C-BrEase

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Version 1.2.4

User Guide

September 2020

Welcome

Welcome to C-BrEase

C-BrEase is a software application written by *H_2Flo Consulting* for the purpose of making the plotting and analysis of channel cross-sections simple and informative for engineers.

First created in 1997, the original program was known as *BrEase* and operated as an application of Microsoft Excel. Newly rewritten in 2017 using the programing language C# as a stand-alone program, **C-BrEase** now has greater flexibility, improved stability and more capabilities than ever before.

For more information about **C-BrEase** or the services of *H_2Flo Consulting*, please visit the website.

Why C-BrEase?

Why C-BrEase?

C-BrEase provides a streamlined approach to plotting channel cross-sections.

Past studies of bridge failures have demonstrated the essential value of maintaining accurate, graphical records of channel cross-sections at bridge openings to assess channel instability and to identify potential vulnerabilities with the bridge foundation.

C-BrEase has been specifically designed to make the calculation of channel cross-sections efficient for the engineer in order to highlight important changes in the channel which might indicate channel stability concerns.

To do this, the program was designed to accurately calculate the channel cross-section data and create plots that relates the historic channel cross-sections with the bridge foundation.

Accurate Cross-Section Calculations

To calculate the correct elevation of each cross-section data point, **C-BrEase** accounts for

- Variations in the Bridge Geometrics
  - cross-slope
  - superstructure depths
  - bridge vertical alignment
  - bridge skew
- Adjusts for Measurement Offsets
  - Rail height
  - Tape leader
- Allows for Flexible Data collection methods
  - Laser readings
  - Weighted tape
  - Stationing based on face of substructure item

Visually Compelling Plots

To generate meaningful plots of the bridge and channel cross-sections, **C-BrEase** offers

- Flexible Displays
  - Turn on and off different cross-sections
  - Annotate the chart to show key points of interest
  - Quickly adjust the line style, thickness and color of each cross-section
- Interactive Charts
  - Easily zoom into important locations
  - Quickly compare elevation data from various years

What's New?

What's New?

C-BrEase will be comprised of 3 modules:

1. Historic Channel Cross-Section Monitoring
2. Field Data Collection on Mobile Devices
3. Hydraulic Calculations and Scour Computations

The initial release of **C-BrEase** will only include the cross-section monitoring module.

Compared to earlier versions of *BrEase*, many new features have been added to make **C-BrEase** more useful like

- Greater flexibility to add unique superstructure details and vertical alignments
- Graphical view of individual bridge items during input
- Texture fill for Bridge elements for more realistic looking structure
- Quick means to change plot elements such as line thickness, opacity of substructure, etc.
- Solid earth representation of channel
- Rapid zooming and panning of bridge plots
- Enhanced annotation system
- Integrated Help System

However, compared to the prior versions of *BrEase*, the **C-BrEase** no longer supports the following features:

- Nonbridge Option for cross-sections not located at bridge site
- Clearance Diagram

Release History

C-BrEase Release History

Version 1.0 - Released July 6, 2017

Version 1.1.0 - Released September 19, 2017

- Added Option to Name Report Files
- Printing
  - Cleaned up missing legend on charts
  - Removed Status Strip from print
  - Added Paper Size Options
  - Removed bug when printing charts without report
- Editing Annotations on Charts
  - Enabled moving of Bridge Labels
  - Enabled moving of annotations with mouse
  - Enabled changing font size, line size and rock size with mouse
- Fixed Licensing bug which locked out user if wrong password used

Version 1.1.1 - Released November 27, 2017

- Added Trace Values of Deck and Soffit on Chart
- Fixed Bug in X-Section Input to prevent hiding of Point Entries upon selecting From Item

Version 1.1.2 - February 8, 2018

- Corrected Bug which ignored Vertical Adjustments to X-Sections points on Read-in of *.cbz file.
  Subsequently, when the file was saved, all Vertical Adjustment Values were being set to False.

Version 1.2.0 - July 7, 2018

- Corrected Bug which ignored referencing face of substructure item for station in cross-section calculations
- Added Status Strip help for all fields in form
- Added Hydraulic Module with Rating Curve and Risk Analysis

Version 1.2.1 - October 5, 2018

- Added Pier Scour Module based on CSU Pier Scour Equation
- Added Risk Analysis for Pier Scour

Version 1.2.2 - February 24, 2019

- Improved validation on Hydraulics module
- Fixed Issue causing the PDF Report to crash
- Fixed Bug with Bridge Labels on Charts
- Reorganized image files in Program directory

Version 1.2.3 - March 3, 2019

- Improved Zooming on Charts
- Fixed Bug in Annotations on Charts
- Fixed Bug for Superstructure Length

Version 1.2.4 - September 2020

- Improved Chart Labels
- Addtion of Markers for Plots
- Rotation of Annotations on Charts
- Bugs fixed for modifying Annotation Table Entries
- Bugs fixed for Saving Chart Images and Printing Charts
- Export for Cross-Sections Added for both Survey Data and General Cross-Sections
- Bug fixes on X-Section Entries
- Bugs fixes for Font Size on Chart Title and Axis Labels

Getting Started

Let's Get Started

C-BrEase is designed to be an intuitive program which provides the user with a clear and consistent approach to plotting channel cross-sections at bridge openings.

Using As-Built Bridge Plans and field measurements of channel cross-sections, one can develop accurate and professional plots that illuminate channel changes and potential problems at bridge site.

To navigate in **C-BrEase**, one uses User Forms to input data and for commands for generating and modifying plots.

System requirements

System Requirements

Hardware and Software Requirements

The computational and graphical demands for **C-BrEase** are fairly low making the program usable on most PCs and Laptop computers running Microsoft Windows 7 or later.

C-BrEase is built on the Microsoft .Net Framework and requires Version 4.5 or later.

Evaluating C-BrEase

Evaluating C-BrEase

Upon starting C-BrEase for the first time, a 30-day license will be automatically generated. The evaluation license is fully functional, but will place a "Demo Document" watermark on the PDF Report Documents.

After the evaluation period, you will no longer be able to open, modify, save C-BrEase files or in any other way use the C-BrEase program.

To upgrade to a Paid Version of C-BrEase, see the help section on License Registration.

For more information on acquiring a Paid Version of C-BrEase, visit the following web page or contact sales@h2floconsulting.com or 916-832-5327.

Getting help

HELP

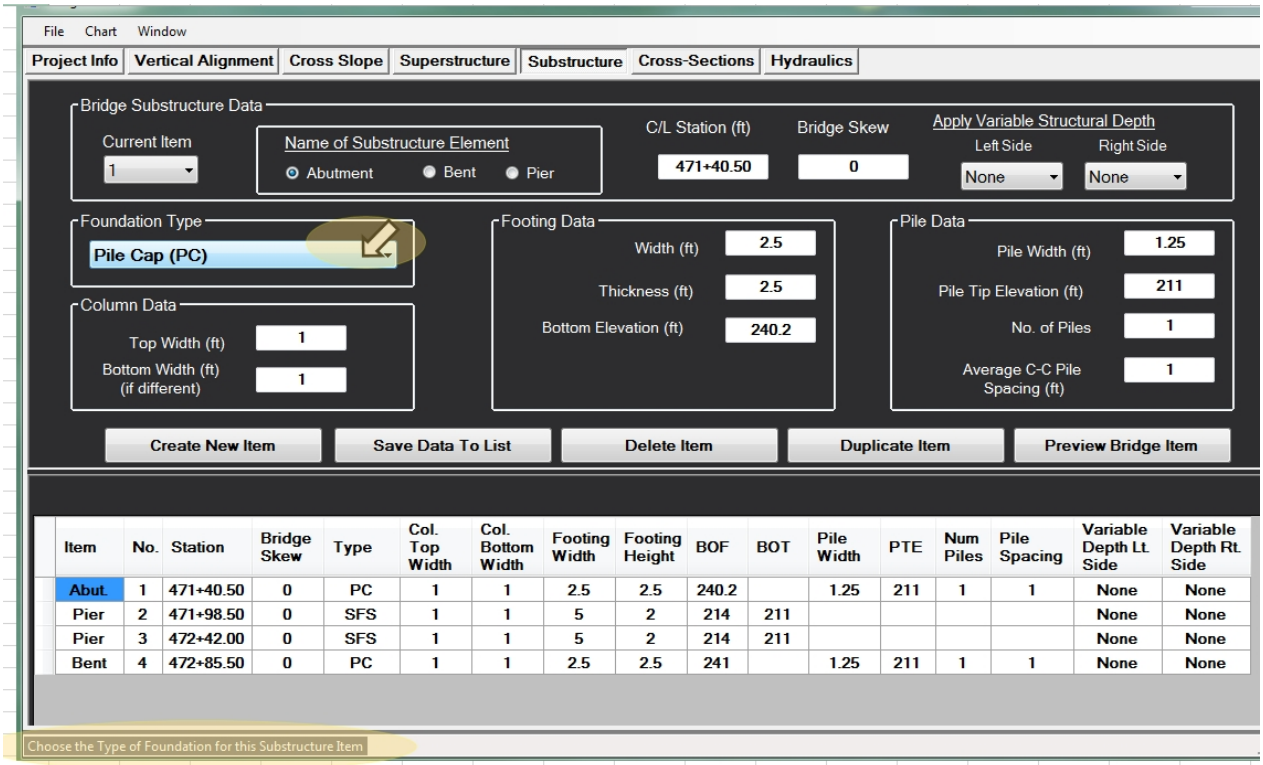
Help Button

On each user form, a Help Button,  , is located at the upper right corner of the form to provide specific guidance for that section of the user form.

After clicking the  button, you can select various items on the form to open the Help file document to the topic which is relevant to the selection.

Status Strip

In the lower left corner of the form, instructions are given in the Status Strip for what information or action is required for each field or tool on the form.
To access this information, hover the mouse over the textbox, dropdown box or combo box to see the display in the Status Strip as as highlighted in the image below.



Item	No.	Station	Bridge Skew	Type	Col. Top Width	Col. Bottom Width	Footing Width	Footing Height	BOF	BOT	Pile Width	PTE	Num Piles	Pile Spacing	Variable Depth Lt. Side	Variable Depth Rt. Side
Abut.	1	471+40.50	0	PC	1	1	2.5	2.5	240.2		1.25	211	1	1	None	None
Pier	2	471+98.50	0	SFS	1	1	5	2	214	211					None	None
Pier	3	472+42.00	0	SFS	1	1	5	2	214	211					None	None
Bent	4	472+85.50	0	PC	1	1	2.5	2.5	241		1.25	211	1	1	None	None

To report bugs or if you need additional assistance, please email support@h2floconsulting.com

Program Organization

Program Organization

C-BrEase uses User Forms to record and display bridge and cross-section data.

The Project Information, Bridge Data and Cross-Section Data is entered and modified through the General Form.

In addition, the General Form is used to Create Charts, Open and Save Files and Print Reports.

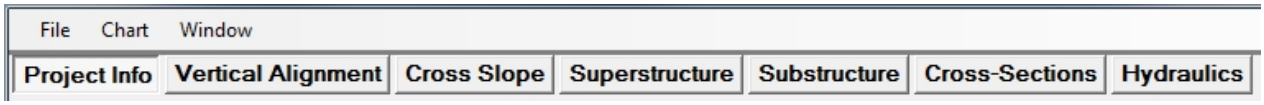
General Form

GENERAL FORM

The *General User Form* will automatically be displayed when **C-BrEase** is opened.

Organization of the General User Form

The **General Form** in **C-BrEase** consists of 6 Tabs (Pages) which show across the User Form as show below.



1. **Project Info** - for entering project related information
2. **Vertical Alignment** **-** for specifying the type vertical alignment of the bridge
3. **Cross Slope** **-** for defining the cross-slope and distance to the edge of deck
4. **Superstructure** - for defining the structural depth of the bridge
5. **Substructure** **-** for defining the dimensions and elevations of the substructure elements
6. **Cross-Sections** - for entering the data about the cross-sections
7. **Hydraulics** - for entering hydraulic parameters and executing hydraulic analysis. Note: The Tab is only available as an Add-On Extension of **C-BrEase** and will not be visible under the Licensing
for the basic program. See www.h2floconsulting.com for more information about purchasing the Hydraulic Add-On.

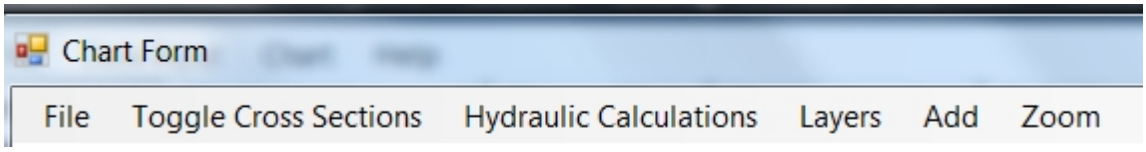
One moves between the tabs by clicking on the Tab you want to access.

Chart Form

CHART FORM

The Chart Form provides a set of tools and commands by which user can easily modify and adjust the Chart generated by **C-BrEase.**

Below are the menu options to control the appearance of the Chart.



1. **File** - for managing the project including printing and saving charts

2. **Toggle Cross-Sections** - for turning on and off X-sections and modifying the presentation of the x-section
3. **Layers** - for changing the visibility and color of components of the chart
4. **Add** - for adding annotation to the chart
5. **Zoom** - for focusing on specific parts of the bridge/cross-section

File Organization

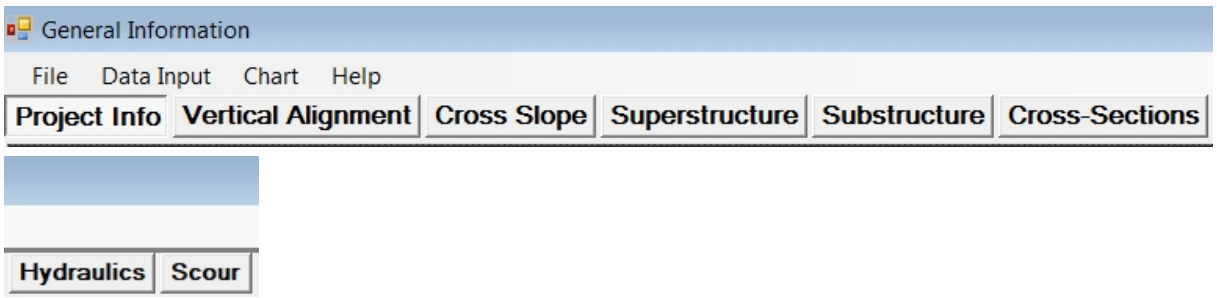
File Organization

There are 4 types of files generated by **C-BrEase:**

1. Project Files for **C-BrEase** are ascii (text) files and may be stored to any location on your hard drive or other storage medium and will have the file extension "cbz" (i.e., sample.cbz). Information in these files can be viewed using any text editor such as Notepad, Wordpad or Microsoft Word.
2. Image files of the Charts can be saved individually as "jpg" files.
3. Report files documenting the bridge and cross-section inputs are recorded as PDF files.
4. Hydraulic Risk assessment ascii files used for future scour analysis and recorded as "risk_estimate.cbz"

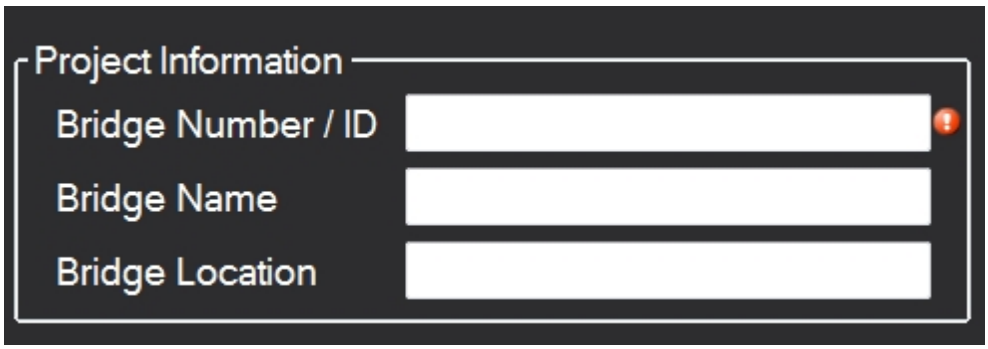
General Form

The *General User Form* is comprised of the following 6 Required Tabs and 2 Optional Tabs.
The first 6 Tabs are for the development of the bridge and cross-section plots.
The last 2 Tabs are for the optional license purchase for analyzing hydraulic and scour calculations



In principle, it is best to start with the Project Info Tab, then proceed to completing each subsequent tab moving to the right.

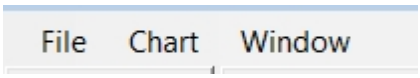
If critical information is missing, you will be alerted by a flashing red dot when trying to move on prematurely as shown below.



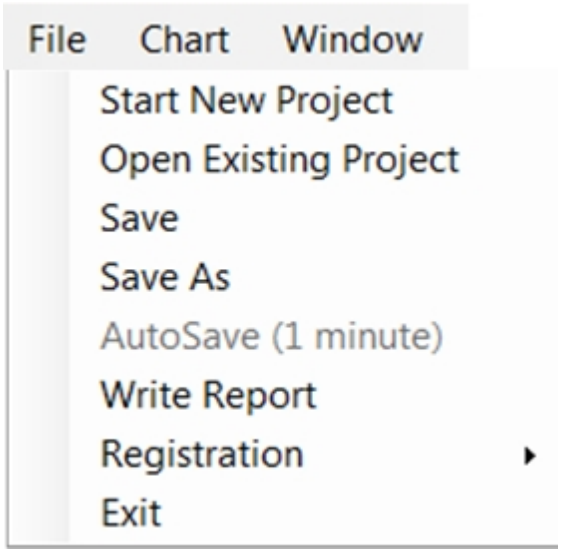
Menu Items

General Form Menu System

The Menu system for the General Form consists of the following 3 Items



The Sub Menu Items for the File Menu Item are as follows:



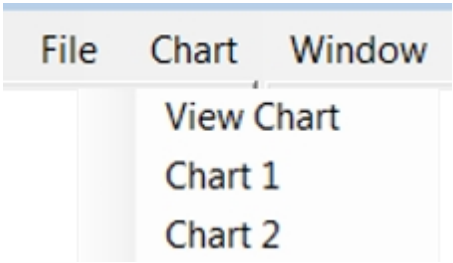
Clicking the AutoSave Menu Item will toggle the program to Save the *.cbz file every 1 minute.

The Write Report Option will provide the user with a summary PDF report of the data entered for the project, bridge geometry and cross-sections.

The Registration Menu Option provides options to

- View the current registration information,
- Register the program o
- Deactivate a License on one computer to move it to another computer

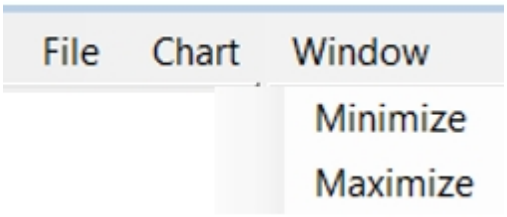
The Sub Menu Items for the Chart Menu Item are as follows:



To Plot a Chart of the Data, choose the View Chart Item.

