P. A. HILTON LTD.

INSTRUCTION MANUAL

HSTS
Structures Software Package

Index

LABORATORY TECHNIQUE

Safety in the Laboratory

The principal hazards in using apparatus that demonstrates the static and dynamic performance of associated theorems and the assumptions involved are where rotary or linear motion occurs and where the handling of loose heavy items, for example weights, is part of the procedure.

Of the loose items the heavier weights must be regarded as the most dangerous objects. Should one of these fall onto the feet of those around the apparatus the potential for damage is present. Hence it is recommended that cast iron weights be handled carefully and when moving and placing the heavier ones (say 10 N upward) on load hangers this should be regarded as a two handed operation. It is surprisingly easy to spill a complete stack of weights off a hanger when adding a further one.

In addition to weights there are some heavy parts that have to be interchanged during some experiments and a similar approach using two hands where required is suggested. It may also be both sensible and necessary for two people to take part in changes to the apparatus.

Success in the Laboratory

Work in the laboratory depends on understanding, observation and skill. In the first place a good understanding of the performance, and limitations, of experimental models is needed. To know about the theory involved is useful but not essential. In the second place keen observation leads to better results and avoidance of mechanical mistakes. Lastly, the way in which students handle the apparatus can influence the accuracy and speed of the work.

To help students gain experience and improve their experimental technique a range of information is offered in the following notes. Bear in mind that in the world of real engineering it is often necessary to check the performance of new designs using the methods and instruments of laboratory experiments.

Design of Experimental Models

The purpose of each experiment is to illustrate an item of structural theory, or to show how well simplifying assumptions in the applied mathematics correspond to actual behaviour. This often requires the model to exaggerate the behaviour of a real structure.

In order to achieve specific objectives each experiment has a particular arrangement best suited to the theoretical requirement. These arrangements of the apparatus are described in the Construction Appendix, where included, of each experimental Instruction Manual. Before starting an experiment students should read through the Instruction Manual and be prepared to follow the recommended procedure.

Increased deflections are usually achieved by using very flexible models. The stiffness depends on ***EI*** or ***EA*** so a change of material from steel (***E*** = 205 kN/mm^2) to aluminium (***E*** about 1/3 ***E*** for steel) or a plastic (***E*** about 1/80 ***E*** for steel) is a solution. The alternative is to use thin steel beams with a low ***I***.

One disadvantage experimentally is that friction in bearings may affect displacements and force measurements. The other is that large changes in dimension (geometry) of models must be accommodated if possible.

Results can be improved by using stiffer models and larger loads, but this reduces visual effects such as curvature of beams**.**

Sources of Resistance

A knife-edge can simulate a frictionless pin or bearing, but horizontal and rotational movements demand ball bearings. These are packed with grease and fitted with shields to keep out dust and grit. Hence ball bearings have some torsional restraint, which affects forces in the order of magnitude 1 N. This shows up as a difference in readings for loading and unloading.

Pin joints in trusses are also subject to friction, which increases in proportion to the loading.

Repeatability of Readings

The ability to obtain accurate and repeatable experimental results is generally a matter of care and technique. Of course it helps to know the sources of error and to recognise when the apparatus contributes to the variability of readings.

Frictional variation can be minimised by using vibration. The extent of the friction can be observed by first increasing and then decreasing an applied load by hand to get the difference in readings. Tapping the frame on which the experiment is mounted will reduce the variation.

Cast iron weights for loading must always be applied gently. A load suddenly added will instantaneously apply twice its static value. Although weights are hand finished there is a manufacturing tolerance of ± ½%. This may affect linearity in experimental readings.

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Email: sales@p-a-hilton.co.uk

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The Results given in this Manual are to be used only as a guide for the calculations given in the experiments. The results should not be considered as correct. All machines are different and are tested in different ambient conditions.

HSTS STRUCTURES SOFTWARE PACKAGE

INTRODUCTION

The HSTS Structures software package contains all available experiment softwares for P.A.Hilton Ltd Structures Softwares.

The software allows the end user to fulfil the following key elements:

1. Simulation of some elements of the hardware experiment
2. Run the software in conjunction with the hardware experiment and hence compare actual results with theoretical
3. Obtain theoretical results
4. Run the software on-line (connected to hardware) or completely off-line (not connected to hardware)
5. Adjust parameters outside the scope and range of the hardware experiment
6. Store data and manipulate it afterwards
7. Enhances the users experience of the hardware

SYSTEM REQUIREMENTS of HOST COMPUTER (NOT SUPPLIED)

The minimum system requirements for the Hitech Structures Experiment software are as follows:

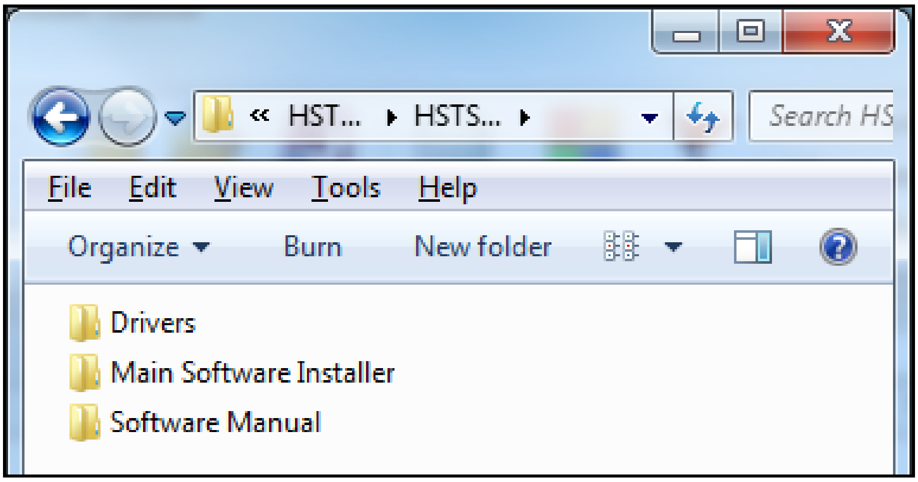
- Windows 8 and 8.1 (32 & 64 bit)
- Windows 7
- Windows 7 Service Pack 1
- Windows Vista Service Pack 1
- Windows XP Service Pack 3
- Recommended Minimum: Pentium 1 GHz or higher with 512 MB RAM or more
- 850MB minimum disk space for x86
- 2GB minimum disk space for x64
- VGA Monitor capable of at least 16-bit color at 1024 x 768 resolution
- USB1.1 or USB2 for data acquisition connection.
- Powered USB port(s) if possible

SOFTWARE INSTALLATION – NEW INSTALL

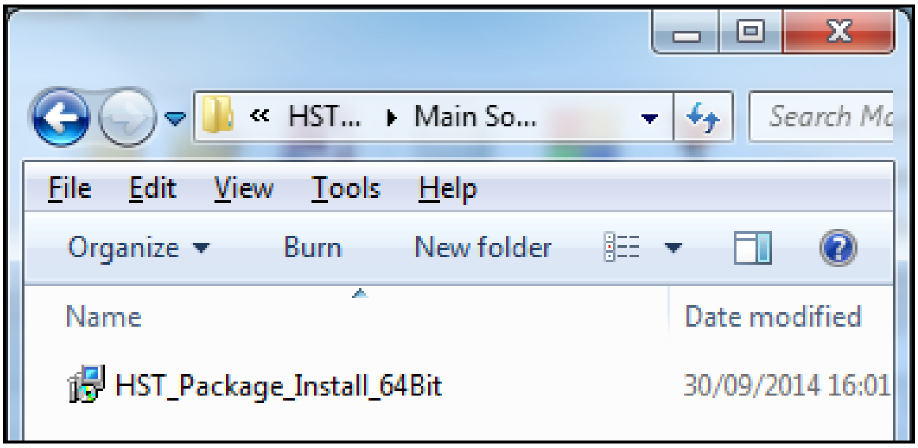
1. On the Media disc (or other format) supplied for the Experiment software you will have two folders as shown below:.

2. Depending on the operating system being used these folders will contain all the necessary installation files and manual.
3. Double click the relevant folder.

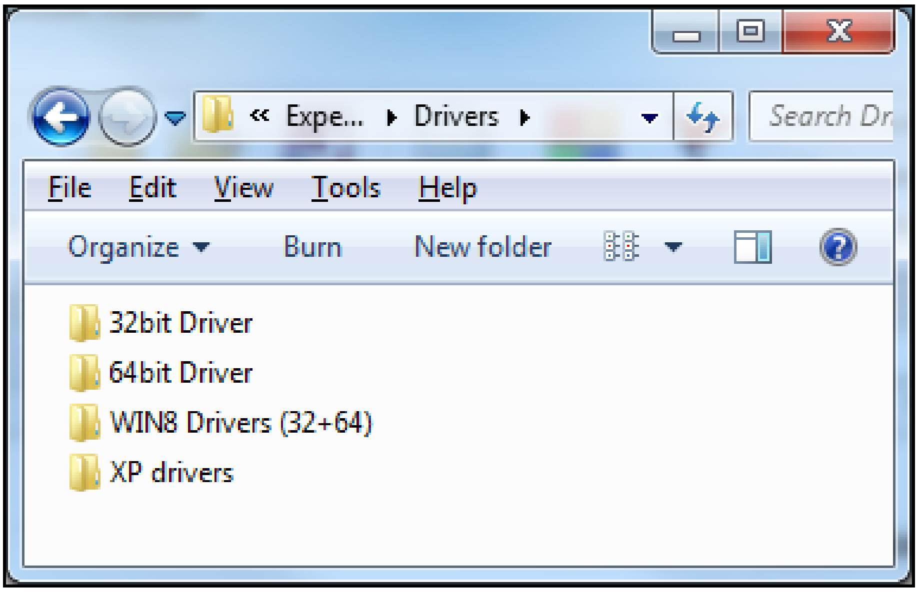
4. You will then see the following folders within this folder.



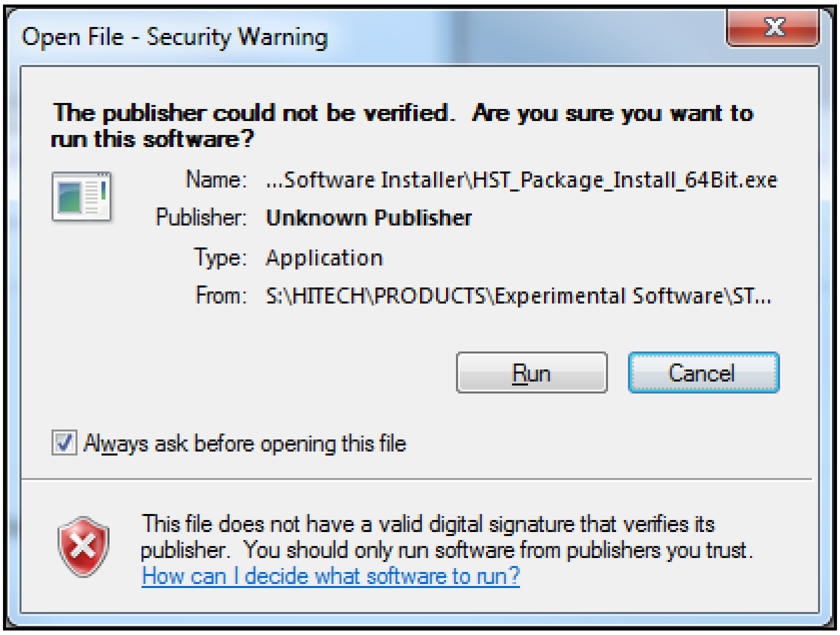
5. The **Main Software Installer** folder contains the application, as the example below shows:



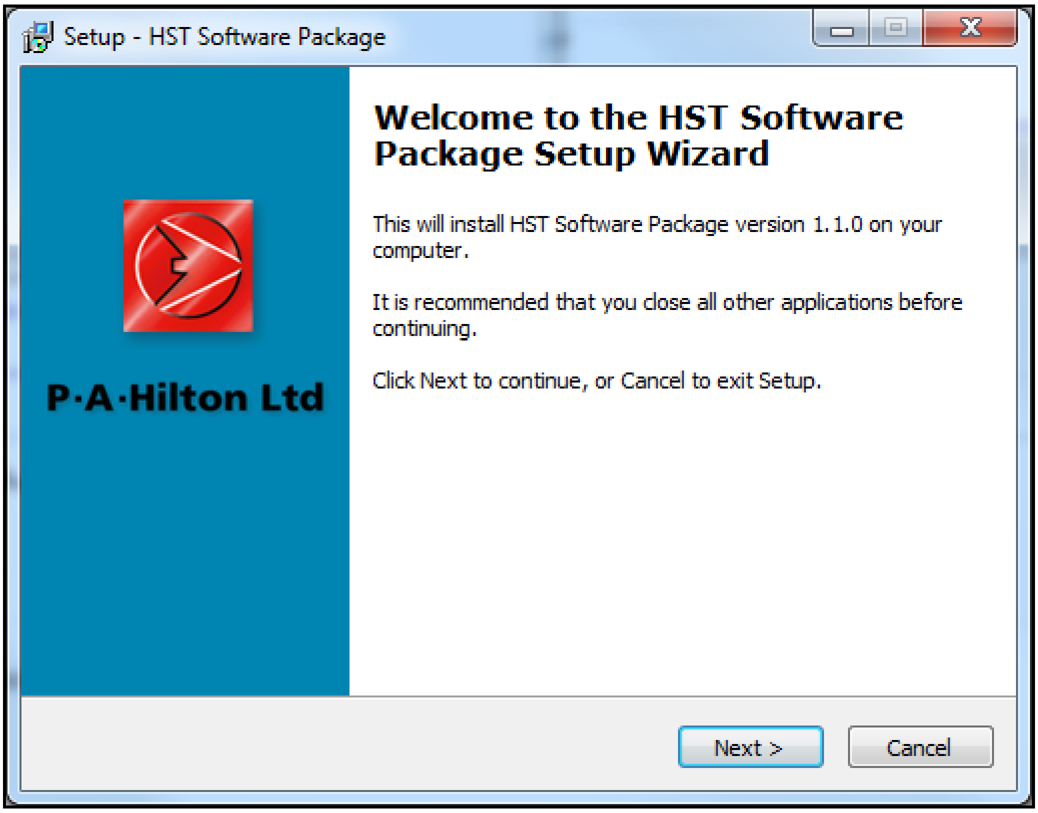
6. The **Software manual** folder will contain this manual.
7. The **Drivers** folder will contain all necessary drivers and information to assist with installing the software.



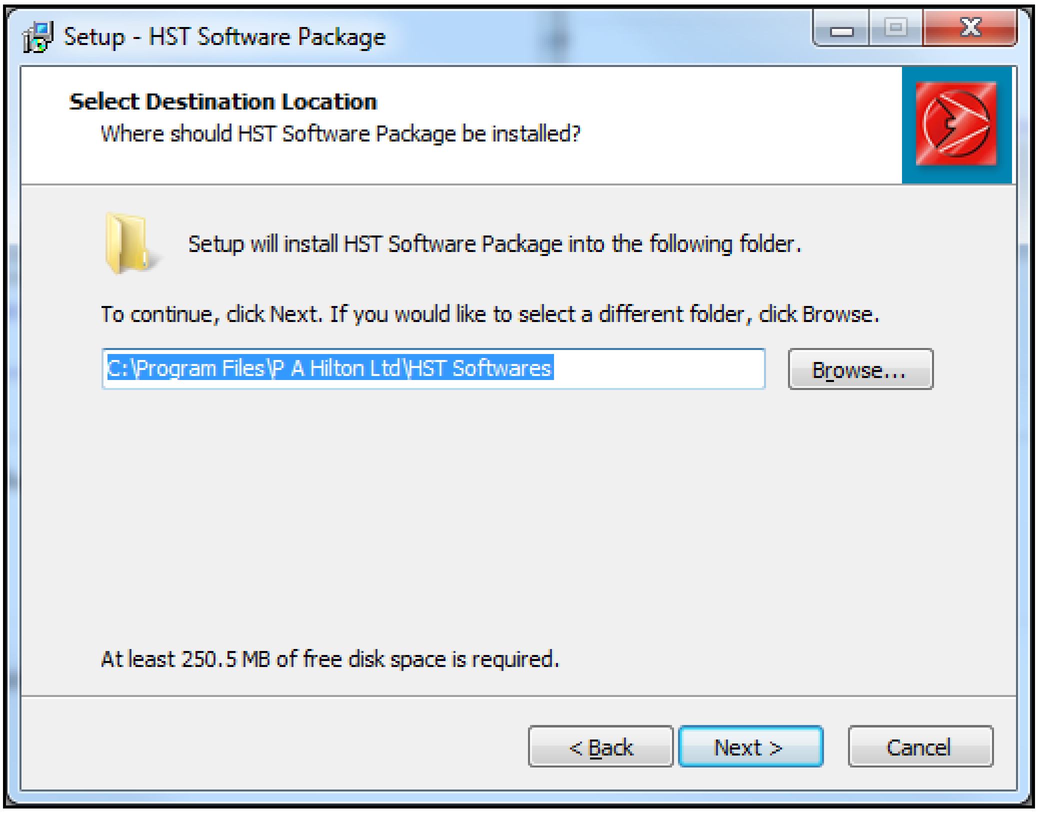
8. Enter the **Main Software Installer** folder and double click the application. The following screen will appear:



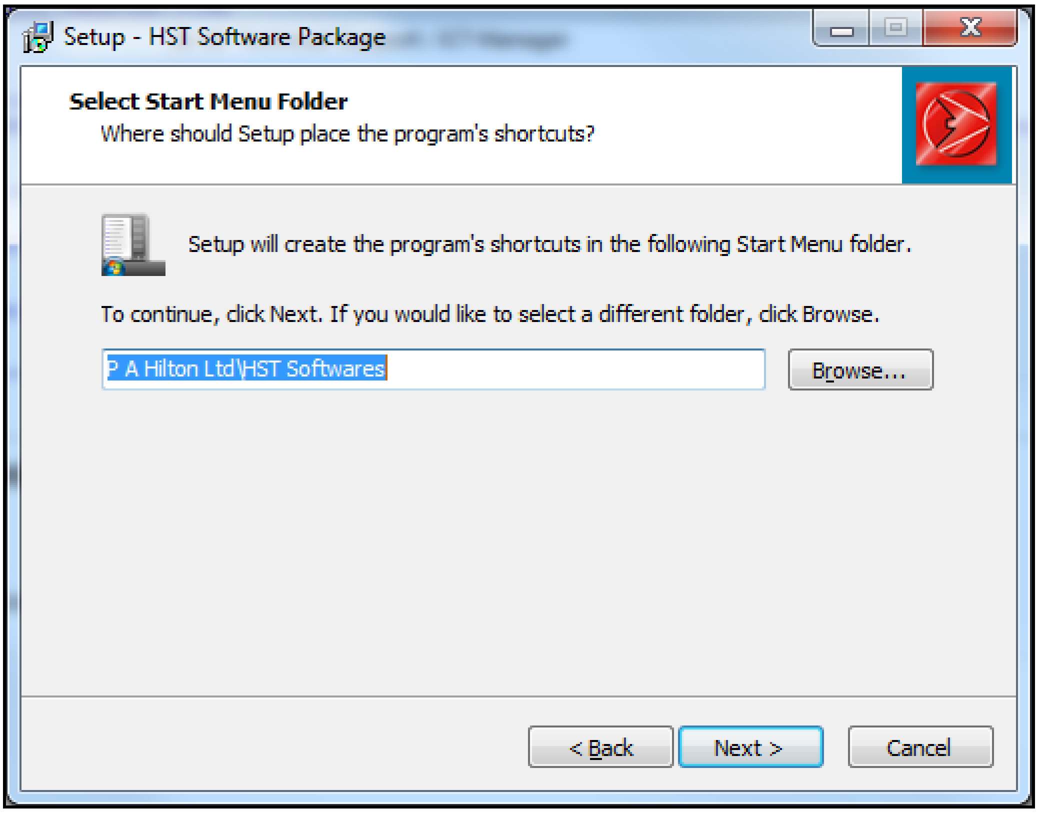
9. Click on **Run**.



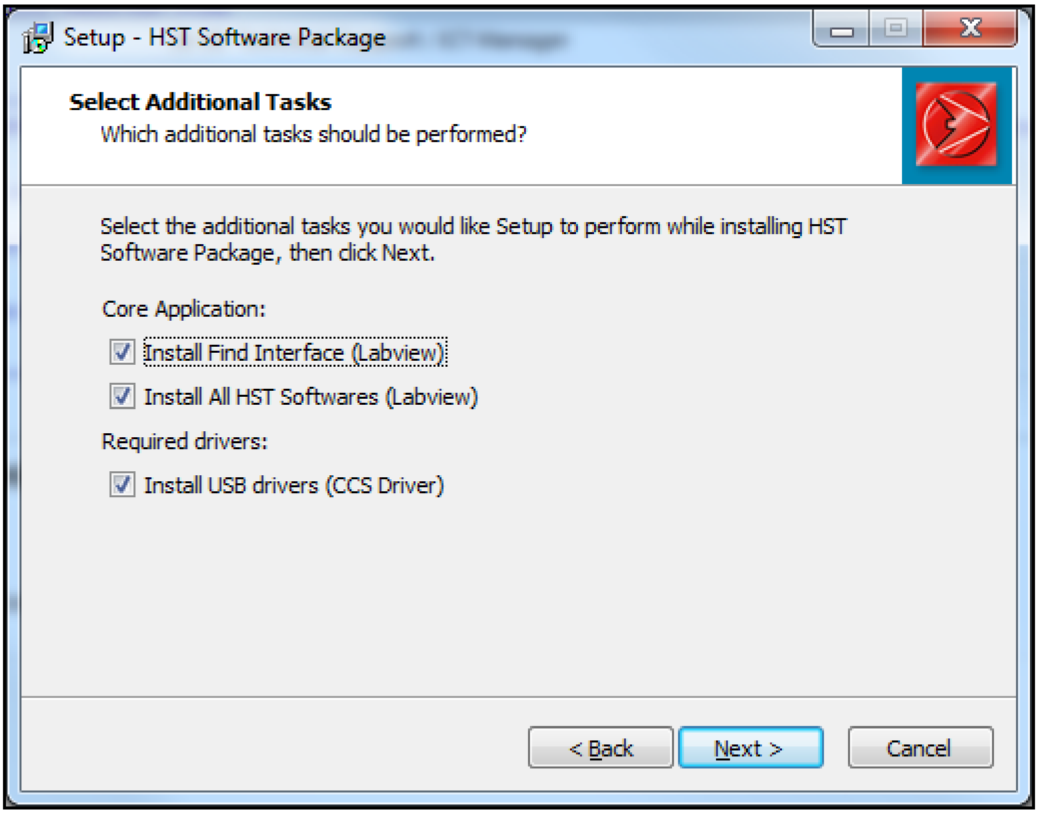
10. Click **Next>>** and the following screen will appear:



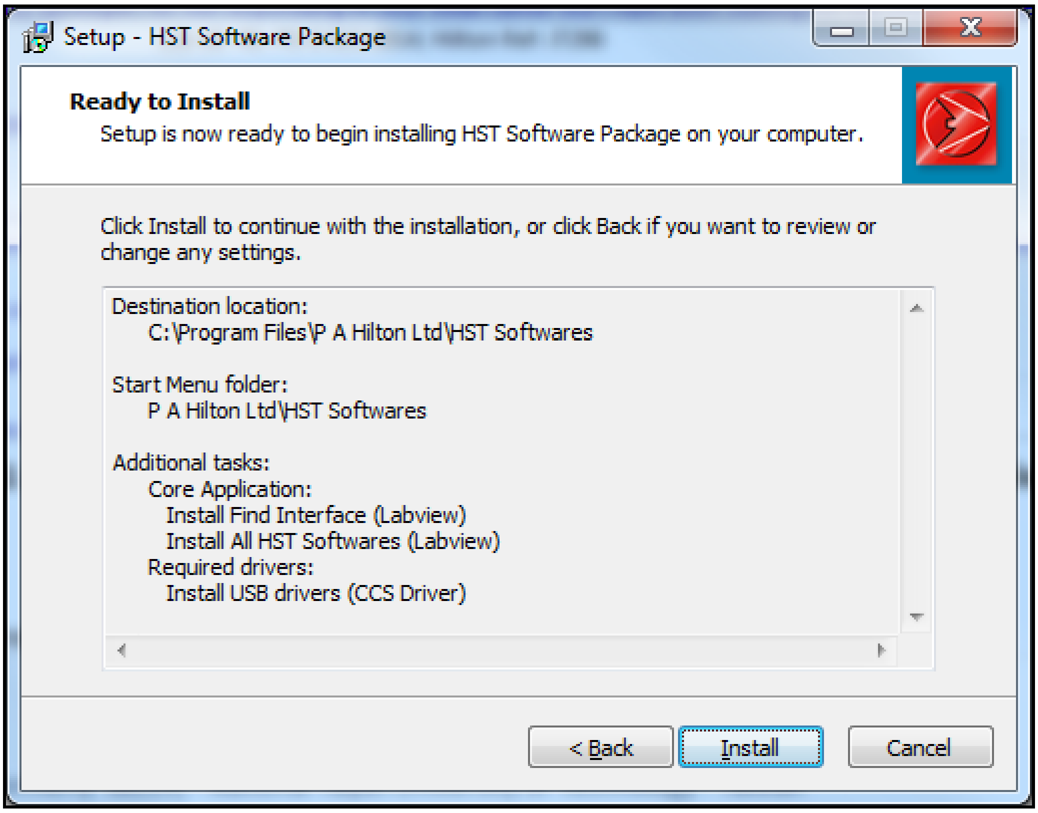
11. Click **Next>>** and the following screen will appear:



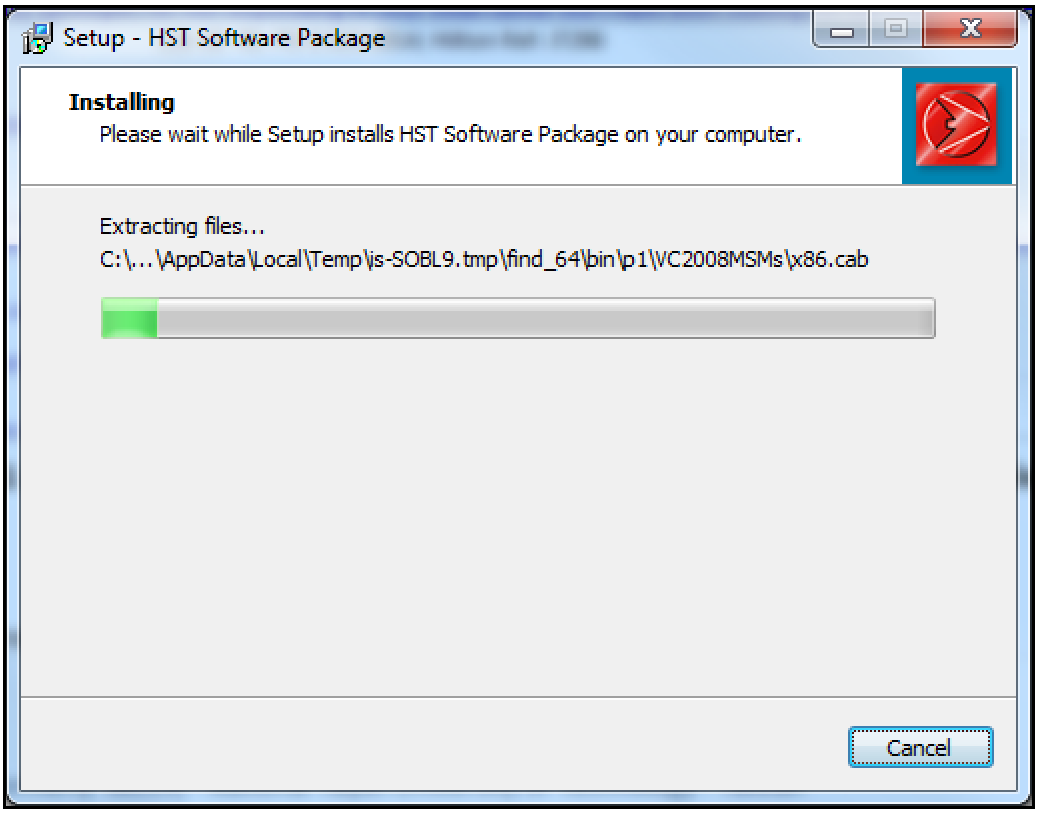
12. Click **Next>>** and the following screen will appear:



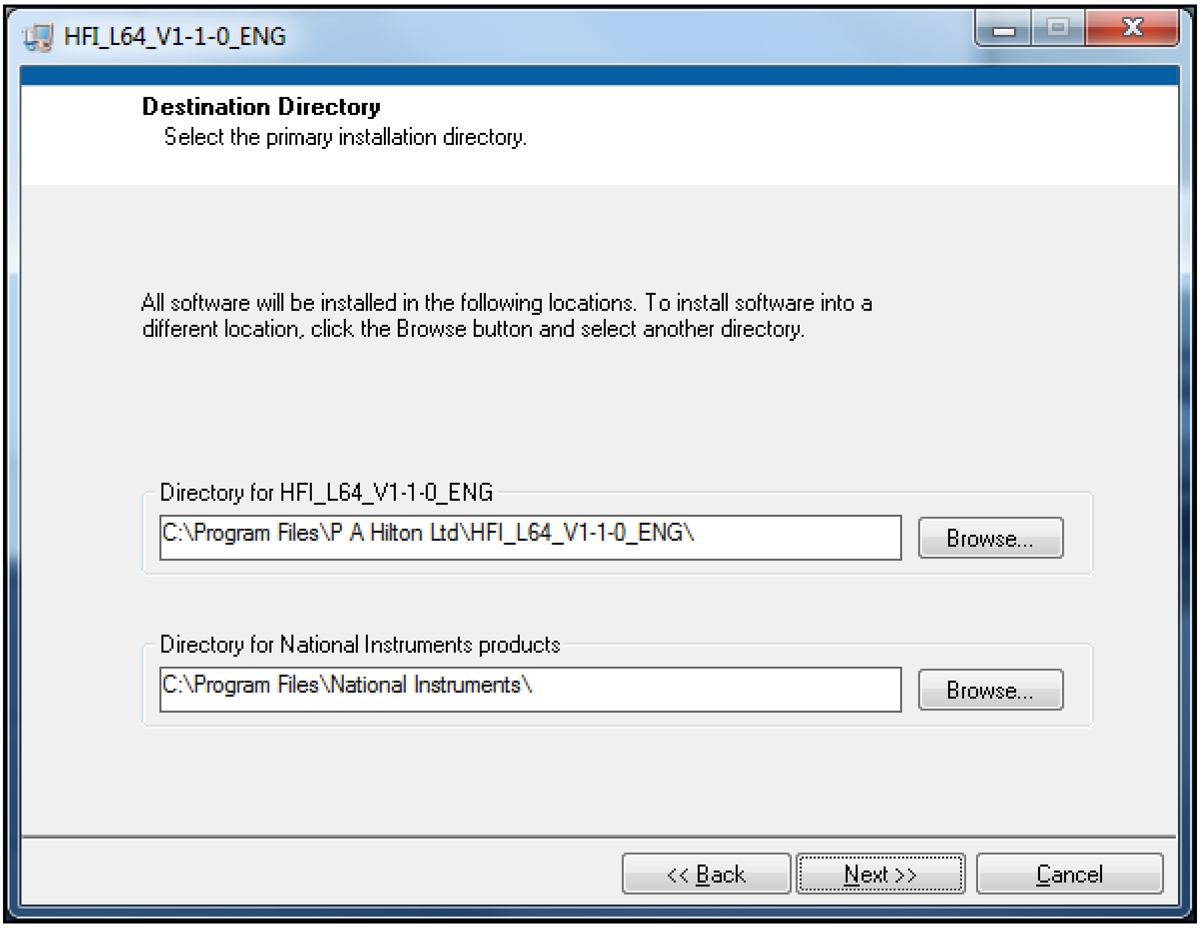
13. Click **Next>>** and the following screen will appear:



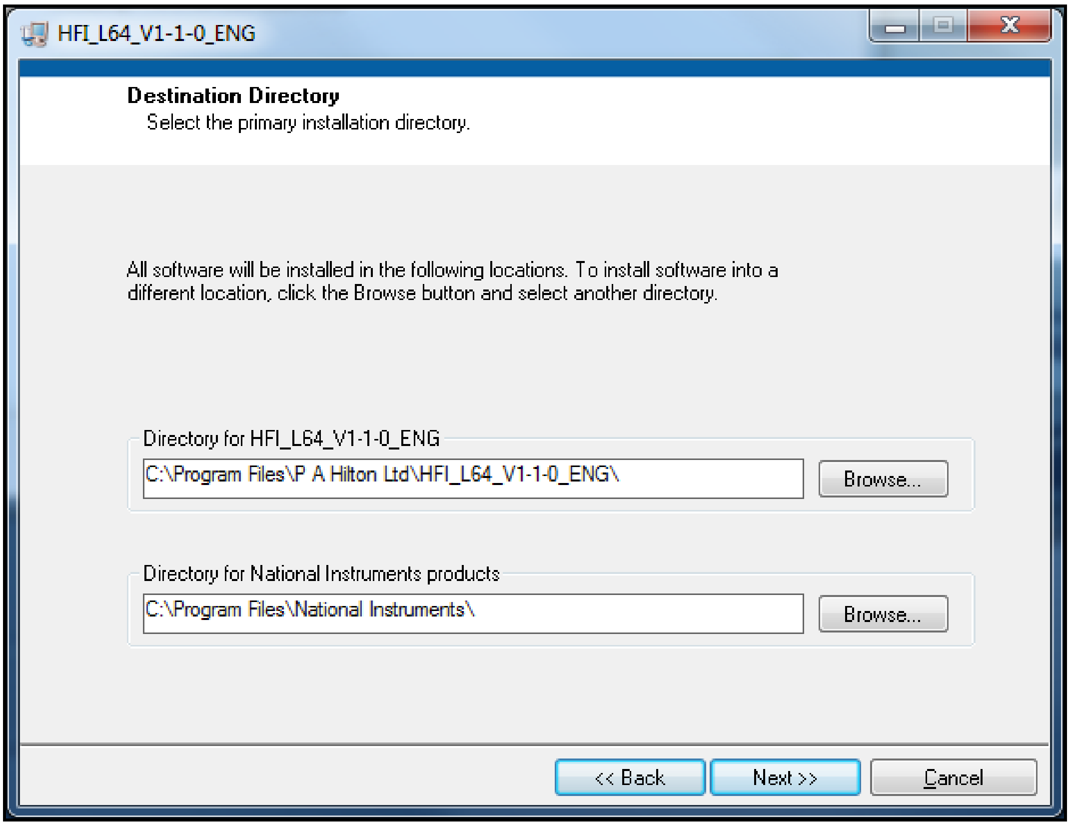
14. Click **Install** and the following will appear:



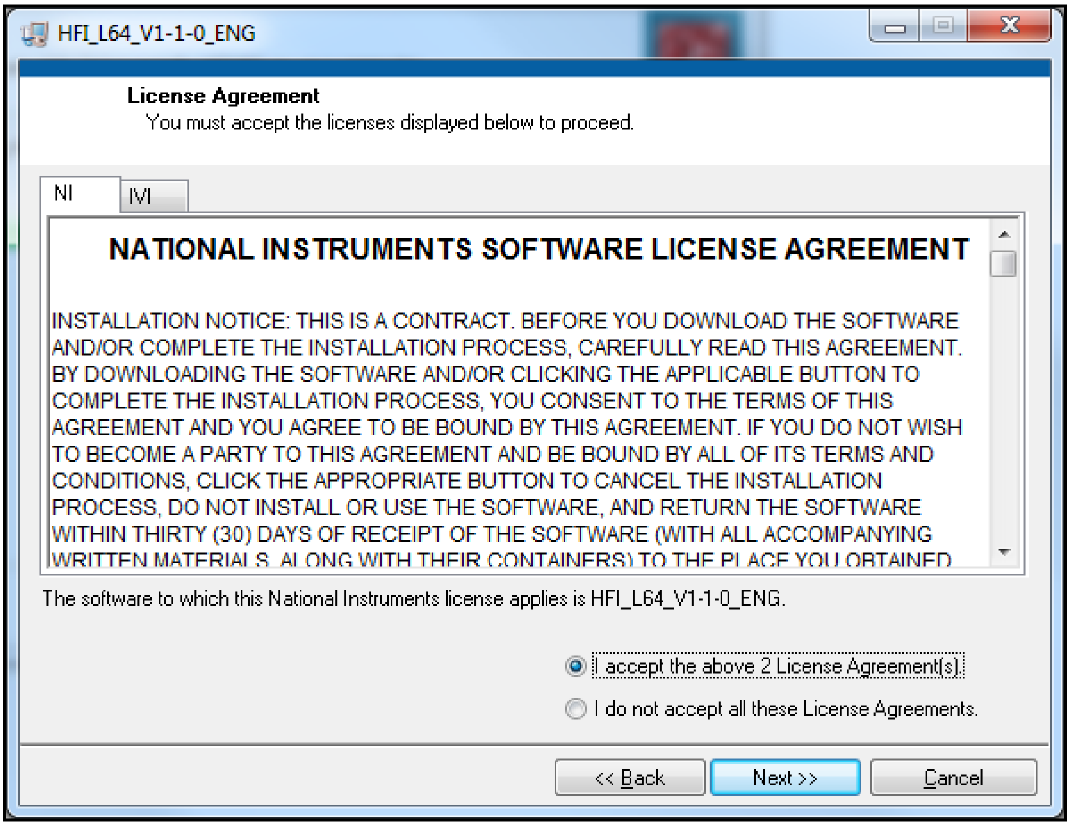
15. The following screen will appear:



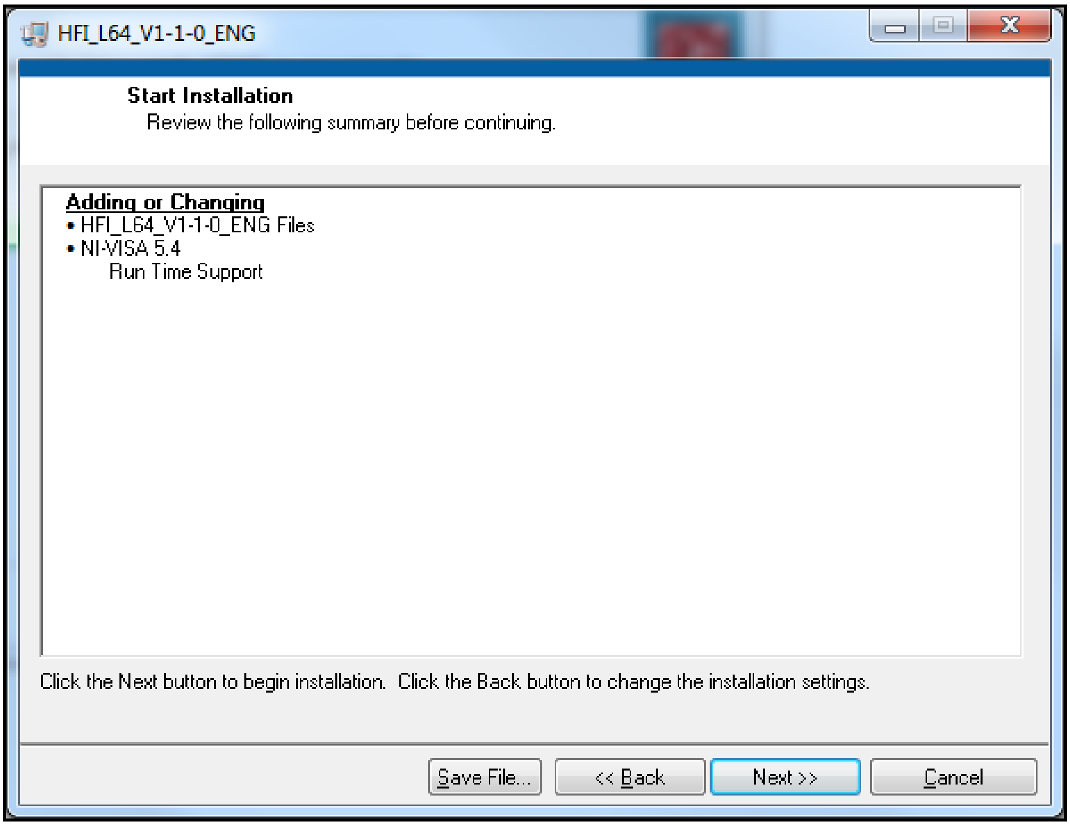
16. Click **Next>>**:



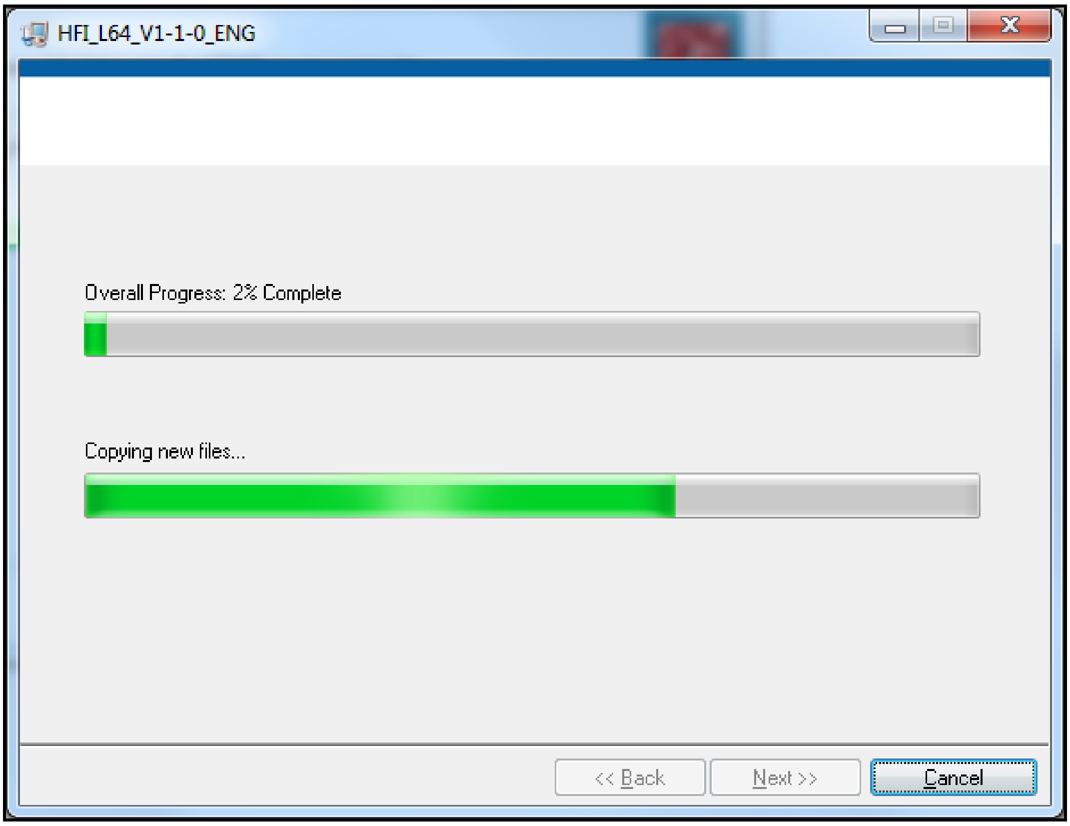
17. From the following screen make sure the top option is selected and then press **Next >>**:



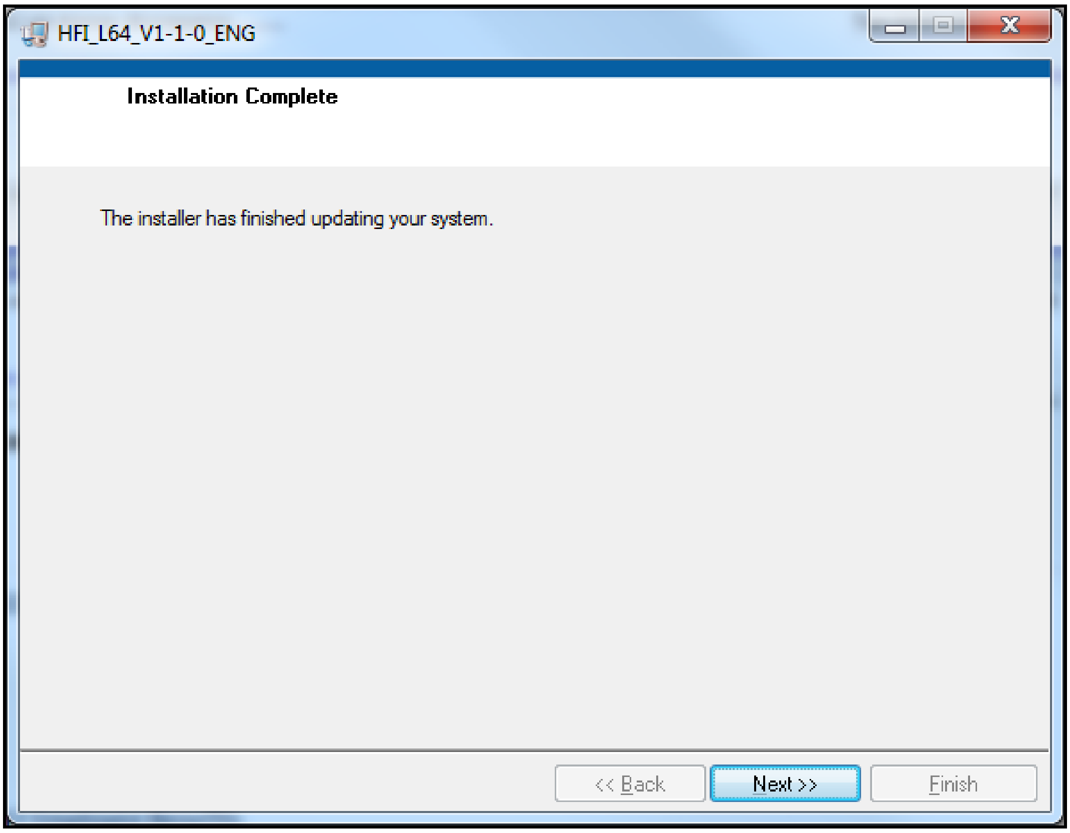
18. The following screen will appear. Click **Next>>**.



