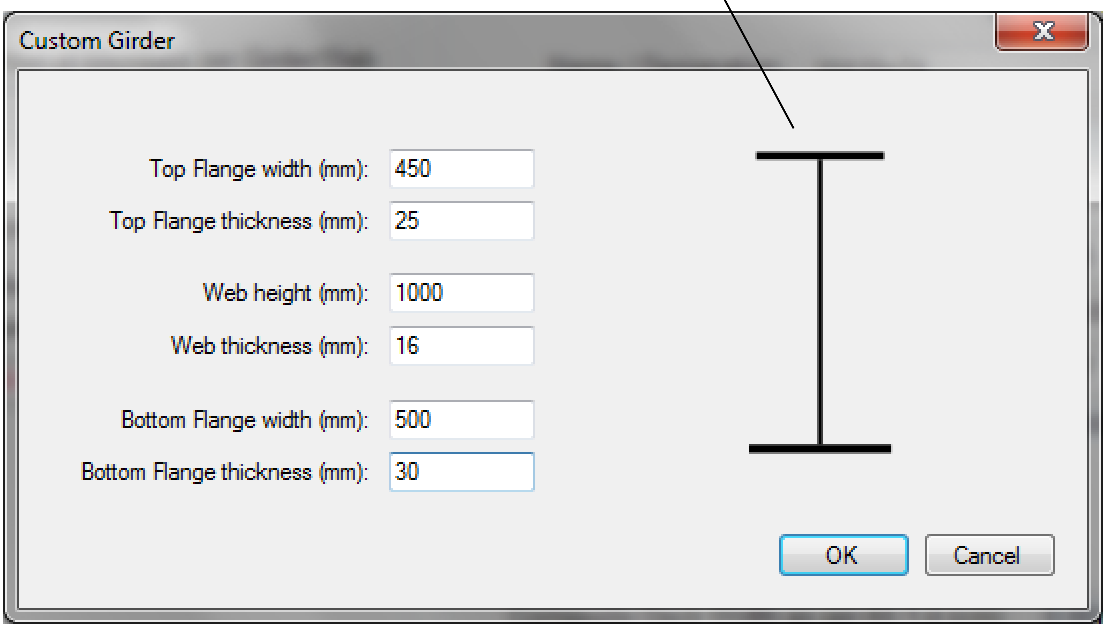


Constant: One Section property over span length
Parabolic: Symmetrical parabolic soffit of slab superstructure
Tapered: Symmetrical tapered soffit of slab superstructure
Variable: Divides span into members for changing section. Length of last member input into span will be automatically calculated.

New: Generate a new section property
Current: Set non-active member to currently loaded section properties. This option enables the assigning of same section properties to different members to form a group.
Other: Set non-active member to stored section properties. This option enables the assigning of same section properties to different members to form a group.

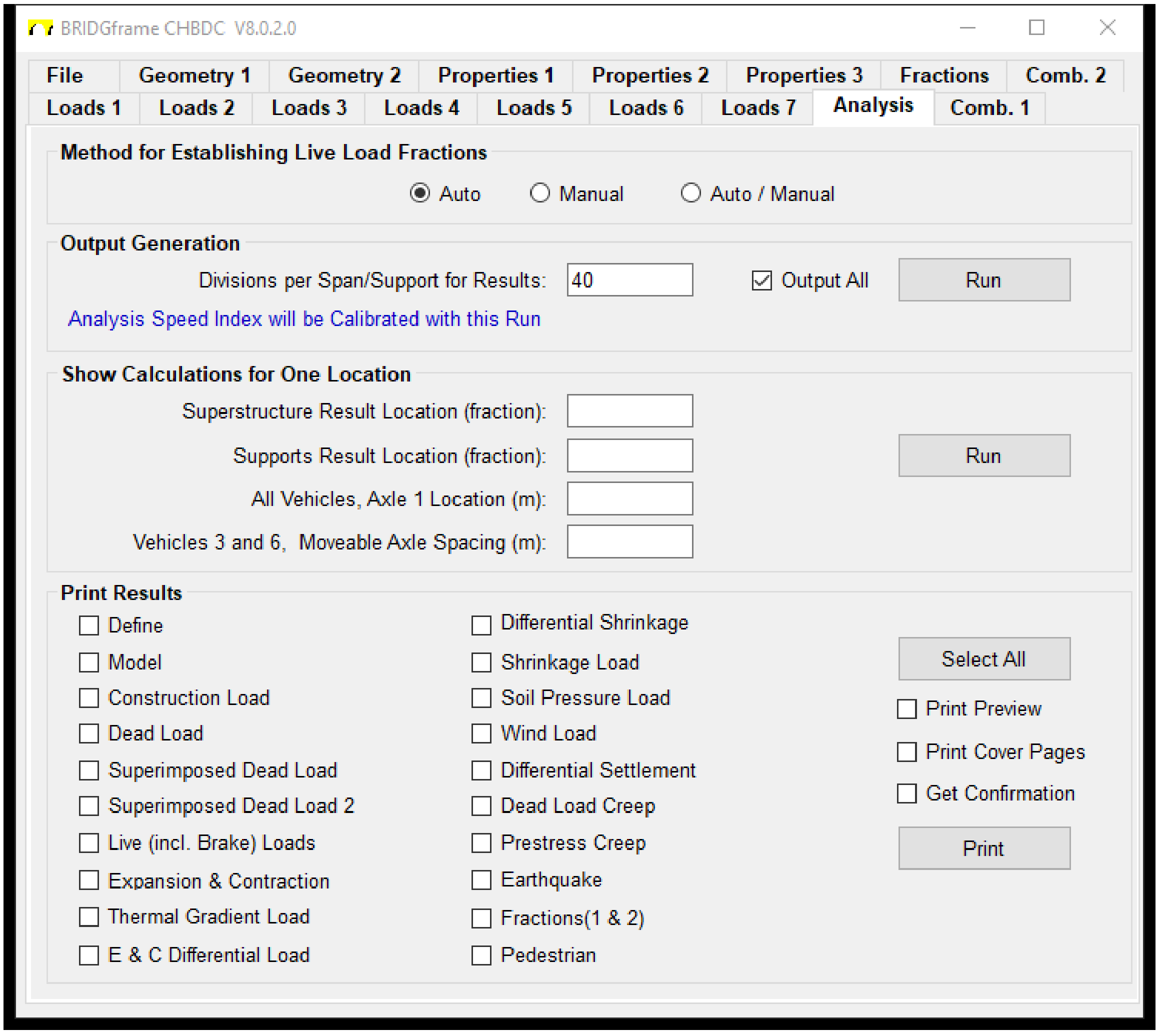
APPENDIX 8 – CUSTOM SECTION PROPERTY DIALOGUE WINDOW

Diagram of girder is dynamic and
to proportion for visual assistance



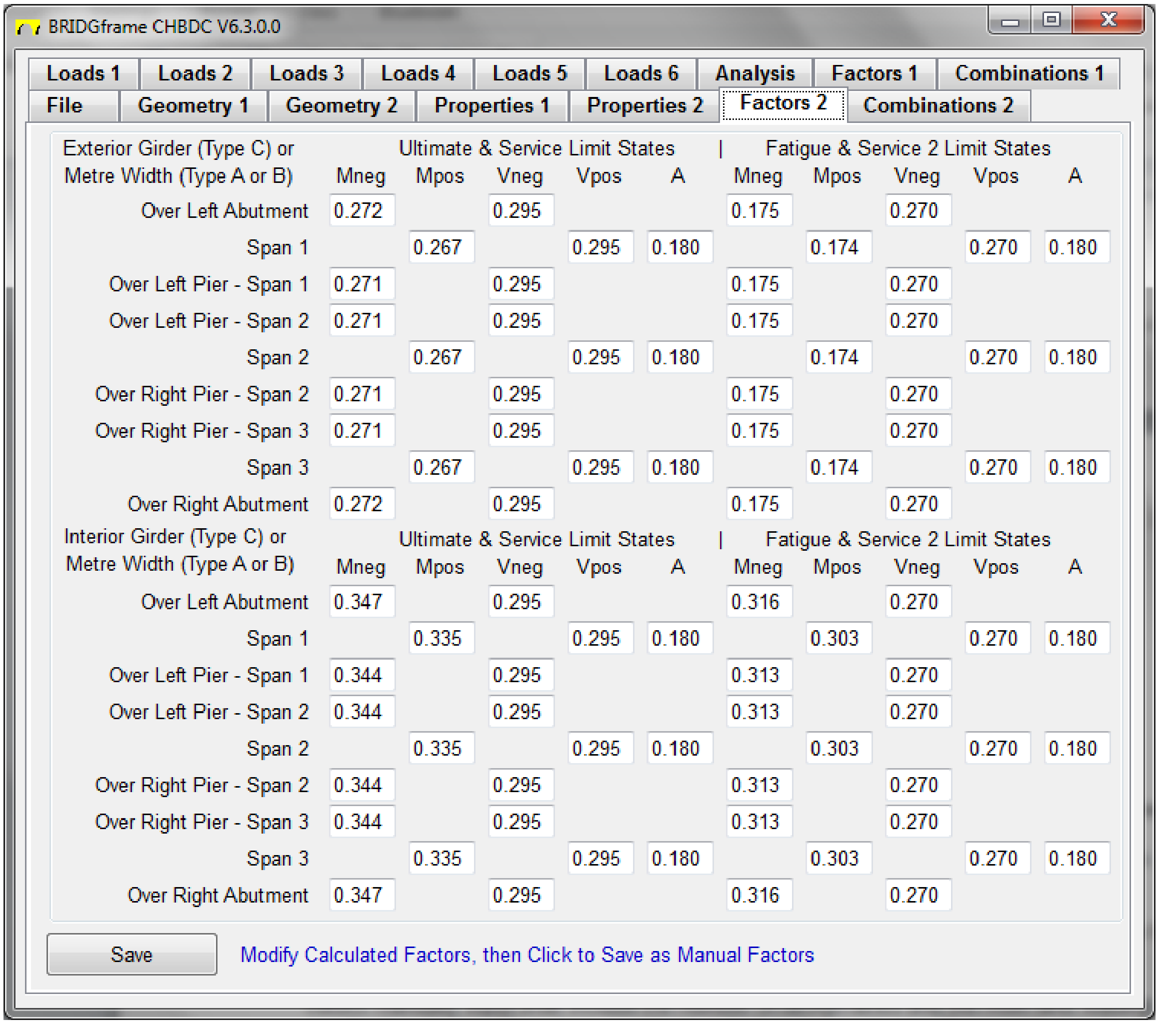
- Generate custom section properties of 'I' steel plate girders from the Properties1 input tab using the 'Custom' button

APPENDIX 9 – ANALYSIS



- Select the number of divisions per span or continuous support to get output results. Analysis can be paused or canceled using the F1 key. Output can be done in groups by unclicking the Output All box to speed up populating the output results when some results are not required.
- The program will automatically calculate the Live Load Fractions for a design strip when the Auto radio button is selected. When Manual is selected the program does not calculate the Live Load Fractions for a design strip but advances to the Fractions tab to be completed by the User. When Auto/Manual is selected the program automatically calculates the Live Load Fractions for a design strip and populates the Fractions tab for editing by the User.
- Using the Show Calculations for One Location, the User may find results at a location between that requested. The results are represented by the red number shown on the individual worksheets.

APPENDIX 10 – Live Load Fractions



BRIDGframe CHBDC V6.3.0.0

Loads 1 | Loads 2 | Loads 3 | Loads 4 | Loads 5 | Loads 6 | Analysis | Factors 1 | Combinations 1
File | Geometry 1 | Geometry 2 | Properties 1 | Properties 2 | Factors 2 | Combinations 2

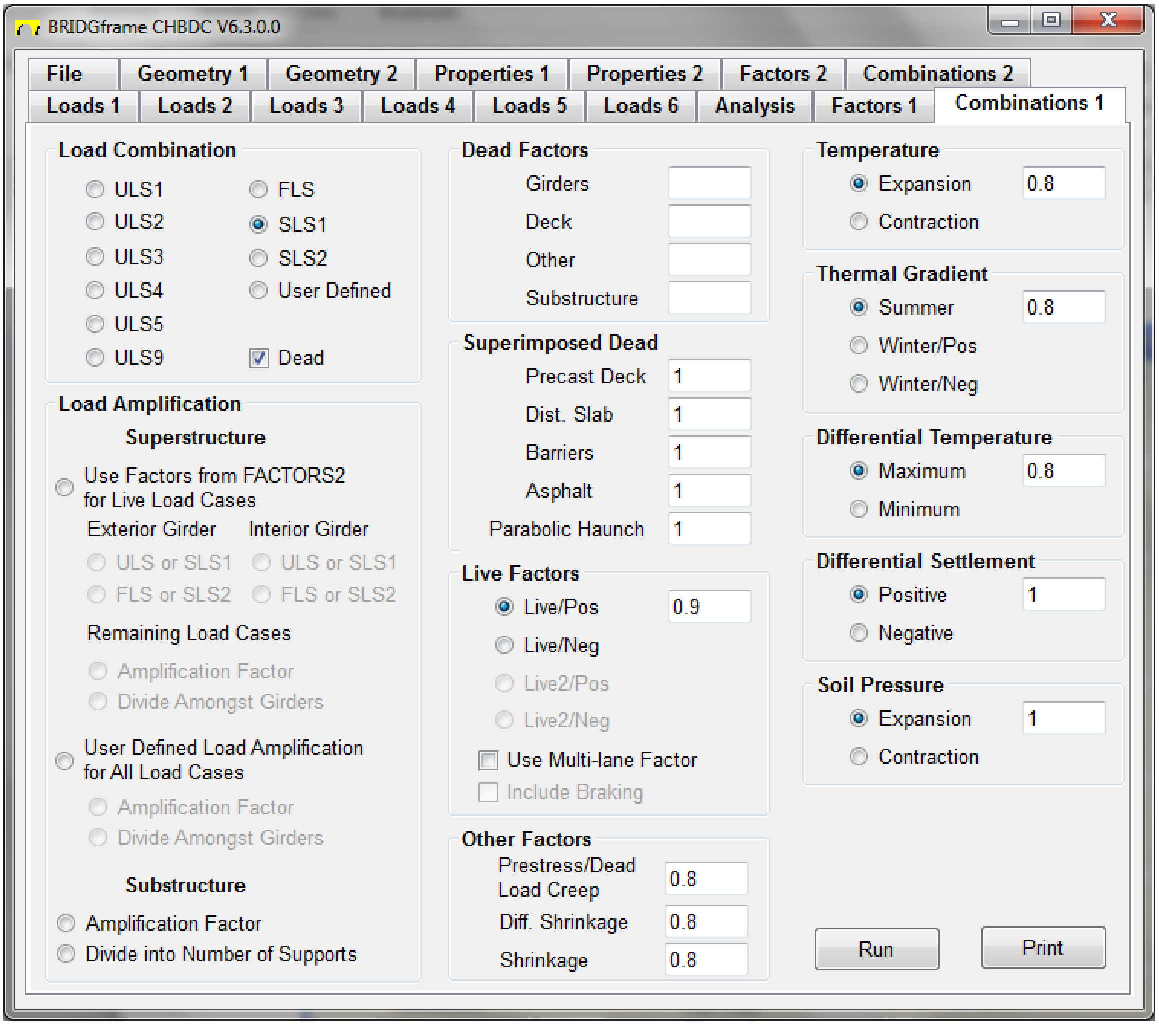
Exterior Girder (Type C) or Metre Width (Type A or B)	Ultimate & Service Limit States Mneg	Mpos	Vneg	Vpos	A	Fatigue & Service 2 Limit States Mneg	Mpos	Vneg	Vpos	A
Over Left Abutment	0.272		0.295			0.175		0.270		
Span 1		0.267		0.295	0.180		0.174		0.270	0.180
Over Left Pier - Span 1	0.271		0.295			0.175		0.270		
Over Left Pier - Span 2	0.271		0.295			0.175		0.270		
Span 2		0.267		0.295	0.180		0.174		0.270	0.180
Over Right Pier - Span 2	0.271		0.295			0.175		0.270		
Over Right Pier - Span 3	0.271		0.295			0.175		0.270		
Span 3		0.267		0.295	0.180		0.174		0.270	0.180
Over Right Abutment	0.272		0.295			0.175		0.270		

Interior Girder (Type C) or Metre Width (Type A or B)	Ultimate & Service Limit States Mneg	Mpos	Vneg	Vpos	A	Fatigue & Service 2 Limit States Mneg	Mpos	Vneg	Vpos	A
Over Left Abutment	0.347		0.295			0.316		0.270		
Span 1		0.335		0.295	0.180		0.303		0.270	0.180
Over Left Pier - Span 1	0.344		0.295			0.313		0.270		
Over Left Pier - Span 2	0.344		0.295			0.313		0.270		
Span 2		0.335		0.295	0.180		0.303		0.270	0.180
Over Right Pier - Span 2	0.344		0.295			0.313		0.270		
Over Right Pier - Span 3	0.344		0.295			0.313		0.270		
Span 3		0.335		0.295	0.180		0.303		0.270	0.180
Over Right Abutment	0.347		0.295			0.316		0.270		

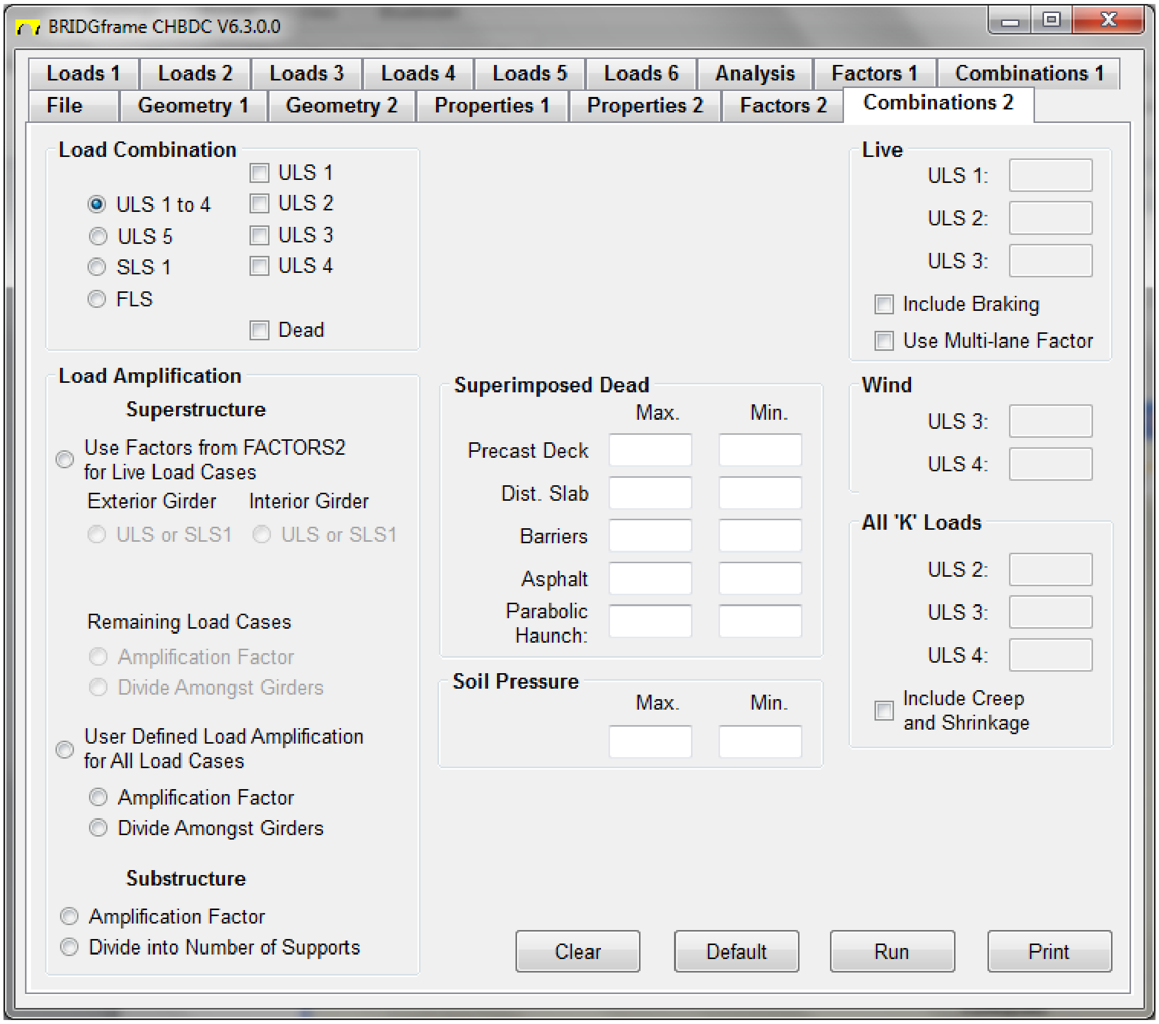
Save — Modify Calculated Factors, then Click to Save as Manual Factors

- Live Load Fractions manually input shall include the number of design lanes and the multi-lane loading modification factor. Therefore, fractions obtained using the simplified method as per part 5 of CHBDC shall be divided by the number of lanes and multiplied by the modification factor.

