



Sectrics - Civil Engineering Software – Part C – HSC MAJOR PROJECT

By Shaan Khan



User Guide

Hello & Welcome. Thank you for installing Sectrics a truss analysis program developed & funded by Shaan Khan. The purpose of this document is to act as an operation manual of how to install & use the Sectrics application in the correct method in addition to troubleshooting commonly encountered errors.

Software Prerequisites

Minimum:

- Python 2.7 with libraries including:
 - o NumPy
 - o SciPy
- .NET Core

Recommended:

- Python 3.7.3 with libraries including:
 - o NumPy
 - o SciPy
- .NET Framework

Hardware Prerequisites

The minimum hardware specifications for this application to run requires the minimum hardware requirements for Windows 10 to run. Due to this the minimum hardware requirement are:

- **Processor:** 1 gigahertz (GHz) or faster processor or SoC
- **RAM:** 1 gigabyte (GB) for 32-bit or 2 GB for 64-bit
- **Hard disk space:** 16 GB for 32-bit OS 20 GB for 64-bit OS
- **Graphics card:** DirectX 9 or later with WDDM 1.0 driver
- **Display:** 1920x1080

Recommended Specifications

Depending on the user's bridge requirements the specifications of the software varies, for commercial applications such as calculating the forces on a real-world bridge with hundreds to thousands of nodes and members, the utilization of more powerful hardware is required, for programs requiring such processing power the recommended specifications are:

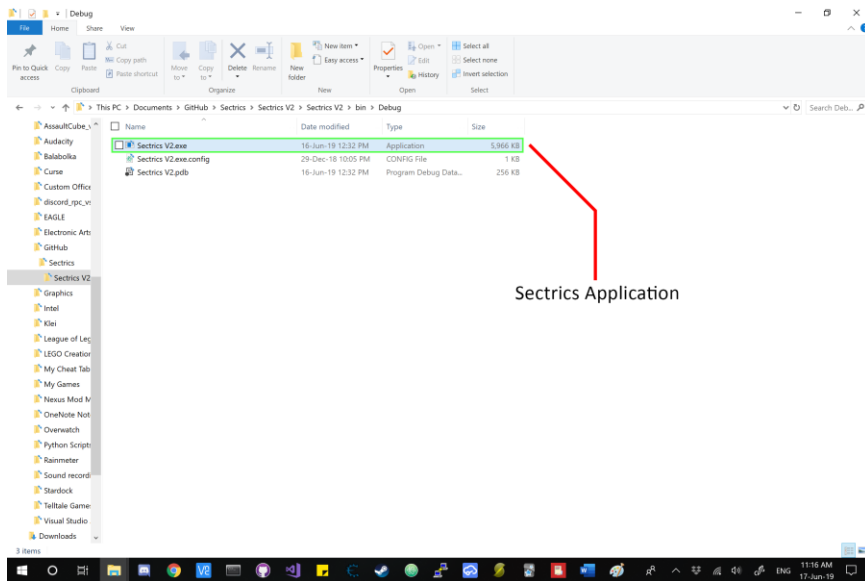
- **Processor:** Intel® Core™ i7-6700K @ 4.4GHz-Hi-Perf
- **Memory:** 16GB DDR4
- **Graphics:** NVIDIA® GeForce® GTX 1080 OC 8GB GDDR5X VRAM PCIe
- **Storage:** 512GB Solid State Drive NVMe Samsung® 950 PRO M.2 PCIe 3.0 x4 2500/1500MB/s
- **Display:** 1920x1080

Installation

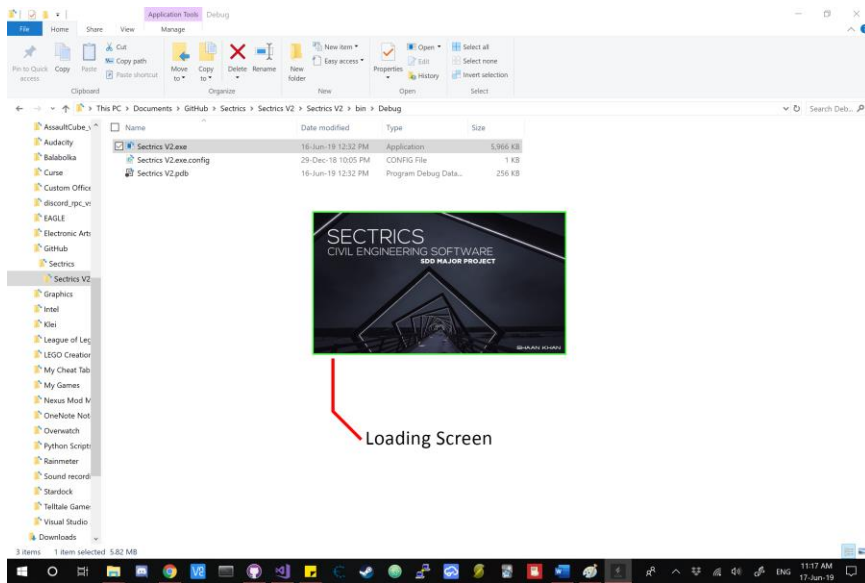
To install this project first ensure python is installed onto the computer as well as .NET core. After which in command prompt (CMD) install the required python libraries, NumPy & SciPy. To install them in command prompt, write "pip install NumPy" and "pip install SciPy" after which the Sectrics application is able to run. To run the program double, click the Sectrics application and wait for it to load. For addition help in the operation of the Sectrics application please refer to the "How to Operate" section of this manual.