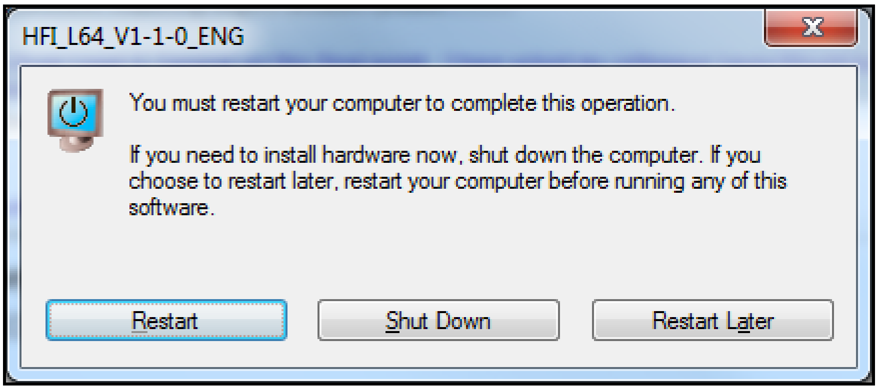
19. Progress will now be made as shown by the screen below:



20. Upon completion of the install the following will appear:

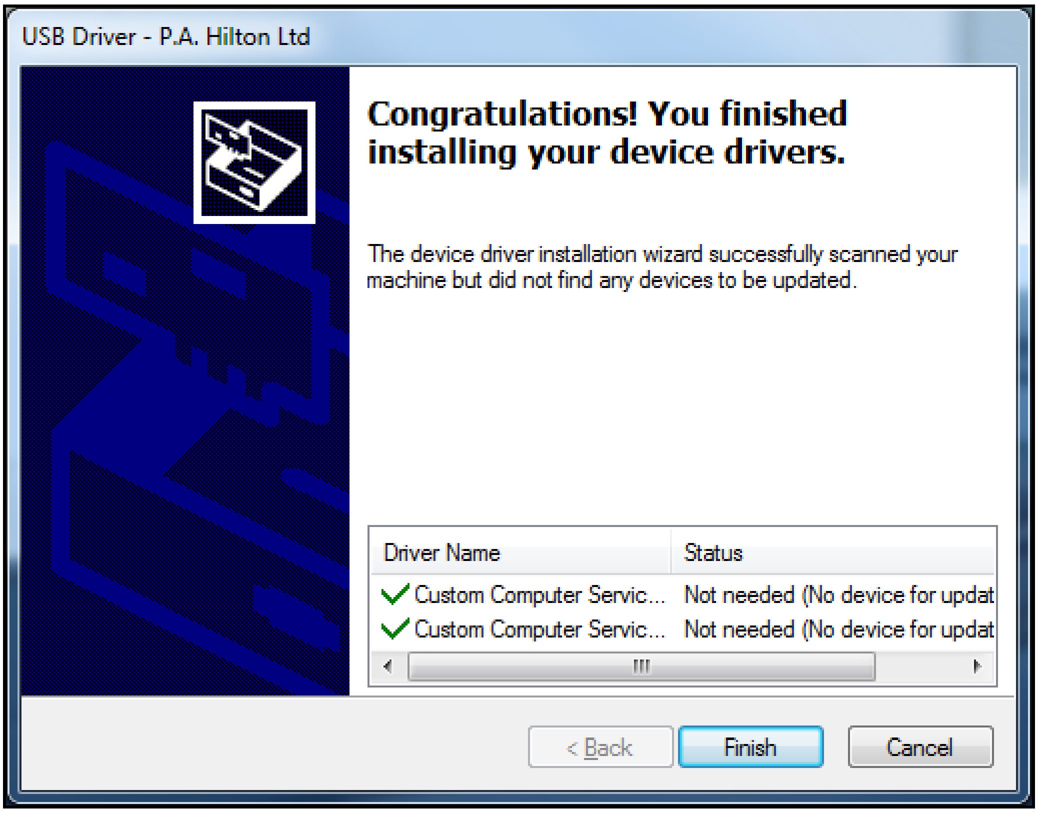


21. Press **Next >>** and the following will appear:



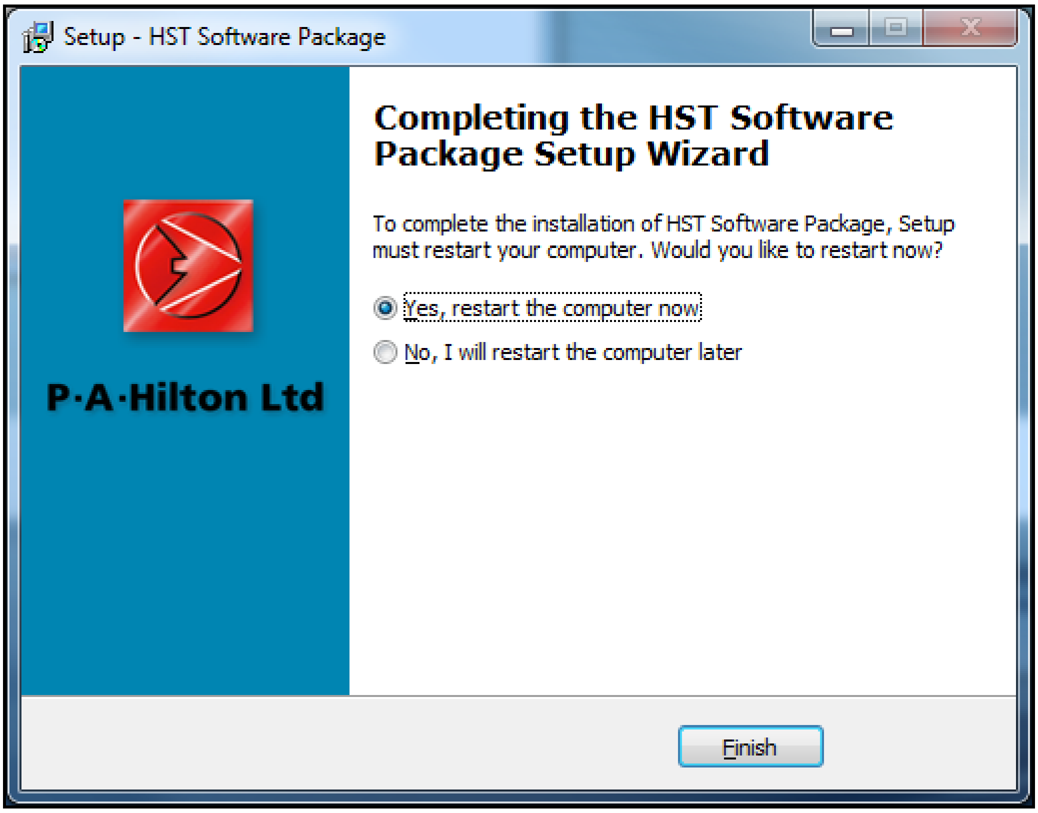
22. Press the ***red cross*** in the top right hand corner of the above window. The following will now appear:

23. Press **Next >>**:



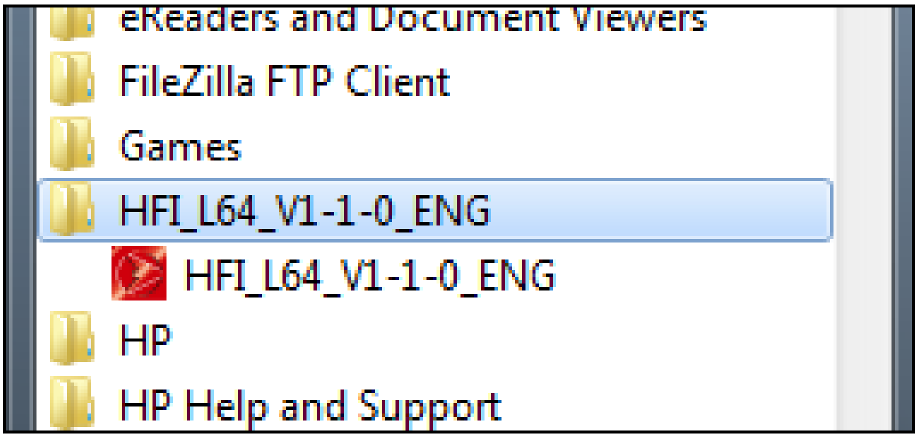
24. Press **Finish.**

25. The following will appear**. Restart.**

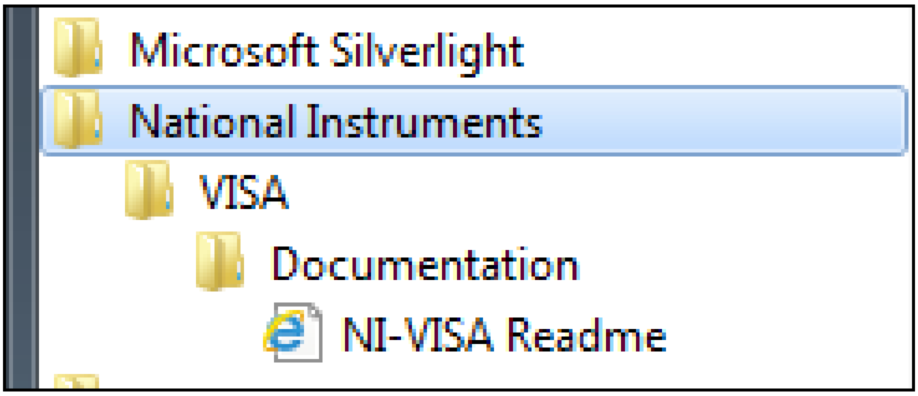


26. You should find that you host computer will now have the following installed:

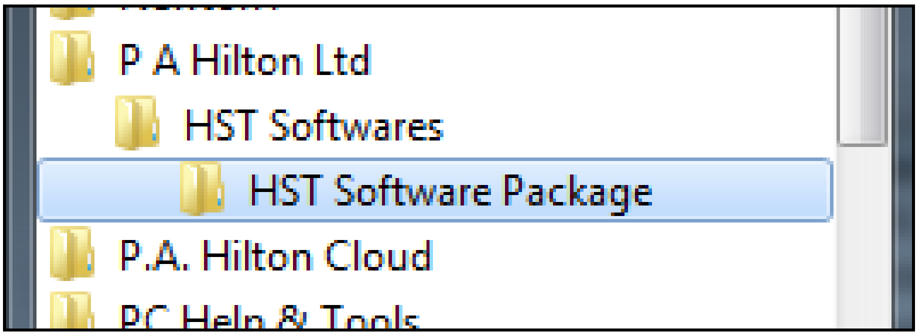
a. Find Interface:



b. National Instruments software



c. Main Software



WINDOWS 8 NOTES:

You MUST disable Driver Signature Enforcement before the driver will install on Windows 8.

To do this, follow the below instructions:

a) Hover the mouse over the right hand side of the screen, and select "Settings"
b) Click on the "Power" button.
c) You should see 3 options, hold 'Shift' on the keyboard and click "Restart"
d) The computer will now take a few minutes to reboot
e) From the menu that appears, click "Troubleshoot"
f) From the next menu, click "Advanced Options"
g) From the new menu, click "Startup Settings"
h) Now click the "Restart" button
i) The computer will now completely reboot, this will take a few minutes
j) A new menu should appear, you can't use the mouse on this one so you have to hit the number '7' on the keyboard
k) The computer will now boot automatically into Windows 8, this has disabled the driver signature enforcement so the driver will install successfully.

NOTE: Don't worry, the next time the computer is shut down, the driver signature enforcement is automatically re-enabled so there are no security concerns.

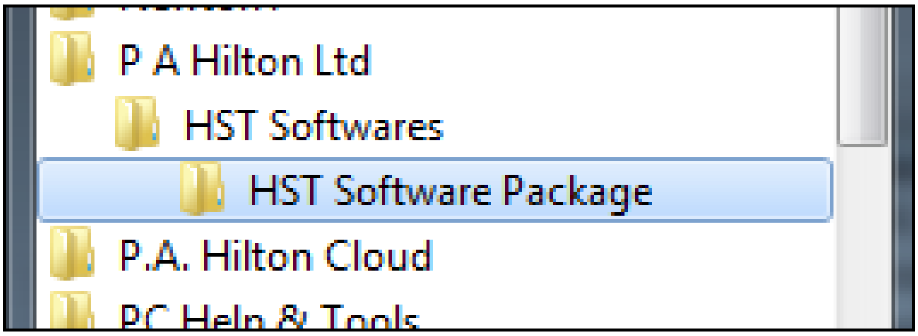
To update from old driver to new:

Note: Make sure the USB device is plugged in at this point.
Note 2: If you're running Windows 8, please see the other text file first, "WINDOWS 8 NOTES".

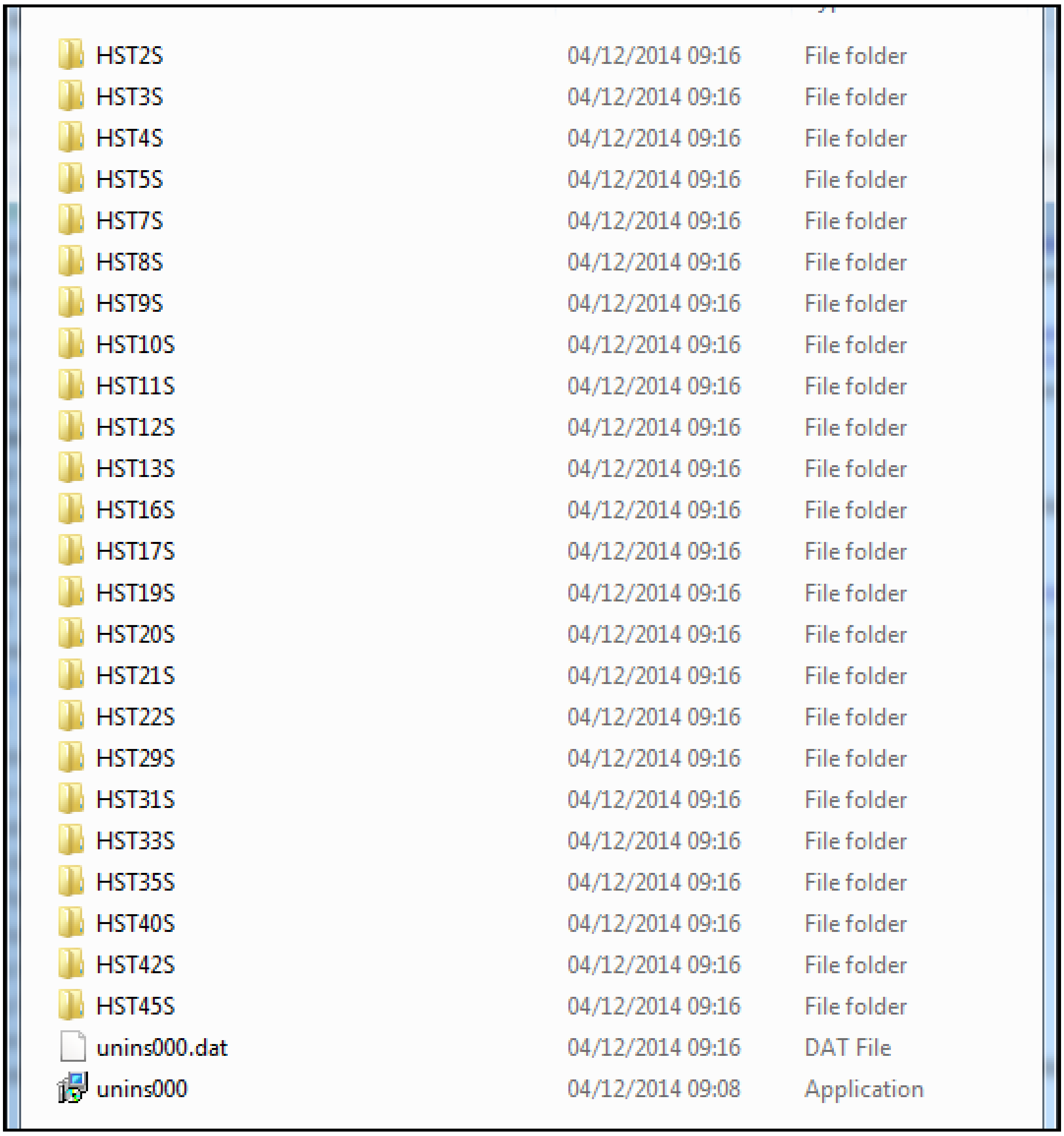
l) Open "Control Panel" as normal.
m) Under the "Hardware and Sound" category should be "Device Manager", click that.
n) In Device Manager, find the "Ports" category.
o) You should see your plugged in device under this category, with a COM port number, right click on it.
p) Select "Update Driver Software".
q) Select "Browse my computer for driver software".
r) Browse to the folder (**WIN8 Drivers (32+64)**) where the driver files are stored.
s) Click "Next".
t) The driver should now go through and update.

STARTING THE SOFTWARES:

1. From the Start Menu select the **HST Software Package** folder as shown below:

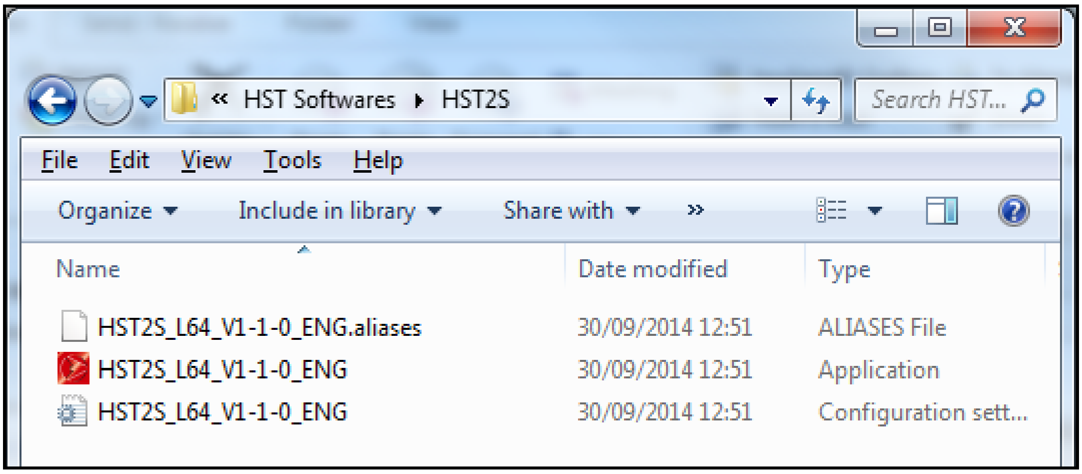


2. The following will appear:



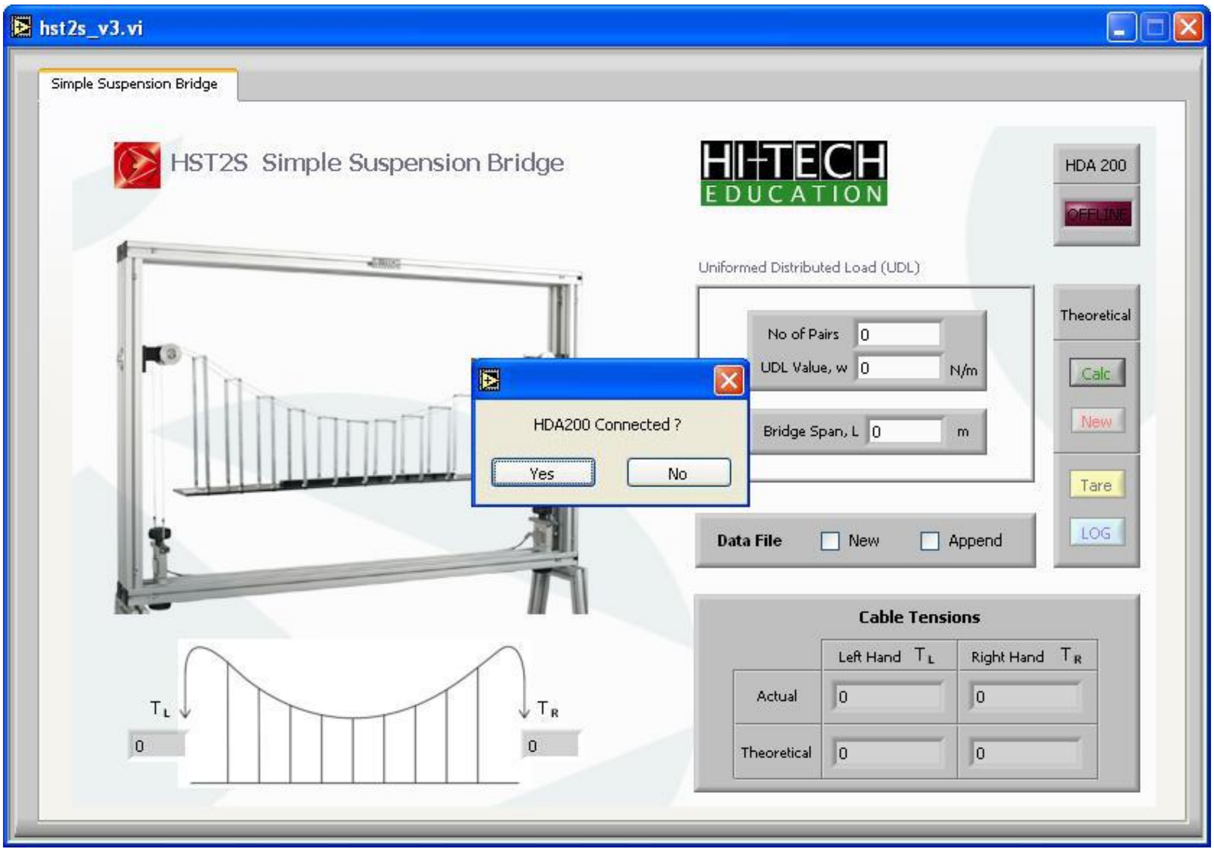
These are the software folders.

3. Open a folder, say HST2S, and you will be presented with the following.



.

4. Click on the application and after 5-10seconds the following screen will appear:

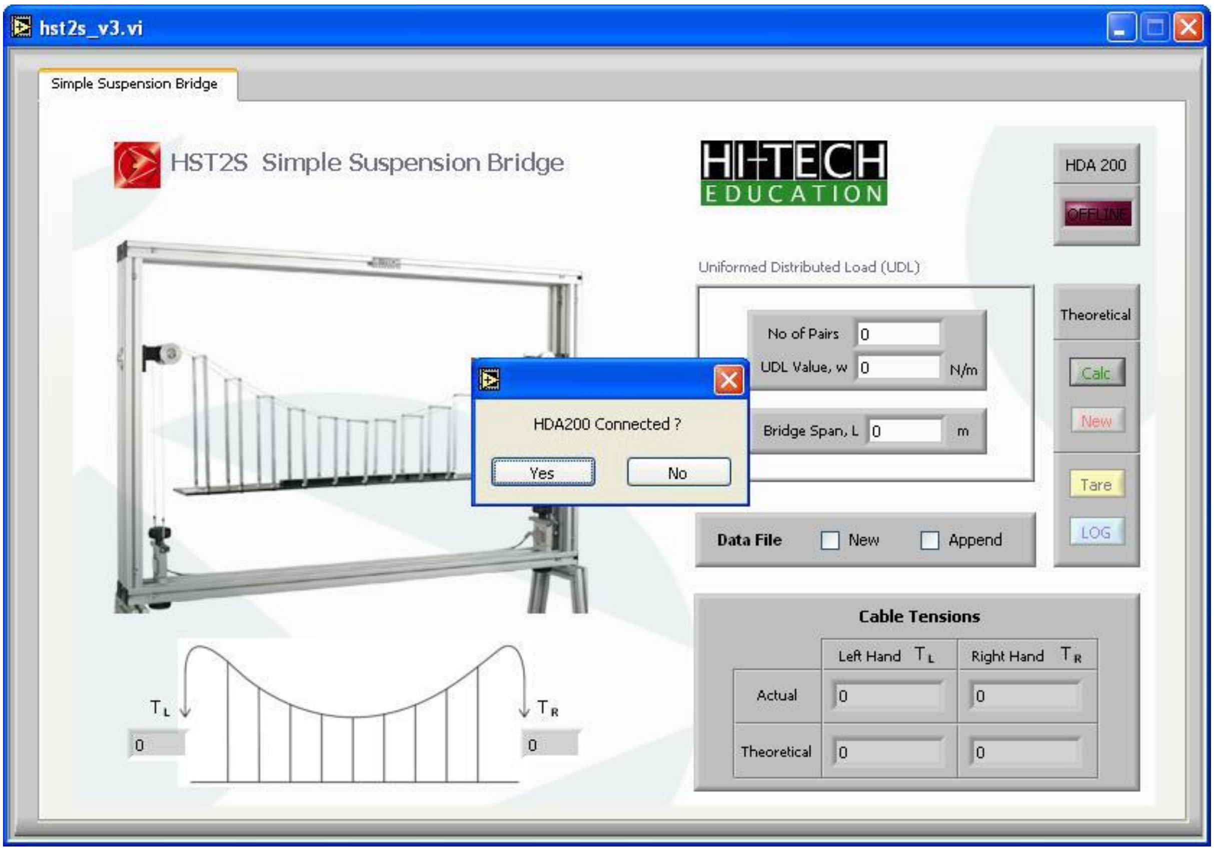


5. This will be a common theme for all softwares.

Common Software occurrences

For all softwares certain aspects will be common, and hence are listed here for reference:

OFFLINE & ONLINE MODE



1. You will notice that in the middle of the software screen is the following small window message:

2. If you wish to run the software in conjunction with the hardware then the HDA200 needs to be connected to the host computer and found using the find_HDA200 software (see HDA200 Installation Software Procedure Manual-xx.doc). By pressing the button '**YES'** from the pop up window above you are then permitting the software to connect to the HDA200 Interface and to obtain true values from the hardware. We will call this 'ON-LINE'.

3. When the ‘YES’ button is pressed the following will appear in the top right hand corner of the software screen:

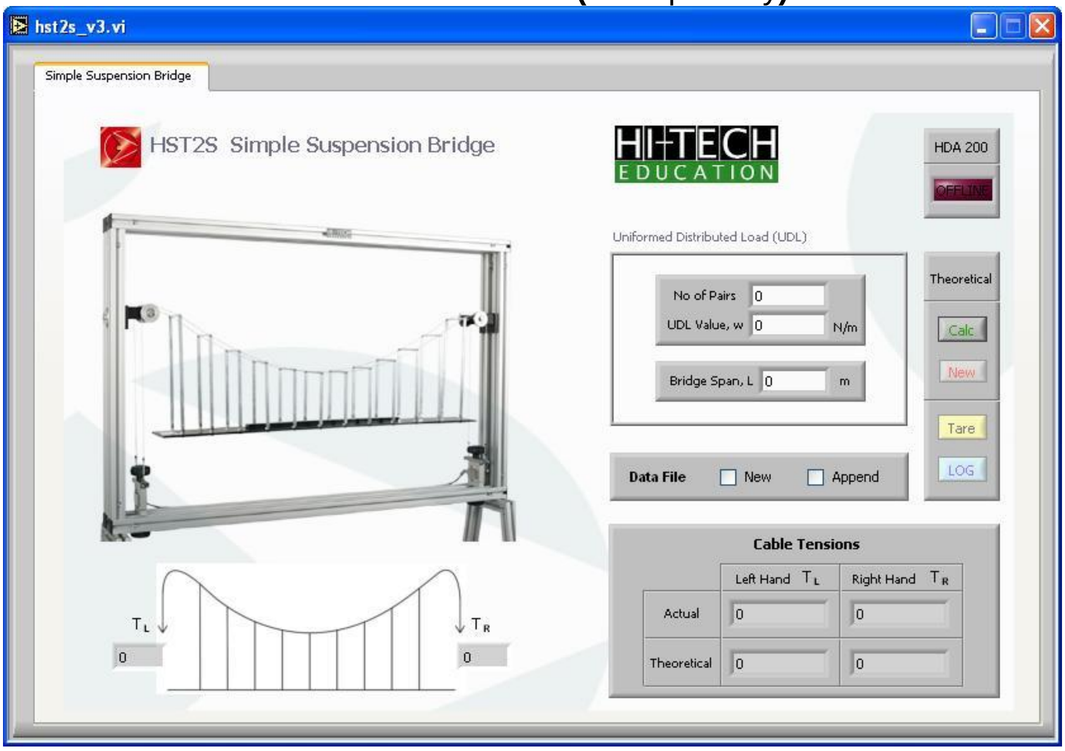
This denotes the software is working in ‘ONLINE’ mode.

4. If you wish to run the software completely remote from the hardware (OFF-LINE) then simply press the ‘**NO’** button when the pop up window appears above.
5. When the ‘NO’ button is pressed the following will appear in the top right corner of the software screen:

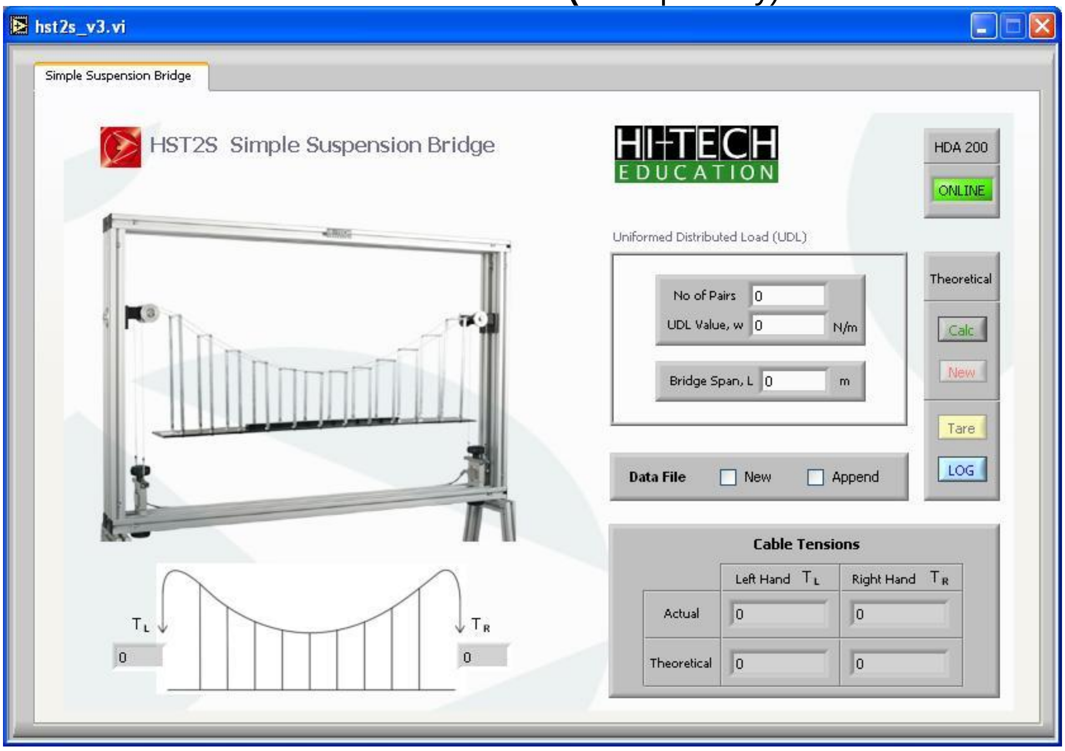
This denotes the software is working in ‘OFFLINE’ mode.

6. Depending on what mode you are running in you will then see the following software windows in the screen of the host computer:

OFFLINE MODE (Example only**)**



ONLINE MODE (Example only)



ONLINE MODE with HDA200

1. Connect the HDA200 to the power supply and host computer and at the same time keep you finger pressed down onto the upper button. The following screen will appear:

2. The next screen will appear.

3. If the experiment number is not present in the screen above then press the button next to the words CHANGE. Press the button until the experiment number that you require appears

4. Press the  button next to the word SELECT. The next screen will appear.

5. Press the  button next to the word NO and the following screen will appear.

6. Press the  button next to the word USB and the following screen will appear

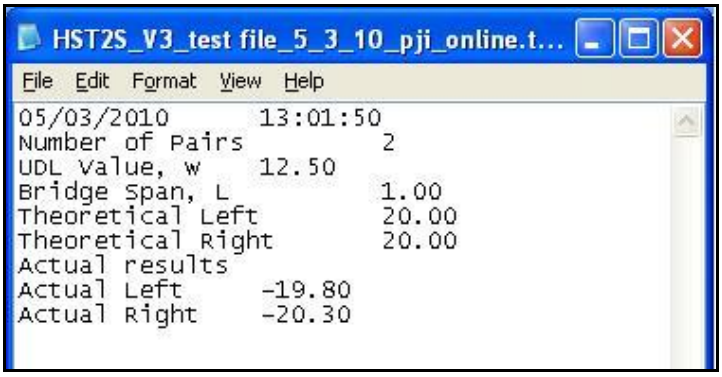
7. Start the software and when the pop window appears asking if the HDA200 is connected, press the ‘YES’ button.

DATA FILE CONTENTS

The data file created contains information that is useful in allowing the end user to further manipulate the data in a spreadsheet software.

The image below shows the typical data at the start of the data file for this experiment when a new file has been created and the LOG button has been pressed:

The data is as follows:



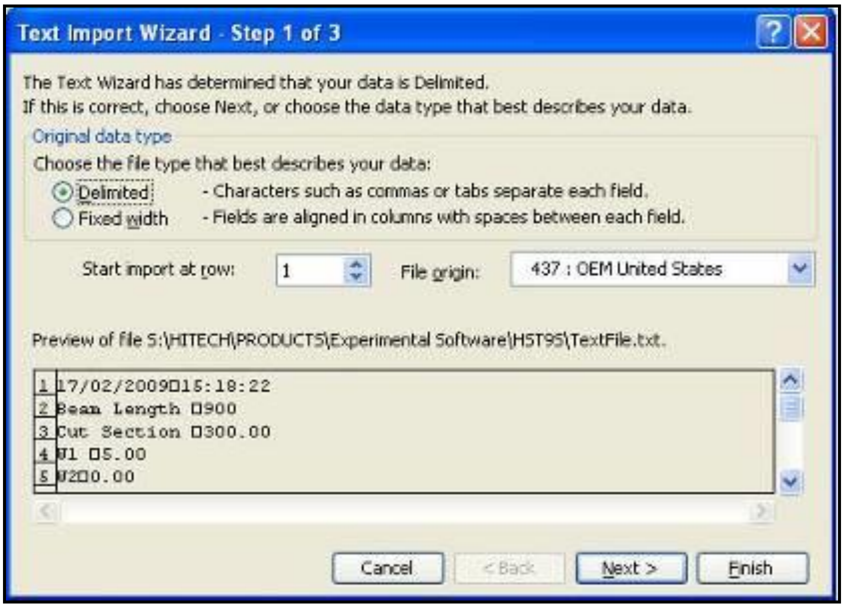
The information will then repeat itself depending on how many test points have been logged.

IMPORTING DATA FILES INTO SPREADSHEET SOFTWARE

The data file can be imported into spreadsheet software such as EXCEL. From the spreadsheet it is then possible to arrange the data into a format of your choosing.

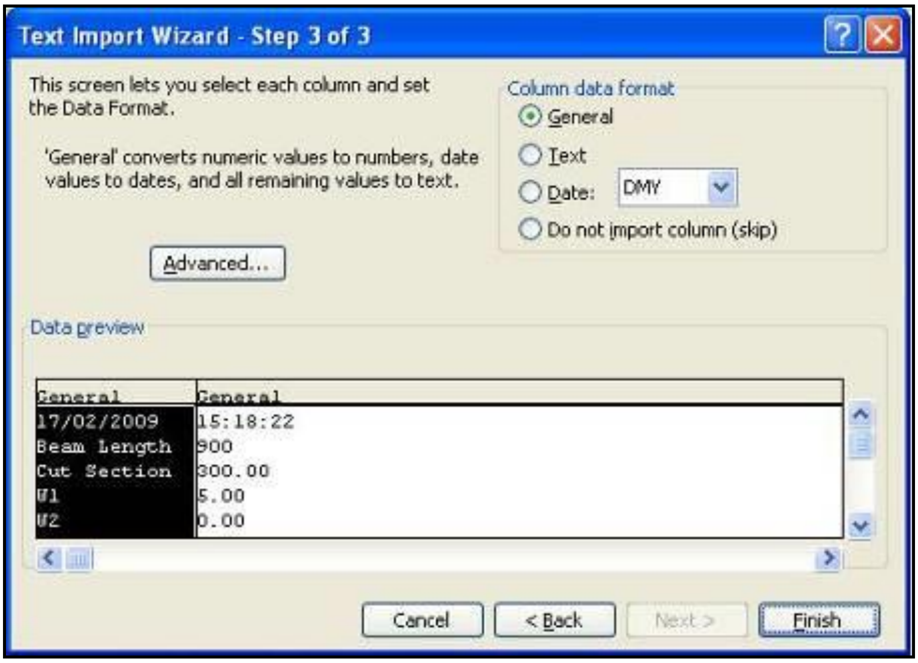
To do this follow the procedure listed below (this procedure uses Excel as the spreadsheet software):

1. Open the spreadsheet software and have a new worksheet open.
2. Open the data file from the location that it is saved within.
3. You will be shown the following window:



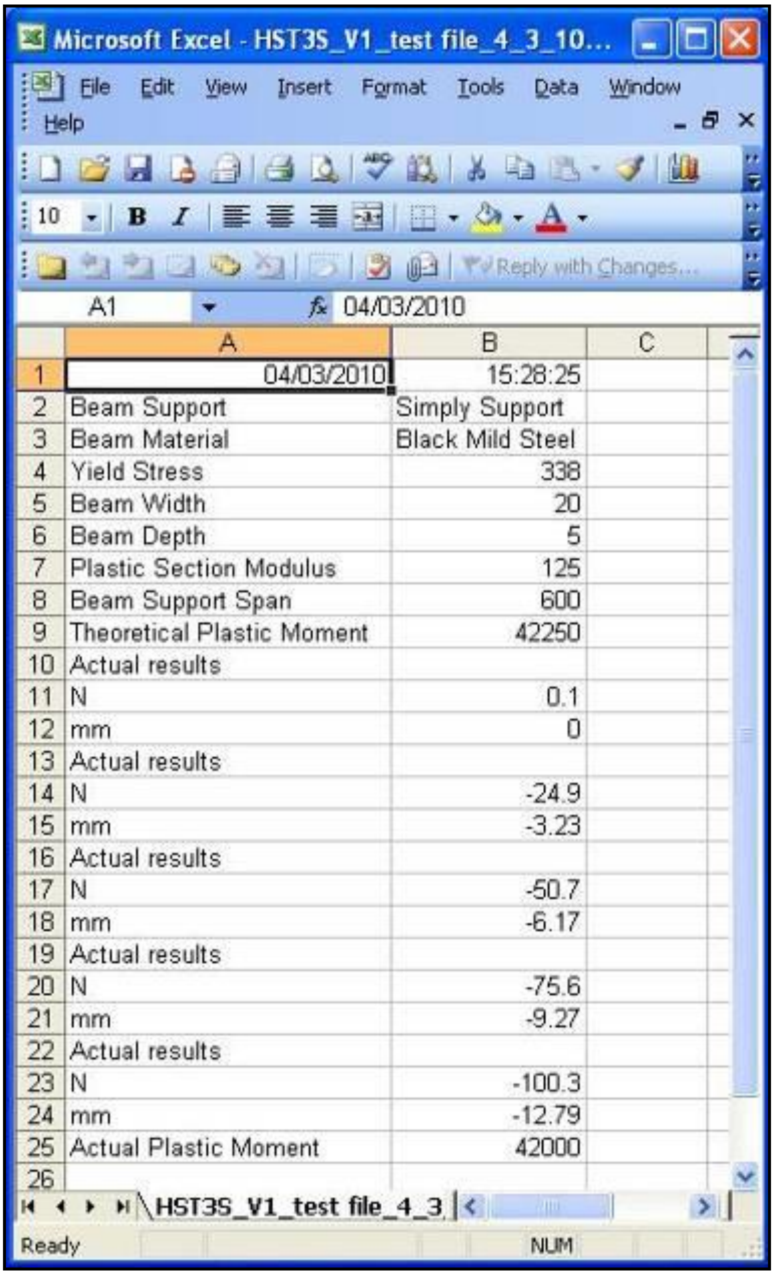
4. Press the **Next >** button.
5. The following screen will appear:

6. Press the **Next >** button.
7. The following screen will appear:



8. Press **Finish**.
9. The data will now be imported into the work sheet of the spreadsheet software and will allow further manipulation.

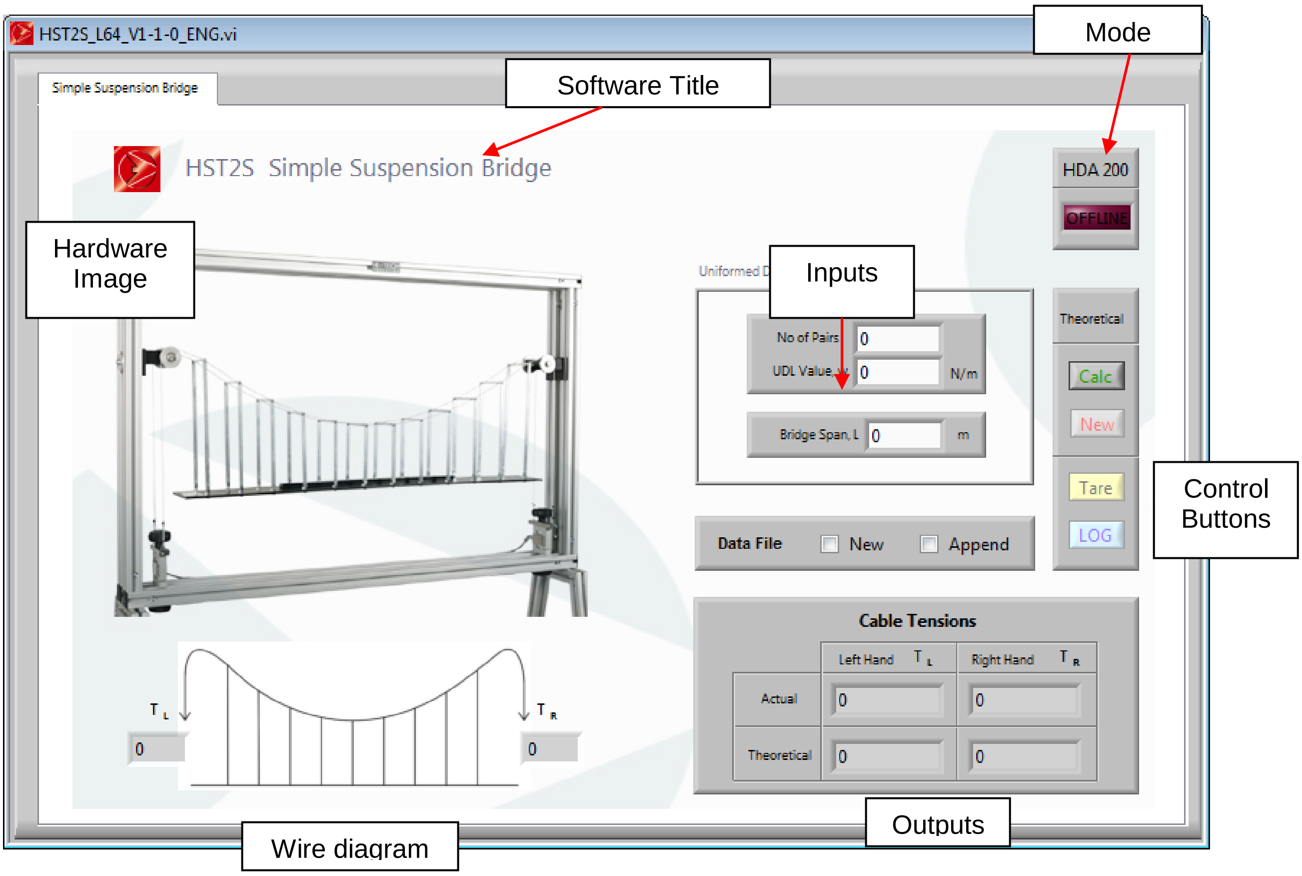
10. Alternatively simply open a fresh worksheet in the spreadsheet software and drag and drop the text file into the worksheet. It will be laid out as shown below. You may have to adjust the column widths to ensure all values are visible.



	A	B	C
1	04/03/2010	15:28:25	
2	Beam Support	Simply Support	
3	Beam Material	Black Mild Steel	
4	Yield Stress	338	
5	Beam Width	20	
6	Beam Depth	5	
7	Plastic Section Modulus	125	
8	Beam Support Span	600	
9	Theoretical Plastic Moment	42250	
10	Actual results		
11	N	0.1	
12	mm	0	
13	Actual results		
14	N	-24.9	
15	mm	-3.23	
16	Actual results		
17	N	-50.7	
18	mm	-6.17	
19	Actual results		
20	N	-75.6	
21	mm	-9.27	
22	Actual results		
23	N	-100.3	
24	mm	-12.79	
25	Actual Plastic Moment	42000	
26			

HST2S – SIMPLE SUSPENSION BRIDGE

SOFTWARE WINDOW



In either mode the details of what is presented in the software window is the same. These are highlighted in the above image and detailed as follows:

Hardware image: This is a true representation of the actual hardware thus ensuring consistency in viewing between software and hardware.

Software Title: The title and number of the software.

Mode: This highlights which mode the software is in, i.e. OFFLINE or ONLINE.

Inputs: These boxes allow the end user to input values for the specific parameters listed. The blue boxes on the left hand column show the description of the input and the right hand column blue boxes show the units for these parameters. The central column is where the value is input via the keyboard. It is possible to press the TAB button on the keyboard and the cursor will jump to the next parameter.

The inputs available are as follows:

- **No. of Pairs:** These are the number of pairs of UDL bars being placed onto the bridge deck.
- **UDL value, w:** This is the value of the UDL bars being added to the bridge deck.
- **Bridge span, L:** Enter the value of the bridge deck span. This value is in metres.

Outputs: These are theoretical values and actual values from the hardware based on the input parameters chosen. This is where the end user can compare actual results with theoretical.

The outputs available are as follows:

- **Left Hand, T_L:** The actual and theoretical cable tension for the left hand end of the suspension bridge. These are also displayed on the wire diagram. In offline mode only the theoretical value will appear.
- **Right Hand, T_R:** The actual and theoretical cable tension for the left hand end of the suspension bridge. These are also displayed on the wire diagram. In offline mode only the theoretical value will appear.

Control buttons: these buttons give the end user a choice of what to do with the software and the values presented on the screen. They are described in more detail as follows:

- **CALC**: When the inputs have been set, pressing this button will calculate the theoretical outputs.
- **NEW**: When this button is pressed it stops background processes and allows any of the inputs to be adjusted and then recalculated. You will have to wait a short time for the background processing to finish. When finished the CALC button becomes live and the NEW button becomes inactive.
- **LOG**: When the end user wishes to record ACTUAL data from the software during ONLINE running, they can press this button and the key input and output parameters will then be logged into the data file.
- **Data File NEW:** This tick box is used when the end user wishes to store the input and output data to a brand new file on the host computer. When this is ticked and the CALC button pressed you will be prompted to create a new data file. **You can only choose this button or the append button, not both.**
- **Data file APPEND:** If a data file has already been created then ticking this box will allow data to be added to this file rather than having to create a new file.