APPENDIX 11 – LOAD COMBINATION



- Generate composite and non-composite load combinations
- For ULS, SLS and FLS, only applicable load cases will activate and factor values will default. All options available for User Defined.
- Live load amplification (distribution) fractions for interior and exterior girder
- User defined amplification fractions
- Eliminates possible error of combining winter and summer events
- Utilize or exclude multi-lane loading modification factor (CHBDC 3.8.4.2)
- Weight of abutments and piers, and wingwall loads make up Dead - Substructure
- Note: for Construction Loads go directly to Construction Load worksheet for unfactored output results



- Generate maximum and minimum force envelopes
- Compares all ULS combinations to generate one envelope
- Compares maximum and minimum load case values within each load combination prior to developing governing envelope
- User defined amplification fractions or default values
- Eliminates possible error of combining winter and summer events
- Automatically manages Transitory or 'K' loads
- Utilize or exclude multi-lane loading modification factor (CHBDC 3.8.4.2)
- Weight of abutments and piers, and wingwall loads make up Dead - Substructure
- Note: for Construction Loads go directly to Construction Load worksheet for unfactored output results

APPENDIX 12 – SEMI-INTEGRAL ABUTMENT INPUT

Modeling a semi-integral abutment (single span) or semi-integral abutment and piers (multi-span) with no horizontal fixed joint:

3 Span Example:

Model as a Rigid Frame with continuous abutments and piers.
Abutment and Pier bases to be pinned.

Say abutments have 15 bearings total and piers have 30 bearings total, using same bearing stiffness for all bearings equal to 1.05 kN / mm (If applicable use friction rather than shear stiffness). Therefore 15 x 1.05 = 15750 N / mm and 30 x 1.05 = 31500 N / mm.

Say height of abutment and pier equals distance from neutral axis of superstructure to underside of girder. The value may be obtained from the Excel file on the DEFINE worksheet, cell E73 / E106 / E137. For this example, use 462 mm = l.

Say E = 27098 MPa for the abutment and pier.

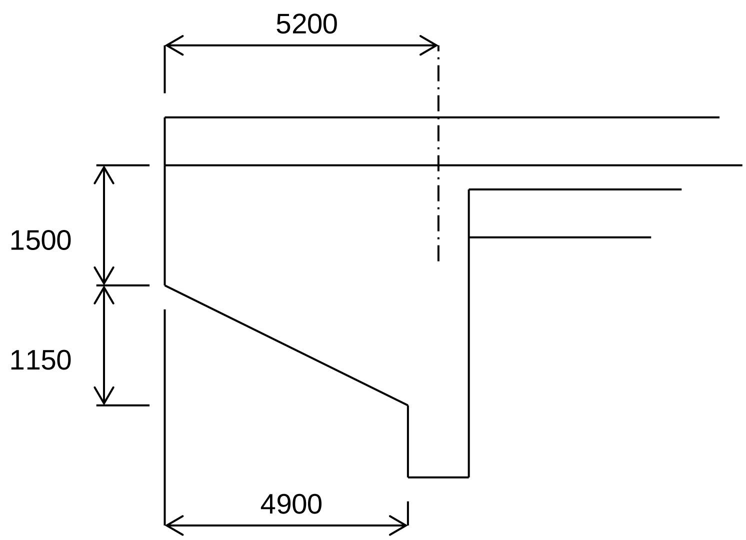
Using $I = P*l^3 / (3*E*\Delta)$, set $\Delta = 1$ mm

Abutment: $I = 15750*462^3 / (3*E*\Delta) = 2588542$ mm^4
b = h = $(2588542*12)^{0.25}$ = 74.7 mm, therefore; use an abutment thickness of 7.47 cm and a width of 7.47 cm as required input on the Properties 2 tab.

Pier: $I = 31500*462^3 / (3*E*\Delta) = 38210084$ mm^4
b = h = $(38210084*12)^{0.25}$ = 146.3 mm, therefore; use a pier thickness of 14.63 cm and a width of 14.63 cm as required input on the Properties 2 tab.

Soil Pressure input on Loads 4 may be left out or if adding than use the actual abutment width.

APPENDIX 13 – WINGWALL LOAD EXAMPLE CALCULATIONS



Wingwalls: 0.45m thick

4.9 x 1.5 x 0.45 x 24 kN/m^3 x 2 walls / abut. = 159 kN

1.15 x 4.9/2 x 0.45 x 24 kN/m^3 x 2 walls / abut. = 61 kN

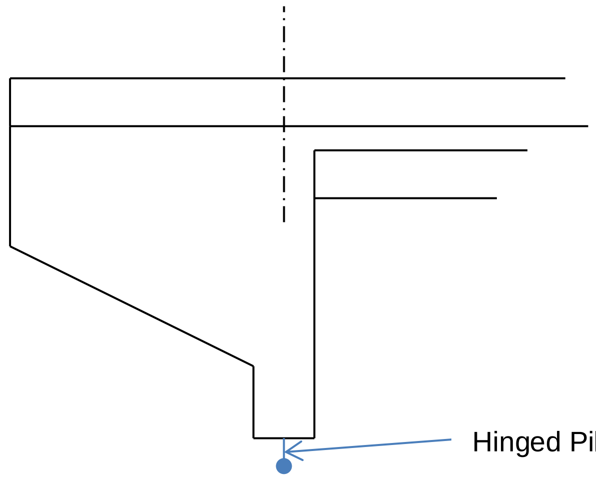
Barriers: 7 kN / m / barrier

7 x 5.2 x 2 barriers / abut. = 73 kN

Vertical Load = 159 + 61 + 73 = 293 kN
Moment = 159 x 2.75 + 61 x 1.933 + 73 x 2.6 = 745 kN.m

Note: Not shown above, the weight of the abutment above the N.A. of the superstructure would also be included as part of the Vertical Load.

APPENDIX 14 – INTEGRAL ABUTMENT WITH HINGED PILE TOP OR RIGID FRAME WITH HORIZONTAL SPRING AT BOTTOM



Integral Abutment with Hing between pile and abutment:

1) Enter the pile height as 0.01 metres
2) Select a pinned base for the pile
3) Number of piles = 1
4) Inertia of pile = 1 cm^4
5) Modulus of elasticity of pile = 1 MPa

Rigid Frame with Horizontal Spring at Substructure Base (for allowing partial longitudinal movement of footing):

Assuming a horizontal spring stiffness K of 20 kN/mm (20000 N/mm)
Using 1 – HP310x110(x-x), I = 237E6 mm^4, E = 200000 MPa

Pile length = $(3EI/K)^{1/3}$ = $(3*200000*237E6/20000)^{1/3}$ = 1923 mm (1.923 m) for a pinned pile at base.

Note: Modeling a hinged pile or horizontal spring may cause the analysis to fail during earthquake loading as the soil pressure alone may not be sufficient to satisfy the seismic forces. If so, delete all seismic load variables to get results for all other load cases.

Note: If the soil beneath the abutment can compress horizontally towards the low fill side, then it is possible the underside of abutment will move with the founding material and the soil force effects be greater than if modeled as strictly an abutment fixed from longitudinal displacement.

APPENDIX 15 - PART OUTPUT SAMPLE

DIFFERENTIAL SHRINKAGE LOAD BETWEEN GIRDERS AND COMPOSITE DECK RESULTS

Differential Shrinkage Vertical Reactions and Rotations at Top of Supports						Horiz. React. at Support Base (kN)
Location Result (m)	Location Result (x/L)	Vertical Reaction (kN)	Rotation (radians)	Reaction On: Left (kN)	Reaction On: Right (kN)	
0.000	0.000	-23.2	0.000043			0.7
33.600	1.000	46.3	-0.000001	23.2	23.2	0.0
67.200	2.000	-23.2	-0.000043			-0.7

Differential Shrinkage - Forces and Deflection in Superstructure						
Location Result (m)	Location Result (x/L)	Moment (kN.m)	Shear (kN)	Axial (kN)	Deflection Up (mm)	Deflection Down (mm)
0.000	0.000	-6.7	-23.2	972.6		
3.360	0.100	-84.6	-23.2	972.6		-0.4
6.720	0.200	-162.4	-23.2	972.6		-0.6
10.080	0.300	-240.3	-23.2	972.6		-0.8
13.440	0.400	-318.2	-23.2	972.6		-0.9
16.800	0.500	-396.0	-23.2	972.6		-0.9
20.160	0.600	-473.9	-23.2	972.6		-0.8
23.520	0.700	-551.8	-23.2	972.6		-0.7
26.880	0.800	-629.6	-23.2	972.6		-0.5
30.240	0.900	-707.5	-23.2	972.6		-0.3
33.600	1.000	-785.4	-23.2	972.6		
33.600	1.000	-785.4	23.2	972.6		
36.960	1.100	-707.5	23.2	972.6		-0.3
40.320	1.200	-629.6	23.2	972.6		-0.5
43.680	1.300	-551.8	23.2	972.6		-0.7
47.040	1.400	-473.9	23.2	972.6		-0.8
50.400	1.500	-396.0	23.2	972.6		-0.9
53.760	1.600	-318.2	23.2	972.6		-0.9
57.120	1.700	-240.3	23.2	972.6		-0.8
60.480	1.800	-162.4	23.2	972.6		-0.6
63.840	1.900	-84.6	23.2	972.6		-0.4
67.200	2.000	-6.7	23.2	972.6		

APPENDIX 16 – DIFFERENTIAL SHRINKAGE AND DIFFERENTIAL TEMPERATURE

The load is caused by the change in length of the deck relative to the girder (or vice versa). For Differential Shrinkage, the deck has a greater change in length than the girder; and for Differential Temperature, the girder and deck may want to have a different change in length due to different temperature coefficient properties.

The load causes a Driving Force between the deck and girder, which is applied on a per span basis.

Differential Shrinkage and Differential Temperature are assumed to be uniform throughout the depth of the deck and girder.

Differential Shrinkage:

Shrinkage of the deck is applied such that the deck is moving away from the supports of the span and towards the centre of span. The movement of the deck is resisted by the rebar in the deck and by the girder. The rebar and girder are acting in compression and the deck concrete is acting in tension. If a span is simply supported, the differential shrinkage of the deck will cause a compressive force in the deck rebar unless the deck cracks, at which point the rebar goes into tension at the crack location. If a span is continuous, the differential shrinkage generated moments will cause tension in the deck rebar.
Also, since BRIDGframe does not know the amount of rebar in the concrete deck, for simplicity and conservatively, the girder is assumed to provide all the compressive resistance for the deck concrete in tension. Therefore, the "*** Axial in Deck" reported in BRIDGframe output is for the purpose of seeing the force generating the moment and is not meant as a tension force requiring deck rebar design.

Differential Temperature:

Differential Temperature between the girder, concrete deck, and steel rebar in deck is generating forces by the elongating or shortening of the different materials, and relative to the initial construction temperature. During the very early stage temperature increase for steel girder bridges, the girder is trying to elongate relative to the deck. Due to the differences in thicknesses between the girder and the deck, the expansion of the steel girder is putting the deck rebar into tension. During later stage temperature increase, the temperature of the deck rebar will match the temperature of the girders and concrete deck, putting the deck rebar into compression. The opposite is true for a temperature decrease. Therefore, it is possible to have deck rebar tension during temperature increases or decreases for steel girders with composite concrete decks.

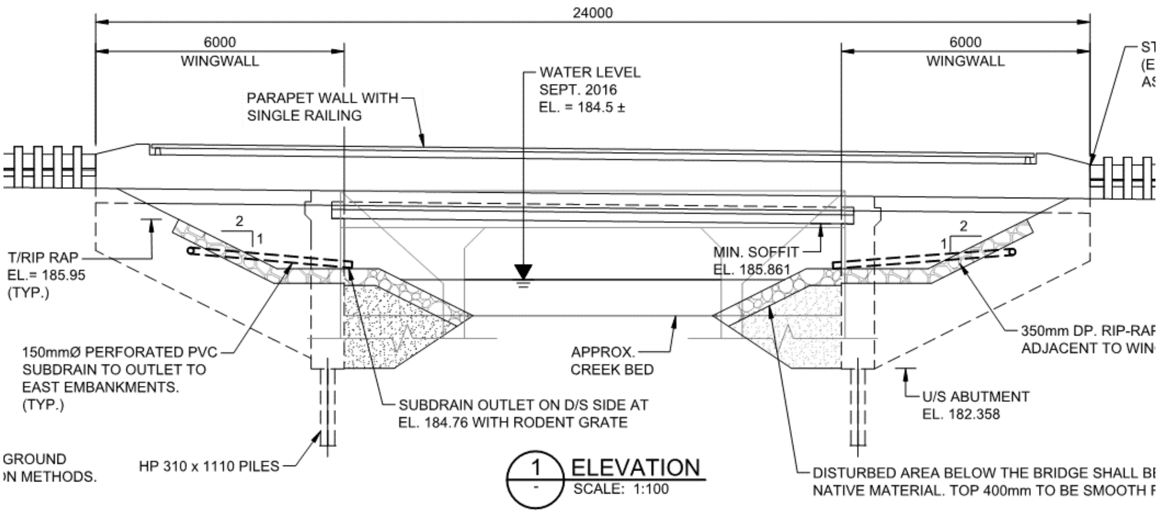
If a span is not simply supported but is continuous, the moments generated by Differential Temperature Increase will cause tension in the deck rebar, and the moments generated by Differential Temperature Decrease will cause compression in the deck rebar.

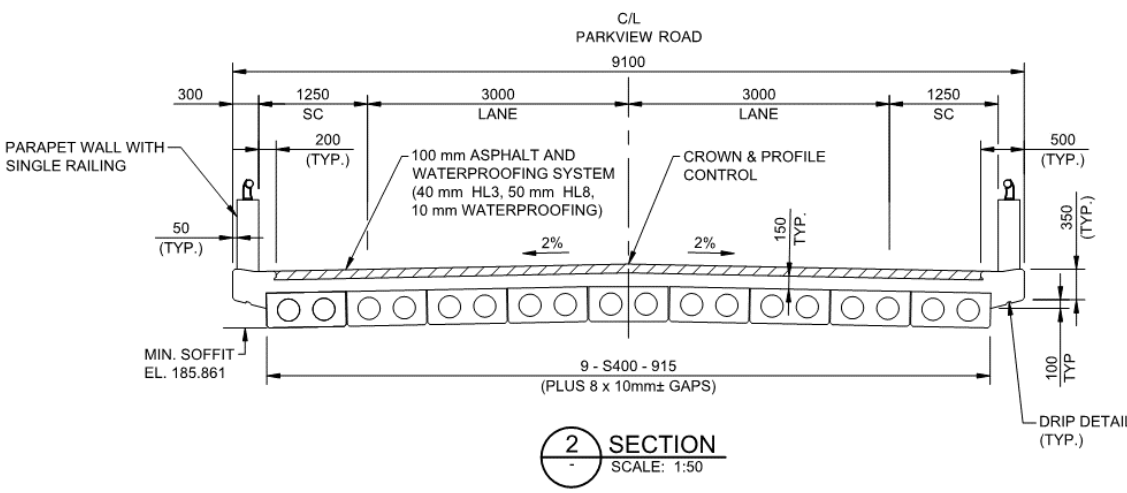
Since BRIDGframe does not know the amount of rebar in the concrete deck, the "*** Axial in Deck" reported in BRIDGframe output is for concrete properties only.

APPENDIX 17 – PILE DESIGN (INTEGRAL ABUTMENTS)

Pile design can be completed immediately after an analysis is complete, to confirm the model is correct with respect to the pile selection.

The following example will utilize the tables starting at COMBINATION2 CL 46, the Pile Factor worksheet, and Steel Pile Design worksheet.





Structural Pile Design assuming 5 – HP310 x 110 x-x (not corroded)

The Integral Abutment Design Manual by the Ministry of Transportation of Ontario refers to using an equivalent pile length of $10d_p$ where d_p is the diameter of the pile. For a pile with an approximate diameter or width of approximately 0.3m, the pile length would be 3.0m. Add to this the top 3.0m of loose material for an approximate pile length of 6.0m. Loose material will be interpreted as a free length of pile above grade.

Pile length may also be approximately calculated using $4\left(\frac{EI}{Kh}\right)^{0.25}$ for soils with constant K_h (over-consolidated clay), or $4\left(\frac{EI}{nh}\right)^{0.2}$ for soils with a K_h increasing linearly with depth (normally consolidated clay and granular material).

Example: HP310x110, E = 200000 MPa, I_x = 237E6 mm^4,
Granular Material

n_h = constant of horizontal subgrade reaction = say 0.006 N/mm^2/mm approximately over the length of the pile.

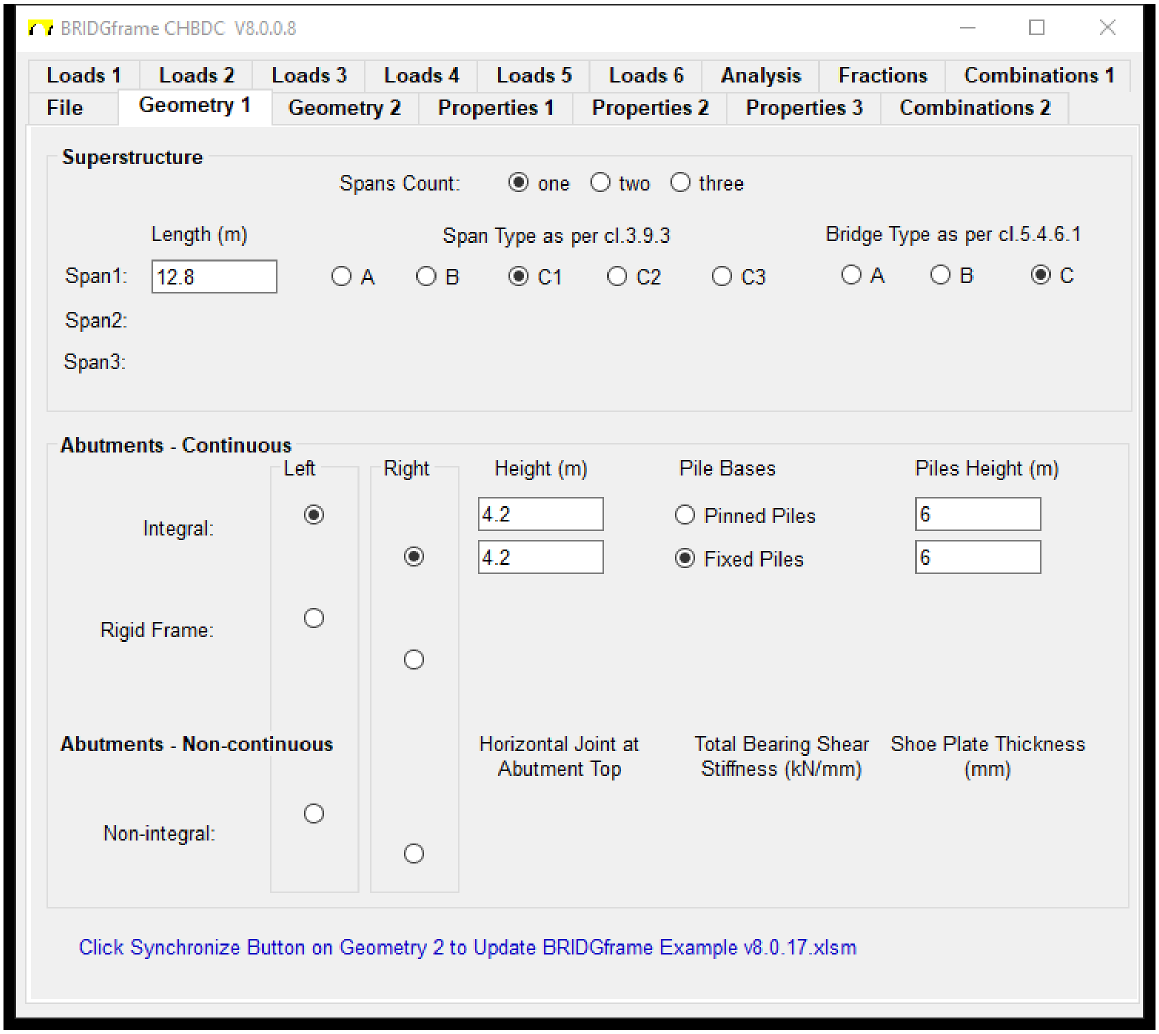
Lc = critical length = 6.048m.