How to Operate

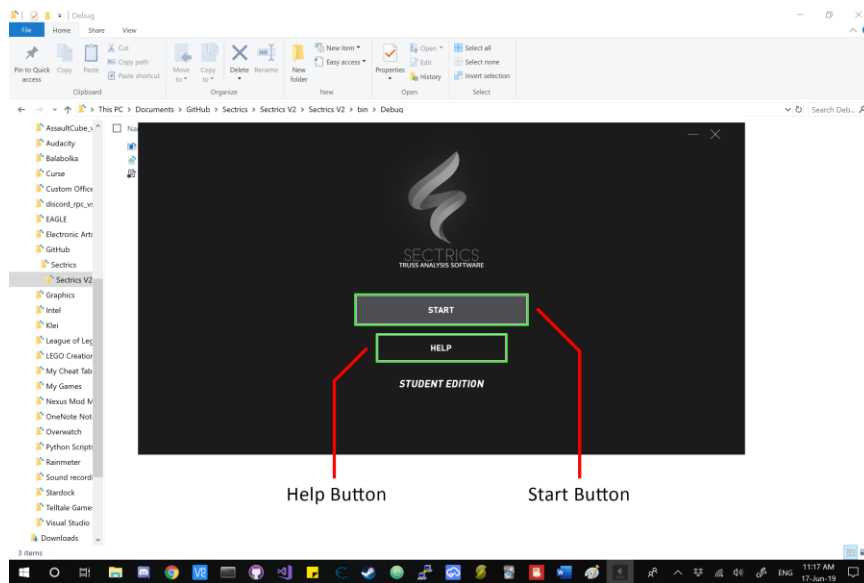
1. After installing the Sectrics application, find & locate the location of the Sectrics application & double click on it. After which, wait patiently this will open the Sectrics application.



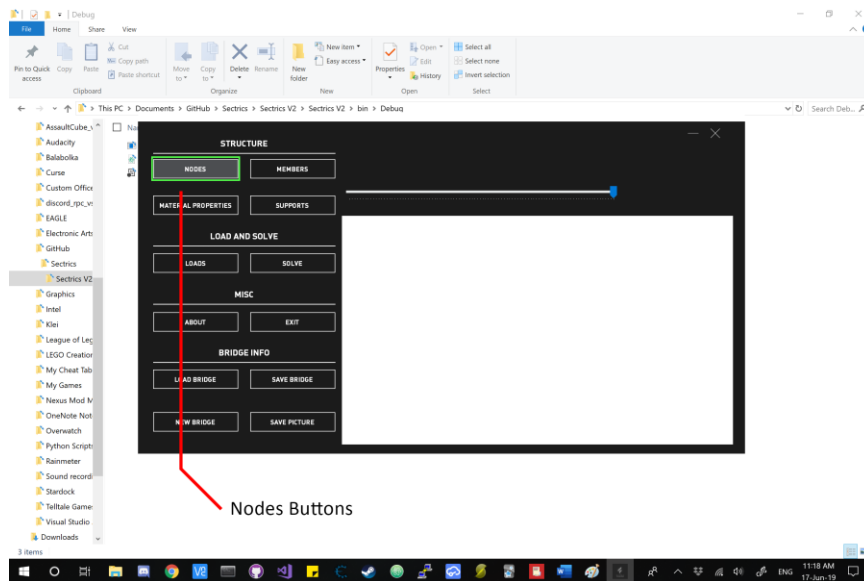
2. After the Sectrics application has been double clicked you will have a loading screen come up saying “SECTRICS CIVIL ENGINEERING SOFTWARE – SDD MAJOR PROJECT” if this loading screen does not come up in an appropriate time as it should open immediately. Refer back to step 1.



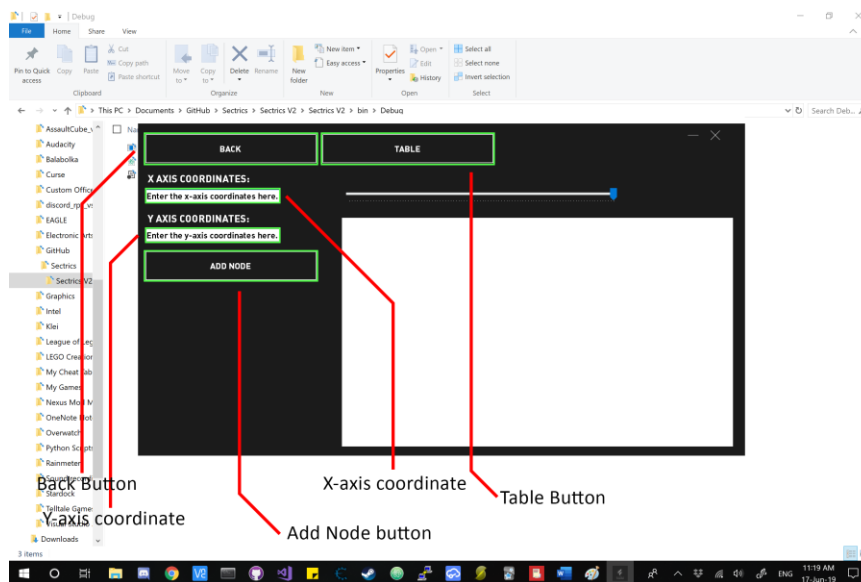
3. After 2-5 seconds when the Sectrics application is done being loaded completely, the loading screen will instead be replaced with the start menu, this menu is the starting menu of the Sectrics application. To start press the “Start Button” or for a summarized version of this user manual press the “Help Button” after which you can then press the “Start Button”.



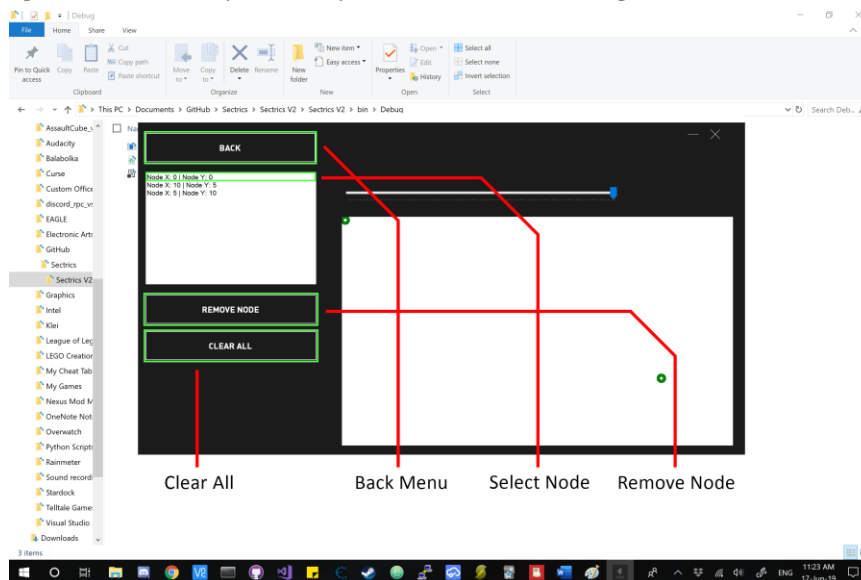
4. After pressing the “Start Button” you will be prompted to the main menu of the Sectrics application, this menu displays a picture of the bridge you draw in this program as well as the navigation menu for the whole program. To begin construction of your bridge first select the “Node Button”.