To view a previously saved chart, select the chart of interest (e.g., Chart 1 or Chart 2 in the example above)

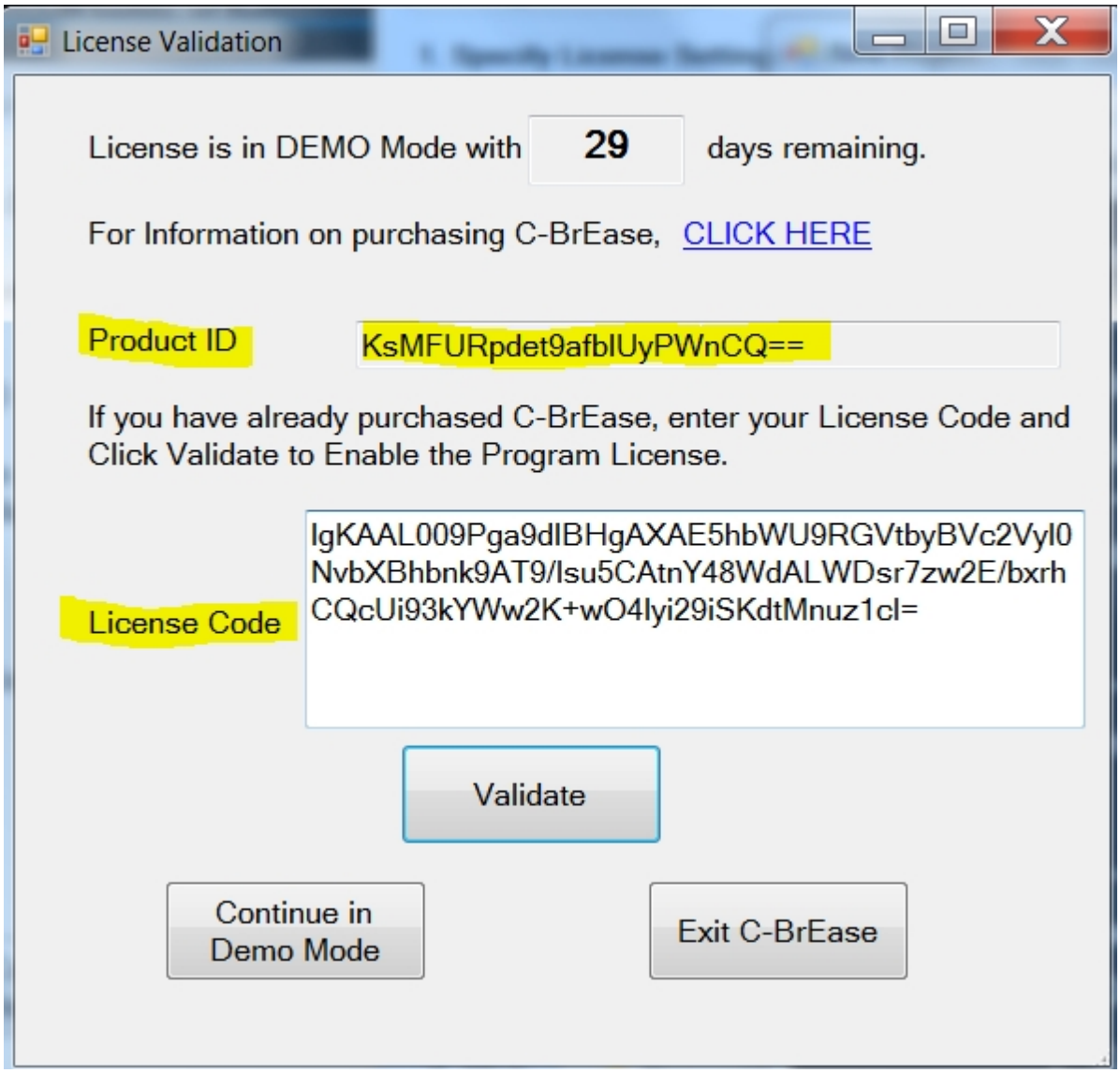
The Sub Menu Items for the Window Menu Item are shown as below to either Minimize or Maximize the General Form on the Monitor.



License Registration

To Register C-BrEase, select the Register Program Option and form showing the Product ID will appear. Copy the Product ID to the clipboard and mail to sales@h2floconsulting.com. Upon receipt of the Product ID and payment for a license, a Registration Code will be emailed back to you which you can enter in the same form as shown below.

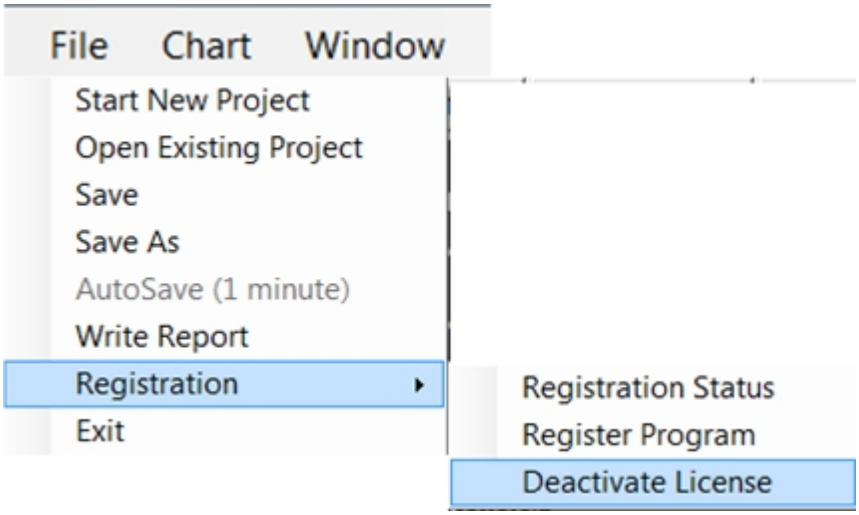
After clicking the Validate Button, you should see a message confirming the validation. To complete the registration, close C-BrEase and restart.

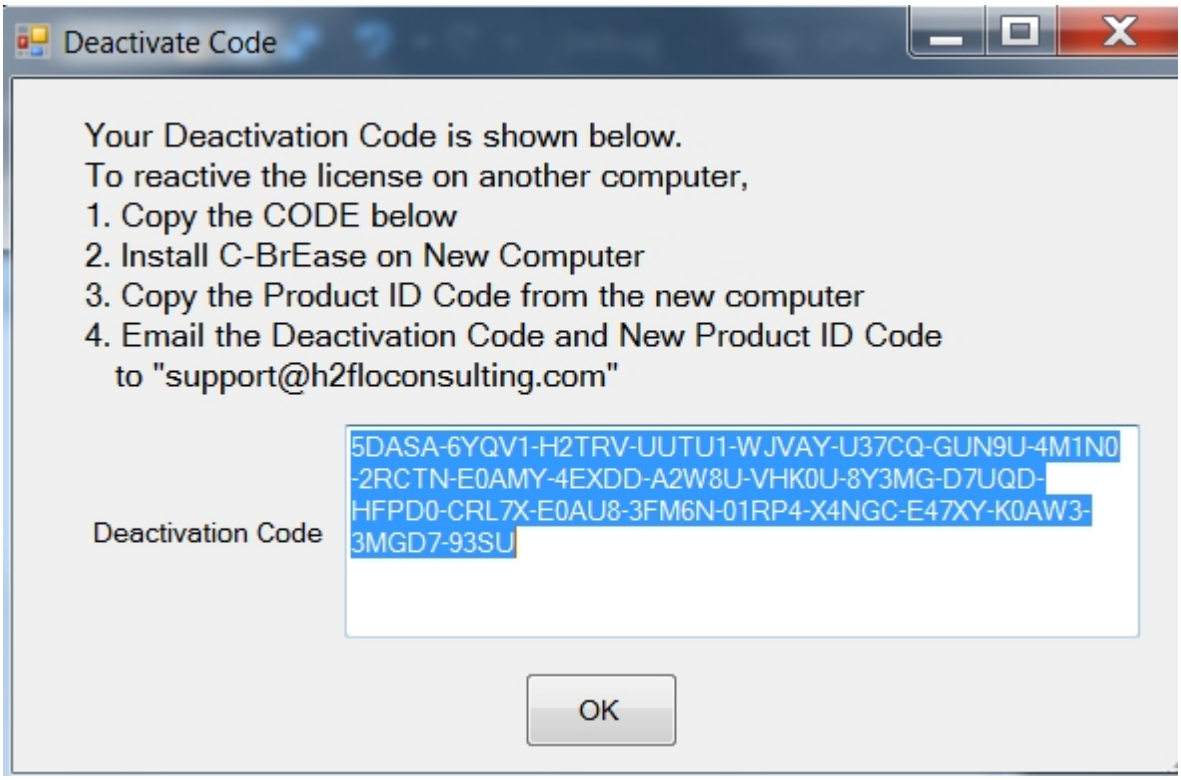


License Deactivation

License Deactivation

If your license is limited to a specific machine and you want to move the C-BrEase license to another computer, the active license must be deactivated by selecting the menu option below and following the instructions provided on the user form.



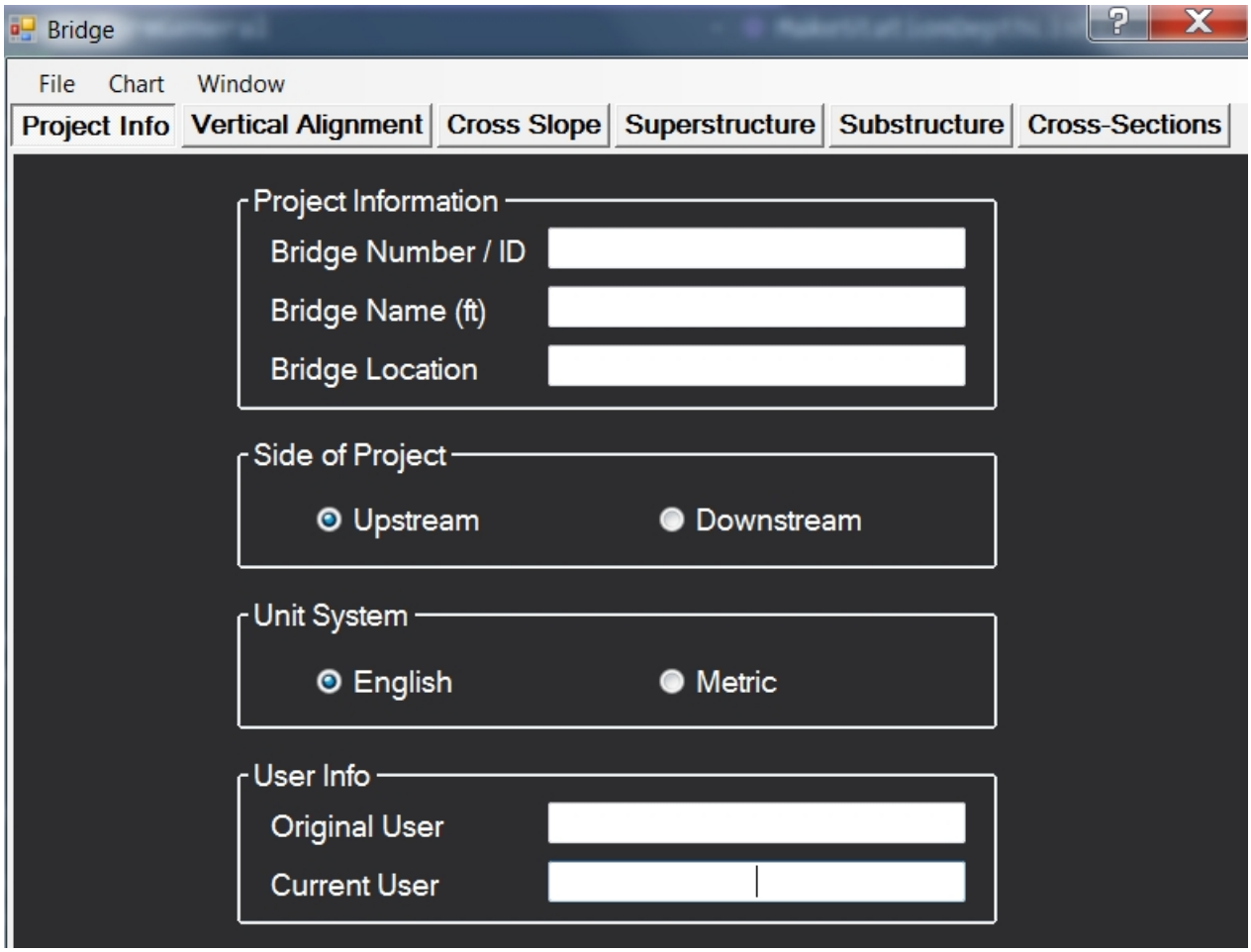


Once deactivated, a new license can be acquired from support@h2floconsulting.com following the directions for License Registration.

Project Information

Project Information

Basic identifying information regarding the project is found on this tab.



Specifically, the bridge number or ID, the bridge name and bridge location are recorded on this tab.

In addition, one must select which side of the bridge (upstream or downstream) that will be used for the cross-section location.

The bridge number/ID and side of bridge are used to automatically define the file name for the project (e.g., Bridge 99-0011 with cross-sections on the the upstream side will be named "99-0011 Upstream.cbz").

*Note: If cross-sections will be recorded on both sides of the bridge, then 2 separate **C-BrEase** files will be required. Typically, the only difference between the upstream and downstream bridge data is the direction of the bridge skew and cross-slope information.*

The Unit System (English or Metric) is selected on this tab.

Optionally, the Original User and Current User names can optionally be entered on this page.

Vertical Alignment

Vertical Alignment

Three options are provided to define the vertical alignment of the bridge.

Use this option for flat bridge decks

Use this option of decks that follow a constant slope

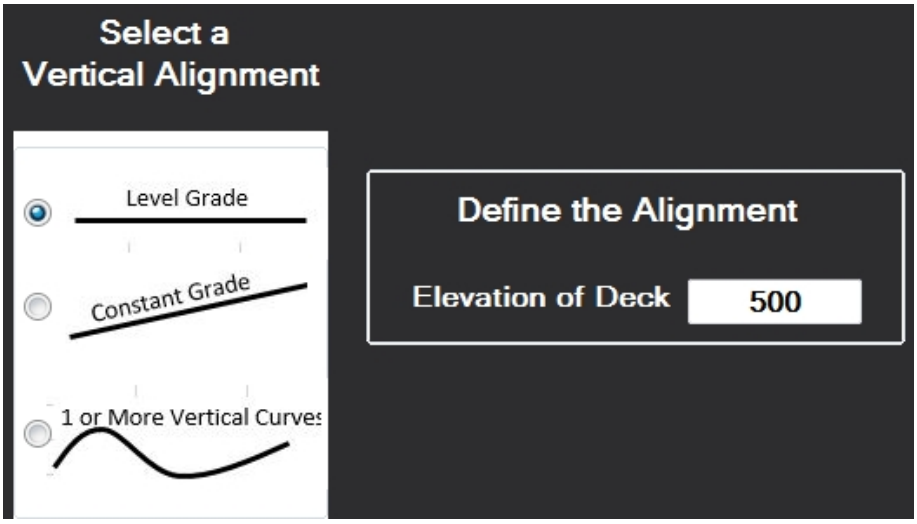
Use this option if the highway and bridge are on one or more vertical curves.

Level Grade

Level Grade

Use this option for flat bridge decks.

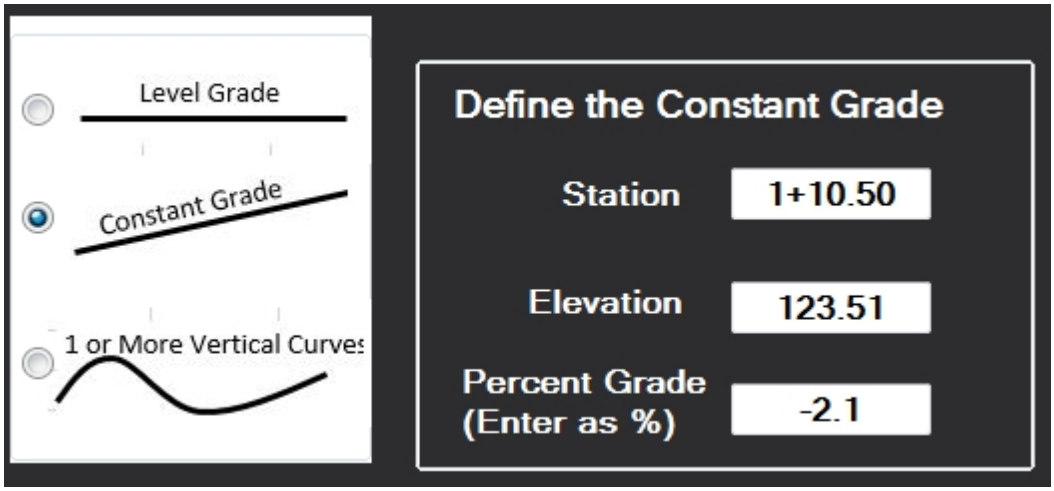
All that needs to be entered is the elevation of the layout line for the bridge.



Constant Grade

Constant Grade

Use this option for bridge decks that follow a constant slope along the full length of the bridge.



To define a constant grade, any point (e.g., beginning of bridge) with a known station, elevation and grade can be used.

NOTES

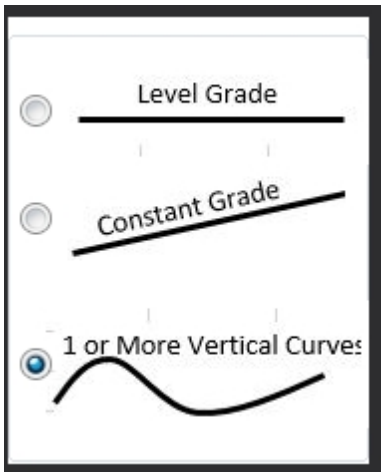
1. The Station information can be entered as a standard number ("110.50" or with the station delineation as "1+10.50"), but will be displayed with the "+" stationing as shown in the diagram below.

2. The slope should be entered as a percentage rather than in decimal form (for a -2.1% slope enter -2.1, NOT -0.021) as shown above.

Vertical Curves

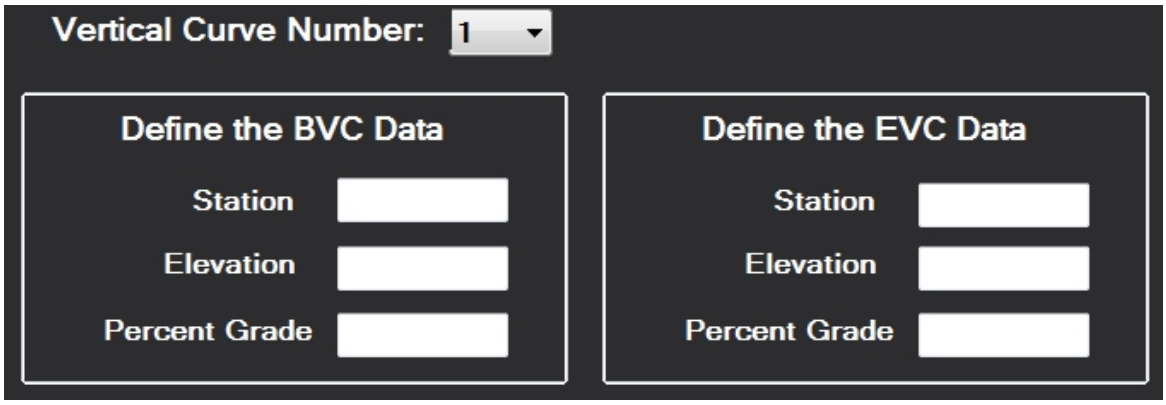
1 or More Vertical Curves

Use this option for bridge decks that are on an alignment defined by 1 or more vertical curves.



There is no limit to how many vertical curves can be used with **C-BrEase.**
To define a vertical curve, one must enter the Station, Elevation and Percent Grade at the beginning and end of each vertical curve.

Like the data for the Constant Grade, the Station data may be entered in either decimal form (123.45) or station notation (1+23.45), but will be displayed in typical station format. The Grade information is entered as a percent (e.g, enter 1.25 for 1.25%).



After entering the BVC and EVC data, click the 

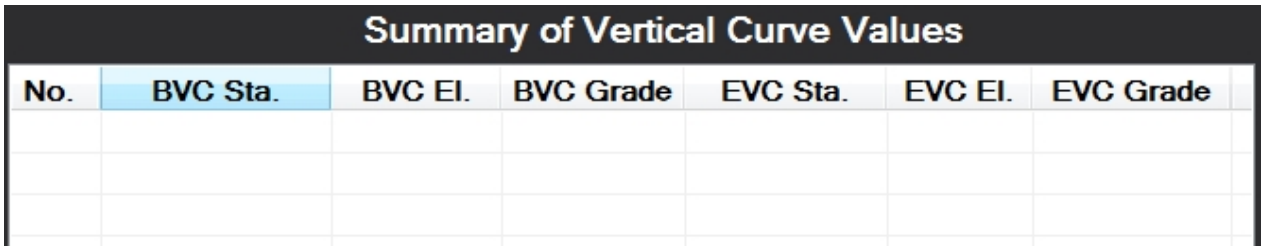
button which will store the data and list it in the drop down box 

for later viewing or modification.

To create an additional vertical curve, click the 

button.

All of the vertical curve data is displayed in the summary table at the bottom of the form.



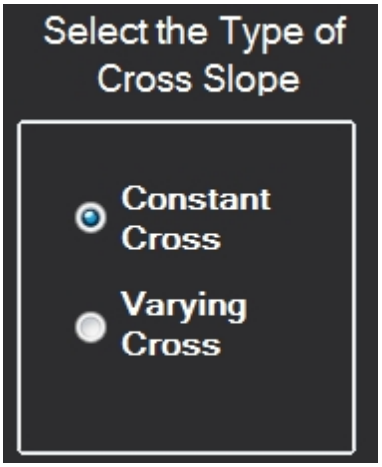
Cross Slope

Cross Slope

To adjust the profile grade elevation along the layout line to the elevation at point of the cross-section measurement along the edge of the deck, the cross slope of the bridge deck must be taken into account.

