The Vehicle Assessment Tool

(For testing only)

Version 0.9

User Manual

(Version 0.9)

Monash Uninversity

Acknowledgements

This program was initially developed by Dr Colin Caprani in Monash University, Melbourne, Australia. Its initial development was funded as part of the Vicroads.

Dr Colin Caprani,

May 2015

Contents

1. About this guide

1.1 The Vehicle Assessment Tool (VAT)

The Vehicle Assessment Tool (VAT) is developed to facilitate the quick assessment of the access levels for high-performance freight vehicle (HPFVs). Based on two types of the assessments, commercial vehicle and special permit, vehicles are modelled as a set of spaced point loads applied on different positions on the bridge and key plots about the impact such vehicles will have on a wide range of bridge types and lengths are provided to compare with the reference vehicle or design code model.

The output file contains envelo1ps of maxima and minima values for the vehicle traverse and the data graphs or tables can be exported to other software (e.g. Microsoft Excel) for further comparison or analysis.

1.2 The User Manual

The user manual has been written to provide a comprehensive guide for understanding and utilizing the Vehicle Assessment Tool (VAT), and to explain its capabilities and limitations. It also explains the user interface, the required input and output information with typical examples displayed. Throughout the user manual, the term VAT is most commonly used as the abbreviation of the Vehicle Assessment Tool.

To access and search the Help system, you can do either one of the following:

- On the VAT menu, clicks Help ➤About VAT. The landing page of the Help system is displayed.
- In the toolbar, click the '?' button. The help topic related to the dialog box is linked to **the Web browser**. Otherwise, the landing page of the Help system is displayed.

1.3 History

Vehicle Assessment Tool (VAT) Program

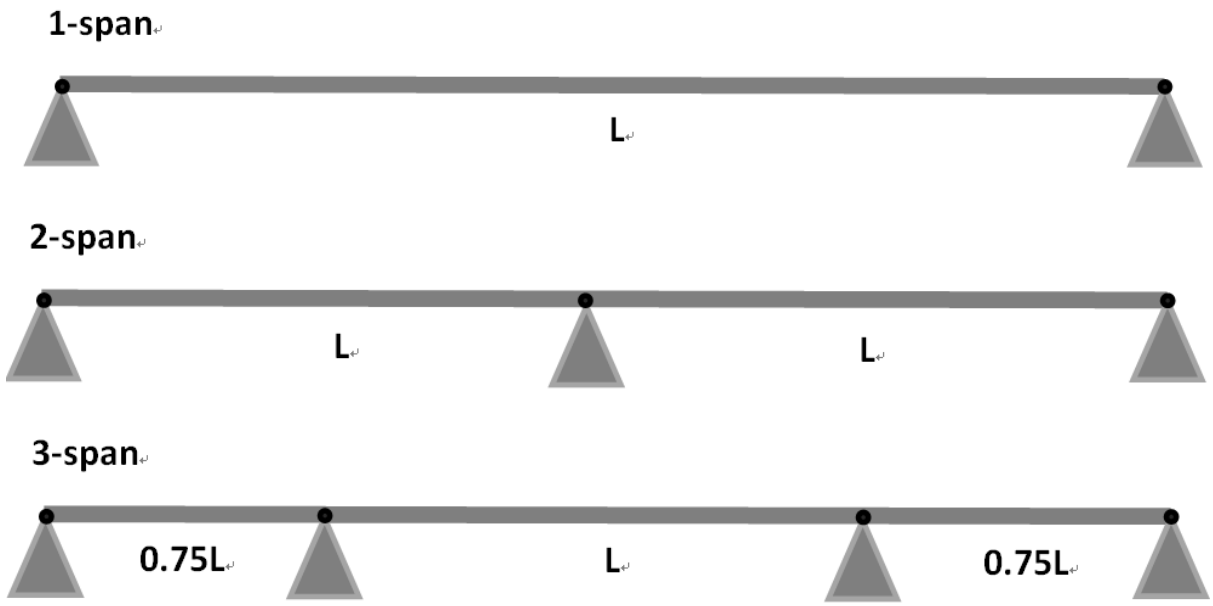
Version	Date	Description:
0.8.0.0	15/5/2015	• Initial release—α tinitial release –α version

1.4 Terminology

Commercial vehicle assessment: vehicle check for all routes with full access.

Special permit assessment: this route is for single journey only.

Bridge configuration: 1-span or 2-span or 3-span bridge (L: span), as shown.



Load Model: produces the reference values comparing with the outputs from vehicles on bridge and it is based on design codes.

Load Model ensembles: a package of load model.

Envelope: a culmination of all plots in one figure by applying superposition of each output graph.

Reference set: a range of bridges under a load models ensembles.

Reference collection: a package of reference sets.

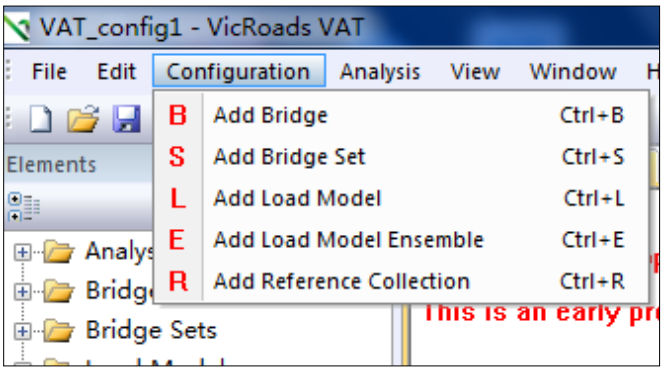
1.5 Conventions

Menus

Menu commands are written as:

Configuration > Add Bridge

And mean the user should select Add Bridge from the Configuration menu as shown:



Keyboard

The use of shortcut keys is indicated as:

Ctrl+I

And means that the user should press the Control and "I" keys simultaneously.

Notices

Points of significant importance are denoted as:

Important!

Typically, failure to adhere to these points will result in unexpected behaviour or a program crash.

Parameters that may be changed in the VAT.ini configuration file are coloured in red as:

3.5 tonnes

Values in this text are default values and may be changed by a Developer User.

1.6 Glossary

HML: Higher Mass Limit

B-VAT: Basic version of Vehicle Assessment Tool

E-VAT: Enhanced version of Vehicle Assessment Tool

SDI: single document interface

UDLs: Uniform distributed load

Partial UDLs: Partial uniform distributed load

MLA: Moving Load Analysis

BMD: Bending Moment Diagram

SFD: Shear Force Diagram

2. Overview of the Vehicle Assessment Tool (VAT)

2.1 Introduction

Vehicle Assessment Tool (VAT) broadly performs the following steps:

Step 1 Start a new file and add a bridge or bridge set.

Step 2 Select Load Models and define the corresponding reference set as a comparison.

Step 3 Run the analysis to obtain the outputs with envelopes and tables.

Step 4 Export the data to other software, e.g. Microsoft Excel, if necessary.

2.2 VAT: Capabilities and Limitations

Capabilities

B-VAT is able to:

- analyse one- and two-equal-span bridges in the span range of 1 to 50m;
- analyse three-span bridges in the ratio 0.75:1.0:0.75 from 1 to 50m;
- take account of database facility for reference and permit vehicles;
- display envelopes of load effects for a vehicle passage for a single bridge;
- provide bending moment and shear force diagrams of a static analysis of a single bridge for a single vehicle position;
- produce envelopes of load effects of bridge set for all positions;
- obtain outputs of maximum and minimum load effects for bending, shear, and reactions;
- export of graph data to Microsoft Excel;
- incorporate HML vehicles as a choice for reference values of load effects;

E-VAT is able to:

- use the overstress method for determining remaining bridge capacity envelopes;
- conduct analyses including an assumed dead load model by span length;
- contain Historic and contemporary bridge loading models from A26 to SM1600;
- set the HML vehicles as a base model
- take account of variation of the dynamic impact factor;
- multiply factor to account for lateral distribution of load;
- producing graphs defining the span range for which the permit vehicle can travel at full speed, reduced speed, or not at all;

- producing output data tables over the span range 0-50m in a format acceptable to VicRoads current assessment tool (to be discussed in more detail after commencement of project).
- consider vehicles with up to two variable axle spacings;
- model knife-edge loads and coincident uniformly distributed loads.

2.3 Limitations

Vehicle Assessment Tool (VAT) is not able to:

- determine the transverse load effects on bridges;
- analysis dynamic load effects on bridges;
- take the effect of bridge construction materials into consideration;
- consider the vehicle travelling speed.

2.4 User level

There will be two main types of user of Vehicle Assessment Tool:

Ordinary user

This type of user typically use the a basic permit to reference vehicle checking tool B-VAT and mainly run the program to generate outputs of load effects for three bridge configurations(1-span, 2-span and 3-span) within the range of 1 to 50m span. After comparing with the corresponding reference set, the access safety when the vehicle travels on the bridge can be decided. Generally, they will not require for exclusive usage but obtain the information to assist the bridge owner in making decision by running the program directly.

Developed user

An enhanced tool E-VAT with additional capabilities is required for this type of user but the exclusive usage will be retained by the software publish company. They will model the bridge with span over 1 to 50m from A26 to SM1600. The utilization of overstressed method may need to be applied for determine remaining bridge capacity envelopes. Also, the output data graphs may be produced based on the changing speed of the permit vehicles.

3. Installing the Program

3.1 System requirements

This program has been tested on Window 7 32-bit and 64-bit machine.

3.2 Installation

To install the program, carry out the following steps:

Step 1 Extract the zip-archive to a folder;

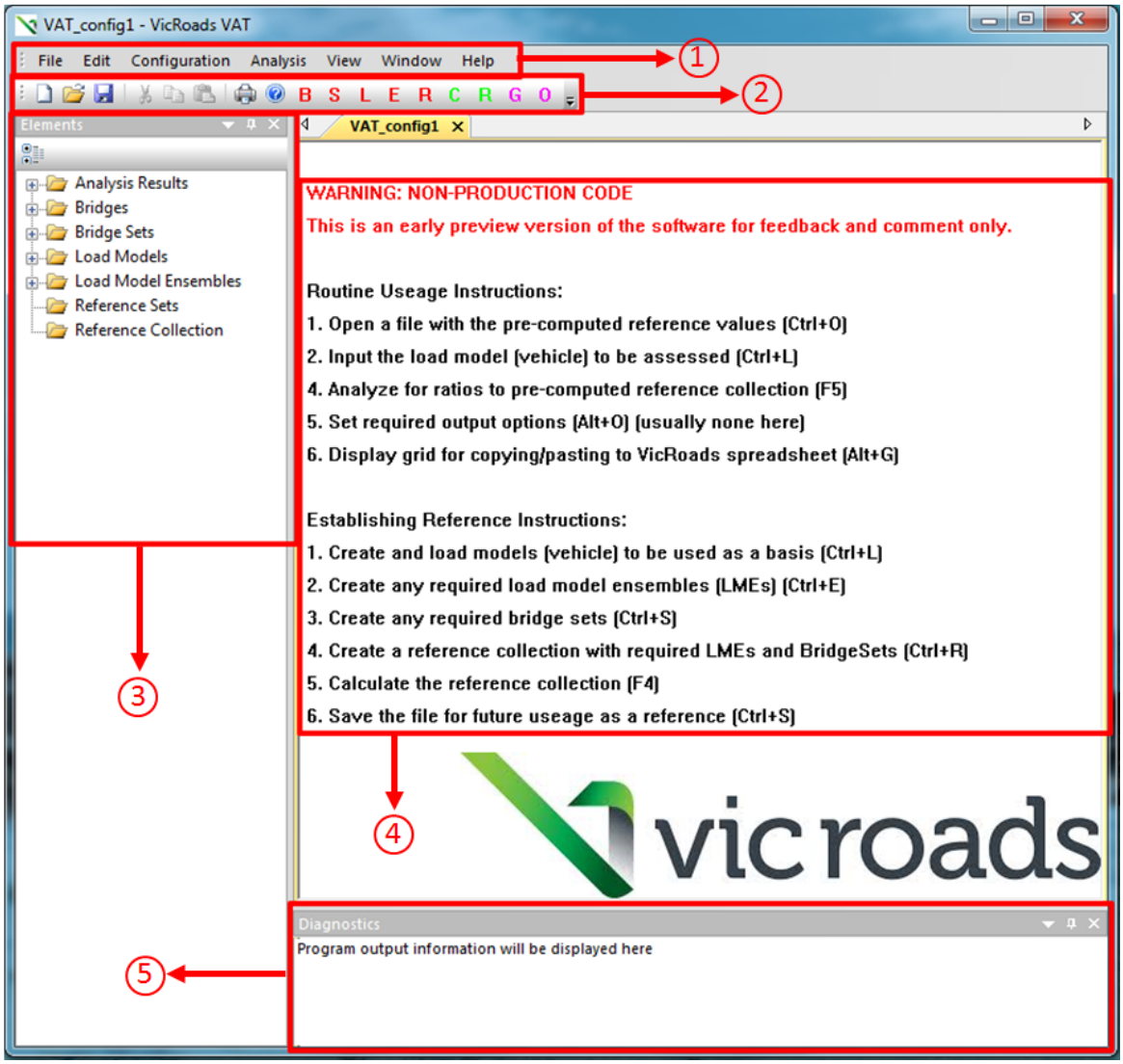
Step 2 In that folder, double click on the file Setup.exe;

Step 3 Follow the on-screen instructions to install the program

4. The Vehicle Assessment Tool (VAT) User Interface

4.1 Introduction

The Vehicle Assessment Tool supports a Single Document Interface (SDI). Only one VAT file is allowed to be opened at any one time. The general user interface consists of menu, toolbar and Elements toolset to access may frequently used commands. Also, several keyboard shortcuts are designed as extensive support in VAT to make it easier and quicker when using the program. The typical VAT user interface is shown here.