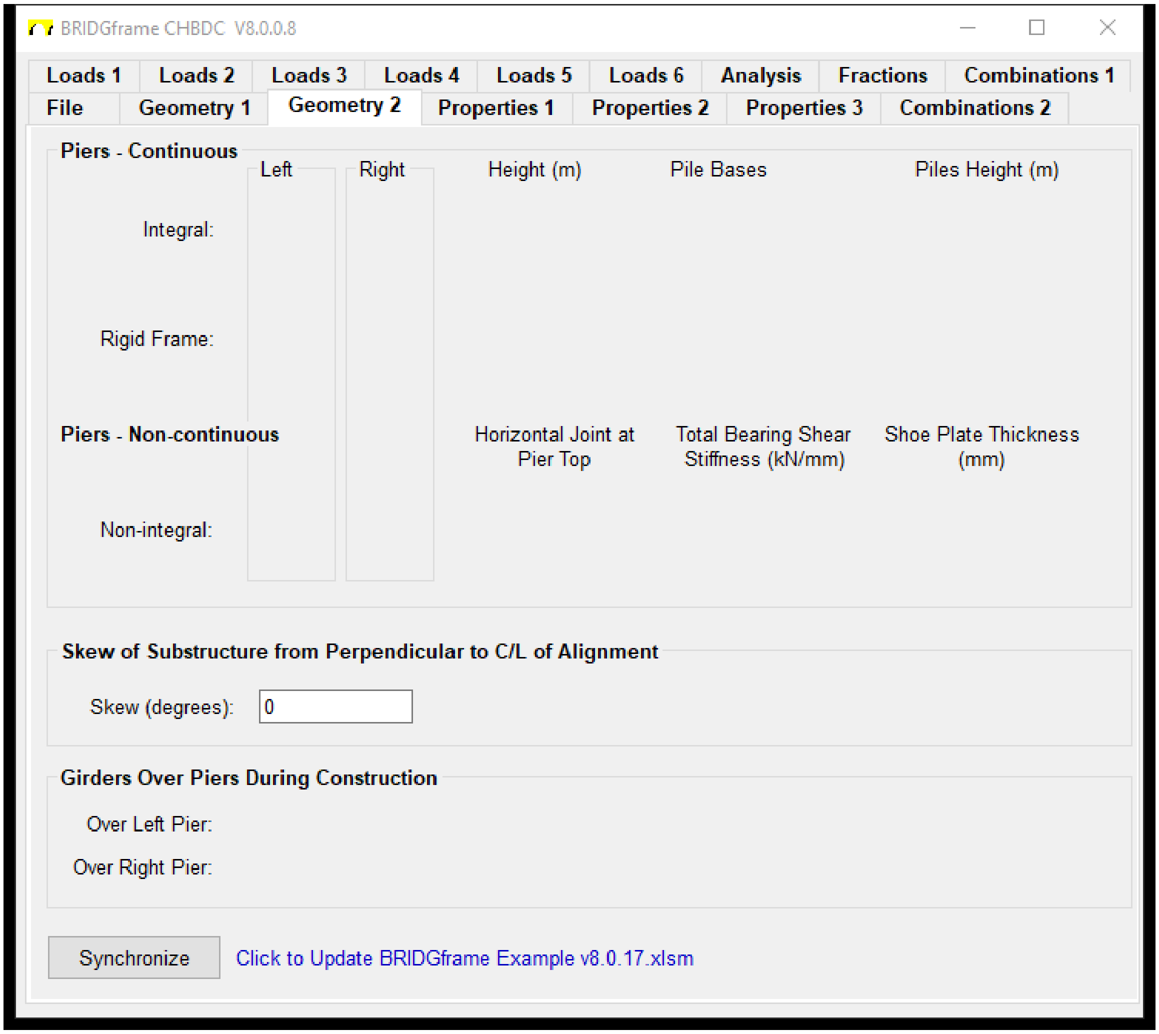
The distance to the point of fixity = $0.5L_c$ = 3.024m

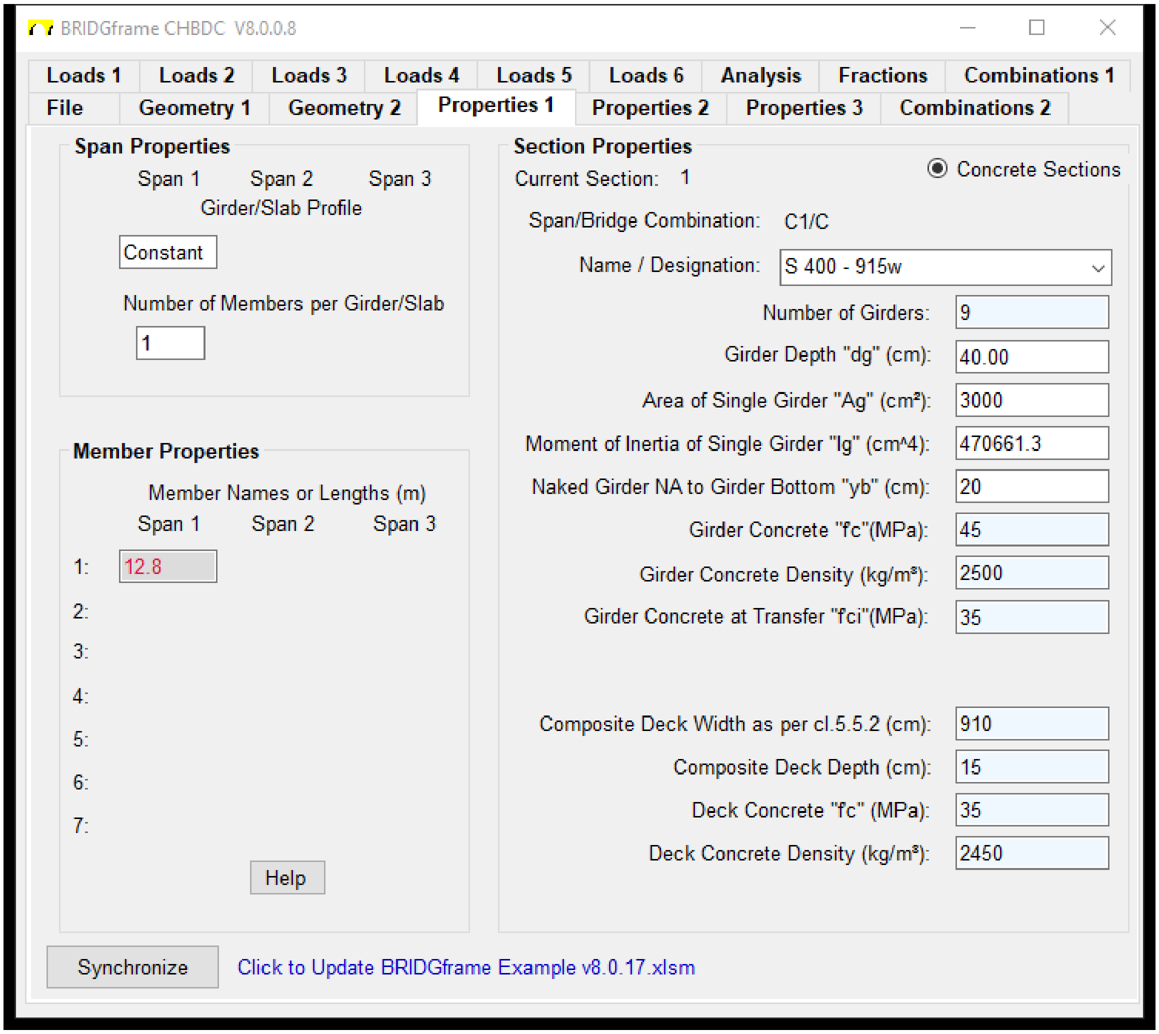
Add to this the top 3.0m of loose material for an approximate pile length of 6.0m.

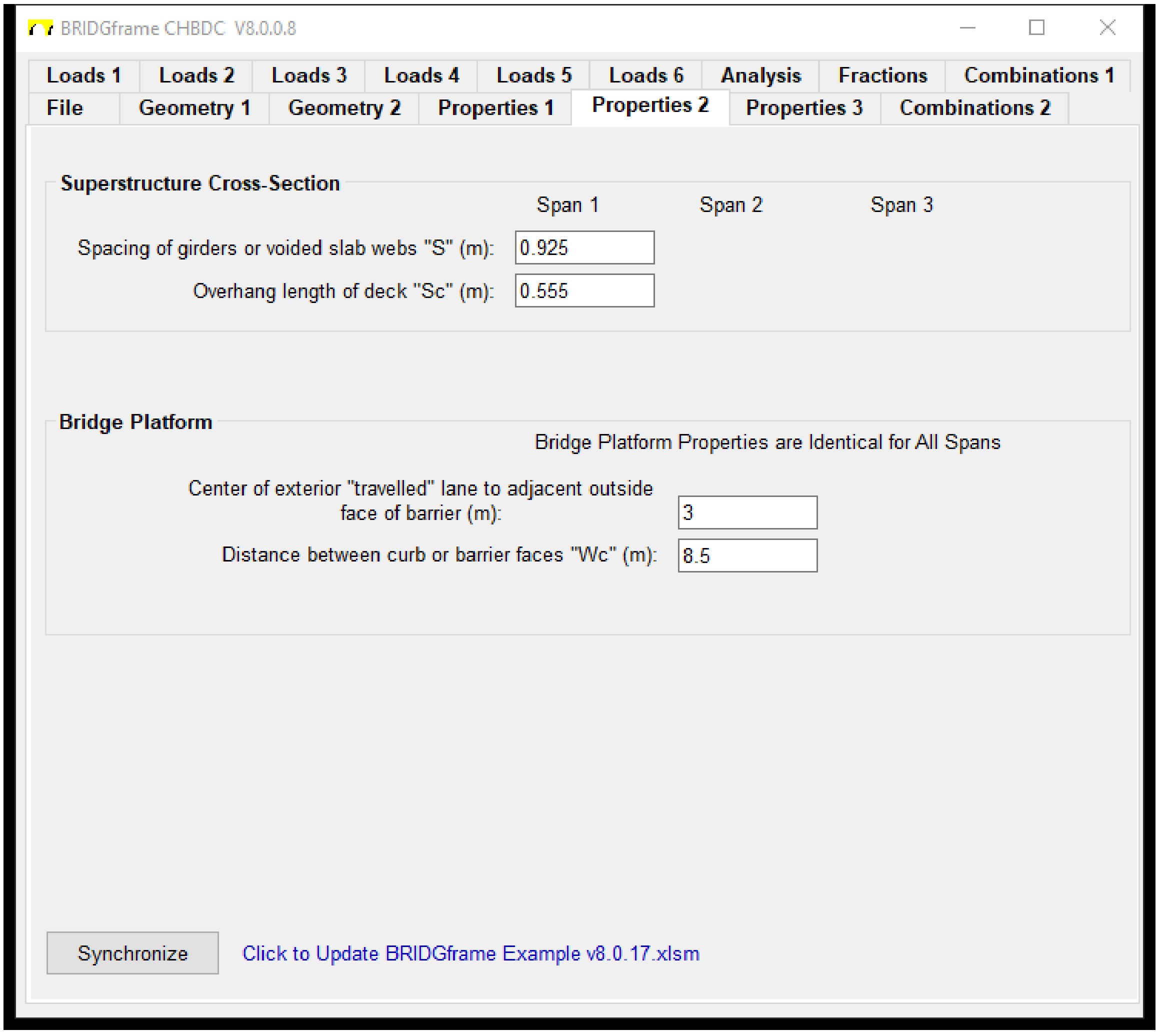
Note: the above model is using piles oriented in their x-x direction, although it is recommended that HP piles be oriented in their y-y direction regardless of span length or skew.

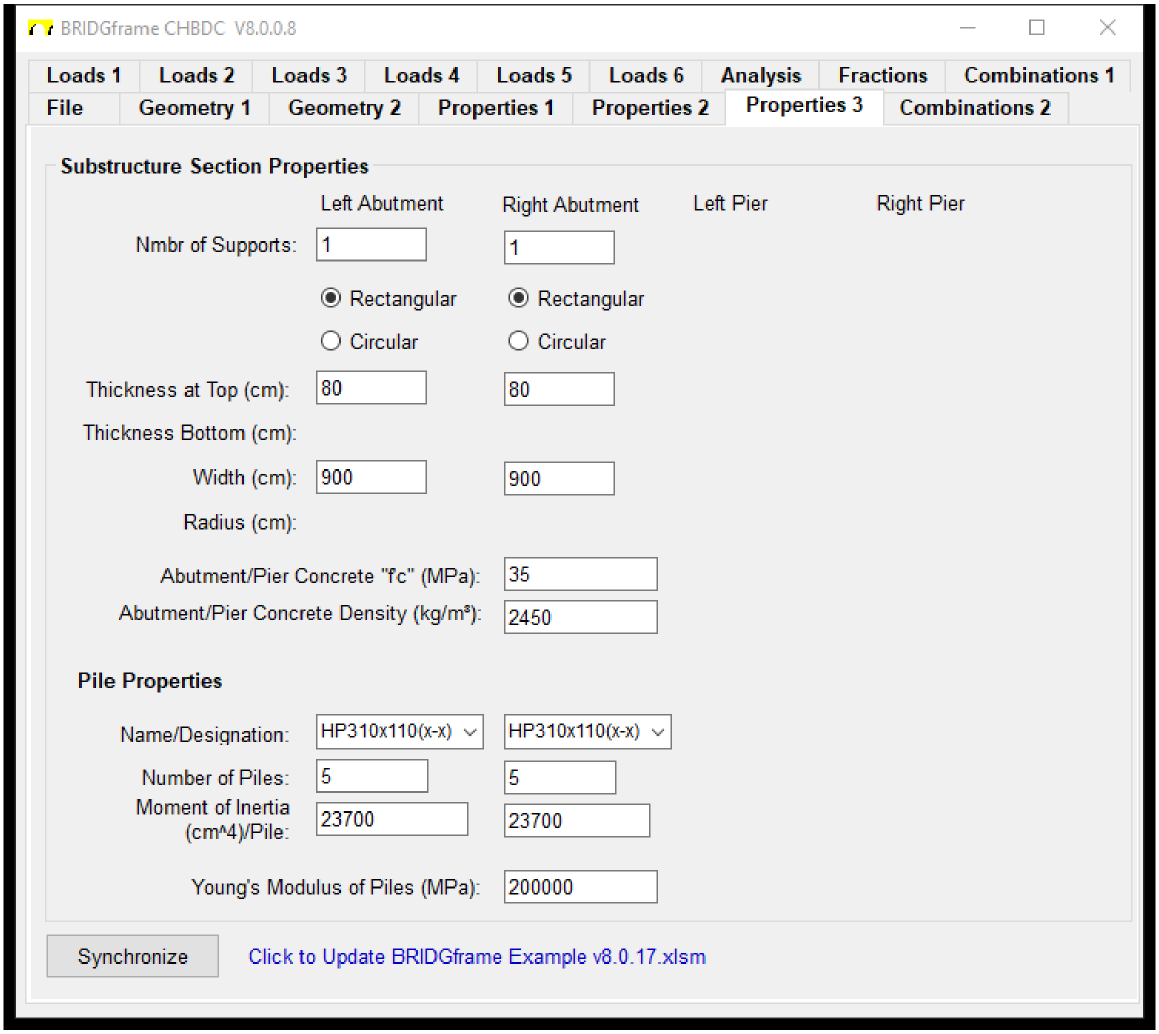
BRIDGframe:


BRIDGframe CHBDC V8.0.0.8
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Analysis
Fractions
Combinations 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Combinations 2
Superstructure
Spans Count:
one
two
three
Length (m)
Span Type as per cl.3.9.3
Bridge Type as per cl.5.4.6.1
Span1:
12.8
A
B
C1
C2
C3
A
B
C
Span2:
Span3:
Abutments - Continuous
Left
Right
Height (m)
Pile Bases
Piles Height (m)
Integral:
4.2
4.2
Pinned Piles
Fixed Piles
6
6
Rigid Frame:
Abutments - Non-continuous
Horizontal Joint at Abutment Top
Total Bearing Shear Stiffness (kN/mm)
Shoe Plate Thickness (mm)
Non-integral:
Click Synchronize Button on Geometry 2 to Update BRIDGframe Example v8.0.17.xlsm

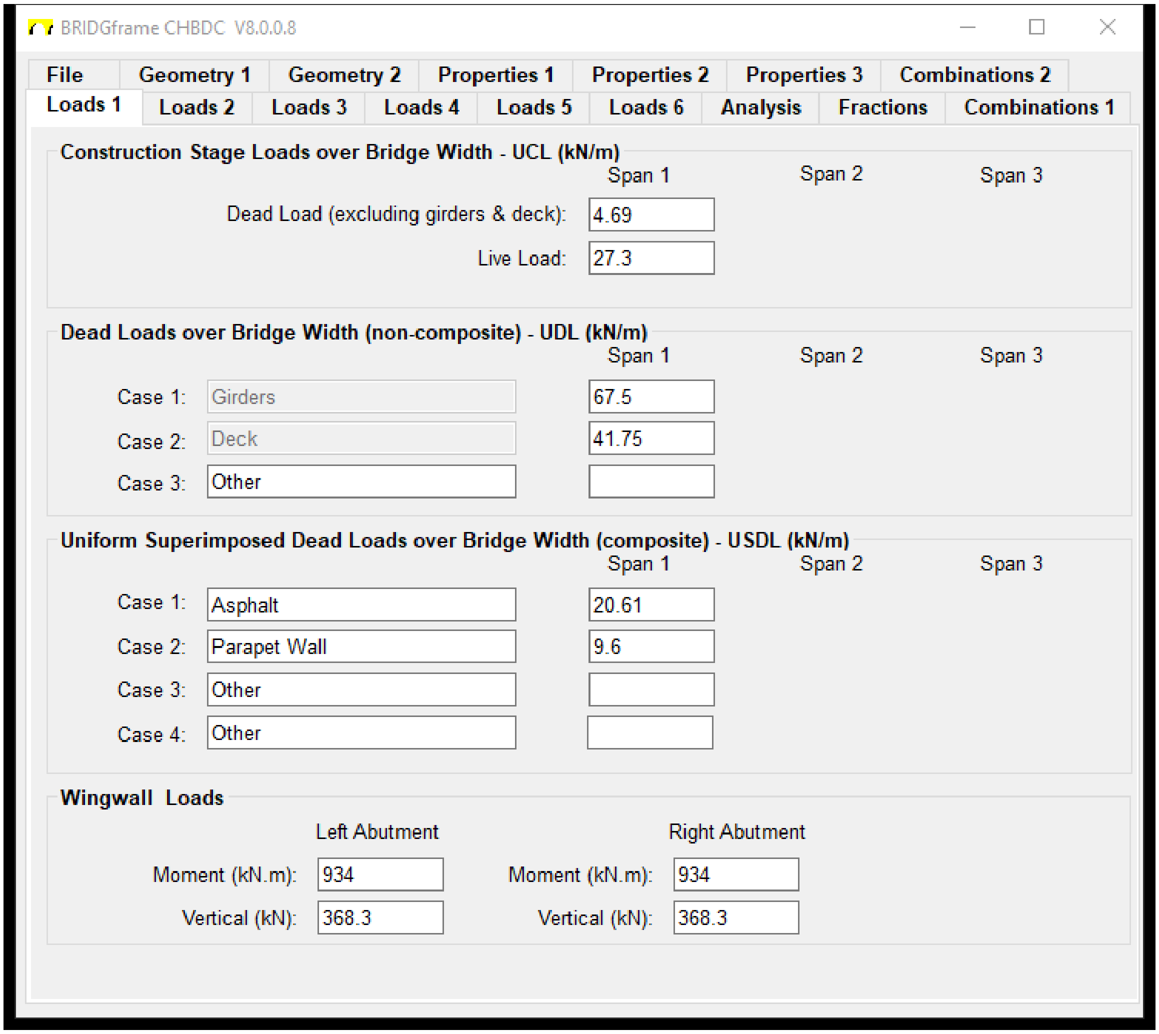

BRIDGframe CHBDC V8.0.0.8
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Analysis
Fractions
Combinations 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Combinations 2
Piers - Continuous
Left
Right
Height (m)
Pile Bases
Piles Height (m)
Integral:
Rigid Frame:
Piers - Non-continuous
Horizontal Joint at Pier Top
Total Bearing Shear Stiffness (kN/mm)
Shoe Plate Thickness (mm)
Non-integral:
Skew of Substructure from Perpendicular to C/L of Alignment
Skew (degrees):
0
Girders Over Piers During Construction
Over Left Pier:
Over Right Pier:
Synchronize
Click to Update BRIDGframe Example v8.0.17.xlsm