OPERATING THE SOFTWARE

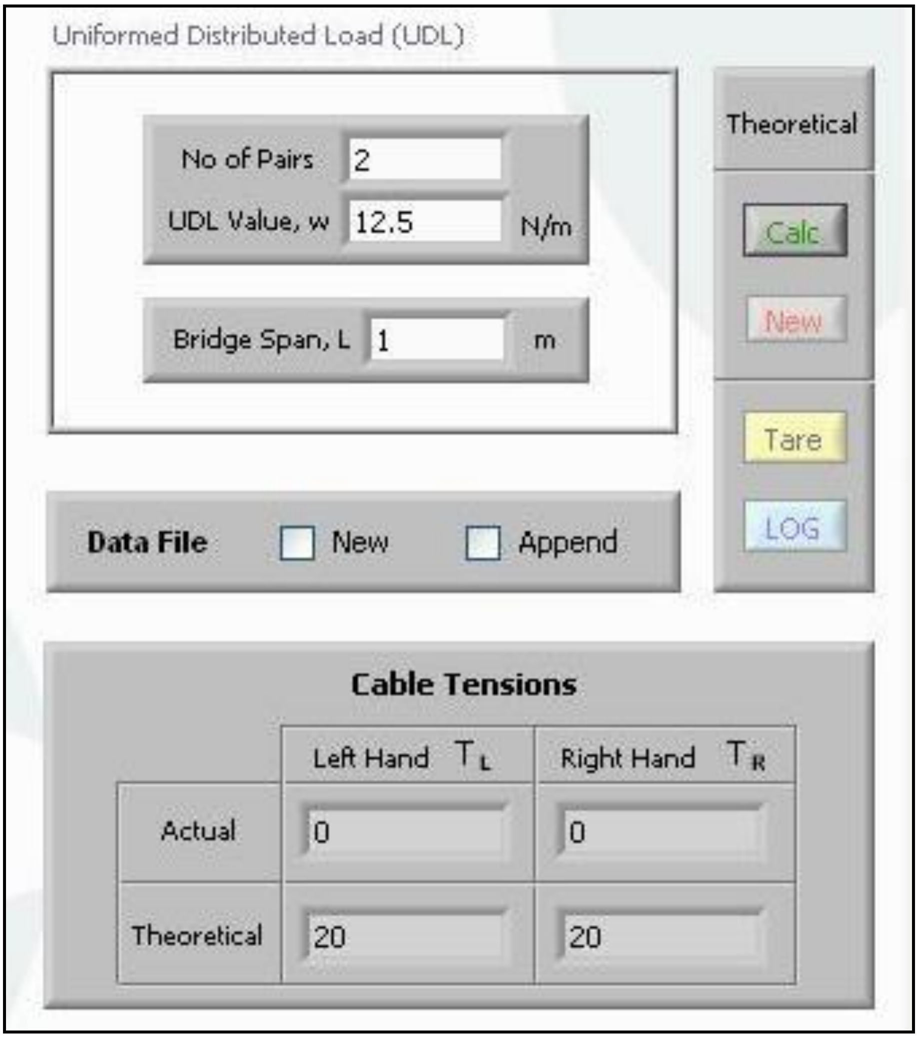
The following procedure outlines the steps required to operate the software and to obtain outputs for the inputs chosen. It is one of many variations that could be followed.

It assumes that the end user has set up the HDA200 (if necessary) and installed the software correctly and all inputs are being undertaken using the keyboard of the host computer.

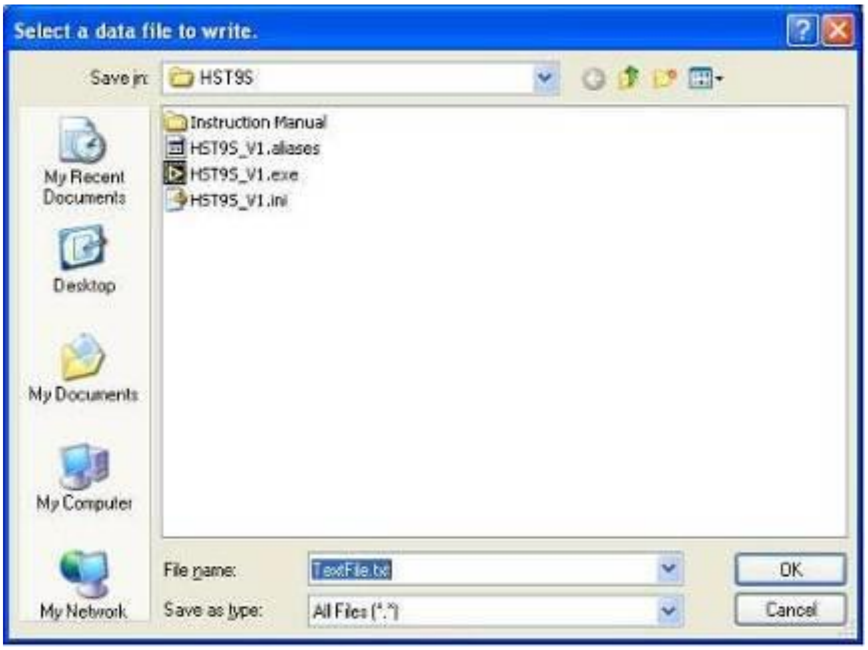
OFFLINE MODE

1. Load the experiment software by double clicking the **.exe** files supplied.
2. Choose ‘NO’ when the pop up window appears asking if the HDA200 is connected.
3. Enter 1000 in the arch span input box.
4. Enter 200 in the arch rise input box.
5. Select Point from the type of load drop down menu.
6. Enter 50 in the single point load, W input box.
7. Choose 0.500 as the span fraction.

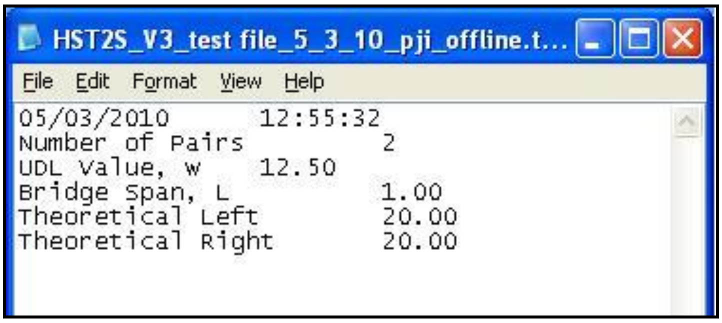
8. Press the CALC button with no data file tick boxes ticked. The screen should appear as follows:



9. The theoretical cable tensions will be presented on the hardware image also.
10. The TARE button, although live will not operate in offline mode.
11. Press the NEW button
12. Tick the Data File NEW box.
13. Right click on the graph and choose clear graph. Repeat this for the graph on the graph tab also.
14. Press CALC.
15. You will then be shown the following window (the contents of this window will vary depending on the experiment running) and prompted to create a data file name in the location of your choice.



16. Either rename the default name of TextFile.txt or keep this default name. Its up to you. Ensure the file extension of ***.txt*** remains. Once the filename and location have been chosen then press **OK**.
17. The input and output data will now be saved in the data file created. To prove this open the text file in ***NOTEPAD*** that you have just created from its location and check the contents. It should look similar to the image below.



18. If you wish to change the inputs then simply press the NEW button, change the input parameter, press the data file APPEND button and then press CALC. You will be given the data file to append to, choose this and then press ok.
19. The data file should now have the new data saved into it, AND added (appended) to the existing data.
20. In the OFFLINE mode the LOG button will be greyed out.
21. When finished with the software shut the software down.
22. You can continue to adjust the inputs and see what outputs are obtained by following the same process above.

HDA200 CHANNEL SETTINGS and CONNECTIONS

Prior to running this experiment software in ONLINE mode with the HDA200 you will have to make sure that the correct experiment hardware sensors/transducers are connected to the HDA200 and the correct channels are being displayed by the HDA200. Refer to the HDA200 instruction manual and use the following table as a reference also:

Sensor/Transducer	HDA200 Connector Number	HDA200 Channel number	Resolution
Load Cell	Force 1	17	
Load Cell	Force 2	18	

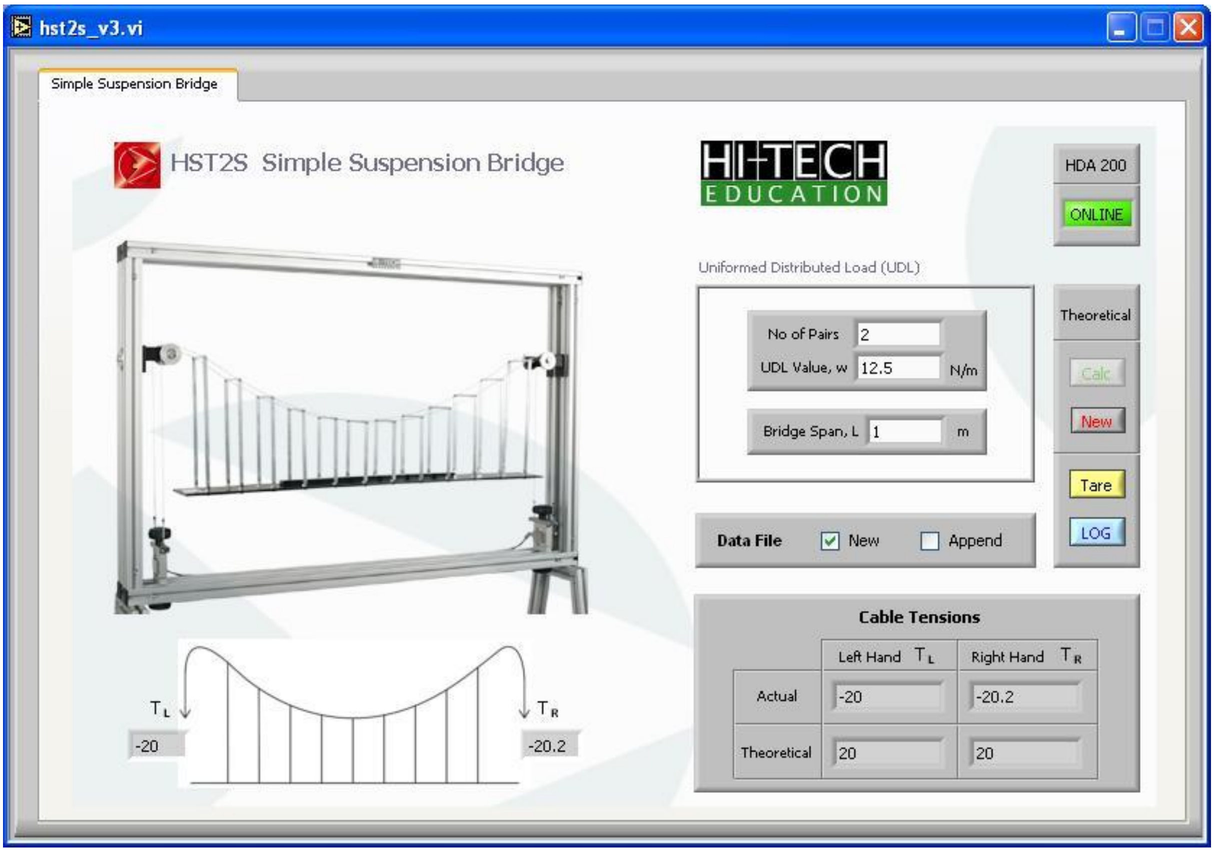
Run the HDA200 in LOCAL mode to check that the above channels only are being displayed. This will then ensure that the software collects the right data from the right channels.

NB: If the dial gauges (if used) are connected but not turned on then the software and HDA200 will not display the dial gauge values and the software and HDA200 screens will wait until they are turned on. Ensure the dial gauges are turned on when running the experiment and software.

If the above channels are not set correctly then you will have to enter the configuration of the HDA200 which will require reading and following the HDA200 instruction manual.

ONLINE MODE

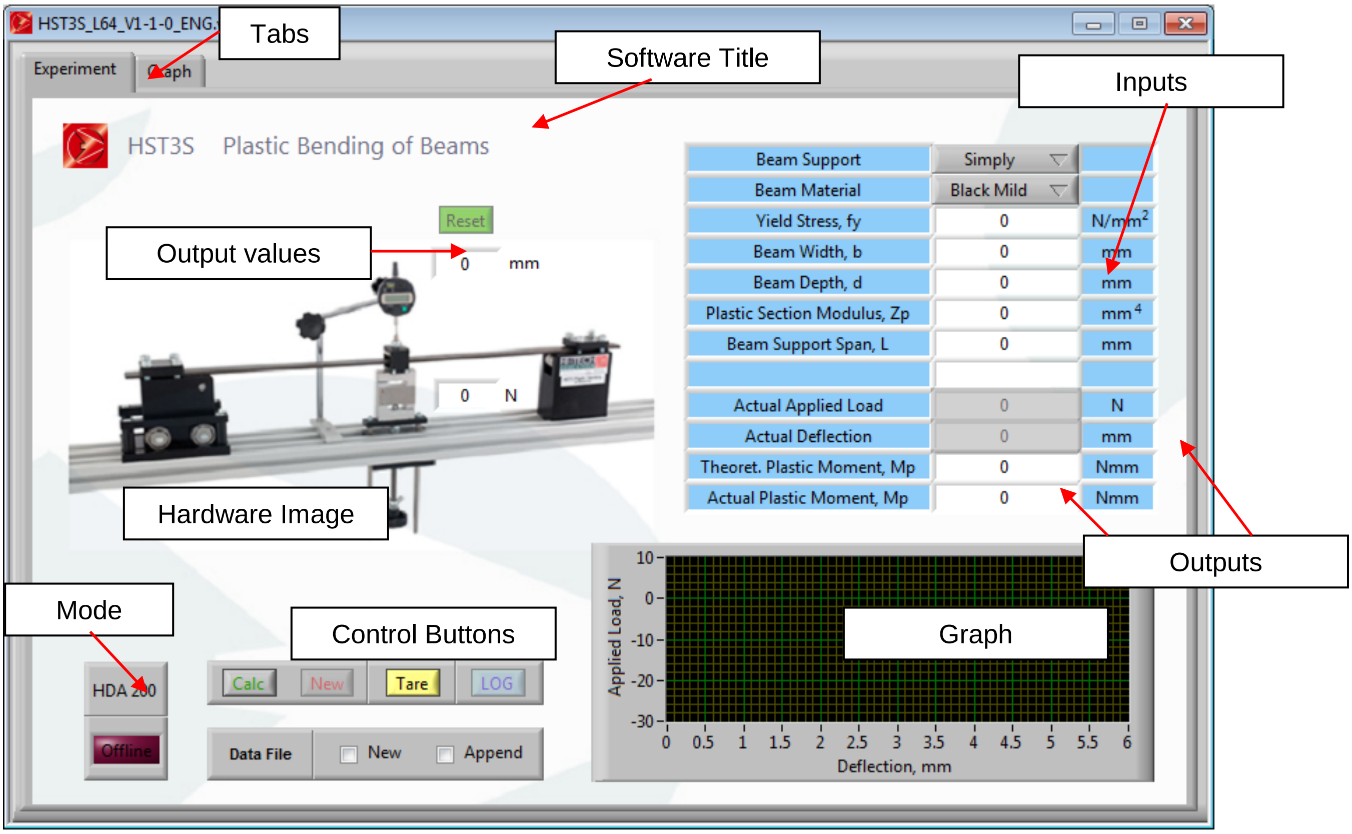
Repeat the input parameters from the OFFLINE mode procedure above, press the CALC button and the software window should look like the image below:



1. In 'ONLINE' mode you will notice that the actual cable tensions are no longer greyed out. These values will now start to change as they come in from the HDA200.
2. Load the hardware experiment to the same parameters as the input boxes. You should then be able to compare the actual values with theoretical values.
3. If you wish to save the data into a NEW or existing data file then press NEW to stop the software capturing data from the HDA200.
4. Tick the data file option required.
5. Press the CALC button and you will be prompted to create a new data file or append to the existing file. Choose the option required.
6. The input parameters will then be saved to the data file.
7. Press the LOG button to store the actual values to the data file.
8. Should you change the hardware load to a new value and you wish to change the software inputs then adjust the hardware, press NEW, adjust the software inputs to be the same as the hardware, click the data file APPEND tick box and then press CALC.
9. You can then continue to create new inputs and obtain new outputs depending on how you set up the hardware and by following the procedure above.
10. The graph will be drawn automatically each time the actual applied load and hence actual applied torque are changed.

HST3S – PLASTIC BENDING OF BEAMS

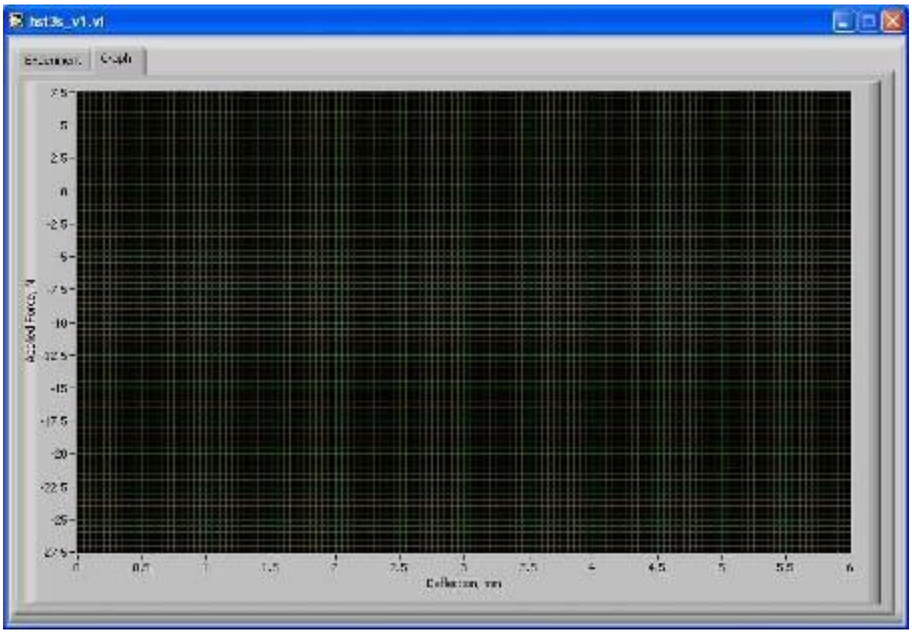
SOFTWARE WINDOW



In either mode the details of what is presented in the software window is the same. These are highlighted in the above image and detailed as follows:

Hardware image: This is a true representation of the actual hardware thus ensuring consistency in viewing between software and hardware.

Tabs: The main experiment software is on the tab labelled experiment. A larger version of the graph is displayed when the graph tab is pressed (see image below):



Software Title: The title and number of the software.

Mode: This highlights which mode the software is in, i.e. OFFLINE or ONLINE.

Inputs: These boxes allow the end user to input values for the specific parameters listed. The blue boxes on the left hand column show the description of the input and the right hand column blue boxes show the units for these parameters. The central column is where the value is input via the keyboard. It is possible to press the TAB button on the keyboard and the cursor will jump to the next parameter.

The inputs available are as follows:

- **Beam support:** Choose from the drop down list between simply supported, propped cantilever, fixed. This links in with the elements of the hardware experiment.
- **Beam material:** This is fixed at Black Mild Steel which is the material supplied with the hardware experiment.
- **Yield Stress, fy**: Enter the yield stress of the black mild steel. This is typically 338 N/mm^2.
- **Beam width, b**: Enter the beam width in millimetres.
- **Beam height, d**: Enter the beam height in millimetres.
- **Plastic section modulus, Zp**: This value is calculated automatically.
- **Beam support span, L**: Enter the support span in millimetres.

Outputs: These are theoretical values and actual values from the hardware based on the input parameters chosen. This is where the end user can compare actual results with theoretical.

The outputs available are as follows:

- **Actual Applied Load:** This is the actual applied load from the hardware itself via the HDA200. This value is also displayed on the hardware image.
- **Actual Deflection**: This is the actual dial gauge value from the hardware. It has the units of millimetres. This value is also displayed on the hardware image.
- **Theoret. Plastic Moment, Mp**: This is the theoretically calculated plastic moment based on the geometry given.
- **Actual Plastic moment, Mp:** This is the actual plastic moment based on the actual results obtained from the hardware.

Control buttons: these buttons give the end user a choice of what to do with the software and the values presented on the screen. They are described in more detail as follows:

- **CALC**: When the inputs have been set, pressing this button will calculate the theoretical outputs.
- **NEW**: When this button is pressed it stops background processes and allows any of the inputs to be adjusted and then recalculated. You will have to wait a short time for the background processing to finish. When finished the CALC button becomes live and the NEW button becomes inactive.
- **LOG**: When the end user wishes to record ACTUAL data from the software during ONLINE running, they can press this button and the key input and output parameters will then be logged into the data file.
- **Data File NEW:** This tick box is used when the end user wishes to store the input and output data to a brand new file on the host computer. When this is ticked and the CALC button pressed you will be prompted to create a new data file. You can only choose this button or the append button, not both.
- **Data file APPEND:** If a data file has already been created then ticking this box will allow data to be added to this file rather than having to create a new file.

Graph: Each time a load position is set and the LOG button pressed the graph will be plotted. Each point will be added to the graph. The same graph is displayed on the graph tab. To clear the graph simply right click the cursor on the graph and choose clear chart.

Rest: The dial gauge supplied with the hardware apparatus will have a limited measuring range. When the maximum range of the dial gauge is reached during a test, this reset button can be pressed, the dial gauge then manually zeroed using the front buttons on the dial gauge display, and then the test resumed. Any new values of deflection will be added to the last value saved prior to the reset button being pressed. This then allows measurements up to 50mm to be taken.

OPERATING THE SOFTWARE

The following procedure outlines the steps required to operate the software and to obtain outputs for the inputs chosen. It is one of many variations that could be followed.

It assumes that the end user has set up the HDA200 (if necessary) and installed the software correctly and all inputs are being undertaken using the keyboard of the host computer.

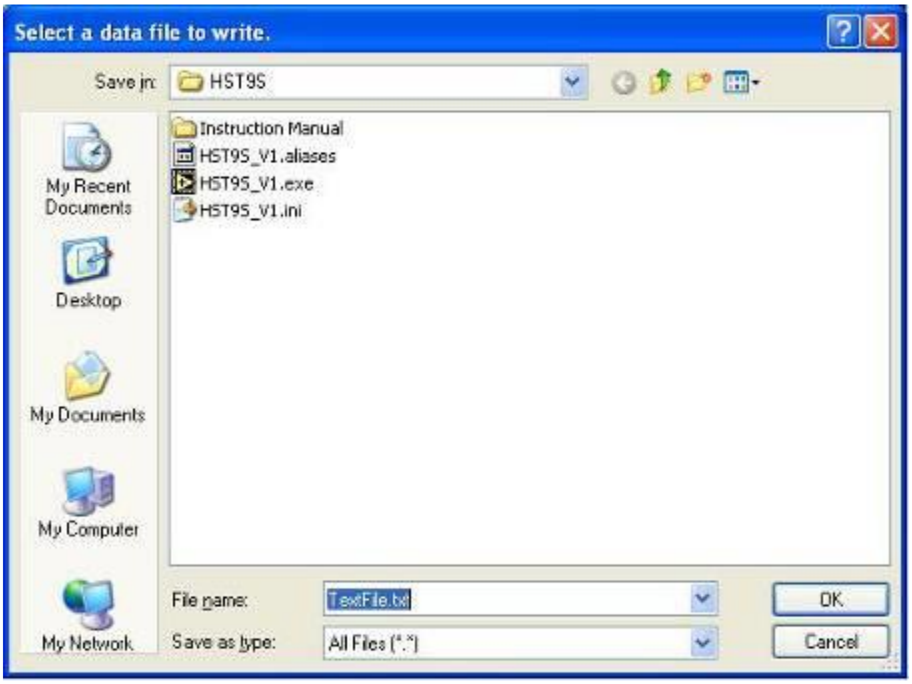
OFFLINE MODE

1. Load the experiment software by double clicking the **.exe** files supplied.
2. Choose 'NO' when the pop up window appears asking if the HDA200 is connected.
3. Select 'Simply support' in the beam support drop down list.
4. Enter 338 in the yield stress, fy input box.
5. Enter 20 in the beam width, b input box.
6. Enter 5 in the beam height, d input box.
7. The plastic section modulus will be calculated automatically.
8. Enter 600 in the beam support span, L input box.
9. Press the CALC button with no data file tick boxes ticked. The screen should appear as follows:

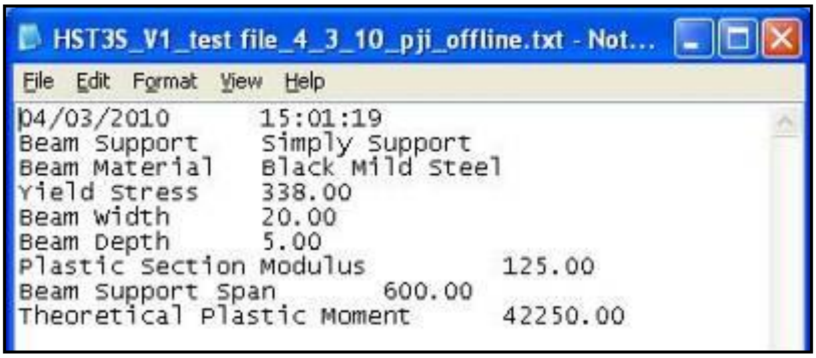
Beam Support	Simply Support ▽	
Beam Material	Black Mild Steel ▽	
Yield Stress, fy	338	N/mm^2
Beam Width, b	20	mm
Beam Depth, d	5	mm
Plastic Section Modulus, Zp	125	mm^4
Beam Support Span, L	600	mm
Actual Applied Load	0	N
Actual Deflection	0	mm
Theoret. Plastic Moment, Mp	42250	Nmm
Actual Plastic Moment, Mp		Nmm

10. The theoretical plastic moment in the first output box. The actual plastic moment will not appear because the actual applied load and actual deflection are greyed out because you are in 'OFFLINE' mode.
11. Press the NEW button
12. Tick the Data File NEW box.
13. Press CALC.

14. You will then be shown the following window (the contents of this window will vary depending on the experiment running) and prompted to create a data file name in the location of your choice.



15. Either rename the default name of TextFile.txt or keep this default name. Its up to you. Ensure the file extension of ***.txt*** remains. Once the filename and location have been chosen then press **OK**.
16. The input and output data will now be saved in the data file created. To prove this open the text file in ***NOTEPAD*** that you have just created from its location and check the contents. It should look similar to the image below.



17. If you wish to change the inputs then simply press the NEW button, change the input parameter, press the data file APPEND button and then press CALC. You will be given the data file to append to, choose this and then press ok.
18. The data file should now have the new data saved into it, AND added (appended) to the existing data.
19. In the OFFLINE mode the LOG button will be greyed out.
20. When finished with the software shut the software down. You can continue to adjust the inputs and see what outputs are obtained by following the same process above.

HDA200 CHANNEL SETTINGS and CONNECTIONS

Prior to running this experiment software in ONLINE mode with the HDA200 you will have to make sure that the correct experiment hardware sensors/transducers are connected to the HDA200 and the correct channels are being displayed by the HDA200. Refer to the HDA200 instruction manual and use the following table as a reference also:

Sensor/Transducer	HDA200 Connector Number	HDA200 Channel number	Resolution
Load cell	Force 1	17	
Dial Gauge	Dial gauge 1	28	0.01mm

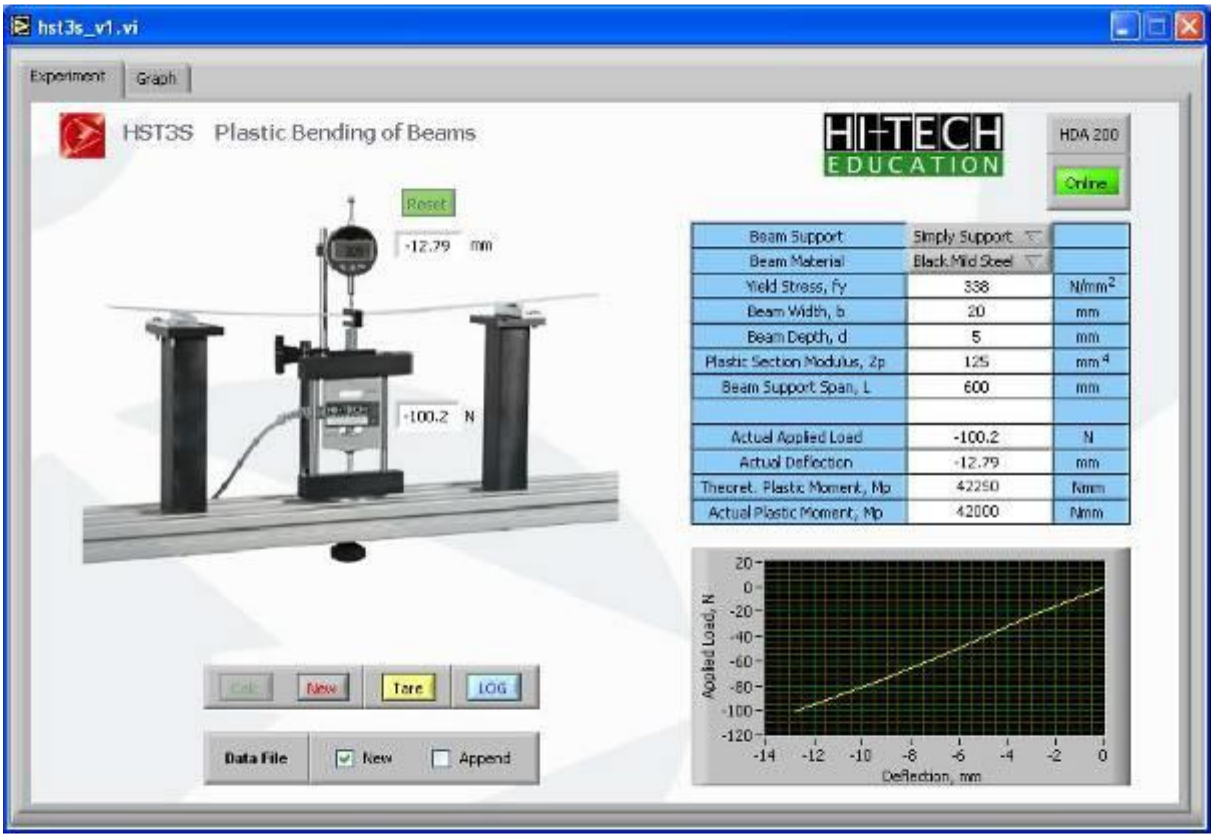
Run the HDA200 in LOCAL mode to check that the above channels only are being displayed. This will then ensure that the software collects the right data from the right channels.

NB: If the dial gauges (if used) are connected but not turned on then the software and HDA200 will not display the dial gauge values and the software and HDA200 screens will wait until they are turned on. Ensure the dial gauges are turned on when running the experiment and software.

If the above channels are not set correctly then you will have to enter the configuration of the HDA200 which will require reading and following the HDA200 instruction manual.

ONLINE MODE

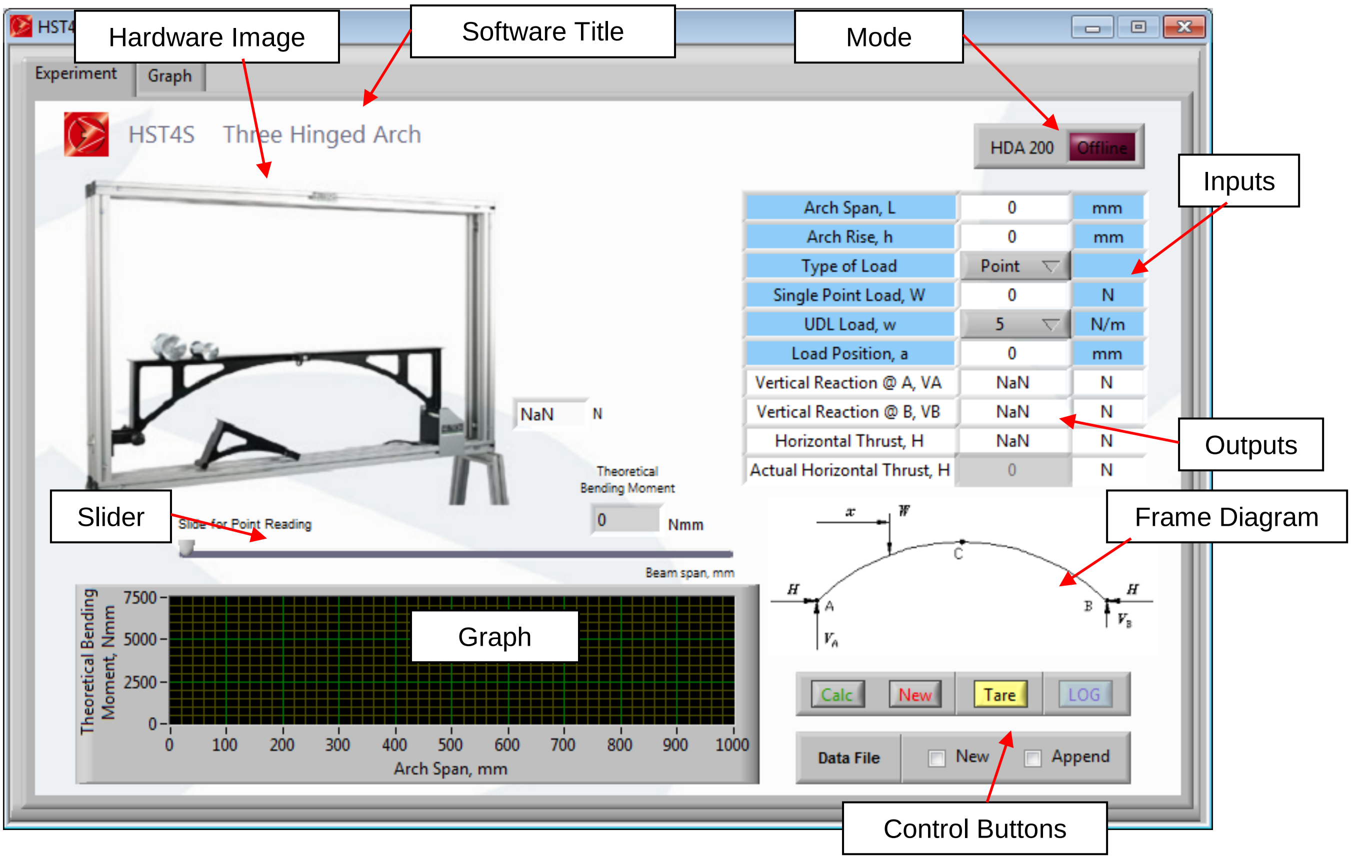
Repeat the input parameters from the OFFLINE mode procedure above, press the CALC button and the software window should look like the image below:



1. In 'ONLINE' mode you will notice that the actual applied load and deflection are no longer greyed out. These values will now start to change as they come in from the HDA200.
2. Load the hardware experiment to the same parameters as the input boxes. You should then be able to compare the actual values with theoretical values.
3. If you wish to save the data into a NEW or existing data file then press NEW to stop the software capturing data from the HDA200.
4. Tick the data file option required.
5. Press the CALC button and you will be prompted to create a new data file or append to the existing file. Choose the option required.
6. The input parameters will then be saved to the data file.
7. Press the LOG button to store the actual values to the data file.
8. Incrementally change the load position from NONE right through to -100mm, and at each increment press the LOG button.
9. The graph will be drawn automatically at each load position point, but you must follow the load position points in turn otherwise the graph will appear incorrect and the actual shear centre will not be correct.

HST4S – THREE HINGED ARCH

SOFTWARE WINDOW



In either mode the details of what is presented in the software window is the same. These are highlighted in the above image and detailed as follows:

Hardware image: This is a true representation of the actual hardware thus ensuring consistency in viewing between software and hardware.

Software Title: The title and number of the software.

Mode: This highlights which mode the software is in, i.e. OFFLINE or ONLINE.

Inputs: These boxes allow the end user to input values for the specific parameters listed. The blue boxes on the left hand column show the description of the input and the right hand column blue boxes show the units for these parameters. The central column is where the value is input via the keyboard. It is possible to press the TAB button on the keyboard and the cursor will jump to the next parameter.

The inputs available are as follows:

- **Arch Span, L:** This is the span of the arch. On the hardware this is 1000mm. It has the units of millimetres (mm).
- **Arch Rise, h:** This is the rise of arch. On the hardware this is 200mm. It has the units of millimetres (mm).
- **Type of load**: the user can select from ‘POINT’ load or ‘UDL’ load. The ‘UDL’ load stands for uniformly distributed load.
- **Single Point Load, W**: When the user selects the type of load as a ‘POINT’ load then the value of the ‘POINT’ load can be input here. It has units of Newton (N).
- **UDL Load *w***: When the user selects the type of load as ‘UDL’ then the value of the ‘UDL’ can be selected from the drop down list. It has the units of N/m.
- **Load Position, a**: This is input by the user between 0 and 1000mm. It has the units of millimetres (mm).

Outputs: These are theoretical values and actual values from the hardware based on the input parameters chosen. This is where the end user can compare actual results with theoretical. Again the format of the columns is the same as the inputs except that the central column is automatically updated depending on the inputs chosen and cannot be adjusted via the keyboard.

The outputs available are as follows:

- **Vertical Reaction @ A, VA**: This is the theoretical vertical reaction at A based on the input parameters chosen. It has the units of Newton’s (N).
- **Vertical Reaction @ B, VB**: This is the theoretical vertical reaction at B based on the input parameters chosen. It has the units of Newton’s (N).
- **Horizontal Thrust, H**: This is the theoretical value of horizontal thrust based on the input parameters selected. It has units of Newton’s (N). When in OFFLINE mode this value of horizontal thrust will appear in the text box in the bottom right hand corner of the hardware image.
- **Actual Horizontal Thrust, H**: This is the actual value of horizontal thrust from the hardware itself. It has units of Newton’s (N). When in ONLINE mode this value of horizontal thrust will appear in the text box in the bottom right hand corner of the hardware image. This value will be greyed out when in OFFLINE mode.

Control buttons: these buttons give the end user a choice of what to do with the software and the values presented on the screen. They are described in more detail as follows:

- **CALC**: When the inputs have been set, pressing this button will calculate the theoretical outputs.
- **NEW**: When this button is pressed it stops background processes and allows any of the inputs to be adjusted and then recalculated.
- **TARE**: This button is only valid when running in ONLINE mode as when pressed it zeroes (tares) the values from any strain gauges and load cell channels which are being used in the software.
- **LOG**: When the end user wishes to record any data from the software during ONLINE running, they can press this button and the key input and output parameters will then be logged into the data file.
- **Data File NEW:** This tick box is used when the end user wishes to store the input and output data to a brand new file on the host computer. When this is ticked and the CALC button pressed you will be prompted to create a new data file.
- **Data file APPEND:** If a data file has already been created then ticking this box will allow data to be added to this file rather than having to create a new file.

Frame Diagram: This represents a schematic of the hardware arrangement and is a cross reference for the inputs. This will not be present on all experiment softwares.

Graph: If present it is possible to view the theoretical bending moment diagram for the parameters chosen. This will be created when the CALC button is pressed.

Slider: To view the theoretical bending moment values along the arch span, the user can move this slider across the arch span at various positions. The value of the bending moment at this position will then appear in the text box in the top right hand corner above the slider.

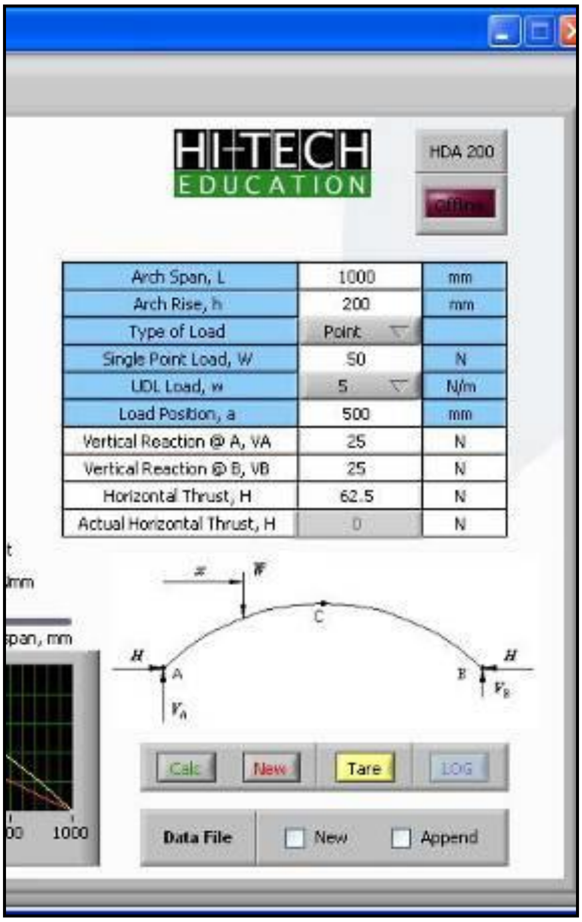
OPERATING THE SOFTWARE

The following procedure outlines the steps required to operate the software and to obtain outputs for the inputs chosen. It is one of many variations that could be followed.

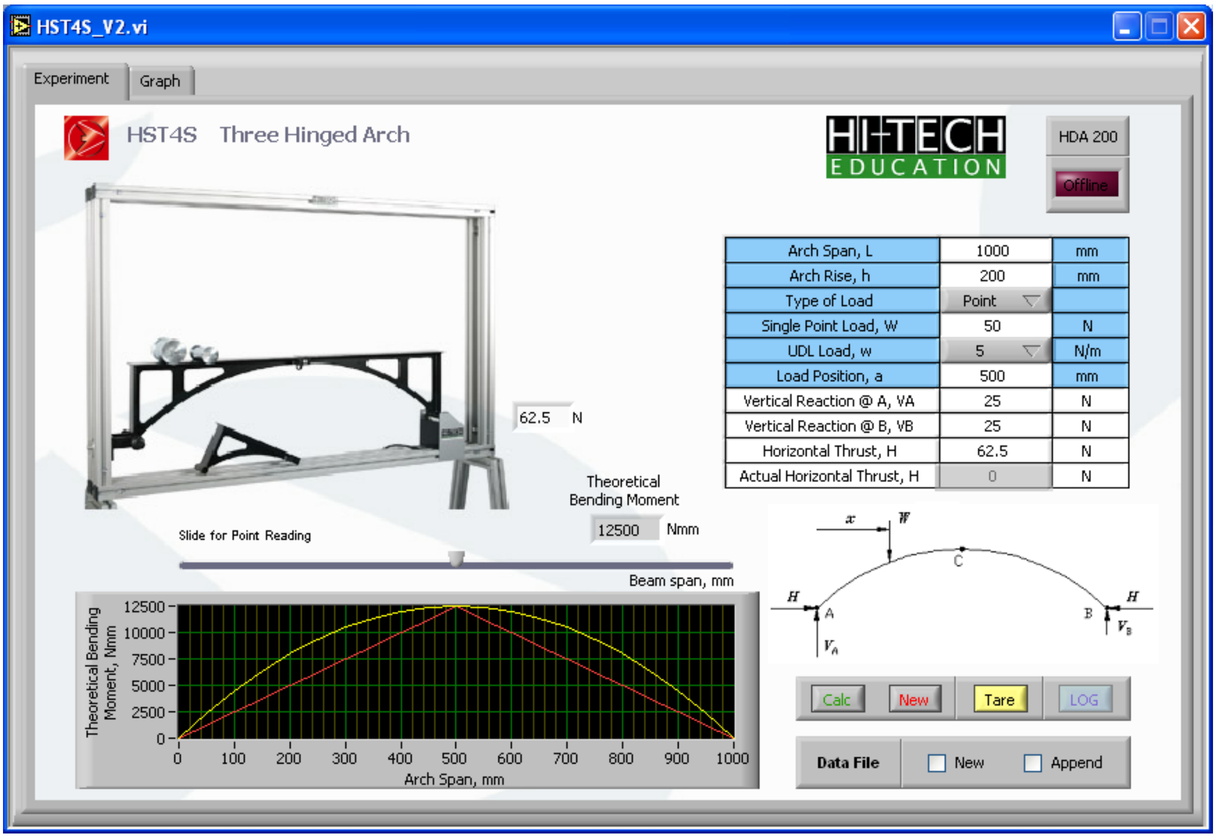
It assumes that the end user has set up the HDA200 (if necessary) and installed the software correctly and all inputs are being undertaken using the keyboard of the host computer.