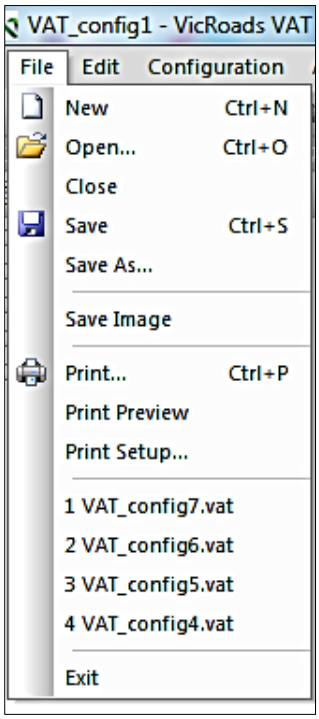
◯,1Menu ◯,2Toolbar ◯,3Elements Toolset ◯,4Content area ◯,5 Diagnostics

4.2 Menu

The menu bar contains all available commands organized into logical categories. Use the menu bar when running the program, or browsing for a command.

Tip: Right click the button in the menu bar can select and customize the style of the commands

File



- File > New:

  Open a new *.vat document.

- File > Open:

  Display the Open File dialog for choosing an existing *. vat file.

- File > Clos:

  Close the current file.
- File > Save:

  Save the current file.
- File > Save as:

  Save the current file as *.vat file in different name or storage folder.
- File > Save Image:

  Saves the view currently visible to a *.bmp file specified in the Save dialog. This feature is useful for including configurations in reports/presentations etc. and replaces the need for using the Windows Print Screen command.
- File > Print:

  Print the current view and allow adjusting the print properties
- File > Print Preview

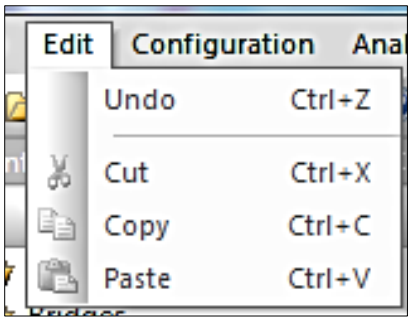
  Display a preview of the current view or output that may be sent to the printer
- File > Print Setup

  Specify the print setup when printing.
- File > Recently Used File

  A list of recently used *.vat files for ease of access.
- File> Exit:

  Close the program.

Edit



- Edit > Undo:

  Cancel the current action;

- Edit > Cut:

  Cut the highlighted view or data to the clipboard;

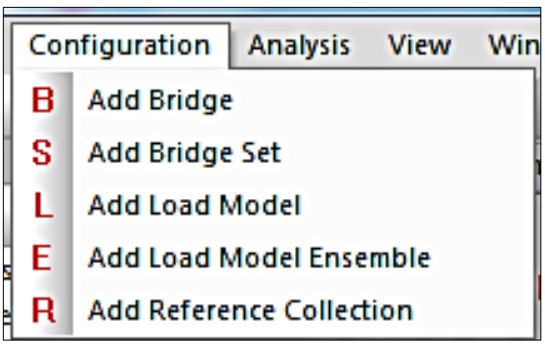
- Edit > Copy

  Copy the highlighted view or data to the clipboard.

- Edit > Paste

  Paste the view or data from the clipboard.

Configuration



- Configuration > Add Bridge

  Bring up the Define Bridge dialog box – see **section5.2.**

- Configuration > Add Bridge Set

  Bring up the Define Bridge Set dialog box – see **section5.3**.

- Configuration > Add Load Model

  Bring up the Load Model Definition dialog box – see **section5.4.**

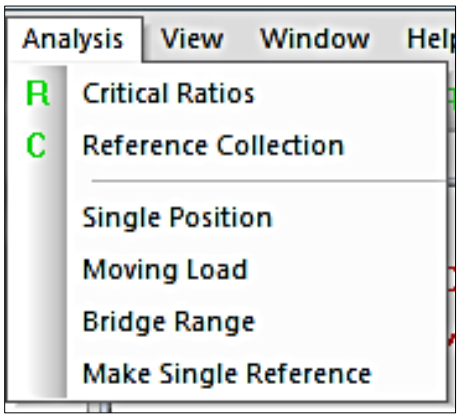
- Configuration > Add Load Model Ensemble

Bring up the Load Model Ensemble Definition dialog box – see **section5.5.**

- Configuration > Add Reference Collection

  Bring up the Make Reference Collection dialog box- see **section6.5.**

Analysis



- Analysis > Critical Ratios

  Start the analysis of determines the critical ratios of the Load Model to each of the reference sets contained in the reference collection.

- Analysis > Reference Collection

  Start the analysis of load effect of a bridge set under several Load Model ensembles simultaneously.

- Analysis > Single Position

  Start the analysis of load effect for single bridge with specific location of Load Model

- Analysis > Moving Load

  Start the analysis of load effect of proposed bridge under moving load

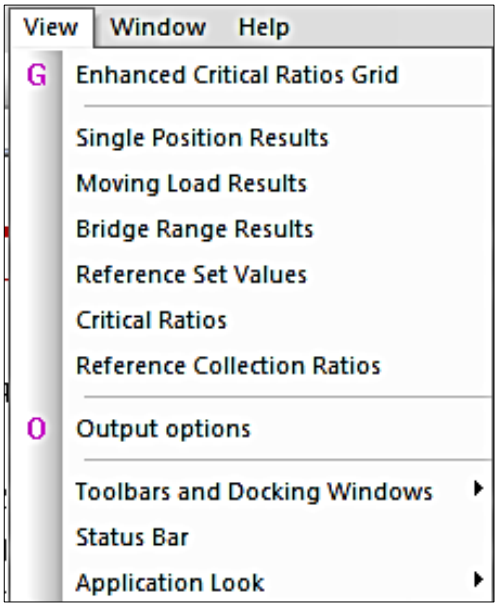
- Analysis > Bridge Range

  Start the analysis of load effect of a set of bridges under selected Load Model for all positions

- Analysis > Make Single Reference

  Start the analysis of load effect of a bridge set under one Load Model ensemble

View



- View > Enhanced Critical Ratios Grid

Choose to view the outputs of critical ratios based on reference collections in one table (only displaying the critical load effects for different bridge types)

- View > Single Position Results

  Choose to view the outputs of single bridge under specific location of Load Modell.

- View > Moving Load Results

  Choose to view the outputs of single bridge under moving load.

- View > Bridge Range Results

  Choose to view the outputs of a set of bridges under selected Load Modell for all positions.

- View > Reference Set Results

  Choose to view the outputs of a bridge set under one Load Modell ensemble.

- View > Critical Ratios

  Choose to view the outputs of the critical ratios in graphs and tables.

- View > Reference Collection Ratios

  Choose view the results of critical ratios of load models to each of reference set contained in the reference collection.

- View > Output Options

  Choose to open or close which type of results can be displayed

- View > Toolbars and Docking Windows

  Choose whether or not to display the toolbar.

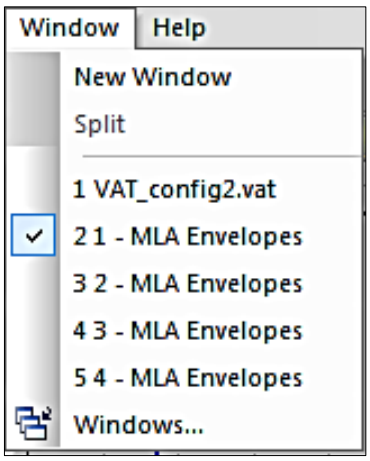
- View > Status Bar

  Choose whether or not to display the status bar at the bottom of the screen.

- View > Application Look

  Choose the style of user interface.

Window



- Window > New Window

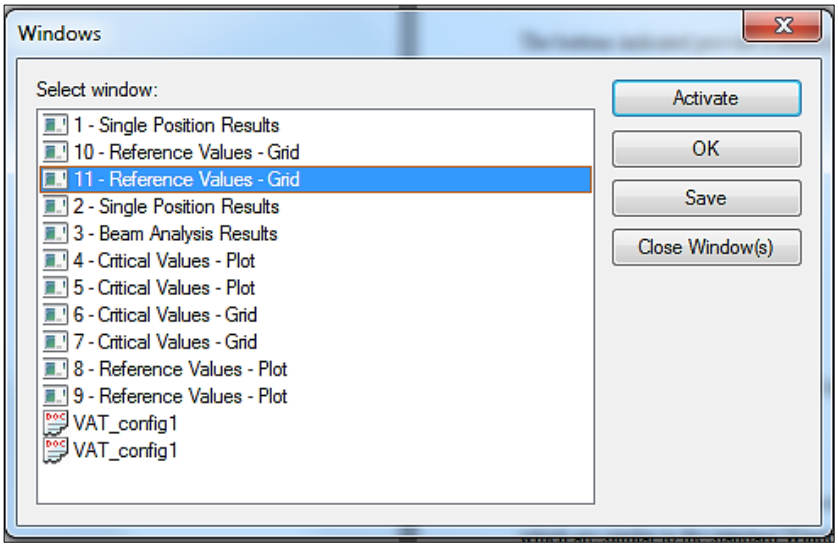
  Create a new file.

- Window > Results Window

  List of the results by analysing the current *.vat file.

- Window > Windows

  List of all output plots and tables after analysing the current *.vat file and you can choose save or close any one of them.

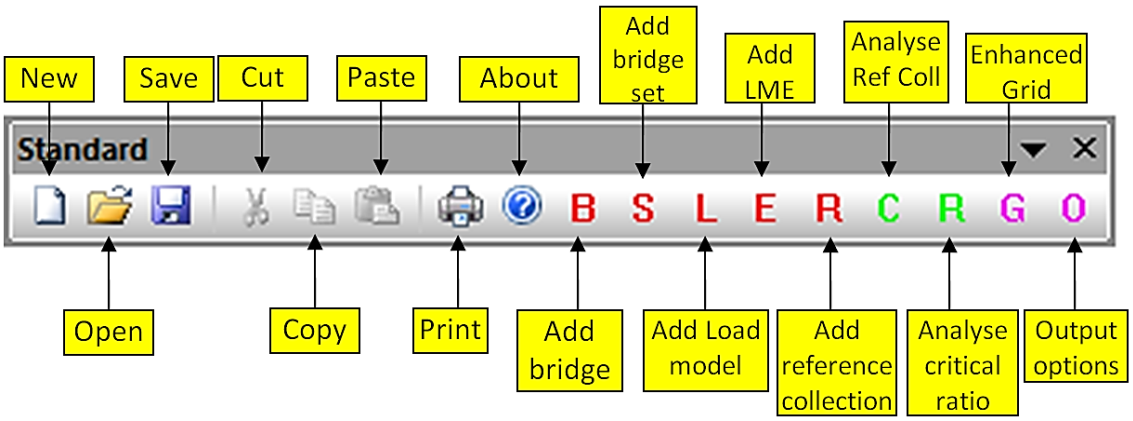


Help

- Help > About VAT:

This shows information about the version of the program running and land to the help system of VAT.