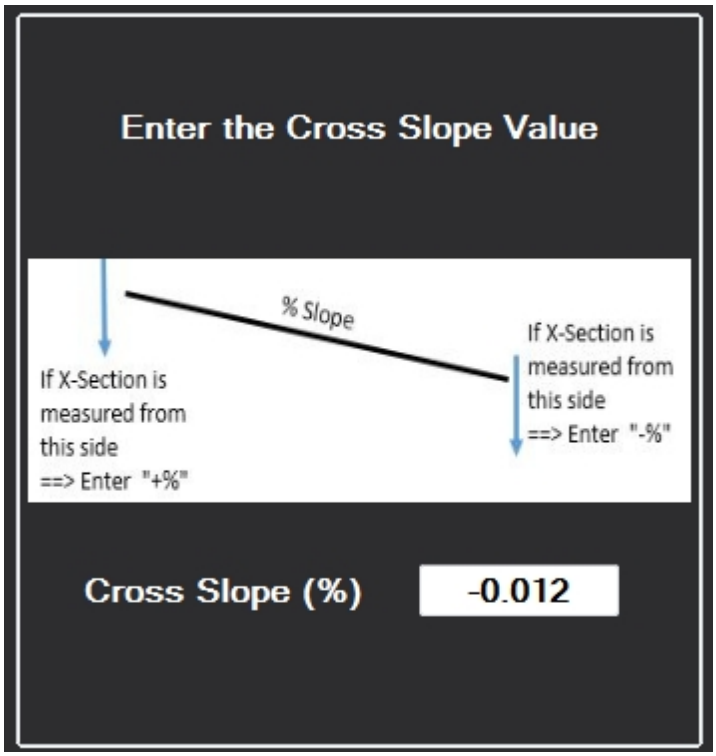
To do this, first enter the

Next, two options are provided to define the cross slope of the bridge deck depending on whether the bridge is located in a super-elevation transition or not.



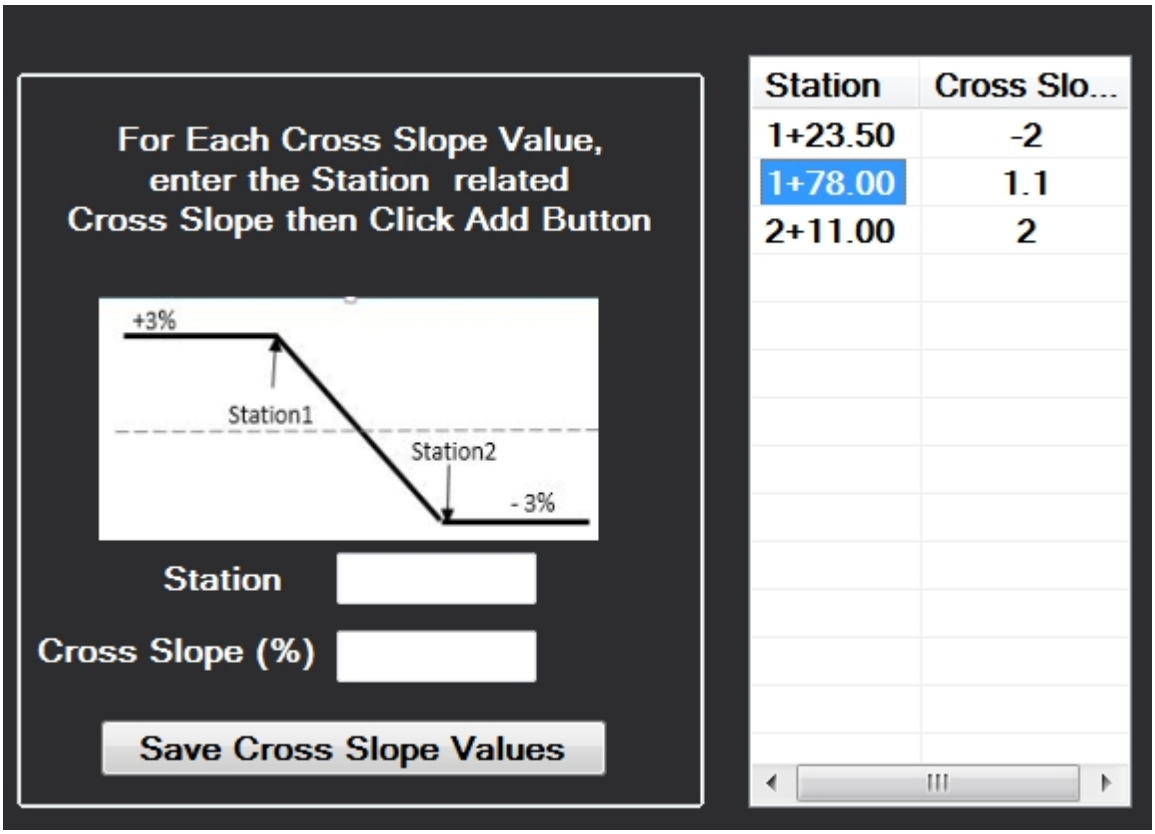
Constant Cross Slope

Constant Cross Slope - enter a single value for the cross slope using a negative value when the edge of deck is below the layout line and a positive value if the edge of deck is above the layout line. The value of the cross slope should be entered as a percent (e.g., enter -0.012 if the slope is -1.2%)



Varying Cross Slope

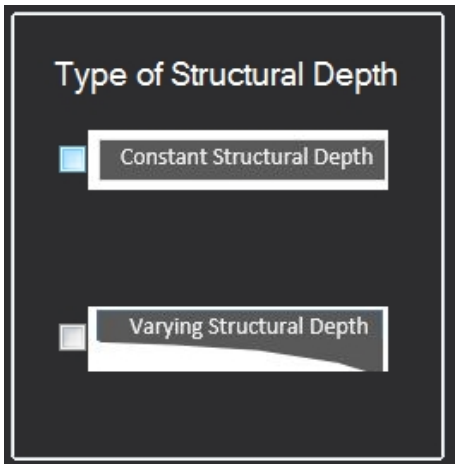
Varying Cross Slope - Data for for a varying cross slope is input as key points according to the station and cross slope. Values for the cross slope at a particular location will be interpolated linearly according to figure below and displayed in the summary table on the right after clicking the button to Save the Cross Slope.



Superstructure

Superstructure

The Superstructure is defined by the structural depth which can be a constant value or a varying template.



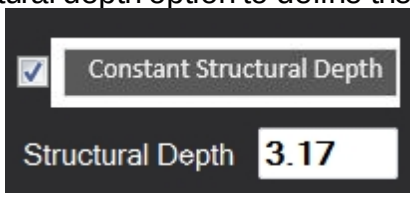
However, if a bridge has multiple constant structural depths, it is possible to represent this in C-BrEase by creating 2 Varying Structural Depth Templates - each with a constant structural depth for each as shown below.

Distance	Depth
1	2
5	2

Constant Structural Depth

Constant Structural Depth

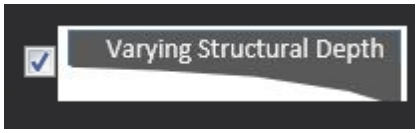
For bridge with a constant depth such as are defined by slabs, box girders and most girders, use the constant structural depth option to define the depth.



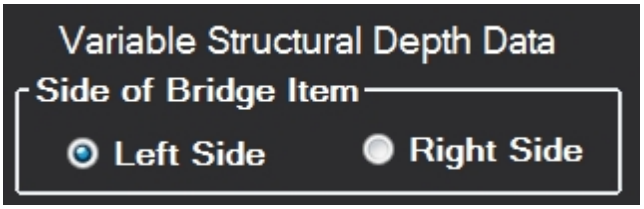
Varying Structrual Depth

Varying Structural Depth

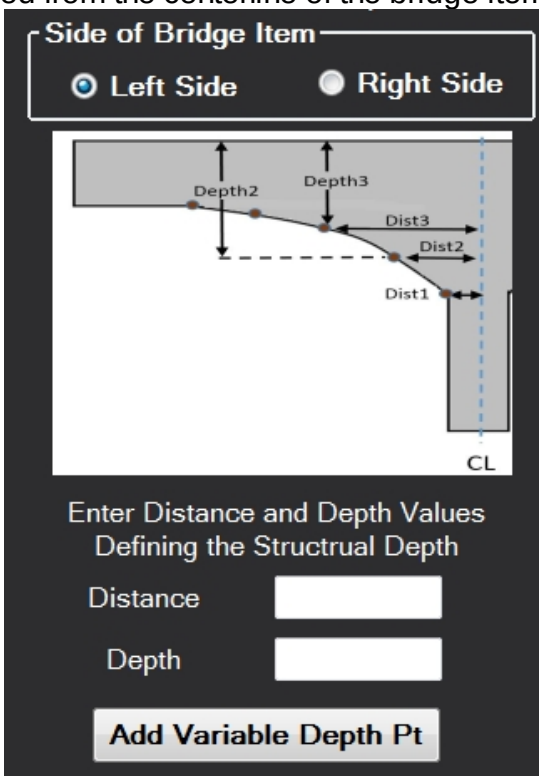
For bridge with a variable structural depth such as arch type bridges, select the check box as below



After checking the box, new input fields will appear for you to define a template for the variable depth. Templates can be defined for either the left or right side of the bridge item, so you will then need to select which side of the substructure item you are creating a template.

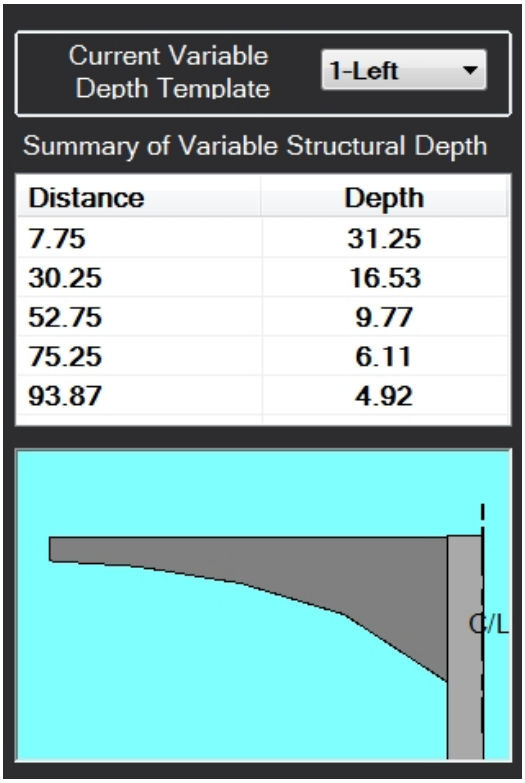


After choosing the side of the template, enter points to define the depth of the superstructure as referenced from the centerline of the bridge item.



After entering the data and clicking the 

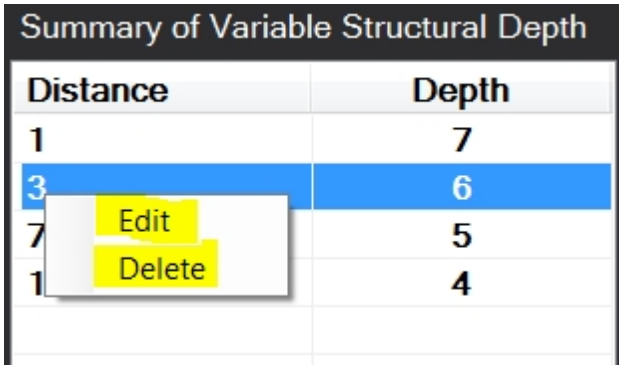
button, the data will be recorded the template and displayed in the table the right side of the form and displayed in the preview chart.



You can choose the modify or delete individual data points by right clicking on the value in the table and switch between existing templates by choosing a different template in the drop down box at the top.

Modifying and Deleting Key Points

To Modify or Delete a Point after it was saved, Right Click on the point your wish to change and select either Edit or Delete from the Context Menu.



If you choose Edit, then the existing value you selected with be written into the Distance and Depth Boxes where you can change them and resave them by clicking the Modify Variable Depth Button below the values.

Substructure

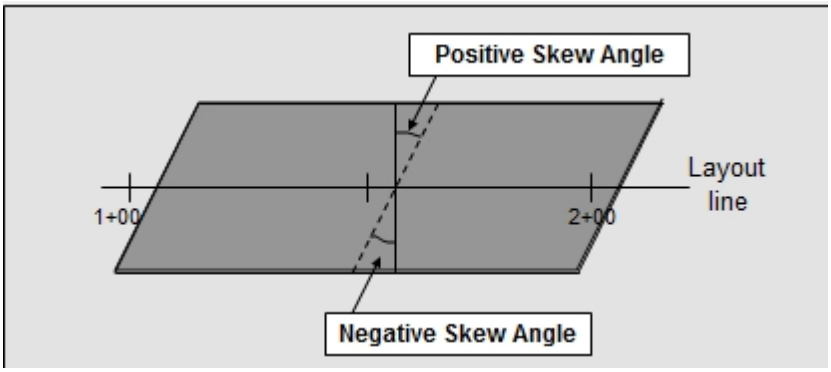
Substructure

To Add a New Bridge Item, click the 

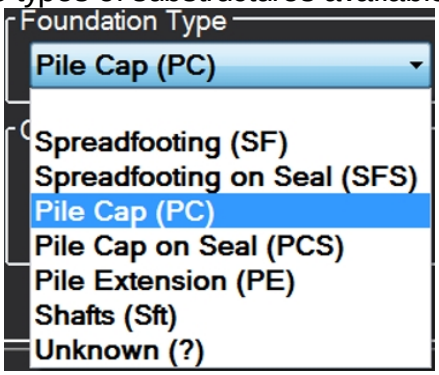
button.

For each bridge item, basic information needs to be entered to describe the type of element, its stationing, the bridge skew of the item and whether a variable superstructure is applied to either side of the bridge item as show below.

Note: For bridge skew, enter a positive skew value in degrees if the projected station from the bridge item at edge of deck is farther ahead on station or a negative skew value if it is behind on station as shown below.

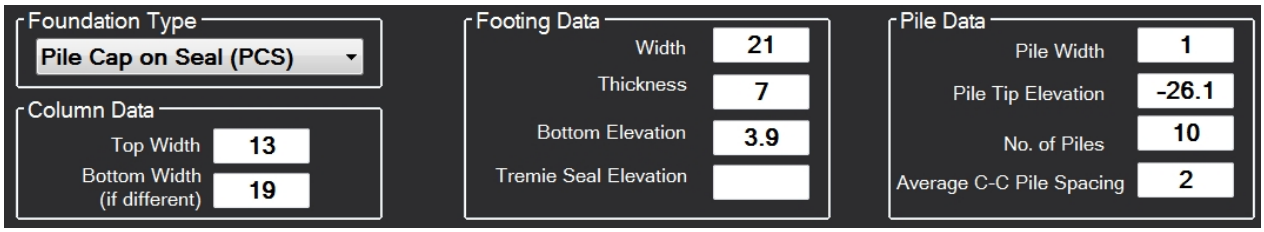


Next, the type of substructure of substructure for each bridge item needs to be selected. In **C-BrEase,** there are possible types of substructures available as show below.



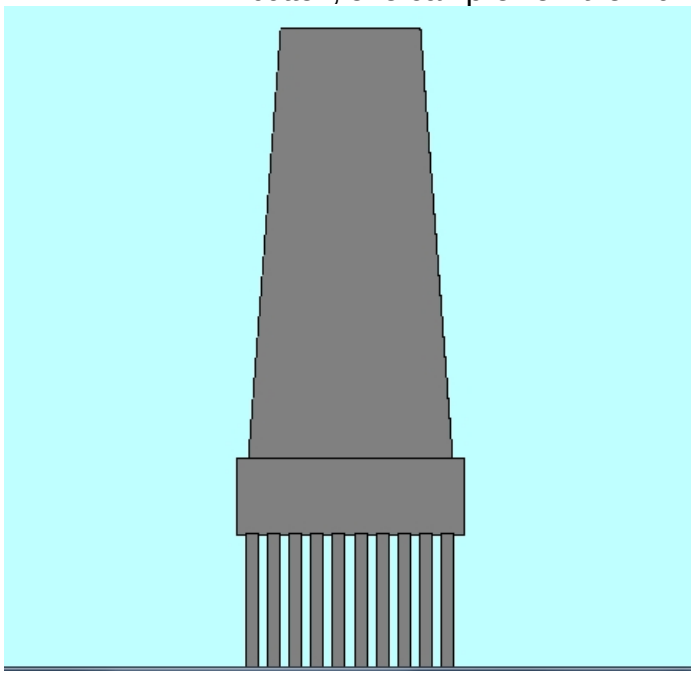
Depending on the type of substructure selected, various input textboxes will become visible for you to supply the appropriate geometric information. In all cases the column information is required; however, information regarding piles and tremie seals may or may not be needed depending on the type of foundation.

For the case of pile cap with a tremie seal, all the data fields are required as shown below.



For cases of "Unknown Foundations", only the column information is required. For this case the column will terminate at the ground line in the Chart.

By clicking the Preview Bridge Item button, one can preview the individual bridge item.



After entering all of the required information for a particular bridge item, click the Save Data To List button to record the data and display it on the table at the bottom of the form.

Note: if a substructure item is inserted with a station between two other substructure stations, the data will be automatically reordered.

Cross-Sections

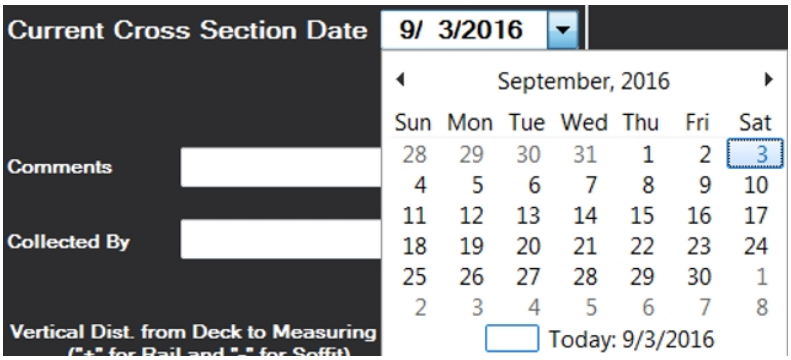
Cross-Sections

Cross-Section Data consists of the date, measurement offsets, vertical and horizontal measurements and point values and descriptions.

Date

Cross-Section Date

After clicking the Create New button, one adds the cross section date by using the calendar.



Type of Cross-Sections

Type of Cross-Section Data

Three types of data can be used for C-BrEase Cross-Sections:

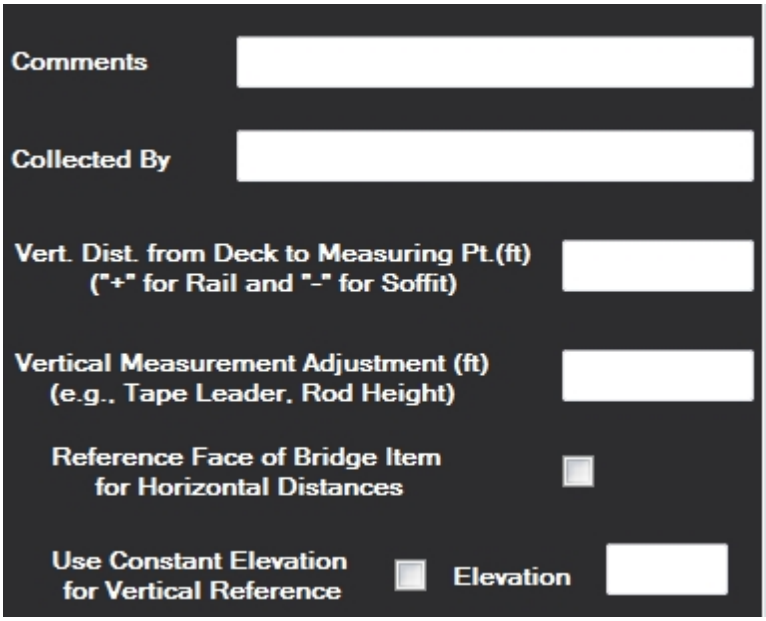
1. Channel X-Sections - used for cross-sections taken using traditional bridge inspection methods such as a weighted tape or laser.

2. Engineering Plans or Surveys - used when you are entering a horizonatal distance and elevation values obtained from traditional survey methods or sonar surveys or from plans such as Foundation Plans and create a list of horizontal distances and elevations.