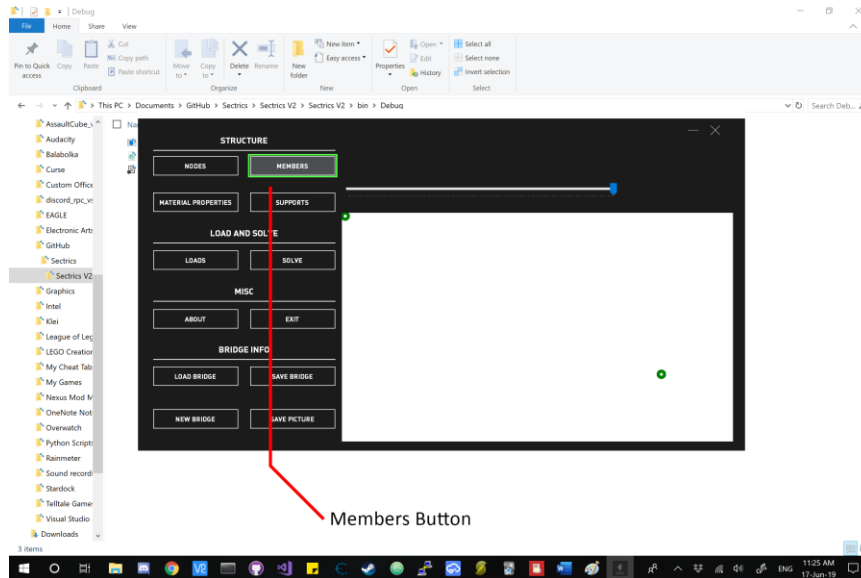
- After selecting the “Node Button” you will be directed to the node menu, this menu allows you to create, add & remove nodes in the application. A node is a set of X & Y coordinates correlating to a point on the bridge where a member or a beam can connect to, these points are the connecting joints of the bridge and for each change in direction (non-straight line) a node will be required. To begin you must create nodes for your program, select the “X-axis coordinate” input box and enter the x value for your coordinate and then similarly repeat for the “Y-axis coordinate” inputting the y value for the coordinate. After this is done press the “Add Node Button”. Repeat adding nodes until you have added all the nodes required for the specified bridge after which you can select “Back” to return back to the main menu, otherwise if you have a node to remove select the “Table Button”.



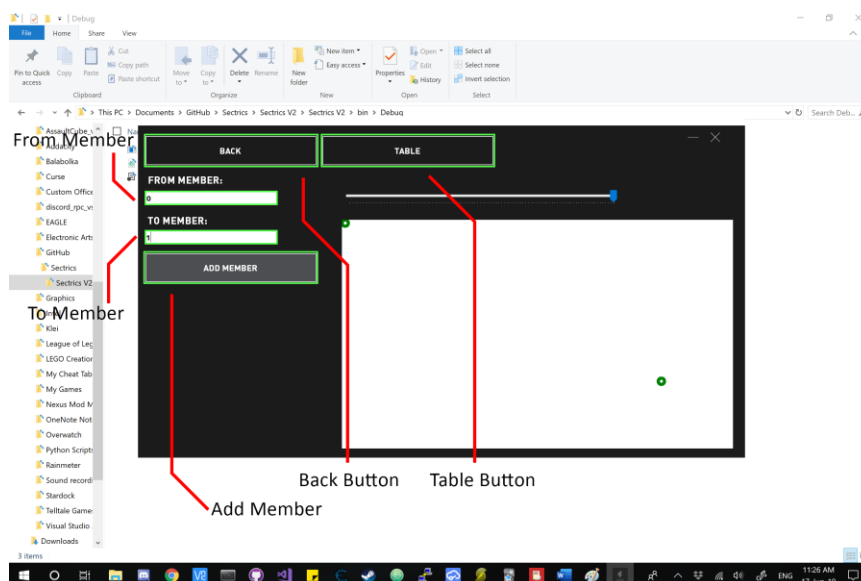
- If you have selected the “Tables Button” this step is important to you, otherwise please skip this step and go to step 7. After selecting the “Tables Button” as a node has been incorrectly entered or you desire to remove a node, there are two methods of removing nodes. If you wish to remove all nodes, select the “Clear All” button, this removes all nodes throughout the program. However, if you wish to remove a specific node, select a specified node in the table listing node coordinates and click on it, this should lead to the same highlighted scenario as “Select Node”, after a specified node has been selected for removal, select the “Remove Node” button. This will in turn remove the selected node. Repeat this operation for as many nodes as you wish and then after so press the “Back” button to return back to the nodes menu.



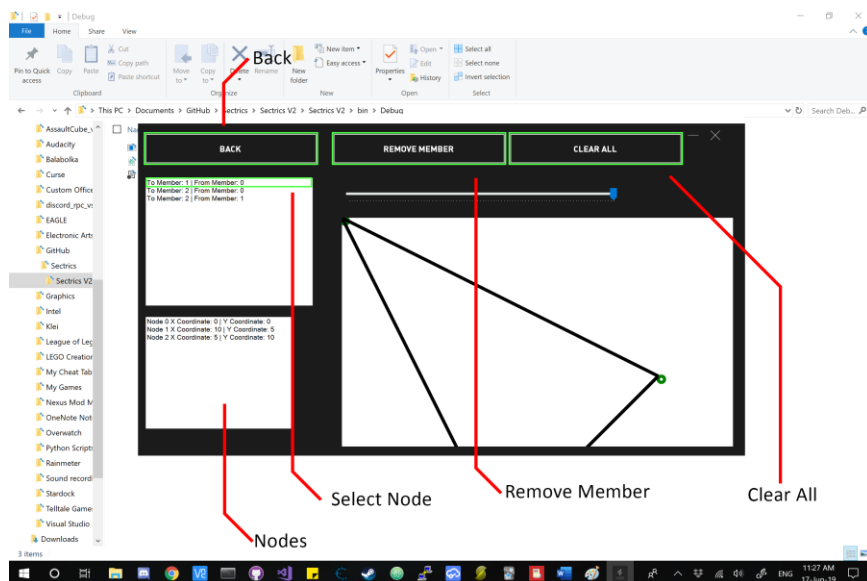
- After returning back to the main menu, to complete the next step of the construction of the bridge click on the “Members Button”, this will navigate you to the members menu.