4.3 Toolbar



The buttons indicated provide a shortcut for ease of menu commands as follows:

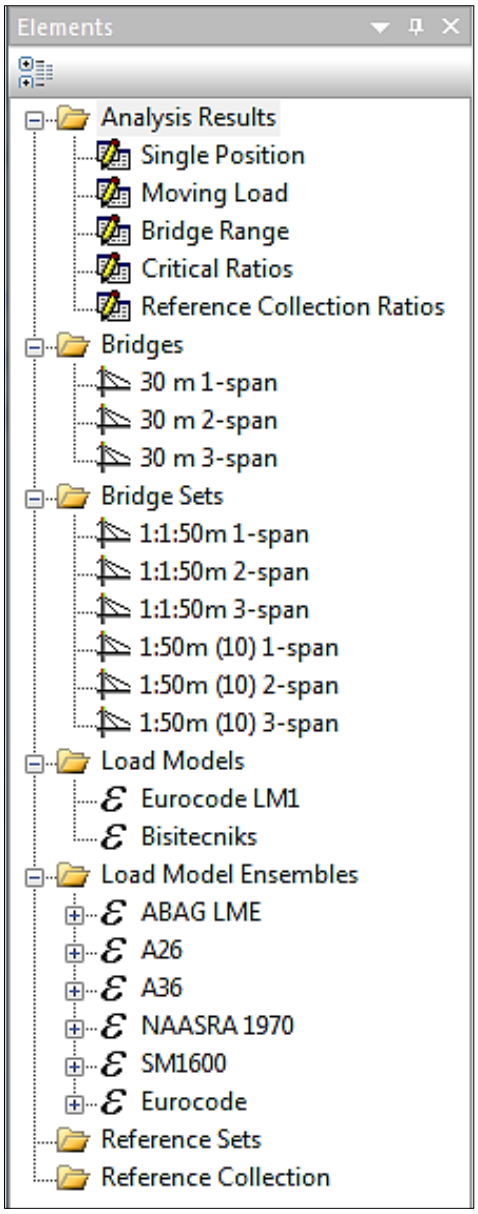
- New: File > New;
- Open: File > Open;
- Save: File > Save;
- Cut: Exit > Cut;
- Copy: Exit > Copy;
- Paste: Exit > Paste;
- Print: File > Print;

- About: Help > About VAT;
- Configuration > Add Bridge
- Configuration > Add Bridge Set
- Configuration > Add Load Model
- Configuration > Add Load Model Ensemble
- Configuration > Add Reference Collection
- Analysis > Reference Collection
- Analysis > Critical Ratios
- View > Enhanced Critical Ratios Grid
- View > Output Options

4.4 Elements

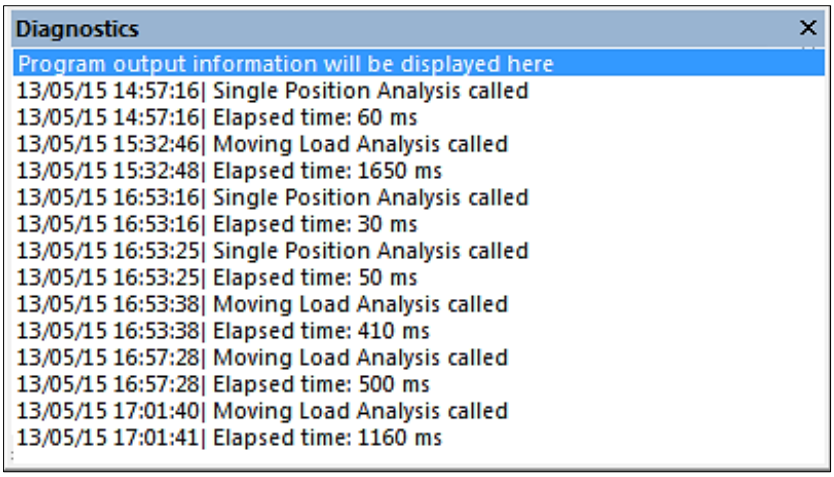
Elements Toolset contains different folders covering all settings in the VAT. It can act as a list or a quick link showing the available bridges and Load Models in this program. An example of Elements toolset is present blew.

Also, you can extend the folder Analysis Results and choose one option to view the outputs which has already been done. This means the program can have memory and display the results again after conducting the analysis. Details of each folder in Elements toolbar are explained in **section5, 6, and 7**.



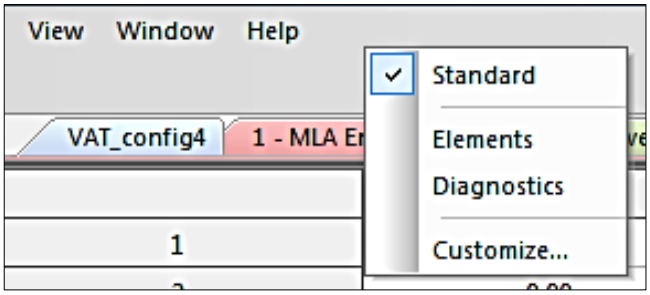
4.5 Diagnostics

Diagnostics is a dialog box presenting the program output information for all analysis when running the program. Both progress date and the elapsed time with the corresponding analysis are displayed in the Diagnostics dialog box. An example of the Diagnostics is shown.



To view the Diagnostics, you can do either one of the following:

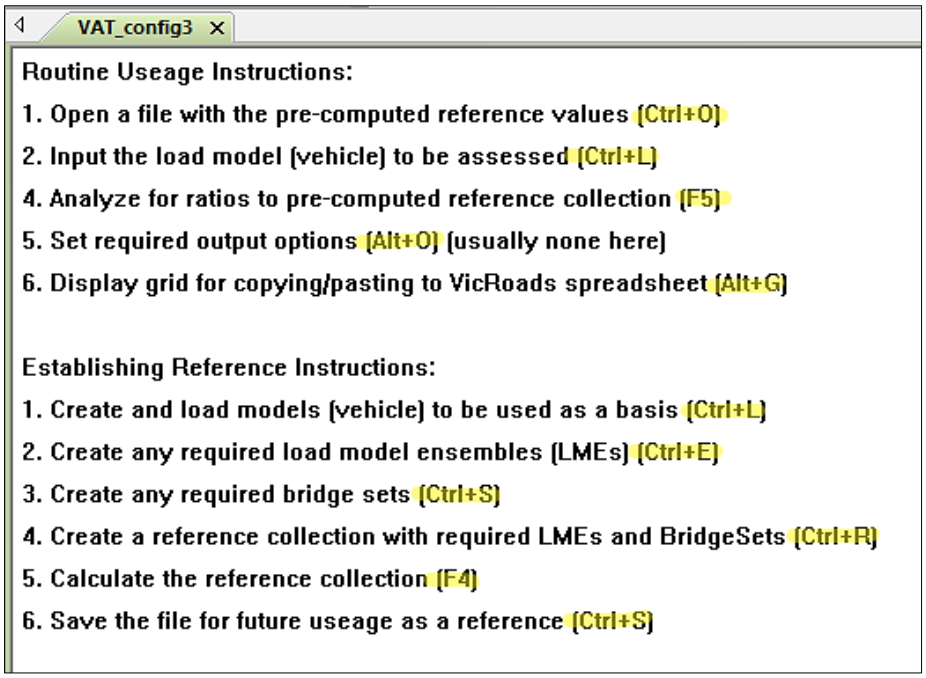
- Click the left mouse button in the Menu, click the Diagnostics in the dialog box(as shown)



- Click the left mouse button in the Toolbar; click the Diagnostics in the same dialog box.
- Click the left mouse button in the Elements Toolset; click the Diagnostics in the same dialog box.

4.6 Shortcut Keys

Vehicle Assessment Tool (VAT) provides extensive support for shortcut keys which are similar to the standard Windows Keyboard of menu commands. Also, some commands are only accessible through the keyboard. Figure shows the start interface of a *.vat file with some shortcut keys highlighted.



In addition to these, VAT provides the following shortcuts:

- **Home**: Move the viewport to the left end of output table in one row.
- **End**: Move the viewport to the right end of output table in one row.
- **Ctrl+N**: File > New;
- **Ctrl+O**: File > Open;
- **Ctrl+S**: File > Save;
- **Ctrl+P**: File > Print;
- **Ctrl+F6 or Tab**: Move the viewpoint to the next result tab;
- **Alt+F**: Expand File;
- **Alt+A**: Expand Analysis;
- **Alt+E**: Expand Edit;
- **Alt+C**: Expand Configuration;
- **Alt+V**: Expand View;
- **Alt+W**: Expand Window R;
- **Alt+H**: Help > About VAT;
- **Alt+F4**: File > New

- **Zoom In**: Drag box from left to right in the plot area;
- **Zoom Out**: Drag box from right to the left in the plot area;

5. The Vehicle Assessment Tool (VAT) Input

5.1 Introduction

The input data in the VAT consist of definitions of proposed bridge and selected Load Models. Since mainly four types of analyses are carried out in this program (see in **section6**), the input data is classified as single bridge and bridge

set compared with Load Model or Load Model ensembles. To define the bridge, there are three configurations (1-span, 2-span and 3-span) and the span length is from 1 to 50m for ordinary user, while bridges over the span range 0 to 50m is only available for developed user. In terms of the Load Model, they are based on the various bridge design codes to provide the reference values. Once a single bridge or a bridge set has been defined, the corresponding Load Model or Load Model ensemble may be chosen to apply on the bridge for single position or all positions.

5.2 Bridges

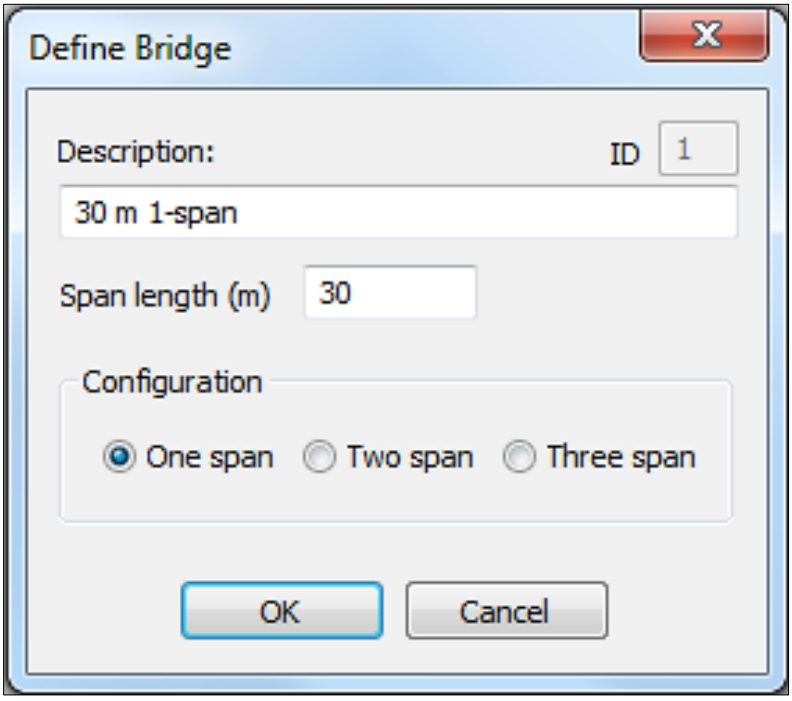
To input the definition of a single bridge each time, the following steps should be performed:

Step 1 Configuration > Add Bridge, or in the Elements Toolset, click the right mouse button on folder Bridges > Add Bridge, or click the shortcut **B** in Toolbar.

Step 2 Type the exact value of the span length and select the configuration to define a single bridge.

An example of defining the single bridge is shown. The description '30 m 1-span' means a single one span bridge has a span length of 30m.

Note: For the input data, bridge is always related with span length. Only in the output, the coordinate of the plot is determined based on the bridge length.



5.3 Bridge sets

Bridge sets indicates several bridges with various span length but same configuration are packaged as a set. When conducting the analysis, a set of bridge is applied the corresponding spaced point loads modelled from the vehicles. There are two methods determining the number of bridges in one set with specified span range. One method is to make decision based on the increment of the span length, which means in the particular span range, the

number of bridges is counted as the bridge span length increases with same increment each time. The other method is according to how many bridges that user wants to analyse in this bridge set and only one number is entered directly in the dialog box.

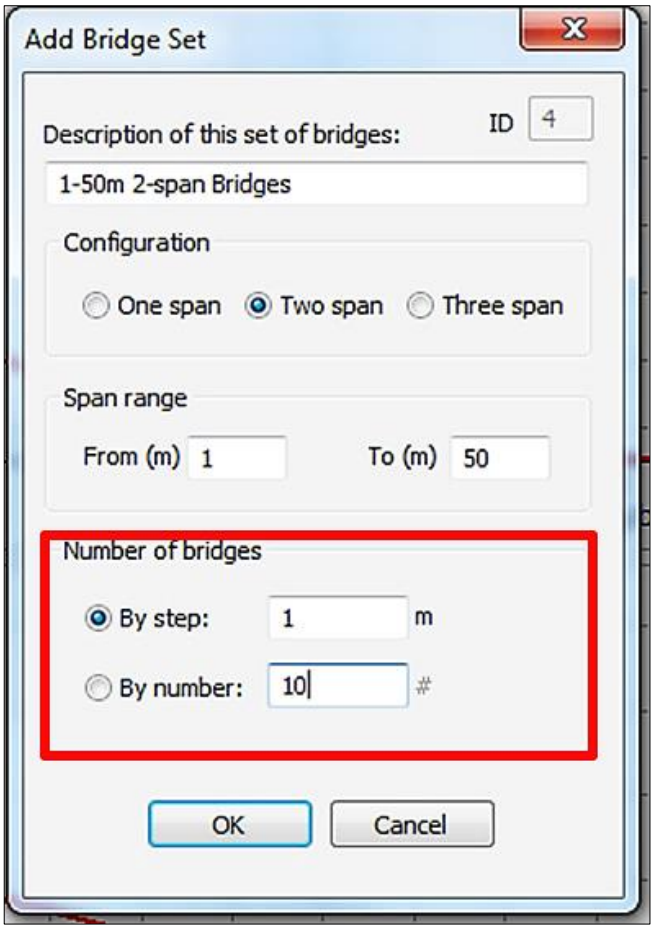
Therefore, to add a bridge set, the following steps can be carried out:

Step 1 Configuration > Add Bridge Set, or in the Elements Toolset, click the right mouse button on folder Bridge Sets > Add Bridge Set, or click the shortcut **S** in Toolbar.

Step 2 Type the values of the span range and select the configuration for the bridge set.

Step 3 Choose one method to determine the number of bridges in one set.

A typical two-equal-span bridge set in the span range from 1 to 50m is shown. In this bridge set, a unit increment (1m) is added to the span length of the bridge each time until reaching the maximum span 50m.