Support Data

Support Data

In the remaining part of the left box,

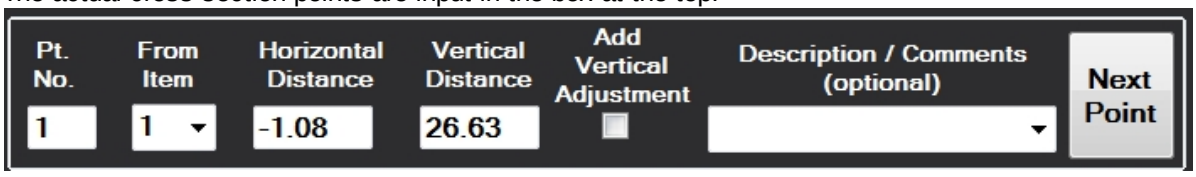


- Comments can be added such as might relate to the nature, quality or reference of the measurements.
- The name of the inspector can be documented in the "Collected By" field.
- The vertical distance from where the measurement is taken and the edge of the deck can be entered
- A vertical offset such as for a tape leader or rod height can be applied to the collected data
- A checkbox can be selected if the horizontal measurements are referenced to the column face of an element rather than its centerline station.
- If a constant vertical alignment other than the bridge deck is referenced for a cross-section, such as could occur if one were taking depth readings from a boat where the water surface elevation was known, check the box next to "Use Constant Elevation for Vertical Reference", then supply a constant reference elevation for the cross-section points.

Recording Data Points

Cross-Section Data Points

The actual cross-section points are input in the box at the top.



- The point number is automatically generated.

- The "From Item" reflects the bridge item for which the horizontal measurement is based. While commonly this is Item 1 for all points if say all the horizontal readings were taken from the beginning of the bridge, it is possible to reference different items such as when using a laser from below the bridge.
- The Horizontal Distance for the point is commonly positive when all points are taken from a single reference bridge item, but can be entered as negative when the reference item is ahead on station from the measurement point.
- The Vertical Distance as measured.
- The Add Vertical Adjustment adds the vertical offset to the vertical measurement.
- Select from the drop down list or enter your own description of the point as desired.

Click the Next Point button to add additional points. This will also record the cross section point and write it onto the summary table as shown below.

Note: To modify or delete any particular point, right click on the point of interest and select your desired action.

If a substructure item is inserted with a station between two other substructure stations, the data will be automatically reordered.

Pt.	From Item	Horiz. Dist.	Vertical Dist.	Add V Adjust.	Description	Station	Elevati
1	1	-1.08	26.63	False		-9.08	29.89
2	1	1.08	30.7	False		9.08	25.82
3	1	54.56	30.54	False		62.56	25.98
4	1	61.13	35.33	False		69.13	21.19
5	2	-90.65	44.74	False		96.85	11.78
6	2	-40.23	45.92	False	Top Scou...	147.27	10.6
7	2	-33.47	48.55	False		154.03	7.97
8	2	-3.22	54.74	False		184.28	1.78
9	2	3.22	53.54	False		206.72	2.98
10	2	16.08	51.57	False		219.58	4.95
11	2	50.53	47.63	False	Edge of ...	246.03	8.89
12	2	110.24	45.99	False		305.74	10.53
13	3	-37.73	45.66	False	Edge of ...	353.27	10.86
14	3	-9.84	52.55	False		381.16	3.97

Entering Data for Engineering Survey Data or Engineering Plans, the input values will be slightly different.

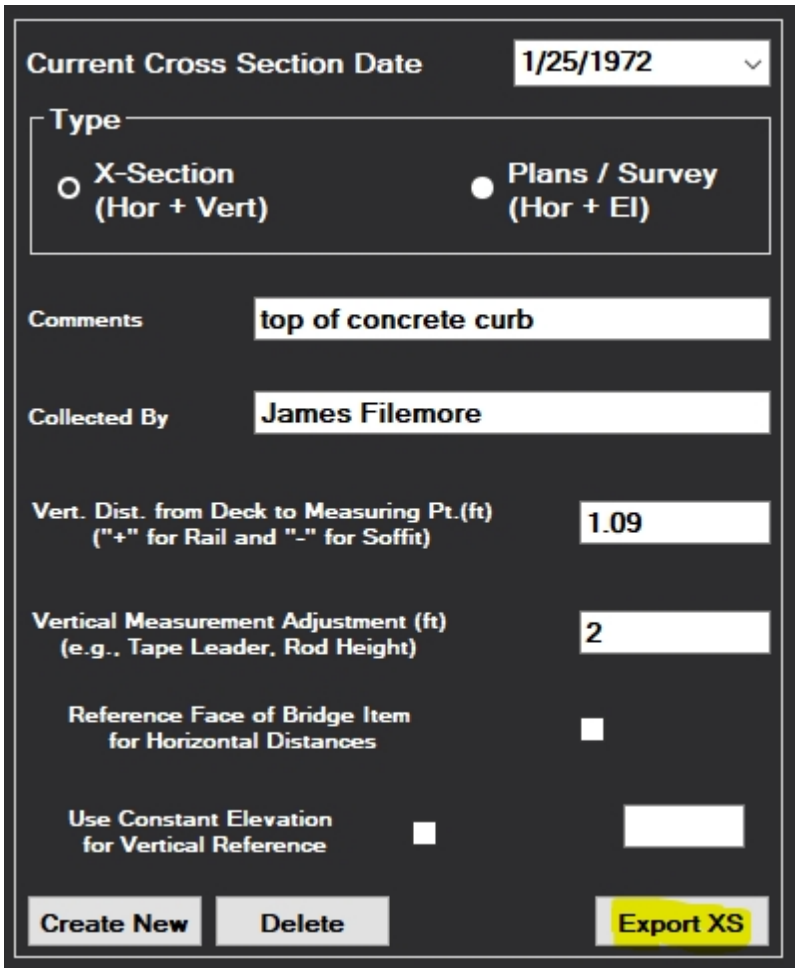
For Survey data, one enters only the Station and Elevation Value.

For Engineering Plans, one enters the Horizontal Distance and Elevation Value.

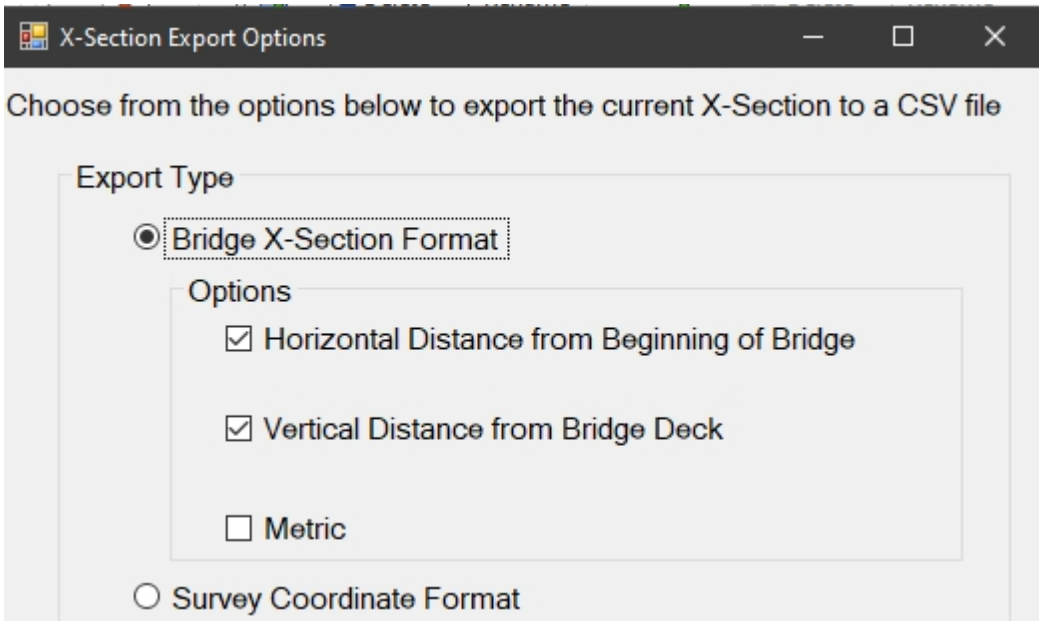
Exporting Cross-Sections

Exporting Cross-Sections

Cross-Sections can be exported to a CSV (comma-delimited) format by clicking the Export XS button at the bottom of the tab.



Clicking the Export XS button will open a new User Form



On this form, you see two export formats:

1. Bridge X-Section Format
   This selection will export each point in the cross-section with horizontal and vertical values.
   The user can modify the output if desired in 3 ways:
      i) Use "Horizontal Distance from Beginning of Bridge" to mimick having all horizontal values

starting at the beginning of the bridge.

ii) Use "Vertical Distance from Bridge Deck" to reference all the vertical measurements to the top of deck at the edge of the bridge.

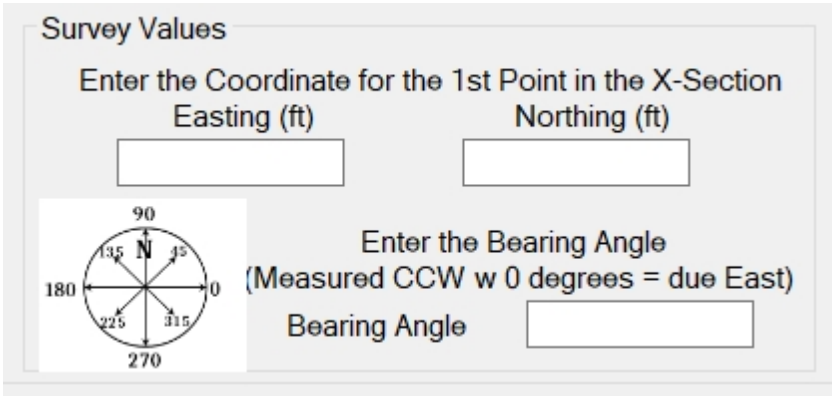
ii) Use "Metric" to have both the horizontal and vertical values converted to metric units

2. Survey Coordinate Format

This selction is intended to be used if you would like to use the cross-section data in a a program requiring Survey Coordinates such as the Surface-Water Modeling System (SMS) by Aquaveo ™

Selecting this option will show additional inputs a to enter the starting Easting, and Northing values for the cross-section which is not found in **C-BrEase** nbut will need to be found using another means such as a GPS measurement.

In addition, you will need to enter a bearing line in degrees for the direction of the cross-section using East as 0 degrees and CCW as the direction of the angle.

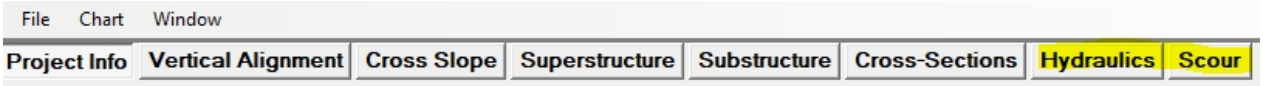


Clicking the "Export" Button will provide you with an opportunity to name the file and provide a path. By default, the file is named with "BridgeNumber_xs_mmddyyyy.csv and will be stored in the same directory as the cbz file.

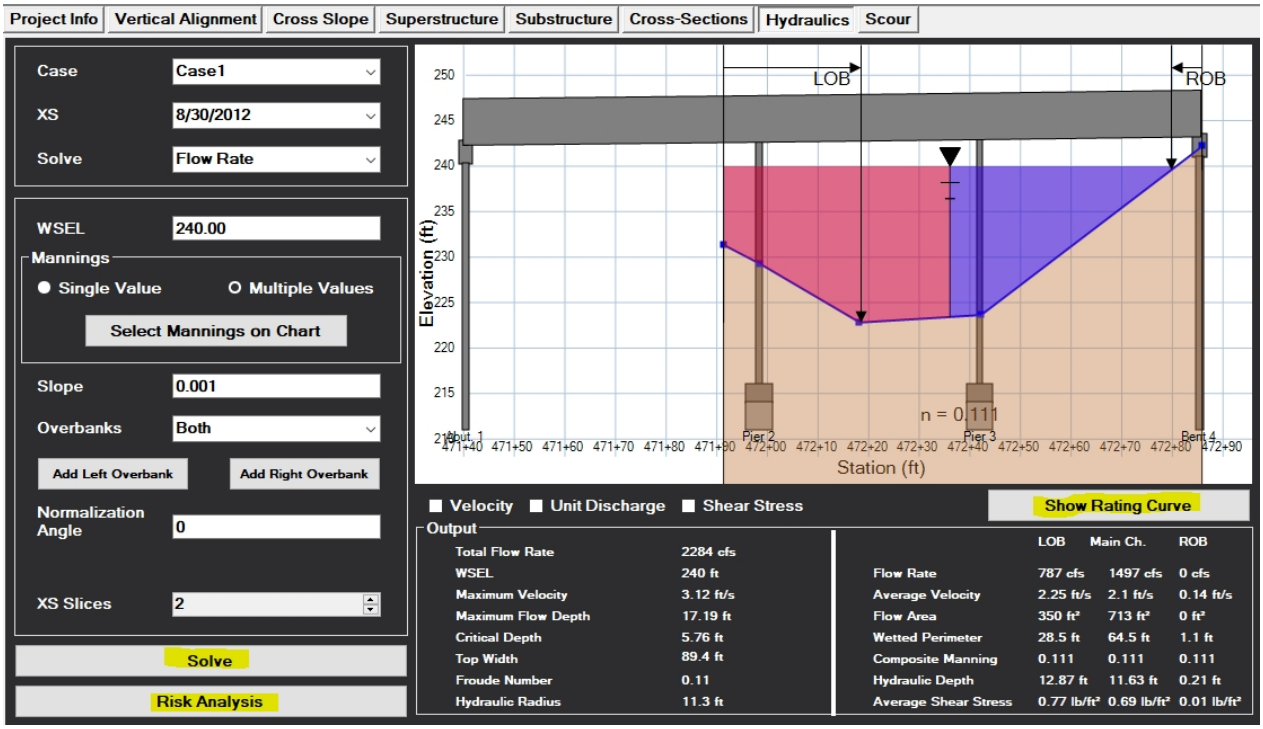
Hydraulics

Hydraulics

If the Hydraulics and Scour Licensing has been acquired, then two additional Tabs will appear at the Right to access these modules:



The Hydraulics Tab provides 3 tools for the engineer to estimate hydraulic conditions for Cross-Sections in **C-BrEase** as described below. For more information on how to use these tools, click on the corresponding Hyperlinks.



1. Solving with the Basic Normal Depth Hydraulic Calculator.

   This tool will estimate either
   - the water surface elevation for a known discharge or
   - the discharge for a given water surface elevation

   The tool is graphical in design and can calculate flows with multiple mannings values, overbanks and for known amounts of backwater.

2. Rating Curve

   A Rating Curve can be easily generated for a set of hydraulic parameters providing the flow rate for the range of possible flow levels in the channel

3. Risk Analysis

   To help Hydraulic Engineers better understand the possible range of flow conditions and to help define and quantify the uncertainty with Hydraulic parameters, the Risk Estimation Tool provides a power means of running Monte Carlo Simulations for the flow based on the level of uncertainty of the data.

Normal Depth Calculator

Normal Depth Calculator

The Hydraulic Calculator is estimates the flow according to a single cross-section via Mannings Equation.

$$Q = AV = \frac{k}{n} AR^{2/3} S^{1/2}$$

where :

A is the Flow Area

V is the Average Velocity in the Channel

k is a conversion coeffient. For English Units k =1.486 and for Metric Units, k = 1.00

n is the Mannings Roughness Coefficiting

R is the Hydraulic Radius which is equal to the ratio of the Flow Area to Wetted Perimeter of the Channel

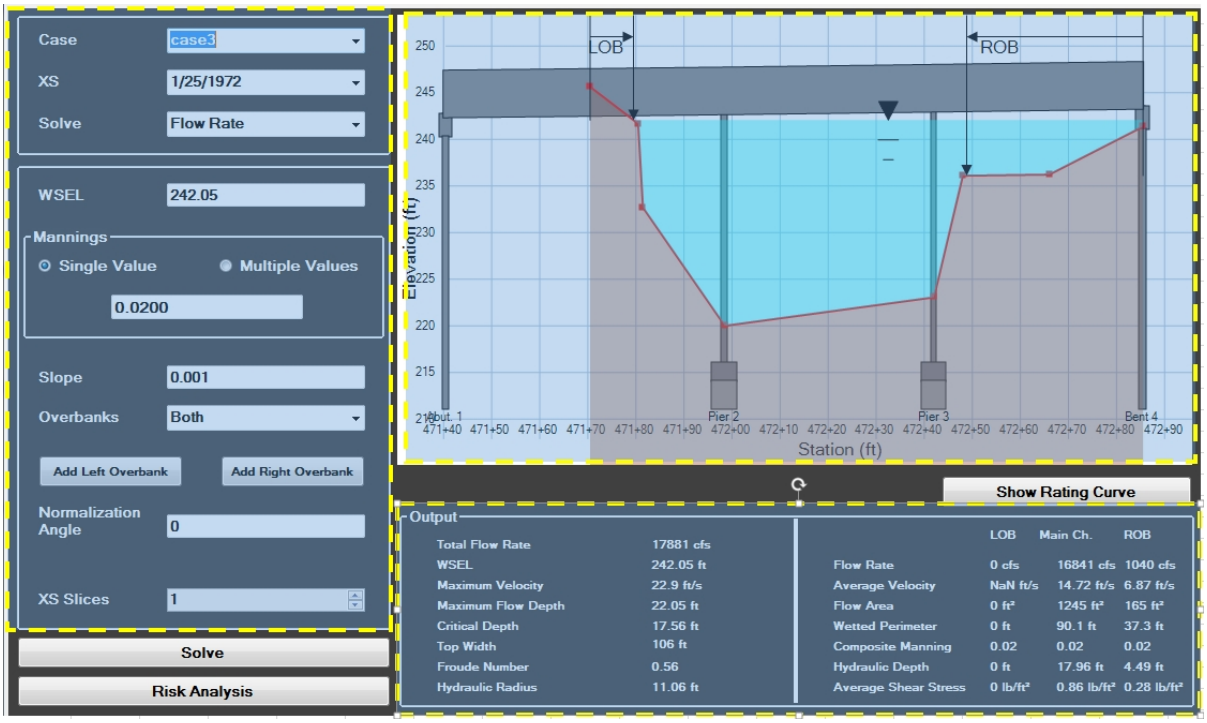
S is the slope of the channel and equals the hydraulic grade line or energy slope under uniform flow conditions

Inherent in the Mannings Equation is the assumption that flow is "Uniform" or "Normal" meaning that there is no acceleration of the flow. In this condition, the flow upstram and downstream of the cross-sctioon should be identical in depth and velocity. Strictly speaking, for this to be true, there can be no change in

- channel geometry,
- alignment (i.e, no bends),
- roughness, or
- slope.

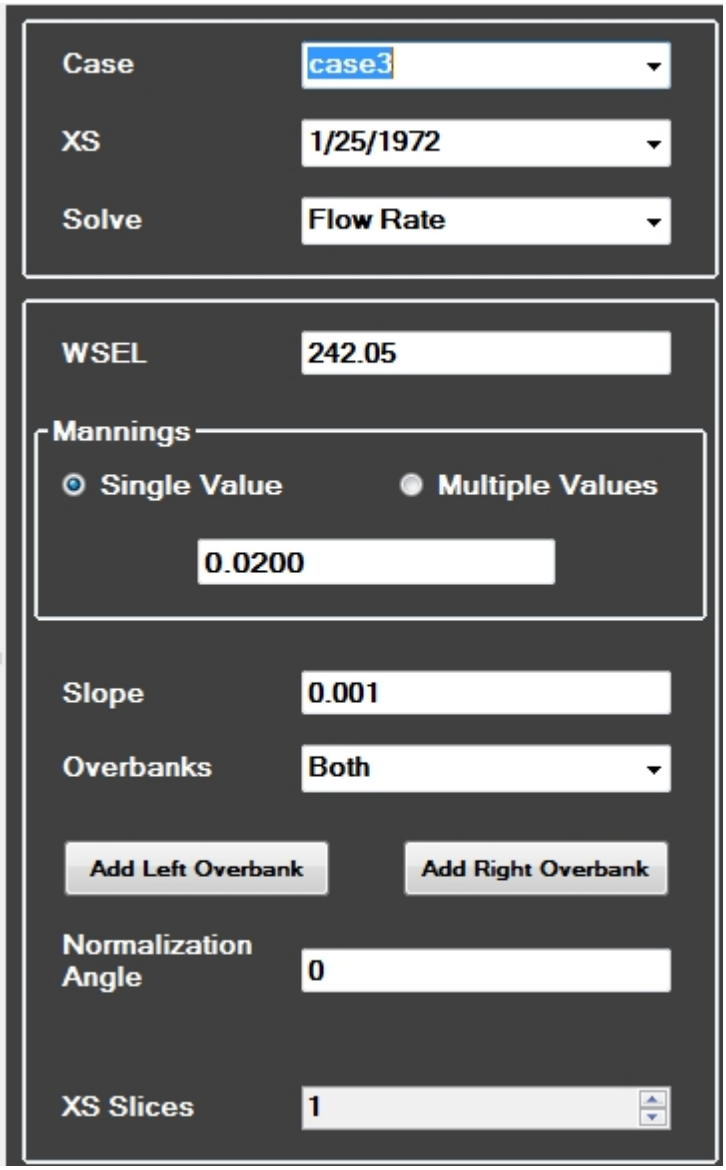
Other than in laboratory flumes or man-made canals, this will not occur in nature. However, as a rough assumption, Mannings Equation can provide a good estimate of the flow conditions when the above conditions are not severely violated.