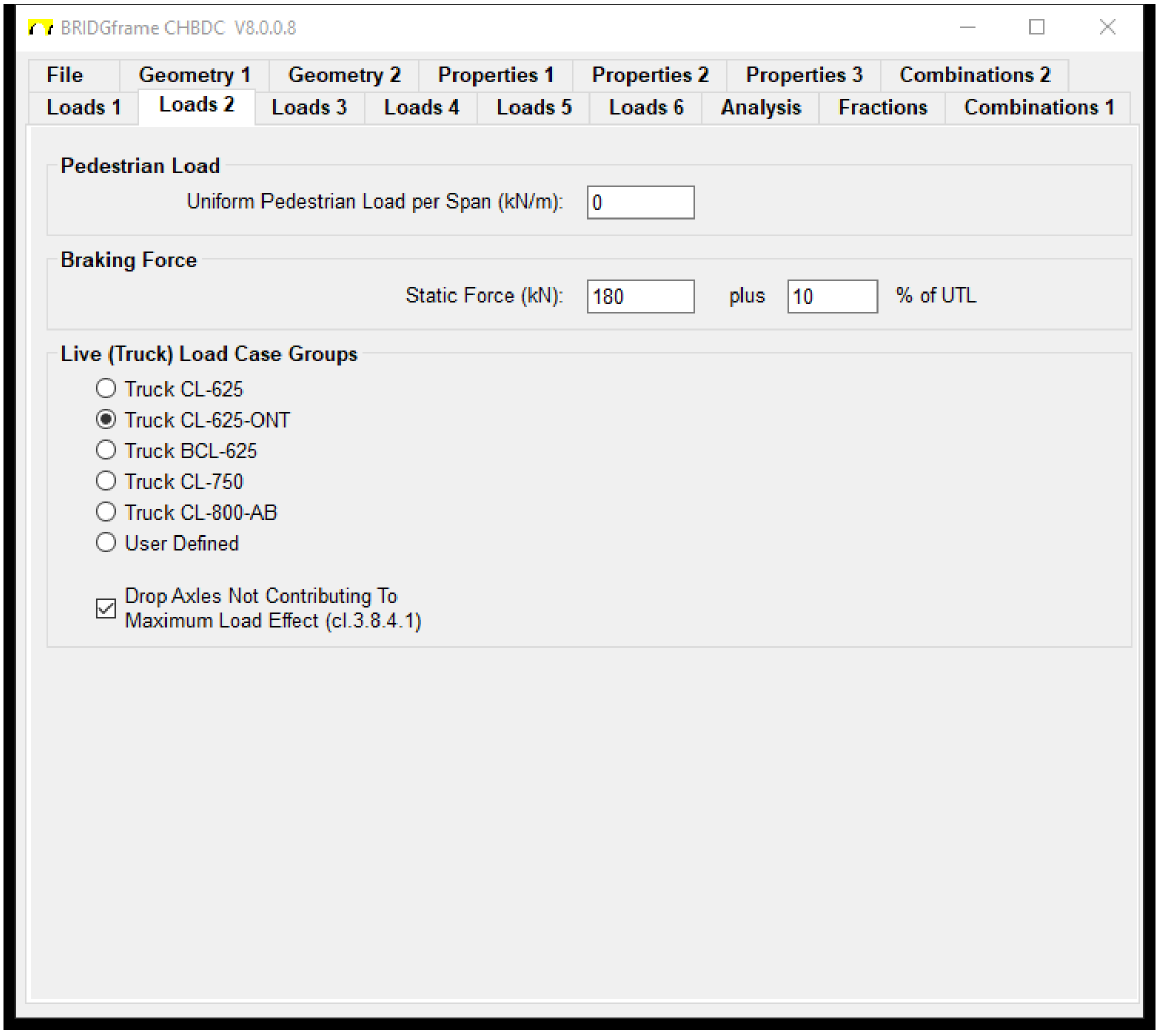

BRIDGframe CHBDC V8.0.0.8
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Analysis
Fractions
Combinations 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Combinations 2
Span Properties
Span 1 Span 2 Span 3
Girder/Slab Profile
Constant
Number of Members per Girder/Slab
1
Member Properties
Member Names or Lengths (m)
Span 1 Span 2 Span 3
1: 12.8
2:
3:
4:
5:
6:
7:
Help
Section Properties
Concrete Sections
Current Section: 1
Span/Bridge Combination: C1/C
Name / Designation: S 400 - 915w
Number of Girders: 9
Girder Depth "dg" (cm): 40.00
Area of Single Girder "Ag" (cm²): 3000
Moment of Inertia of Single Girder "Ig" (cm^4): 470661.3
Naked Girder NA to Girder Bottom "yb" (cm): 20
Girder Concrete "f'c"(MPa): 45
Girder Concrete Density (kg/m³): 2500
Girder Concrete at Transfer "f'ci"(MPa): 35
Composite Deck Width as per cl.5.5.2 (cm): 910
Composite Deck Depth (cm): 15
Deck Concrete "f'c" (MPa): 35
Deck Concrete Density (kg/m³): 2450
Synchronize
Click to Update BRIDGframe Example v8.0.17.xlsm

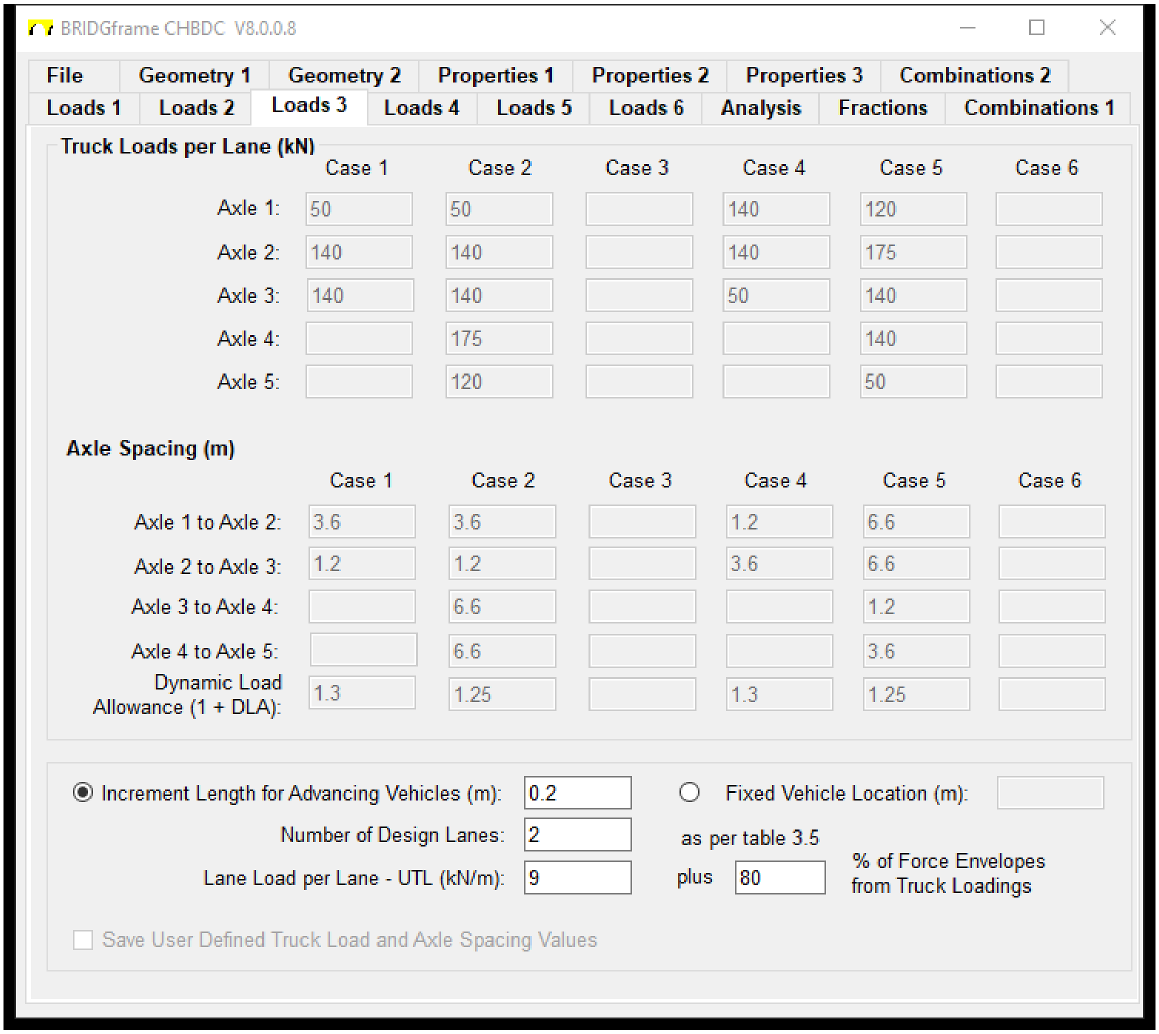

BRIDGframe CHBDC V8.0.0.8
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Analysis
Fractions
Combinations 1
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Combinations 2
Superstructure Cross-Section
Span 1
Span 2
Span 3
Spacing of girders or voided slab webs "S" (m):
0.925
Overhang length of deck "Sc" (m):
0.555
Bridge Platform
Bridge Platform Properties are Identical for All Spans
Center of exterior "travelled" lane to adjacent outside face of barrier (m):
3
Distance between curb or barrier faces "Wc" (m):
8.5
Synchronize
Click to Update BRIDGframe Example v8.0.17.xlsm

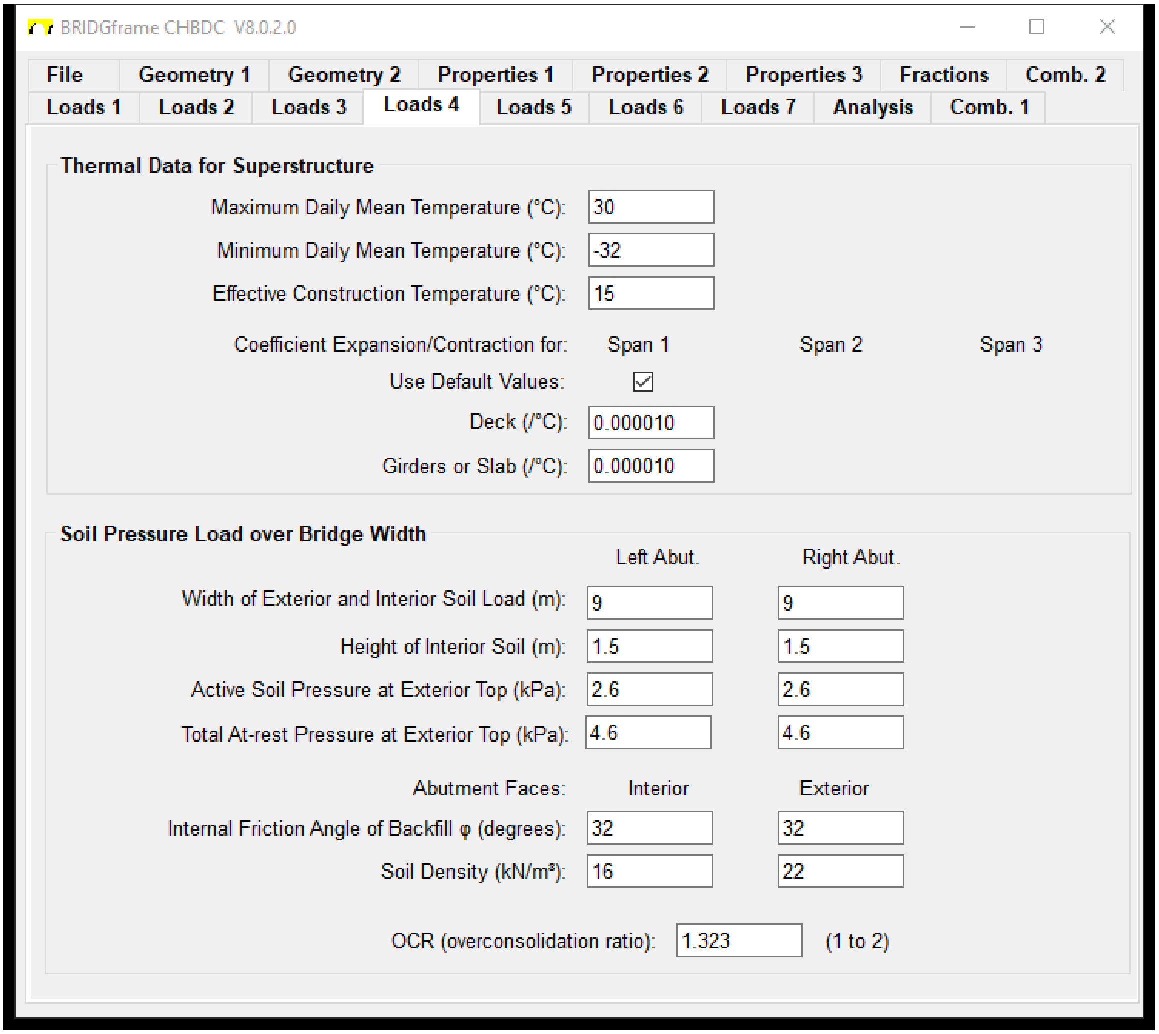


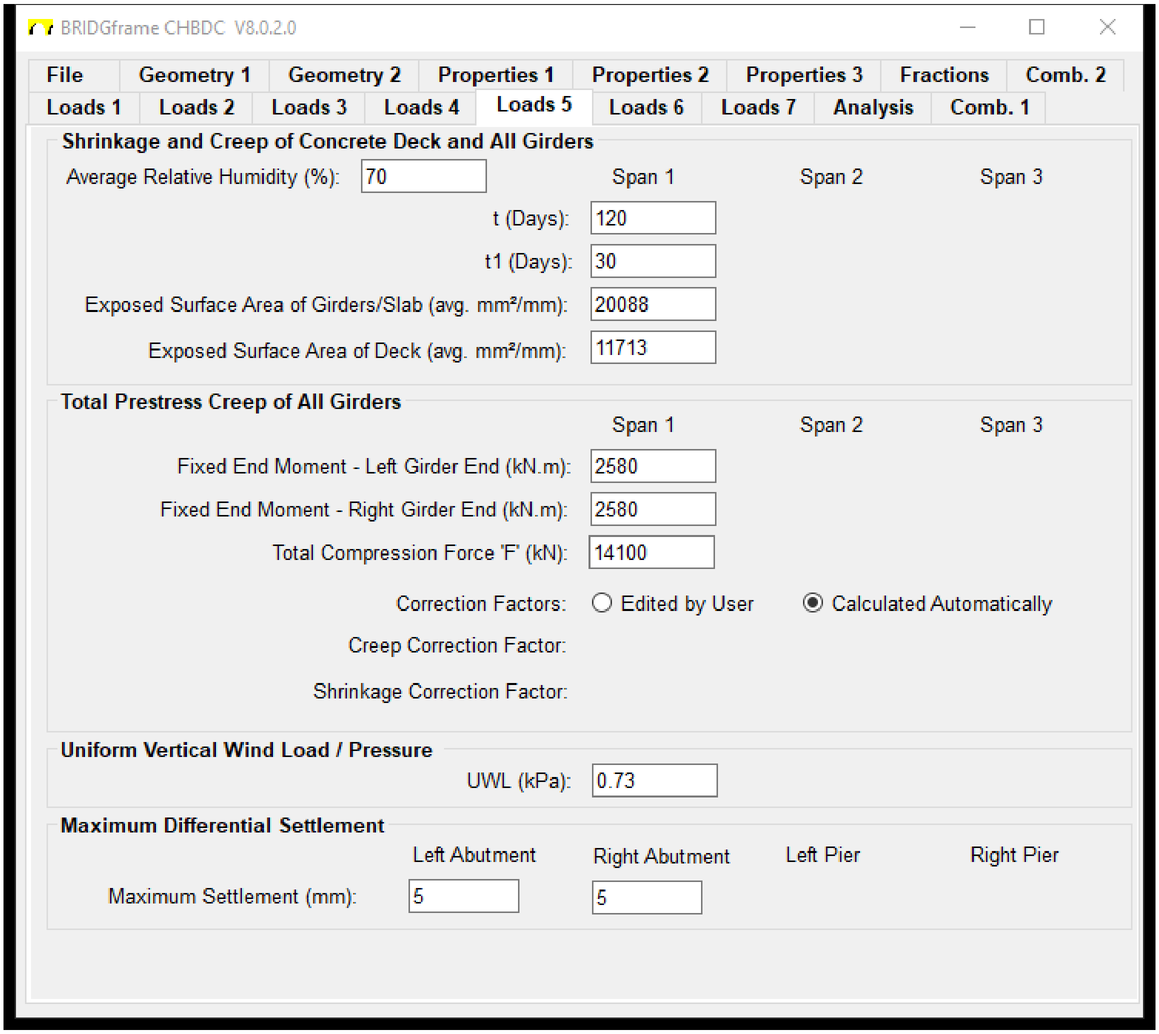
Note: the above model is using piles oriented in their x-x direction, although it is recommended that HP piles be oriented in their y-y direction regardless of span length or skew.


BRIDGframe CHBDC V8.0.0.8
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Combinations 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Analysis
Fractions
Combinations 1
Construction Stage Loads over Bridge Width - UCL (kN/m)
Span 1
Span 2
Span 3
Dead Load (excluding girders & deck):
4.69
Live Load:
27.3
Dead Loads over Bridge Width (non-composite) - UDL (kN/m)
Span 1
Span 2
Span 3
Case 1:
Girders
67.5
Case 2:
Deck
41.75
Case 3:
Other
Uniform Superimposed Dead Loads over Bridge Width (composite) - USDL (kN/m)
Span 1
Span 2
Span 3
Case 1:
Asphalt
20.61
Case 2:
Parapet Wall
9.6
Case 3:
Other
Case 4:
Other
Wingwall Loads
Left Abutment
Right Abutment
Moment (kN.m):
934
Moment (kN.m):
934
Vertical (kN):
368.3
Vertical (kN):
368.3

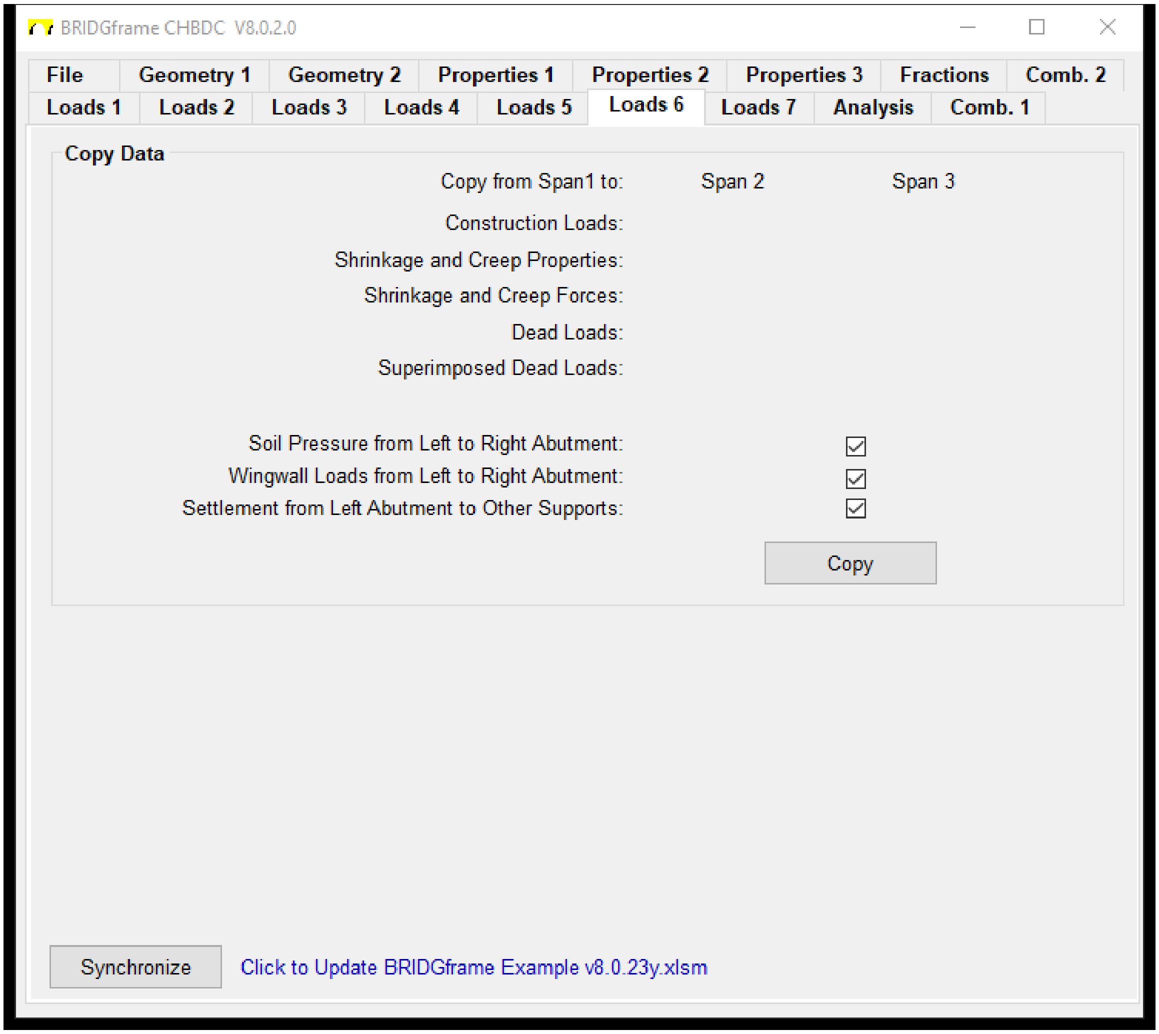

BRIDGframe CHBDC V8.0.0.8
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Combinations 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Analysis
Fractions
Combinations 1
Pedestrian Load
Uniform Pedestrian Load per Span (kN/m):
0
Braking Force
Static Force (kN):
180
plus
10
% of UTL
Live (Truck) Load Case Groups
Truck CL-625
Truck CL-625-ONT
Truck BCL-625
Truck CL-750
Truck CL-800-AB
User Defined
Drop Axles Not Contributing To
Maximum Load Effect (cl.3.8.4.1)