Note:

- In the VAT program code, within the span range from 1 to 50m, the number of bridges by step is written as 1:**1**:50 and by number is (1, 50, **10**).
- The link between step and number is,

  Step increment =Length of span range/Number of spacing

  = (50-1) / (10-1) = 5.44m
- 1:50m (10) 1-span: 10 bridges with one span in the span range of 1 to 50m.

5.4 Load Model

Load Model produces the reference values comparing with the outputs from vehicles on bridge and it consists of spaced point loads, uniform distributed loads (UDLs) and partial uniform distributed loads (Partial UDLs). All Load Models in this program are developed from the design codes. Both the B-VAT and E-VAT user could define a new Load Model for the proposal bridge or use the current Load Models listed in the Element toolset, but only the E-VAT user has the priority to use the bridge loading models from A26 to SM1600.

If the user wants to check the parameters in the exited Load Model,

Step 1 Press Elements > Load Models.

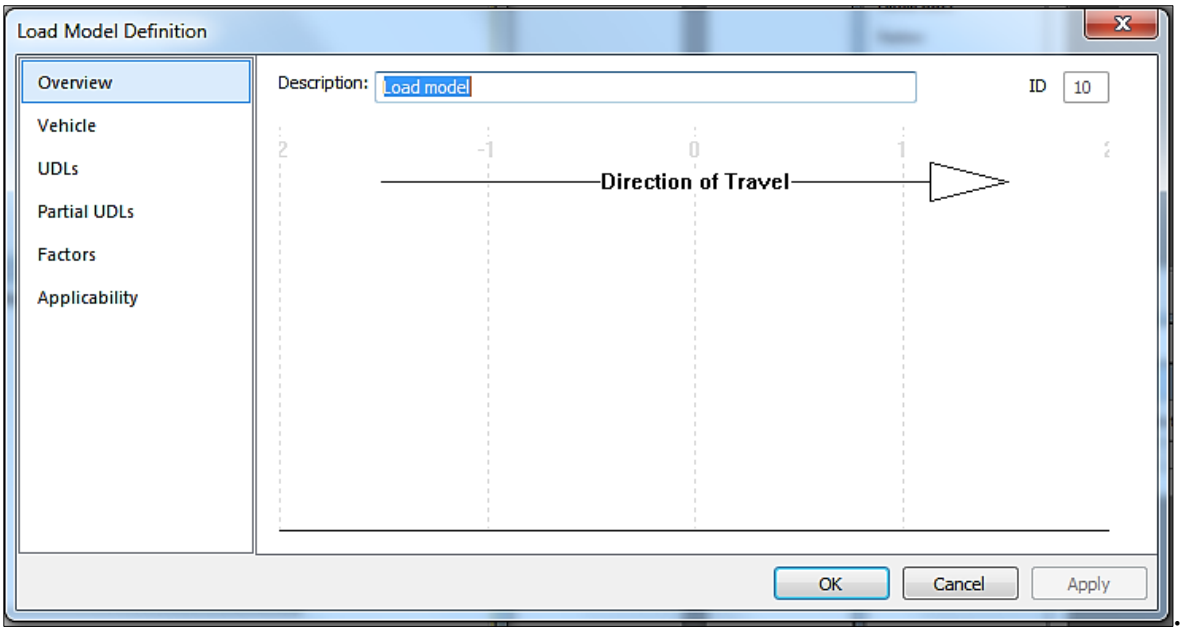
Step 2 Double click the load model that you want to check and a dialog box can be brought up in the content area.

If a new load model is designed, then the following steps should be performed to add a new load model.

Step 1 Configuration > Add Load Model or in the Elements Toolset, click the right mouse button on folder Load Models > Add Load Model, or click the shortcut **L** in Toolbar.

Step 2 Define name of the new load model

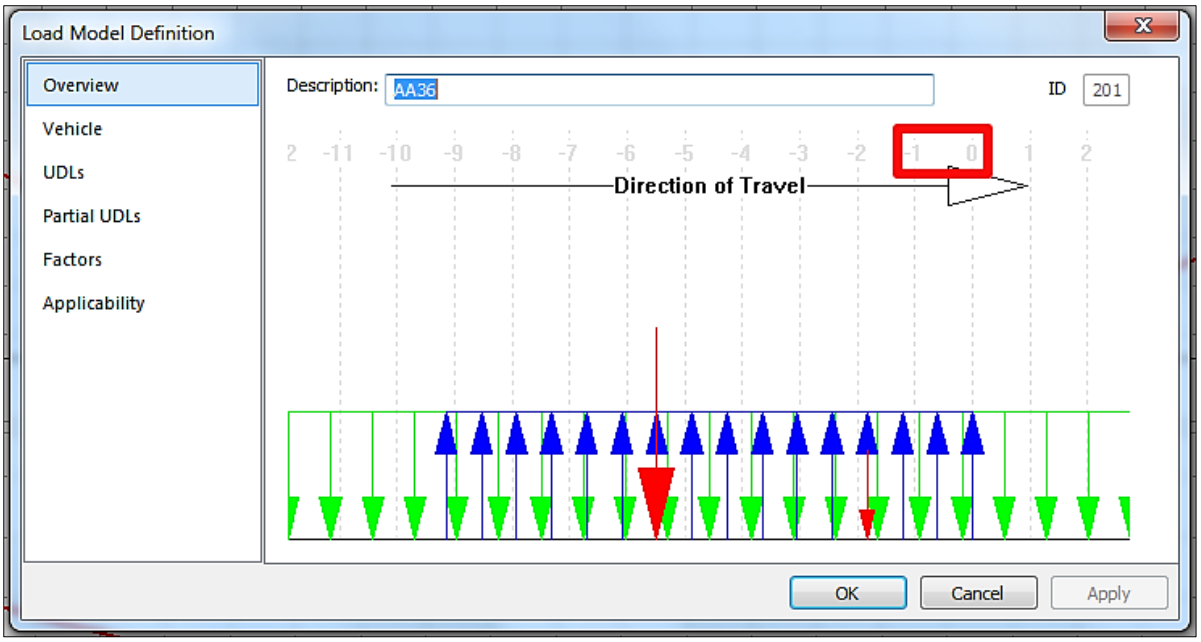
Step 3 Input parameters of the new load model including the arrangement of spaced axle loads, UDLs, Partial UDLs, factors and applicability.



⚠ **Caution**: Pay attention to the origin of the coordinate system in the load model which will influence the number of bridges calculated by step when making reference set.

A Load Model base on the AA36 is shown:

- **ID** (see on the right corner): the sequence number of the current load model on the load model list.
- **Direction of Travel**: the direction of vehicle when travelling on the bridge.
- **Red arrow**: the spaced axle loads when travelling on the bridge.
- **Green arrow**: uniform distributed loads (UDLs) on bridge
- **Blue arrow**: Partial UDLs on bridge
- **Coordinates with vertical dashed line**: load model coordinate system. '0' indicated the origin of the load model coordinate and coincident with the start of the bridge coordinate system.
- **Applicability**: specify limits to load effects or bridge span(smallest span length or largest span length)(not implement)

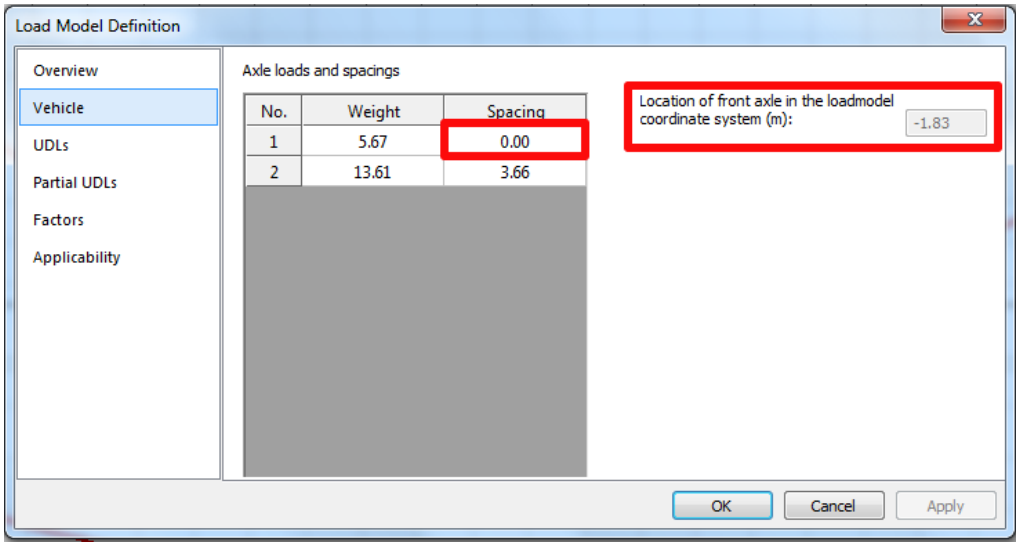


Note: The locations of all loads are count backwards in the negative direction of the load model coordinates

Vehicle

In the tool, vehicles are modelled as a set of spaced axle loads applied on the bridge based on the arrangement of the vehicle axles. Since the load model has its own coordinate system, the locations of axles are measured based on the load model coordinate system, which means the location of first axle load can be zero or a negative values and its spacing is zero. The other load spacings are measured from the location of the previous axle load.

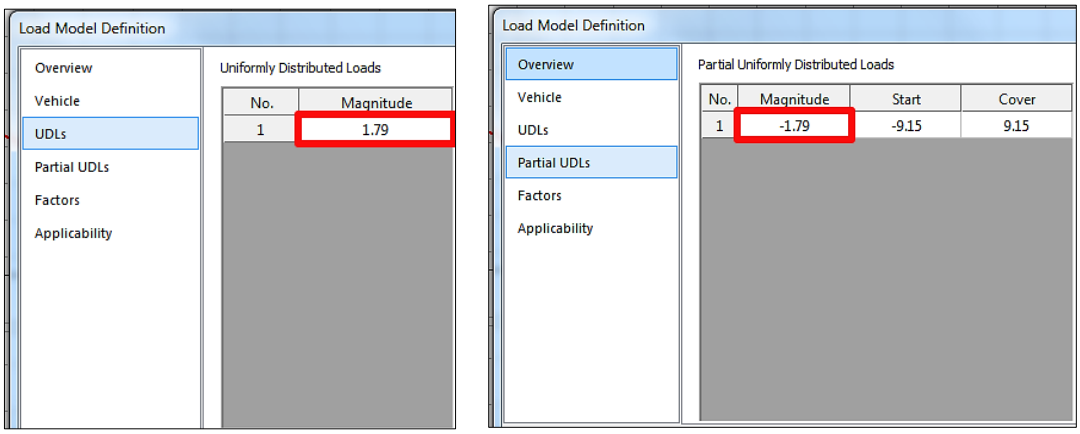
To input the weights and spacing into the load mode easily, the user can finish the data table in Microsoft Excel and copy/ paste here. Pressing the button **No.** on the left corner can select all data in the table. Also, the data table can be transferred inversely into Microsoft Excel using same procedure.



Note: the unit of weight is **tonne** and unit of spacing is **meter.**

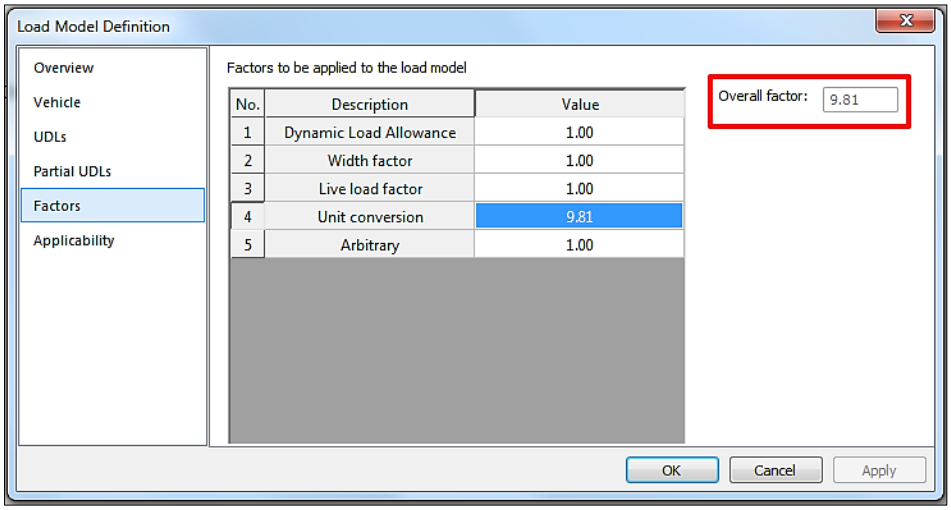
UDLs and Partial UDLs

Partial UDLs is designed to cancel the UDLs within some parts on the bridge in this program, which means only the axle loads are applied in the particular parts of bridge. Thus, the magnitude of this two types of load should have same value but in the opposite directions.



Factors

According to different deisgn load codes, load factors are required to apply to the UDLs or axle loads to sitmulate an accurate bridge loading condition. In VAT, you can type value for each load factor is necessary and onverall factor indicates the sum of effective factors applying in this load model.