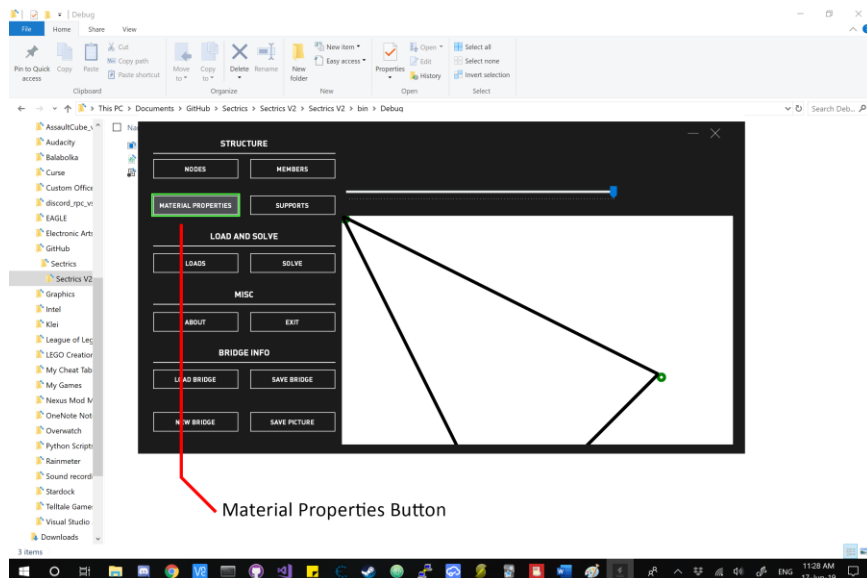
7. Once in the members menu select the “From Member” textbox and enter a specified node number for the “From Member”, starting from 0, and then enter a specified “To Member” in the “To Member” textbox. After which select “Add Members”. Again, once done select the “Back Button” to return to the main menu or if an error with the selection of from members & to members exist, select table to remove members. In addition, it will also show coordinates for all members inputted and in addition will show the coordinates & index of nodes in aid for referencing during the construction of the bridge. A “To Member” and “From Member” are the indices of the nodes or the order they’ve been inputted in to indicate which node is which. These indices represent the beam of the bridge as a line is drawn between these “To” and “From” members.



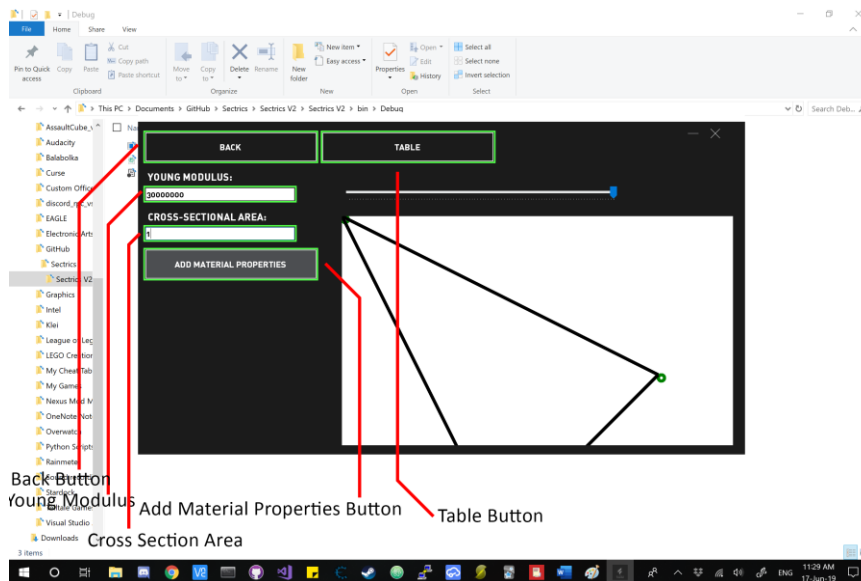
8. After selecting the “Tables Button” and navigating to the tables menu the corresponding created members will be shown in the first select box and the total created nodes will be listed in the second select box labeled “Nodes”. To remove a single member, select the corresponding member such as in “Select Node”, left clicking it, and then select the “Remove Member” button. This will remove the corresponded member. If you instead wish to remove all members select the “Clear All” button. Once done removing or viewing members / nodes, select the “Back” button will return you back to the members menu.



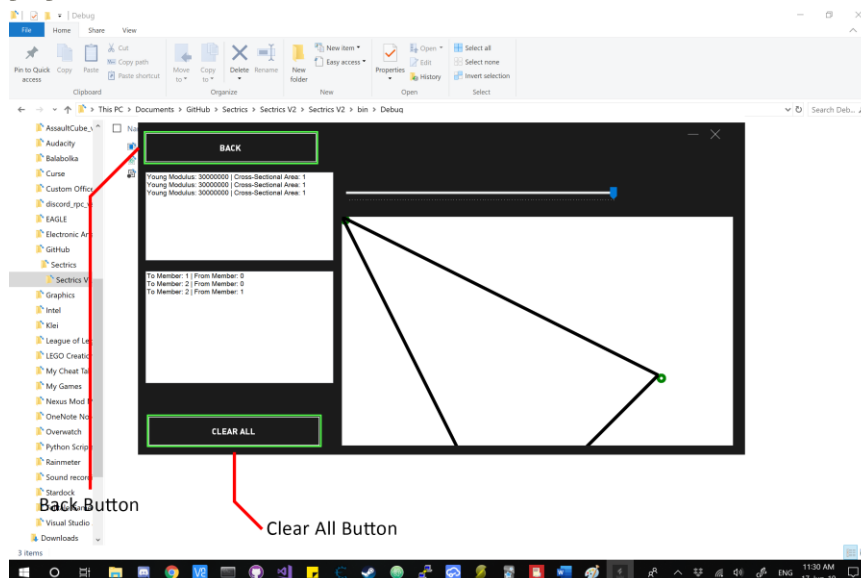
9. After returning back to the main menu, to complete the next step of the construction of the bridge click on the “Material Properties Button”, this will navigate you to the material properties menu.