OFFLINE MODE

1. Load the experiment software by double clicking the **.exe** files supplied.
2. Choose 'NO' when the pop up window appears asking if the HDA200 is connected.
3. Enter 1000 in the Arch Span input box.
4. Enter 200 in the Arch Rise input box.
5. Choose Point Load form the Type of Load drop down list.
6. Enter 50 in the Single Point Load, W input box.
7. Enter 500 in the Load position input box. The screen should now have inputs that look like the following image:

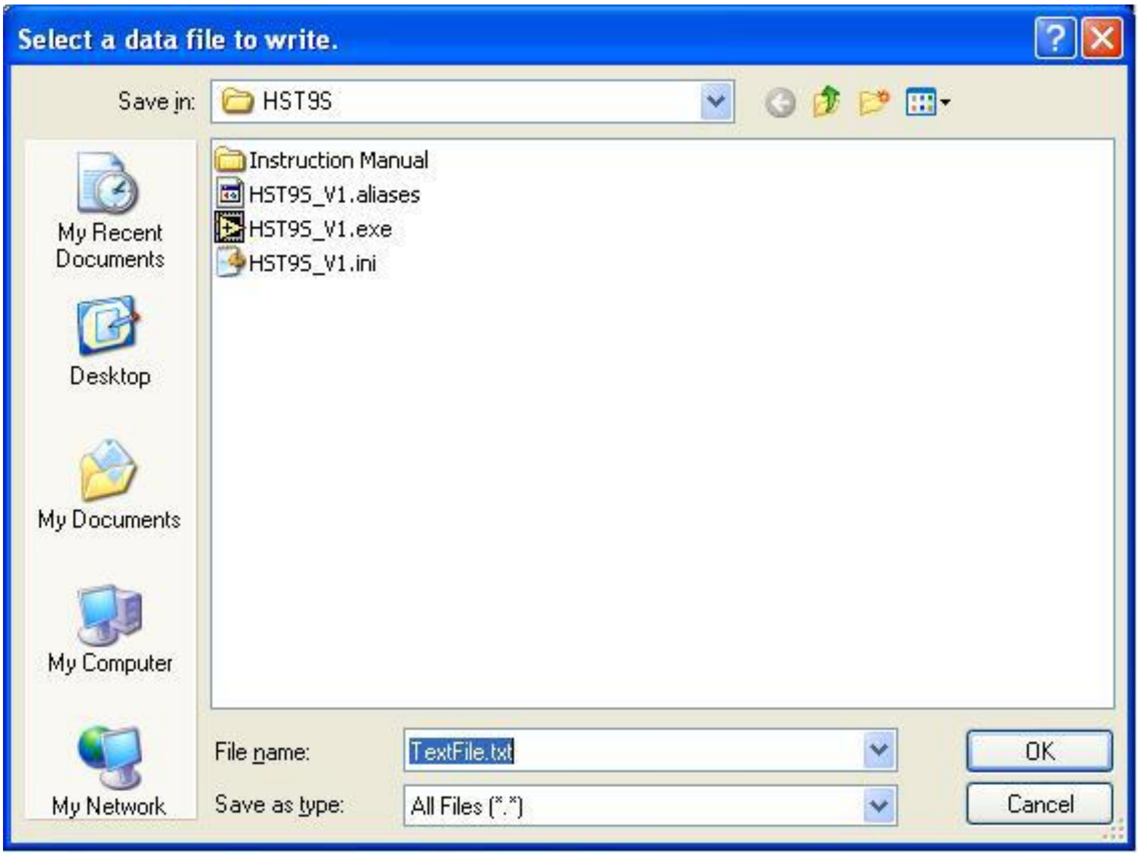


8. Press the CALC button and the values will appear in the output boxes, on the hardware image, the bending moment graph created and moving the slider to mid span will show the bending moment at this point on the arch as shown in the image below:



9. There will be no value for the **Actual Horizontal Thrust, H** as the software has been chosen to run in OFFLINE mode.
10. Right click in the graph display and choose clear chart. This then clears the chart for a new diagram to be created. If you do not clear the chart new graphs will be appended to this existing graph.
11. Tick the Data File NEW box.
12. Press CALC.

13. You will then be shown the following window (the contents of this window will vary depending on the experiment running) and prompted to create a data file name in the location of your choice.



14. Either rename the default name of TextFile.txt or keep this default name. Ensure the file extension of ***.txt*** remains. Once the filename and location have been chosen then press **OK**.
15. A new bending moment graph will appear and the same values appear in the output boxes.
16. The input and output data will now be saved in the data file created.
17. Press the NEW button, and then tick the Data File APPEND box. Press CALC and then choose the same data file as created previously. The current input and output data will now be appended to this file without overwriting the original data.
18. Locate this text file and open in NOTEPAD to see the format and information that it is being saved.
19. If you wish to change the inputs then simply clear the graphs, change the input, choose whether to create a new data file or append to an existing file and then press CALC.
20. In the OFFLINE mode the NEW and TARE buttons although live will not perform any function. The LOG button will not be live and greyed out but the data can still be stored by the use of the CALC button.
21. When finished with the software shut the software down.
22. You can continue to adjust the inputs and see what outputs are obtained by following the same process above.

HDA200 CHANNEL SETTINGS and CONNECTIONS

Prior to running this experiment software in ONLINE mode with the HDA200 you will have to make sure that the correct experiment hardware sensors/transducers are connected to the HDA200 and the correct channels are being displayed by the HDA200. Refer to the HDA200 instruction manual and use the following table as a reference also:

Sensor/Transducer	HDA200 Connector Number	HDA200 Channel number	Resolution
Load cell	Force 1	17	

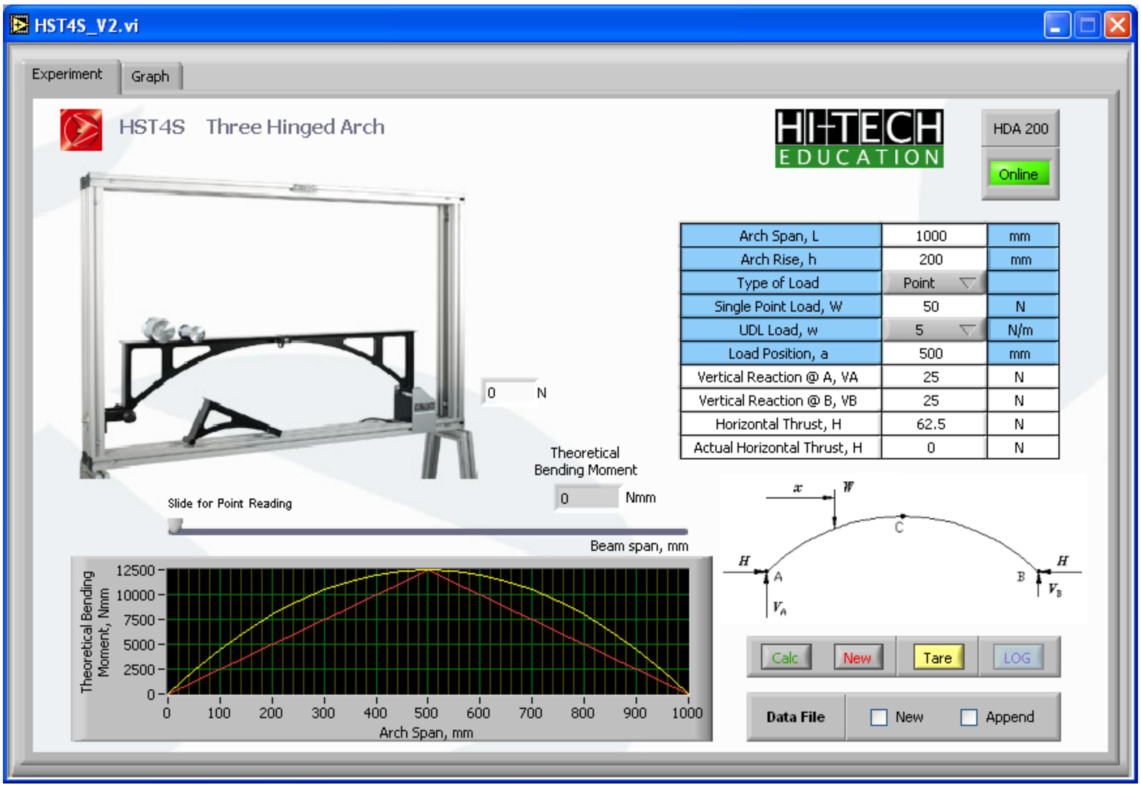
Run the HDA200 in LOCAL mode to check that the above channels only are being displayed. This will then ensure that the software collects the right data from the right channels.

NB: If the dial gauges (if used) are connected but not turned on then the software and HDA200 will not display the dial gauge values and the software and HDA200 screens will wait until they are turned on. Ensure the dial gauges are turned on when running the experiment and software.

If the above channels are not set correctly then you will have to enter the configuration of the HDA200 which will require reading and following the HDA200 instruction manual.

ONLINE MODE

1. Repeat the input parameters from the OFFLINE mode procedure above, press the CALC button and the software window should look like the image below:

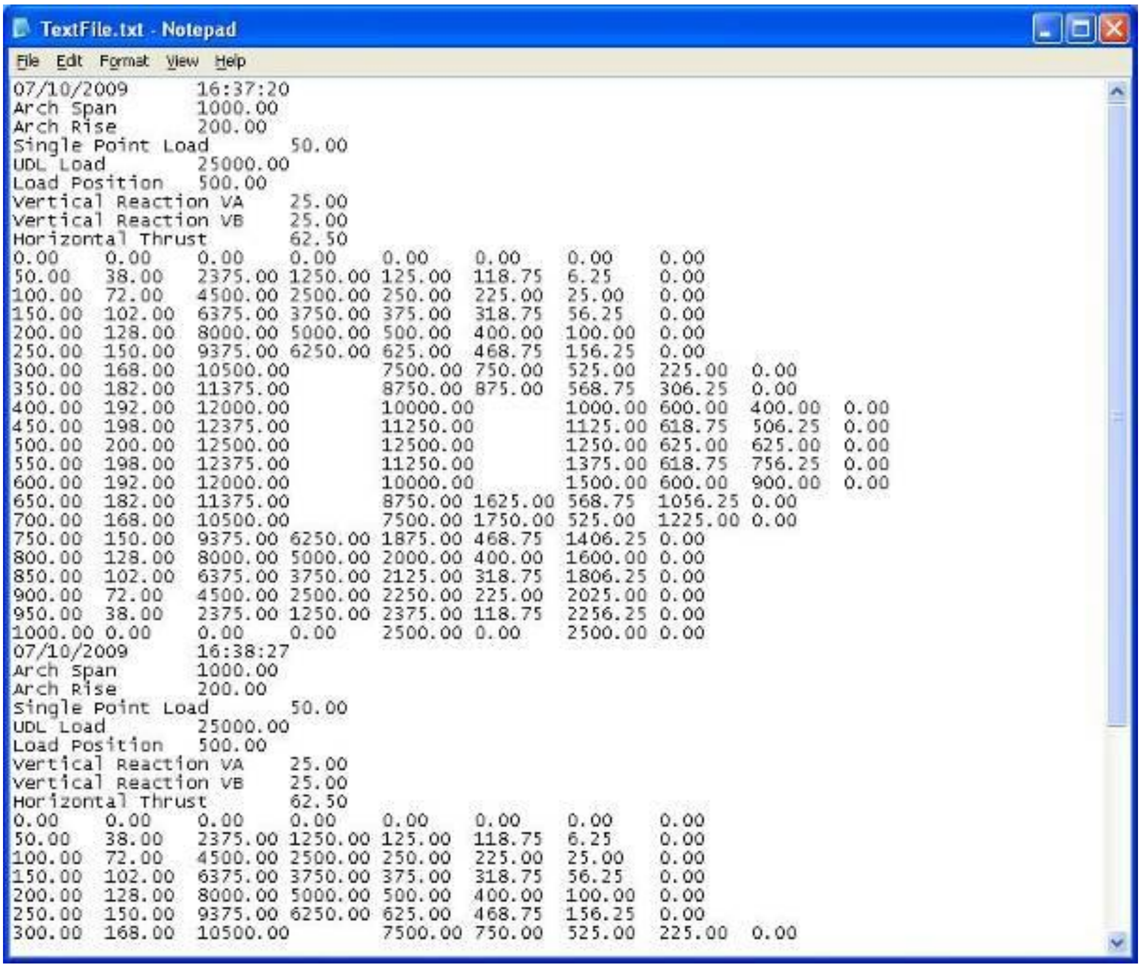


2. You will notice that the **Actual Horizontal Thrust, H** output line is now live and not greyed out.
3. You will now see the actual value of the horizontal thrust coming from the hardware within this output box. To zero this reading simply press the TARE button. You may have to press it again if the reading does not return to zero.
4. Load the hardware experiment to the same parameters as the input boxes. You should then be able to compare the **Actual Horizontal Thrust, H** value with the theoretical value.
5. If you wish to save the data into the existing data file or a new data file then press the NEW button. The value in the **Actual Horizontal Thrust, H** output box will change due to the fact that the software is not retrieving the actual value from the hardware.
6. Clear the graph if necessary.
7. Tick the data file option required.
8. Press the CALC button and you will be prompted to create a new data file or append to the existing file. Choose the option required.
9. The current input and output values will then be saved to the data file.
10. Press the NEW button when you need to change a value of one of the inputs.
11. Change the input parameter.
12. Clear the graph if necessary.
13. Choose whether to create a new data file or append to an existing file.
14. Press CALC and the new outputs will be created along with a graph.
15. You can then continue to create new inputs and obtain new outputs depending on how you set up the hardware and by following the procedure above.

DATA FILE CONTENTS

The data file created contains information that is useful in allowing the end user to further manipulate the data in a spreadsheet software.

The image below shows the typical data at the start of the data file for the HST4S:




```
07/10/2009      16:37:20
Arch Span       1000.00
Arch Rise       200.00
Single Point Load       50.00
UDL Load        25000.00
Load Position   500.00
Vertical Reaction VA    25.00
Vertical Reaction VB    25.00
Horizontal Thrust       62.50
0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00
50.00   38.00   2375.00 1250.00 125.00  118.75  6.25    0.00
100.00  72.00   4500.00 2500.00 250.00  225.00  25.00   0.00
150.00  102.00  6375.00 3750.00 375.00  318.75  56.25   0.00
200.00  128.00  8000.00 5000.00 500.00  400.00  100.00  0.00
250.00  150.00  9375.00 6250.00 625.00  468.75  156.25  0.00
300.00  168.00  10500.00        7500.00 750.00  525.00  225.00  0.00
350.00  182.00  11375.00        8750.00 875.00  568.75  306.25  0.00
400.00  192.00  12000.00        10000.00        1000.00 600.00  400.00  0.00
450.00  198.00  12375.00        11250.00        1125.00 618.75  506.25  0.00
500.00  200.00  12500.00        12500.00        1250.00 625.00  625.00  0.00
550.00  198.00  12375.00        11250.00        1375.00 618.75  756.25  0.00
600.00  192.00  12000.00        10000.00        1500.00 600.00  900.00  0.00
650.00  182.00  11375.00        8750.00 1625.00 568.75  1056.25 0.00
700.00  168.00  10500.00        7500.00 1750.00 525.00  1225.00 0.00
750.00  150.00  9375.00 6250.00 1875.00 468.75  1406.25 0.00
800.00  128.00  8000.00 5000.00 2000.00 400.00  1600.00 0.00
850.00  102.00  6375.00 3750.00 2125.00 318.75  1806.25 0.00
900.00  72.00   4500.00 2500.00 2250.00 225.00  2025.00 0.00
950.00  38.00   2375.00 1250.00 2375.00 118.75  2256.25 0.00
1000.00 0.00    0.00    0.00    2500.00 0.00    2500.00 0.00
07/10/2009      16:38:27
Arch Span       1000.00
Arch Rise       200.00
Single Point Load       50.00
UDL Load        25000.00
Load Position   500.00
Vertical Reaction VA    25.00
Vertical Reaction VB    25.00
Horizontal Thrust       62.50
0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00
50.00   38.00   2375.00 1250.00 125.00  118.75  6.25    0.00
100.00  72.00   4500.00 2500.00 250.00  225.00  25.00   0.00
150.00  102.00  6375.00 3750.00 375.00  318.75  56.25   0.00
200.00  128.00  8000.00 5000.00 500.00  400.00  100.00  0.00
250.00  150.00  9375.00 6250.00 625.00  468.75  156.25  0.00
300.00  168.00  10500.00        7500.00 750.00  525.00  225.00  0.00
```

The data is as follows:

Date and time.
Arch span input value from software.
Arch Rise input value from software.
Single Point Load value from software
UDL Load (even if the software is not being run with UDL selected) from software
Load Position from software
Vertical Reaction VA from software
Vertical Reaction VB from software
Horizontal Thrust

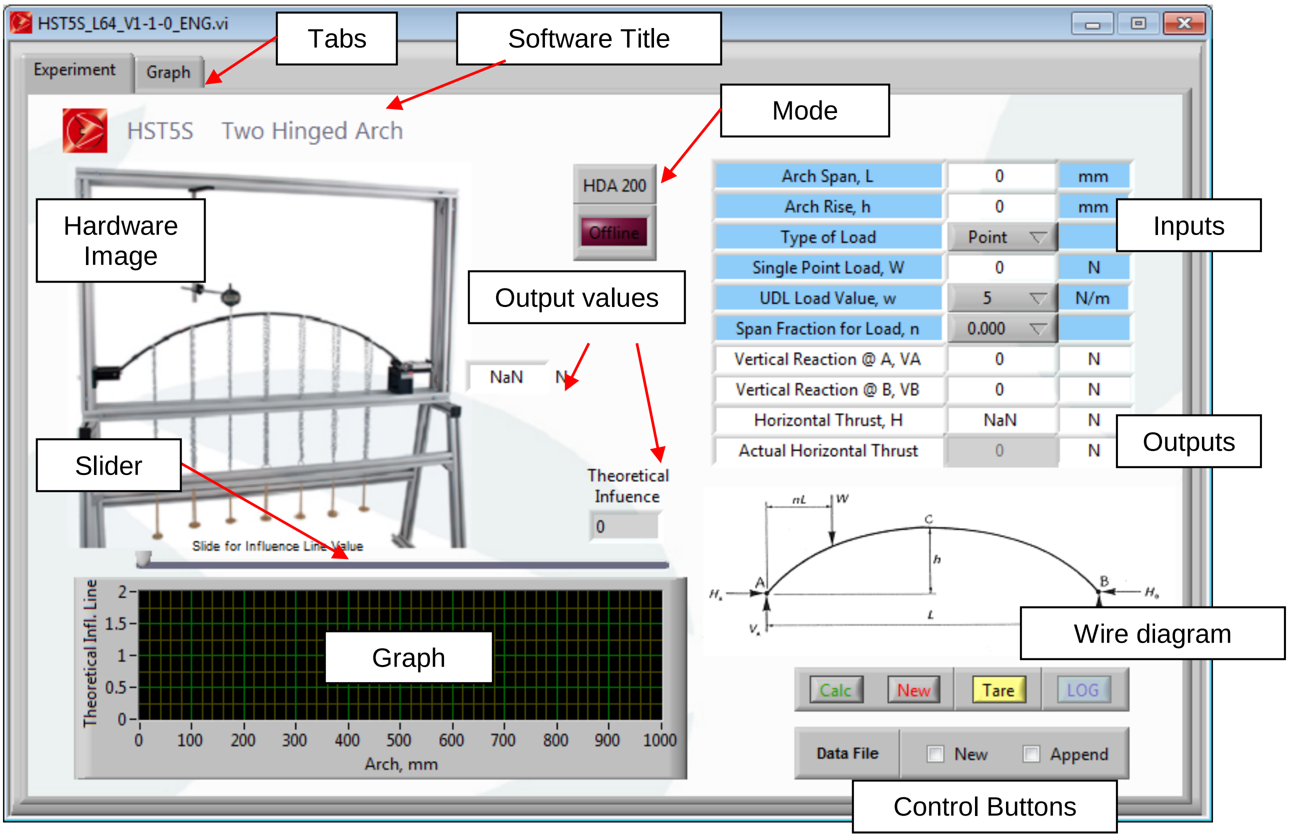
There are 8 columns shown in the data file of which two are important:

Column 1: Beam span increments (mm)
Column 4: Bending Moment values across the beam span for the particular input parameters chosen.

All data appended to this file will be saved in this data file and can be viewed.

HST5S – TWO HINGED ARCH

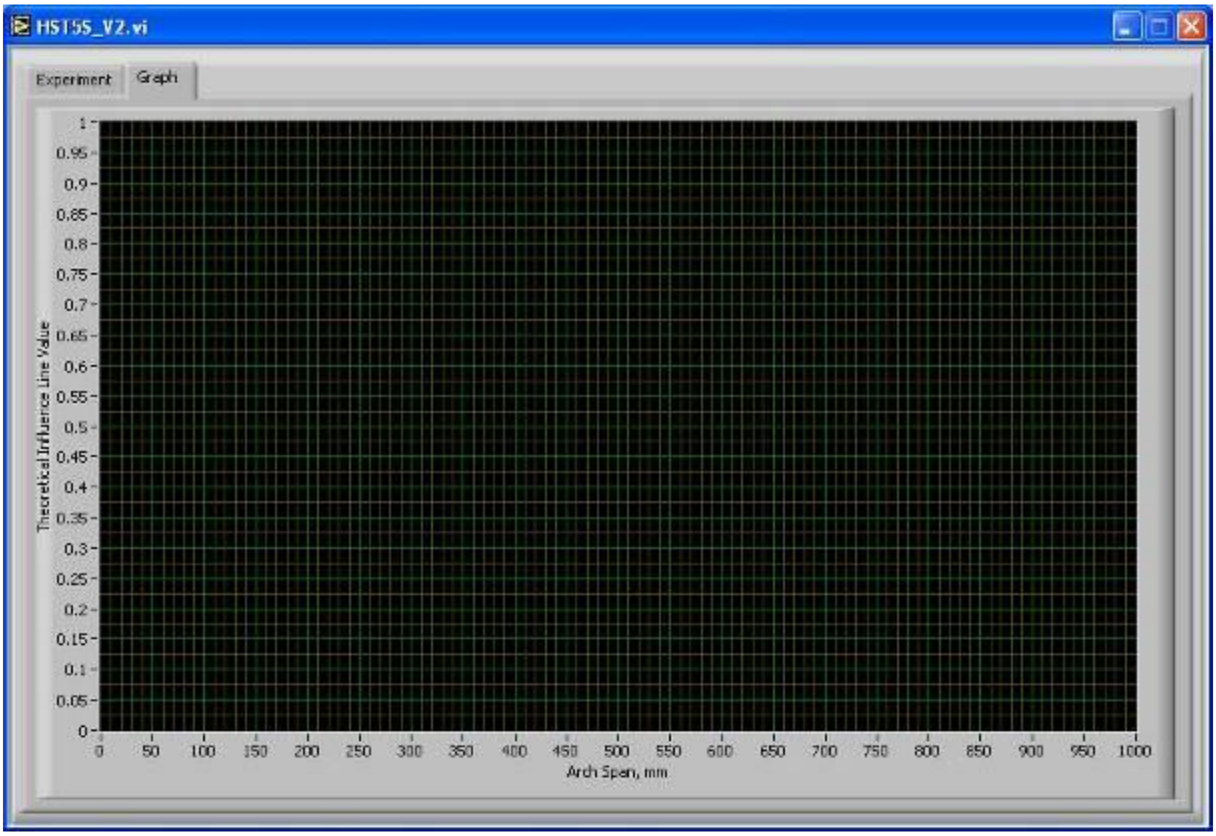
SOFTWARE WINDOW



In either mode the details of what is presented in the software window is the same. These are highlighted in the above image and detailed as follows:

Hardware image: This is a true representation of the actual hardware thus ensuring consistency in viewing between software and hardware.

Tabs: The tabs at the top allow the main software screen to be shown and also a larger version of the graph. The following image shows the graph on this tab.



Software Title: The title and number of the software.

Mode: This highlights which mode the software is in, i.e. OFFLINE or ONLINE.

Inputs: These boxes allow the end user to input values for the specific parameters listed. The blue boxes on the left hand column show the description of the input and the right hand column blue boxes show the units for these parameters. The central column is where the value is input via the keyboard. It is possible to press the TAB button on the keyboard and the cursor will jump to the next parameter.

The inputs available are as follows:

- **Arch Span, L:** Input the span of the arch in millimetres.
- **Arch rise, h:** Input the rise of the arch in millimetres.
- **Type of Load:** Select from the drop down list the type of load you require. The options are Point or UDL.
- **Single Point Load, W**: If the type of load chosen is POINT then enter the value of the point load here in Newton's.
- **UDL Load Value, w**: If UDL is chosen for the type of load select the value of the UDL from the drop down list.
- **Span Fraction for Load, n:** Select the fraction of the span where the load is being applied from the drop down list. These fractions are the same as on the hardware experiment.

Outputs: These are theoretical values and actual values from the hardware based on the input parameters chosen. This is where the end user can compare actual results with theoretical.

The outputs available are as follows:

- **Vertical Reaction @ A, VA:** This is the theoretical reaction at the left hand end of the arch in Newton’s.
- **Vertical Reaction @ B, VB:** This is the theoretical reaction at the right hand end of the arch in Newton’s.
- **Horizontal Thrust, H:** This the calculated theoretical value of horizontal thrust based on the parameters given above.
- **Actual Horizontal Thrust:** This the actual horizontal thrust from the hardware. When in offline mode this value will be greyed out.

Control buttons: these buttons give the end user a choice of what to do with the software and the values presented on the screen. They are described in more detail as follows:

- **CALC**: When the inputs have been set, pressing this button will calculate the theoretical outputs.
- **NEW**: When this button is pressed it stops background processes and allows any of the inputs to be adjusted and then recalculated. You will have to wait a short time for the background processing to finish. When finished the CALC button becomes live and the NEW button becomes inactive.
- **LOG**: When the end user wishes to record ACTUAL data from the software during ONLINE running, they can press this button and the key input and output parameters will then be logged into the data file.
- **Data File NEW:** This tick box is used when the end user wishes to store the input and output data to a brand new file on the host computer. When this is ticked and the CALC button pressed you will be prompted to create a new data file. **You can only choose this button or the append button, not both.**
- **Data file APPEND:** If a data file has already been created then ticking this box will allow data to be added to this file rather than having to create a new file.

- **Slider:** The influence line for the arch can be obtained by moving the slider horizontally across the span of the arch. The graph produced reflects also the influence line of the arch for the particular loading applied. The influence line value is displayed in the output box near the hardware image.

OPERATING THE SOFTWARE

The following procedure outlines the steps required to operate the software and to obtain outputs for the inputs chosen. It is one of many variations that could be followed.

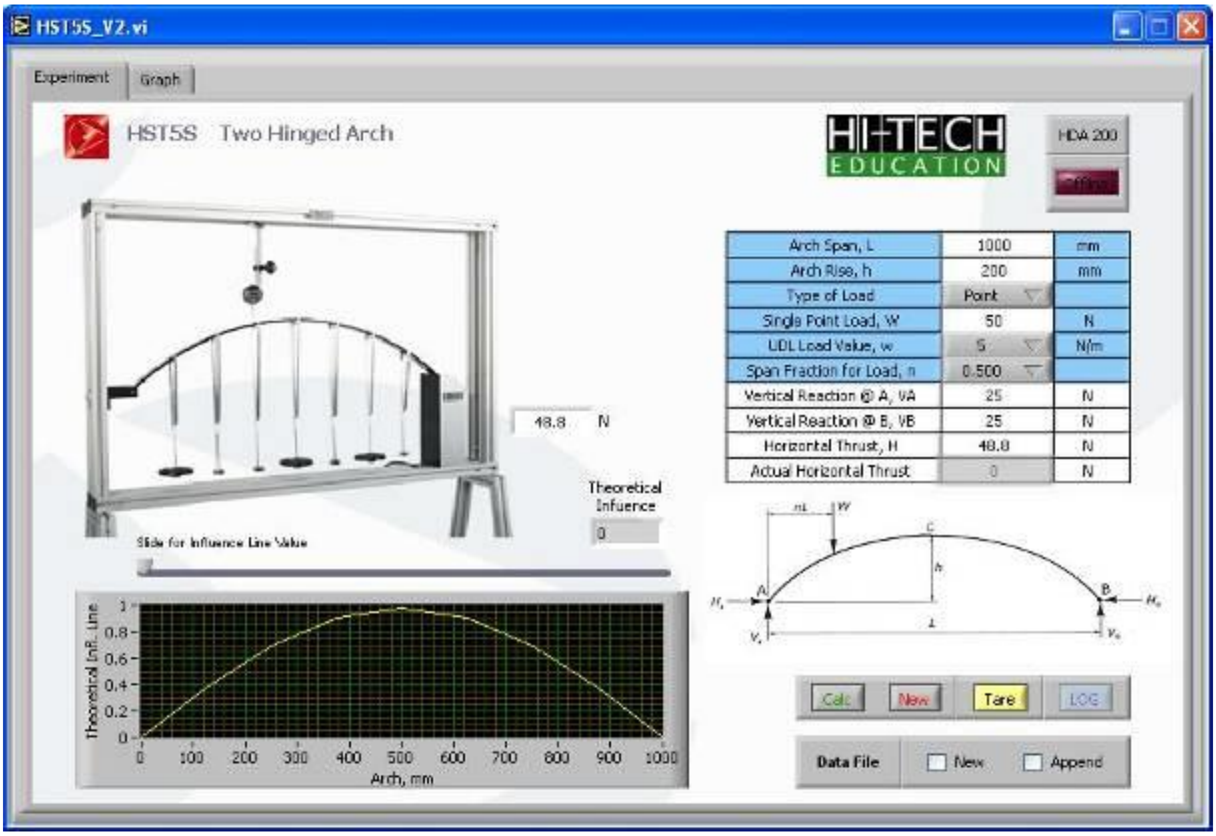
It assumes that the end user has set up the HDA200 (if necessary) and installed the software correctly and all inputs are being undertaken using the keyboard of the host computer.

OFFLINE MODE

1. Load the experiment software by double clicking the **.exe** files supplied.
2. Choose ‘NO’ when the pop up window appears asking if the HDA200 is connected.
3. Enter 1000 in the arch span input box.
4. Enter 200 in the arch rise input box.
5. Select Point from the type of load drop down menu.
6. Enter 50 in the single point load, W input box.
7. Choose 0.500 as the span fraction.
8. Press the CALC button with no data file tick boxes ticked. The screen should appear as follows:

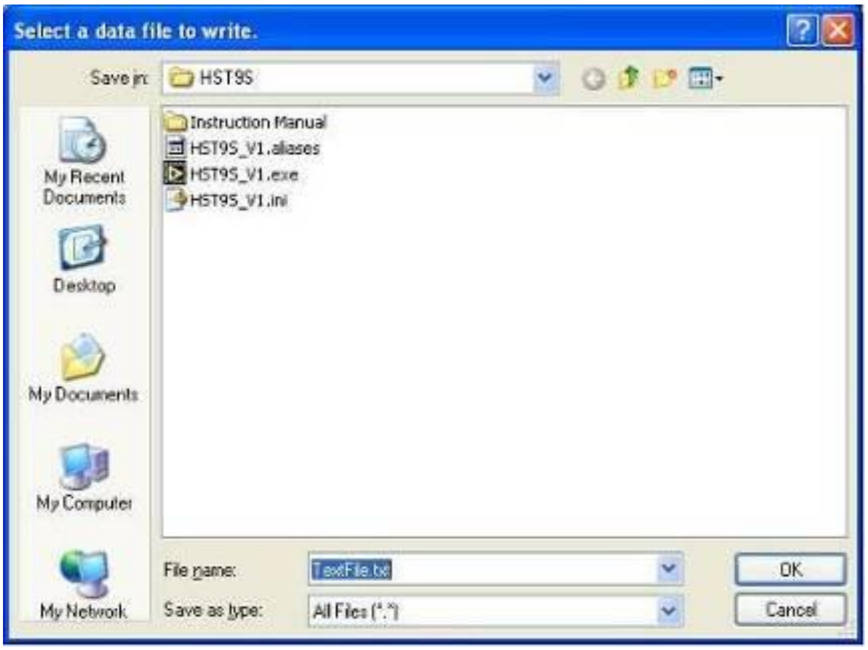
Arch Span, L	1000	mm
Arch Rise, h	200	mm
Type of Load	Point	
Single Point Load, W	50	N
UDL Load Value, w	5	N/m
Span Fraction for Load, n	0.500	
Vertical Reaction @ A, VA	25	N
Vertical Reaction @ B, VB	25	N
Horizontal Thrust, H	48.8	N
Actual Horizontal Thrust	0	N

9. The complete screen should look like the following image:

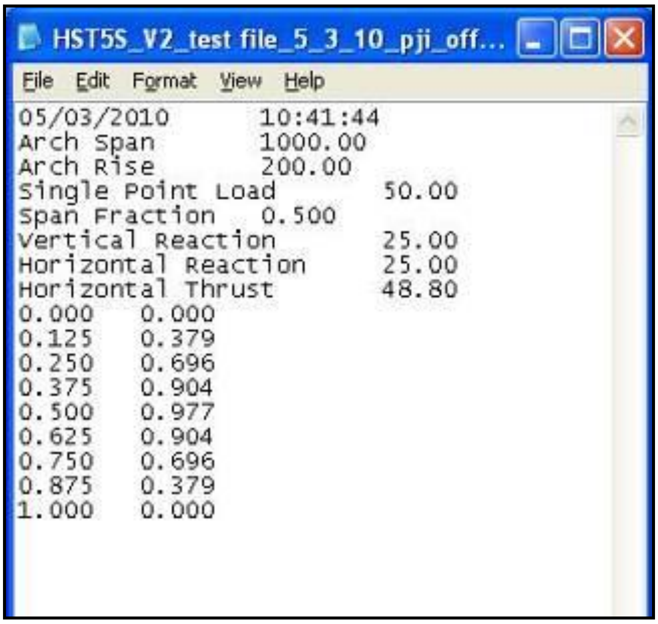


10. The theoretical horizontal thrust will be presented on the hardware image also.
11. The TARE button, although live will not operate in offline mode.
12. Press the NEW button
13. Tick the Data File NEW box.
14. Right click on the graph and choose clear graph. Repeat this for the graph on the graph tab also.
15. Press CALC.

16. You will then be shown the following window (the contents of this window will vary depending on the experiment running) and prompted to create a data file name in the location of your choice.



17. Either rename the default name of TextFile.txt or keep this default name. Its up to you. Ensure the file extension of ***.txt*** remains. Once the filename and location have been chosen then press **OK**.
18. The input and output data will now be saved in the data file created. To prove this open the text file in ***NOTEPAD*** that you have just created from its location and check the contents. It should look similar to the image below.




```
05/03/2010      10:41:44
Arch Span       1000.00
Arch Rise       200.00
Single Point Load         50.00
Span Fraction    0.500
Vertical Reaction         25.00
Horizontal Reaction       25.00
Horizontal Thrust         48.80
0.000    0.000
0.125    0.379
0.250    0.696
0.375    0.904
0.500    0.977
0.625    0.904
0.750    0.696
0.875    0.379
1.000    0.000
```

19. If you wish to change the inputs then simply press the NEW button, change the input parameter, press the data file APPEND button and then press CALC. You will be given the data file to append to, choose this and then press ok.

20. The data file should now have the new data saved into it, AND added (appended) to the existing data.
21. In the OFFLINE mode the LOG button will be greyed out.
22. When finished with the software shut the software down.
23. You can continue to adjust the inputs and see what outputs are obtained by following the same process above.

HDA200 CHANNEL SETTINGS and CONNECTIONS

Prior to running this experiment software in ONLINE mode with the HDA200 you will have to make sure that the correct experiment hardware sensors/transducers are connected to the HDA200 and the correct channels are being displayed by the HDA200. Refer to the HDA200 instruction manual and use the following table as a reference also:

Sensor/Transducer	HDA200 Connector Number	HDA200 Channel number	Resolution
Load Cell	Force 1	17	
Dial Gauge	Dial Gauge 1	28	0.01mm

Run the HDA200 in LOCAL mode to check that the above channels only are being displayed. This will then ensure that the software collects the right data from the right channels.

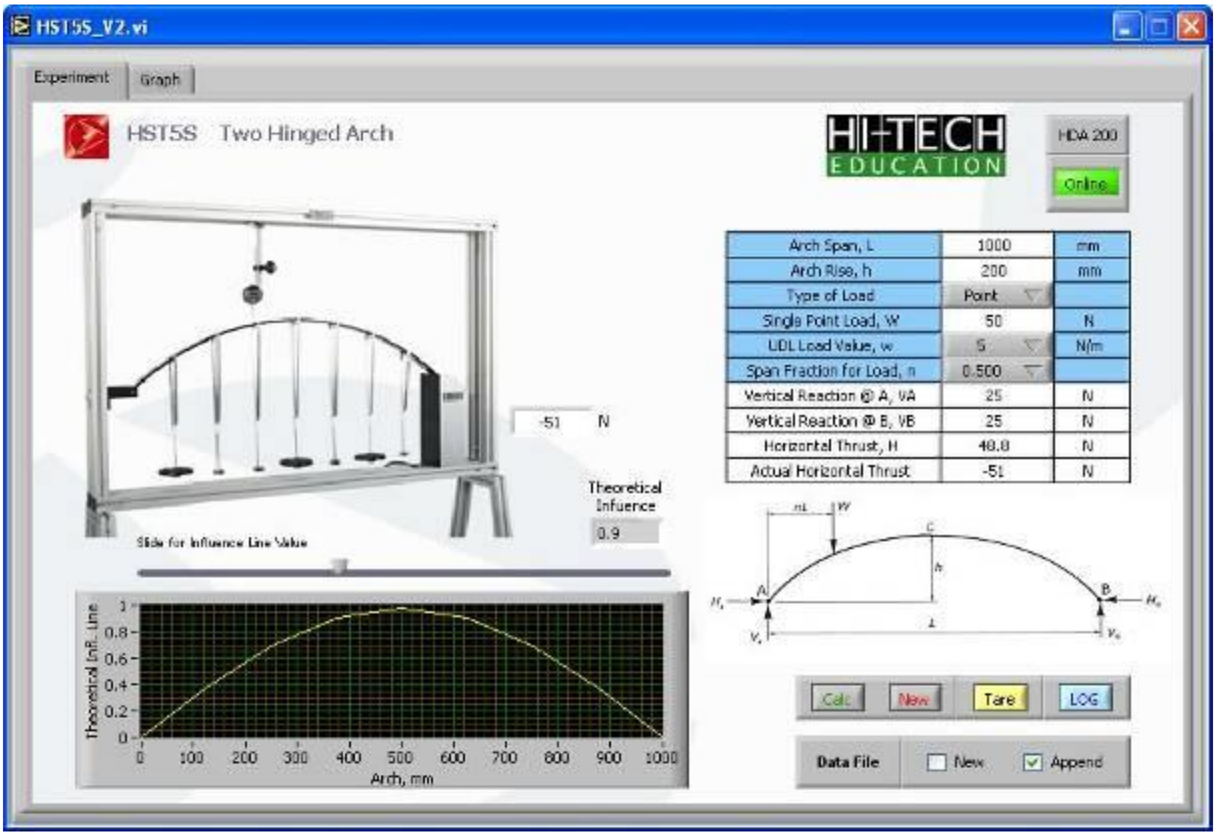
NB: If the dial gauges (if used) are connected but not turned on then the software and HDA200 will not display the dial gauge values and the software and HDA200 screens will wait until they are turned on. Ensure the dial gauges are turned on when running the experiment and software.

If the above channels are not set correctly then you will have to enter the configuration of the HDA200 which will require reading and following the HDA200 instruction manual.

ONLINE MODE

NB: If the dial gauges (if used) are connected but not turned on then the software and HDA200 will not display the dial gauge values and the software and HDA200 screens will wait until they are turned on. Ensure the dial gauges are turned on when running the experiment and software.

1. Repeat the input parameters from the OFFLINE mode procedure above, press the CALC button and the software window should look like the image below:



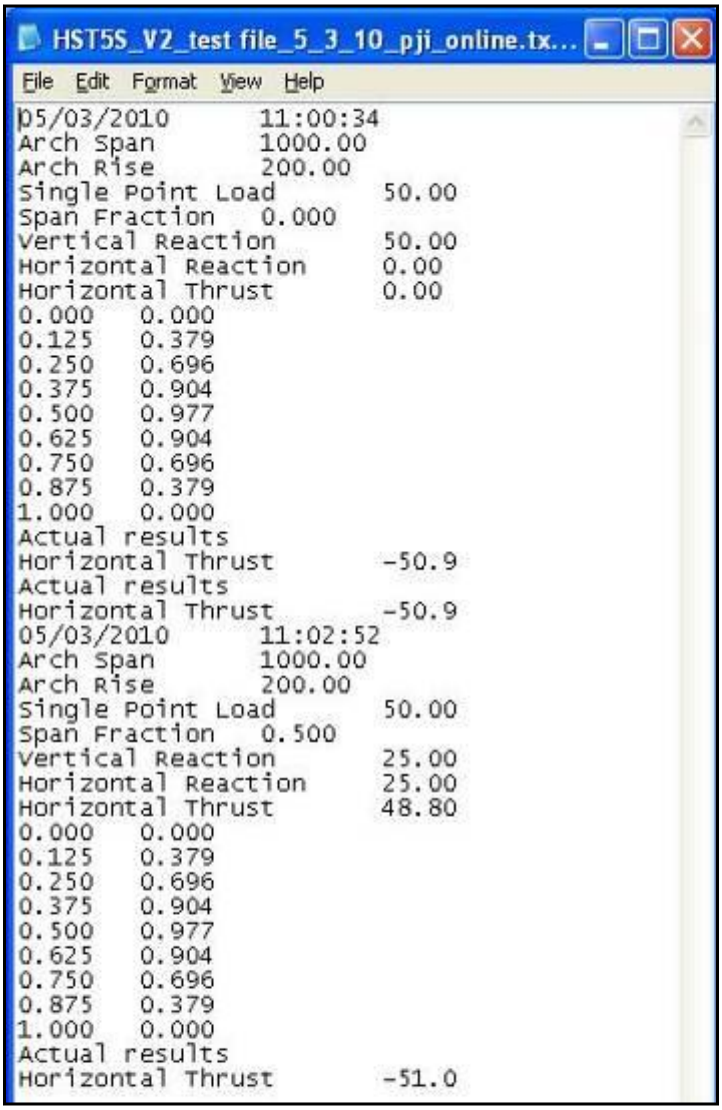
2. In 'ONLINE' mode you will notice that the actual horizontal thrust is no longer greyed out. These values will now start to change as they come in from the HDA200.
3. Load the hardware experiment to the same parameters as the input boxes. You should then be able to compare the actual values with theoretical values.
4. If you wish to save the data into a NEW or existing data file then press NEW to stop the software capturing data from the HDA200.
5. Tick the data file option required.
6. Press the CALC button and you will be prompted to create a new data file or append to the existing file. Choose the option required.
7. The input parameters will then be saved to the data file.
8. Press the LOG button to store the actual values to the data file.
9. Should you change the hardware load to a new value and you wish to change the software inputs then adjust the hardware, press NEW, adjust the software inputs to be the same as the hardware, click the data file APPEND tick box and then press CALC.
10. You can then continue to create new inputs and obtain new outputs depending on how you set up the hardware and by following the procedure above.

11. The graph will be drawn automatically each time the actual applied load and hence actual applied torque are changed.

DATA FILE CONTENTS

The data file created contains information that is useful in allowing the end user to further manipulate the data in a spreadsheet software.

The image below shows the typical data at the start of the data file for this experiment when a new file has been created and the LOG button has been pressed. The data is as follows:



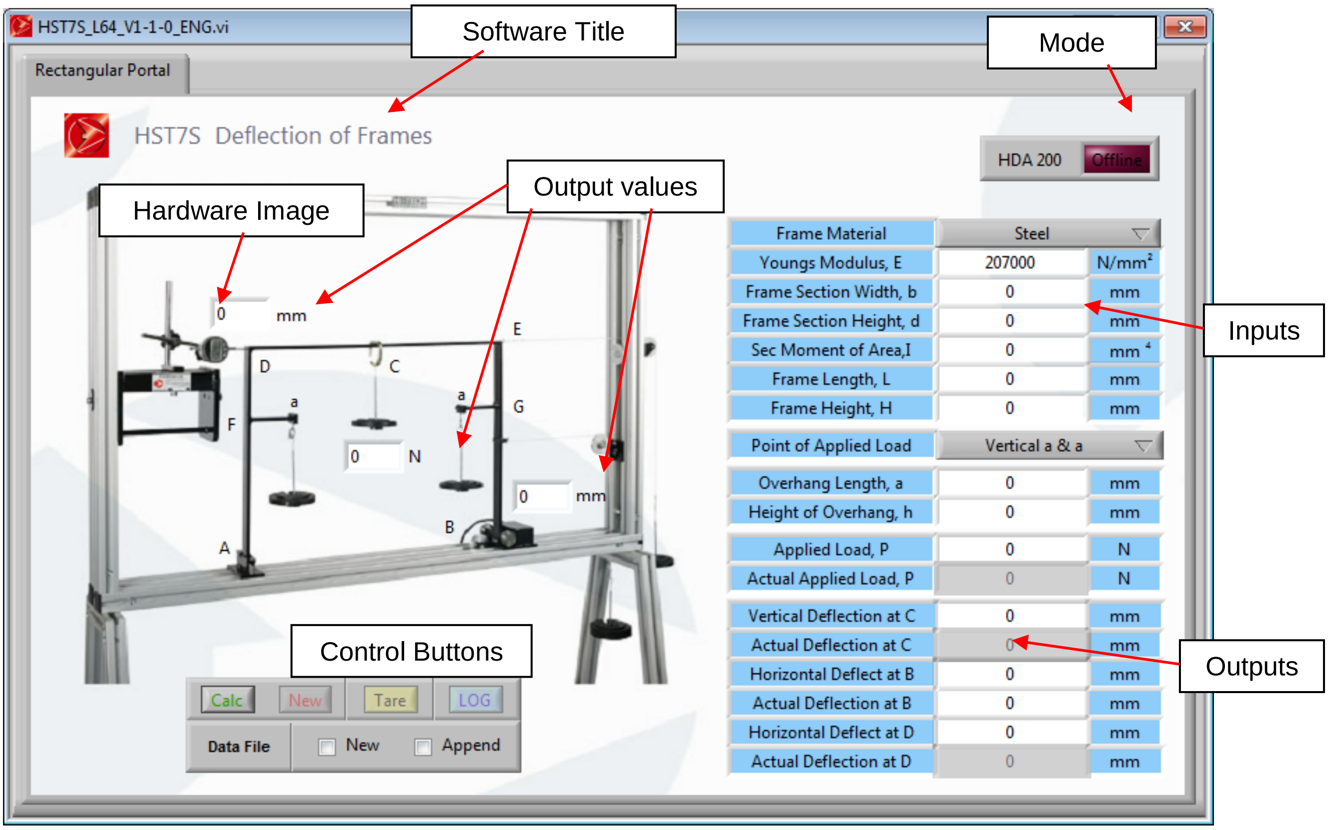
HST5S_V2_test file_5_3_10_pji_online.tx...
File Edit Format View Help

```
05/03/2010        11:00:34
Arch Span         1000.00
Arch Rise         200.00
Single Point Load         50.00
Span Fraction     0.000
Vertical Reaction         50.00
Horizontal Reaction       0.00
Horizontal Thrust         0.00
0.000    0.000
0.125    0.379
0.250    0.696
0.375    0.904
0.500    0.977
0.625    0.904
0.750    0.696
0.875    0.379
1.000    0.000
Actual results
Horizontal Thrust         -50.9
Actual results
Horizontal Thrust         -50.9
05/03/2010        11:02:52
Arch Span         1000.00
Arch Rise         200.00
Single Point Load         50.00
Span Fraction     0.500
Vertical Reaction         25.00
Horizontal Reaction       25.00
Horizontal Thrust         48.80
0.000    0.000
0.125    0.379
0.250    0.696
0.375    0.904
0.500    0.977
0.625    0.904
0.750    0.696
0.875    0.379
1.000    0.000
Actual results
Horizontal Thrust         -51.0
```

The information will then repeat itself depending on how many test points have been logged.

HST7S – DEFLECTION of FRAMES

SOFTWARE WINDOW



In either mode the details of what is presented in the software window is the same. These are highlighted in the above image and detailed as follows:

Hardware image: This is a true representation of the actual hardware thus ensuring consistency in viewing between software and hardware.

Software Title: The title and number of the software.