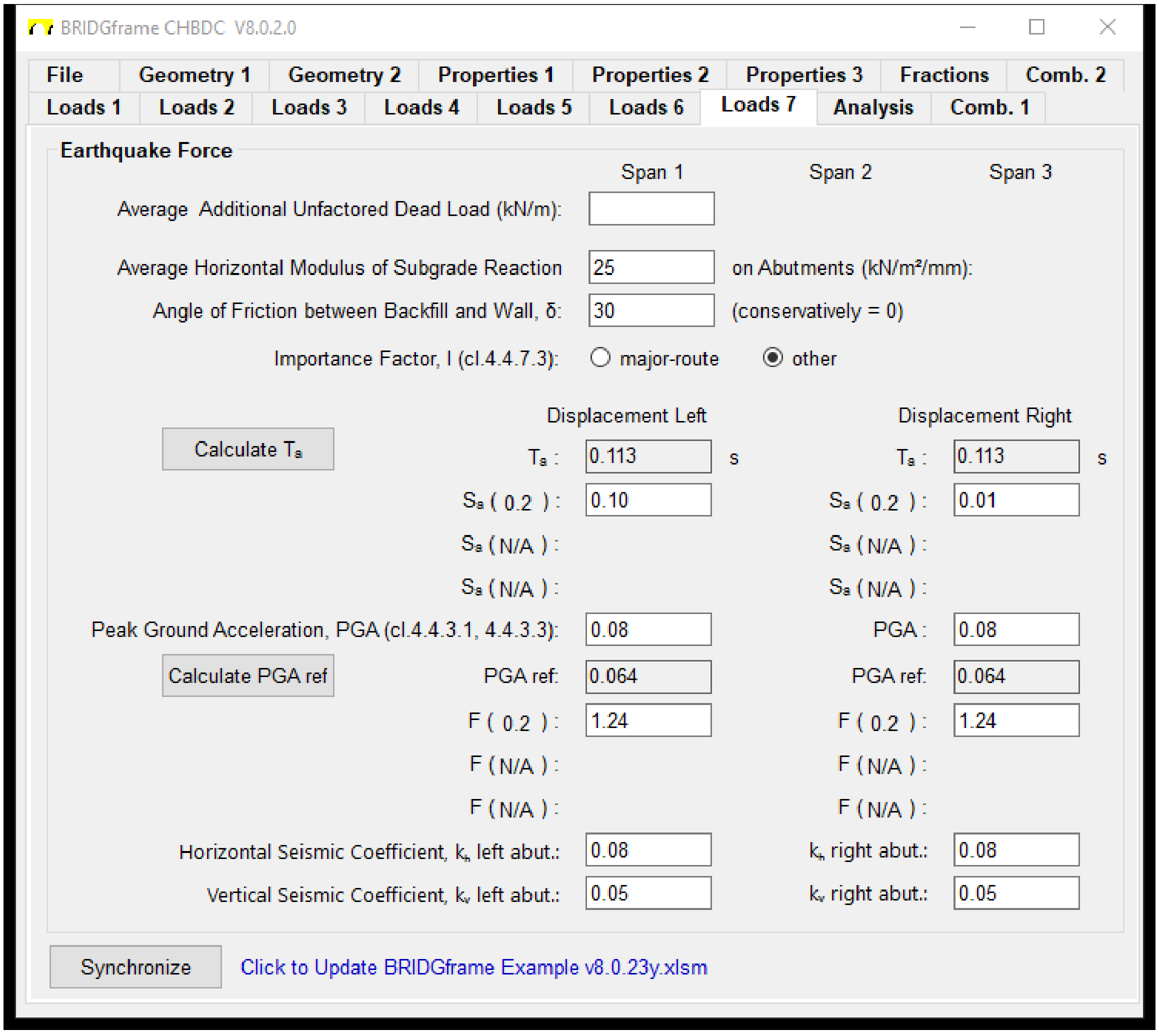

BRIDGframe CHBDC V8.0.0.8
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Combinations 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Analysis
Fractions
Combinations 1
Truck Loads per Lane (kN)
Case 1
Case 2
Case 3
Case 4
Case 5
Case 6
Axle 1:
50
50
140
120
Axle 2:
140
140
140
175
Axle 3:
140
140
50
140
Axle 4:
175
140
Axle 5:
120
50
Axle Spacing (m)
Case 1
Case 2
Case 3
Case 4
Case 5
Case 6
Axle 1 to Axle 2:
3.6
3.6
1.2
6.6
Axle 2 to Axle 3:
1.2
1.2
3.6
6.6
Axle 3 to Axle 4:
6.6
1.2
Axle 4 to Axle 5:
6.6
3.6
Dynamic Load Allowance (1 + DLA):
1.3
1.25
1.3
1.25
Increment Length for Advancing Vehicles (m):
0.2
Fixed Vehicle Location (m):
Number of Design Lanes:
2
as per table 3.5
Lane Load per Lane - UTL (kN/m):
9
plus
80
% of Force Envelopes from Truck Loadings
Save User Defined Truck Load and Axle Spacing Values

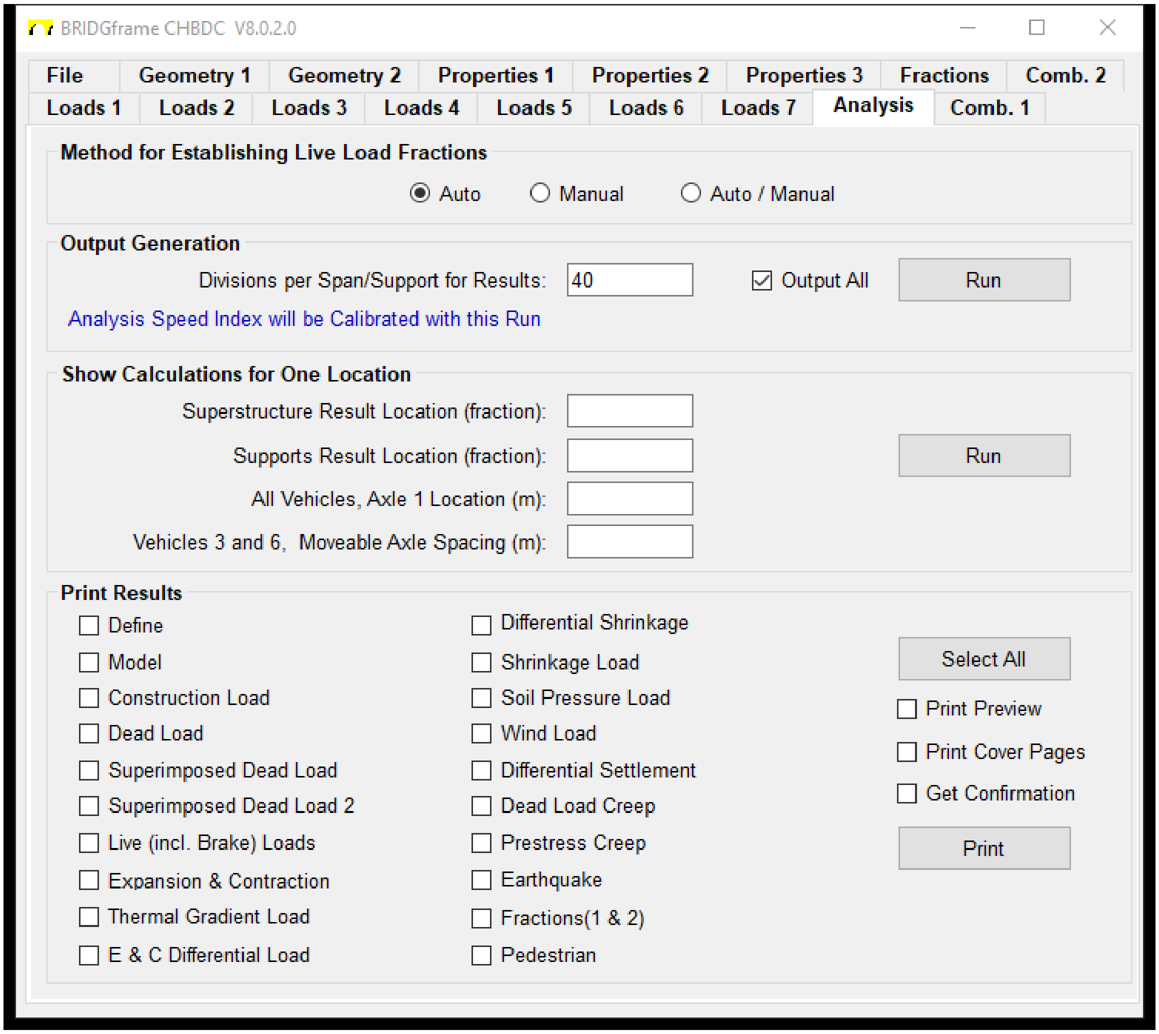

BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Thermal Data for Superstructure
Maximum Daily Mean Temperature (°C): 30
Minimum Daily Mean Temperature (°C): -32
Effective Construction Temperature (°C): 15
Coefficient Expansion/Contraction for: Span 1 Span 2 Span 3
Use Default Values:
Deck (/°C): 0.000010
Girders or Slab (/°C): 0.000010
Soil Pressure Load over Bridge Width
Left Abut. Right Abut.
Width of Exterior and Interior Soil Load (m): 9 9
Height of Interior Soil (m): 1.5 1.5
Active Soil Pressure at Exterior Top (kPa): 2.6 2.6
Total At-rest Pressure at Exterior Top (kPa): 4.6 4.6
Abutment Faces: Interior Exterior
Internal Friction Angle of Backfill φ (degrees): 32 32
Soil Density (kN/m³): 16 22
OCR (overconsolidation ratio): 1.323 (1 to 2)



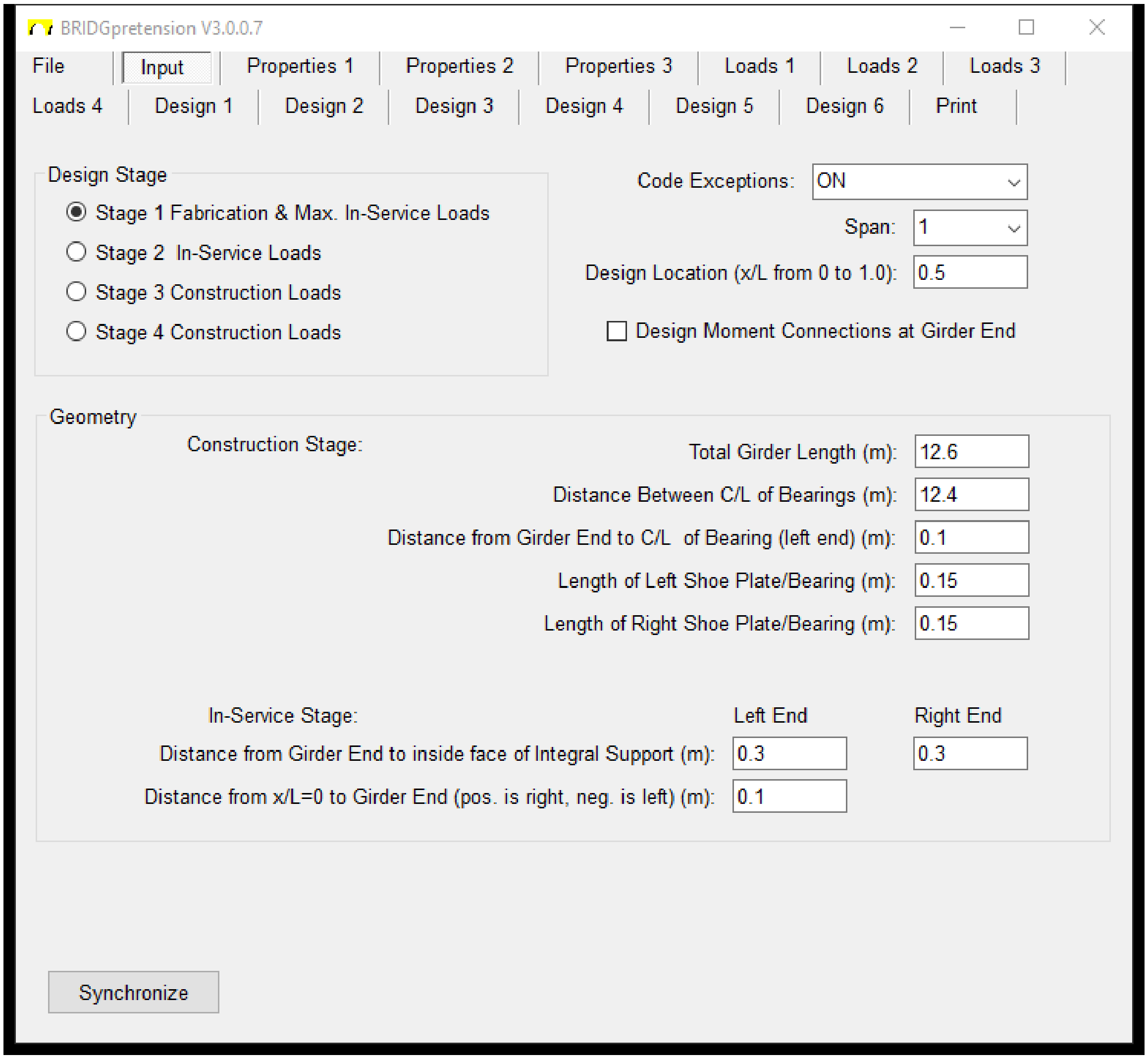
Prestress Creep forces were obtained through trial and error using BRIDGpretension

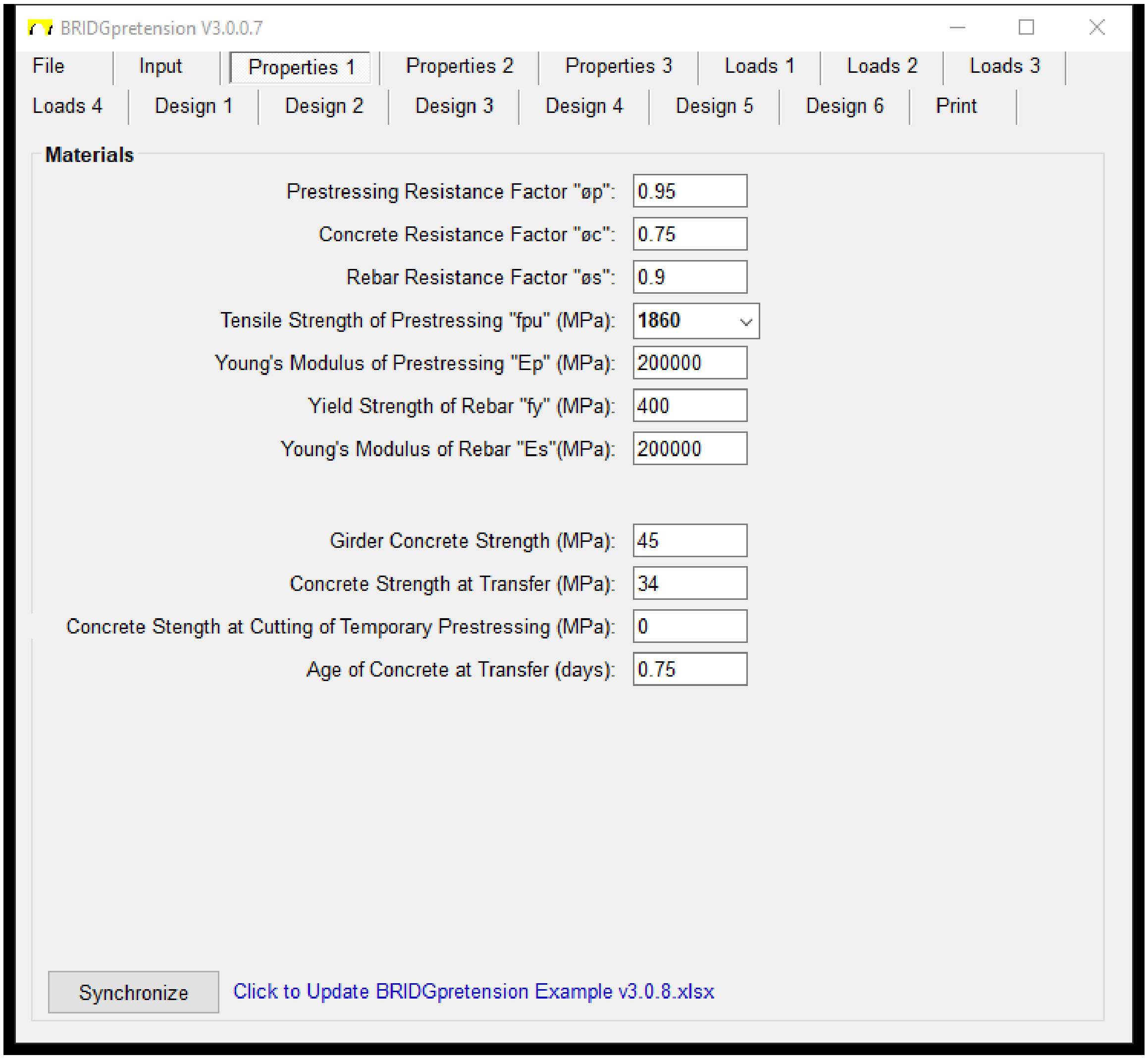

BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Copy Data
Copy from Span1 to:
Span 2
Span 3
Construction Loads:
Shrinkage and Creep Properties:
Shrinkage and Creep Forces:
Dead Loads:
Superimposed Dead Loads:
Soil Pressure from Left to Right Abutment:
Wingwall Loads from Left to Right Abutment:
Settlement from Left Abutment to Other Supports:
Copy
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm

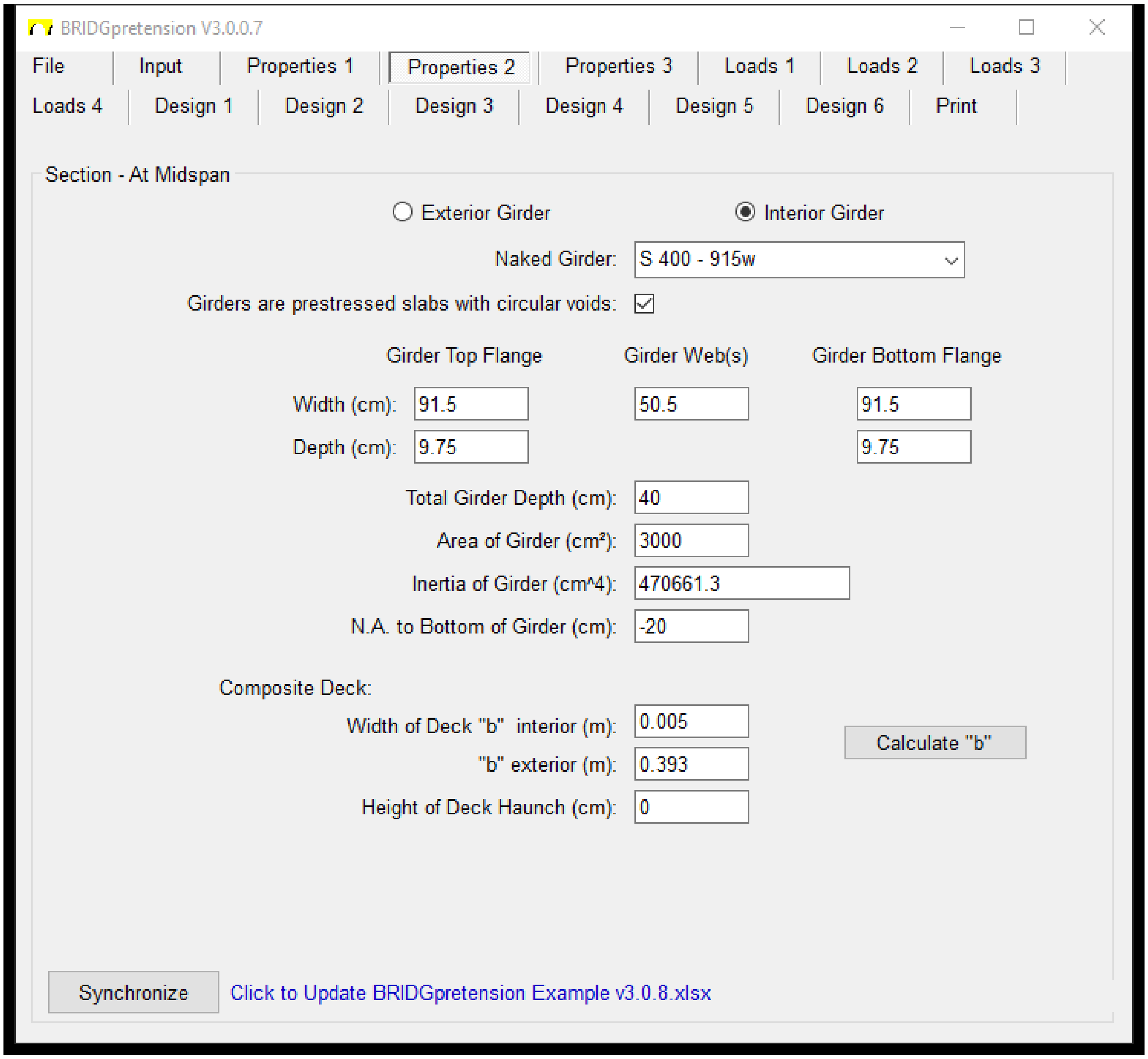

BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Earthquake Force
Span 1
Span 2
Span 3
Average Additional Unfactored Dead Load (kN/m):
Average Horizontal Modulus of Subgrade Reaction
25
on Abutments (kN/m²/mm):
Angle of Friction between Backfill and Wall, δ:
30
(conservatively = 0)
Importance Factor, I (cl.4.4.7.3):
major-route
other
Displacement Left
Displacement Right
Calculate Ta
Ta :
0.113
s
Ta :
0.113
s
Sa (0.2) :
0.10
Sa (0.2) :
0.01
Sa (N/A) :
Sa (N/A) :
Sa (N/A) :
Sa (N/A) :
Peak Ground Acceleration, PGA (cl.4.4.3.1, 4.4.3.3):
0.08
PGA :
0.08
Calculate PGA ref
PGA ref:
0.064
PGA ref:
0.064
F (0.2) :
1.24
F (0.2) :
1.24
F (N/A) :
F (N/A) :
F (N/A) :
F (N/A) :
Horizontal Seismic Coefficient, kh left abut.:
0.08
kh right abut.:
0.08
Vertical Seismic Coefficient, kv left abut.:
0.05
kv right abut.:
0.05
Synchronize
Click to Update BRIDGframe Example v8.0.23y.xlsm