The Hydraulic Tab consists of 3 Main Parts shown below:



1. **Hydraulic Parameter Input**

Below are descriptions of the various fields and selection options for the Hydraulic analysis

1. 

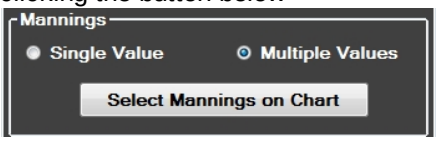
Case represents the current simulation parameters. You can create new simulations by choosing "Create New" from the dropdown list.

XS allows you to select from any previously saved Channel Cross-Sections to use in the Hydraulic Calculation

Solve allows you to choose either to solve for ***Water Surface Elevation*** from a known Flow Rate or to calculate the ***Flow Rate*** from a known water surface elevation.

WSEL is the user provided Water Surface Elevation used for calculating the Flow Rate or the Calculated Water Surface Elevation when solving for WSEL

Mannings Value Options:
You can choose to use a single Manning value for the entire Cross-Section by entering the value in the textbox below
or choose to use Multiple Mannings Values clicking the radio button then clicking the button below



and graphically drawing on the Chart the location and values of multiple Mannings Values where the values are shown on the chart and colored by n-values (See chart below)

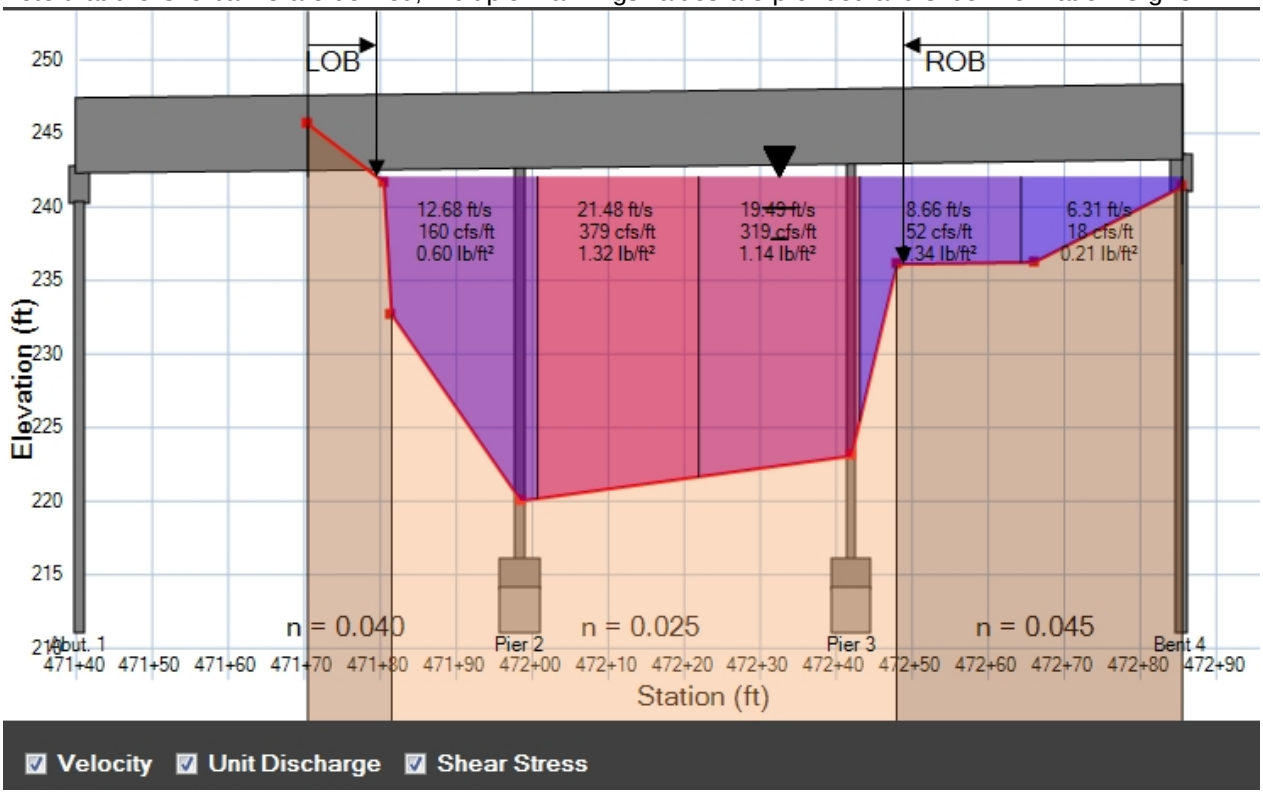
Slope is for entering the channel slope. Use decimal values (e.g., 0.01 for a 1% slope)

Overbanks allows you to choose to have a Left and/or Right Overbank defined for the calculations which is essential for obtaining a correct value when floodplains exist.
You can add the overbank locations

	graphically by clicking the appropriate "Add Left Overbank" or "Add Right Overbank" button and graphically selecting the station on the chart **Normalizing Angle** is used to correct for Cross-Sections which do not cross perpendicular to the channel. Enter the angle to normalize the flow area. **XS Slices** can be used to dynamically divide the channel into slices (a.k.a., stream tubes) to display graphically on the chart values of velocity, unit flow rate and/or shear stress

2. **Graphical Display**

Below is an example of an chart of a hydraulic calculation.
Note that the Overbanks are defined, multiple Mannings values are provided and slice information is given.



3. **Output Table**

The results from the Hydraulic Calculation are shown in the Output Table. The values on theLeft side represent Channel average values.
On the Righthalf of the Table the values are separately calculated for each Overbank and the Main Channel.

Output

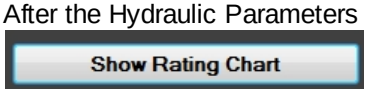
Total Flow Rate	17881 cfs
WSEL	242.05 ft
Maximum Velocity	22.9 ft/s
Maximum Flow Depth	22.05 ft
Critical Depth	17.56 ft
Top Width	106 ft
Froude Number	0.56
Hydraulic Radius	11.06 ft

	LOB	Main Ch.	ROB
Flow Rate	0 cfs	16841 cfs	1040 cfs
Average Velocity	NaN ft/s	14.72 ft/s	6.87 ft/s
Flow Area	0 ft²	1245 ft²	165 ft²
Wetted Perimeter	0 ft	90.1 ft	37.3 ft
Composite Manning	0.02	0.02	0.02
Hydraulic Depth	0 ft	17.96 ft	4.49 ft
Average Shear Stress	0 lb/ft²	0.86 lb/ft²	0.28 lb/ft²

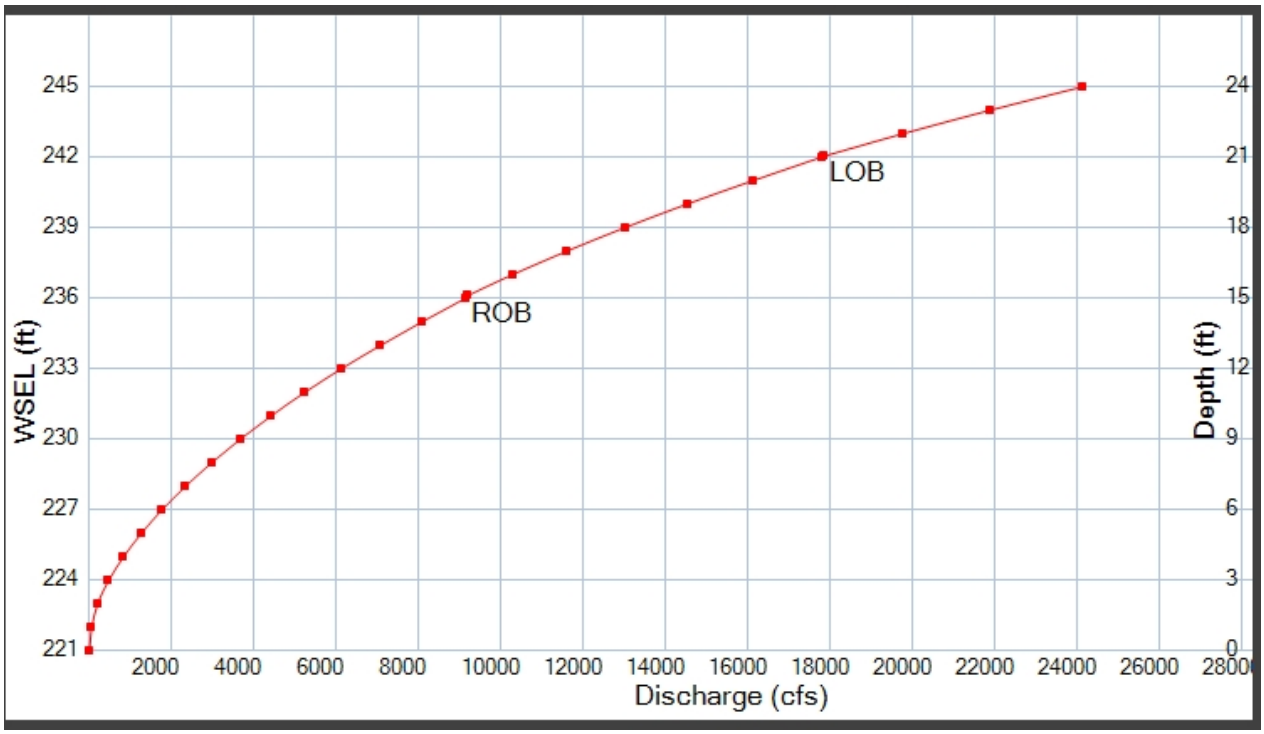
Rating Curve

Rating Curve

The Rating Curve shows how the Discharge varies with Depth/Water Surface Elevation.
After the Hydraulic Parameters have been entered, then a Rating Curve can be generated by clicking the



button which located to the bottom right of the Chart.



Risk Estimate

Risk Analysis

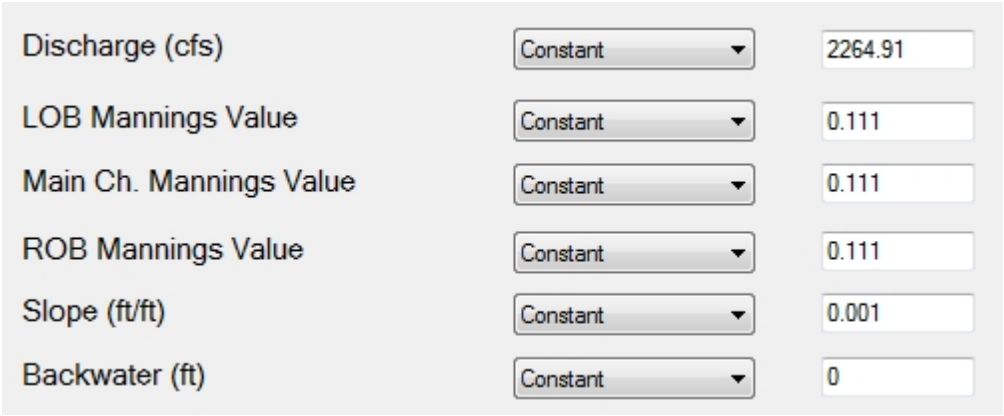
For each Hydraulic parameter in the Normal Depth Calculation, uncertain may exist regarding the accuracy of the parameter. For instance, through a Hydrologic analysis of a Stream Gage, the a 100-Year Flow Rate

(Q100) may be determined; however, there is always a Standard Deviation associated with the value which reflects the level of confidence or uncertainty for the value. The Risk Analysis allows the User to see how the Uncertainty for Various Parameters may combine to generate a Range of Water Surface Elevations and Velocities by running numerous Monte Carlo simulations.

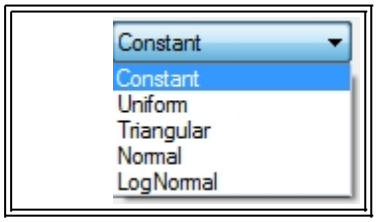
Input

To run the analysis for a desired Confidence Value, enter the degree of confidence (1 - 99.9%) in the fielld as shown below:

After starting the Risk Analysis, the field for the various parameters will be automatically assigned a Constant Distribution value and filled with the values used in the Basic Normal Depth Calculator. However, the Risk Analysis requires that a least one of the parameters be defined with a "Non-Constant" Probability Distribution Function (PDF) in order to randomly generate different results.



To define the Uncertainty for the various Hydraulic Parameters, you can select a PDF type from the drop down list for each item. The options for PDF's are

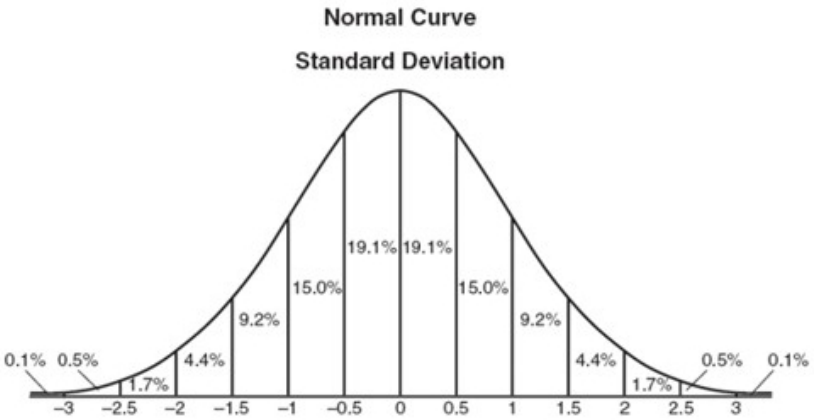


- A **Constant Value** assumes no uncertainty and the single value shown in the adjacent Text Box will be used for all simulations.

- A **Uniform Distribution** assumes that all values between the minimum and maximum range are equally possible.

- A **Triangular Distribution** assumes that all values will be between the minimum and maximum values, but will be proportionally more likely be randomly selected near the value in the middle Text Box

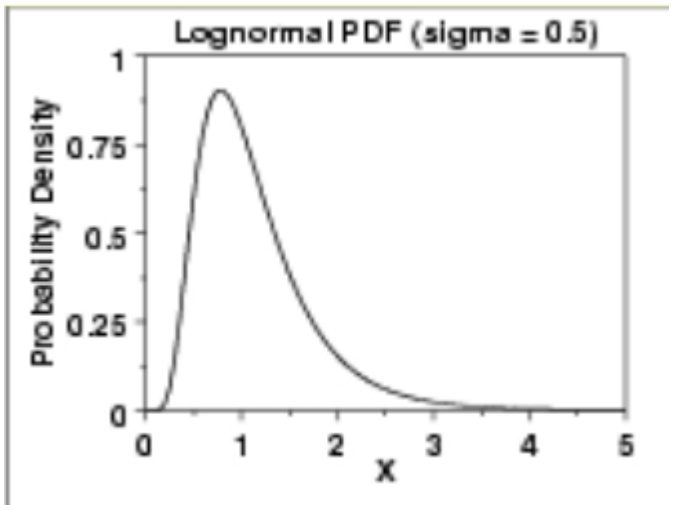
- A **Normal Distribution** (a.k.a., a Gaussian Distribution) follows a typical Bell shaped curve



By defining the median and standard deviation, the probability of randomly choosing values within

- 1 standard deviation is 68.27%,
- 2 standard deviations is 95.45%
- 3 standard deviations is 99.73%

- A **Log-normal Distribution** is a continuous probability distribution of a random variable whose logarithm is normally distributed and will only have positive real values.



Running a Simulation

After defining the various PDFs for your Hydraulic Inputs, you then choose the level of effort (number of simulations) for the Monte Carlo Simulations

with Low Effort simulating 5000 cases, Medium Effort simulating 25,000 cases and High Effort Simulating 100,000 cases.

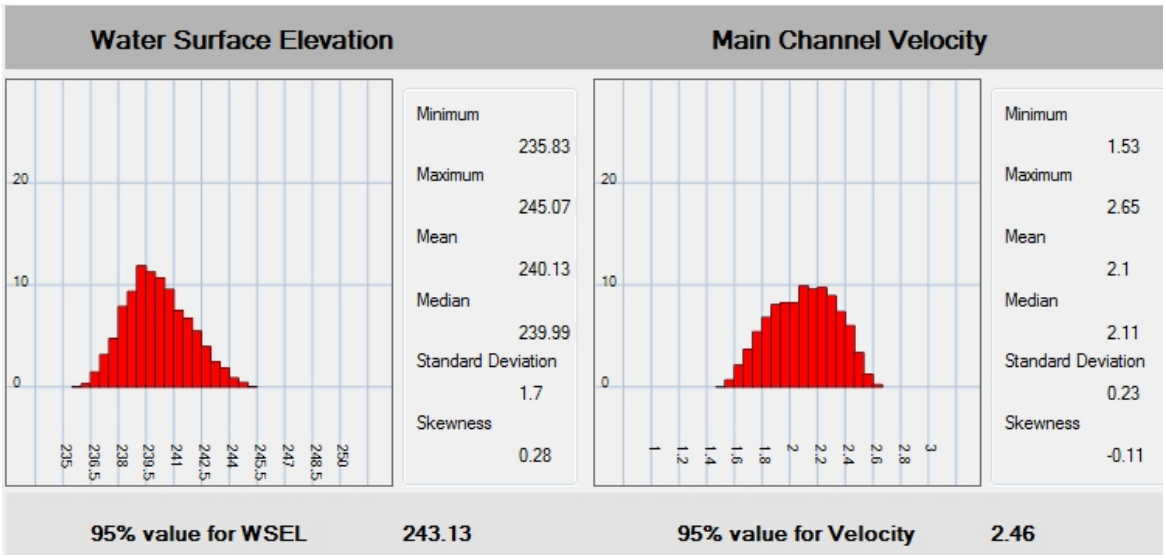
Typically, Low Effort will provide a reasonable estimate for the results.

Click the Analyze Button to start the Simulations

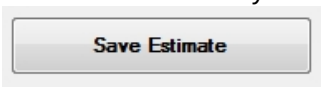
Output

While the simulation is running, you can see a Histogram for Water Surface Elevation and Main Channel Velocities develop and the corresponding statistical values for each displayed.

At the bottom of the Output, the Confidence Level (default 95%) set in the Input Section will show the value for the Water Surface Elevation and Main Channel Velocity corresponding to the percentage of simulations with values below the required Confidence Level.
In the case below, it was determined that 95% of the simulations had a Water Surface Elevation below 243.13 ft and a Velocity less than 2.46 ft/s.



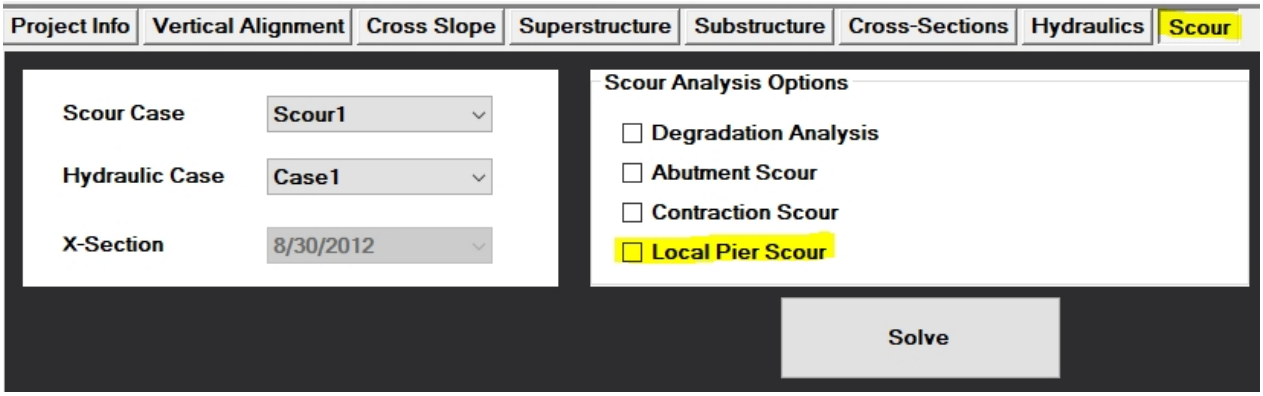
To Save the Risk Analysis for future use such as for Scour Risk Analysis, Click the



button and the randomly generated parameters and results will be saved in a ascii file called **"risk_estimate.cbz"**.