Mode: This highlights which mode the software is in, i.e. OFFLINE or ONLINE.

Inputs: These boxes allow the end user to input values for the specific parameters listed. The blue boxes on the left hand column show the description of the input and the right hand column blue boxes show the units for these parameters. The central column is where the value is input via the keyboard. It is possible to press the TAB button on the keyboard and the cursor will jump to the next parameter.

The inputs available are as follows:

- **Frame Material:** The user can choose the frame material. Choices range from steel, aluminium and brass. When a material is chosen the young's modulus is automatically chosen and displayed in the input box below.
- **Frame Section Width, b:** This is the width of the frame section material. Typically this will be 25mm. It has the units of millimetres (mm).
- **Frame Section Height, d**: This is the height of the frame section material. Typically this is 8mm. It has the units of millimetres (mm).
- **Sec Moment of Area, I**: This is the value of the second moment of area, which is a calculated value using the values of b and d from above. It has the units of mm^4.
- **Frame Length, L**: This is the value of the length of the frame from the centre line of one side to the centreline of the other side. This is typically 600mm. It has the units of millimetres (mm).
- **Frame Height, H**: This is the height of the frame from the knife edge and roller bearing centre line to the centreline of the top horizontal member. This is typically 450mm. It has the units of millimetres (mm).
- **Point of Applied Load**: This is a drop down list of options for the position of the applied load to the frame. The options are ***vertical a & a***, ***vertical C only***, ***horizontal E only***, ***horizontal E & G***. You select which load option depending in which part of the hardware experiment you are running.
- **Overhang Length, a**: This is the length of the overhang for the rectangular portal frame. It is labelled a to be consistent with the hardware instruction manual. It has the units of millimetres (mm).
- **Height of Overhang, h**: This is the height of the overhang for the rectangular portal frame. It is labelled h to be consistent with the hardware instruction manual. Typically this value will be 300mm. It has the units of millimetres (mm).
- **Applied Load, P**: This is the value of the applied load which is being applied at the option chosen in the Point of Applied Load input above. The units of this parameter are Newton (N).
- **Actual Applied Load, P**: This is the value of the applied load being added to the frame by the user when running the software in ONLINE mode ONLY. When running in OFFLINE mode this input box will be greyed out. It has the units of Newton (N).

Outputs: These are theoretical values and actual values from the hardware based on the input parameters chosen. This is where the end user can compare actual results with theoretical. Again the format of the columns is the same as the inputs except that the central column is automatically updated depending on the inputs chosen and cannot be adjusted via the keyboard.

The outputs available are as follows:

- **Vertical Deflection at C**: this is theoretical value of the vertical deflection at point C on the rectangular frame. It has the units of millimetres (mm).
- **Actual Deflection at C**: When in ONLINE mode this is the actual value of the vertical deflection of point C on the rectangular frame. It has the units of millimetres (mm). NB: IN ORDER TO COMPARE THE ACTUAL RESULTS WITH THEORETICAL IT IS IMPORTANT THAT THE INPUTS OF THE SOFTWARE ARE SET TO THE SAME VALUES AS THE HARDWARE ARRANGEMENT. IF NOT THEN A COMPARISON IS NOT ACHIEVABLE.
- **Vertical Deflection at B**: this is theoretical value of the vertical deflection at point C on the rectangular frame. It has the units of millimetres (mm).
- **Actual Deflection at B**: When in ONLINE mode this is the actual value of the vertical deflection of point C on the rectangular frame. It has the units of millimetres (mm).
- **Vertical Deflection at D**: this is theoretical value of the vertical deflection at point C on the rectangular frame. It has the units of millimetres (mm).
- **Actual Deflection at D**: When in ONLINE mode this is the actual value of the vertical deflection of point C on the rectangular frame. It has the units of millimetres (mm).

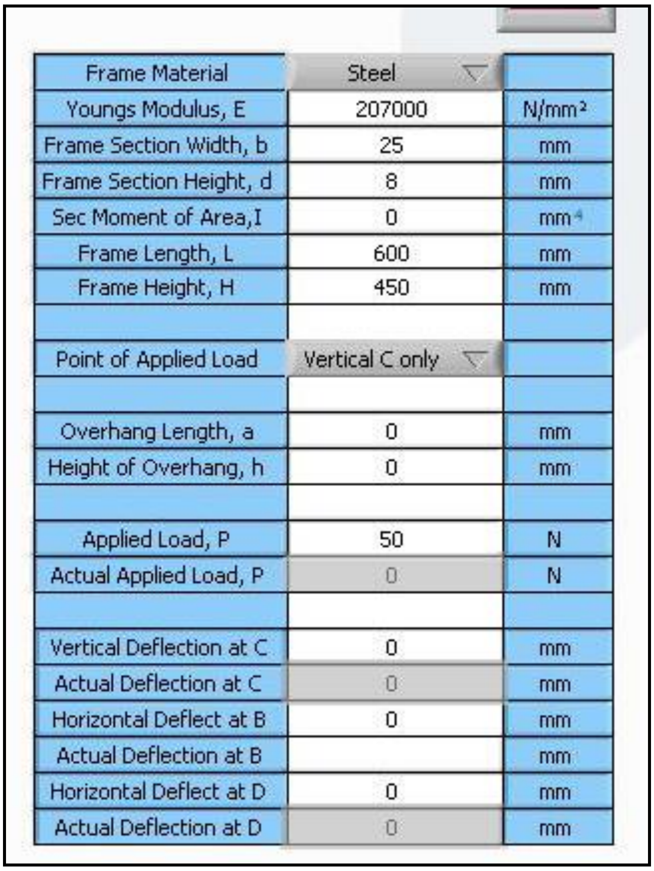
Control buttons: these buttons give the end user a choice of what to do with the software and the values presented on the screen. They are described in more detail as follows:

- **CALC**: When the inputs have been set, pressing this button will calculate the theoretical outputs.
- **NEW**: When this button is pressed it stops background processes and allows any of the inputs to be adjusted and then recalculated.
- **TARE**: This button is only valid when running in ONLINE mode as when pressed it zeroes (tares) the values from any strain gauges and load cell channels which are being used in the software.
- **LOG**: When the end user wishes to record any data from the software during ONLINE running, they can press this button and the key input and output parameters will then be logged into the data file.
- **Data File NEW:** This tick box is used when the end user wishes to store the input and output data to a brand new file on the host computer. When this is ticked and the CALC button pressed you will be prompted to create a new data file.
- **Data file APPEND:** If a data file has already been created then ticking this box will allow data to be added to this file rather than having to create a new file.

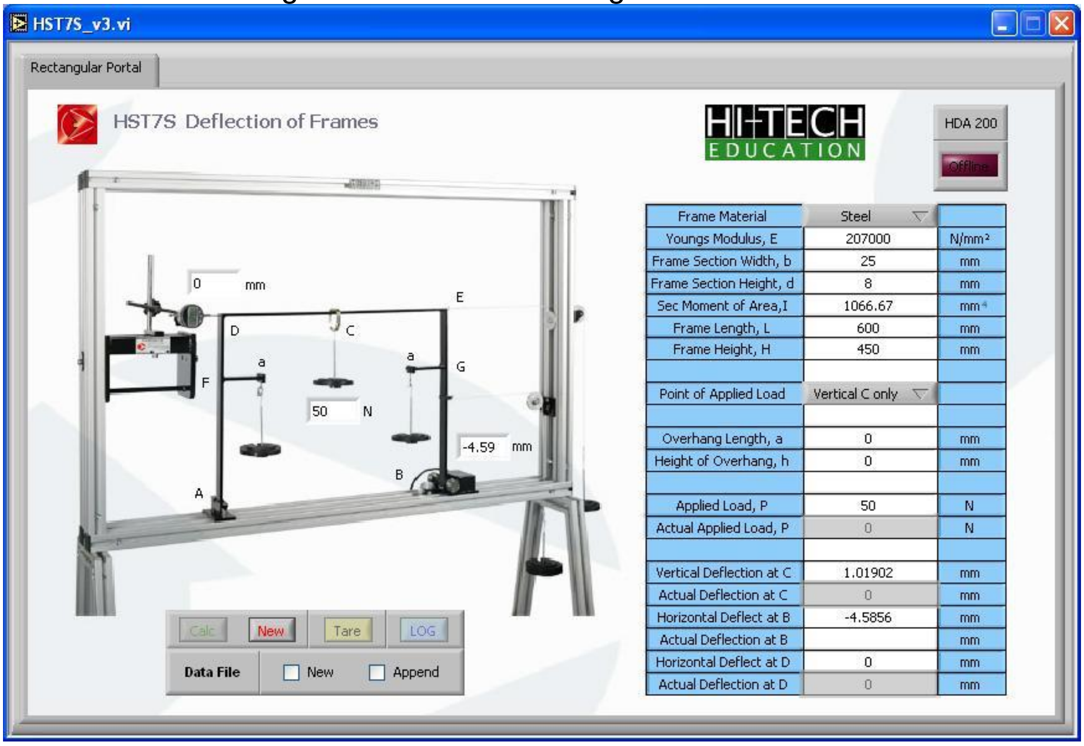
Output Values: These values are the key output values from the hardware. They have been placed within the hardware image near the area they represent to give a guide to the end user.

<u>OFFLINE MODE</u>

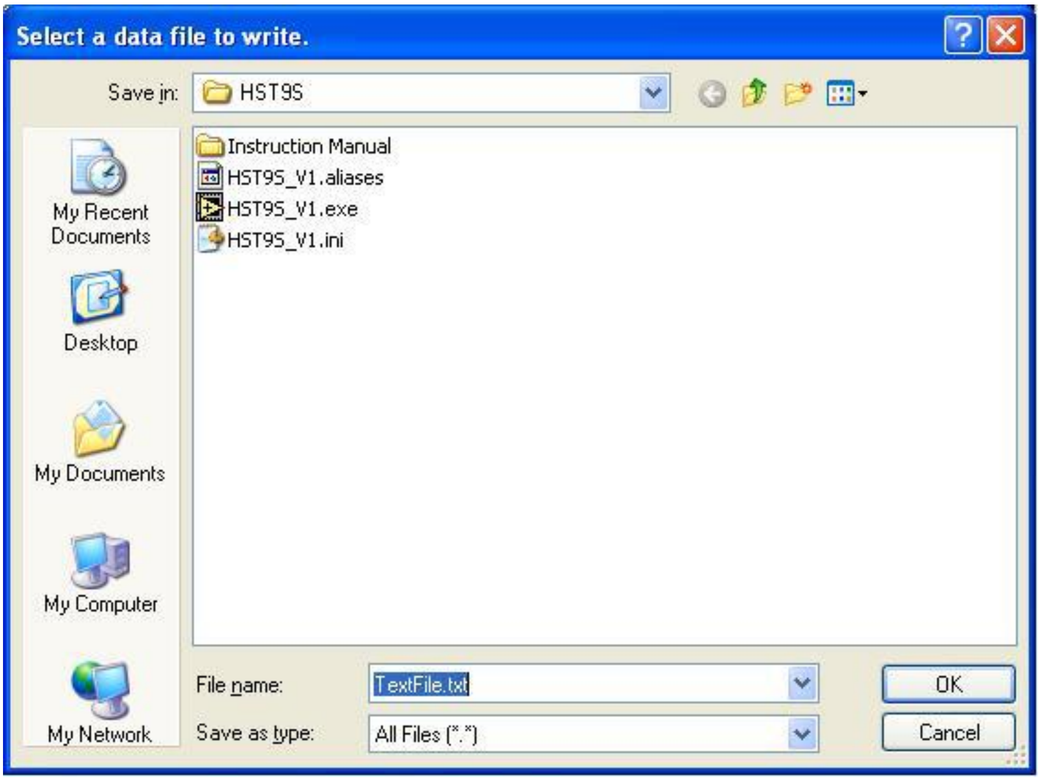
1. Load the experiment software by double clicking the **.exe** files supplied.
2. Choose 'NO' when the pop up window appears asking if the HDA200 is connected.
3. Choose the frame material to be steel. The young's modulus should now be automatically selected from here.
4. Enter 25 in the section width input box.
5. Enter 8 in the section height input box.
6. Enter 600 in the frame length input box.
7. Enter 450 in the frame length input box.
8. Choose vertical C only for the point of load.
9. Enter 50 in the Applied Load input box. The screen should now have inputs that look like the following image:



10. Press the CALC button and the values will appear in the output boxes and on the hardware image as shown in the image below:



11. There will be no values for the ***Actual Applied Load, P; Actual Deflection at C*** and ***Actual Deflection at D*** as the software has been chosen to run in OFFLINE mode.
12. Press the NEW button.
13. Tick the Data File NEW box.
14. Press CALC.
15. You will then be shown the following window (the contents of this window will vary depending on the experiment running) and prompted to create a data file name in the location of your choice.



16. Either rename the default name of TextFile.txt or keep this default name. Ensure the file extension of ***.txt*** remains. Once the filename and location have been chosen then press **OK**.

17. The input and output data will now be saved in the data file created.

18. Press the NEW button again, and then untick the Data File NEW box and then tick the Data File APPEND box. Press CALC and then choose the same data file as created previously. The current input and output data will now be appended to this file without overwriting the original data.

19. Locate this text file and open in NOTEPAD to see the format and information that it is saving.

20. If you wish to change the inputs then simply press the NEW button, change the input, choose whether to create a new data file or append to an existing file and then press CALC.

21. In the OFFLINE mode the NEW and TARE buttons although live will not perform any function. The LOG button will not be live and greyed out but the data can still be stored by the use of the CALC button.

22. Press the NEW button.

23. Now select the ***vertical a & a*** option from the point of applied load list.

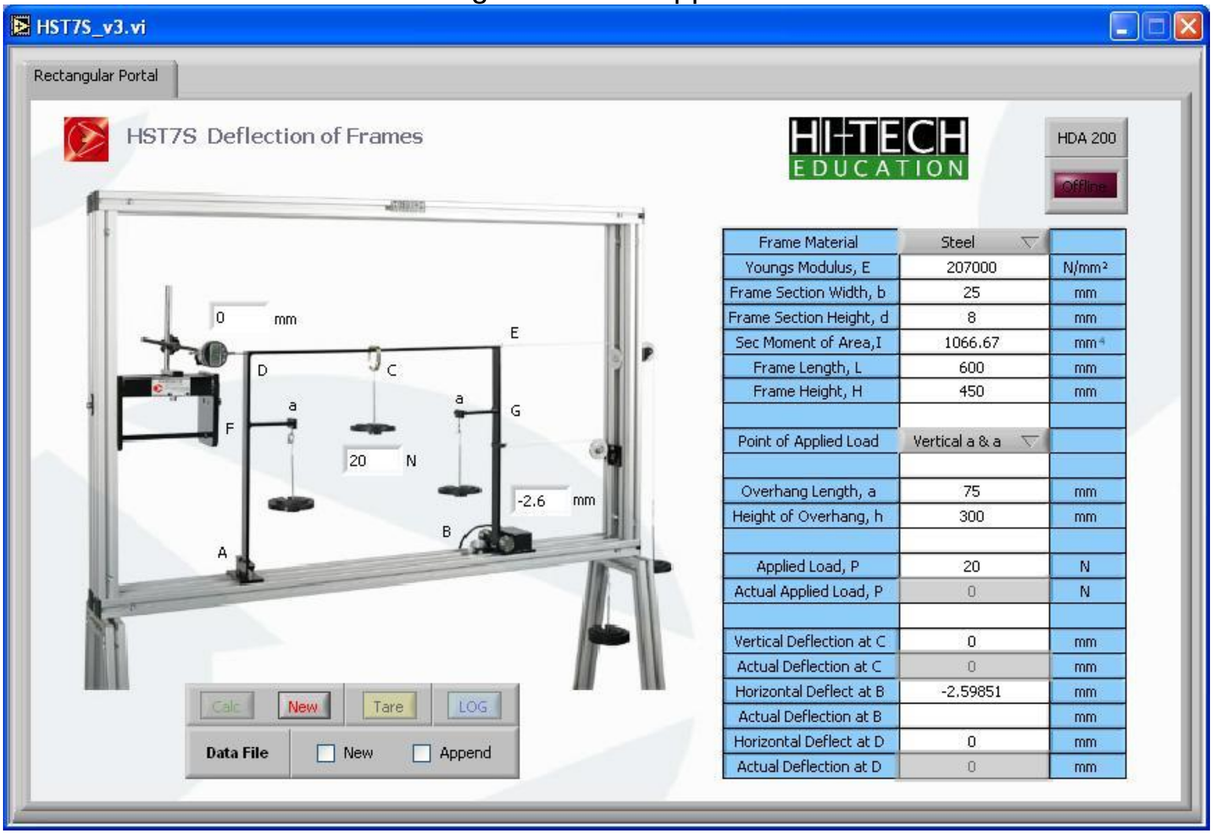
24. Enter 75 in the overhang length input box.

25. Enter 300 in the overhang height input box.

26. Enter 20 in the applied load input box. The screen should look like the following:

Frame Material	Steel	
Youngs Modulus, E	207000	N/mm^2
Frame Section Width, b	25	mm
Frame Section Height, d	8	mm
Sec Moment of Area,I	1066.67	mm^4
Frame Length, L	600	mm
Frame Height, H	450	mm
Point of Applied Load	Vertical a & a	
Overhang Length, a	75	mm
Height of Overhang, h	300	mm
Applied Load, P	20	N
Actual Applied Load, P	0	N
Vertical Deflection at C	1.01902	mm
Actual Deflection at C	0	mm
Horizontal Deflect at B	-4.5856	mm
Actual Deflection at B		mm
Horizontal Deflect at D	0	mm
Actual Deflection at D	0	mm

27. Choose whether to create a new or append to a data file and then press the CALC button. The following screen will appear.



28. You will notice that the horizontal deflection only now appear at point B on the frame. This is because the load point a & a are linked with the deflection point B.

29. By applying the same procedure from list item 22 above it is possible to change the point of applied load which will then give the deflection values at point D also.

30. The software has been designed to follow the hardware instruction manual so please refer to this for further details.

31. When finished with the software shut the software down.

32. You can continue to adjust the inputs and see what outputs are

HDA200 CHANNEL SETTINGS and CONNECTIONS

Prior to running this experiment software in ONLINE mode with the HDA200 you will have to make sure that the correct experiment hardware sensors/transducers are connected to the HDA200 and the correct channels are being displayed by the HDA200. Refer to the HDA200 instruction manual and use the following table as a reference also:

Sensor/Transducer	HDA200 Connector Number	HDA200 Channel number	Resolution
Load cell	Force 1	17	
Load cell	Force 2	18	
Dial Gauge	Dial gauge 1	28	0.01mm
Dial Gauge	Dial gauge 2	29	0.01mm

Run the HDA200 in LOCAL mode to check that the above channels only are being displayed. This will then ensure that the software collects the right data from the right channels.

NB: If the dial gauges (if used) are connected but not turned on then the software and HDA200 will not display the dial gauge values and the software and HDA200 screens will wait until they are turned on. Ensure the dial gauges are turned on when running the experiment and software.

If the above channels are not set correctly then you will have to enter the configuration of the HDA200 which will require reading and following the HDA200 instruction manual.

ONLINE MODE

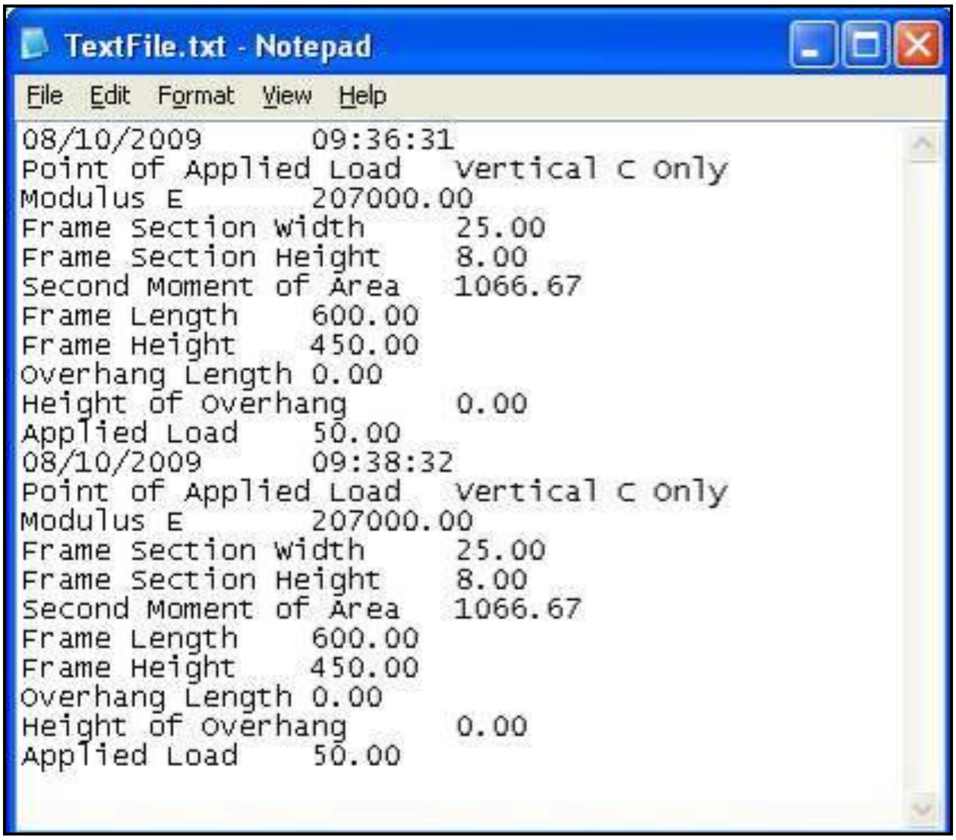
NB: ENSURE THAT ALL DIAL GAUGES ARE ATTACHED TO THE HDA200. THE DEFLECTION VALUES WILL NOT APPEAR IN THE SOFTWARE SCREEN IF THE DIAL GAUGES HAVE NOT BEEN CONNECTED.

1. Repeat the input parameters from the OFFLINE mode procedure above, press the CALC button.
2. You will notice that the ***Actual Applied Load, P; Actual Deflection at C*** and ***Actual Deflection at D*** output lines are now live and not greyed out.
3. Repeat the same process with the ONLINE mode as the OFFLINE mode as detailed above.
4. Zero the dial gauges.
5. Load the hardware experiment as outlined in the hardware instruction manual. You should then be able to compare the actual values with the theoretical values.
6. If you wish to save the data into the existing data file or a new data file then tick the appropriate box.
7. Press the CALC button and you will be prompted to create a new data file or append to the existing file, depending on the option chosen.
8. The current input and output values will then be saved to the data file.
9. Press the NEW button when you need to change a value of one of the inputs.
10. Change that input.
11. Choose whether to create a new data file or append to an existing file.
12. Press CALC and the new outputs will be created.
13. You can then continue to create new inputs and obtain new outputs depending on how you set up the hardware and by following the procedure above.

DATA FILE CONTENTS

The data file created contains information that is useful in allowing the end user to further manipulate the data in a spreadsheet software.

The image below shows the typical data at the start of the data file for the HST7S:




```
08/10/2009      09:36:31
Point of Applied Load   Vertical C Only
Modulus E       207000.00
Frame Section Width     25.00
Frame Section Height    8.00
Second Moment of Area   1066.67
Frame Length    600.00
Frame Height    450.00
Overhang Length 0.00
Height of Overhang      0.00
Applied Load    50.00
08/10/2009      09:38:32
Point of Applied Load   Vertical C Only
Modulus E       207000.00
Frame Section Width     25.00
Frame Section Height    8.00
Second Moment of Area   1066.67
Frame Length    600.00
Frame Height    450.00
Overhang Length 0.00
Height of Overhang      0.00
Applied Load    50.00
```

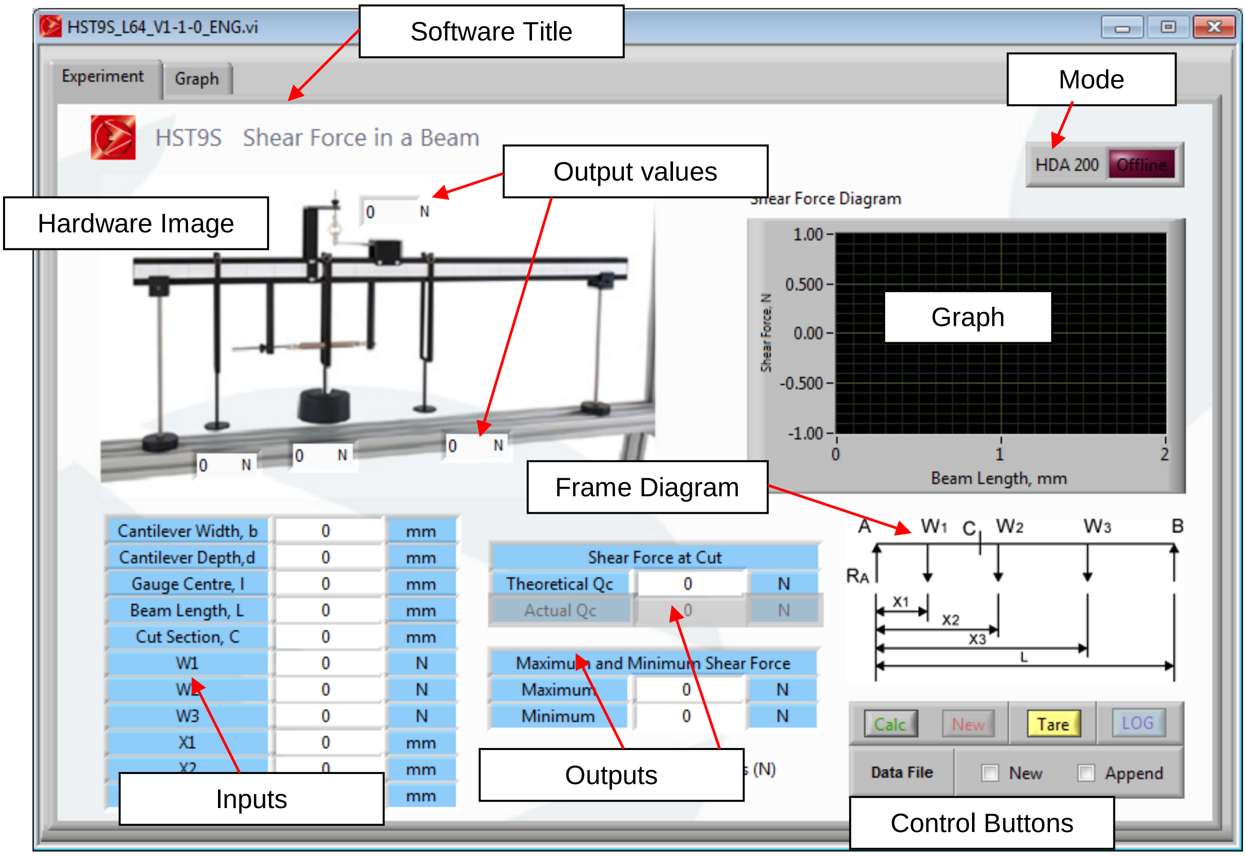
The data is as follows:

Date and time.
Point of load chosen.
Modulus of Elasticity, E of material chosen
Frame section width chosen
Frame section height chosen
Second Moment of Area calculated
Frame length chosen
Frame height chosen
Overhang length chosen
Height of overhang chosen

All data appended to this file will be saved in this data file and can be viewed.

HST9S – SHEAR FORCE in a BEAM

SOFTWARE WINDOW



In either mode the details of what is presented in the software window is the same. These are highlighted in the above image and detailed as follows:

Hardware image: This is a true representation of the actual hardware thus ensuring consistency in viewing between software and hardware.

Software Title: The title and number of the software.

Mode: This highlights which mode the software is in, i.e. OFFLINE or ONLINE.

Inputs: These boxes allow the end user to input values for the specific parameters listed. The blue boxes on the left hand column show the description of the input and the right hand column blue boxes show the units for these parameters. The central column is where the value is input via the keyboard. It is possible to press the TAB button on the keyboard and the cursor will jump to the next parameter.

The inputs available are as follows:

- **<u>Beam Length:</u>** this is the total beam length or the span of the supports. In the hardware manual this will be 900mm. It has the units of millimetres (mm).
- **<u>Cut section:</u>** This is the position of the cut section on the beam. On the hardware this is 300mm. It has the units of millimetres (mm).
- **<u>W1</u>**: this is value of the load applied to the weight hanger W1 with units of Newton’s (N). Refer also to the frame diagram within the software window.
- **<u>W2</u>**: this is value of the load applied to the weight hanger W2 with units of Newton’s (N). Refer also to the frame diagram within the software window.
- **<u>W3</u>**: this is value of the load applied to the weight hanger W3 with units of Newton’s (N). Refer also to the frame diagram within the software window.
- **<u>X1</u>**: this is the horizontal position of W1 from the left hand support A. It has the units of millimetres (mm). Refer also to the frame diagram within the software window.
- **<u>X2</u>**: this is the horizontal position of W2 from the left hand support A. It has the units of millimetres (mm). Refer also to the frame diagram within the software window.
- **<u>X3</u>**: this is the horizontal position of W2 from the left hand support A. It has the units of millimetres (mm). Refer also to the frame diagram within the software window.

<u>Outputs</u>: These are theoretical values and actual values from the hardware based on the input parameters chosen. This is where the end user can compare actual results with theoretical. Again the format of the columns is the same as the inputs except that the central column is automatically updated depending on the inputs chosen and cannot be adjusted via the keyboard.

The outputs available are as follows:

- **Theoretical Qc**: this is theoretical value of the shear force at the cut section based on the loadings of W1, W2 and W3 and the positions X1, X2 and X3. It has the units of Newton’s (N).
- **Actual Qc**: When in ONLINE mode this is the actual value of shear from the hardware. It has the units of Newton’s (N). NB: IN ORDER TO COMPARE THE ACTUAL RESULTS WITH THEORETICAL IT IS IMPORTANT THAT THE INPUTS OF THE SOFTWARE ARE SET TO THE SAME VALUES AS THE HARDWARE ARRANGEMENT. IF NOT THEN A COMPARISON IS NOT ACHIEVABLE.
- **Maximum**: This is the calculated maximum shear force based on the input parameters selected. This value is calculated and is used within the shear force diagram within the software screen. It has units of Newton’s (N).
- **Minimum**: This is the calculated minimum shear force based on the input parameters selected. This value is calculated and is used within the shear force diagram within the software screen. It has units of Newton’s (N).

Control buttons: these buttons give the end user a choice of what to do with the software and the values presented on the screen. They are described in more detail as follows:

- **<u>CALC</u>**: When the inputs have been set, pressing this button will calculate the theoretical outputs.
- **<u>NEW</u>**: When this button is pressed it stops background processes and allows any of the inputs to be adjusted and then recalculated.
- **<u>TARE</u>**: This button is only valid when running in ONLINE mode as when pressed it zeroes (tares) the values from any strain gauges and load cell channels which are being used in the software.
- **<u>LOG</u>**: When the end user wishes to record any data from the software during ONLINE running, they can press this button and the key input and output parameters will then be logged into the data file.
- **<u>Data File NEW:</u>** This tick box is used when the end user wishes to store the input and output data to a brand new file on the host computer. When this is ticked and the CALC button pressed you will be prompted to create a new data file.
- **<u>Data file APPEND:</u>** If a data file has already been created then ticking this box will allow data to be added to this file rather than having to create a new file.

<u>Frame Diagram:</u> This represents a schematic of the hardware arrangement and is a cross reference for the inputs. This will not be present on all experiment softwares.

<u>Graph</u>: If present it is possible to view data that is being captured or logged from the software. In this particular experiment the Shear Force diagram will be drawn based on the inputs chosen. You will also notice that in the top left corner of the software screen is a tab with Graph text written. Pressing this tab will bring up a new screen showing exactly the same graph as on the main software window.

<u>Output Values:</u> These values are the key output values from the hardware. They have been placed within the hardware image near the area they represent to give a guide to the end user.

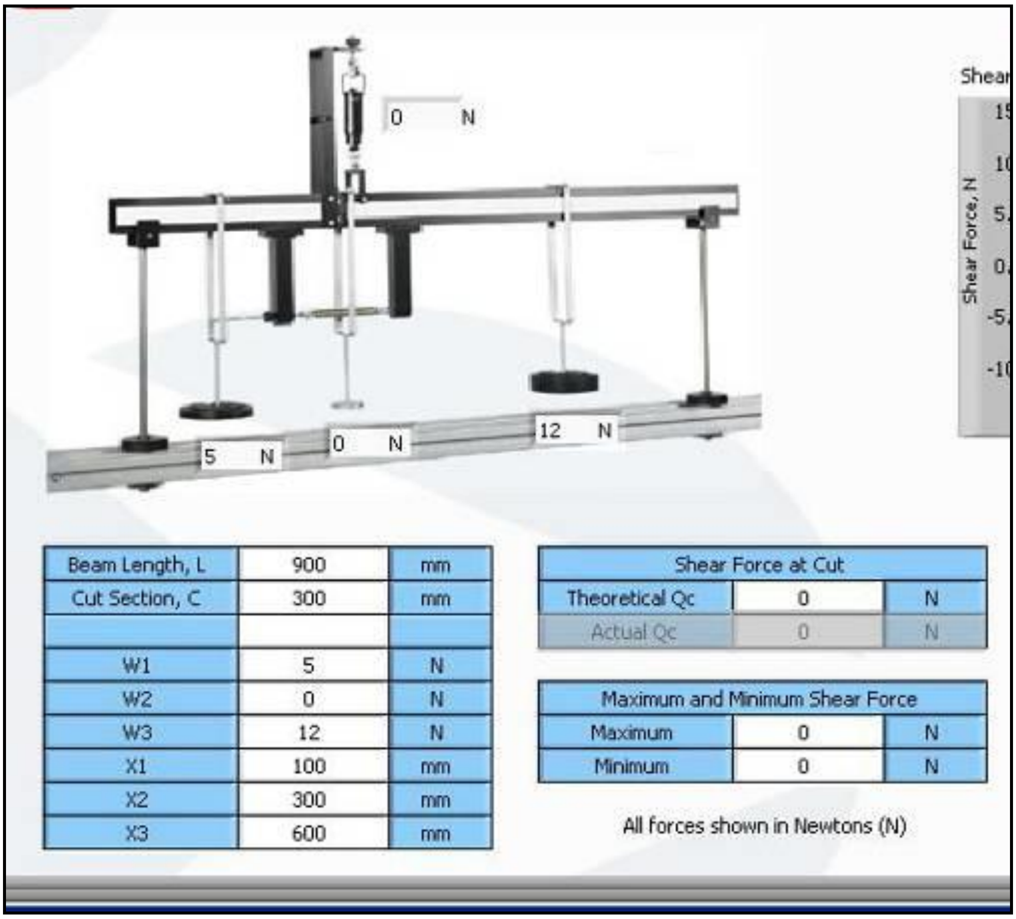
<u>OPERATING THE SOFTWARE</u>

The following procedure outlines the steps required to operate the software and to obtain outputs for the inputs chosen. It is one of many variations that could be followed.

It assumes that the end user has set up the HDA200 (if necessary) and installed the software correctly and all inputs are being undertaken using the keyboard of the host computer.

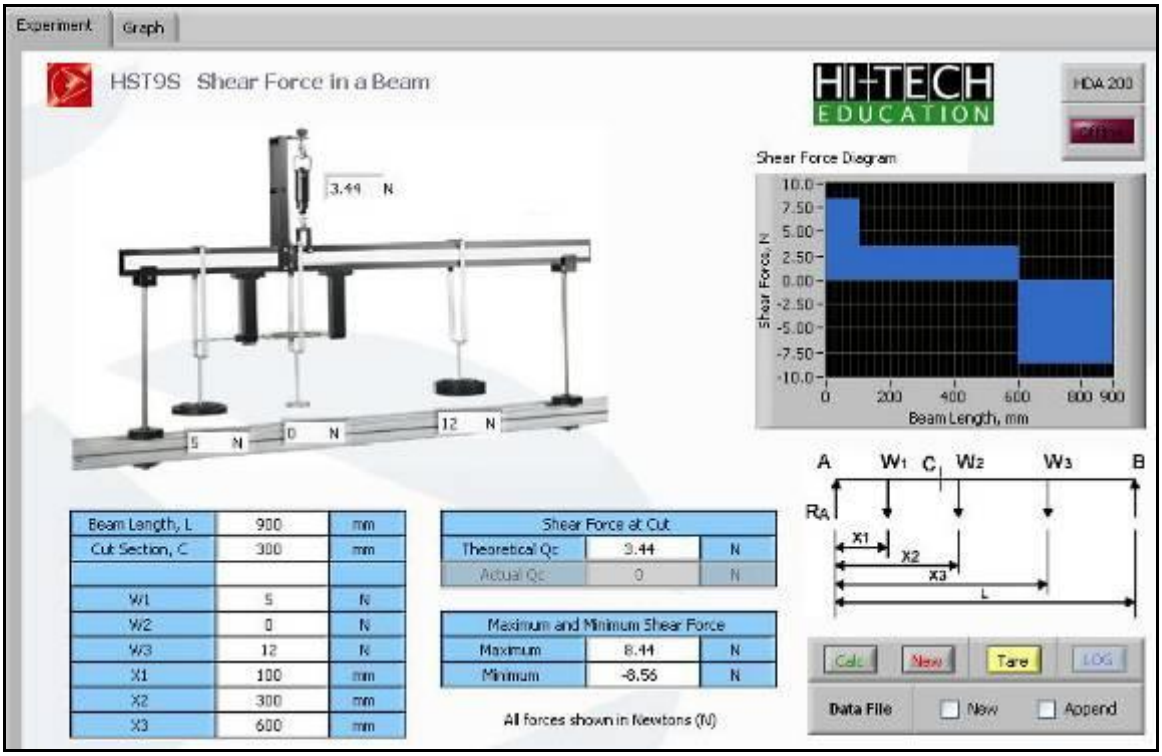
<u>OFFLINE MODE</u>

1. Load the experiment software by double clicking the **.exe** files supplied.
2. Choose ‘NO’ when the pop up window appears asking if the HDA200 is connected.
3. Enter 900 in the beam length input box.
4. Enter 300 in the cut section input box.
5. Enter 5 in the W1 input box.
6. Leave the value of W2 as zero.
7. Enter 12 in the W3 input box.
8. Enter 100 in the X1 input box
9. Enter 300 in the X2 input box.
10. Enter 600 in the X3 input box. The screen should now have inputs that look like the following image:

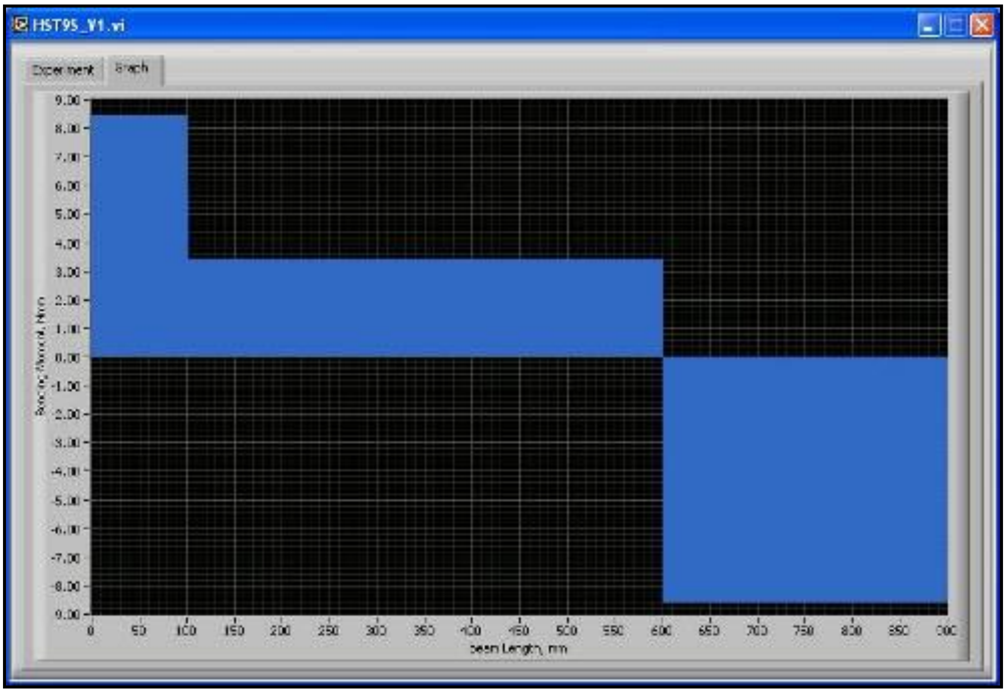


11. The values of W1, W2 and W3 will be seen in the output values on the hardware image.

12. Press the CALC button and the values will appear in the output boxes, on the hardware image and a shear force diagram will appear as shown in the image below:

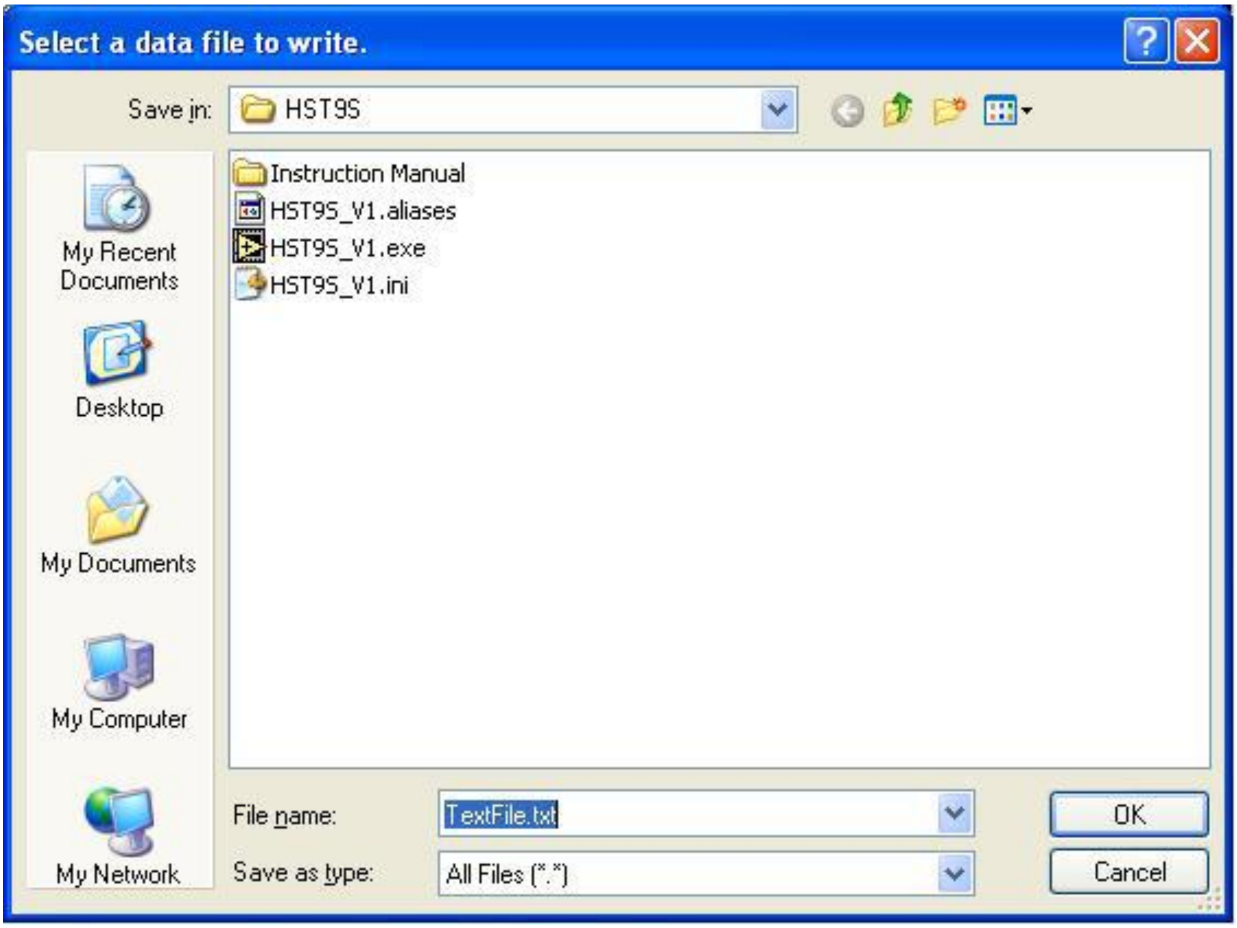


13. There will be no value for the ***Actual Qc*** as the software has been chosen to run in OFFLINE mode.
14. Press the graph tab in the top left of the software screen and the following will appear:



15. This diagram will be a replica of the diagram on the main software window.

16. Return to the main software window by pressing on the experiment tab in the top left of the software window.
17. Right click in the graph display and choose clear chart. This then clears the chart for a new diagram to be created. If you do not clear the chart new graphs will be appended to this existing graph. Repeat this for the main graph window.
18. Tick the Data File NEW box.
19. Press CALC.
20. You will then be shown the following window (the contents of this window will vary depending on the experiment running) and prompted to create a data file name in the location of your choice.



21. Either rename the default name of TextFile.txt or keep this default name. Ensure the file extension of ***.txt*** remains. Once the filename and location have been chosen then press **OK**.
22. A new shear force diagram will appear and the same values appear in the output boxes.
23. The input and output data will now be saved in the data file created.
24. Clear the graph again, and then tick the Data File APPEND box. Press CALC and then choose the same data file as created previously. The current input and output data will now be appended to this file without overwriting the original data.
25. Locate this text file and open in NOTEPAD to see the format and information that it is saving.

26. If you wish to change the inputs then simply clear the graphs, change the input, choose whether to create a new data file or append to an existing file and then press CALC.
27. In the OFFLINE mode the NEW and TARE buttons although live will not perform any function. The LOG button will not be live and greyed out but the data can still be stored by the use of the CALC button.
28. When finished with the software shut the software down.
29. You can continue to adjust the inputs and see what outputs are obtained by following the same process above.