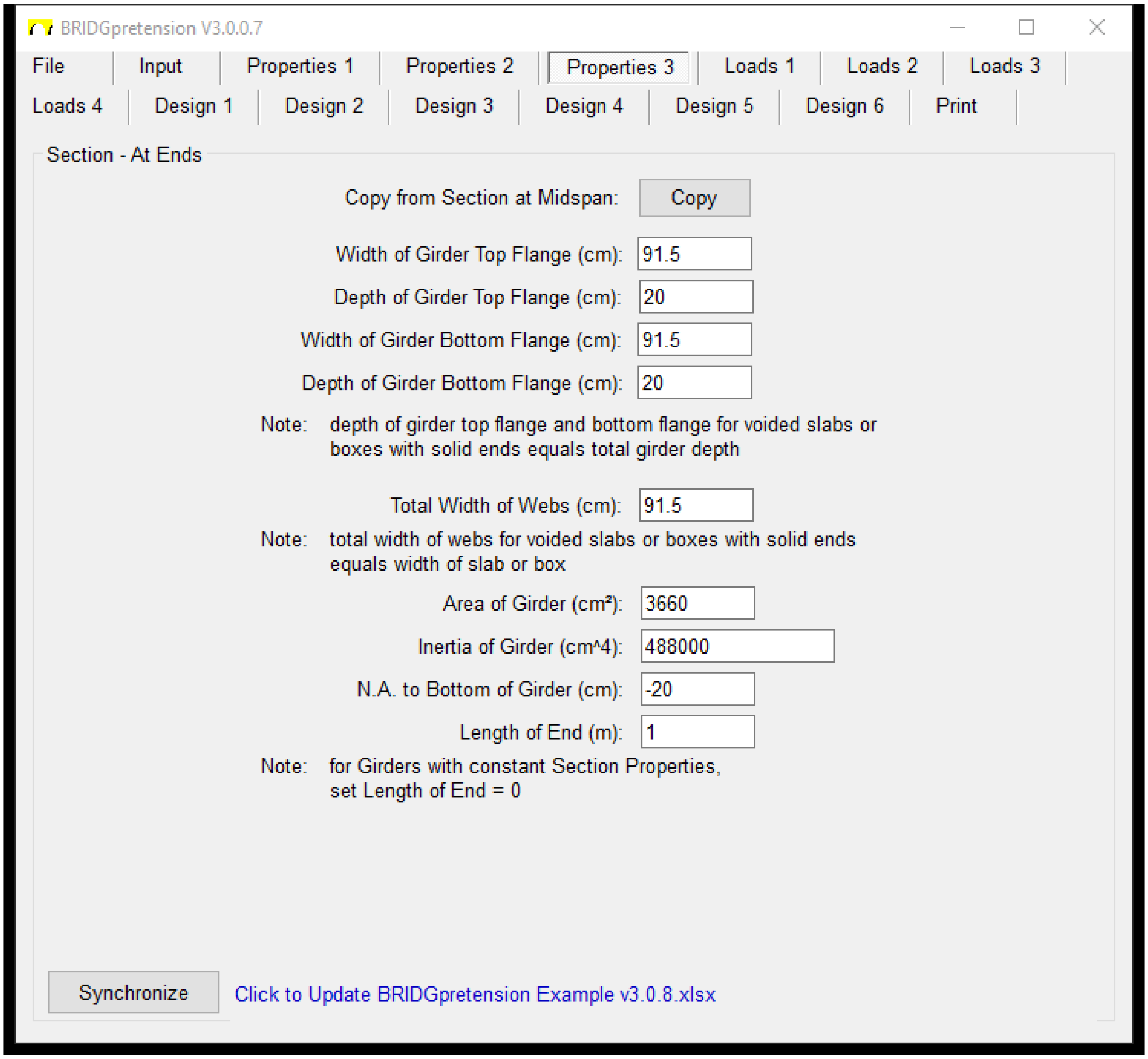

BRIDGframe CHBDC V8.0.2.0
File
Geometry 1
Geometry 2
Properties 1
Properties 2
Properties 3
Fractions
Comb. 2
Loads 1
Loads 2
Loads 3
Loads 4
Loads 5
Loads 6
Loads 7
Analysis
Comb. 1
Method for Establishing Live Load Fractions
Auto
Manual
Auto / Manual
Output Generation
Divisions per Span/Support for Results:
40
Output All
Run
Analysis Speed Index will be Calibrated with this Run
Show Calculations for One Location
Superstructure Result Location (fraction):
Supports Result Location (fraction):
Run
All Vehicles, Axle 1 Location (m):
Vehicles 3 and 6, Moveable Axle Spacing (m):
Print Results
Define
Differential Shrinkage
Model
Shrinkage Load
Select All
Construction Load
Soil Pressure Load
Print Preview
Dead Load
Wind Load
Print Cover Pages
Superimposed Dead Load
Differential Settlement
Get Confirmation
Superimposed Dead Load 2
Dead Load Creep
Live (incl. Brake) Loads
Prestress Creep
Print
Expansion & Contraction
Earthquake
Thermal Gradient Load
Fractions(1 & 2)
E & C Differential Load
Pedestrian

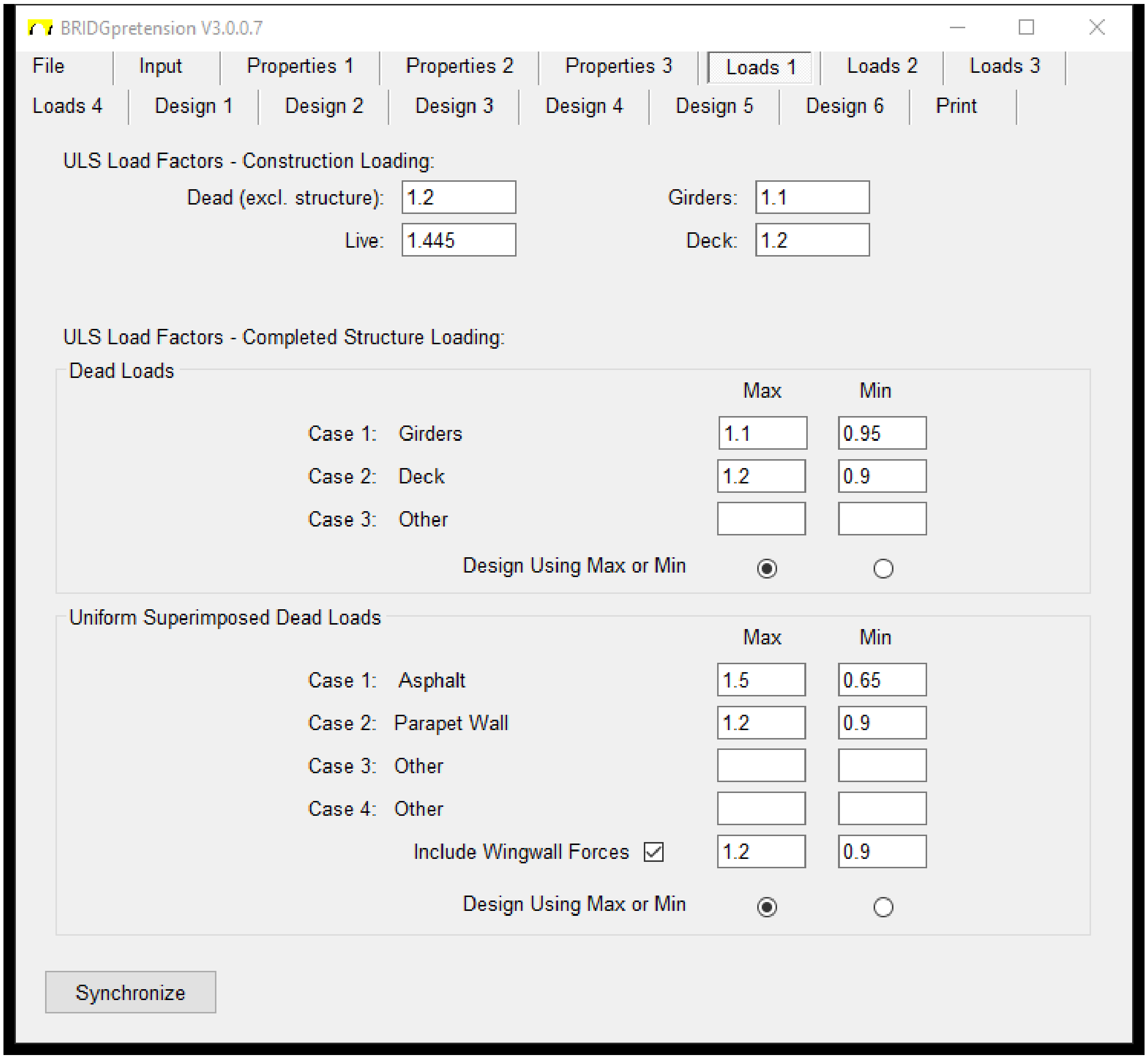
BRIDGpretension:



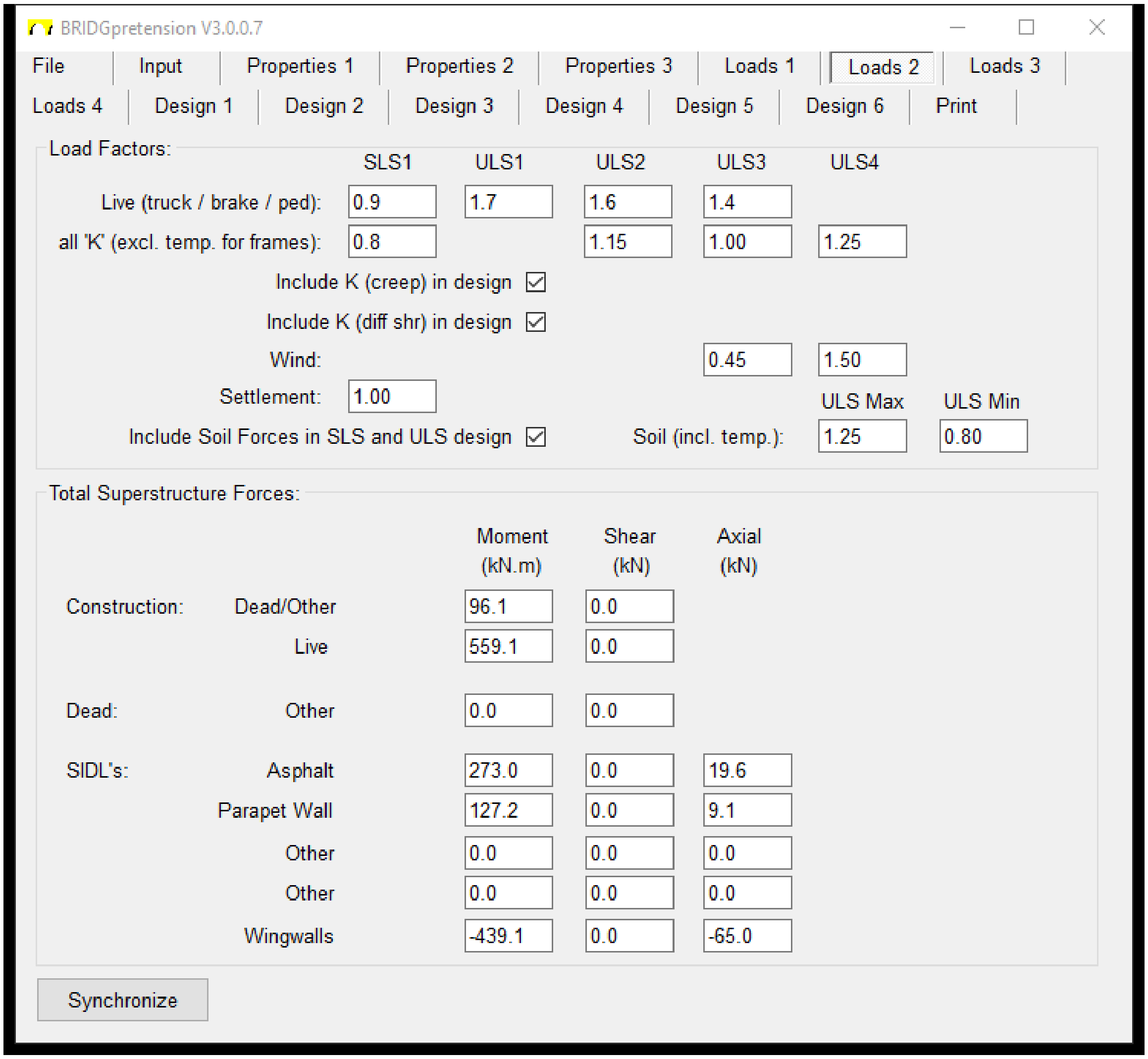

BRIDGpretension V3.0.0.7
File
Input
Properties 1
Properties 2
Properties 3
Loads 1
Loads 2
Loads 3
Loads 4
Design 1
Design 2
Design 3
Design 4
Design 5
Design 6
Print
Materials
Prestressing Resistance Factor "øp": 0.95
Concrete Resistance Factor "øc": 0.75
Rebar Resistance Factor "øs": 0.9
Tensile Strength of Prestressing "fpu" (MPa): 1860
Young's Modulus of Prestressing "Ep" (MPa): 200000
Yield Strength of Rebar "fy" (MPa): 400
Young's Modulus of Rebar "Es"(MPa): 200000
Girder Concrete Strength (MPa): 45
Concrete Strength at Transfer (MPa): 34
Concrete Stength at Cutting of Temporary Prestressing (MPa): 0
Age of Concrete at Transfer (days): 0.75
Synchronize
Click to Update BRIDGpretension Example v3.0.8.xlsx


BRIDGpretension V3.0.0.7
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
Section - At Midspan
Exterior Girder
Interior Girder
Naked Girder:
S 400 - 915w
Girders are prestressed slabs with circular voids:
Girder Top Flange
Girder Web(s)
Girder Bottom Flange
Width (cm):
91.5
50.5
91.5
Depth (cm):
9.75
9.75
Total Girder Depth (cm):
40
Area of Girder (cm²):
3000
Inertia of Girder (cm^4):
470661.3
N.A. to Bottom of Girder (cm):
-20
Composite Deck:
Width of Deck "b" interior (m):
0.005
"b" exterior (m):
0.393
Calculate "b"
Height of Deck Haunch (cm):
0
Synchronize
Click to Update BRIDGpretension Example v3.0.8.xlsx

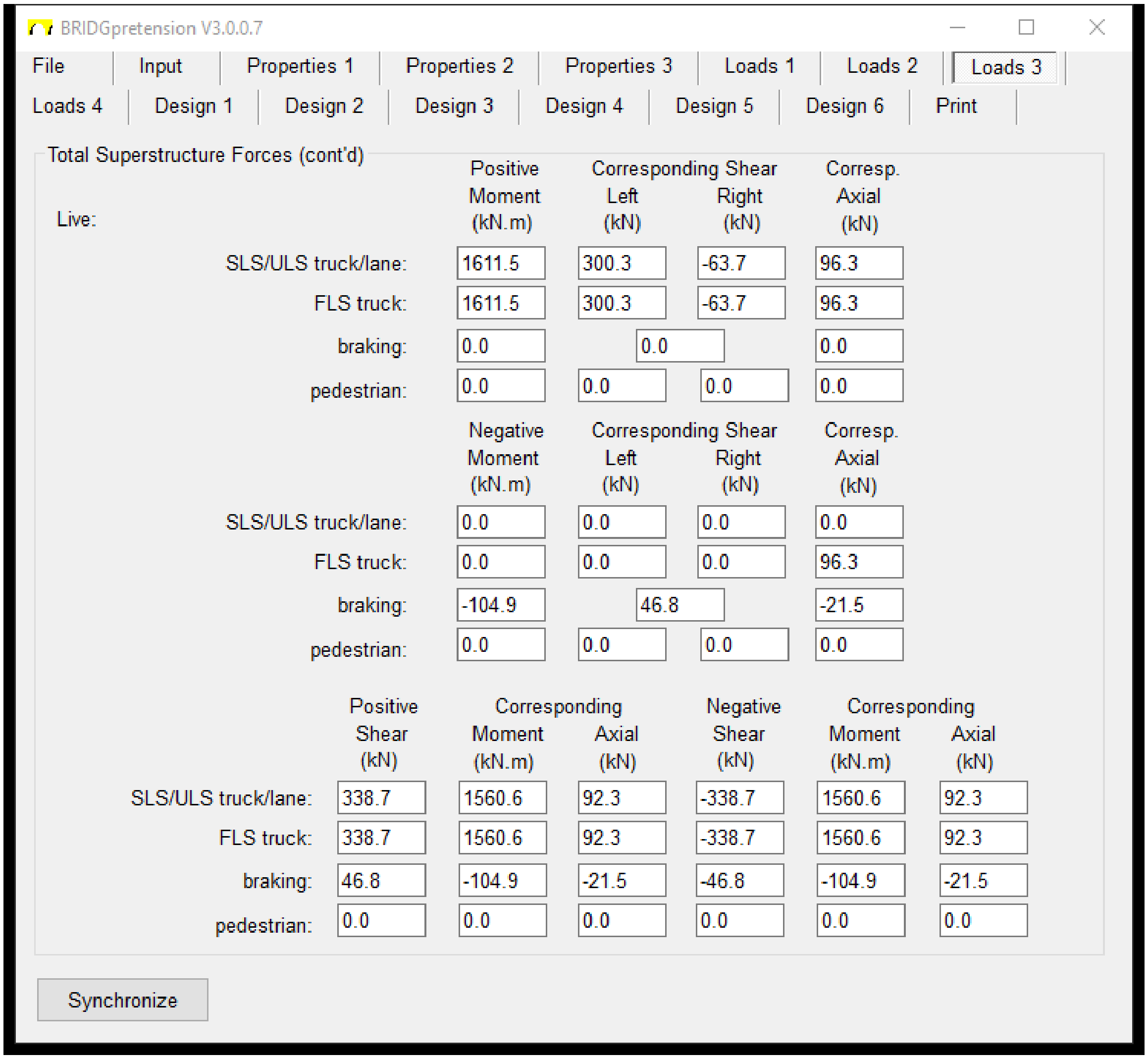

BRIDGpretension V3.0.0.7
File
Input
Properties 1
Properties 2
Properties 3
Loads 1
Loads 2
Loads 3
Loads 4
Design 1
Design 2
Design 3
Design 4
Design 5
Design 6
Print
Section - At Ends
Copy from Section at Midspan:
Copy
Width of Girder Top Flange (cm):
91.5
Depth of Girder Top Flange (cm):
20
Width of Girder Bottom Flange (cm):
91.5
Depth of Girder Bottom Flange (cm):
20
Note: depth of girder top flange and bottom flange for voided slabs or boxes with solid ends equals total girder depth
Total Width of Webs (cm):
91.5
Note: total width of webs for voided slabs or boxes with solid ends equals width of slab or box
Area of Girder (cm²):
3660
Inertia of Girder (cm^4):
488000
N.A. to Bottom of Girder (cm):
-20
Length of End (m):
1
Note: for Girders with constant Section Properties, set Length of End = 0
Synchronize
Click to Update BRIDGpretension Example v3.0.8.xlsx