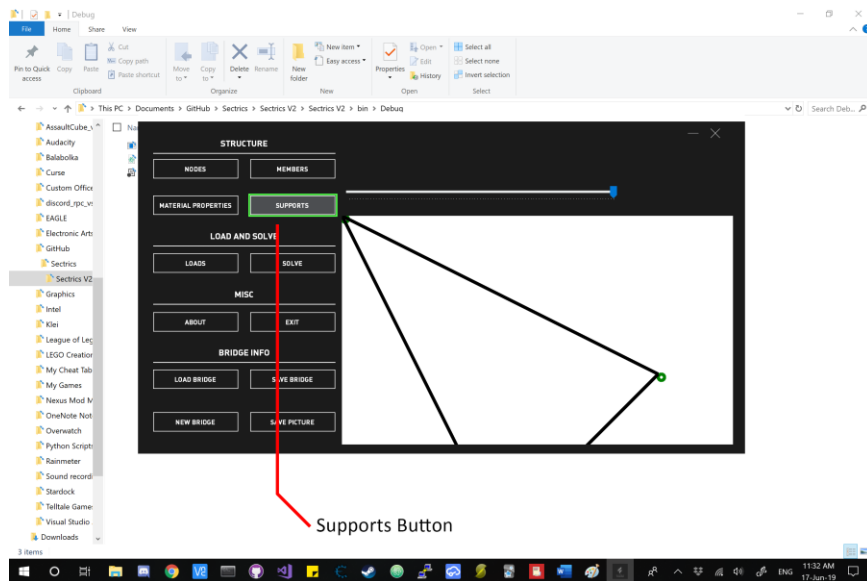
10. Once in the material properties menu, for each correlated ‘beam’ or ‘member’ a cross-sectional area & young modulus is required. The index or the selected member will increase automatically as the “Add Material Properties” button is selected. To begin enter the young modulus in the “Young Modulus” textbox, after which enter a specified cross-sectional area in the “Cross-Sectional Area” textbox then select “Add Material Properties” Once done select the “Back Button” otherwise if you wish to view selected entries of material properties or remove a selected entry, select “Table”.



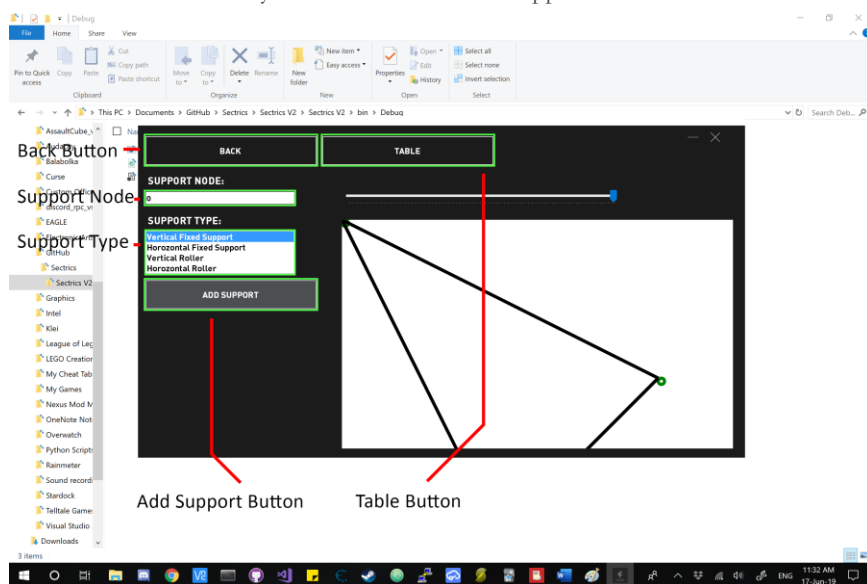
11. If you’ve selected “Tables” for material properties follow this step otherwise skip this step. After selecting tables, you can view selected entries of material properties in the first textbox or view the “To Member” & “For Member” for each index. If you wish to remove a material property for a selected beam, you must unfortunately remove all entries and start again. After viewing or removing all members by selecting the “Back Button” you will return back to the material properties menu.



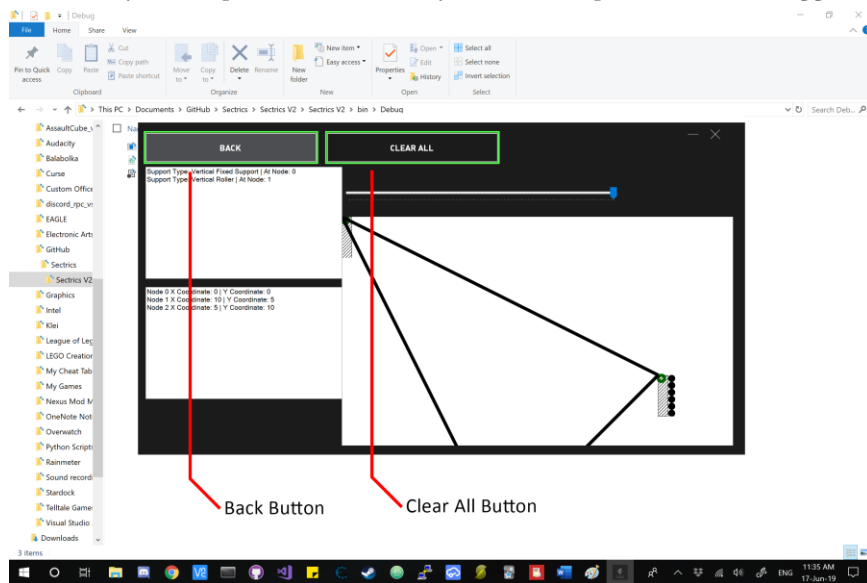
12. After inserting material properties for all members, and pressing back to return the main menu. To continue the creation of the bridge now select the “Supports Button”