HDA200 CHANNEL SETTINGS and CONNECTIONS

Prior to running this experiment software in ONLINE mode with the HDA200 you will have to make sure that the correct experiment hardware sensors/transducers are connected to the HDA200 and the correct channels are being displayed by the HDA200. Refer to the HDA200 instruction manual and use the following table as a reference also:

Sensor/Transducer	HDA200 Connector Number	HDA200 Channel number	Resolution
Strain	Strain1	1	

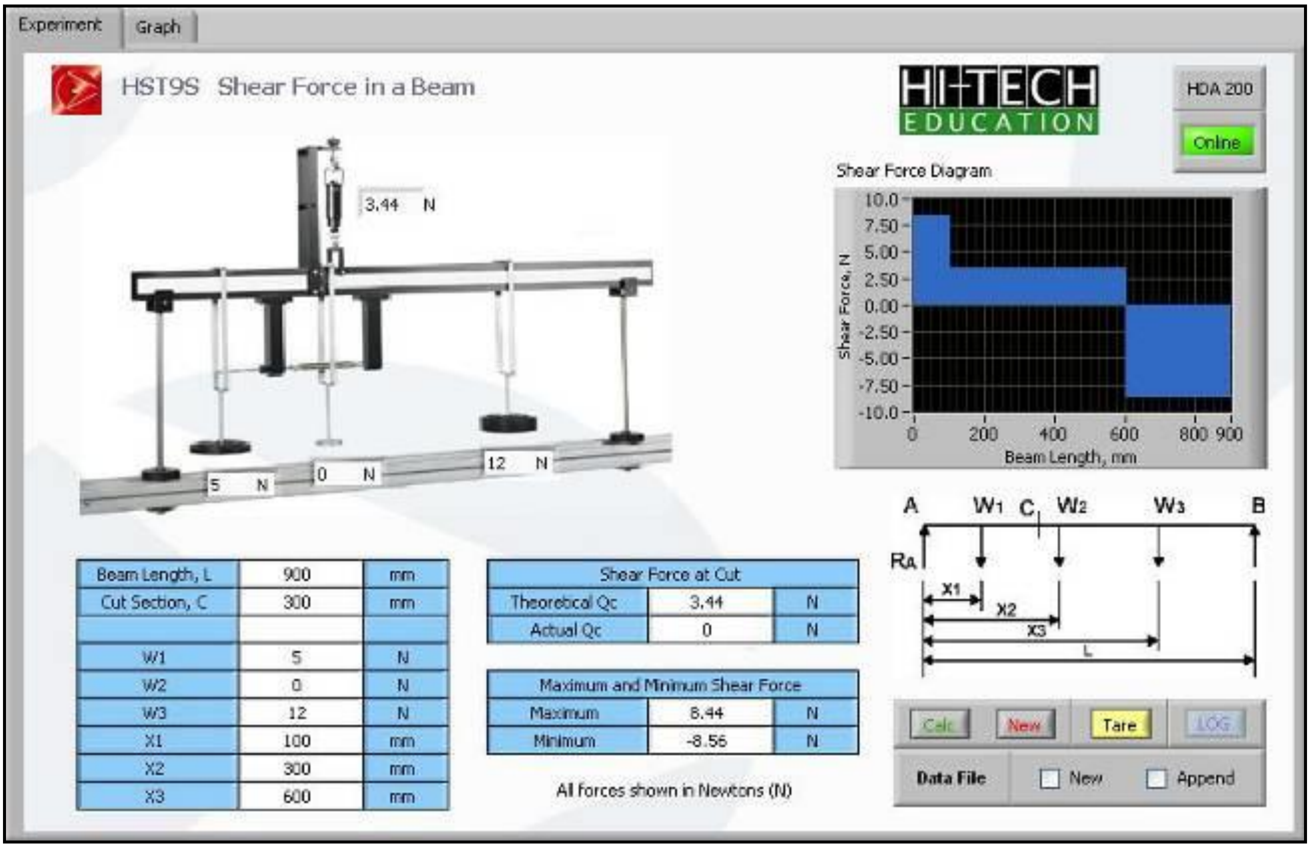
Run the HDA200 in LOCAL mode to check that the above channels only are being displayed. This will then ensure that the software collects the right data from the right channels.

NB: If the dial gauges (if used) are connected but not turned on then the software and HDA200 will not display the dial gauge values and the software and HDA200 screens will wait until they are turned on. Ensure the dial gauges are turned on when running the experiment and software.

If the above channels are not set correctly then you will have to enter the configuration of the HDA200 which will require reading and following the HDA200 instruction manual.

ONLINE MODE

1. Repeat the input parameters from the OFFLINE mode procedure above, press the CALC button and the software window should look like the image below:



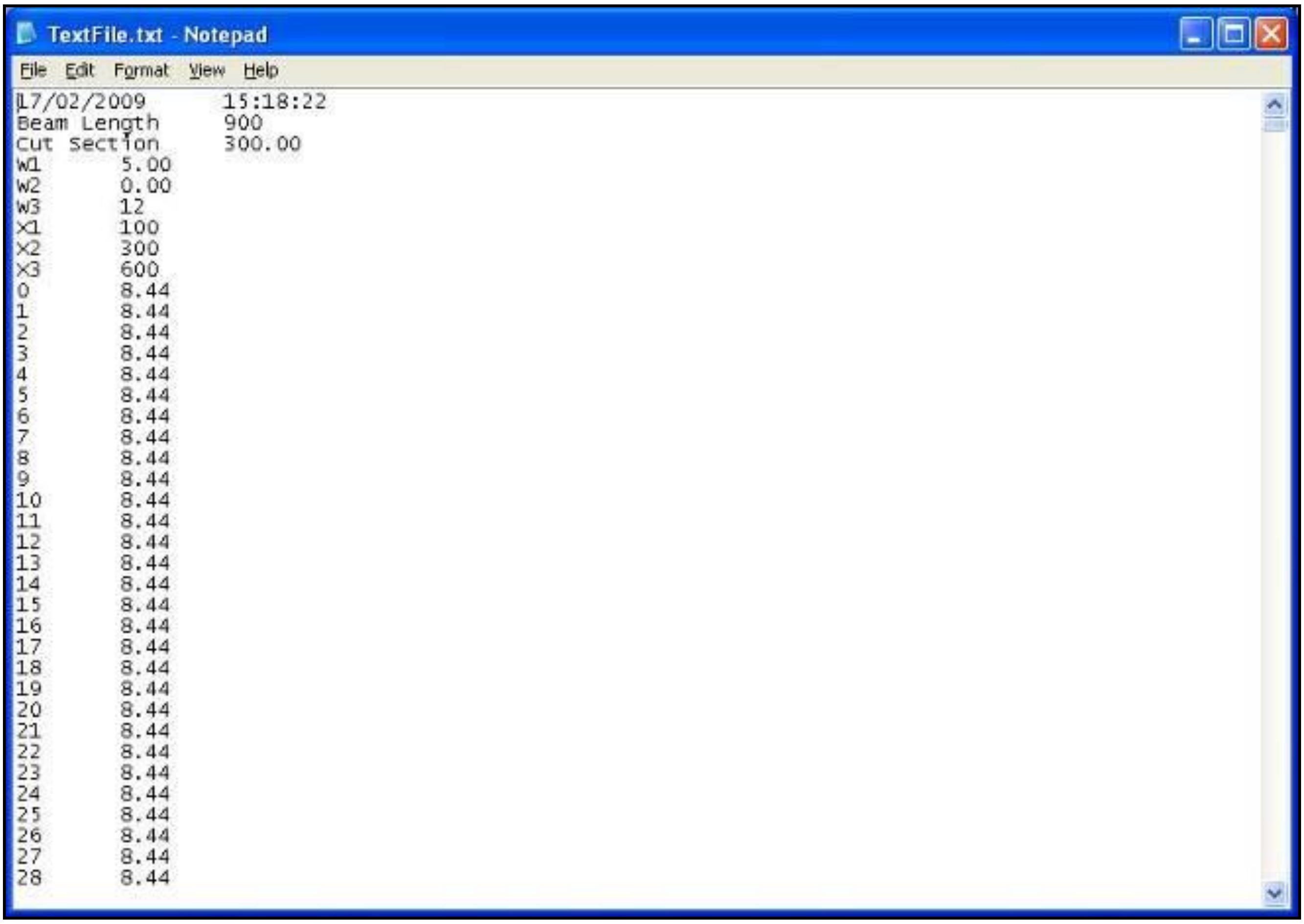
2. You will notice that the Actual Qc output line is now live and not greyed out.
3. You will now see the actual value of the shear force coming from the hardware within the Actual Qc output box. To zero this reading simply press the TARE button. You may have to press it again if the reading does not return to zero.
4. Load the hardware experiment to the same parameters as the input boxes. You should then be able to compare the actual Qc value with the theoretical value.
5. If you wish to save the data into the existing data file or a new data file then press the NEW button. The value in the Actual Qc output box will change due to the fact that the software is not retrieving the actual value from the hardware.
6. Clear the graph.
7. Tick the data file option required.

8. Press the CALC button and you will be prompted to create a new data file or append to the existing file. Choose the option required.
9. The current input and output values will then be saved to the data file.
10. Press the NEW button when you need to change a value of one of the inputs.
11. Change the input.
12. Clear the graphs.
13. Choose whether to create a new data file or append to an existing file.
14. Press CALC and the new outputs will be created along with a graph.
15. You can then continue to create new inputs and obtain new outputs depending on how you set up the hardware and by following the procedure above.

<u>DATA FILE CONTENTS</u>

The data file created contains information that is useful in allowing the end user to further manipulate the data in a spreadsheet software.

The image below shows the typical data at the start of the data file for the HST9S:




```
17/02/2009      15:18:22
Beam Length     900
Cut Section     300.00
W1      5.00
W2      0.00
W3      12
x1      100
x2      300
x3      600
0       8.44
1       8.44
2       8.44
3       8.44
4       8.44
5       8.44
6       8.44
7       8.44
8       8.44
9       8.44
10      8.44
11      8.44
12      8.44
13      8.44
14      8.44
15      8.44
16      8.44
17      8.44
18      8.44
19      8.44
20      8.44
21      8.44
22      8.44
23      8.44
24      8.44
25      8.44
26      8.44
27      8.44
28      8.44
```

The data is as follows:

Date and time.
Beam length input value from software.
Cut section input value from software.
W1 value from software
W2 value from software

W3 value from software
X1 value from software
X2 value from software
X3 value from software

The next two columns relate to the data from the shear force diagram.

The left hand column are incremental points going across the beam length starting at 0 (zero) and ending at the beam length stated in the input, i.e. 900mm.

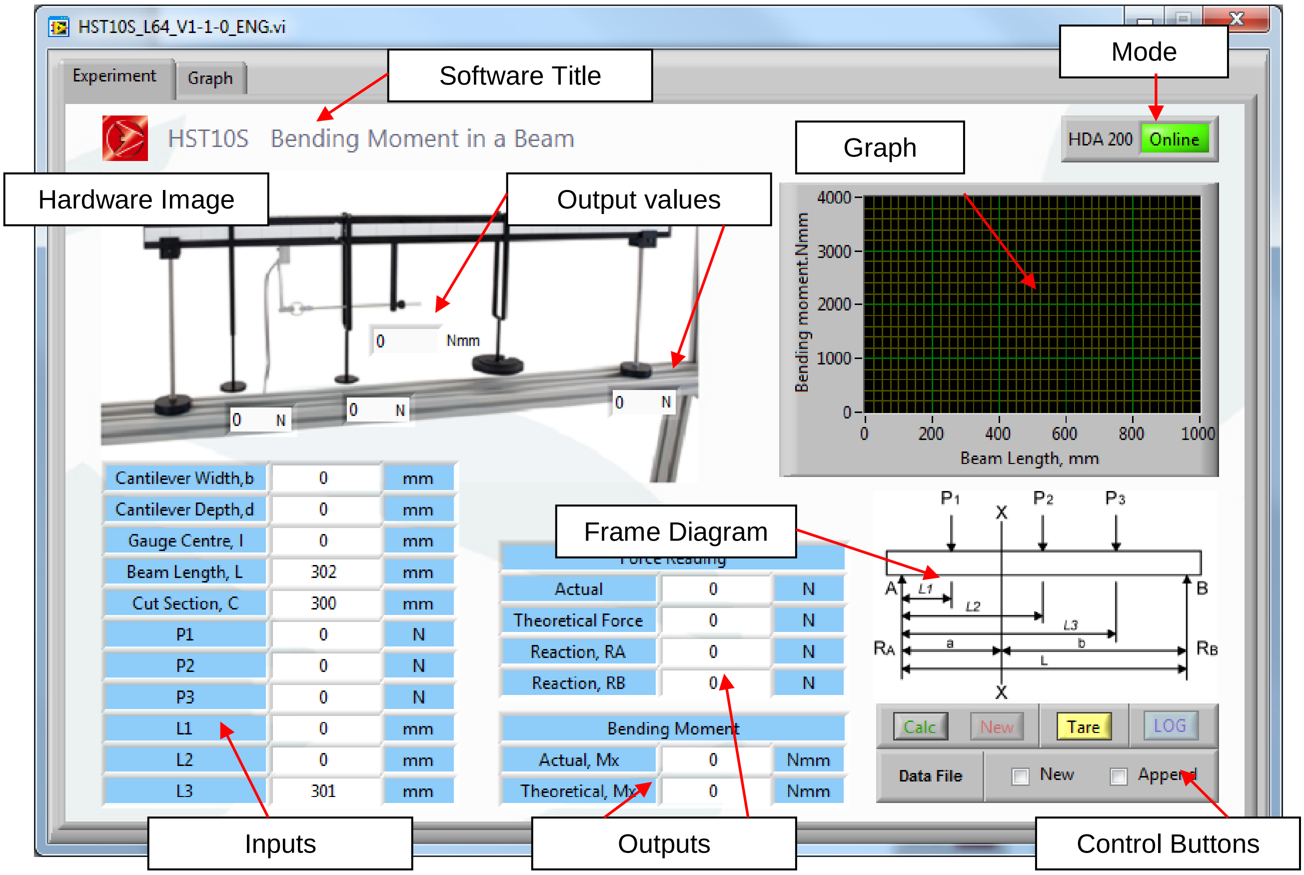
The right hand column is the shear force value going across the beam length for each increment. You will notice that the first and last values in this column are the same as the maximum and minimum shear force values shown in the output boxes of the software window.

Scrolling down these columns will also show the shear force value at the cut section.

All data appended to this file will be saved in this data file and can be viewed.

HST10S – BENDING MOMENTS in a BEAM

SOFTWARE WINDOW



In either mode the details of what is presented in the software window is the same. These are highlighted in the above image and detailed as follows:

Hardware image: This is a true representation of the actual hardware thus ensuring consistency in viewing between software and hardware.

Software Title: The title and number of the software.

Mode: This highlights which mode the software is in, i.e. OFFLINE or ONLINE.

Inputs: These boxes allow the end user to input values for the specific parameters listed. The blue boxes on the left hand column show the description of the input and the right hand column blue boxes show the units for these parameters. The central column is where the value is input via the keyboard. It is possible to press the TAB button on the keyboard and the cursor will jump to the next parameter.

The inputs available are as follows:

- **Cantilever Width:** This is the width of the strain gauged cantilever on the hardware. This is nominally 9.525mm but will need to be measured from the hardware. It has the units of millimetres (mm).
- **Cantilever Depth:** This is the depth of the strain gauged cantilever on the hardware. This is nominally 3.175mm but will need to be measured from the hardware. It has the units of millimetres (mm).
- **Gauge Centre:** This is the distance from the centre line of the strain gauge on the cantilever to the centreline of the hole in the free end of the cantilever. This is nominally 48mm but will need to be measured from the hardware. It has the units of millimetres (mm).
- **Beam Length:** this is the total beam length or the span of the supports. In the hardware manual this will be 900mm. It has the units of millimetres (mm).
- **Cut section:** This is the position of the cut section on the beam. On the hardware this is 300mm. This input is fixed at 300mm. It has the units of millimetres (mm).
- **P1**: this is value of the load applied to the weight hanger P1 with units of Newton's (N). Refer also to the frame diagram within the software window.
- **P2**: this is value of the load applied to the weight hanger P2 with units of Newton's (N). Refer also to the frame diagram within the software window.
- **P3**: this is value of the load applied to the weight hanger P3 with units of Newton's (N). Refer also to the frame diagram within the software window.
- **L1**: this is the horizontal position of P1 from the left hand support A. It has the units of millimetres (mm). Refer also to the frame diagram within the software window. This input is fixed between 0 and 299mm.
- **L2**: this is the horizontal position of P2 from the left hand support A. It has the units of millimetres (mm). Refer also to the frame diagram within the software window.
- **L3**: this is the horizontal position of P3 from the left hand support A. It has the units of millimetres (mm). Refer also to the frame diagram within the software window. This input is fixed between 301 and 900mm

Outputs: These are theoretical values and actual values from the hardware based on the input parameters chosen. This is where the end user can compare actual results with theoretical. Again the format of the columns is the same as the inputs except that the central column is automatically updated depending on the inputs chosen and cannot be adjusted via the keyboard.

The outputs available are as follows:

- **Actual**: this is the actual force reading from the hardware. It has the units of Newton's (N).
- **Theoretical Force**: This is theoretical value of the bending force at the cut section based on the loadings of P1, P2 and P3 and the positions L1, L2 and L3. It has the units of Newton's (N).
- **Reaction RA**: This is a theoretical value for the reaction at support A based on the value of the loads and their positions on the beam. It has the units of Newton's (N).

Reaction RB: This is a theoretical value for the reaction at support B based on the value of the loads and their positions on the beam. It has the units of Newton's (N).

- **Actual Mx**: When in ONLINE mode this is the actual value of the bending moment from the hardware. It has the units of Newton millimetres (Nmm). NB: IN ORDER TO COMPARE THE ACTUAL RESULTS WITH THEORETICAL IT IS IMPORTANT THAT THE INPUTS OF THE SOFTWARE ARE SET TO THE SAME VALUES AS THE HARDWARE ARRANGEMENT. IF NOT THEN A COMPARISON IS NOT ACHIEVABLE.
- **Theoretical Mx**: This is the theoretical value of the bending moment for the hardware arrangement. It has the units of Newton millimetres (Nmm).

Control buttons: these buttons give the end user a choice of what to do with the software and the values presented on the screen. They are described in more detail as follows:

- **CALC**: When the inputs have been set, pressing this button will calculate the theoretical outputs.
- **NEW**: When this button is pressed it stops background processes and allows any of the inputs to be adjusted and then recalculated.
- **TARE**: This button is only valid when running in ONLINE mode as when pressed it zeroes (tares) the values from any strain gauges and load cell channels which are being used in the software.
- **LOG**: When the end user wishes to record any data from the software during ONLINE running, they can press this button and the key input and output parameters will then be logged into the data file.
- **Data File NEW:** This tick box is used when the end user wishes to store the input and output data to a brand new file on the host computer. When this is ticked and the CALC button pressed you will be prompted to create a new data file.
- **Data file APPEND:** If a data file has already been created then ticking this box will allow data to be added to this file rather than having to create a new file.

Frame Diagram: This represents a schematic of the hardware arrangement and is a cross reference for the inputs. This will not be present on all experiment softwares.

Graph: If present it is possible to view data that is being captured or logged from the software. In this particular experiment the bending moment diagram will be drawn based on the inputs chosen. You will also notice that in the top left corner of the software screen is a tab with Graph text written. Pressing this tab will bring up a new screen showing exactly the same graph as on the main software window.

Output Values: These values are the key output values from the hardware. They have been placed within the hardware image near the area they represent to give a guide to the end user.

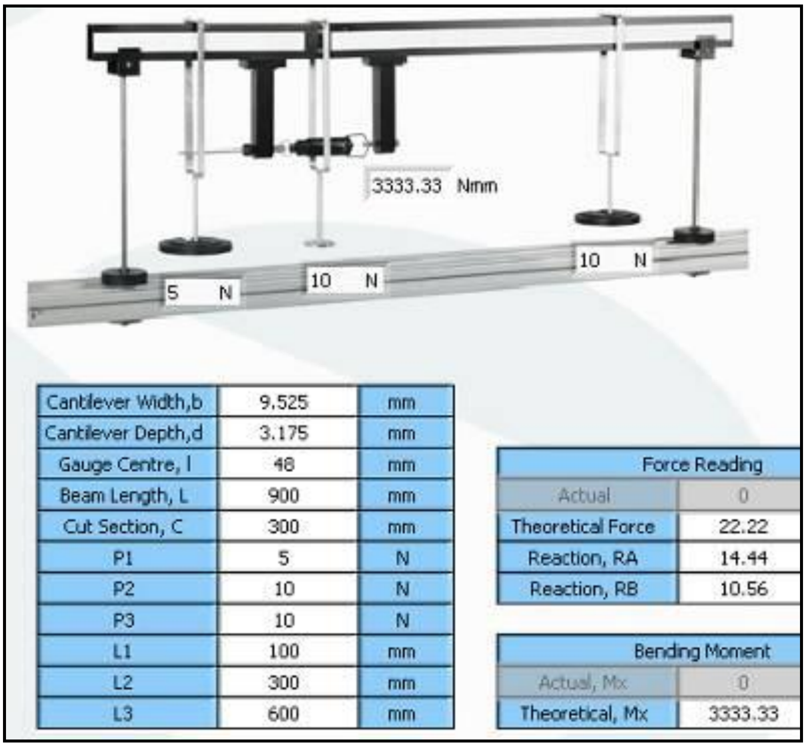
OPERATING THE SOFTWARE

The following procedure outlines the steps required to operate the software and to obtain outputs for the inputs chosen. It is one of many variations that could be followed.

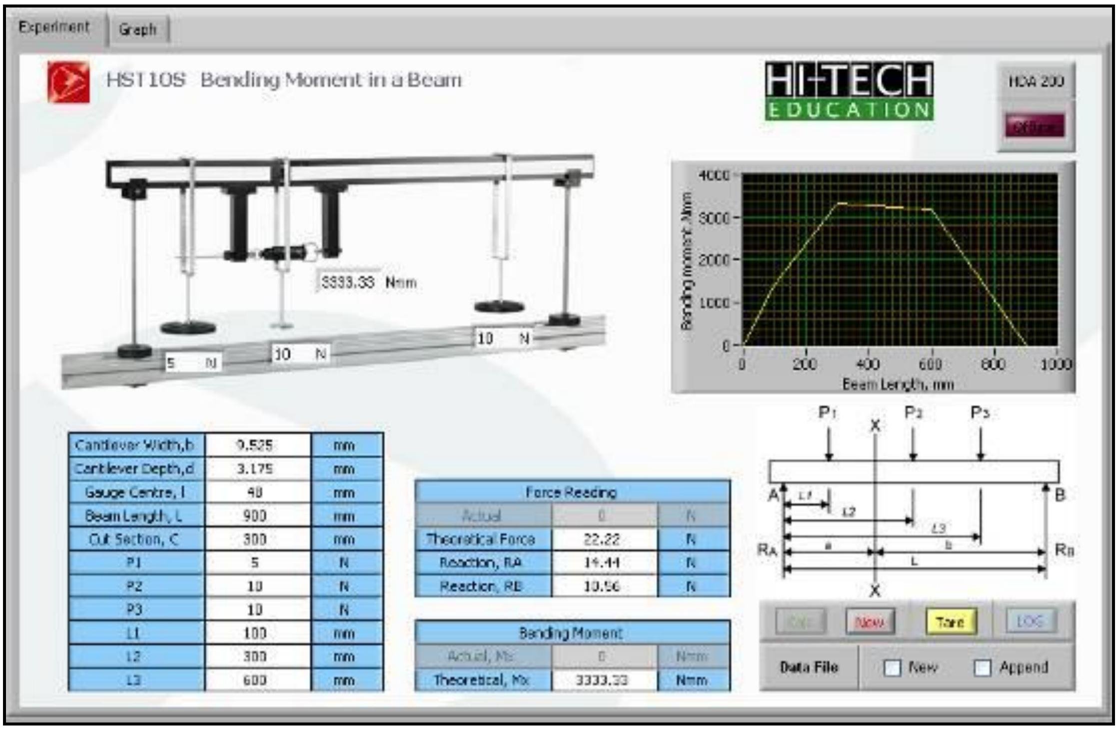
It assumes that the end user has set up the HDA200 (if necessary) and installed the software correctly and all inputs are being undertaken using the keyboard of the host computer.

OFFLINE MODE

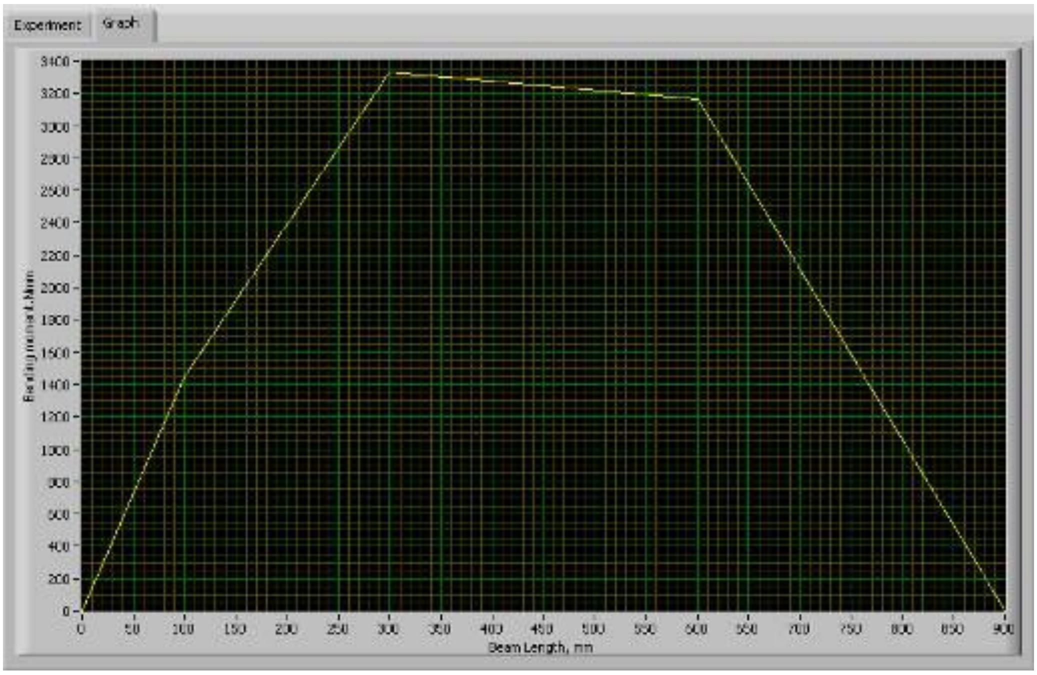
1. Load the experiment software by double clicking the **.exe** files supplied.
2. Choose ‘NO’ when the pop up window appears asking if the HDA200 is connected.
3. You will notice that there a number of the input and output boxes with the letters NaN shown. This is because there have been no values input or output since starting up the software. These will be removed once values have been input.
4. Enter 9.525 in the cantilever width input box.
5. Enter 3.175 in the cantilever depth input box.
6. Enter 48 in the gauge centre input box.
7. Enter 900 in the beam length input box.
8. Enter 300 in the cut section input box.
9. Enter 5 in the P1 input box.
10. Enter 10 in the P2 input box.
11. Enter 10 in the P3 input box.
12. Enter 100 in the L1 input box
13. Enter 300 in the L2 input box.
14. Enter 600 in the L3 input box. The screen should now have inputs that look like the following image:



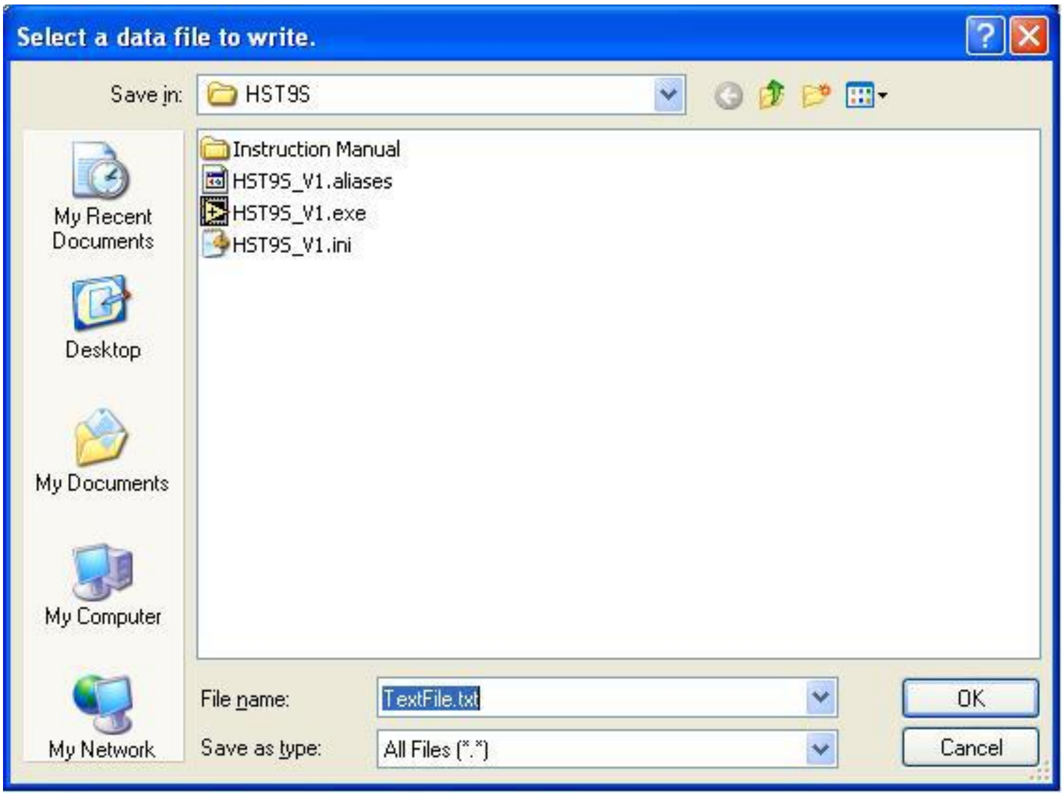
15. The values of P1, P2 and P3 will be seen in the output values on the hardware image.
16. Press the CALC button and the values will appear in the output boxes, on the hardware image and a bending moment diagram will appear as shown in the image below:



17. There will be no value for the ***Actual Force*** and ***Actual Mx*** output boxes as the software has been chosen to run in OFFLINE mode.
18. Press the graph tab in the top left of the software screen and the following will appear:



19. This diagram will be a replica of the diagram on the main software window.
20. Return to the main software window by pressing on the experiment tab in the top left of the software window.
21. Tick the Data File NEW box.
22. Press CALC.
23. You will then be shown the following window (the contents of this window will vary depending on the experiment running) and prompted to create a data file name in the location of your choice.



24. Either rename the default name of TextFile.txt or keep this default name. Ensure the file extension of ***.txt*** remains. Once the filename and location have been chosen then press **OK**.
25. A new diagram will appear and the same values appear in the output boxes.
26. The input and output data will now be saved in the data file created.
27. Tick the Data File APPEND box. Press CALC and then choose the same data file as created previously. The current input and output data will now be appended to this file without overwriting the original data.
28. Locate this text file and open in NOTEPAD to see the format and information that it is saving.
29. If you wish to change the inputs then simply change the input, choose whether to create a new data file or append to an existing file and then press CALC.
30. In the OFFLINE mode the NEW and TARE buttons although live will not perform any function. The LOG button will not be live and greyed out but the data can still be stored by the use of the CALC button.
31. When finished with the software shut the software down.
32. You can continue to adjust the inputs and see what outputs are obtained by following the same process above.

HDA200 CHANNEL SETTINGS and CONNECTIONS

Prior to running this experiment software in ONLINE mode with the HDA200 you will have to make sure that the correct experiment hardware sensors/transducers are connected to the HDA200 and the correct channels are being displayed by the HDA200. Refer to the HDA200 instruction manual and use the following table as a reference also:

Sensor/Transducer	HDA200 Connector Number	HDA200 Channel number	Resolution
Strain	Strain 1	1	

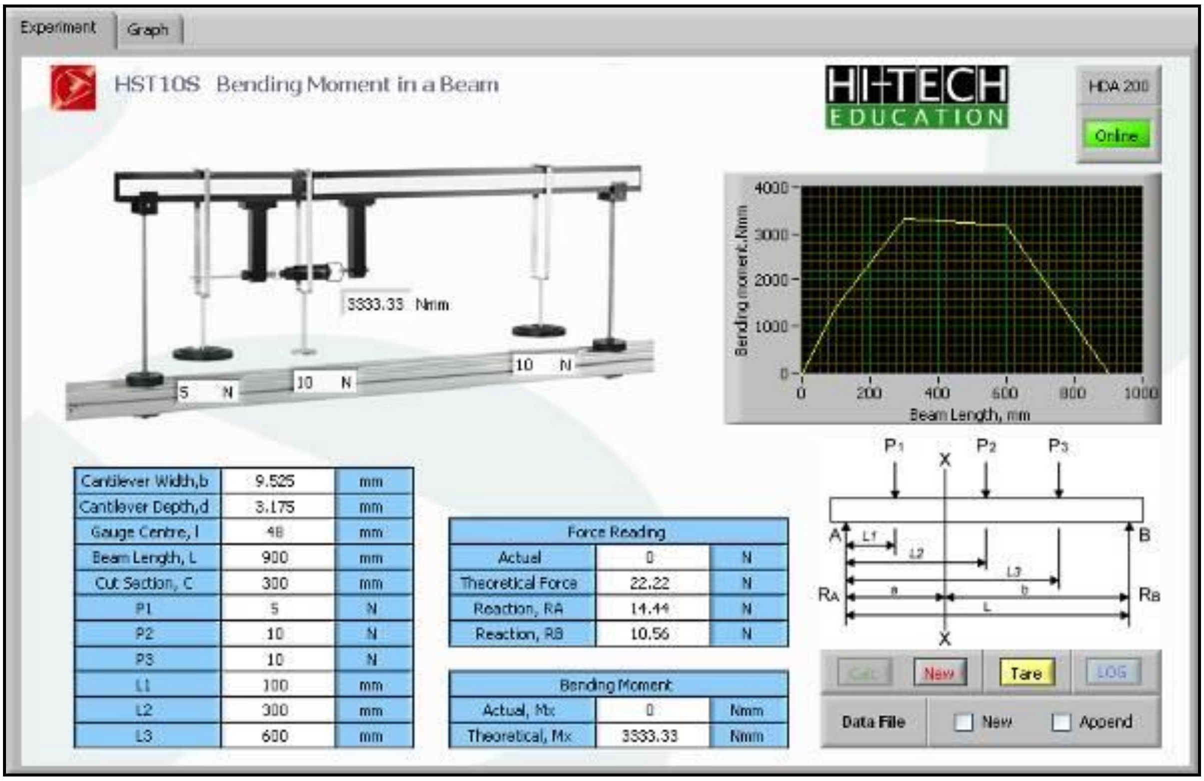
Run the HDA200 in LOCAL mode to check that the above channels only are being displayed. This will then ensure that the software collects the right data from the right channels.

NB: If the dial gauges (if used) are connected but not turned on then the software and HDA200 will not display the dial gauge values and the software and HDA200 screens will wait until they are turned on. Ensure the dial gauges are turned on when running the experiment and software.

If the above channels are not set correctly then you will have to enter the configuration of the HDA200 which will require reading and following the HDA200 instruction manual.

ONLINE MODE

1. Repeat the input parameters from the OFFLINE mode procedure above, press the CALC button and the software window should look like the image below:

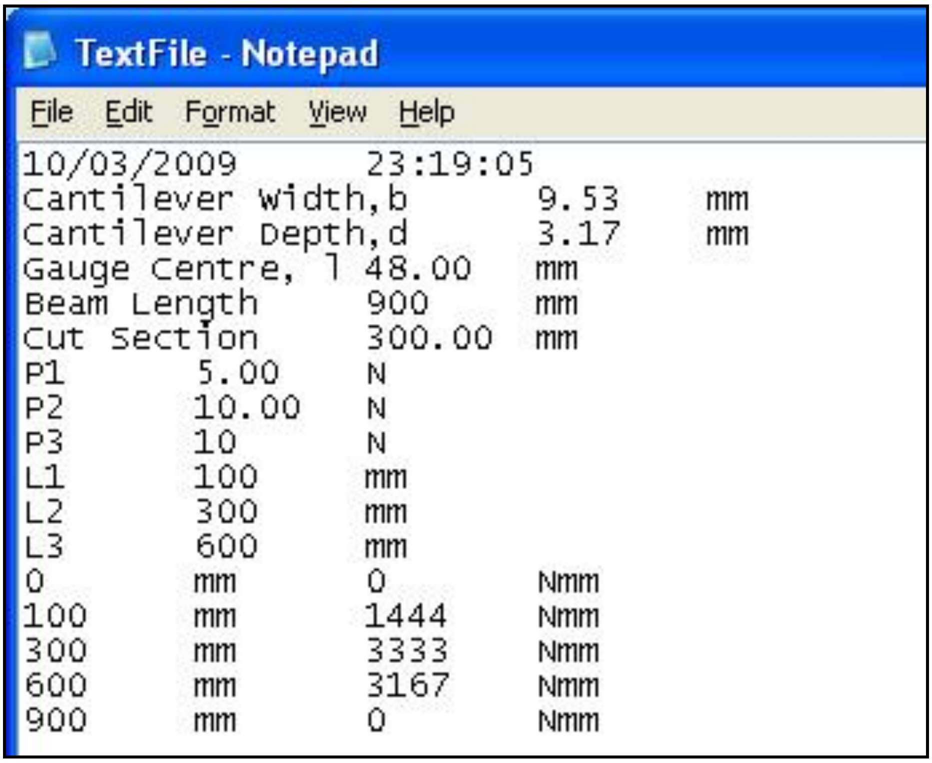


2. You will notice that the ***Actual*** force and ***Actual Mx*** output line is now live and not greyed out.
3. You will now see the actual value of the bending force coming from the hardware within the ***Actual*** force output box. To zero this reading simply press the TARE button. You may have to press it again if the reading does not return to zero.
4. Load the hardware experiment to the same parameters as the input boxes. You should then be able to compare the ***Actual Mx*** value with the theoretical value.
5. If you wish to save the data into the existing data file or a new data file then press the NEW button. The value in the ***Actual Mx*** output box will change due to the fact that the software is not retrieving the actual value from the hardware.
6. Tick the data file option required.
7. Press the CALC button and you will be prompted to create a new data file or append to the existing file. Choose the option required.
8. The current input and output values will then be saved to the data file.
9. Press the NEW button when you need to change a value of one of the inputs.
10. Change the input.
11. Choose whether to create a new data file or append to an existing file.
12. Press CALC and the new outputs will be created along with a graph.
13. You can then continue to create new inputs and obtain new outputs depending on how you set up the hardware and by following the procedure above.

DATA FILE CONTENTS

The data file created contains information that is useful in allowing the end user to further manipulate the data in a spreadsheet software.

The image below shows the typical data at the start of the data file for the HST9S:


TextFile - Notepad

File Edit Format View Help

```
10/03/2009      23:19:05
Cantilever Width,b      9.53    mm
Cantilever Depth,d      3.17    mm
Gauge Centre, l 48.00   mm
Beam Length     900     mm
Cut Section     300.00  mm
P1      5.00    N
P2      10.00   N
P3      10      N
L1      100     mm
L2      300     mm
L3      600     mm
0       mm      0       Nmm
100     mm      1444    Nmm
300     mm      3333    Nmm
600     mm      3167    Nmm
900     mm      0       Nmm
```

The data is as follows:

Date and time.
Cantilever width input value from software
Cantilever depth input value from software
Gauge centre input value from software
Beam length input value from software.
Cut section input value from software.
P1 value from software
P2 value from software
P3 value from software
L1 value from software
L2 value from software
L3 value from software

The next two columns relate to the data from the bending moment diagram.

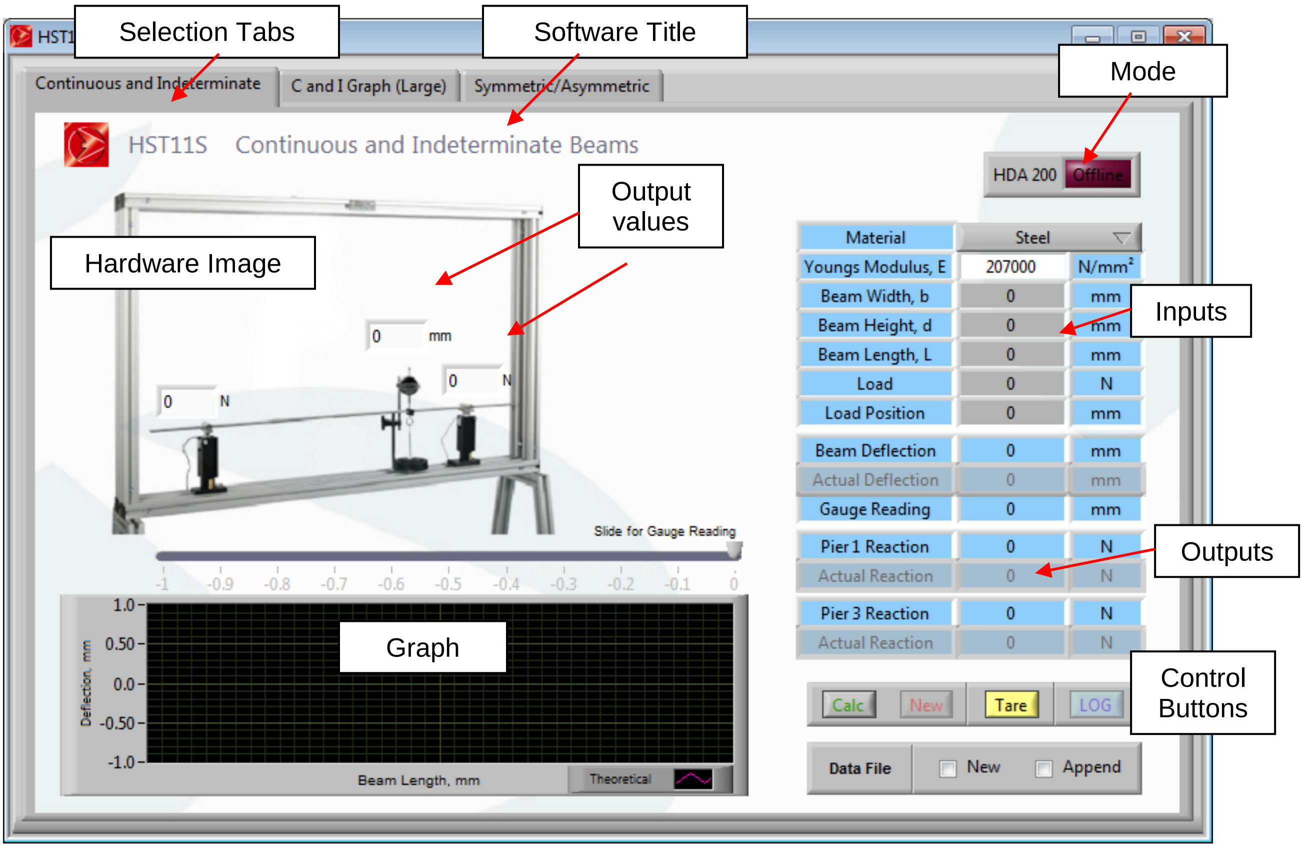
The left hand column are incremental points going across the beam length starting at 0 (zero) and ending at the beam length stated in the input, i.e. 900mm.
The right hand column is the bending moment value going across the beam length for each increment.

You will see the bending moment value at the cut section.

All data appended to this file will be saved in this data file and can be viewed.

HST11S – CONTINUOUS & INDETERMINATE BEAMS

SOFTWARE WINDOW



In either mode the details of what is presented in the software window is the same. These are highlighted in the above image and detailed as follows:

Hardware image: This is a true representation of the actual hardware thus ensuring consistency in viewing between software and hardware.

Software Title: The title and number of the software.

Mode: This highlights which mode the software is in, i.e. OFFLINE or ONLINE.

Inputs: These boxes allow the end user to input values for the specific parameters listed. The blue boxes on the left hand column show the description of the input and the right hand column blue boxes show the units for these parameters. The central column is where the value is input via the keyboard. It is possible to press the TAB button on the keyboard and the cursor will jump to the next parameter.

The inputs available are as follows:

- **Material:** The user can choose the frame material. Choices range from steel, aluminium and brass. When a material is chosen the young's modulus is automatically chosen and displayed in the input box below.
- **Beam Width, b:** This is the width of the beam. Typically this will be 25mm. It has the units of millimetres (mm).
- **Beam Height, d**: This is the height of the beam. Typically this is 3 or 5mm. It has the units of millimetres (mm).
- **Beam Length, L**: This is the length (or span) of the beam. It has the units of millimetres (mm).
- **Frame Height, H**: This is the height of the frame from the knife edge and roller bearing centre line to the centreline of the top horizontal member. This is typically 450mm. It has the units of millimetres (mm).
- **Load**: This is the value of the applied load on the beam. It has the units of Newton (N)
- **Load Position**: This is position of the load along the beam. This will have a value that is in between the beam length (or span). It has the units of millimetres (mm).

Outputs: These are theoretical values and actual values from the hardware based on the input parameters chosen. This is where the end user can compare actual results with theoretical. Again the format of the columns is the same as the inputs except that the central column is automatically updated depending on the inputs chosen and cannot be adjusted via the keyboard.

The outputs available are as follows:

- **Beam Deflection**: This is the theoretical beam deflection value at the point of loading. This is a calculated value. It has the units of millimetres (mm).
- **Actual Deflection**: This is the actual value of the beam deflection coming from the dial gauge attached to the hardware. It has the units of millimetres (mm).
- **Gauge Reading**: A slide is available along the top of the graph. This slider traverses the beam span and allows the end user to get an idea of the beam deflection at whatever position along the beam span. This will enable the maximum beam deflection to be monitored also. As the slider moves so does this value. It has the units of millimetres (mm).
- **Pier 1 Reaction**: This is the theoretical value for the reaction at pier 1. The hardware will have the piers labelled. This value will depend on the magnitude and value of the load. It has the units of Newton's (N).
- **Actual Reaction**: This is the actual value of the reaction at pier 1 coming from the hardware itself. It has the units of Newton's (N).
- **Pier 3 Reaction**: This is the theoretical value for the reaction at pier 3. The hardware will have the piers labelled. This value will depend on the magnitude and value of the load. It has the units of Newton's (N).
- **Actual Reaction**: This is the actual value of the reaction at pier 3 coming from the hardware itself. It has the units of Newton's (N).