Scour

Scour



Selecting the Scour Tab provides access to 4 types of scour analysis as described below; however, in Version 1.2.1 only the Local Pier Scour is currently available.
To use the Scour module, you create a Scour Case which comprises the Hydraulic Case, X-Section and

Scour values. Mulitiple cases can be saved with variations in any of these parameters.

Local Pier Scour

Pier Scour

Local Pier Scour

The local pier scour computation uses the CSU Pier Scour Equations found in the FHWA HEC-18 Manual, *Evaluating Scour at Bridges, 5th Edition*
as shown below in Equation 7.3 of the manual:

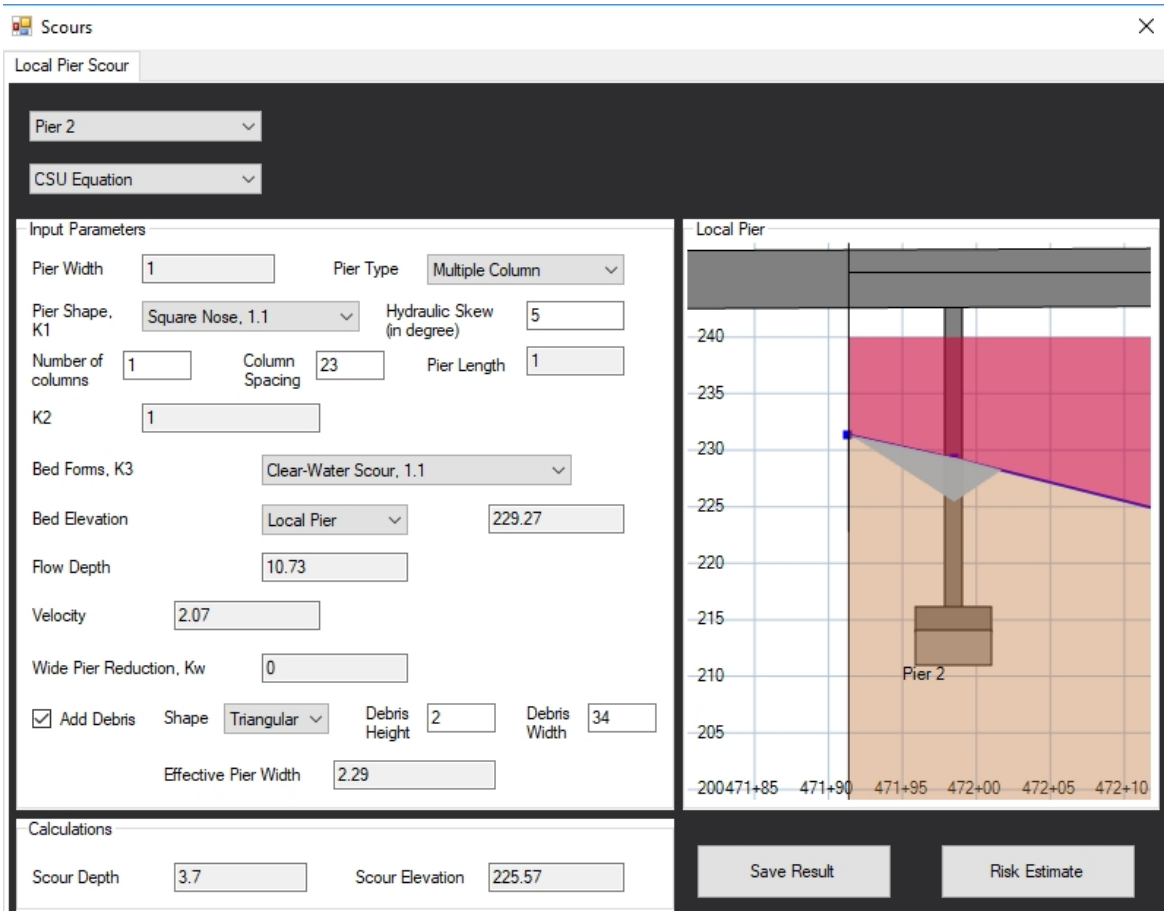
$$\frac{y_s}{a} = 2.0\, K_1\, K_2\, K_3 \left(\frac{y_1}{a}\right)^{0.35} Fr_1^{0.43} \qquad (7.3)$$

where:

y_s	=	Scour depth, ft (m)
y_1	=	Flow depth directly upstream of the pier, ft (m)
K_1	=	Correction factor for pier nose shape from Figure 7.3 and Table 7.1
K_2	=	Correction factor for angle of attack of flow from Table 7.2 or Equation 7.4
K_3	=	Correction factor for bed condition from Table 7.3
a	=	Pier width, ft (m)
L	=	Length of pier, ft (m)
Fr_1	=	Froude Number directly upstream of the pier = $V_1/(gy_1)^{1/2}$
V_1	=	Mean velocity of flow directly upstream of the pier, ft/s (m/s)
g	=	Acceleration of gravity (32.2 ft/s^2) (9.81 m/s^2)

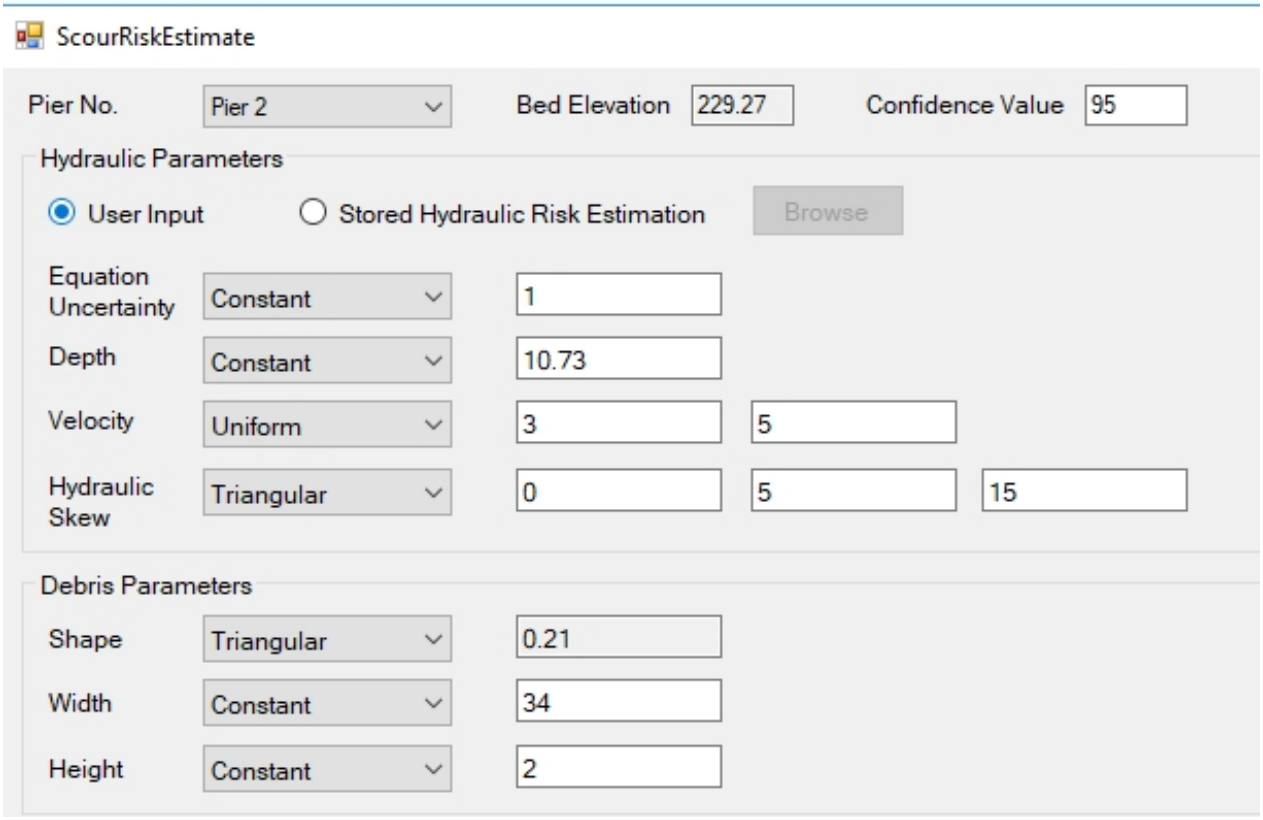
Scour calculations are made 1 pier at a time as selected in the dropdown box.
As Input Parameters are entered, intermediate calculations are immediately displayed.
After all parameters are entered, the scour elevation is shown at the bottom and displayed graphically.
Results can be saved for display on the overall bridge plot shown on the Scour Tab.

Alternatively, input parameters can be estimated using probabilities and the scour determined by Risk Estimate.



Risk Analysis for Scour

Pier Scour Risk Estimate



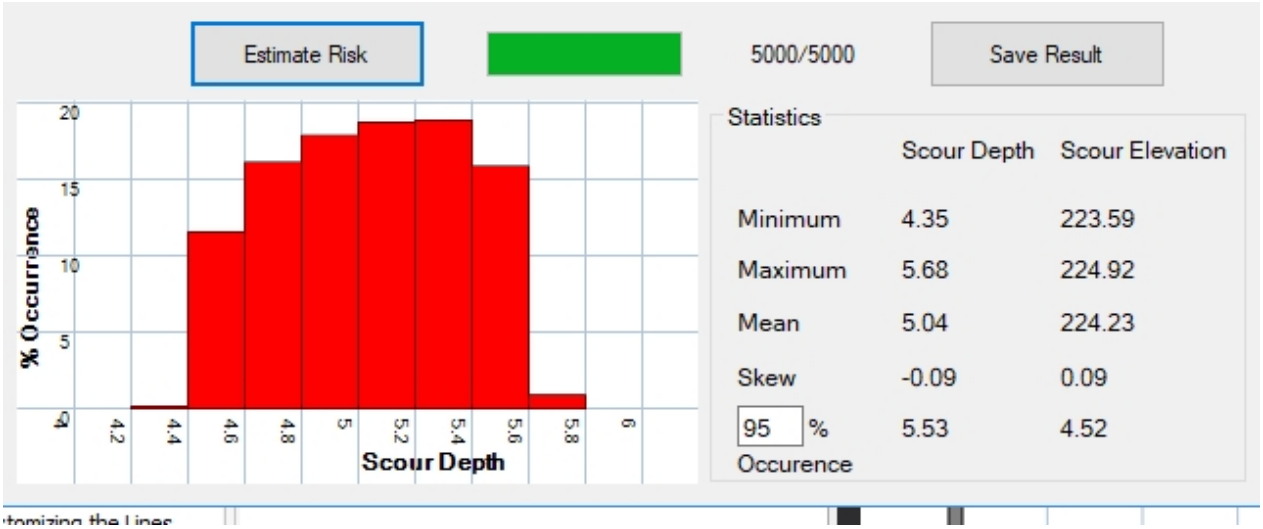
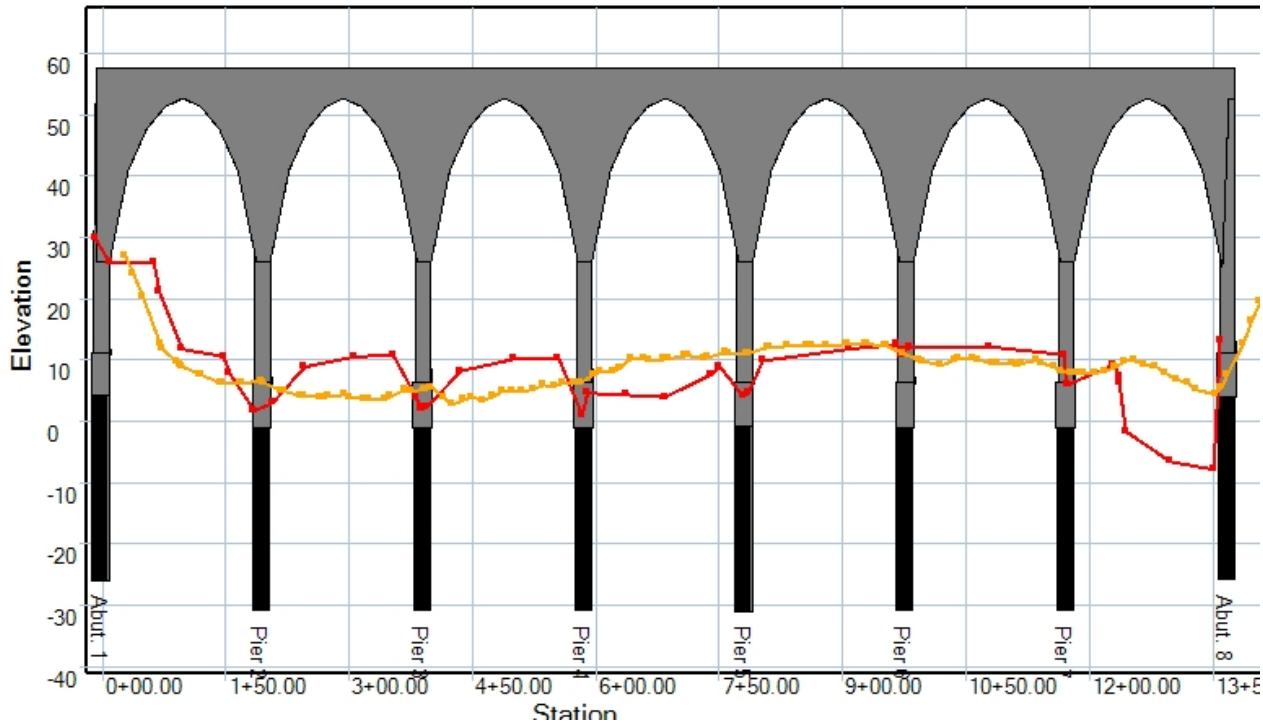


Chart Form

CHART FORM

The Chart Form provides a visual representation of the bridge and cross-section data. The chart can be modified, saved for future reference and printed for documentation.

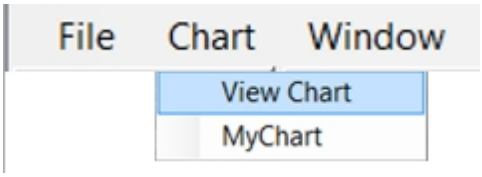


Creating, Saving and Printing

CHART FORM - Creating, Saving and Printing

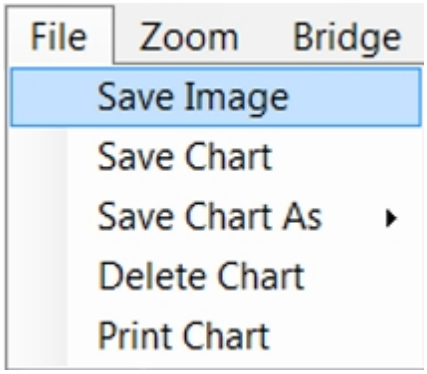
Creating a Chart

The Chart Form is created from the General Form using the Chart => View Chart Command from the Menu



Saving a Chart as a Image

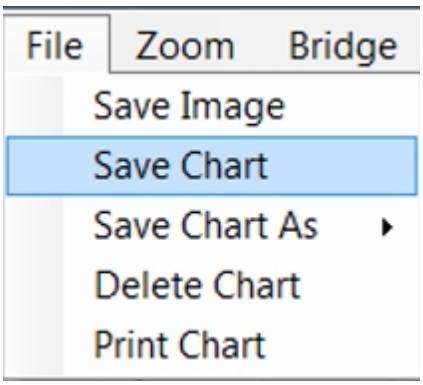
To Save the Chart as a JPG image for future use, execute the File => **Save Image** Command from the Menu



JPG Images can be imported into documents or further modified using a program like Microsoft Paint.

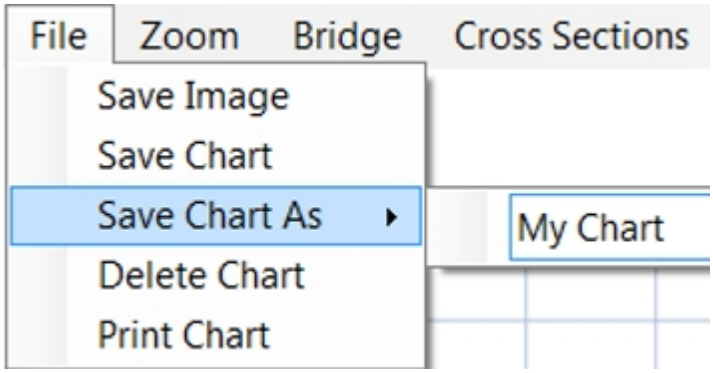
Saving a Chart for Later Recall

To Save the Chart with User Settings as part of the project file (*.cbz), execute the File => **Save Chart** Command from the Menu and provide a Name in the textbox adjacent to the Save Chart Command.



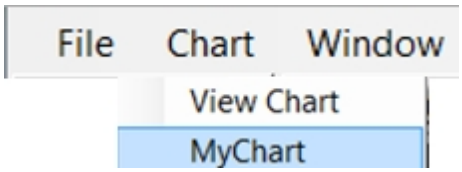
Saving a Chart for Later Recall

To Save the Chart with User Settings as part of the project file (*.cbz), execute the File => **Save Chart As** Command from the Menu and provide a Name in the textbox adjacent to the Save Chart As Command.

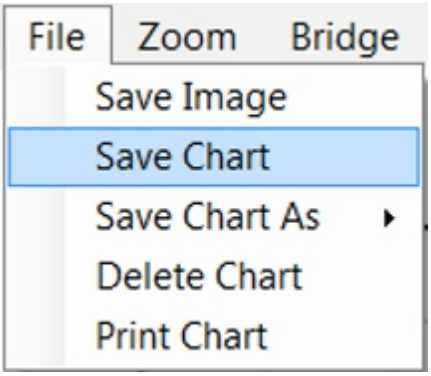


The user's Annotations and Zoom Level will be stored for all Saved Charts and the charts will be recreated when the *.cbz file is reopened by the User.

After saving the project file, you will be able to reopen the Chart with the Name you identified in the General Form Menu under Chart as

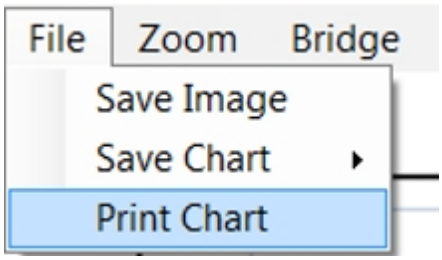


The Chart can be further annotated or modified and resaved using the **Save Chart** command.



Printing a Chart

To Print a Chart, select the Print Chart Menu Item under File in the Chart Form



This will allow you to select the Printer, then Print Preview the Chart before printing.

View Options

View Options

The Chart in C-BrEase is intended to provide a quick visual display of the historic changes in channel cross sections and the amount of cover or pile embedment remaining the the bridge foundation.

To facilitate this activity, enhanced viewing of the details in the Charts by

- Quick Panning and Zooming
- Comparing Cross-Section Values

Panning and Zooming

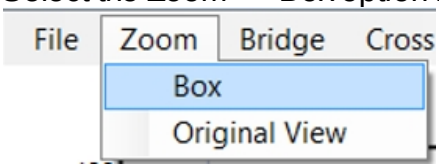
Panning

To Pan within a Chart, click the Left mouse button and drag the Chart.

Zooming

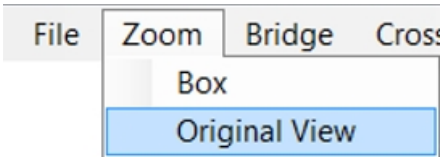
There are two ways to Zoom into a Chart

1. Move your mouse to the area of interest and rotate the mouse wheel
2. Select the Zoom => Box option from the Menu



and draw a box around the area you wish to Zoom into.