Note: the unit of UDLs or Partial UDLs magnitude is **kN/m** and unit conversion is **kN**.

5.5 Load Model Ensembles

Load Model Ensembles allow the multiple comparisons between the load models. Different types of the available load modes are selected to be packed in one envelope of the load mode.

If the user wants to check the exited Load Model Ensemble,

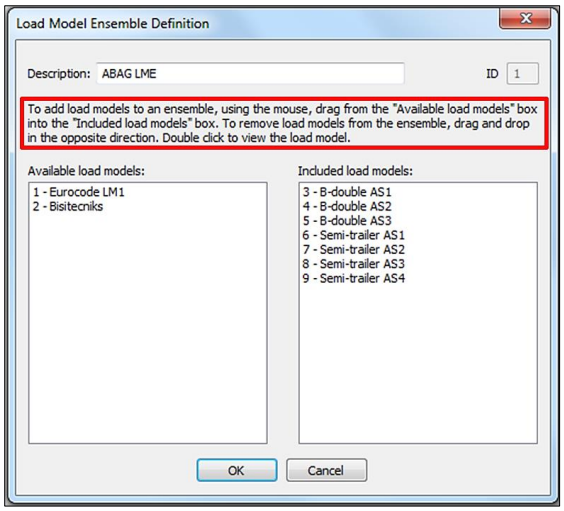
Step 1 Press Elements > Load Model Ensembles.

Step 2 Double click the load model envelop that you want to check and a dialog box can be brought up in the content area.

If a new load model ensemble is designed, then the following steps should be carried out to add a new load model ensemble.

Step 1 Configuration > Add Load Model Ensemble, or in the Elements Toolset, click the right mouse button on folder Load Model Ensembles > Add Load Model Ensemble, or click the shortcut **E** in Toolbar.

Step 2 Follow the instructions on the dialog box to determine load models in the envelope.



6. The Vehicle Assessment Tool (VAT) Analyses

6.1 Introduction

To generate the load effect results including bending moment, shear force and reaction forces for bridges with three configurations, mainly four types of analyses are conducted in this program.

- Vehicles on single bridge at the single position;
- Vehicles on single bridge for all positions(moving load analysis);
- Vehicles on bridge set for all positions by making a reference set;
- Vehicles on bridge sets for all positions by making reference collection;

The user can carry out either one of the above analyses to obtain the load effect results. However, you can only produce critical ratios after performing the third or fourth analyses. Although the routine usage instructions are shown in the initial user interface, detailed producers about how to run each type analyse are explained in this chapter.

6.2 Single bridge & single position

To analyse the load effects of vehicles on single bridge at the specific single position, the fowling steps are performed:

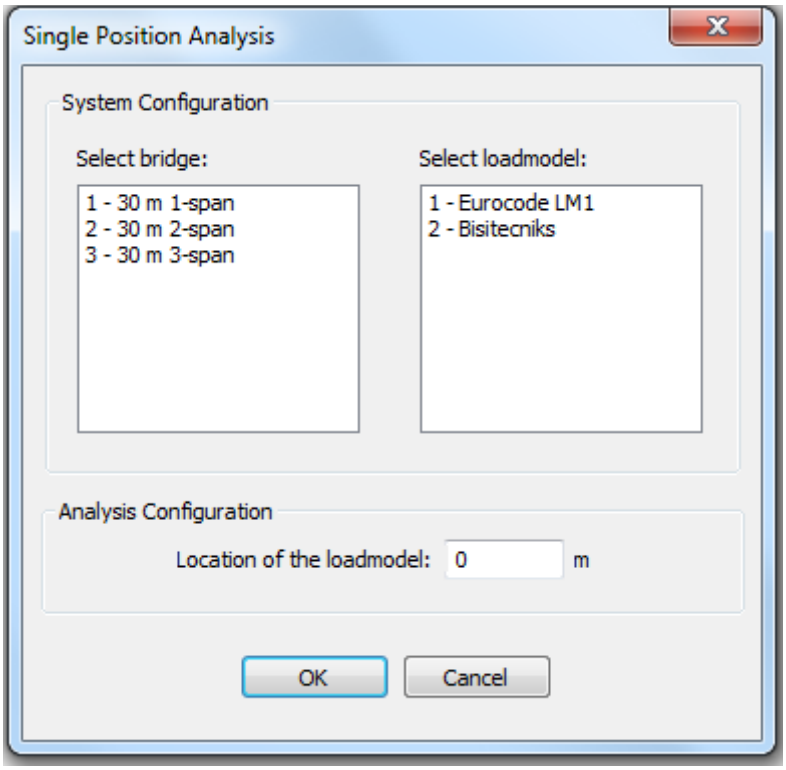
Step 1 Add a new bridge (see **section5.2**);

Step 2 Input the load model to be assessed. (see **section5.4**);

Step 3 Analysis > Single Position to bring up the analysis dialog box;

Step 4 Select the proposed bridge and load model;

Step 5 Define the location of the load model on the bridge, which means the location is in the bridge coordinate system.



6.3 Moving load analysis

A vehicle on single bridge for all positions is to analyse the load effects when vehicle travel all the way on the bridge. To conduct this type analysis, the fowling steps are performed:

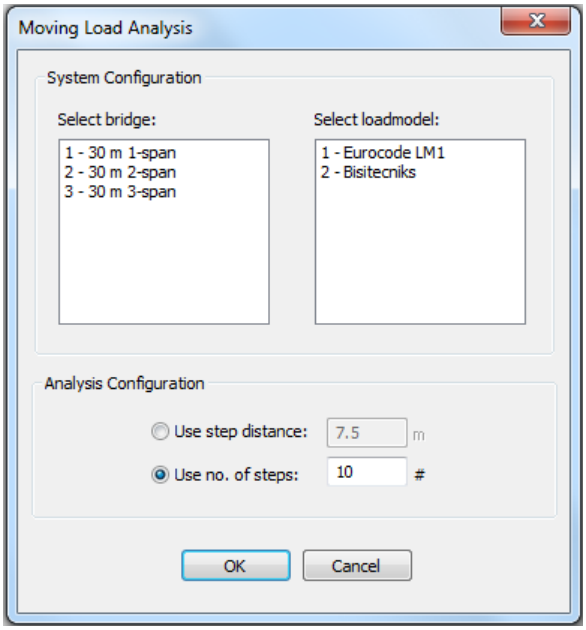
Step 1 Add a new bridge (see **section5.2**);

Step 2 Input the load model to be assessed. (see **section5.4**);

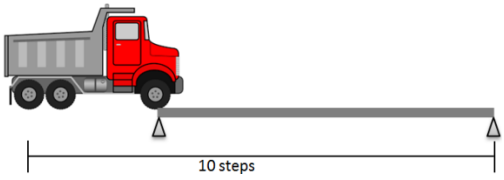
Step 3 Analysis > Moving Load to bring up the analysis dialog box;

Step 4 Select the proposed bridge and load model;

Step 5 Define the analysis configuration by using step distance or number of steps. (Critical data will be measured at the end of each step)



- Step distance: the increment of distance between the location of load model and the origin of bridge coordinate system.
- No. of steps: counts distance is bridge length plus the vehicle length, as shown:



6.4 Bridge set for all positions

This type analysis is to compare load effects of vehicles on a bridge set for all positions by making a reference set. The reference set contains a range of bridges under a group of load models. To conduct this type analysis, the fowling steps are performed:

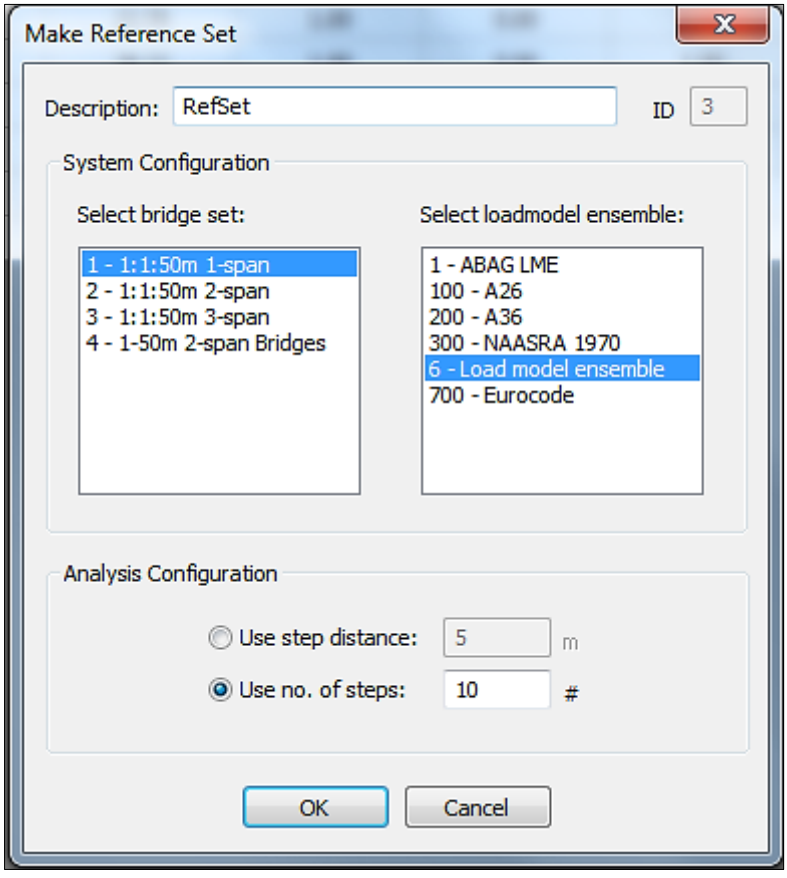
Step 1 Add a new bridge set (see **section5.3**);

Step 2 Add a load model ensemble (see **section5.5**)

Step 3 Analysis >Make a single reference;

Step 4 Select the proposed bridge set and load model ensemble;

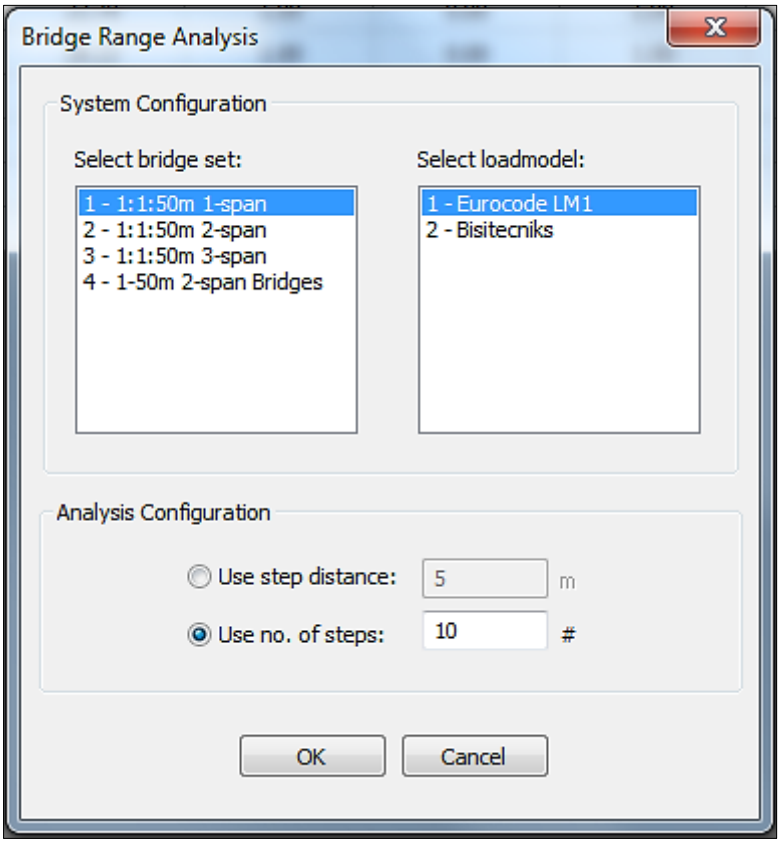
Step 5 Define the analysis configuration by using step distance or number of steps;



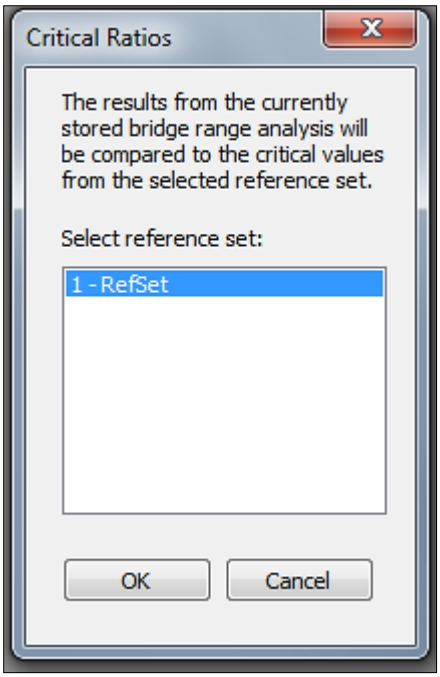
Step 6 Analysis > Bridge Range Analysis;

Step 7 Select the proposed bridge set and load model ensemble;

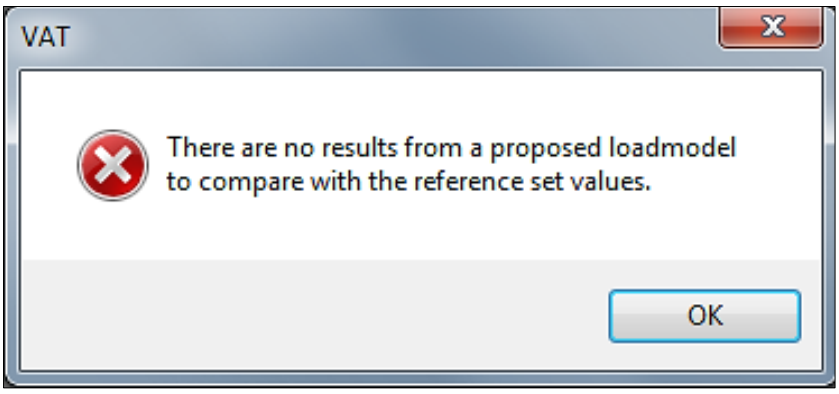
Step 8 Check the analysis configuration by using step distance or number of steps;



Step 9 After doing all above, the Critical ratios dialog box presents automatically. Select the desired reference set to calculate the critical ratios.