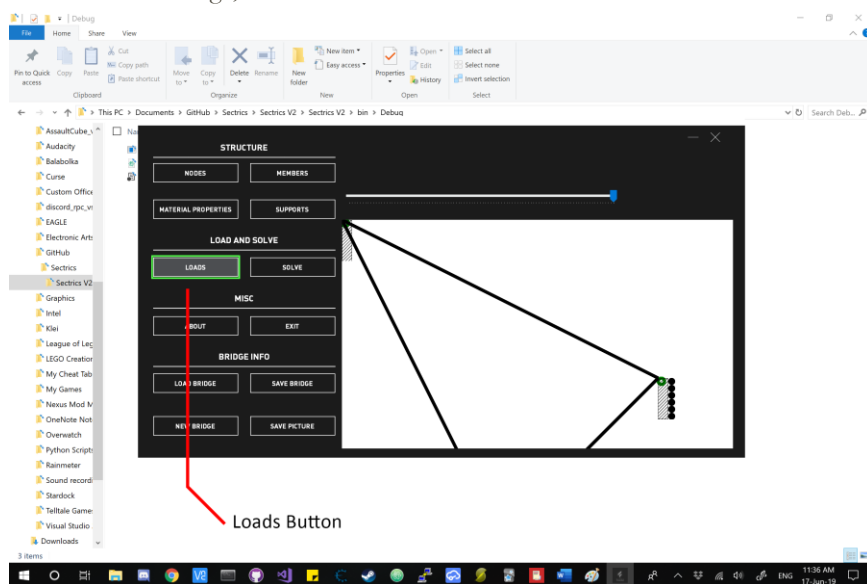
13. After selecting the supports menu, to add a support to a specified node enter the node in the “Support Node” textbox and then in the “Support Type” checklist, select the support type. Once done to add the support select the “Add Support Button”. After adding all the required support nodes, by clicking the “Back Button” you will again return to the main menu otherwise if you wish to view added support elements or node coordinates select “Table”.



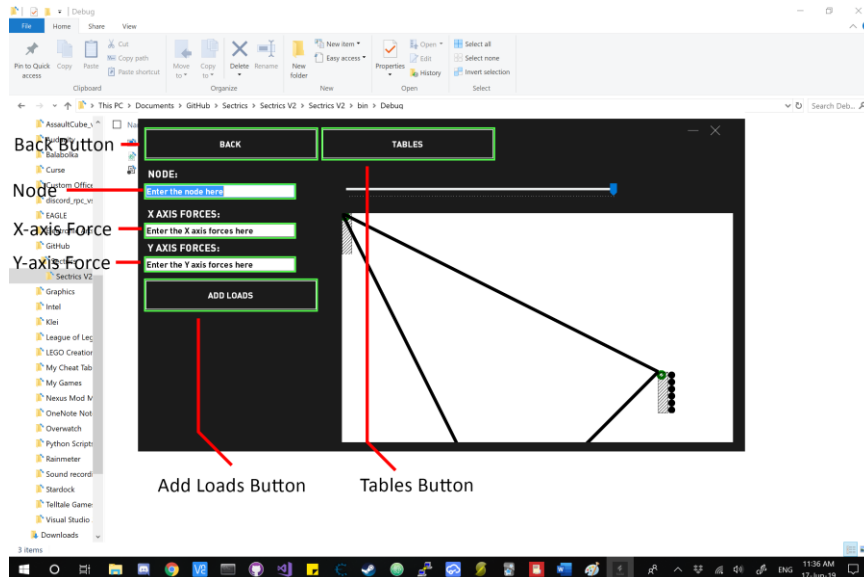
14. Once in the tables menu if you've entered a support incorrectly and wish to remove it select the clear all button. This button will remove all support nodes. The first table will list all nodes added whilst the second table will display the coordinates & positions of nodes with both X & Y as well as index. After removing all supports or viewing supports / members by selecting the "Back Button" you will once again return to the support menu.



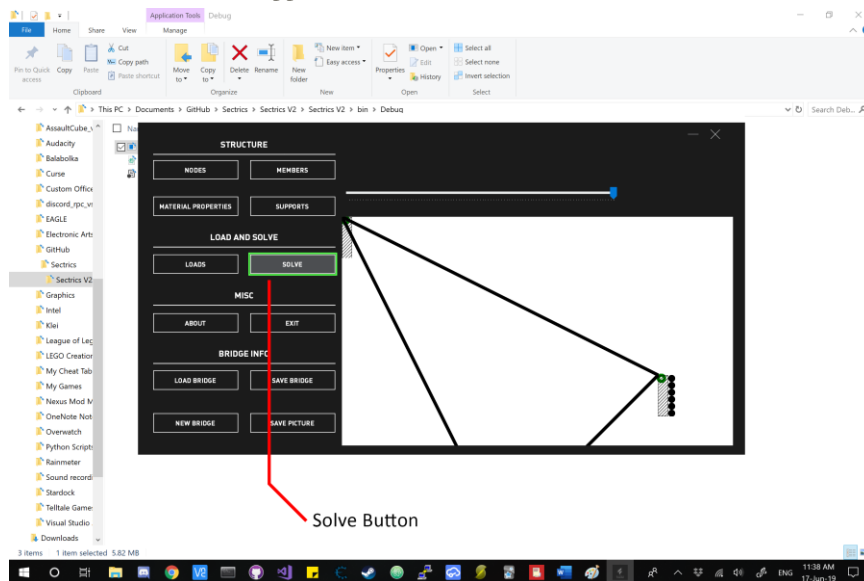
15. After inserting all support nodes for the required nodes, and pressing back to return to the main menu. To continue the creation of the bridge, now select the "Loads Button".