Control buttons: these buttons give the end user a choice of what to do with the software and the values presented on the screen. They are described in more detail as follows:

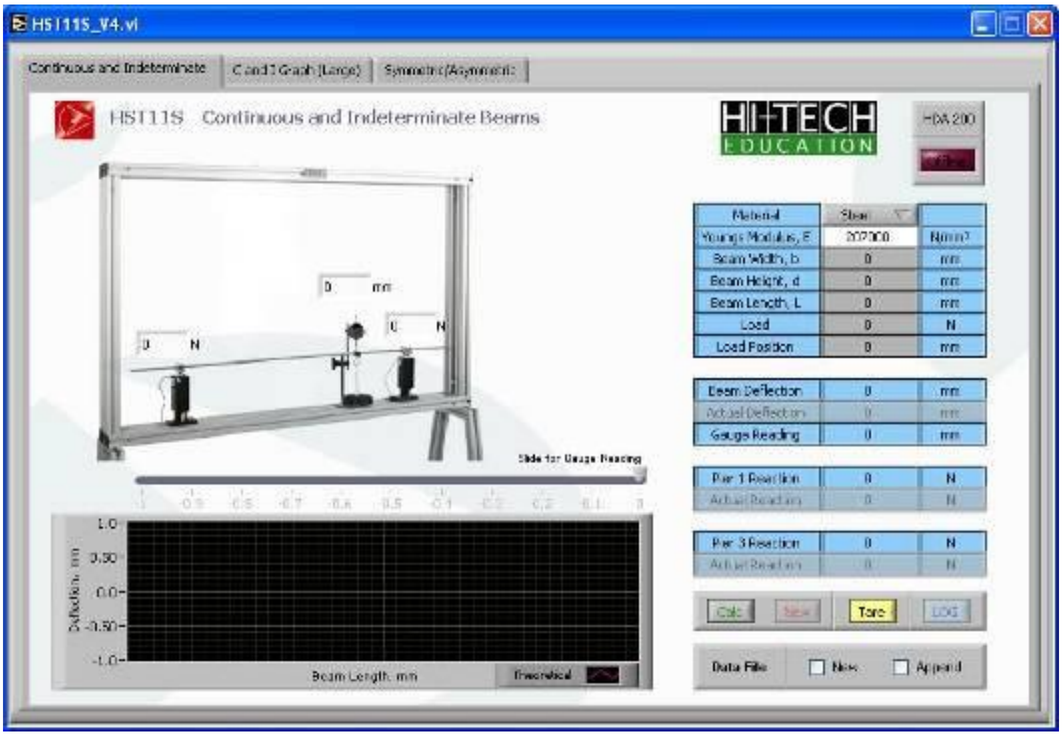
- **<u>CALC</u>**: When the inputs have been set, pressing this button will calculate the theoretical outputs.
- **<u>NEW</u>**: When this button is pressed it stops background processes and allows any of the inputs to be adjusted and then recalculated.
- **<u>TARE</u>**: This button is only valid when running in ONLINE mode as when pressed it zeroes (tares) the values from any strain gauges and load cell channels which are being used in the software.
- **<u>LOG</u>**: When the end user wishes to record any data from the software during ONLINE running, they can press this button and the key input and output parameters will then be logged into the data file.
- **<u>Data File NEW:</u>** This tick box is used when the end user wishes to store the input and output data to a brand new file on the host computer. When this is ticked and the CALC button pressed you will be prompted to create a new data file.
- **<u>Data file APPEND:</u>** If a data file has already been created then ticking this box will allow data to be added to this file rather than having to create a new file.

<u>Slider:</u> To view the deflection at a particular point along the beam, other than at the load point, this slider will allow this. By moving it across the beam span the deflection can then be read off from the ***Gauge reading*** output box.

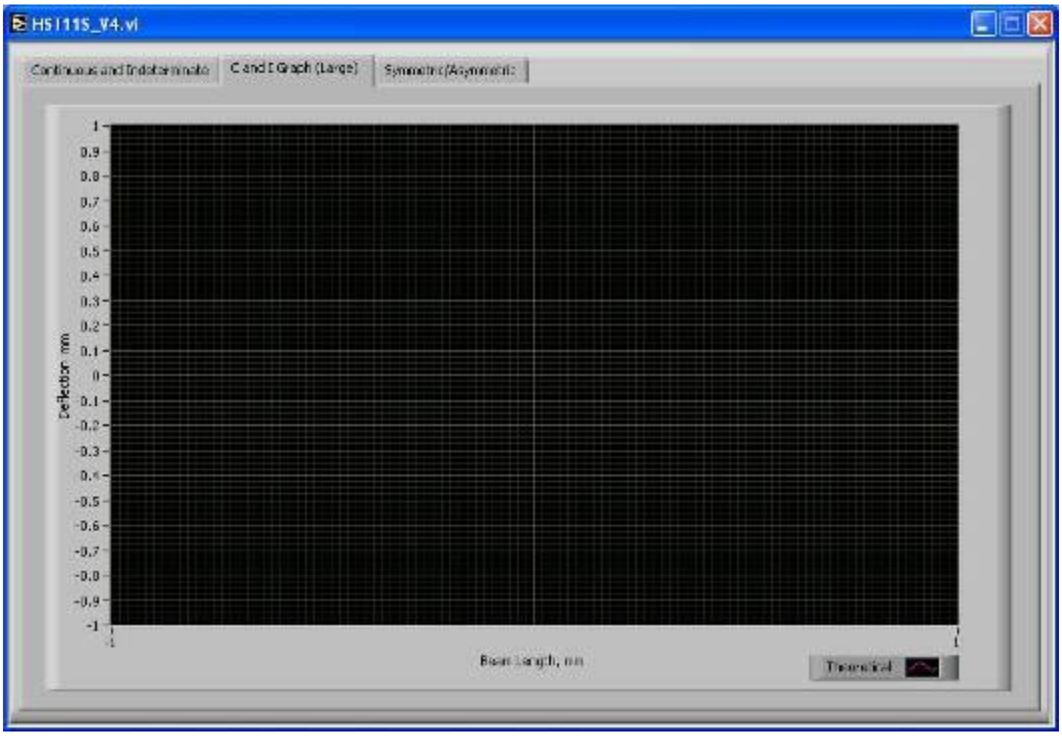
<u>Output Values:</u> These values are the key output values from the hardware. They have been placed within the hardware image near the area they represent to give a guide to the end user.

Selection Tabs: To operate another element of the HST11S experiment or show the graph the selection tabs at the top of the screen can be chosen.

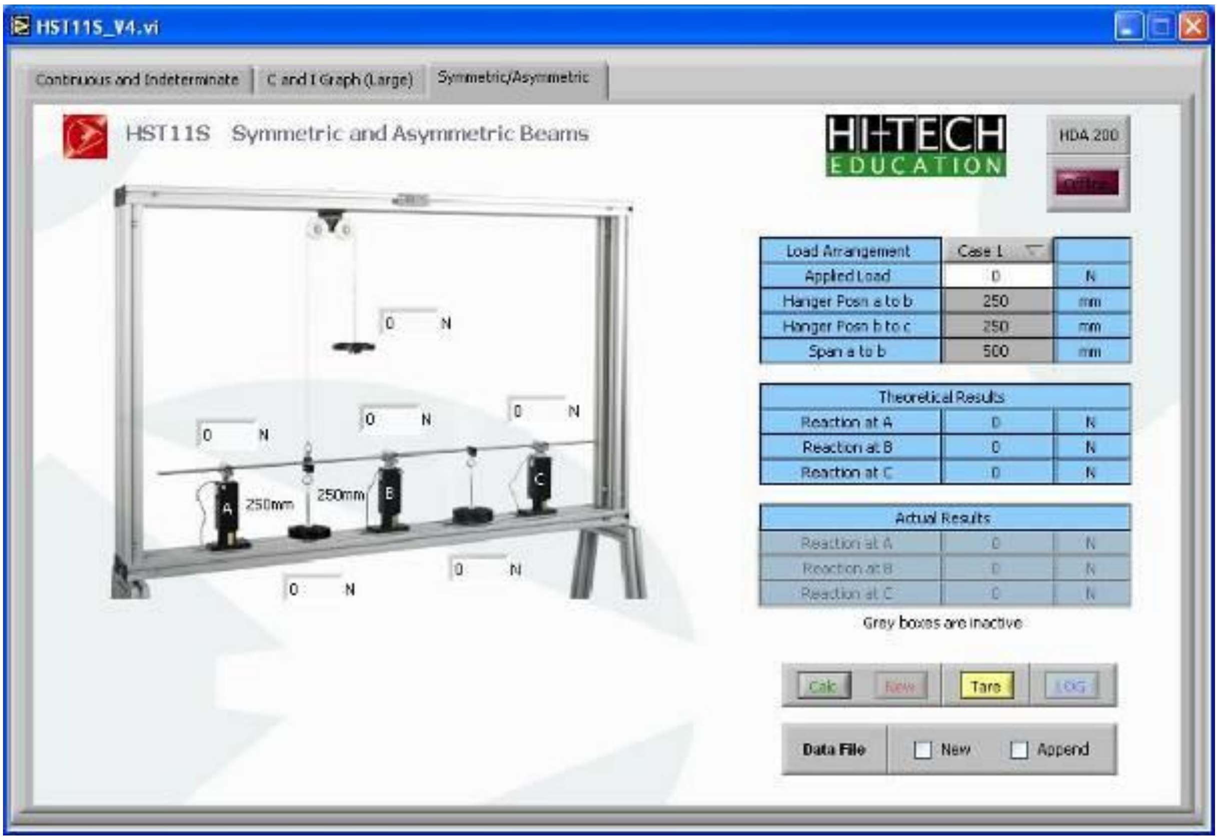
Selecting the first tab (labelled Continuous and Indeterminate) will bring up the software screen for the Continuous and Indeterminate Beam as shown below:



Selecting the second tab (labelled C and I Graph (Large)) will bring up the larger version of the graph shown on the Continuous and Indeterminate software screen. This graph represents the displacement of the beam for the magnitude and position of loading chosen. This will be created when the CALC button is pressed.



Selecting the third tab (Symmetric/Asymmetric) will bring up the software screen for the symmetric and asymmetric part of the hardware experiment as shown in the image below.



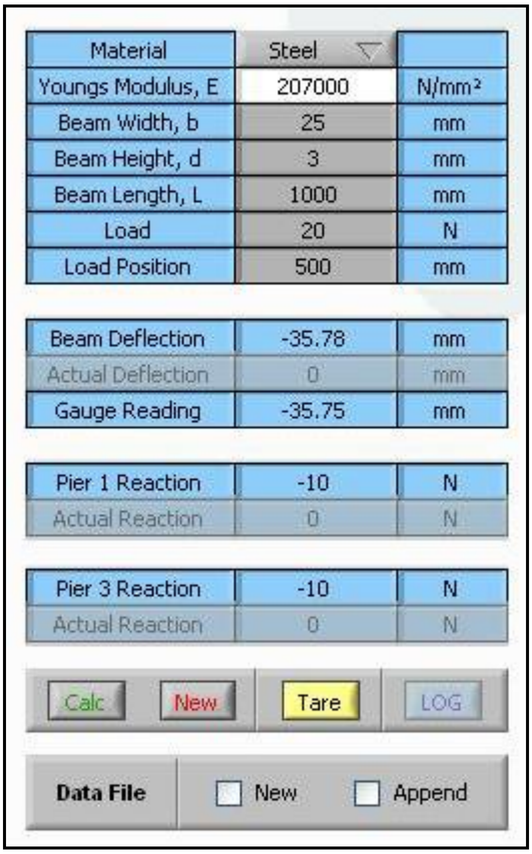
OPERATING THE SOFTWARE

The following procedure outlines the steps required to operate the software and to obtain outputs for the inputs chosen. It is one of many variations that could be followed.

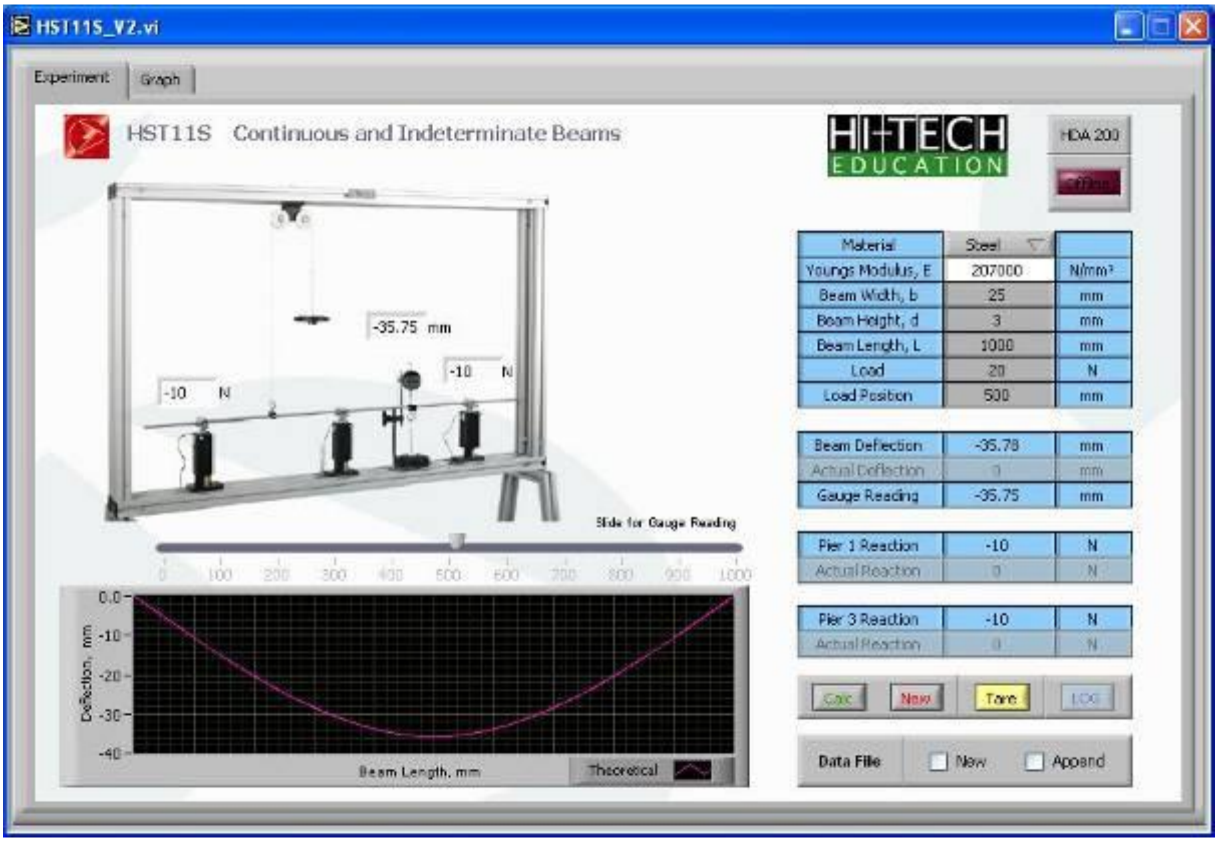
It assumes that the end user has set up the HDA200 (if necessary) and installed the software correctly and all inputs are being undertaken using the keyboard of the host computer.

OFFLINE MODE

1. Load the experiment software by double clicking the **.exe** files supplied.
2. Choose ‘NO’ when the pop up window appears asking if the HDA200 is connected.
3. Enter 25 in the beam width input box.
4. Enter 3 in the beam height input box.
5. Enter 1000 in the beam length input box.
6. Enter 20 in the load input box.
7. Enter 500 in the load position input box. The screen should now have inputs that look like the following image:

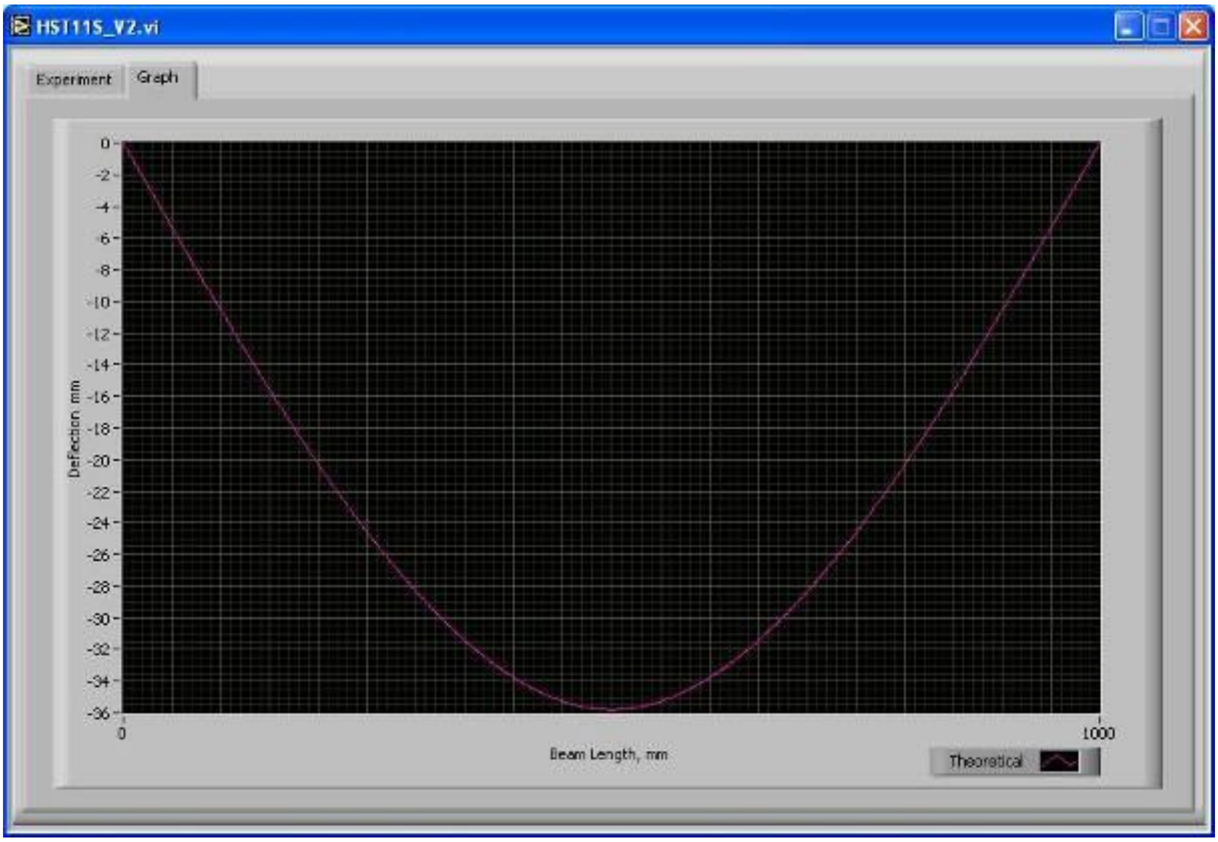


8. Press the CALC button and the values will appear in the output boxes, on the hardware image and a graph will be drawn as shown in the image below:



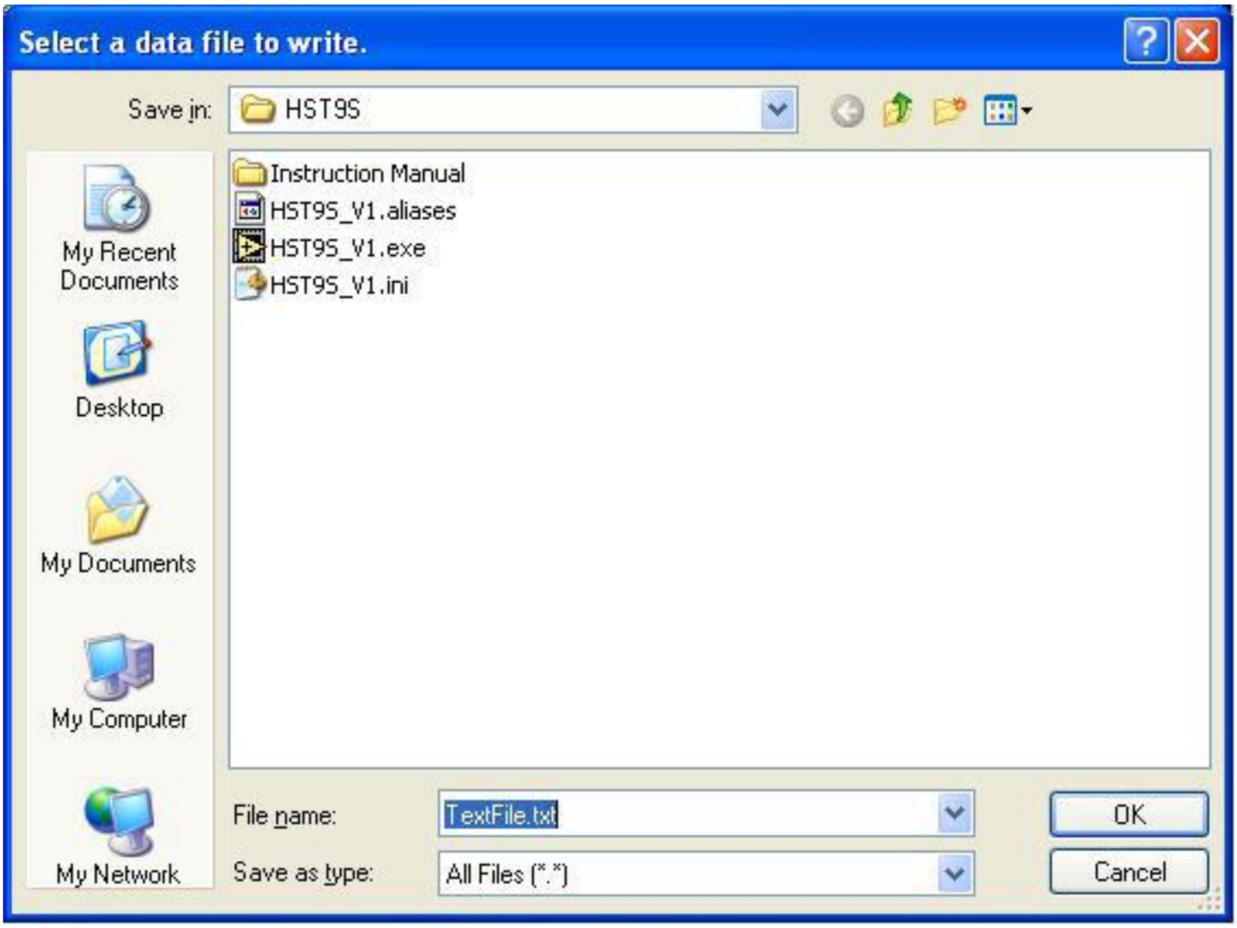
9. There will be no value for the ***Actual Deflection and Actual Reactions*** as the software has been chosen to run in OFFLINE mode.
10. Move the slider from left to right. You will see the value of the gauge reading change both in the output box in the table and on the hardware image. This shows the deflection of the beam at the position at the which the slider is located.

11. Press the graph tab in the top left of the software screen and the following will appear:



12. This diagram will be a replica of the graph on the main software window.
13. Return to the main software window by pressing on the experiment tab in the top left of the software window.
14. Right click in the graph display and choose clear chart. This then clears the chart for a new diagram to be created. If you do not clear the chart new graphs will be appended to this existing graph. Repeat this for the main graph window.
15. Press the NEW button. You will be prompted to clear charts. Do this.
16. Tick the Data File NEW box.
17. Press CALC.

18. You will then be shown the following window (the contents of this window will vary depending on the experiment running) and prompted to create a data file name in the location of your choice.



19. Either rename the default name of TextFile.txt or keep this default name. Ensure the file extension of ***.txt*** remains. Once the filename and location have been chosen then press **OK**.
20. A new graph will appear and the same values appear in the output boxes.
21. The input and output data will now be saved in the data file created.
22. Press the NEW button, clear the graphs, and then tick the Data File APPEND box. Press CALC and then choose the same data file as created previously. The current input and output data will now be appended to this file without overwriting the original data.
23. Locate this text file and open in NOTEPAD to see the format and information that it is saving.
24. If you wish to change the inputs then simply press the NEW button, clear the graphs, change the input, choose whether to create a new data file or append to an existing file and then press CALC.
25. In the OFFLINE mode the NEW and TARE buttons although live will not perform any function. The LOG button will not be live and greyed out but the data can still be stored by the use of the CALC button.
26. When finished with the software shut the software down.
27. You can continue to adjust the inputs and see what outputs are obtained by following the same process above.

HDA200 CHANNEL SETTINGS and CONNECTIONS

Prior to running this experiment software in ONLINE mode with the HDA200 you will have to make sure that the correct experiment hardware sensors/transducers are connected to the HDA200 and the correct channels are being displayed by the HDA200. Refer to the HDA200 instruction manual and use the following table as a reference also:

Sensor/Transducer	HDA200 Connector Number	HDA200 Channel number	Resolution
Load cell	Force 1	17	
Load cell	Force 2	18	
Load cell	Force 3	19	
Dial Gauge	Dial gauge 1	28	0.01mm
Dial Gauge	Dial gauge 2	29	0.01mm
Dial Gauge	Dial gauge 3	30	0.01mm

Run the HDA200 in LOCAL mode to check that the above channels only are being displayed. This will then ensure that the software collects the right data from the right channels.

NB: If the dial gauges (if used) are connected but not turned on then the software and HDA200 will not display the dial gauge values and the software and HDA200 screens will wait until they are turned on. Ensure the dial gauges are turned on when running the experiment and software.

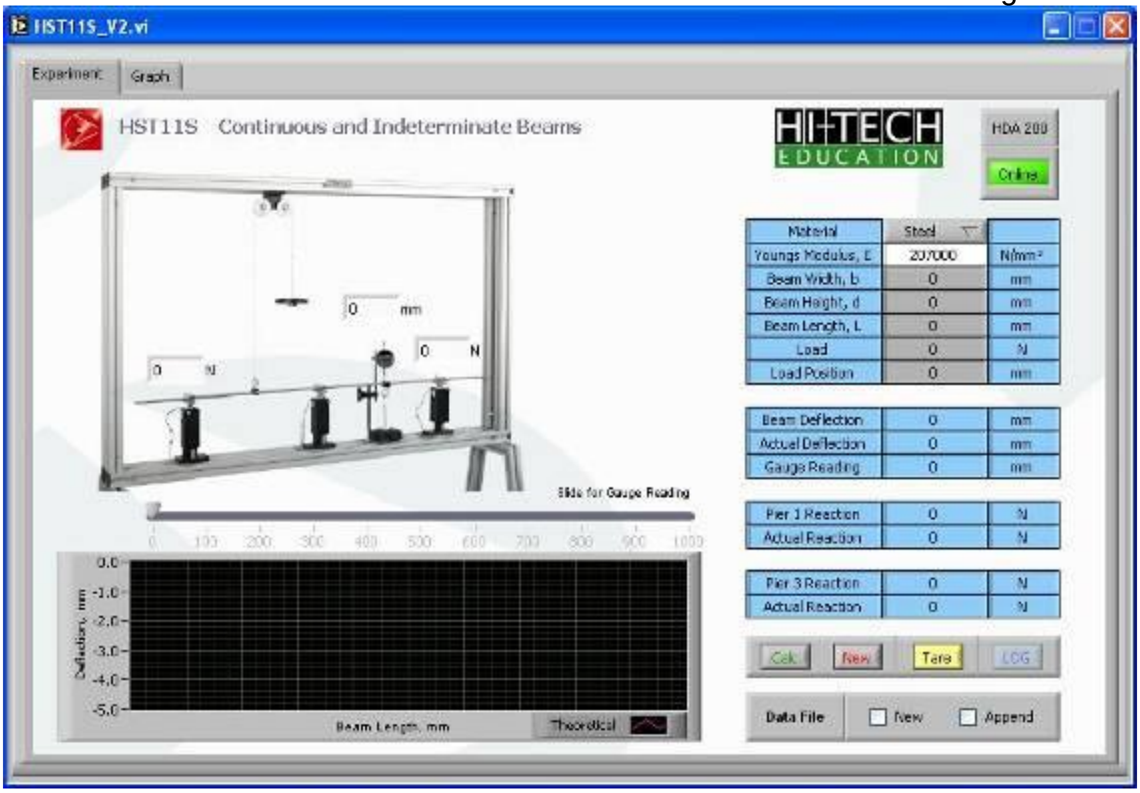
If the above channels are not set correctly then you will have to enter the configuration of the HDA200 which will require reading and following the HDA200 instruction manual.

ONLINE MODE

NB: BEFORE RUNNING THE SOFTWARE IN ONLINE MODE MAKE SURE THERE IS A SINGLE DIAL GAUGE CONNECTED INTO DIAL GAUGE CHANNEL1 AND THE REACTION PIERS 1 and 3 CONNECTED INTO CHANNEL 17 AND 19 OF THE HDA200.

THIS EXPEIRMENT WILL UNDERTAKE PARTS 1 and 2 OF THE HARDWARE INSTRUCTION MANUAL.

14. Repeat the input parameters from the OFFLINE mode procedure above, press the CALC button and the software window should look like the image below:



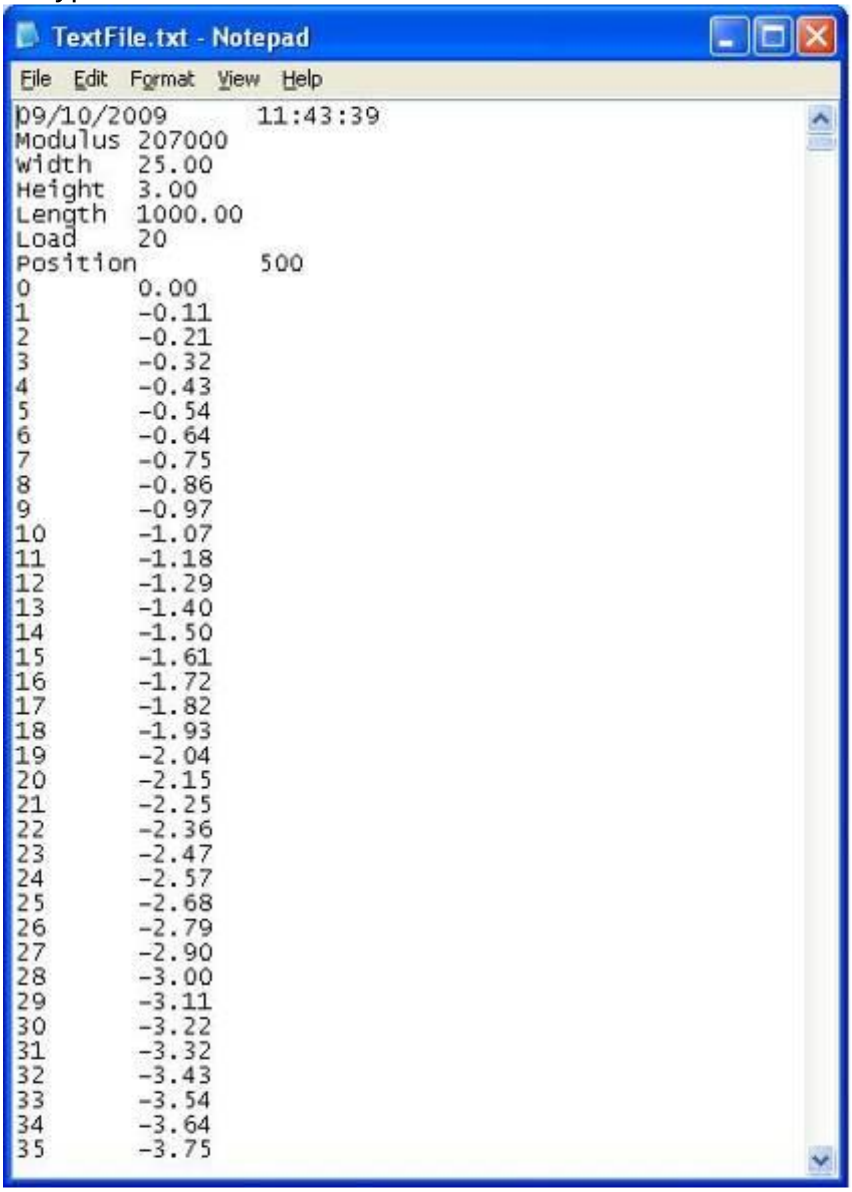
1. You will notice that there are no greyed out boxes on this screen.
2. You will now see the actual value of the dial gauge deflection and pier reactions coming from the hardware. To zero the reaction pier readings simply press the TARE button. You cannot tare the dial gauge readings with this button. You will have to tare the dial gauges using their front panel buttons.
3. Load the hardware experiment to the same parameters as the input boxes. You should then be able to compare the actual values with the theoretical values.
4. If you wish to save the data into the existing data file or a new data file then press the NEW button.
5. Clear the graph.
6. Tick the data file option required.
7. Press the CALC button and you will be prompted to create a new data file or append to the existing file. Choose the option required.
8. The current input and output values will then be saved to the data file.
9. Press the NEW button when you need to change a value of one of the inputs.

10. Change the input.
11. Clear the graphs.
12. Choose whether to create a new data file or append to an existing file.
13. Press CALC and the new outputs will be created along with a graph.
14. You can then continue to create new inputs and obtain new outputs depending on how you set up the hardware and by following the procedure above.

DATA FILE CONTENTS

The data file created contains information that is useful in allowing the end user to further manipulate the data in spreadsheet software.

The image below shows the typical data at the start of the data file for the HST11S:




```
09/10/2009      11:43:39
Modulus 207000
Width   25.00
Height  3.00
Length  1000.00
Load    20
Position        500
0       0.00
1       -0.11
2       -0.21
3       -0.32
4       -0.43
5       -0.54
6       -0.64
7       -0.75
8       -0.86
9       -0.97
10      -1.07
11      -1.18
12      -1.29
13      -1.40
14      -1.50
15      -1.61
16      -1.72
17      -1.82
18      -1.93
19      -2.04
20      -2.15
21      -2.25
22      -2.36
23      -2.47
24      -2.57
25      -2.68
26      -2.79
27      -2.90
28      -3.00
29      -3.11
30      -3.22
31      -3.32
32      -3.43
33      -3.54
34      -3.64
35      -3.75
```

The data is as follows:

Date and time.
Modulus of elasticity of beam material chosen from software.
Beam width input value from software.
Beam height input value from software
Beam length (or span) input value from software
Load input value from software
Position of load from software

The next two columns are described as follows:

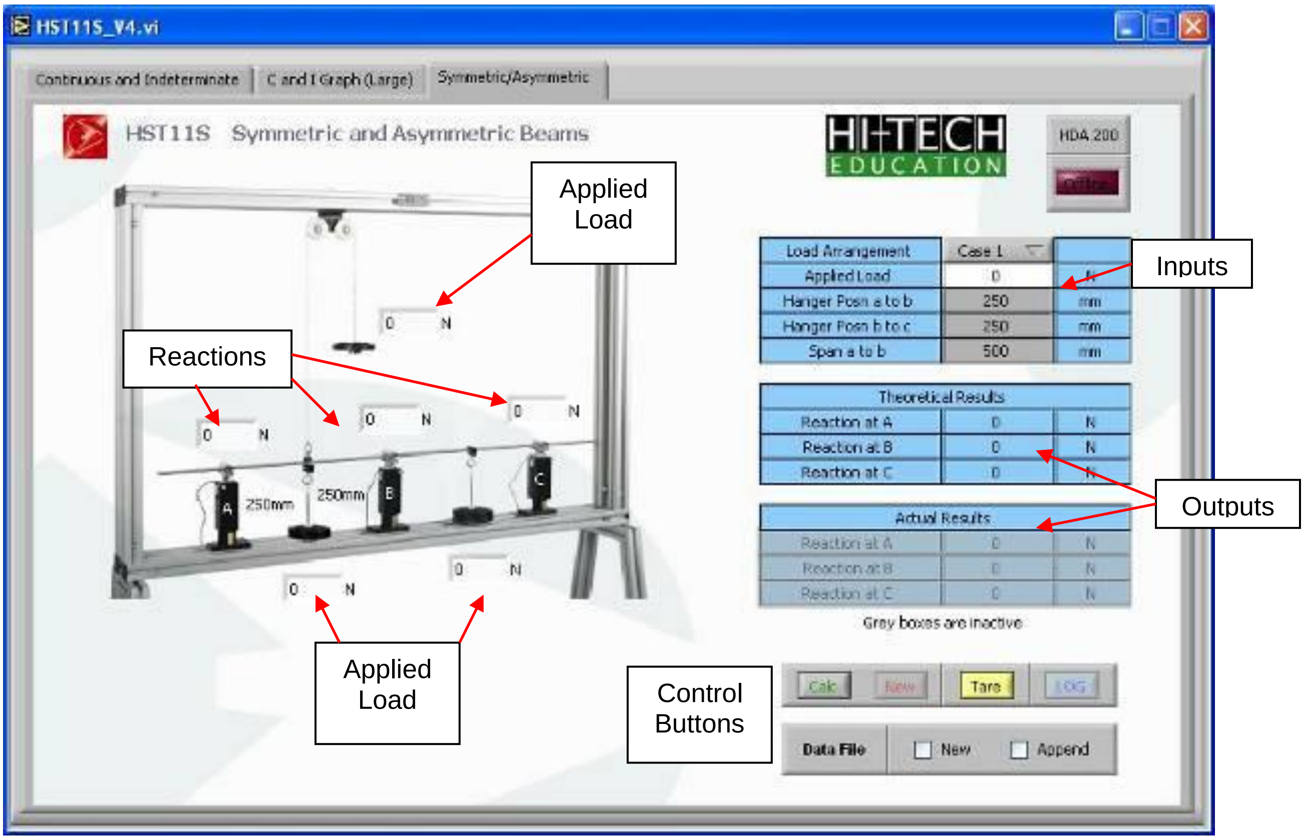
Column 1: Beam span in increments of 1mm. The lowest value will be zero (0) and the maximum value will be whatever value of beam length has been chosen from the software.

Column 2: Beam deflection values for the particular beam span it relates to.

From these two columns it is possible to recreate the beam deflection shape.

All data appended to this file will be saved in this data file and can be viewed.

SYMMETRIC/ASYMMETRIC Software Screen



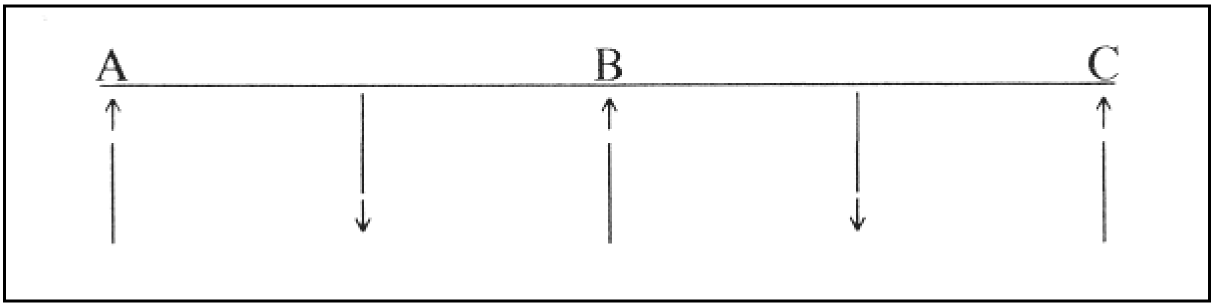
In either mode the details of what is presented in the software window is the same. These are highlighted in the above image and detailed as follows:

Inputs: These boxes allow the end user to input values for the specific parameters listed. The blue boxes on the left hand column show the description of the input and the right hand column blue boxes show the units for these parameters. The central column is where the value is input via the keyboard. It is possible to press the TAB button on the keyboard and the cursor will jump to the next parameter.

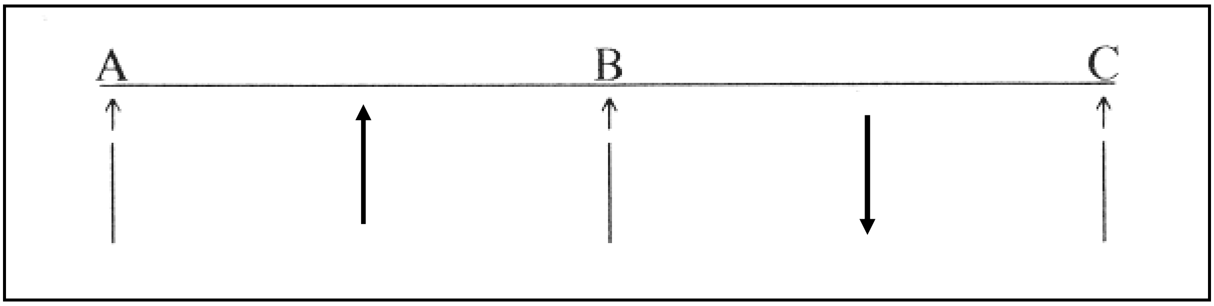
The inputs available are as follows:

- **Load Arrangement:** The user can choose the load arrangement from the drop down list. Three options are presented; Case 1; Case 2; Case 3.

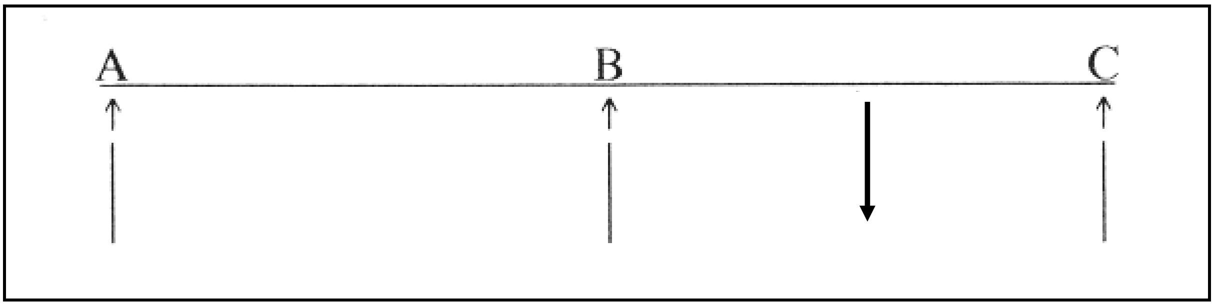
Case 1:



Case 2:



Case 3:



The difference between the load arrangements are the position and orientation of the applied load each time.

As each case is chosen the loading shown on the hardware image will also be seen to change. The value of the load shown is the same as the value entered in the applied load input box.

- **Applied Load:** This is the value of the applied load added to the relevant hanger for the case chosen.
- **Hanger Posn a to b**: This is the distance form the reaction pier A to the load hanger which is situated between reaction pier A and B from. This is a fixed value and not editable. It has the units of millimetres (mm).
- **Hanger Posn b to c**: This is the distance from the reaction pier B to the load hanger which is situated between reaction pier B and C. This is a fixed value and not editable. It has the units of millimetres (mm).
- **Span a to b**: This is the distance between the reactions piers A and B and also B and C. This is a fixed value and not editable. It has the units of millimetres (mm).

Outputs: These are theoretical values and actual values from the hardware based on the input parameters chosen. This is where the end user can compare actual results with theoretical. Again the format of the columns is the same as the inputs except that the central column is automatically updated depending on the inputs chosen and cannot be adjusted via the keyboard.

The outputs available are as follows:

Theoretical Results. Offline mode only.

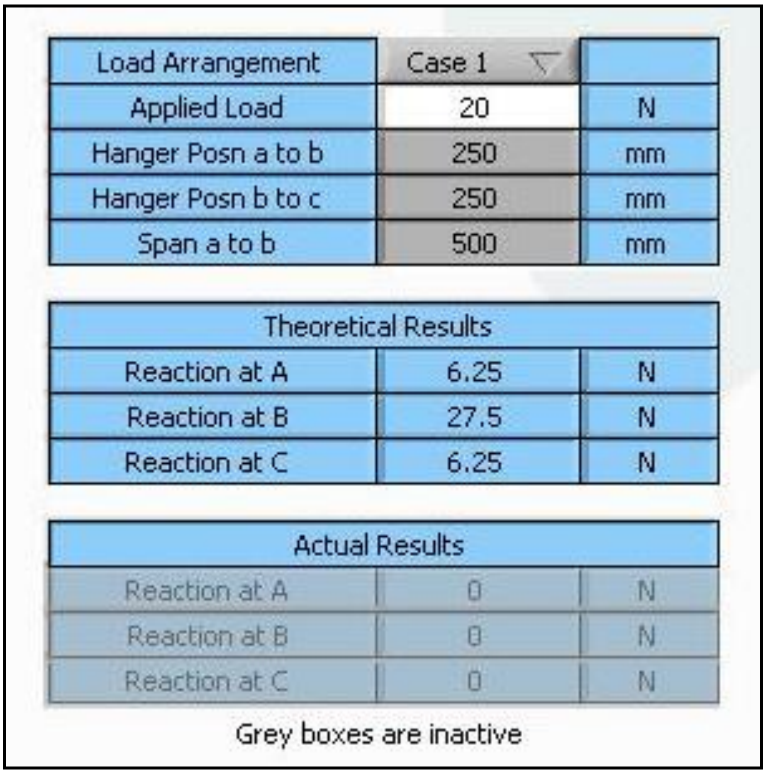
- **<u>Reaction at A</u>**: This is the value of the reaction from reaction pier A. It has the units of Newton's (N).
- **<u>Reaction at B</u>**: This is the value of the reaction from reaction pier A. It has the units of Newton's (N).
- **<u>Reaction at C</u>**: This is the value of the reaction from reaction pier A. It has the units of Newton's (N).

Actual Results. Online mode only.

- **<u>Reaction at A</u>**: This is the value of the reaction from reaction pier A. It has the units of Newton's (N).
- **<u>Reaction at B</u>**: This is the value of the reaction from reaction pier A. It has the units of Newton's (N).
- **<u>Reaction at C</u>**: This is the value of the reaction from reaction pier A. It has the units of Newton's (N).