If the user does the bridge range analysis directly without making a reference set in advanced, the following error dialog will appear to remind you to make a reference set first. In this case, the user can still obtain the bridge range analysis results but cannot calculate the critical ratios.



6.5 Bridge sets for all positions

In this type analysis, several bridge sets are available to be applied under different load model ensembles at the same time. In the tool, reference collection is utilized to represent a package of different load model ensembles

To conduct this type analysis, the fowling steps are performed:

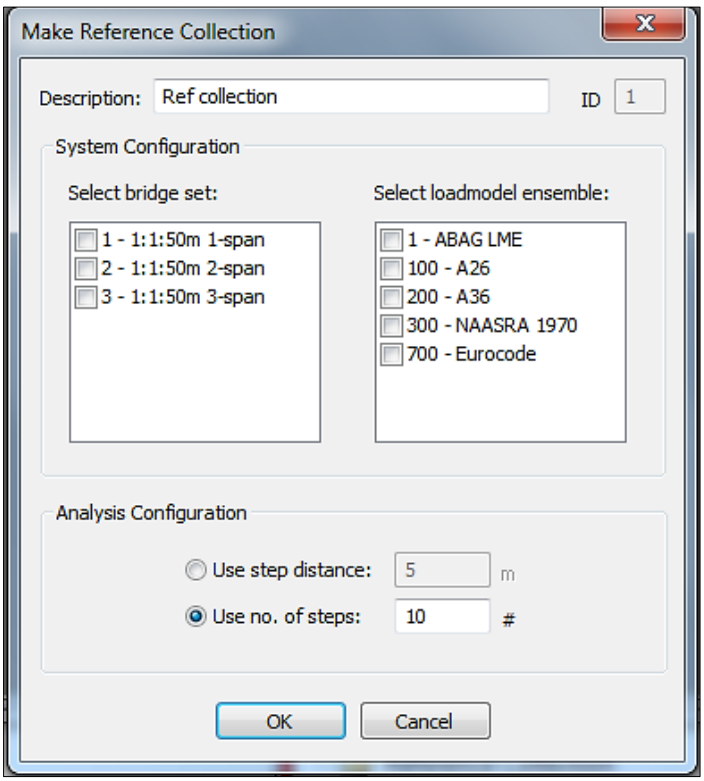
Step 1 Add new bridge sets (see **section5.3**);

Step 2 Add load model ensembles (see **section5.5**);

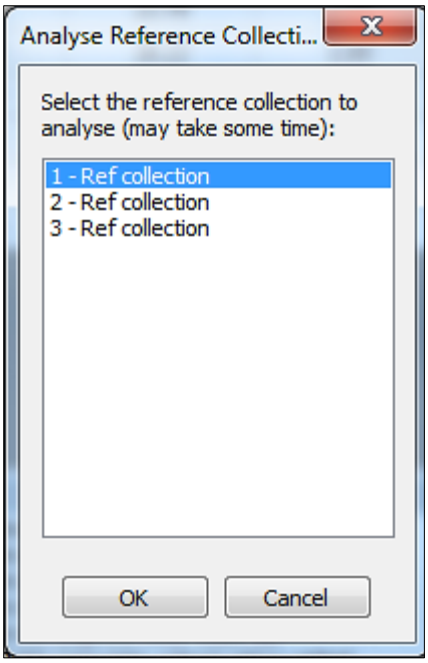
Step 3 Configuration > Add Reference Collection or click **R** in toolbar;

Step 4 Select the proposed bridge sets and load model ensembles;

Step 5 Define the analysis configuration by using step distance or number of steps;

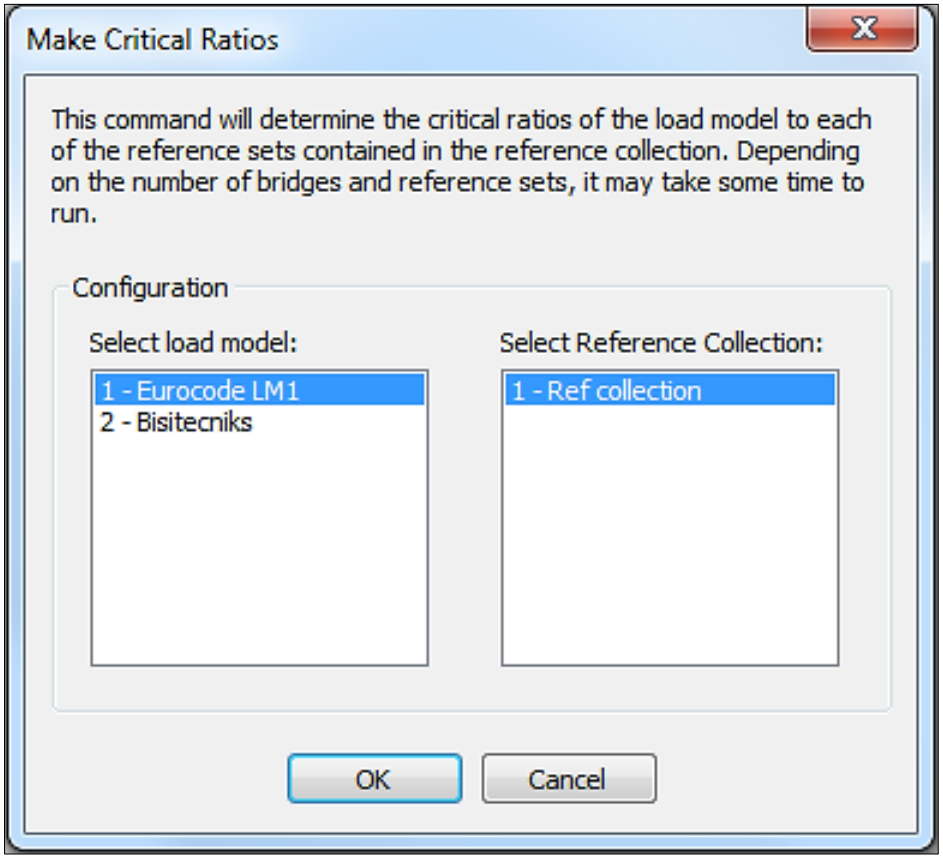


Step 6 Analysis > Reference Collection and select the desired reference collection.



Step 7 Press Analysis > Critical Ratios or click **C** in toolbar

Step 8 Follow the instructions in the dialog and analysis the critical ratios.



Step 9 Press View > Enhanced Critical Ratios Grid or click **G** in toolbar to display the outputs of critical ratios.

7. The Vehicle Assessment Tool (VAT) Output

7.1 Introduction

Vehicle Assessment Tool(VAT) has the ability to produce large amounts of output, such as analysing bridge sets with a reference collection. The progress accesses the critical values based on different positions on bridge. Outputs of load effects contain graphs and grids of bending moment, shear force and reaction forces respectively. Only critical values of load effects are recorded in the data table and envelope diagram is used to display the cumulating results.

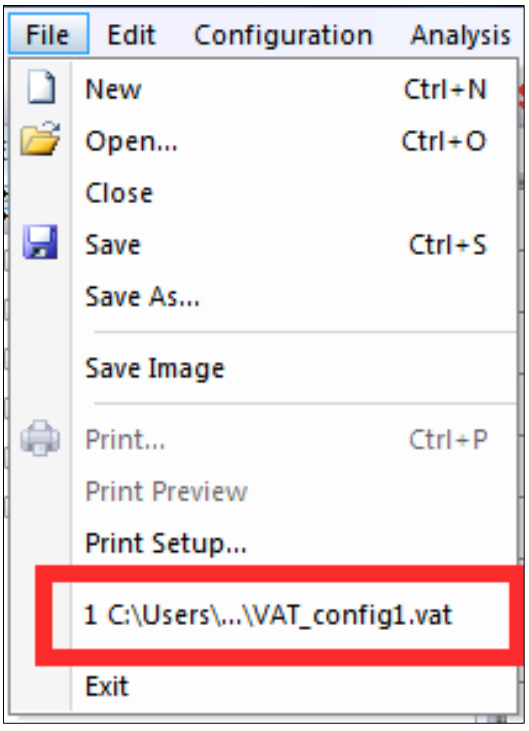
For ease to figure out whether the vehicle can safely travel on the bridge, it is recommended that using the enhanced critical ratios grid to present the maxima and minima values at abutment and pier.

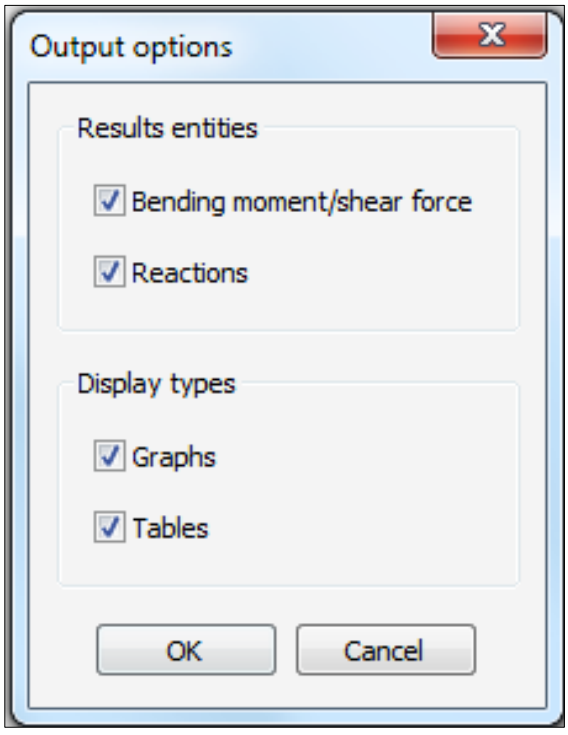
Besides, a *.vat file is generated each time and the output plots can be save as image in *.bmp file. Grids can be export to any spreadsheet viewer, such as MS Excel.

7.2 Output file

For every analysis run, critical values from the load model and reference are recorded at the end of each step which can be figured out as a dot point in the corresponding plot. The definitions of all inputs, such as bridge, bridge sets, load model, reference set or collection are maintained through the analysis, and these are written out to file and will be the same as those read in.

The output file is in the same format as the input file, which is saved with the name, extension and location as shown below. Also, the user can select which kind of results they want to display by pressing View > Output options or click **O** in the toolbar.



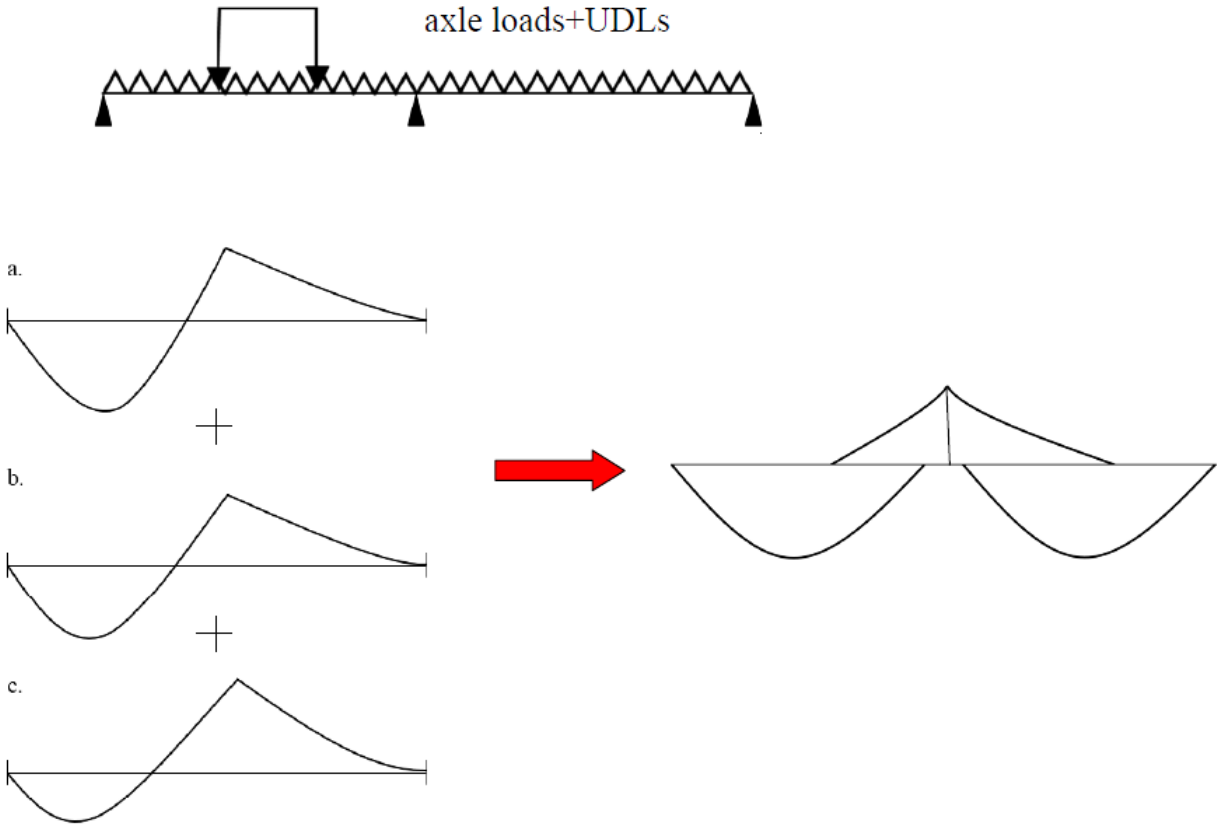


To output the data to MS Excel, click the button on the left corner of the grid, then you can copy paste all data into the Excel sheet.