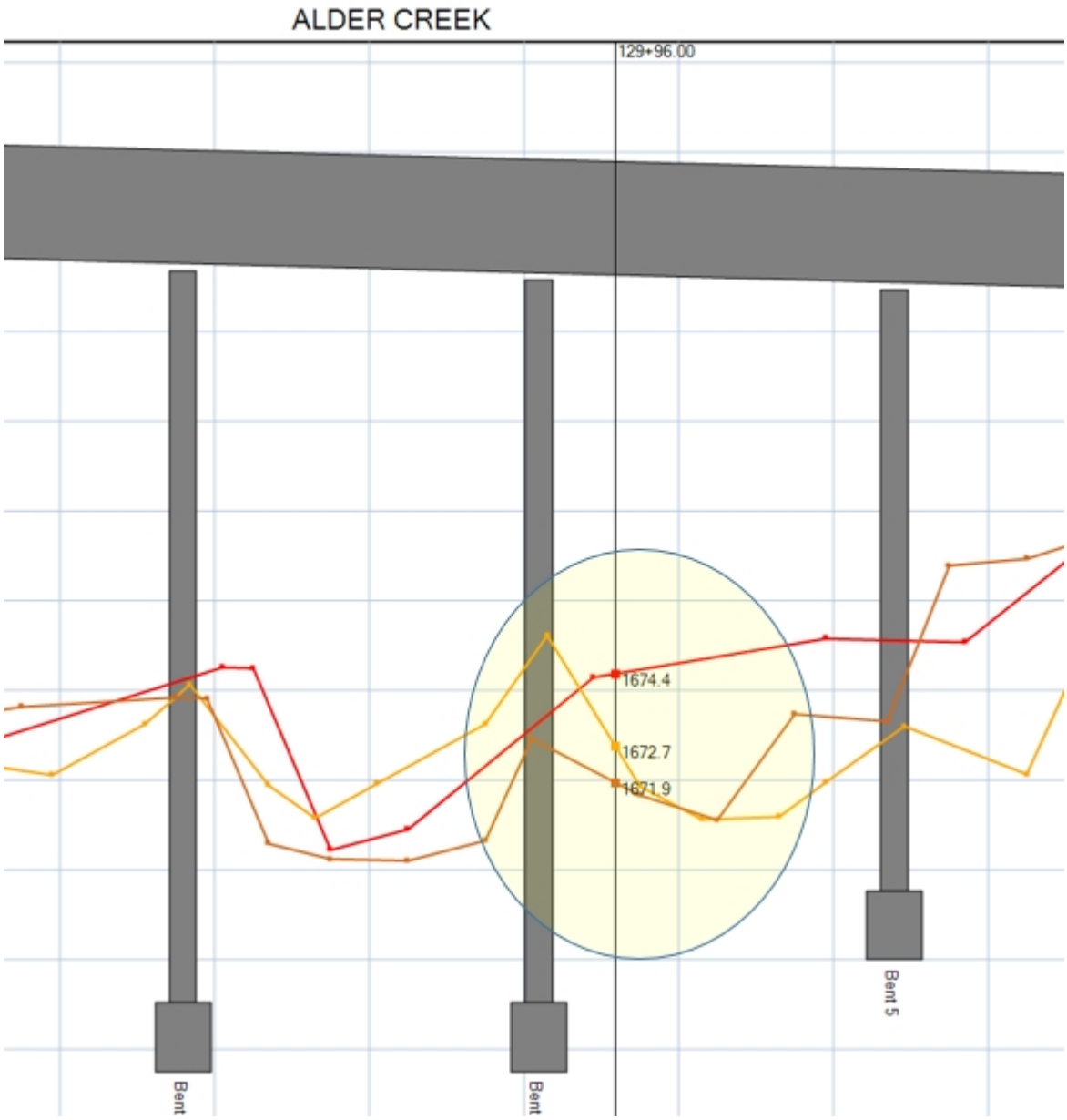
To Zoom back out, the easiest way to to select the Original View Option form the Zoom Menu as below.



Comparing Values

Comparing Values of Cross-Section Data

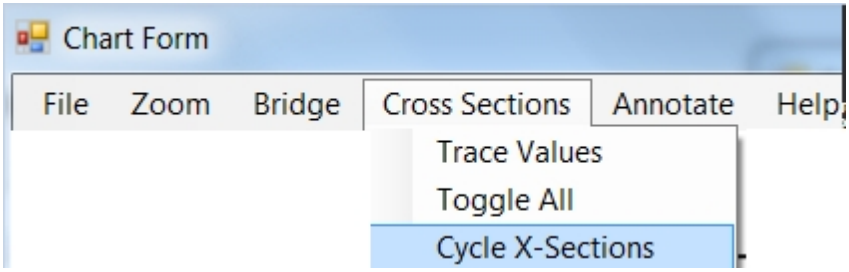
To compare Elevation values of the different cross-sections you can select the TRACE option from the Menu bar or by right clicking on the Chart.
Once enabled, you can move your mouse horizontally and see the station at the top of the Chart and the corresponding values of each cross-section as shown below.



Cycling through Cross-Sections

Cycling Through Cross-Sections

Cycling through the cross-sections allows the user to see the historic sequence for how the channel has changed by having C-BrEase automatically Fade-In and Fade-Out cross-sections chronologically. To activate this command, choose the Cycle X-Section command from the Cross Sections Menu as shown below.



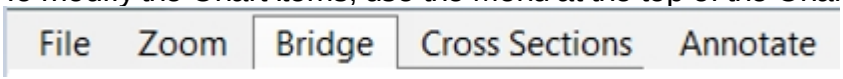
After activating the command, a Toolstripe will appear at the top of the Chart which will allow you to control the cycle program.

Options given are:
1. Push the Pause and Restart button to temporarily stop the program
2. Slide the scroll bar to change the speed of the Fade-In and Fade-Out
3. Select the checkbox to loop the cycle sequence
4. Select the Red Quit but to stop the cycle program

Modifying the Chart

Modifying the Chart

To modify the Chart Items, use the Menu at the top of the Chart

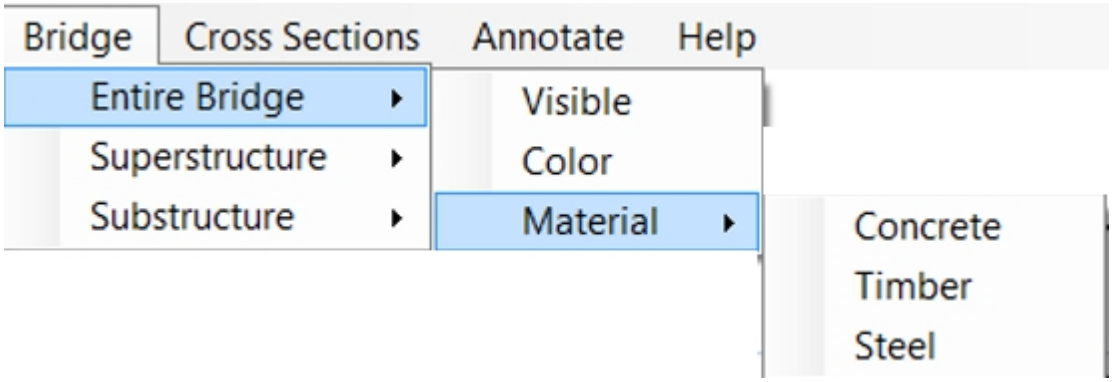


From this Menu, you can modify or change the visibility of the bridge and cross-sections or add specific notes or items to customize the presentation of the Chart.

Modifying the Bridge

Modifying the Bridge

The Chart Menu provides the means to easily customize the bridge.



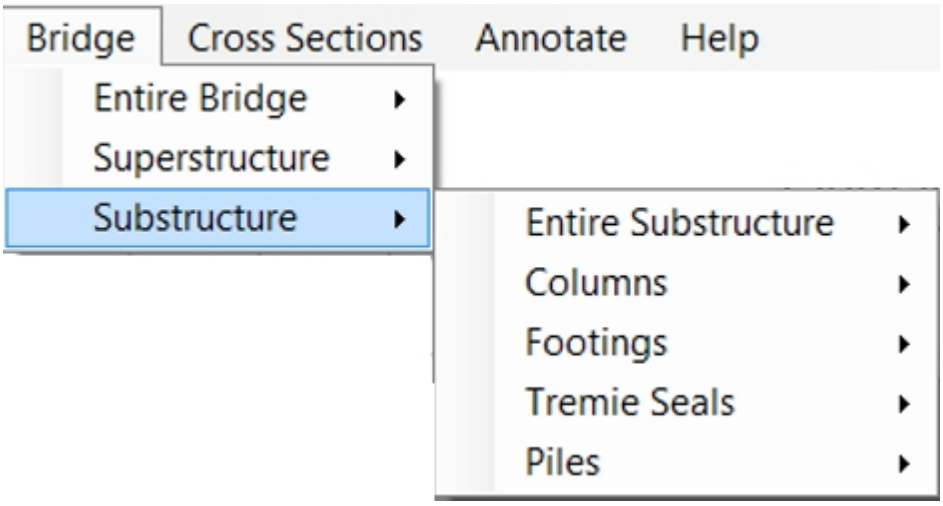
You can Toggle the Visibility, Color or Material Type of any of the following items

- The Entire Bridge
  Use this option to make the Superstructure and all of the Substructure Elements the same.

- The Superstructure
  Use this option to change only the Superstructure.

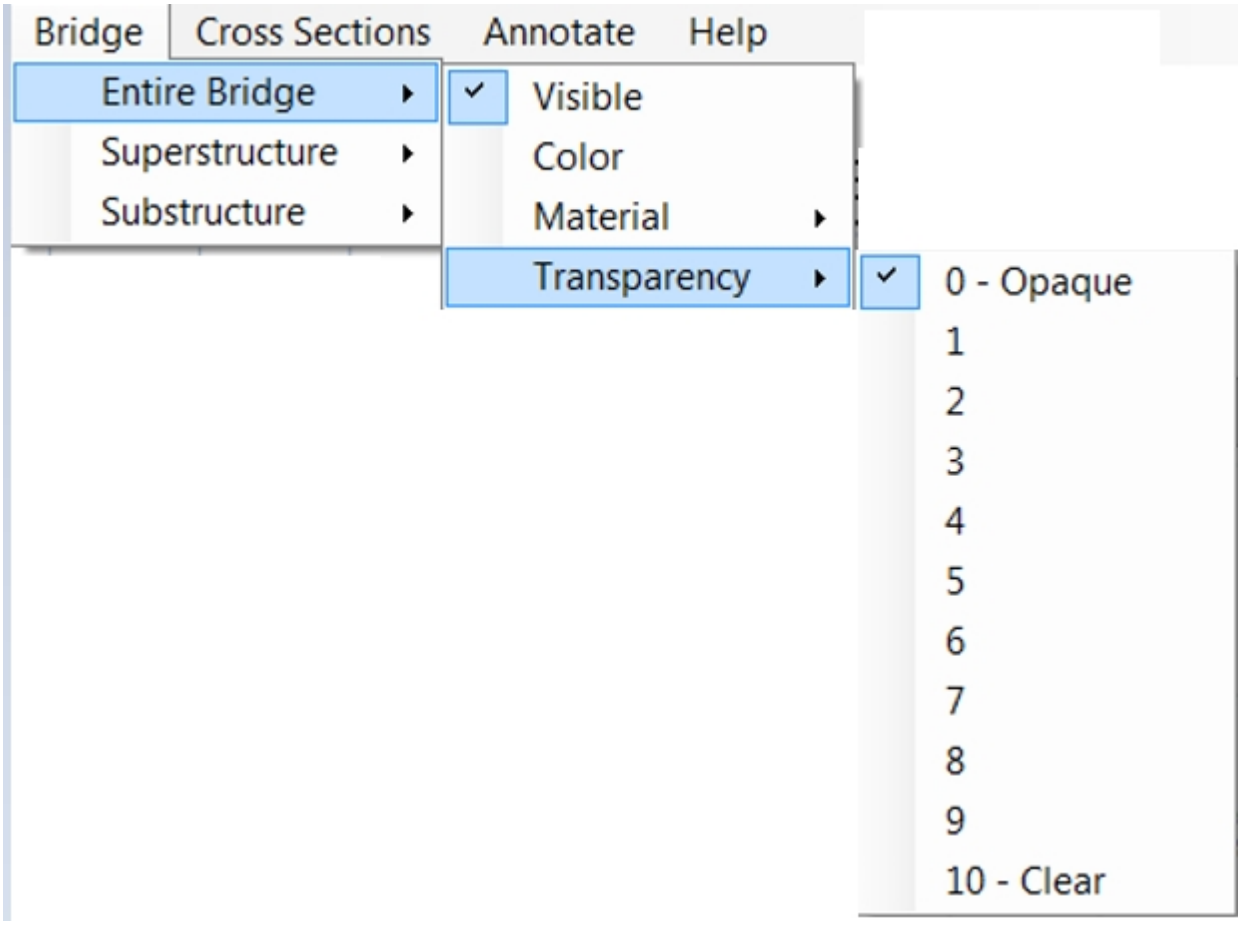
- All Substructure Elements
  Use this option to change all the Substructure Elements (Columns, Footings, Tremie Seals and Piles).

- Individual Substructure Elements
  Use this option to individually change various elements.



Changing the Transparency of the Bridge

To make the color of All of the bridge items transparent, select the value of Transparency you desire under the Entire Bridge Menu as shown below.

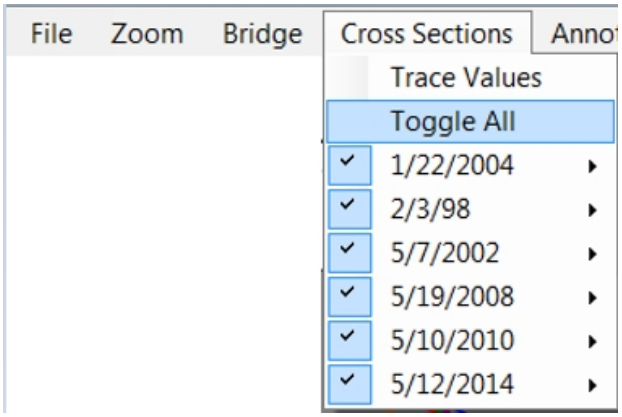


Notes: Transparency only works when Colors are used for the bridge and will not work for the Materials.
The transparency settings will be applied to all bridge superstructure and substructure elements equally.

Toggling the Cross-Sections

Toggling On and Off the Cross-Sections

You can control which cross-sections are displayed on a Chart through the Cross Sections Menu as shown below.



The cross-sections being currently displayed will have a "check" next to the date.

You can quickly turn all the cross-sections on or off by clicking the "Toggle All" menu Item.

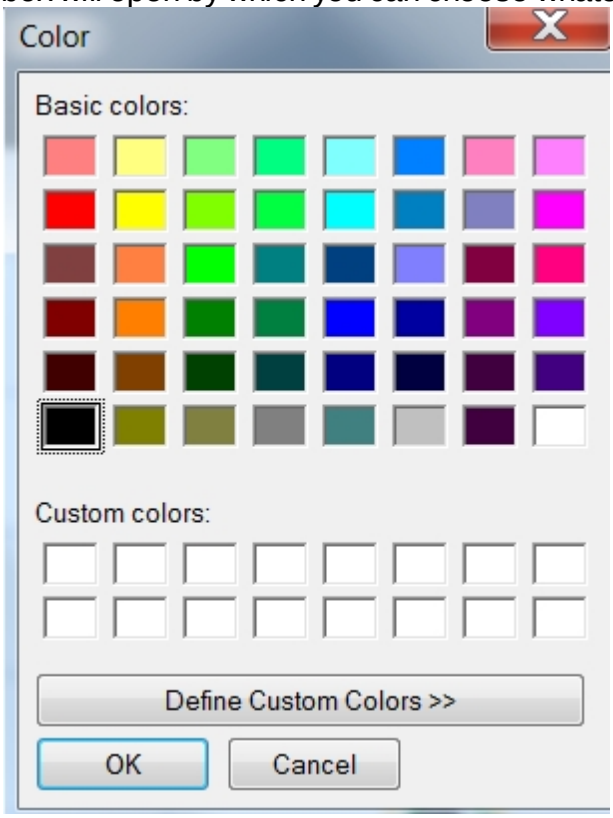
To turn individual cross-sections on or off, click on the specific cross-section of interest.

Customizing the Cross-Section Lines

You can control the Color, Line Thickness or Line Style from the Menu as shown below.

Color

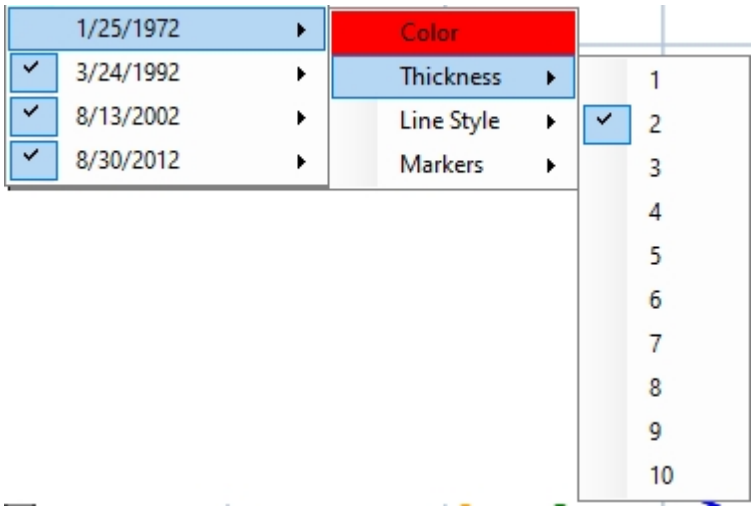
The current color is shown in the Menu. If you click the word, "Color" then a color dialog box will open by which you can choose whatever color you would like.



Line Thickness

The Line Thickness can be adjusted between a value of 1 (thin) to 10 (very thick).
The current line thickness is shown with a check mark.

Click on the thickness you would like for the line.



Line Style

The Line Style can be changed using the Menu.

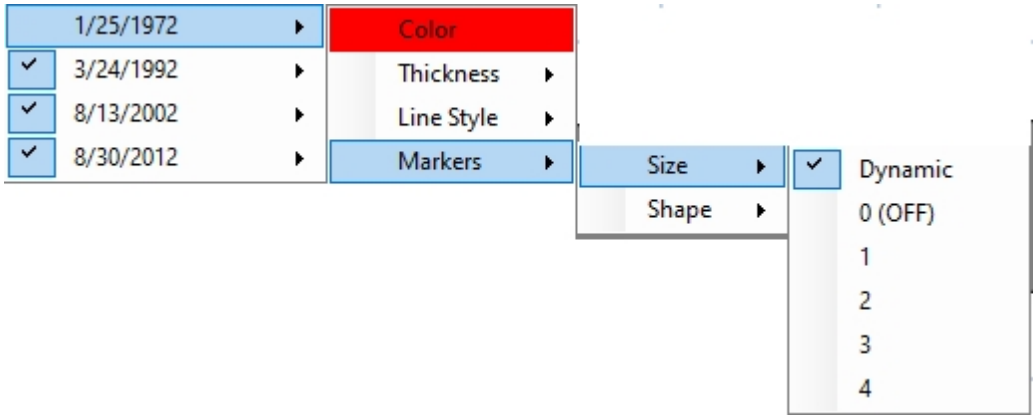
The choices are Solid, Dashed or Dashed-Dot.

Markers

The Markers can be customized by size and shape.

Marker Size

To change the size, select Markers => Size as below



The default setting is Dynamic which will adjust the marker size as you zoom in to maintain a relative constant visual size.

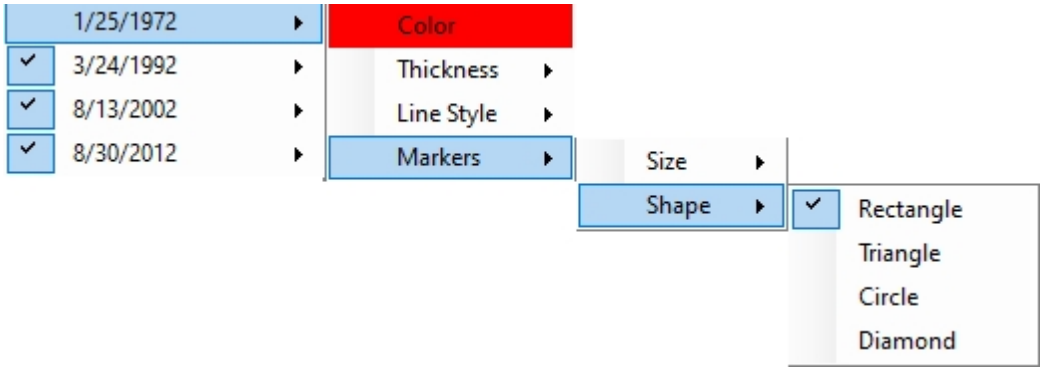
If you want to manually change the size, then you can choose from 1 to 4.

If you do not want to see the Markers, select 0 (OFF)

Marker Shape

Four marker shapes are availble through the menu system as shown below.

Note: The Rectangle shape is the dedault shape and used for charts without a prior selection by the user.