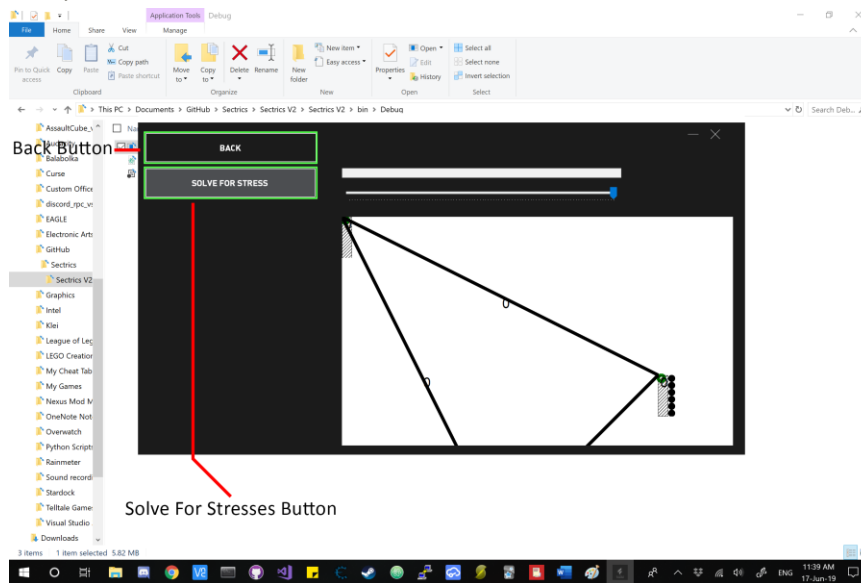
16. A load can only be added on a node. To add a load to the bridge you must select a node and then a force in both x and y giving both magnitude & direction (being either positive or negative) with up being positive and down being negative as well as the same for right and left. To add a force first select the “Node” textbox and enter a specified node, after which then select the “X-axis Force” textbox and enter a specified x-axis force, after which repeat the same for the Y-axis force by selecting the “Y-axis force” and entering the y-axis magnitude in its textbox. Once done select the “Add Loads Button” to finish adding the force. After entering all required forces for the desired nodes select the “Back Button” otherwise if you wish to remove or view added forces select the “Tables Button”



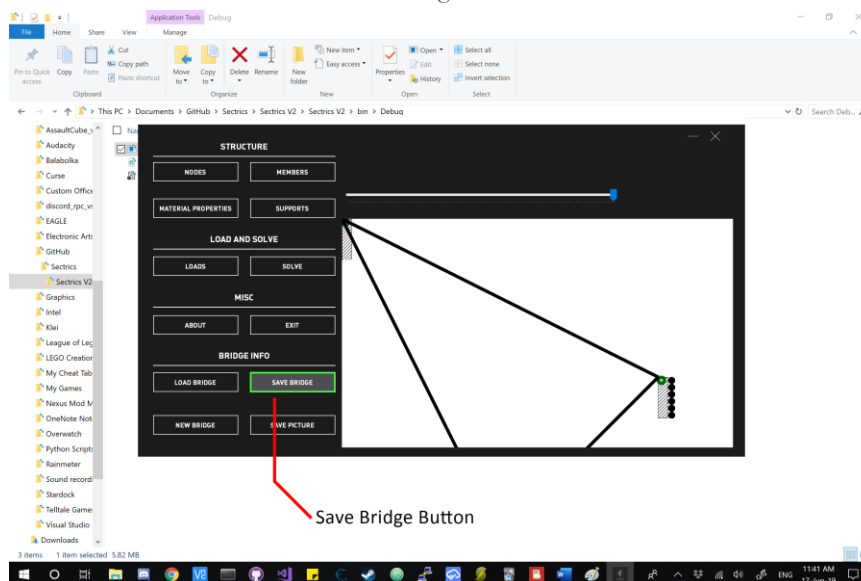
17. Once all forces are added and you’ve returned to the back menu to view the stress inside each member as well as the reaction force for each support, select the “Solve Button”.



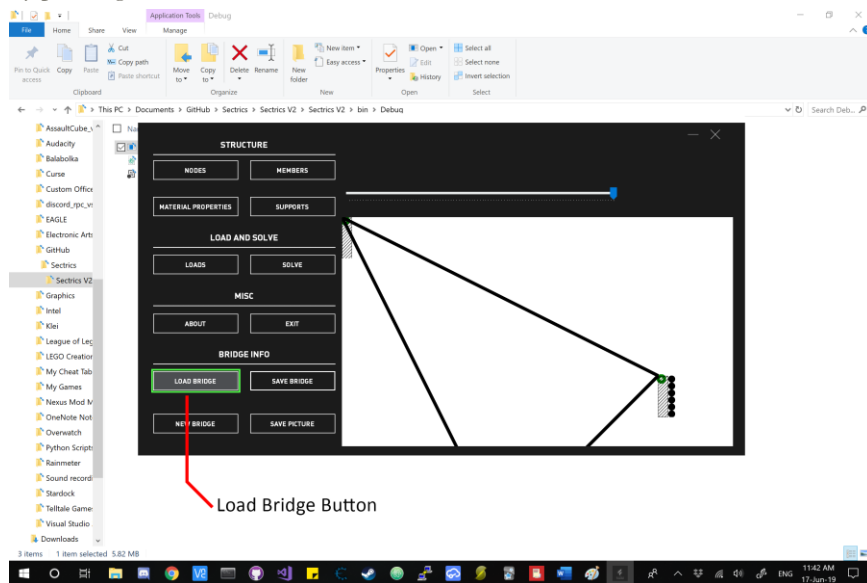
18. After selecting the “Solve Button” and entering the solve menu, to calculate and view internal stresses in members & view the reaction forces on supports, select the “Solve for Stress Button” after which the calculated forces will be displayed on the program. To view each member forces in depth, copy the output of the white square box into notepad or any other text editor to view raw results. Once done to return to the main menu select the “Back Button”



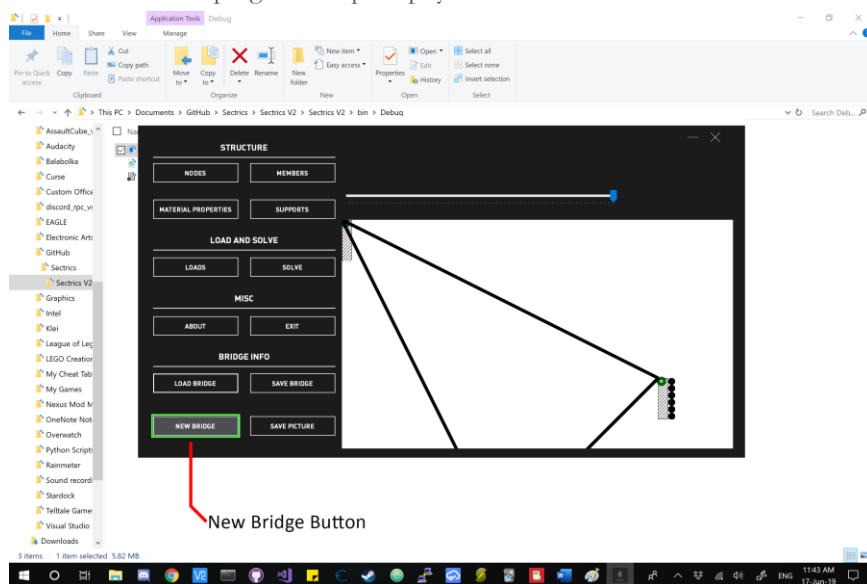
19. To save a work in progress bridge or a finished bridge for future use once back in the main menu, select the “Save Bridge Button”. After pressing which will prompt you to a windows menu asking for a save location, a name and then a confirmation to save. Once done the bridge will be saved as a .CSV file.