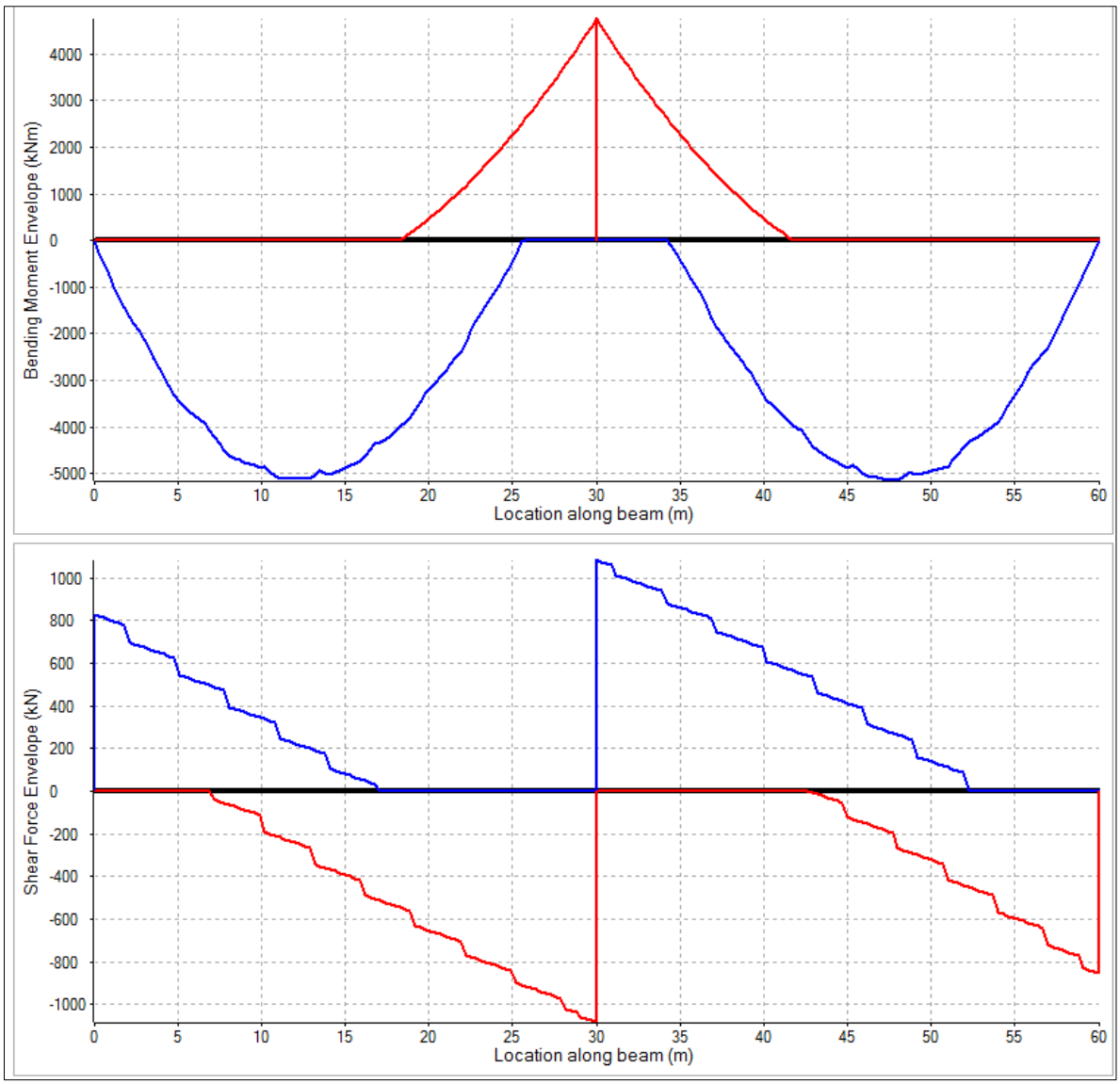
7.3 Bending moment and shear force envelope

Envelope indicates to present a culmination of all plots in one figure by applying superposition of each output graph, which is explained in the figure below. For each load model considered, vehicle located on different positions of bridge can generate different bending moment and shear force diagrams. This program is designed to consider all possible situations based on the user setting, thus, bending moment envelope and shear force envelope are necessary.

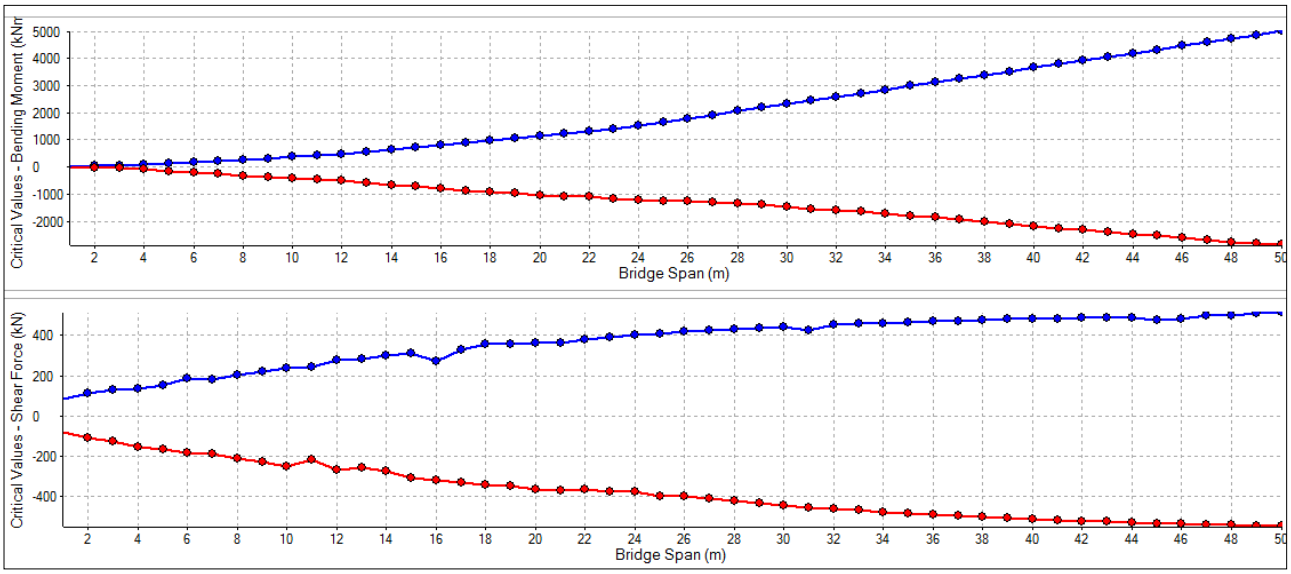
- An example of BMD Envelope



In this program, analyses of single position and moving load will generate the bending moment and shear force envelops respectively. An example of moving load analysis is shown here.



As for analyses of bridge sets with reference or reference collection, critical values are plot in the envelopes, as shown:

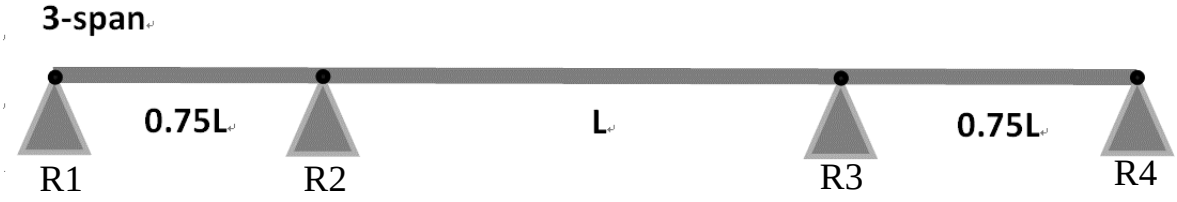


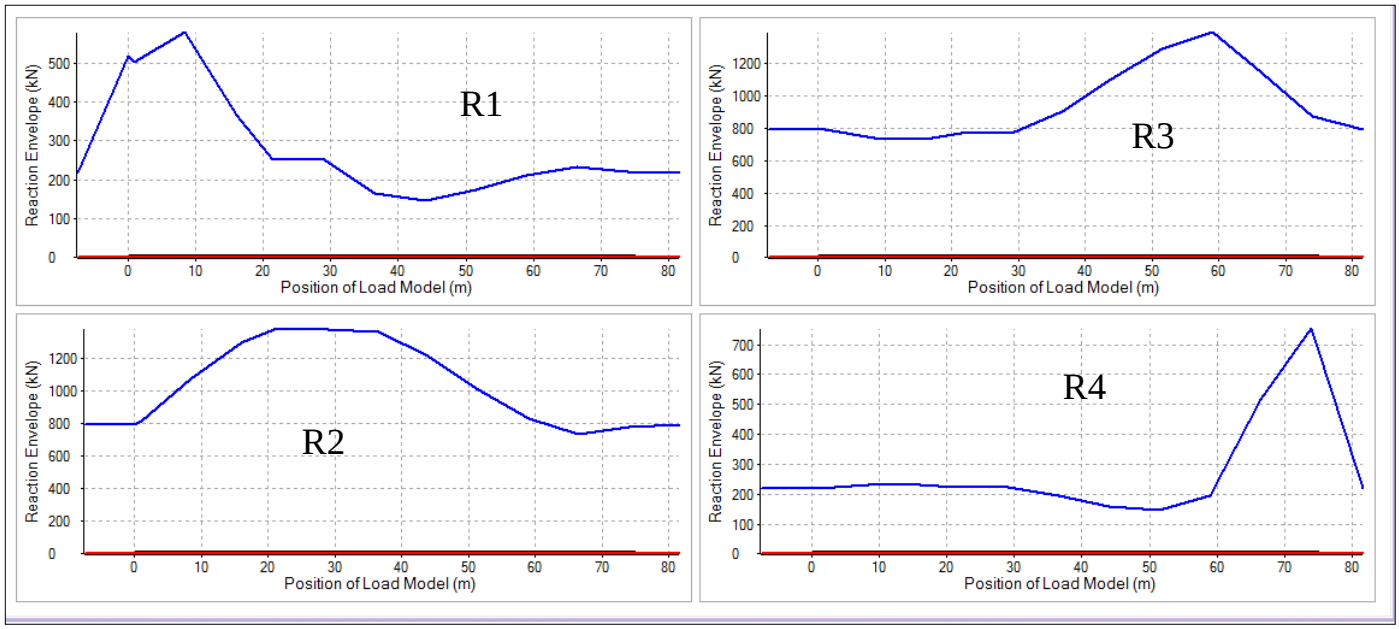
Note:

- Dots on the curve represent the critical value at this step.
- Blue curve: maxima value
- Red curve: minima value

7.4 Reaction Envelope

Three configurations of bridge with different span are defined in VAT. For 1-span bridge, the reaction forces at two supports are same, while for 2-span and 3-span bridges, the reaction forces at support may be different. Therefore, the reaction envelope consists of reaction at the left support, middle support and right support and graphs are displayed from the left support to the right support. An example of reaction envelops of 30m 3-span bridge under moving load is shown here.