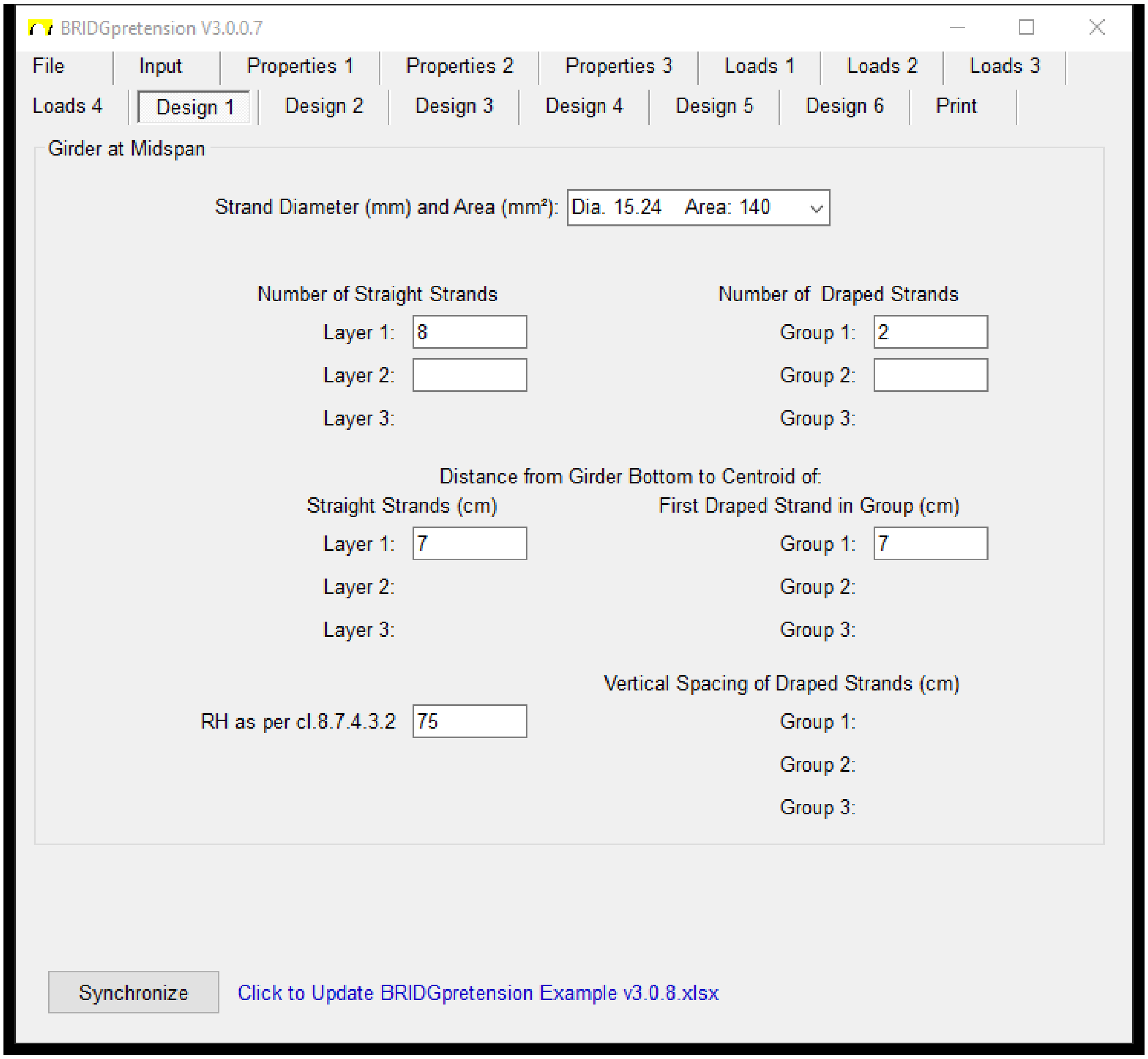


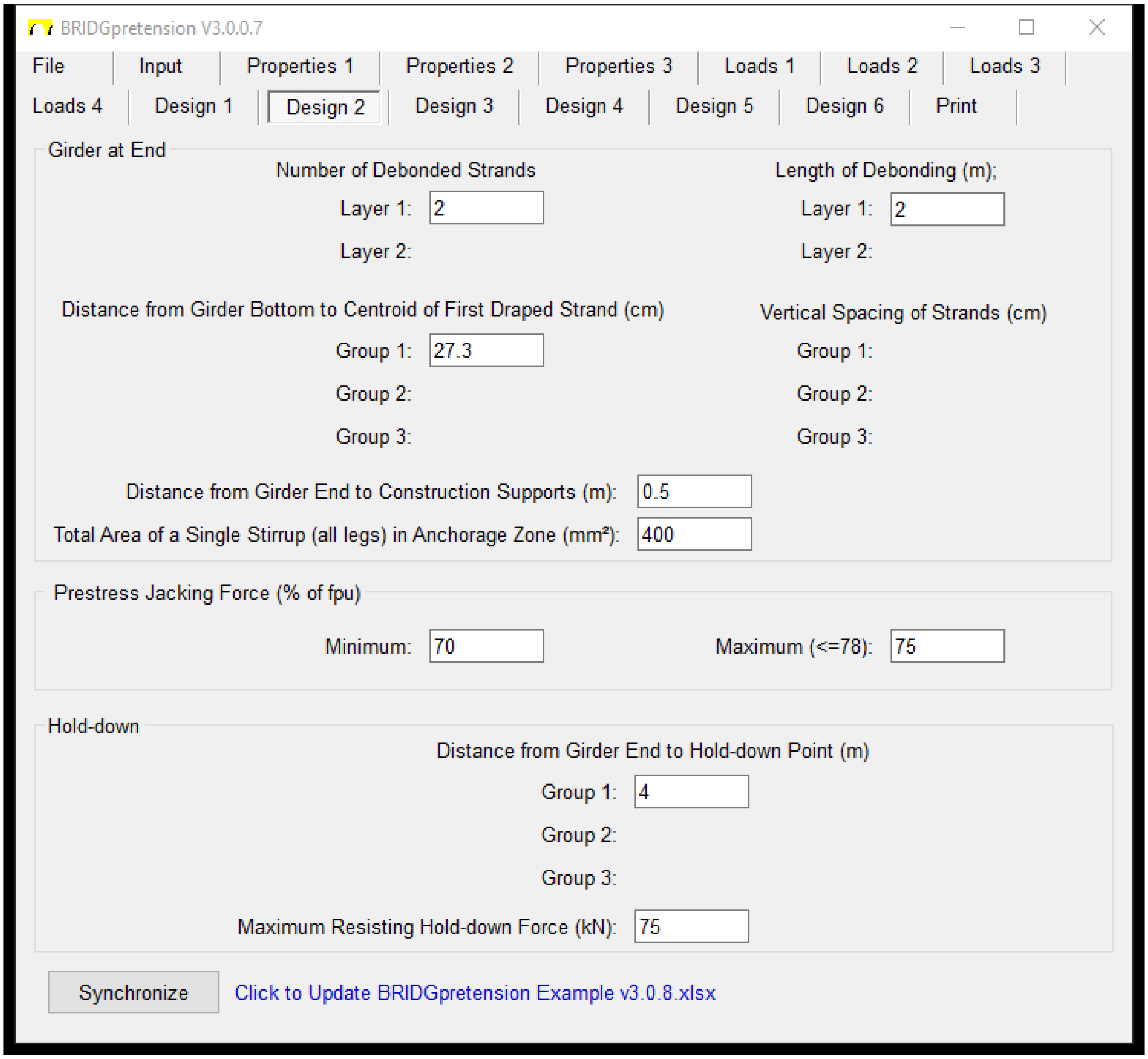
User may choose to exclude wingwall forces since they decrease the mid-span positive moments.



Imported forces may be changed manually


BRIDGpretension V3.0.0.7
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)
Live:
Positive Moment (kN.m)
Corresponding Shear Left (kN) Right (kN)
Corresp. Axial (kN)
SLS/ULS truck/lane: 1611.5 300.3 -63.7 96.3
FLS truck: 1611.5 300.3 -63.7 96.3
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 96.3
braking: -104.9 46.8 -21.5
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: 338.7 1560.6 92.3 -338.7 1560.6 92.3
FLS truck: 338.7 1560.6 92.3 -338.7 1560.6 92.3
braking: 46.8 -104.9 -21.5 -46.8 -104.9 -21.5
pedestrian: 0.0 0.0 0.0 0.0 0.0 0.0
Synchronize


BRIDGpretension V3.0.0.7
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) and Area (mm²):
Dia. 15.24 Area: 140
Number of Straight Strands
Layer 1: 8
Layer 2:
Layer 3:
Number of Draped Strands
Group 1: 2
Group 2:
Group 3:
Distance from Girder Bottom to Centroid of:
Straight Strands (cm)
Layer 1: 7
Layer 2:
Layer 3:
First Draped Strand in Group (cm)
Group 1: 7
Group 2:
Group 3:
Vertical Spacing of Draped Strands (cm)
Group 1:
Group 2:
Group 3:
RH as per cl.8.7.4.3.2 75
Synchronize
Click to Update BRIDGpretension Example v3.0.8.xlsx


BRIDGpretension V3.0.0.7
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 End
Number of Debonded Strands
Layer 1: 2
Layer 2:
Length of Debonding (m);
Layer 1: 2
Layer 2:
Distance from Girder Bottom to Centroid of First Draped Strand (cm)
Group 1: 27.3
Group 2:
Group 3:
Vertical Spacing of Strands (cm)
Group 1:
Group 2:
Group 3:
Distance from Girder End to Construction Supports (m): 0.5
Total Area of a Single Stirrup (all legs) in Anchorage Zone (mm²): 400
Prestress Jacking Force (% of fpu)
Minimum: 70
Maximum (<=78): 75
Hold-down
Distance from Girder End to Hold-down Point (m)
Group 1: 4
Group 2:
Group 3:
Maximum Resisting Hold-down Force (kN): 75
Synchronize
Click to Update BRIDGpretension Example v3.0.8.xlsx

From the DISPL worksheet:

DISPLACEMENT	conc. γ_g =	2500	kg / m^3
	f'_{cg} =	34	MPa
	E_{cg} =	29625	MPa

For BRIDGframe (to establish FEM for prestress creep effects):

- based on final prestress forces and composite section properties

	Left End	Right End
prestr.	-0.004496	0.004496

Fixed End Moment Left end of girder (total all girders) =	2568.2	kN.m
Fixed End Moment Right end of girder (total all girders) =	2568.2	kN.m
Compressive Force (total all girders) =	14017.1	kN

The above forces are to be input into the Loads 5 tab in BRIDGframe.
Repeat this process until the BRIDGpretension values above and the values entered in BRIDGframe are reasonably close.

Effects from eccentric Live Load:

In the following Pile Factor Worksheet, the User is to input the eccentricity of the various number of loaded lanes. Eccentricity is taken about the centroid of the piles. The pile layout is also assumed to be symmetrical about the C/L of the bridge.

Live Load:

PILE FACTOR

1. This worksheet is to assist in determining the maximum live load forces in the end piles for an integral abutment bridge where piles are placed in a single row.
2. All input is done manually on this worksheet.
3. Piles are assumed to be symmetrical about the C/L of bridge.
4. Perpendicular distance from C/L of bridge to centroid of vehicles, eccentricity = e_V

length from first pile to last pile along skew =	7.800	m
number of piles at support =	5	*
pile spacing =	1.95	m
skew of bridge =	0.0	° (degrees)
Section Modulus of Piles using above data =	9.750	m^3
Use the following Section Modulus of Piles =	9.750	m^3

One Lane Loaded:	e_V =	2.885	m	*
Two Lanes Loaded:	e_V =	0.693	m	*
Three Lanes Loaded:	e_V =		m	*
Four Lanes Loaded:	e_V =		m	*
Five Lanes Loaded:	e_V =		m	*
Six or more Lanes Loaded:	e_V =		m	*

Using P/A + M/S to determine governing number of loaded lanes for foundation design:
Calculations include multi-lane load factor as per cl.3.8.4.2 when determining governing condition

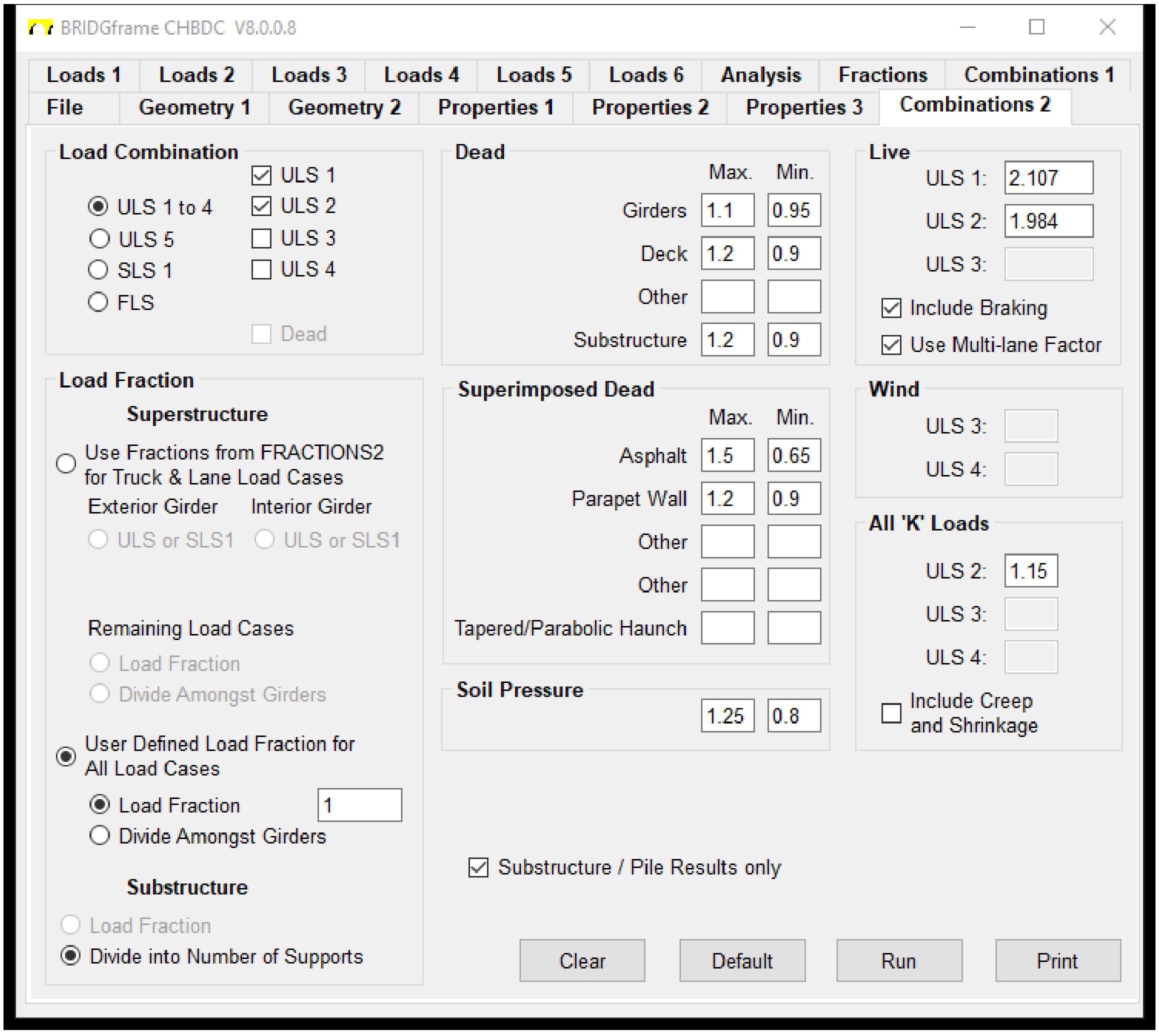
One Lane Loaded:	stress per unit vehicles =	0.49590	GOVERNS
Two Lanes Loaded:	stress per unit vehicles =	0.48794	*
Three Lanes Loaded:	stress per unit vehicles =	*	*
Four Lanes Loaded:	stress per unit vehicles =	*	*
Five Lanes Loaded:	stress per unit vehicles =	*	*
Six or more Lanes Loaded:	stress per unit vehicles =	*	*

Therefore e_V factor = **1.2397** is to be multiplied by the Live Factor on the Combinations 2 BRIDGframe tab. **Select "Use Multi-Lane Factor" in BRIDGframe Combinations 2 since it is not included in this factor.**
This e_V factor is only to be used for pile design and will therefore only apply to COMBINATIONS2 tables starting at CL 46.

Live Load Factor for SLS = 0.9 x 1.2397 = 1.116
Live Load Factor for ULS 1 = 1.7 x 1.2397 = 2.107
Live Load Factor for ULS 2 = 1.6 x 1.2397 = 1.984

Use the above Live Load Factors in the Combinations 2 tab.

Excluding Creep and Shrinkage:



When prompted, choose to populate the reactions and the substructure tables

PILE FORCES

1. The *Absolute Maximum Axial may be used in place of Corresp. Axial for Group #1 for load cases other than Dead and SIDL's
2. Add all Group #1 results together, likewise for Group #2

Note: Piles with opposite sign convention moments at each end are in double cuvature

* - does not include wingwalls and abutment self weight unless Substructure is selected; includes DLA if Live Load is applicable

** - does not include wingwalls and abutment self weight unless Substructure is selected; excludes DLA if Live Load is applicable

ULS 1 to 4 Forces Envelope in Left Abutment Pile(s) (excl. wt. of piles where applicable)									
Location		Group #1			Group #2			Absolute Maximums	
Location Result (m)	Location Result	*Moment (kN.m)	*Corresp. Shear (kN)	*Corresp. Axial (kN)	*Moment (kN.m)	*Corresp. Shear (kN)	*Corresp. Axial (kN)	*Max. Axial (kN)	**Max. Axial (kN)
0.000	Top	-73.8	-20.8	595.1	304.4	89.6	591.4	810.2	746.6
6.000	Bottom	51.0	-20.8	595.1	-233.2	89.6	591.4	810.2	746.6

ULS 1 to 4 Forces Envelope in Right Abutment Pile(s) (excl. wt. of piles where applicable)									
Location		Group #1			Group #2			Absolute Maximums	
Location Result (m)	Location Result	*Moment (kN.m)	*Corresp. Shear (kN)	*Corresp. Axial (kN)	*Moment (kN.m)	*Corresp. Shear (kN)	*Corresp. Axial (kN)	*Max. Axial (kN)	**Max. Axial (kN)
0.000	Top	-73.8	20.8	595.1	304.4	-89.6	591.4	810.2	746.6
6.000	Bottom	51.0	20.8	595.1	-233.2	-89.6	591.4	810.2	746.6

PILE DESIGN TOOL FOR STRUCTURAL CAPACITY

1. Analysis may be done assuming pile sections are not corroded and designed as corroded, and/or analysed using corroded pile section properties and designed as such.
2. As an option, both Analysis and Design may be done using corroded section properties.
3. Analyzed using no lateral loads between top and bottom as per the "Equivelent Cantilevered Method" pile length.
4. Design using governing condition Group #1 or Group #2

- drop-down list

Design Pile at: Left Abutment
Check Design using: Group #1 from COMBINATION2 worksheet, PILE FORCES table at CL40
Note: Group #1 will substitute Corresp. Axial with *Max Axial

INPUT:

Design Forces:

Design Compressive Axial Force	810.2	kN
Calculated moments are about Pile Axis	X - X	
Pile Moment at Top	-73.8	kN.m (using sign convention)
Pile Moment at Bottom	51.0	kN.m (using sign convention)
Corresponding Absolute Shear	20.8	kN
Pile Moment at Top about Y - Y Axis		kN.m (using sign convention)
Pile Moment at Bottom about Y - Y Axis		kN.m (using sign convention)
Corresponding Absolute Shear		kN

Parameters:

length of pile, L	6000	mm	
Yield Strength, F_y	345	MPa	
unbraced length factor, K_x	1.0		
unbraced length factor, K_y	1.0		
resistance factor (Axial), ϕ_s=	0.70		
resistance factor (flexure, shear), ϕ_s=	0.95		
compression parameter, *n*	1.34		cl.10.9.3.1
Elastic Modulus of steel, E_s	200000	MPa	
Shear Modulus of steel, G_s	79300	MPa	
thickness loss due to corrosion of steel	3.0	mm	