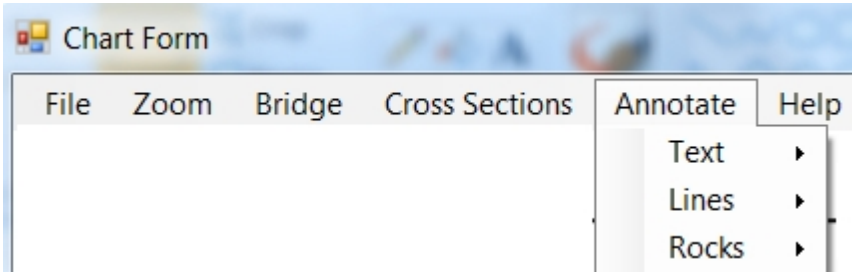
Annotating the Chart

Annotating the Chart

The add specific, descriptive information on the Chart, use the Annotate Menu Item.

With this Menu Option you have 3 types of information to add to the Chart:

1. Text
2. Lines
3. Rocks

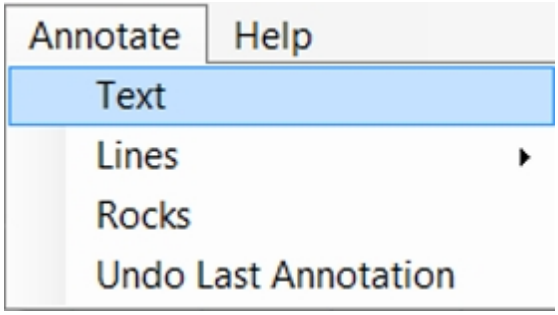


Text

Adding Text (Comments)

To Add Text,

1. Select Text from the Menu.



2. Left click on the location in the Chart to Add the Text
3. Type in the Text
4. To Resize the Font, roll the mouse wheel
5. To complete the Text, left click the chart again.

Notes:

1. *To Cancel the Text Entry, press the Esc Key prior to the second left click.*
2. *All alpha numeric character and many symbols are allowed for text.*

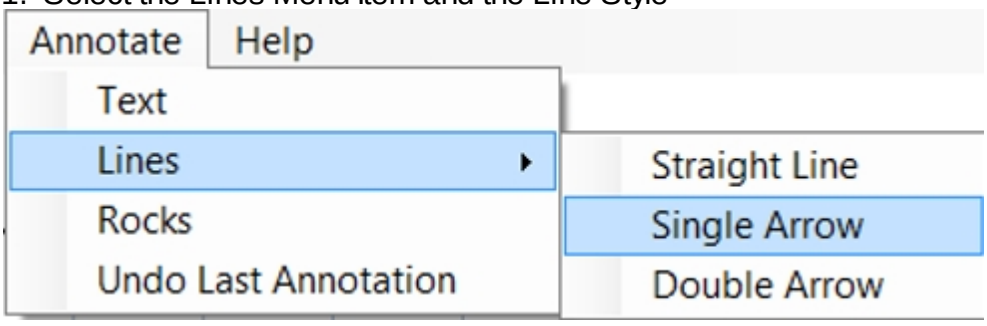
However, commas are not allowed due to problems created with the file structure.

Lines

Adding Lines

To add lines to the chart, you may select from 3 basic line style types as shown in the Menu:

1. Select the Lines Menu Item and the Line Style



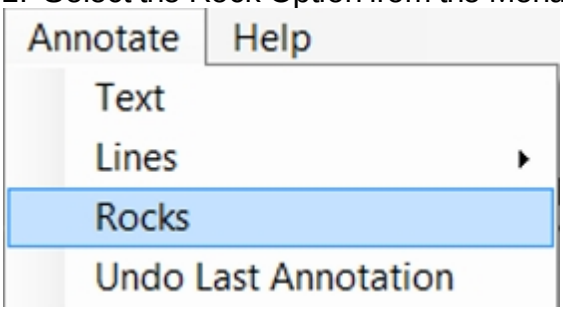
2. Move your mouse to the beginning of where you would like to start the line and Left Click to set the anchor point.
3. Move the mouse to where the line should end.
4. Turn the Mouse Wheel to resize the line thickness.
   Note: *To Cancel the Line, press the Esc Key*
5. To end the line, left click at the end of the line.

Rocks

Adding a Layer of Rocks

To add rocks to the chart,

1. Select the Rock Option from the Menu.



2. Left click at the beginning of the line of rocks.
3. Move the mouse to where the line should end
4. Rotate the Mouse Wheel to resize the size of the rocks.
   Note: *To Cancel the Rocks, press the Esc Key*
5. To end the rocks, left click at the end point.

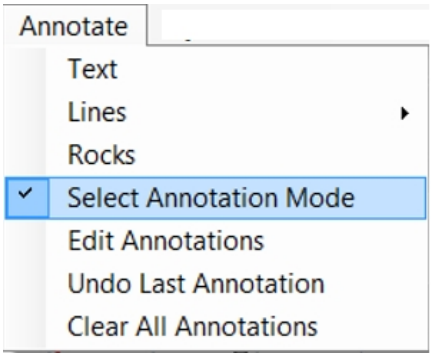
Modifying An Annotation

Modifying An Annotation

Graphically

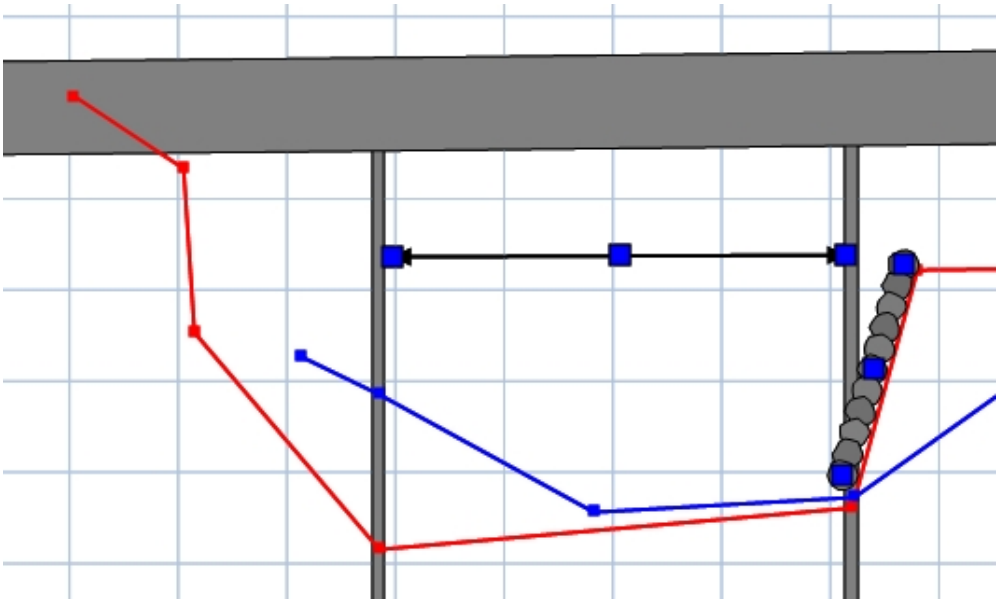
Modifying an Annotation Graphically

To modify an existing annotation using the table, enable this feature from either the Menu or by Right Clicking on the Chart and selecting "Select Annotation Mode" item. After doing so, you will see that it has a check next to the Menu Item as shown below.



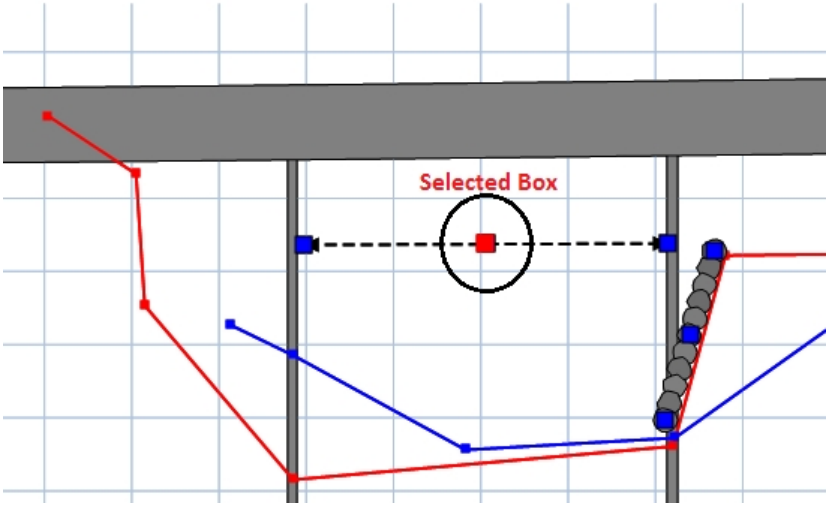
Once the Selection Mode is turned on, moving the mouse over a text annotation or bridge label will cause it to change to italic font.
Clicking on the word once it is italicized will allow you to move the word or resize it using the mouse wheel.

In Selection Mode, Line and Rock Annotations will display Blue nodes at the start, end and midpoints.

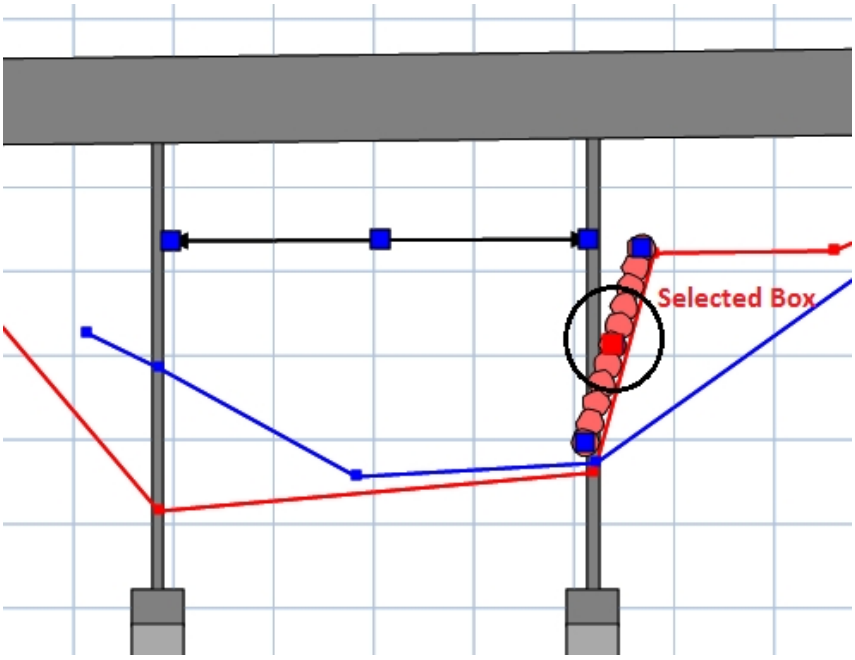


If you move the mouse over one of the blue nodes, it will change to red and

- if the annotation is a Line, it will become dashed



- if the annotation are Rocks, they will change colors



Object Modifications Options

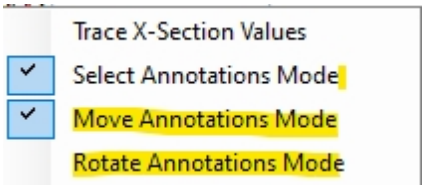
1. If you rotate the mouse wheel, the annotation you are on will change size.
2. If you click the beginning or end nodes, you can move the end of the lines.
3. If you click the middle node, you can shift the location of the entire line.
4.

Text Modification Options

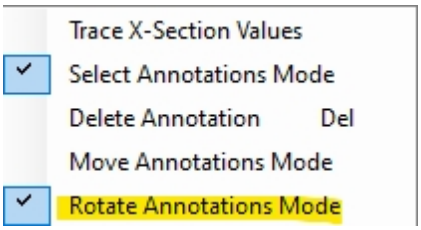
If in "Select Annotation Mode", you can modify text by

- Change the size by hovering over the text and rolling the mouse wheel

In additon, by hovering over the text and right clicking you will see the following menu:



- If the Move Annimations Mode is selcted as shown above, you can move the text by selecting it with the Left mouse button and dragging
- If you want to Rotate the Text, right click on the text and choose the Rotate Annotations Mode as below.

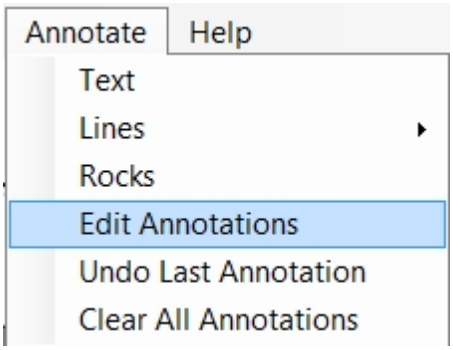


Once in the Rotation Mode, if you click on the text and drag it, it will pivot as you drag the mouse.

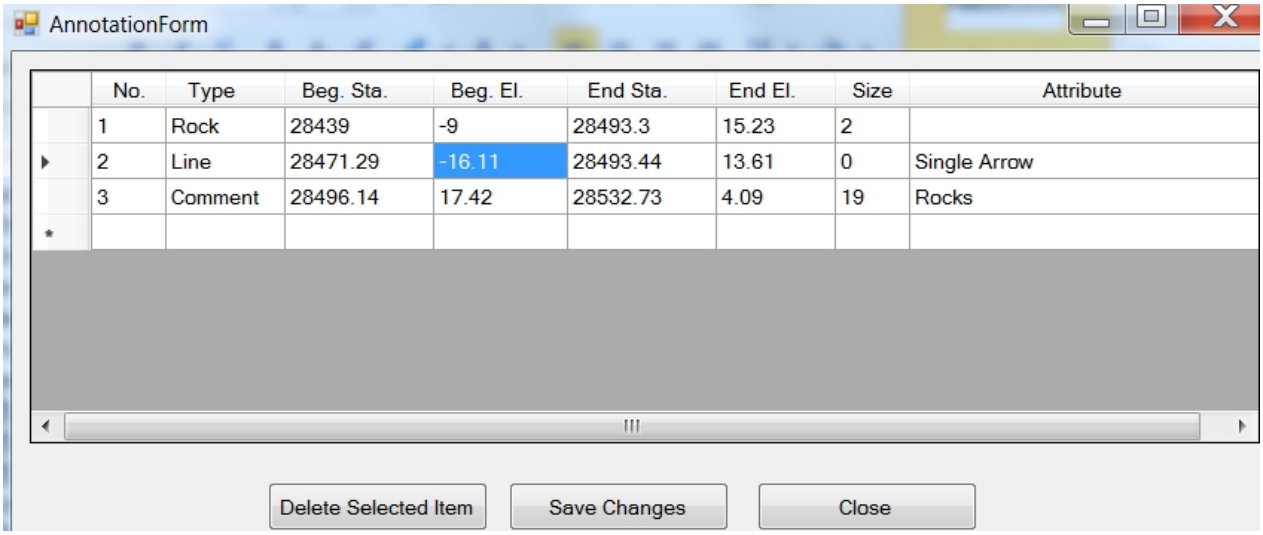
Tabularly

Modifying an Annotation Using the Annotation Table

To modify an existing annotation using the table, select the Edit Annotation Item from the Menu



This will display a table of all the annotations on a Chart including the Type, Starting and Ending Coordinates, Size and Attributes as shown below.



To make a change, you can simple type into the cell, the new value (e.g., station, elevation,

size, etc.) and click "Save Changes".

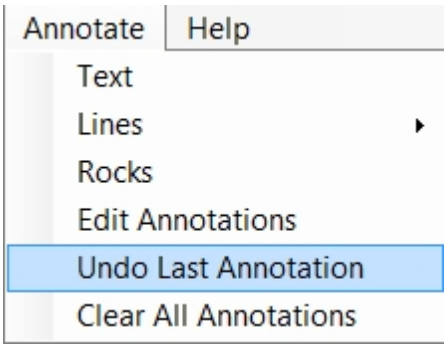
To delete an annotation, select the row by clicking in the left most cell, then click "Delete Selected Item".

Removing Annotations

Removing Annotations

To commands are available to remove annotations.

Undoing the Last Annotation
To remove the Last Annotation, select the "Undo Last Annotation" command from the menu as shown below.

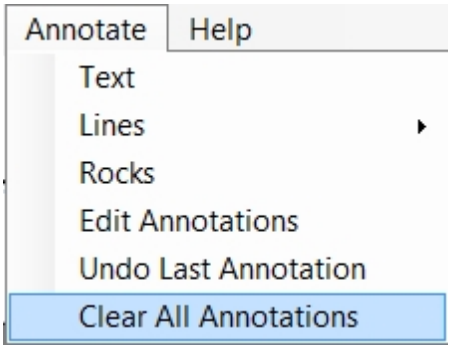


Note: this command can be used successively to remove subsequent annotations; however, once, an annotation is removed, it must be recreated to add it back to the chart.

Deleting a Specific Line or Rock Annotations
To remove a specific annotation,

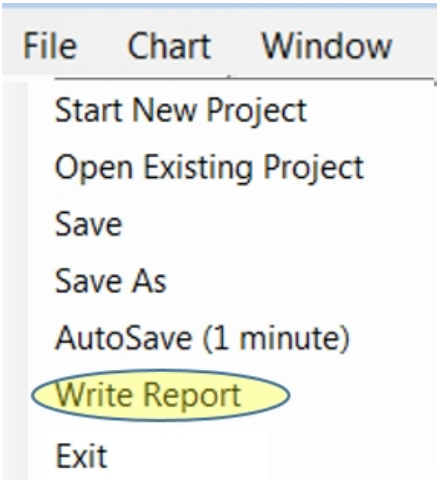
1. Turn on the Select Annotation Mode
2. Hover the mouse over one of the blue nodes
3. Right click and you will see a Delete Annotation Option to remove this annotation or you may click the "Delete" Key on the keyboard.

Clearing All Annotations
To remove all annotations from a Chart, simply select the "Clear All Annotations" command as highlighted below.



Writing Reports

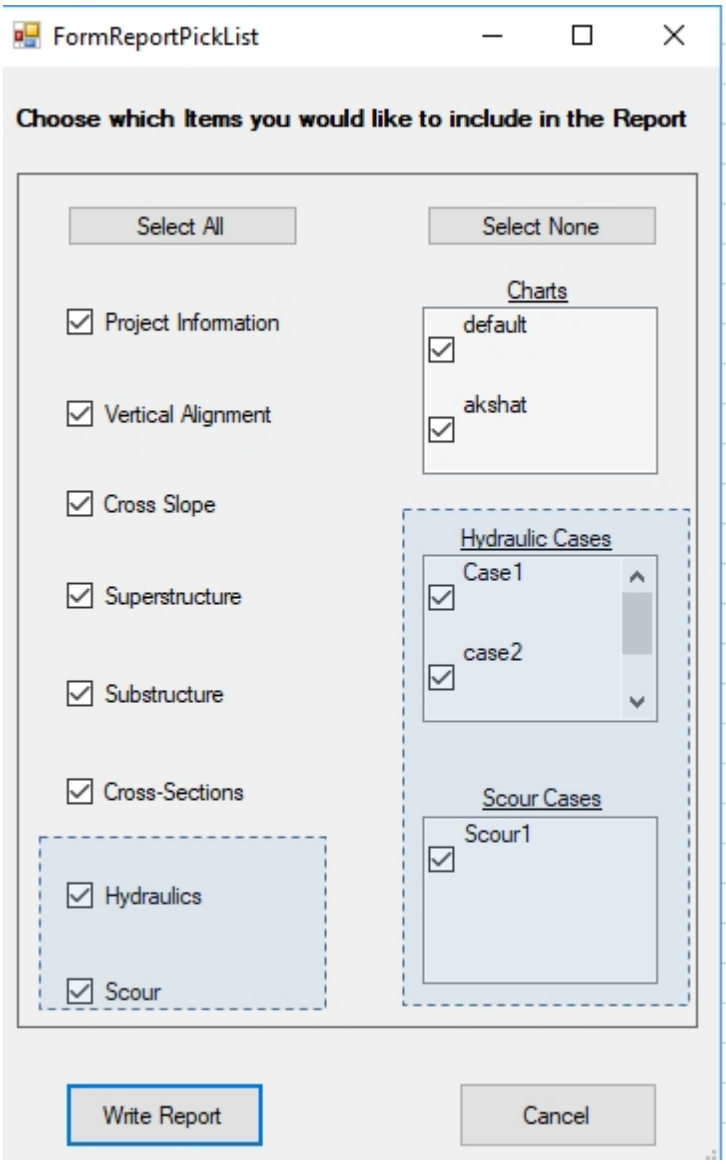
Documenting your project is easy with C-BrEase.



In the General Form, select the Menu Option under File for Writing a Report

You are then given a choice as to what data you would like to include in the Report.

Check the items as shown below.



Note: You are able to select any Saved Chart Images to be included in the Report. If no Charts have been "Saved", then you will be given the option to include the Chart showing the full bridge and all cross-sections.

The Hydraulics and Scour check boxes will only be visible if you have the license for these modules.

Finally, you will be prompted to choose a name and location for the file, then a PDF file will be written and displayed on the screen.