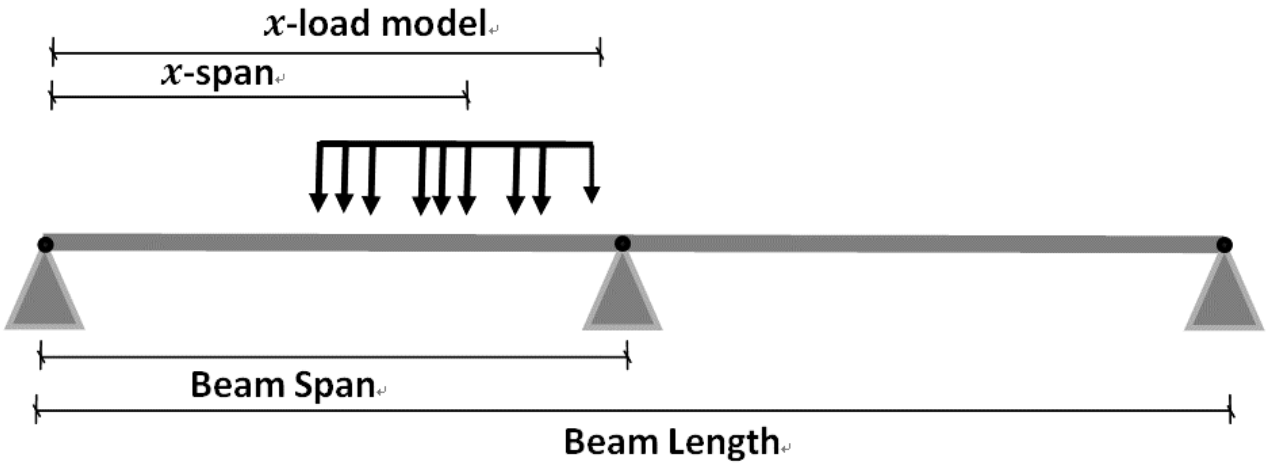


Note: R1=reaction of left support; R2= reaction of middle support near left side

R3=reaction of middle support near right side; R4=reaction of right support

7.5 Grid Envelope

All types of analyses can produce the grid envelopes corresponding to the plots. Maxima and minima values of BMD, SFD and reactions are listed in the table based on the horizontal ordinate, named as x beam and x Load Model. The definition of x beam and x Load Model are shown below.



Example of typical output grids are shown below.

- Moving load

	Bridge Span	Bridge Length	Reaction 1 - Max	Reaction 1 - Min	Reaction 2 - Max	Reaction 2 - Min
1	1.00	1.00	83.39	.00	83.39	.00
2	6.44	6.44	164.40	.00	167.45	.00
3	11.89	11.89	213.75	.00	212.85	.00
4	17.33	17.33	299.62	.00	272.09	.00
5	22.78	22.78	350.21	.00	337.77	.00
6	28.22	28.22	398.47	.00	389.95	.00
7	33.67	33.67	431.12	.00	431.87	.00
8	39.11	39.11	454.68	.00	464.88	.00

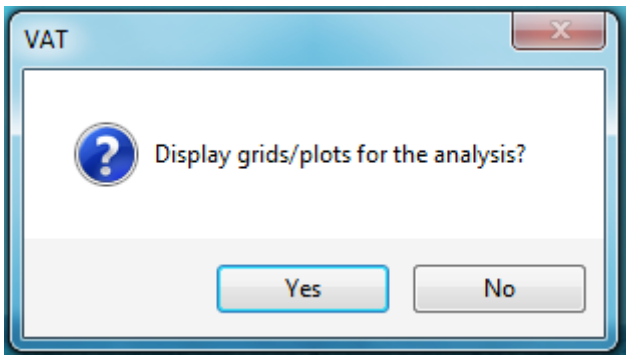
5 - MLA Envelopes

	x Beam	BMD - Max	x Load Model	BMD - Min	x Load Model	SFD - Max	x Load Model	SFD - Min	x Load Model
1	.00	.00	-7.50	.00	-7.50	.00	-7.50	.00	-7.50
2	.00	.00	-7.50	.00	-7.50	577.23	8.50	.00	-7.50
3	.23	129.19	8.50	.00	-7.50	571.16	8.50	.00	-7.50
4	.45	257.02	8.50	.00	-7.50	565.08	8.50	.00	-7.50
5	.68	383.48	8.50	.00	-7.50	559.01	8.50	.00	-7.50
6	.90	508.57	8.50	.00	-7.50	552.93	8.50	.00	-7.50
7	1.13	632.30	8.50	.00	-7.50	546.86	8.50	.00	-7.50
8	1.35	754.66	8.50	.00	-7.50	540.78	8.50	.00	-7.50

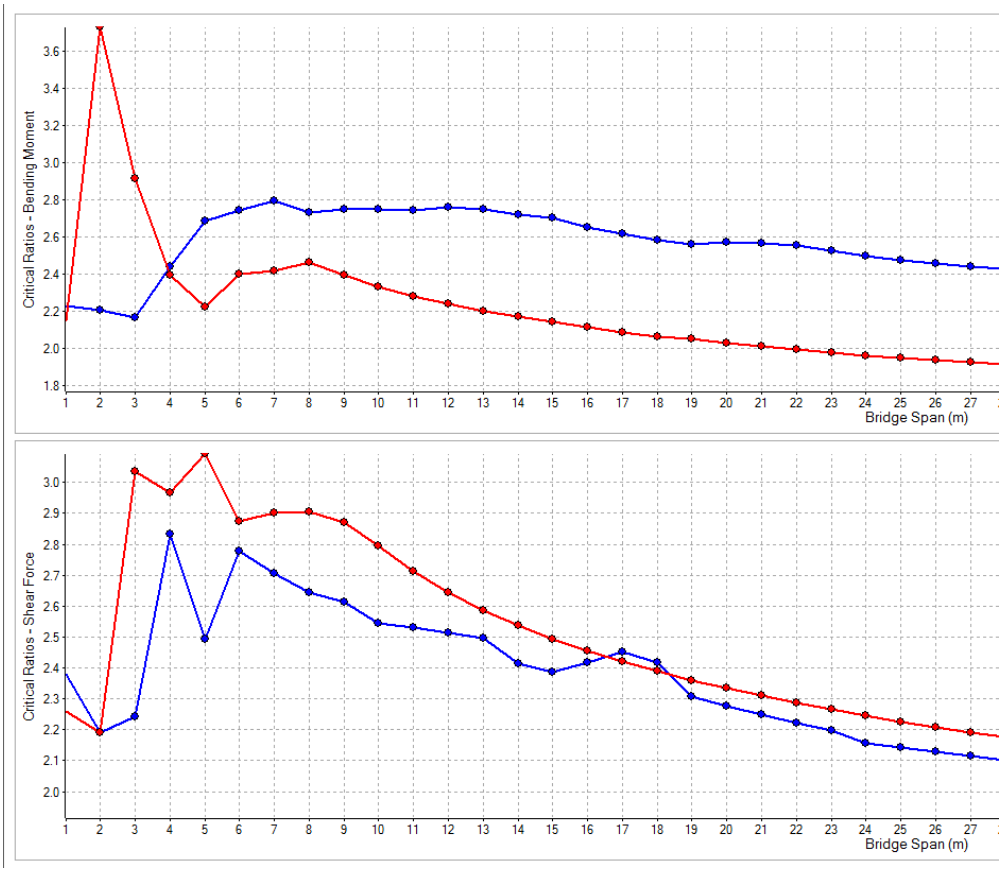
7.6 Critical Ratios

Critical ratio is the ratio of maxima design value divided by the reference value in the reference collection. If ratio is larger than 1, it means this type of load model is overcapacity, so the vehicle travelling on the bridge may generate safety problem. In contrast, if the ratio is less than 1, the load model is within the capacity and vehicle will be allowed to travel on the bridge.

Generally, to compare several different bridges under different load models at the same time, analysis of bridge sets with a reference collection will be performed and critical ratios are easier and obvious for the user to make a decision. To understand and view all plots and grids easier, Enhanced critical ratio grid is used and you can choose whether to display plots/grids at the end of the analysis.



Example of critical ratio plots.



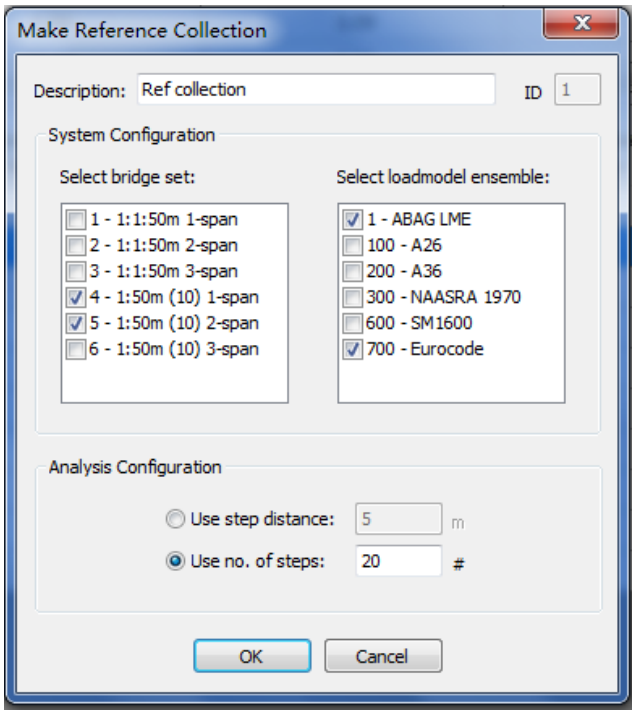
Note:

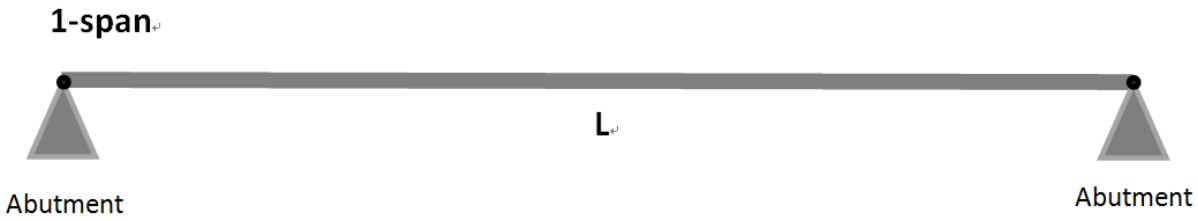
- Dots on the curve represent the critical value at this step.
- Blue curve: maxima value
- Red curve: minima value

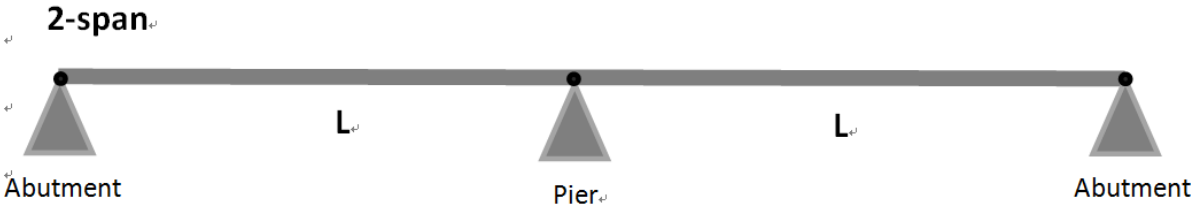
7.6 Examples

An example is shown here to explain how to find data in the output file.

- Analysis critical ratios for a reference collection shown here.







Enhanced Critical Ratios results:

	Bridge Span	Moment	Shear	Abutment	Moment - Sag	Moment - Hog	Shear	Abutment	Pier	Moment	Shear	Abutmen	Moment - Sag	Moment - Hog	Shear	Abutment	Pier
1	1.00	3.76	3.96	3.76	3.71	2.30	3.80	3.72	3.52	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2	6.44	3.09	3.31	3.31	3.00	2.14	3.38	3.58	3.38	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3	11.89	3.18	2.88	3.15	3.10	2.23	2.70	3.40	2.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4	17.33	2.84	2.59	2.70	2.63	2.22	2.54	2.82	2.24	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5	22.78	2.70	2.53	2.53	2.53	2.61	2.53	2.55	2.35	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6	28.22	2.45	2.41	2.41	2.27	3.15	2.43	2.37	2.54	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7	33.67	2.37	2.38	2.38	2.15	3.31	2.41	2.26	2.77	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8	39.11	2.38	2.38	2.38	2.11	3.46	2.44	2.23	3.02	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
9	44.56	2.41	2.41	2.41	2.10	3.65	2.50	2.27	3.28	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	50.00	2.47	2.47	2.47	2.12	3.87	2.59	2.31	3.53	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

(a) (b) (c) (d)

- 1-ABAG LME: (a): 1:50m (10) 1-span; (b): 1:50m (10) 2-span
- 700 Erode: (c): 1:50m (10) 1-span; (d): 1:50m (10) 2-span
- Moment-Sag: BMD – Max
- Moment-Hog: BMD – Min
- Shear: critical value of SFD – Max and SFD – Min
- Abutment and Pier: reaction force at the corresponding location.
- Tabs: 1-4 for (a); 5-8 for (b); 9-12 for (9); 13-16 for

8. FAQs and Troubleshooting

8.1 FAQs

Since this is the first release of this program there are no frequently asked questions!

8.2 Troubleshooting

As this is the testing version of this program there bound to be some bugs and inconsistent behavior. Please check below for some possible solutions. If the problem persists, please send a copy of the `*.vat` and input traffic file that causes the problem to colin.caprani@monash.edu explaining the steps required to reproduce the problem.

It is envisaged that this section of the document will be updated frequently as the program matures.

9. Appendices