New Section Properties:

Member Designation (for I sections only)	**HP310x110**	
Gross Area, A_g	14100.0	mm^2
Radius of Gyration about x-x, r_x	130.0	mm
Radius of Gyration about y-y, r_y	74.0	mm
Web height to thickness ratio, h/w	18.0	
Web thickness, $_w$	15.4	mm
Flange Thickness, t	15.5	mm
Flange, b (50% of flange width)	155.0	mm
Depth, d	308.0	mm
Moment of Inertia about x-x, I_x	237000000	mm^4
Moment of Inertia about y-y, I_y	77100000	mm^4
Elastic Modulus about x-x, S_x	1540000	mm^3
Elastic Modulus about y-y, S_y	497000	mm^3
Plastic Modulus about x-x, Z_x	1730000	mm^3
Plastic Modulus about y-y, Z_y	763000	mm^3
St-Venant torsional constant, J	1240000	mm^4
Warping Constant, C_w	1.6500E+12	mm^6

DESIGN CALCULATIONS:

Section: 1 use I standard section =1, I standard section including corrosion = 2,
manual input of I section with no corrosion = 3, manual input of I section including corrosion = 4

Class of Section: max Class 3 for HP sections as per MTO Structural Manual 3.2.1 cl.10.9.2

Flange b to thickness ratio, b/t	5.00				
IF b/t</=145/$F_y^{0.5}$, Class 1		$145/F_y^{0.5}$ =	7.81		
IF b/t</=170/$F_y^{0.5}$, Class 2		$170/F_y^{0.5}$ =	9.15		
IF b/t</=200/$F_y^{0.5}$, Class 3, else Class 4		$200/F_y^{0.5}$ =	10.77	Flange is:	**Class 1**
Web height to thickness ratio, h/w	18.00				
IF h/w</=1100/$F_y^{0.5}$, Class 1		$1100/F_y^{0.5}$ =	59.22		
IF h/w<=1700/$F_y^{0.5}$, Class 2		$1700/F_y^{0.5}$ =	91.52		
IF h/w</=1900/$F_y^{0.5}$, Class 3, else Class 4		$1900/F_y^{0.5}$ =	102.29	Web is:	**Class 1**

Class of Section is: **1**
*

Using Section Properties:

Gross Area, A_g	14100.0	mm^2
Radius of Gyration about x-x, r_x	130.0	mm
Radius of Gyration about y-y, r_y	74.0	mm
Web height to thickness ratio, h/w	18.0	
Web thickness, w	15.4	mm
Flange thickness, t	15.5	mm
Flange b, (50% of flange width)	155.0	mm
Depth, d	308.0	mm
Moment of Inertia about x-x, I_x	237000000	mm^4
Moment of Inertia about y-y, I_y	77100000	mm^4
Elastic Modulus about x-x, S_x	1540000	mm^3
Elastic Modulus about y-y, S_y	497000	mm^3
Plastic Modulus about x-x, Z_x	1730000	mm^3
Plastic Modulus about y-y, Z_y	763000	mm^4
St-Venant torsional constant, J	1240000	mm^4
Warping Constant, C_w	1.6500E+12	mm^6

Check Slenderness Ratio: cl.10.9.1.3

slenderness ratio about x-x, sl_x	K_x*L/r_x	46.15	**</= 120; therefore OK**
slenderness ratio about y-y, sl_y	K_y*L/r_y	81.08	**</= 120; therefore OK**

Compression Resistance:

λ (cl.10.9.4.1(a) and cl.10.9.4.4(a)) =	0.00			cl.10.9.4.1(a) and cl.10.9.4.4(a)
$C_r = \phi_s*A_g*F_y*(1+\lambda^{(2*n\_s)})^{(-1/n\_s)}/1000$ =	**3405.2**	**kN**		cl.10.9.3.1

λ (cl.10.9.4.1(b) and cl.10.9.4.4(b)):

slenderness ratio about x-x, sl_x	$1.0*L/r_x$	46.15		cl.10.9.4.1(b) and cl.10.9.4.4(b)
slenderness ratio about y-y, sl_y	$1.0*L/r_y$	81.08		
	max(slx, sly)	81.08		
$\lambda = \max(sl_x, sl_y)*(F_y/(\pi^2*E_s))^{0.5}$ =		1.07		
$C_r = \phi_s*A_g*F_y*(1+\lambda^{(2*n\_s)})^{(-1/n\_s)}/1000$ =		**1887.6**	**kN**	cl.10.9.3.1

λ (10.9.4.1(c) and 10.9.4.4(c)) = $\max(sl_x, sl_y)*(F_y/(\pi^2*E_s))^{0.5}$ =	1.07		cl.10.9.4.1(c) and cl.10.9.4.4(c)
$C_r = \phi_s*A_g*F_y*(1+\lambda^{(2*n\_s)})^{(-1/n\_s)}/1000$ =	**1887.6**	**kN**	cl.10.9.3.1

Combined Compression and Bending Moment Resistance: cl.10.9.4

Euler buckling load x-x, C_{ex}	$\pi^2*E_s*I_x/(K_x*L)^2/1000$	12995.0	kN
Euler buckling load y-y, C_{ey}	$\pi^2*E_s*I_y/(K_y*L)^2/1000$	4227.5	kN

ratio of M_{fx1} (smaller moment) to M_{fx2} (bigger moment), k_x	M_{fx1}/M_{fx2}	0.69
ratio of M_{fy1} (smaller moment) to M_{fy2} (bigger moment), k_x	M_{fy1}/M_{fy2}	N/A

Loading Conditions: **Case A** cl.10.9.4.3

uniform bending effect coefficient, ω_{1x}	IF "Case A", IF(0.6-0.4*k_x>=0.4, 0.6-0.4*k_x, 0.4), IF "Case B", 1.0,"ERROR"))	0.40
uniform bending effect coefficient, ω_{1y}	IF "Case A", IF(0.6-0.4*k_y>=0.4, 0.6-0.4*k_y, 0.4), IF "Case B", 1.0, "ERROR"))	N/A

Is the member laterally braced or unbraced? **Braced**

amplification factor cross-sectional strength, U_{1x}	IF($\omega_{1x}/(1-(C_f/C_{ex}))>1$, $\omega_{1x}/(1-(C_f/C_{ex}))$, 1.0))	1.00	cl.10.9.4.2
amplification factor cross-sectional strength, U_{1y}	IF($\omega_{1y}/(1-(C_f/C_{ey}))>1$, $\omega_{1y}/(1-(C_f/C_{ey}))$, 1.0))	N/A	cl.10.9.4.1(a), cl.10.9.4.4(a)
amplification factor overall member strength, U_{1x}	IF "Unbraced", 1, $\omega_{1x}/(1-(C_f/C_{ex}))$)	0.43	cl.10.9.4.2
amplification factor overall member strength, U_{1y}	IF "Unbraced", 1, $\omega_{1y}/(1-(C_f/C_{ey}))$)	N/A	cl.10.9.4.1(b), cl.10.9.4.4(b)
amplification factor torsional buckling strength, U_{1x}	IF "Unbraced", 1, IF($\omega_{1x}/(1-(C_f/C_{ex}))>1$, $\omega_{1x}/(1-(C_f/C_{ex}))$, 1.0))	1.00	cl.10.9.4.2 cl.10.9.4.1(c), cl.10.9.4.4(c)
amplification factor torsional buckling strength, U_{1y}	IF "Unbraced", 1, $\omega_{1y}/(1-(C_f/C_{ey}))$)	N/A	

Bending Moment Resistance for laterally braced members: Class 1 or 2 Section Mr

Bending moment capacity x-x, M_{rx}	IF(section class = 3 or 4, $\phi_s*S_x'*F_y/1*10^6$,			cl.10.10.3.2
	IF(section class = 1 or 2, $\phi_s*Z_x*Fy/1*10^6$))	567.0	kN.m	cl.10.10.2.2
Bending moment capacity y-y, M_{ry}	IF(section class = 3 or 4, $\phi_s*S_y'*F_y/1*10^6$,			cl.10.10.3.2
	IF(section class = 1 or 2, $\phi_s*Z_y*F_y/1*10^6$))	250.1	kN.m	cl.10.10.2.5

Bending Moment Resistance for laterally unbraced members: Class 1 or 2 Section Mr

B_2	$\pi^2*E_s*C_w/(L^2*G_s*J)$	0.92			cl.10.10.2.3
β_x		0.00			
ω_2		1.00			
B_1		0.00			
M_u	$\omega_2*\pi/L*(E_s*I_y*G_s*J+(\pi*E_s/L)^2)*I_y*C_w)^{0.5}/1*10^6$		893.4	kN.m	
M_{yx}	IF(section class = 3 or 4, $S_x*F_y/1*10^6$, IF(section class = 1 or 2, $Z_x*F_y/1*10^6$))		596.9	kN.m	cl.10.10.3.2
M_{rx_uns}	IF(M_u>0.67*M_{yx},1.15*ϕ_s*M_{yx}*(1-0.28*M_{yx} / M_{ux}), ϕ_s*M_{yx})		530.1	kN.m	cl.10.10.3.3

Design Bending Moment Resistance: M_{rx} = **567.0** **kN.m**

M_{ry} = **250.1** **kN.m**

Design to cl.10.9.4.1 or cl.10.9.4.4: Class 3 or 4 of I sections (10.9.4.1), or class 1 and 2 of I sections (10.9.4.4) **10.9.4.4**

MTO Structural Manual section 3 states ratio of factored forces to resisting forces to be </= 0.87 when not using corrosion

Class 3 or 4, cross-sectional strength:	$C_f/C_r+U_{1x}*M_{fx2}/M_{rx}+U_{1y}*M_{fy2}/M_{ry}$ =	**0.00** *****	cl.10.9.4.1(a), cl.10.9.4.2
Class 1 or 2, cross-sectional strength:	$\lambda=K_y*L_y/r_y*(F_y/\pi^2/E_s)^{0.5}$	1.07	cl.10.9.4.4
	β=0.6+0.4*λ</=0.85	0.85	
	$C_f/C_r+0.85U_{1x}*M_{fx2}/M_{rx}+\beta*U_{1y}*M_{fy2}/M_{ry}$ =	**0.35** **</= 0.87, OK with corrosion not used**	cl.10.9.4.4(a), cl.10.9.4.2
Class 3 or 4, overall strength:	$C_f/C_r+U_{1x}*M_{fx2}/M_{rx}+U_{1y}*M_{fy2}/M_{ry}$ =	**0.00** *****	cl.10.9.4.1(b), cl.10.9.4.2
Class 1 or 2, overall strength:	$C_f/C_r+0.85U_{1x}*M_{fx2}/M_{rx}+\beta*U_{1y}*M_{fy2}/M_{ry}$ =	**0.48** **</= 0.87, OK with corrosion not used**	cl.10.9.4.4(b), cl.10.9.4.2
Class 3 or 4, lateral torsional buckling strength:			cl.10.9.4.1(c), cl.10.9.4.2
	$C_f/C_r+U_{1x}*M_{fx2}/M_{rx}+U_{1y}*M_{fy2}/M_{ry}$ =	**0.00** *****	
Class 1 or 2, lateral torsional buckling strength:			cl.10.9.4.4(c), cl.10.9.4.2
	$C_f/C_r+0.85U_{1x}*M_{fx2}/M_{rx}+\beta*U_{1y}*M_{fy2}/M_{ry}$ =	**0.54** **</= 0.87, OK with corrosion not used**	

Shear Resistance:

buckling shear coeff. (unstiffned web), k_v 5.34 cl.10.10.5.1

shear area, A_w $d*t_w$ for rolled shapes and $h*t_w$ for fabricated shapes 4743.2 mm^2

a):	$F_{cr\_a} = 0.577*F_y$	199.1	MPa
	F_{t_a}	0.0	MPa
	$F_{s\_a} = F_{cr\_a}+F_{t\_a}$	199.1	MPa
	$V_{r\_a} = \phi_s*A_w*F_{s\_a}/1000$	897.0	kN
b):	$F_{cr\_b} = 290*(F_y*k_v)^{0.5}/h_{\_w}$	691.5	MPa
	F_{t_b}	0.0	MPa
	$F_{s\_b} = F_{cr\_b}+F_{t\_b}$	691.5	MPa
	$V_{r\_b} = \phi_s*A_w*F_{s\_b}/1000$	3116.0	kN
c):	$F_{cr\_c} = 180000*k_v/(h_{\_w}^2)$	2966.7	MPa
	F_{t_c}	0.0	MPa
	$F_{s\_c} = F_{cr\_c}+F_{t\_c}$	2966.7	MPa
	$V_{r\_c} = \phi_s*A_w*F_{s\_c}/1000$	13367.9	kN

Design Shear Resistance, V_r: IF($h_{\_w}$<=502*(kv/Fy)$^{0.5}$, V_{r_a}, IF(502*(kv/Fy)$^{0.5}$<=$h_{\_w}$<=621*(kv/Fy)$^{0.5}$, V_{r_b}, V_{r_c}) cl.10.10.5.1

$V_r =$ **897.0** **kN**

Combined Shear and Bending Moment Resistance: cl.10.9.4.4, cl.10.10.5.2

MTO Structural Manual section 3 allows ratio of factored forces to resisting forces to be </= 0.87 when not using corroded section properties

$V_f / V_r =$ **0.02** **</= 0.87; therefore OK (with corroded section properties not used)**

$M_{fx2}/M_{rx} + M_{fy2}/M_{ry} =$ **0.13** **</= 0.87; therefore OK (with corroded section properties not used)**

$0.727*M_{fx2}/M_{rx}+0.455*V_{fx}/V_r =$ **0.11** **</= 0.87; therefore OK (with corroded section properties not used)**

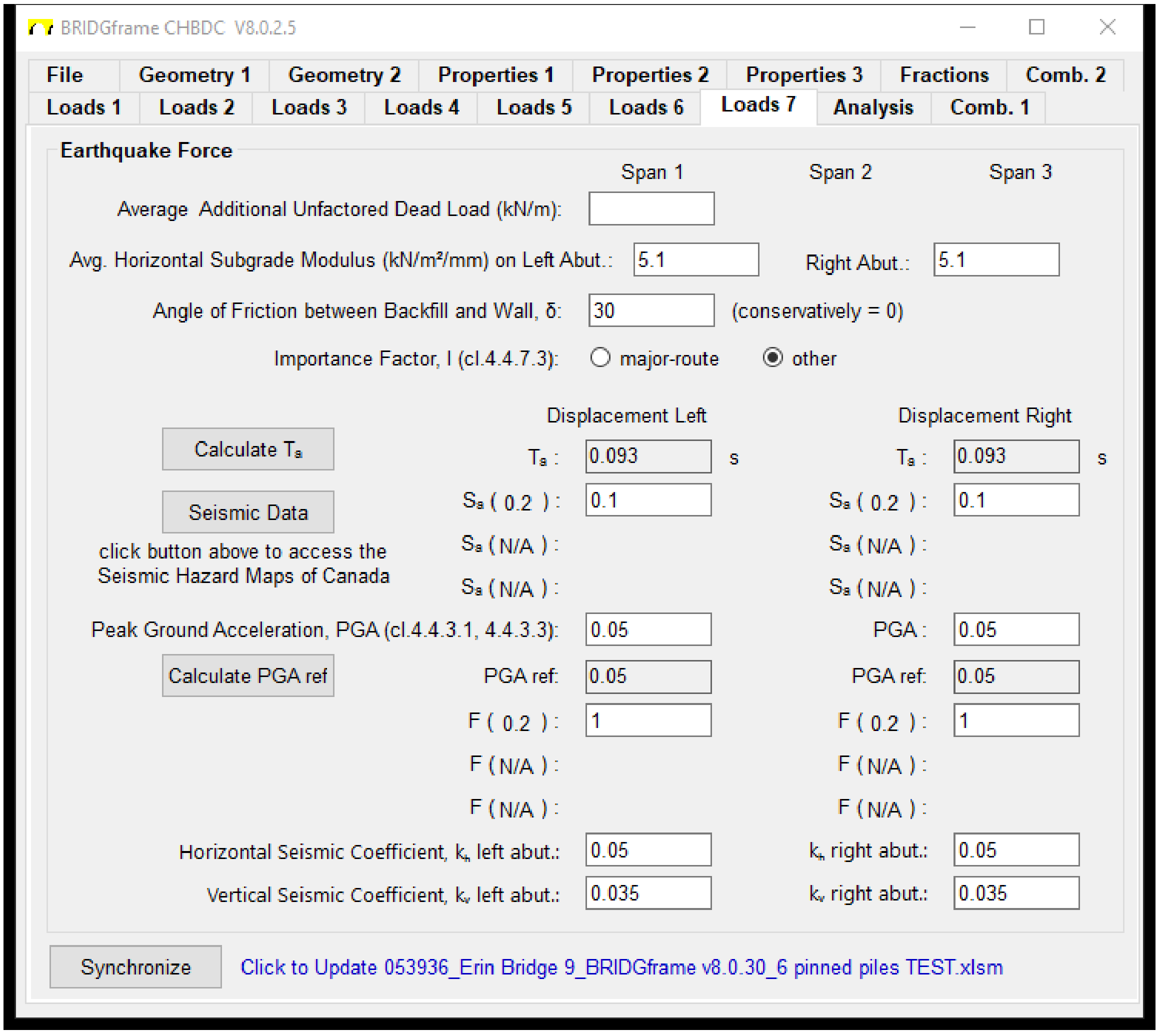
$0.727*M_{fy2}/M_{ry}+0.455*V_{fy}/V_r =$ **0.00** **</= 0.87; therefore OK (with corroded section properties not used)**

$0.727*(M_{fx2}/M_{rx} + M_{fy2}/M_{ry}) + 0.455*(V_{fx}+V_{fy})^{0.5}/ V_r =$ **0.10**
</= 0.87; therefore OK (with corroded section properties not used)

Repeat the above for Group # 2
Repeat the above with creep and shrinkage effects included
Revise the number and/or size of piles as required

A similar method may be used for footings of rigid frames to determine the maximum stresses at the footing end. COMBINATIONS2 tables starting at CL 46 would not be applicable.

APPENDIX 18 – LOADS 7



- Dead Loads are likely already accounted for on the Loads 1 tab, however, provision has been provided to allow for additional dead loads for earthquake design
- The User is required to input the average horizontal modulus of subgrade reaction. The program will multiply this value by the height and length of abutment. This is used when determining the stiffness of a continuous abutment/superstructure bridge.
- The program calculates T_a from which the User inputs the required S_a values.
- The program calculates PGA_{ref} from which the User inputs the required F values.
- k_h and k_v may come from the Geotechnical Engineer. Also refer to AASHTO and Caltrans.
- Information for completing Loads 7 may be found by clicking on the Seismic Data button which will take you to:

https://earthquakescanada.nrcan.gc.ca/hazard-alea/zoning-zonage/NBCC2015maps-en.php#sa0.05

APPENDIX 19 – TIPS

1. Do not have the Auto Save turned on when doing an analysis.

2. The Excel output file may be used as any typical excel file. Worksheets may be added. Graphs and trendlines/equations generated, etc.

3. Worksheets in the workbook may be copied and renamed so they will not get overwritten. Be sure not to rename the original worksheet as the program will not be able to find it since it looks for specific sheet names.
   a. A possible time to use the feature is with the Combination worksheets. A combination can be generated, the Combination worksheet copied, and the name of the copied worksheet changed to reflect the combination generated.
   b. Another time to use copy worksheets is when, by trial-and-error, the F.E.M.'s and axial load for prestress creep is input on the Loads 5 tab. Since the Live Load results will not change, if the User copies and renames the LIVE and LIVE2 worksheets after the initial analysis, and then on subsequent runs fixes the location (set = 0) of the live load on the Loads 3 tab, the program will not move the truck so the program will run quickly. You still have all the live load results on the renamed worksheets, so the LIVE and LIVE2 sheet can be deleted, and the original renamed live sheets can be copied and renamed back to LIVE and LIVE2, giving you the live load results without rerunning the live loads. This can be repeated until the correct F.E.M.'s and axial forces have been established by also using BRIDGpretension, at which time no further analysis is required and the original copied and renamed live sheets can be deleted.

4. After an analysis is complete, the Show Calculations for One Location on the Analysis tab may be used to find the load case forces at any point between the reported locations in the output tables shown on each worksheet. These force values may be found on each worksheet reported in red text. If the option is not available, an updated analysis will be required.

5. On the Analysis tab, the Output All box may be unchecked, and the User will be asked if they only want to populate certain groups of worksheets.

6. When modeling deck slabs with parabolic or tapered soffits, remember, the parabolic or tapered portion of the slab is its own load case. On the Combinations tabs, the parabolic/tapered load case must be checked off with the deck load case to get the total force effects from the superstructure self weight.

7. Tables on COMBINATION2 starting at column CL can be used to determine forces for pile design.