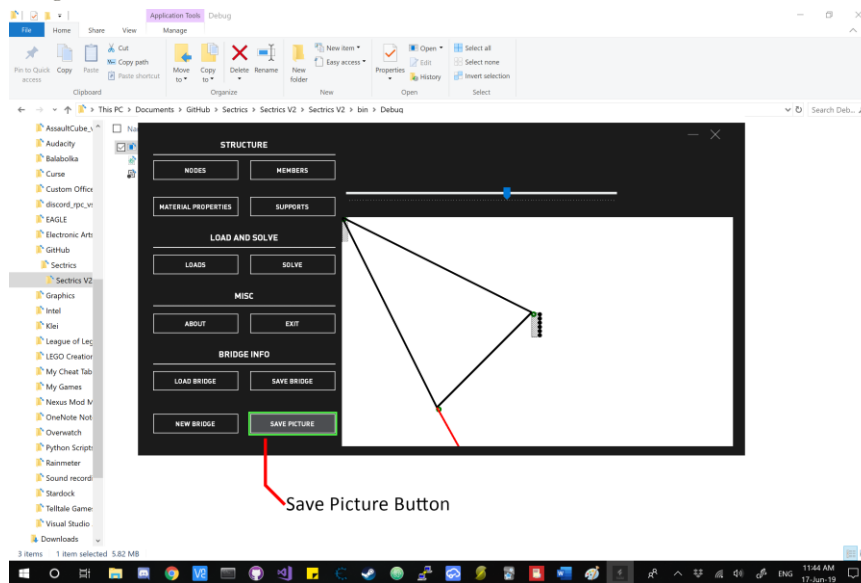
20. To load a saved bridge or other user created bridge, select the “Load Bridge Button” this button will prompt you to a windows form requesting the location of the .CSV file and you to then click on it to select it then confirm the selection by pressing “OK”.



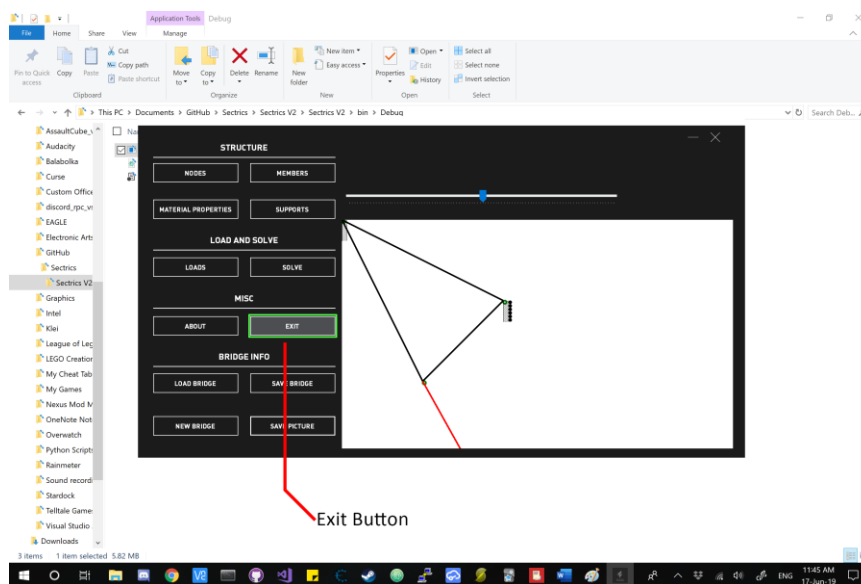
21. To start a new bridge from scratch select the “New Bridge Button” this will prompt you to a confirmation, after selecting the “Yes” button the original bridge will be wiped leaving a blank canvas, if “No” is pressed the original bridge will remain and the program will prompt you back to the main menu.



22. If you wish to save a photo of the bridge select the “Save Picture Button” this will prompt you to a windows form requesting a name and a save location of the file, after pressing “OK” the program will then export a png picture of the bridge.



23. To exit the application, select the “Exit Button” on the main menu, this will prompt you to a “Yes” or “No” confirmation, by pressing “Yes” the application will exit & by pressing “No” the program will redirect you back to the main menu.



Troubleshooting Guide

Unable to Install Sectrics

1. Verify the disk or CD is readable by reading the files on the drive. For example, Windows users can explore the drive in Windows explorer. If the CD attempts to AutoPlay, you may need to right-click the drive and click *Explore* to browse the drive.
2. If the CD reads fine with no errors, verify your computer meets the minimum requirements of the program. If your computer does not have enough disk space or does not meet the requirements the program may not install or function correctly.
3. Make sure the version of Sectrics is correct and the operating system & software is compatible with Sectrics. For instance, running Linux will be incompatible with Sectrics in addition to missing key requirements such as missing Python 2.6 or key libraries such as NumPy & SciPy.

Errors During Installation

1. Verify your computer meets the minimum hardware requirements of the program. If your computer does not have enough storage for the installation of the software, the software will be installed improperly and will not function.
2. If the Sectrics installer is unable to run as Sectrics is a relatively new program your antivirus's heuristic section may have incorrectly flagged it as a virus. Due to this temporarily disabling your antivirus or adding exemptions for Sectrics may be required.
3. Verify the CD is clean and contains no significant scratches.

Program Is Unable to Calculate Forces

This is most likely due to Python & Python's libraries being incorrectly installed or not installed at all. Please ensure that .NET Core, Python 2.6 or later as well as NumPy and SciPy is installed correctly on the machine with Python being linked in environment variables.