<u>OFFLINE MODE – Symmetric/Asymmetric</u>

1. Load the experiment software by double clicking the **.exe** files supplied.
2. Choose 'NO' when the pop up window appears asking if the HDA200 is connected.
3. Choose Case 1 from the drop down list.
4. Enter 20 in the applied load input box.
5. Press the CALC button. The screen should now have inputs that look like the following image:



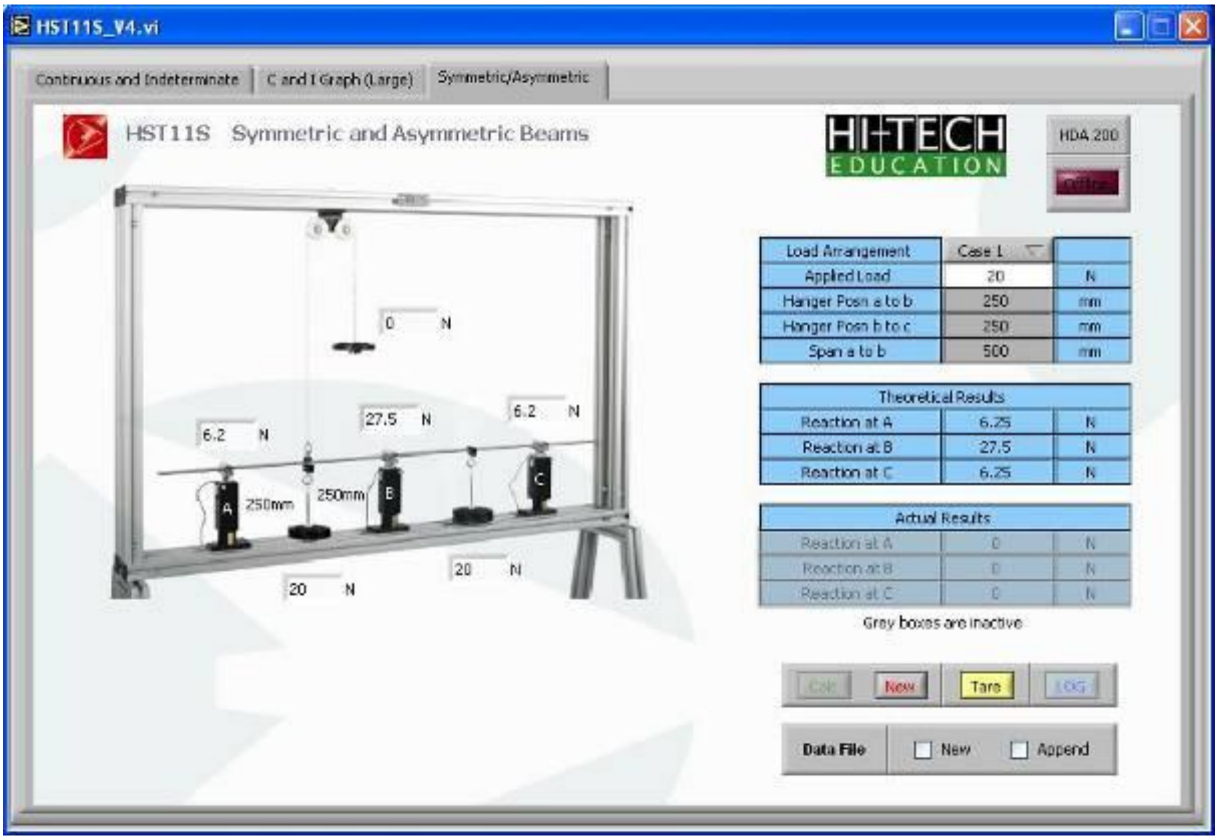
Load Arrangement	Case 1	
Applied Load	20	N
Hanger Posn a to b	250	mm
Hanger Posn b to c	250	mm
Span a to b	500	mm

Theoretical Results		
Reaction at A	6.25	N
Reaction at B	27.5	N
Reaction at C	6.25	N

Actual Results		
Reaction at A	0	N
Reaction at B	0	N
Reaction at C	0	N

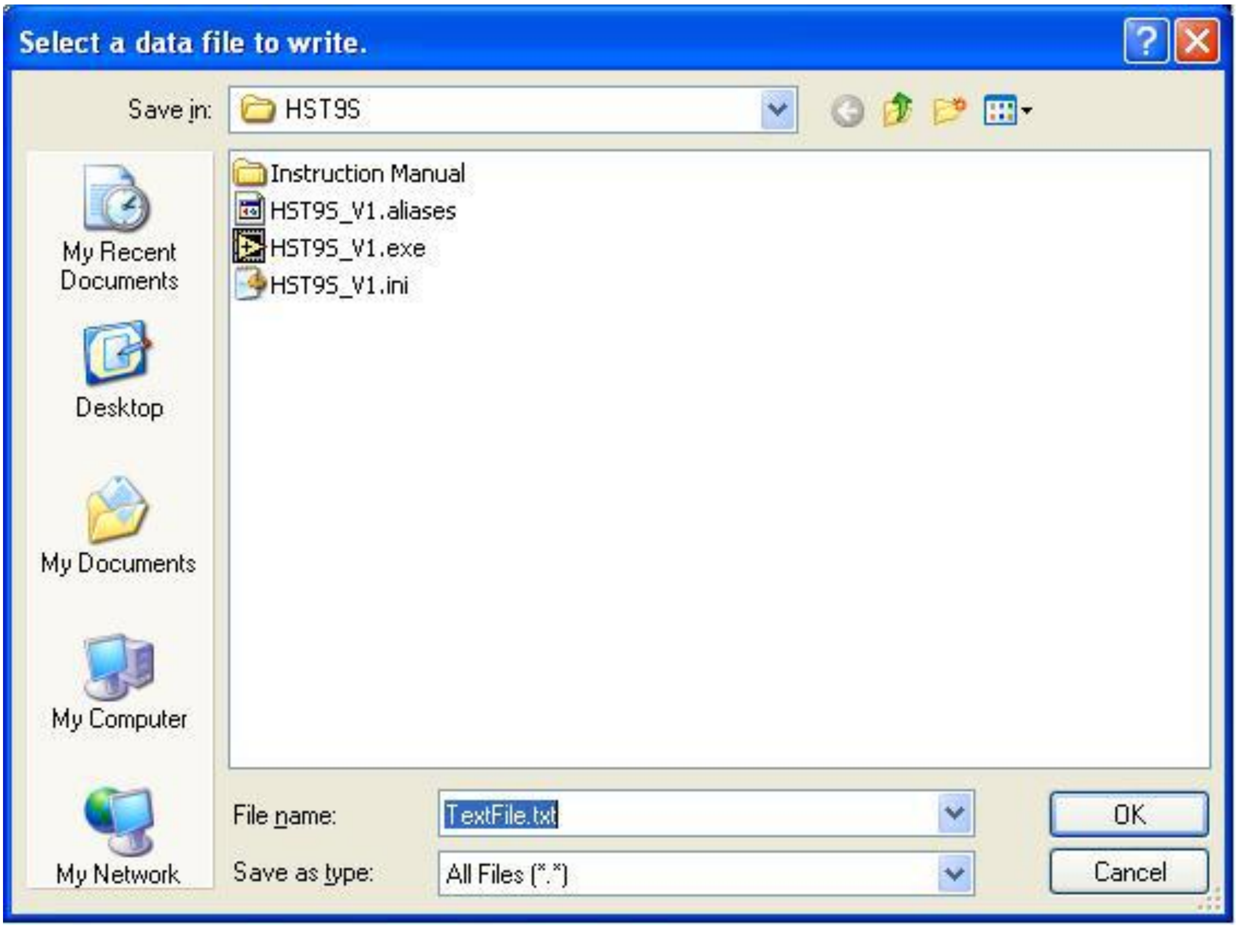
Grey boxes are inactive

6. The main software screen should look like the following:



7. There will be no value for the Actual results reactions as the software has been chosen to run in OFFLINE mode.
8. You will notice on the hardware image that the applied load is shown in the two boxes underneath the hardware image and the reactions shown next to the relevant reaction pier.
9. Press the NEW button.
10. Tick the Data File NEW box.
11. Press CALC.

12. You will then be shown the following window (the contents of this window will vary depending on the experiment running) and prompted to create a data file name in the location of your choice.



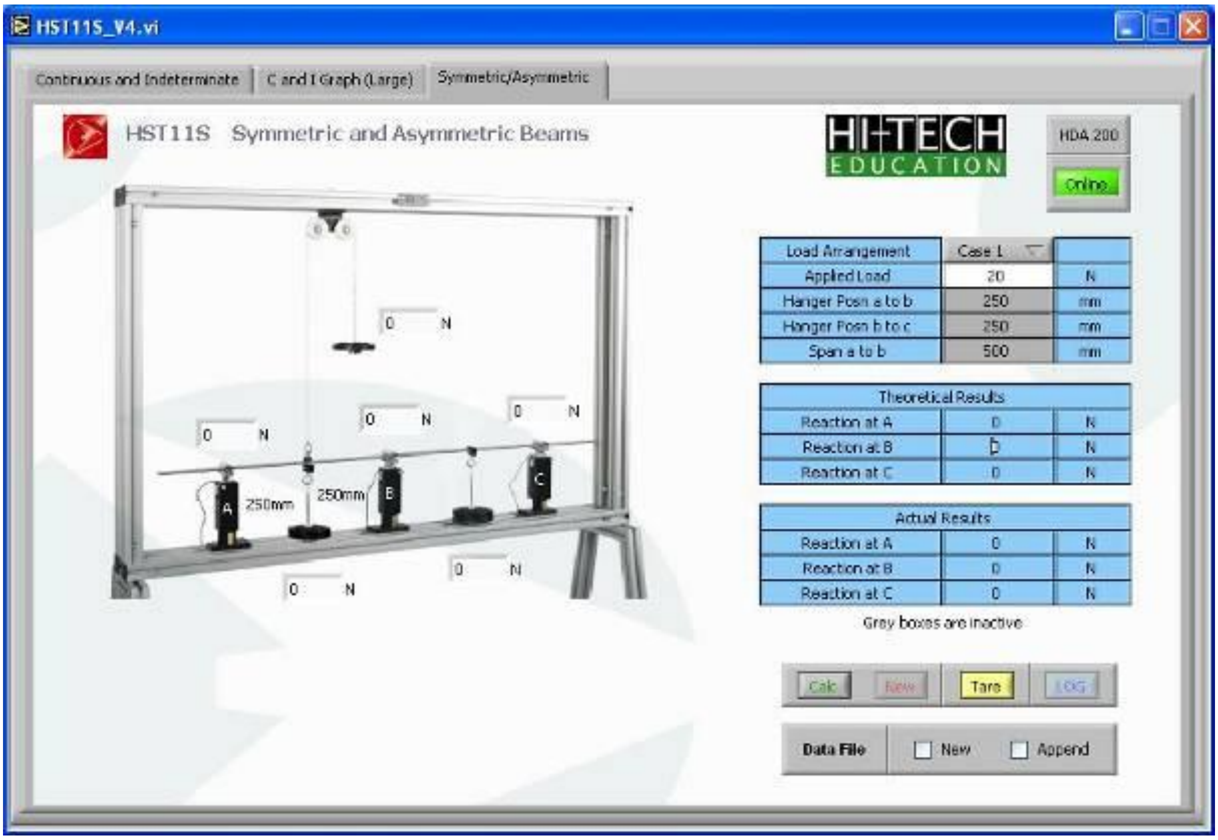
13. Either rename the default name of TextFile.txt or keep this default name. Ensure the file extension of ***.txt*** remains. Once the filename and location have been chosen then press **OK**.
14. A new graph will appear and the same values appear in the output boxes.
15. The input and output data will now be saved in the data file created.
16. Press the NEW button, clear the graphs, and then tick the Data File APPEND box. Press CALC and then choose the same data file as created previously. The current input and output data will now be appended to this file without overwriting the original data.
17. Locate this text file and open in NOTEPAD to see the format and information that it is saving.
18. If you wish to change the inputs then simply press the NEW button, clear the graphs, change the input, choose whether to create a new data file or append to an existing file and then press CALC.
19. In the OFFLINE mode the NEW and TARE buttons although live will not perform any function. The LOG button will not be live and greyed out but the data can still be stored by the use of the CALC button.
20. When finished with the software shut the software down.
21. You can continue to adjust the inputs and see what outputs are obtained by following the same process above.

ONLINE MODE

NB: BEFORE RUNNING THE SOFTWARE IN ONLINE MODE MAKE SURE THERE ARE NO DIAL GUAGES SELECTED AND THE REACTION PIERS 1, 2 and 3 ARE CONNECTED INTO CHANNELS 17, 18 AND 19 RESPECTIVELY OF THE HDA200.

THIS EXPEIRMENT WILL UNDERTAKE PART 10 OF THE HARDWARE INSTRUCTION MANUAL.

1. Repeat the input parameters from the OFFLINE mode procedure above, press the CALC button and the software window should look like the image below:



2. You will notice that there are no greyed out boxes on this screen.
3. You will now see the actual values of the reactions coming from the hardware. To zero the reaction pier readings simply press the TARE button.
4. Load the hardware experiment to the same parameters as the input boxes. You should then be able to compare the actual values with the theoretical values.
5. If you wish to save the data into the existing data file or a new data file then press the NEW button.
6. Clear the graph.
7. Tick the data file option required.
8. Press the CALC button and you will be prompted to create a new data file or append to the existing file. Choose the option required.
9. The current input and output values will then be saved to the data file.
10. Press the NEW button when you need to change a value of one of the inputs.
11. Change the input.

12. Clear the graphs.
13. Choose whether to create a new data file or append to an existing file.
14. Press CALC and the new outputs will be created along with a graph.
15. You can then continue to create new inputs and obtain new outputs depending on how you set up the hardware and by following the procedure above.

DATA FILE CONTENTS

The data file created contains information that is useful in allowing the end user to further manipulate the data in spreadsheet software.

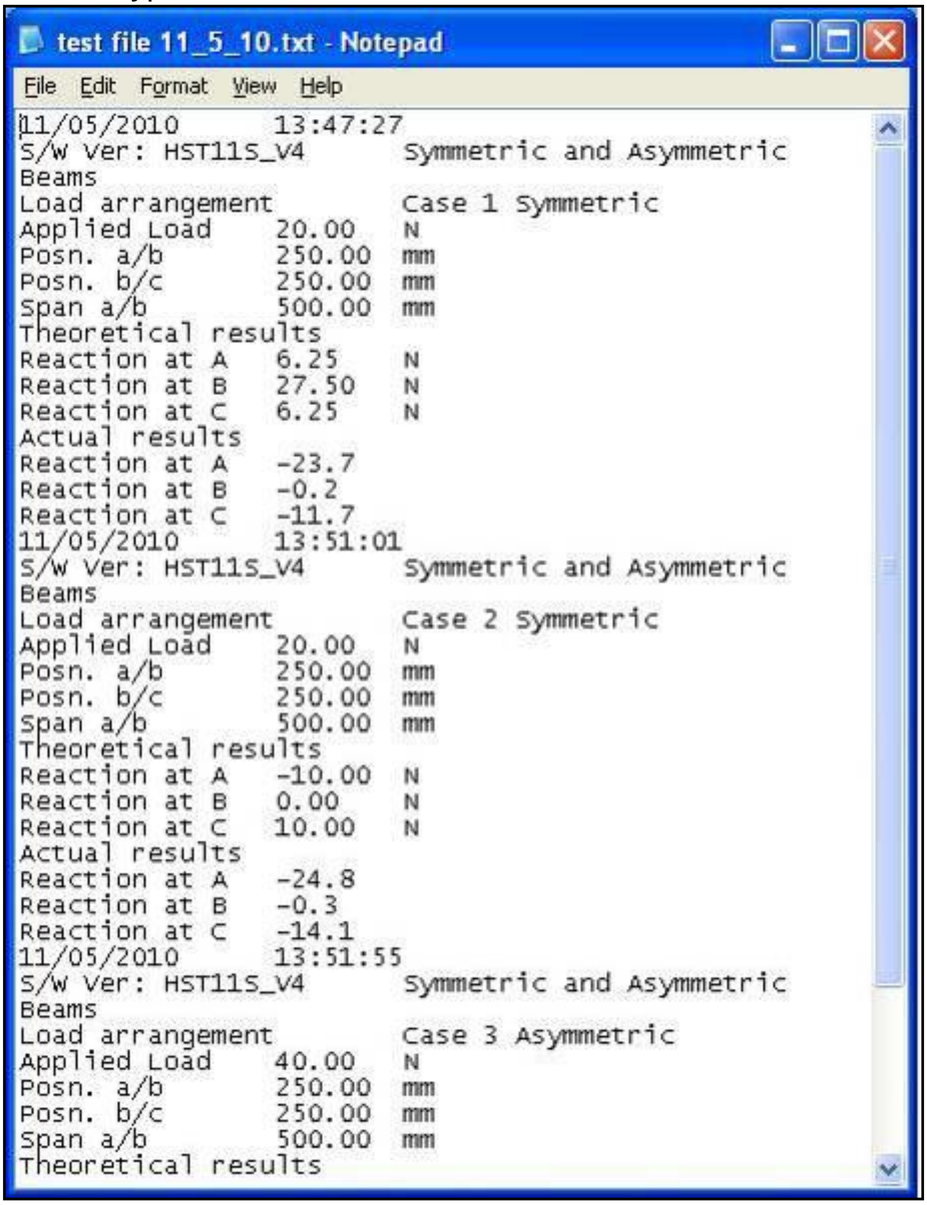
The image below shows the typical data at the start of the data file for the HST11S:

The data is as follows:

Date and time.
Software version
Selection tab
Load arrangement
Applied load
Theoretical Results
Actual Results

From these two columns it is possible to recreate the beam deflection shape.

All data appended to this file will be saved in this data file and can be viewed.



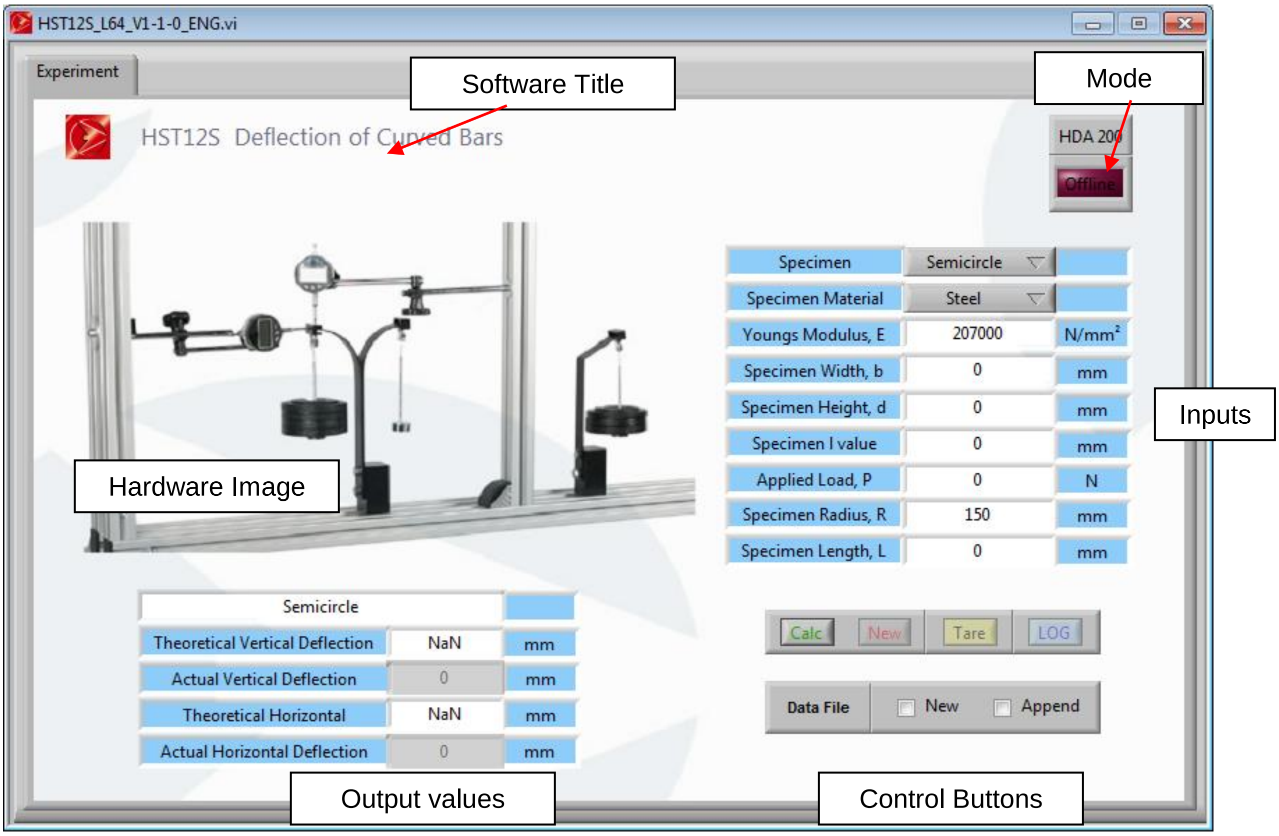
test file 11_5_10.txt - Notepad

File Edit Format View Help

```
11/05/2010      13:47:27
S/W Ver: HST11S_V4      Symmetric and Asymmetric
Beams
Load arrangement        Case 1 Symmetric
Applied Load    20.00   N
Posn. a/b       250.00  mm
Posn. b/c       250.00  mm
Span a/b        500.00  mm
Theoretical results
Reaction at A   6.25    N
Reaction at B   27.50   N
Reaction at C   6.25    N
Actual results
Reaction at A   -23.7
Reaction at B   -0.2
Reaction at C   -11.7
11/05/2010      13:51:01
S/W Ver: HST11S_V4      Symmetric and Asymmetric
Beams
Load arrangement        Case 2 Symmetric
Applied Load    20.00   N
Posn. a/b       250.00  mm
Posn. b/c       250.00  mm
Span a/b        500.00  mm
Theoretical results
Reaction at A   -10.00  N
Reaction at B   0.00    N
Reaction at C   10.00   N
Actual results
Reaction at A   -24.8
Reaction at B   -0.3
Reaction at C   -14.1
11/05/2010      13:51:55
S/W Ver: HST11S_V4      Symmetric and Asymmetric
Beams
Load arrangement        Case 3 Asymmetric
Applied Load    40.00   N
Posn. a/b       250.00  mm
Posn. b/c       250.00  mm
Span a/b        500.00  mm
Theoretical results
```

HST12S – DEFLECTION of CURVED BARS

SOFTWARE WINDOW



In either mode the details of what is presented in the software window is the same. These are highlighted in the above image and detailed as follows:

Hardware image: This is a true representation of the actual hardware thus ensuring consistency in viewing between software and hardware.

Specimen Tabs: This software allows the channel and semicircle specimens to be presented.

Software Title: The title and number of the software.

Mode: This highlights which mode the software is in, i.e. OFFLINE or ONLINE.

Inputs: These boxes allow the end user to input values for the specific parameters listed. The blue boxes on the left hand column show the description of the input and the right hand column blue boxes show the units for these parameters. The central column is where the value is input via the keyboard. It is possible to press the TAB button on the keyboard and the cursor will jump to the next parameter.

The inputs available are as follows:

- **Specimen:** Choose the specimen type. Choices are Semicircle, SemiC bracket, quadrant, single davit, double davit and bent davit.
- **Specimen material:** Choose the specimen material.
- **Young's Modulus, E**: This changes automatically with the material choice.
- **Specimen Width, b**: Enter the specimen width in millimetres.
- **Specimen Height, d**: Enter the specimen height in millimetres.
- **Specimen I value**: This is the calculated theoretical second moment of area for the specimen based on the details entered above.
- **Applied Load, P**: Enter the applied load to the specimen in Newton's.
- **Specimen Radius, R**: Depending on the specimen chosen this value will change automatically.
- **Specimen Length, L**: Depending on the specimen chosen this value will change automatically.

Outputs: These are theoretical values and actual values from the hardware based on the input parameters chosen. This is where the end user can compare actual results with theoretical.

The outputs available are as follows:

- **Theoretical Vertical Deflection:** This is the calculated theoretical vertical deflection for the specimen chosen based on the geometry and loading entered.
- **Actual Vertical Deflection:** This is the actual vertical deflection from the hardware via the HDA200. In offline mode this value will be greyed out.
- **Theoretical Horizontal Deflection:** This is the calculated theoretical horizontal deflection for the specimen chosen based on the geometry and loading entered.
- **Actual Horizontal Deflection:** This is the calculated theoretical Horizontal deflection for the specimen chosen based on the geometry and loading entered. In offline mode this value will be greyed out.

Control buttons: these buttons give the end user a choice of what to do with the software and the values presented on the screen. They are described in more detail as follows:

- **CALC**: When the inputs have been set, pressing this button will calculate the theoretical outputs.
- **NEW**: When this button is pressed it stops background processes and allows any of the inputs to be adjusted and then recalculated. You will have to wait a short time for the background processing to finish. When finished the CALC button becomes live and the NEW button becomes inactive.
- **LOG**: When the end user wishes to record ACTUAL data from the software during ONLINE running, they can press this button and the key input and output parameters will then be logged into the data file.
- **Data File NEW:** This tick box is used when the end user wishes to store the input and output data to a brand new file on the host computer. When this is ticked and the CALC button pressed you will be prompted to create a new data file. You can only choose this button or the append button, not both.
- **Data file APPEND:** If a data file has already been created then ticking this box will allow data to be added to this file rather than having to create a new file.

OPERATING THE SOFTWARE

The following procedure outlines the steps required to operate the software and to obtain outputs for the inputs chosen. It is one of many variations that could be followed.

It assumes that the end user has set up the HDA200 (if necessary) and installed the software correctly and all inputs are being undertaken using the keyboard of the host computer.

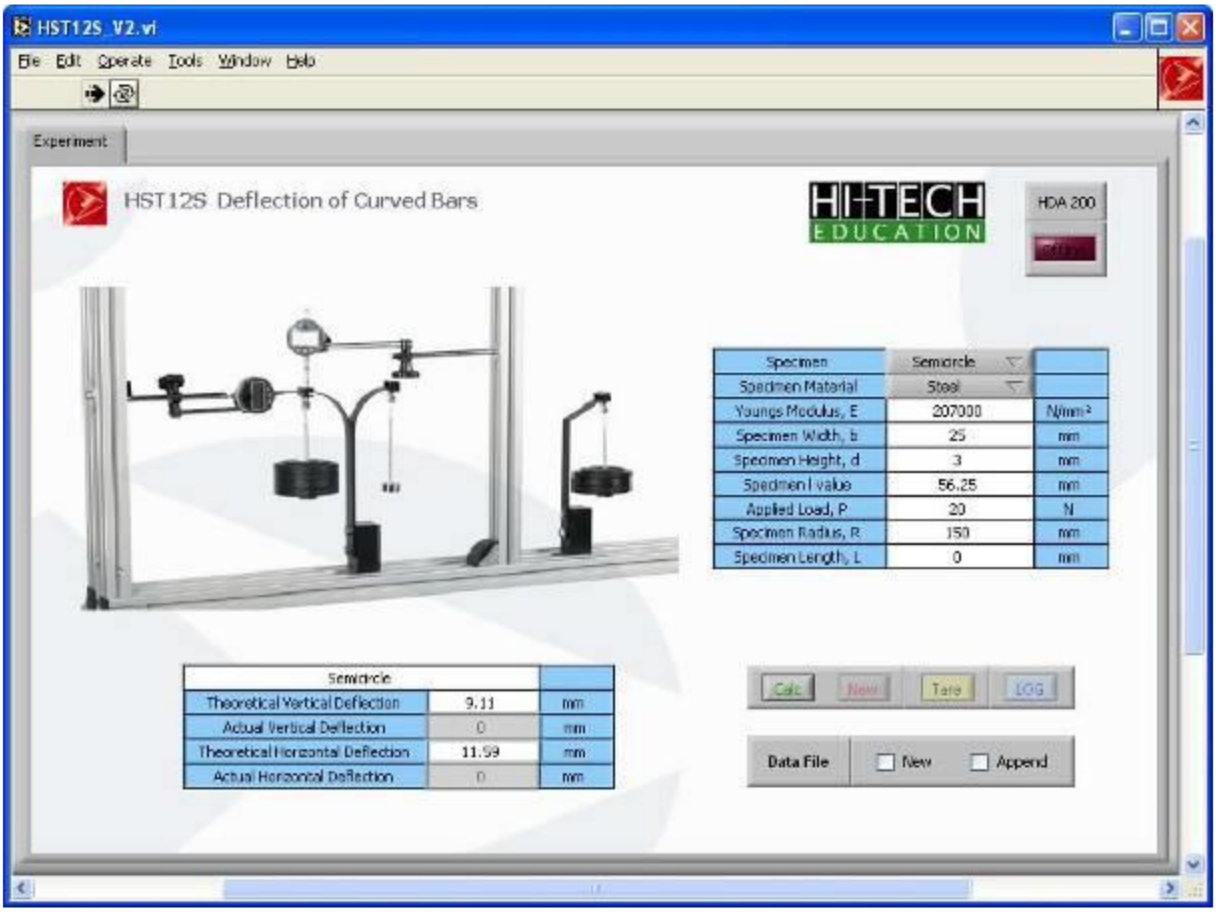
OFFLINE MODE

1. Load the experiment software by double clicking the **.exe** files supplied.
2. Choose 'NO' when the pop up window appears asking if the HDA200 is connected.
3. Select the specimen.
4. Select the specimen material. The E value will change automatically.
5. Enter 25 in the specimen width input box.
6. Enter 3 in the specimen height input box.
7. Enter 20 in the applied load input box.
8. Press the CALC button with no data file tick boxes ticked. The screen should appear as follows:

Specimen	Semicircle	
Specimen Material	Steel	
Youngs Modulus, E	207000	N/mm²
Specimen Width, b	25	mm
Specimen Height, d	3	mm
Specimen I value	56.25	mm
Applied Load, P	20	N
Specimen Radius, R	150	mm
Specimen Length, L	0	mm

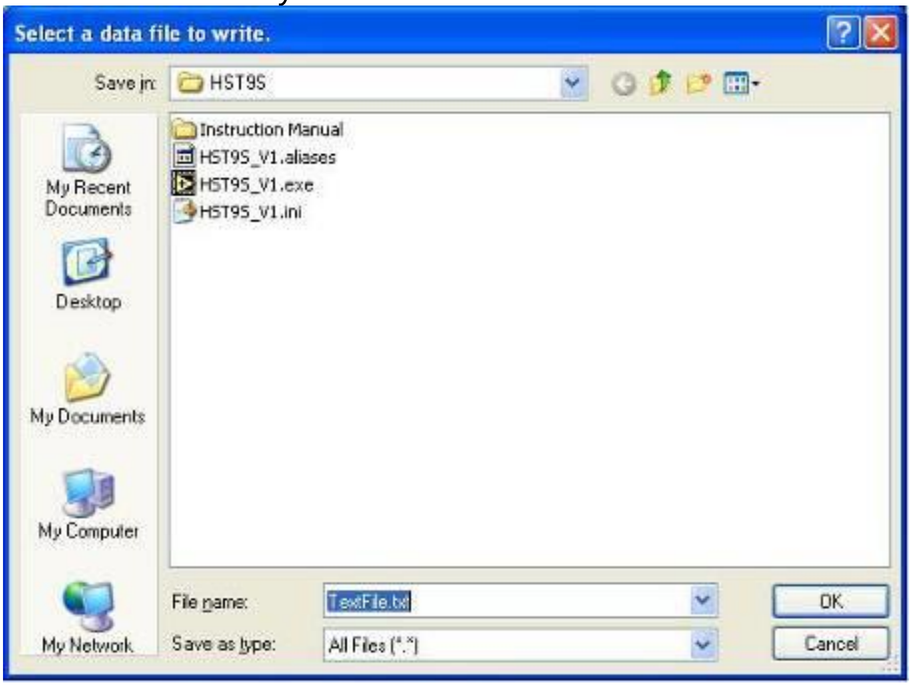
You will notice that the specimen radius is already filled in. This is the relevant dimension for the semi-circle specimen.

9. The complete screen should look like the following image:

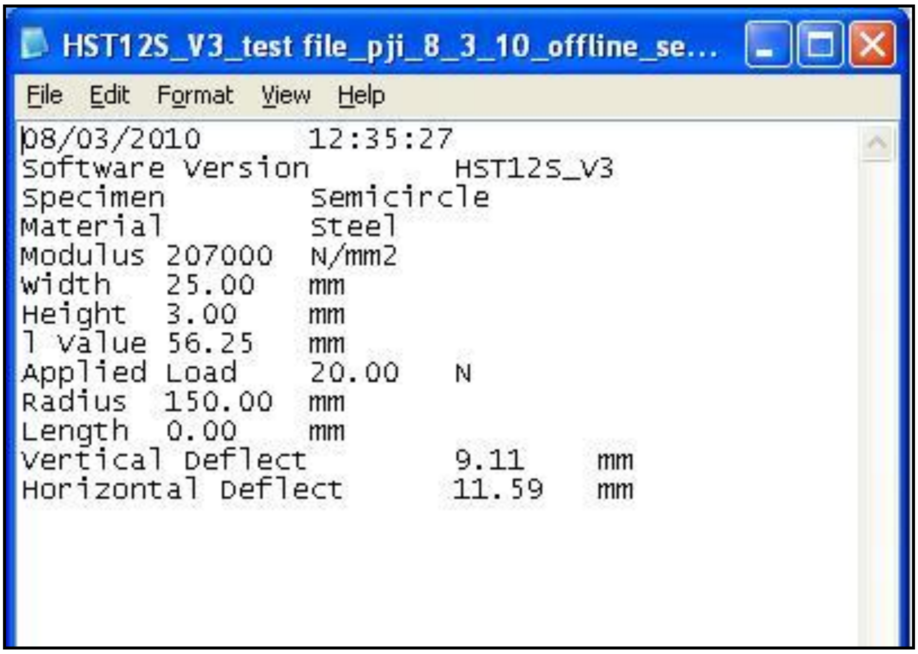


10. The theoretical deflections will be shown in the output boxes. The actual deflections will be greyed out. This is because you are in ‘OFFLINE’ mode.
11. Press the NEW button
12. Tick the Data File NEW box.
13. Press CALC.

14. You will then be shown the following window (the contents of this window will vary depending on the experiment running) and prompted to create a data file name in the location of your choice.



15. Either rename the default name of TextFile.txt or keep this default name. Its up to you. Ensure the file extension of ***.txt*** remains. Once the filename and location have been chosen then press **OK**.
16. The input and output data will now be saved in the data file created. To prove this open the text file in ***NOTEPAD*** that you have just created from its location and check the contents. It should look similar to the image below.



17. If you wish to change the inputs then simply press the NEW button, change the input parameter, press the data file APPEND button and then press CALC. You will be given the data file to append to, choose this and then press ok.
18. The data file should now have the new data saved into it, AND added (appended) to the existing data.
19. In the OFFLINE mode the LOG button will be greyed out.
20. When finished with the software shut the software down.
21. You can continue to adjust the inputs and see what outputs are obtained by following the same process above.

HDA200 CHANNEL SETTINGS and CONNECTIONS

Prior to running this experiment software in ONLINE mode with the HDA200 you will have to make sure that the correct experiment hardware sensors/transducers are connected to the HDA200 and the correct channels are being displayed by the HDA200. Refer to the HDA200 instruction manual and use the following table as a reference also:

Sensor/Transducer	HDA200 Connector Number	HDA200 Channel number	Resolution
Vertical Dial Gauge	Dial gauge 1	28	0.01mm
Horizontal Dial Gauge	Dial gauge 2	29	0.01mm

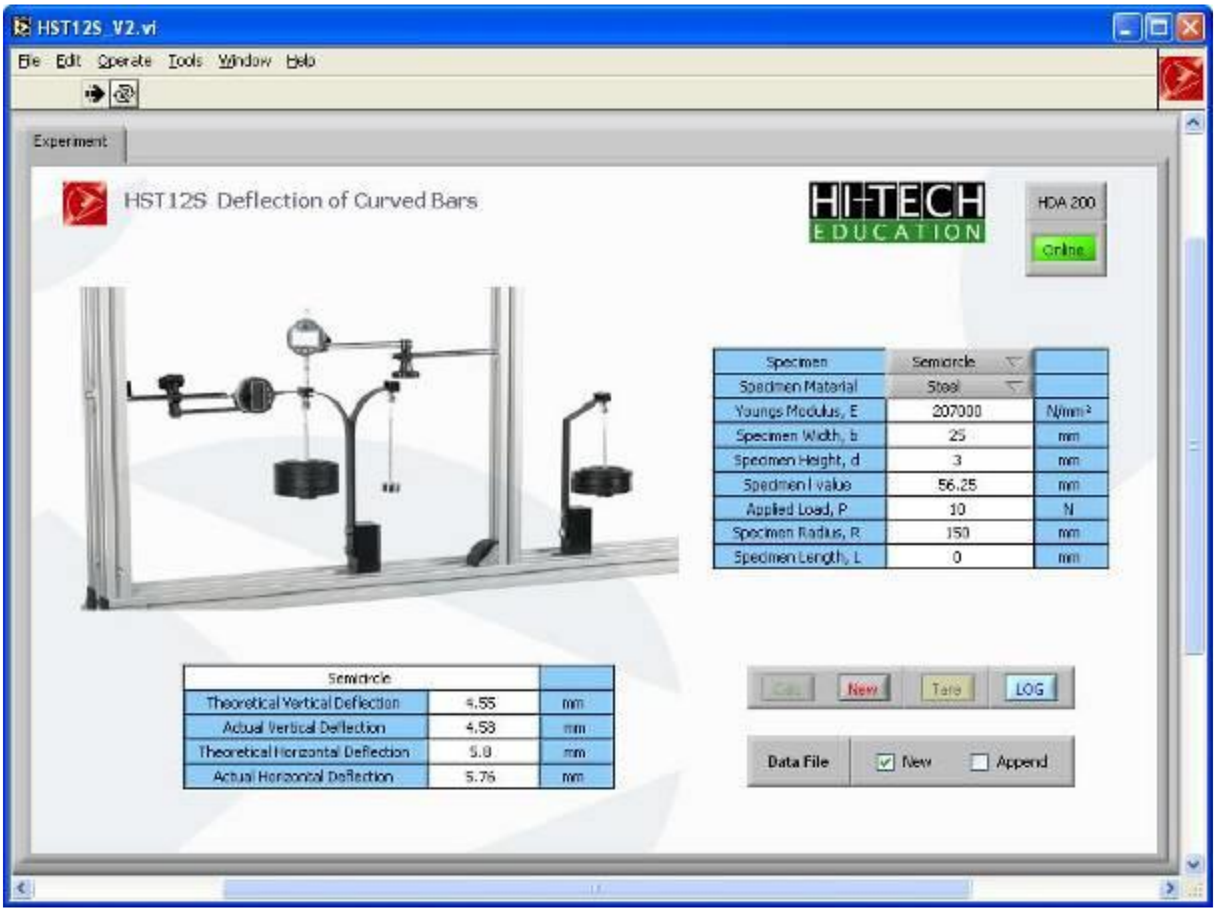
Run the HDA200 in LOCAL mode to check that the above channels only are being displayed. This will then ensure that the software collects the right data from the right channels.

NB: If the dial gauges (if used) are connected but not turned on then the software and HDA200 will not display the dial gauge values and the software and HDA200 screens will wait until they are turned on. Ensure the dial gauges are turned on when running the experiment and software.

If the above channels are not set correctly then you will have to enter the configuration of the HDA200 which will require reading and following the HDA200 instruction manual.

ONLINE MODE

1. Repeat the input parameters from the OFFLINE mode procedure above, press the CALC button and the software window should look like the image below:



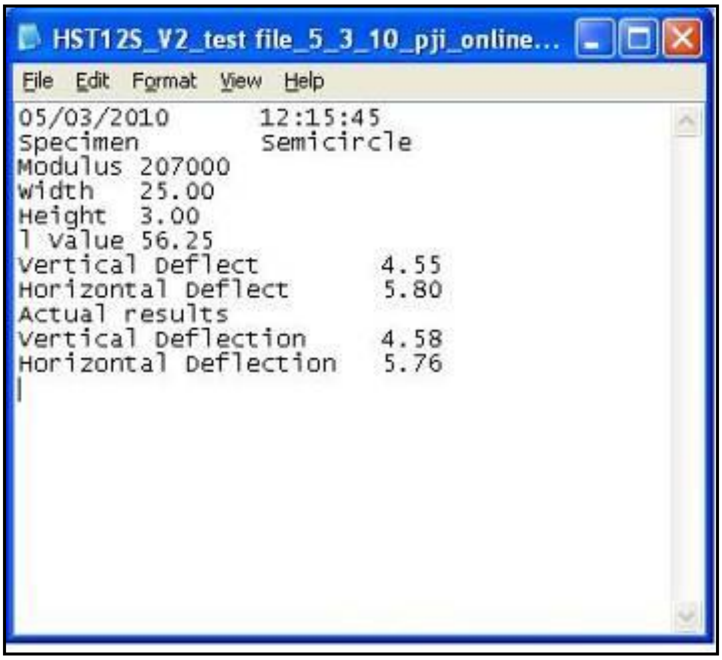
2. In 'ONLINE' mode you will notice that the actual deflection values are no longer greyed out. These values will now start to change as they come in from the HDA200.
3. Load the hardware experiment to the same parameters as the input boxes. You should then be able to compare the actual values with theoretical values.
4. If you wish to save the data into a NEW or existing data file then press NEW to stop the software capturing data from the HDA200.
5. Tick the data file option required.
6. Press the CALC button and you will be prompted to create a new data file or append to the existing file. Choose the option required.
7. The input parameters will then be saved to the data file.
8. Press the LOG button to store the actual values to the data file.
9. Incrementally change the load position from NONE right through to -100mm, and at each increment press the LOG button.
10. The graph will be drawn automatically at each load position point, but you must follow the load position points in turn otherwise the graph will appear incorrect and the actual shear centre will not be correct.

DATA FILE CONTENTS

The data file created contains information that is useful in allowing the end user to further manipulate the data in a spreadsheet software.

The image below shows the typical data at the start of the data file for this experiment when a new file has been created and the LOG button has been pressed at each load position increment:

The data is as follows:



HST12S_V2_test file_5_3_10_pji_online...

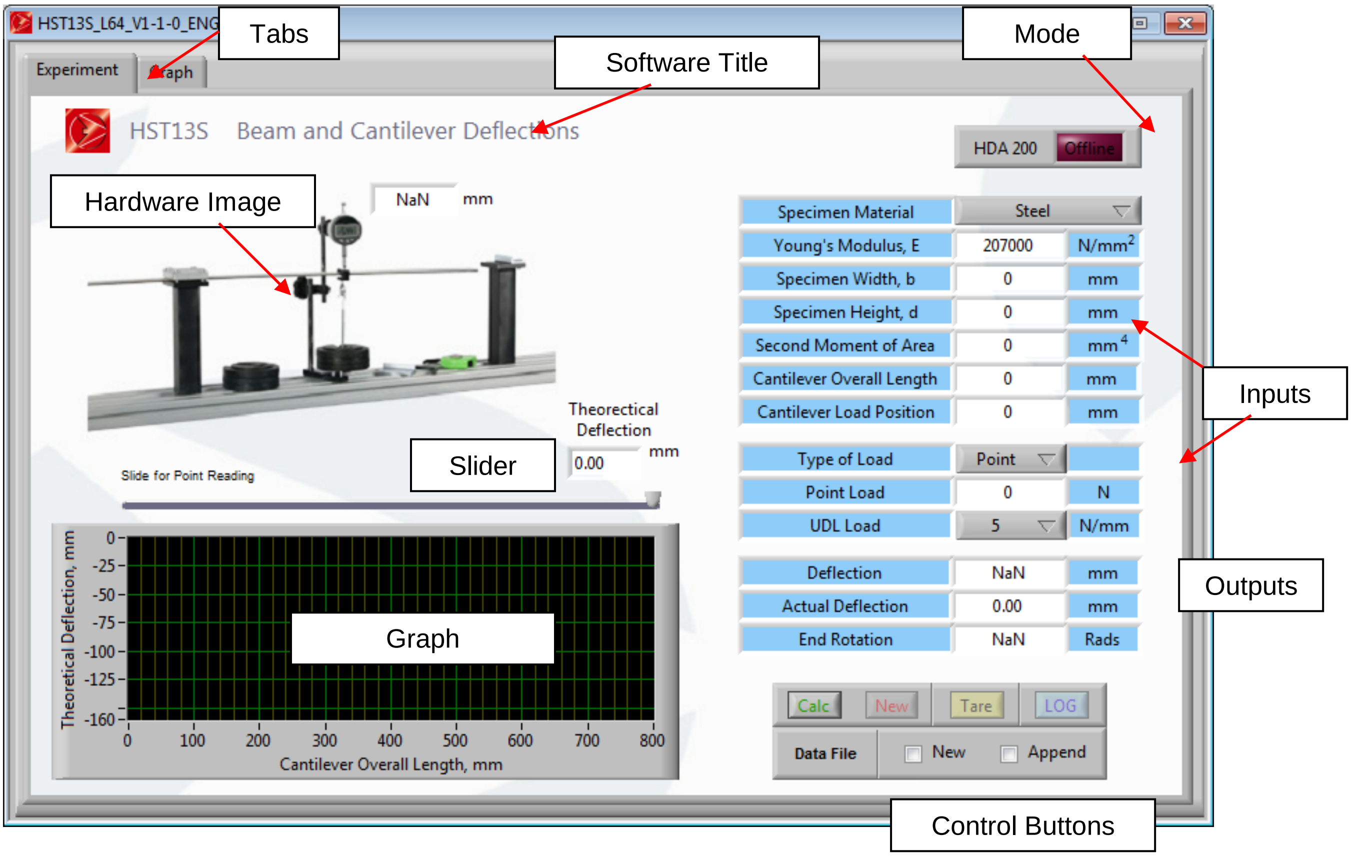
File Edit Format View Help

```
05/03/2010       12:15:45
Specimen         Semicircle
Modulus 207000
Width    25.00
Height   3.00
I Value 56.25
Vertical Deflect         4.55
Horizontal Deflect       5.80
Actual results
Vertical Deflection      4.58
Horizontal Deflection    5.76
```

The information will then repeat itself depending on how many test points have been logged.

HST13S – BEAM and CANTILEVER DEFLECTIONS

SOFTWARE WINDOW



In either mode the details of what is presented in the software window is the same. These are highlighted in the above image and detailed as follows:

Hardware image: This is a true representation of the actual hardware thus ensuring consistency in viewing between software and hardware.

Specimen Tabs: This software allows the channel and semicircle specimens to be presented.

Software Title: The title and number of the software.

Mode: This highlights which mode the software is in, i.e. OFFLINE or ONLINE.

Inputs: These boxes allow the end user to input values for the specific parameters listed. The blue boxes on the left hand column show the description of the input and the right hand column blue boxes show the units for these parameters. The central column is where the value is input via the keyboard. It is possible to press the TAB button on the keyboard and the cursor will jump to the next parameter.

The inputs available are as follows:

- **Specimen Material:** Choose the specimen material from the drop down list.
- **Young's Modulus, E:** This changes automatically with the choice of material.
- **Specimen Width, b**: Enter the specimen width in millimetres.
- **Specimen Height, d**: Enter the specimen height in millimetres.
- **Specimen Width, b**: Enter the specimen width in millimetres.
- **Second Moment of Area:** This is a calculated value based on the geometry given above.
- **Cantilever overall Length:** Enter the length of the cantilever from its tip to where it protrudes from it clamp in millimetres.
- **Cantilever Load Position:** Enter the position at which the load is applied to the cantilever.
- **Type of Load:** Choose from Point or UDL from the drop down list.
- **Point Load:** If point load chosen for the type of load enter the value of the point load in Newton's.
- **UDL Load:** If UDL is chosen for the type of load, enter the value of the UDL here in Newton's.

Outputs: These are theoretical values and actual values from the hardware based on the input parameters chosen. This is where the end user can compare actual results with theoretical.

The outputs available are as follows:

- **Deflection:** This is the theoretical deflection calculated from the parameters given earlier in millimetres.
- **Actual Deflection:** This is the actual dial gauge value from the hardware. It has the units of millimetres. In offline mode this will show a value of zero (0).
- **End Rotation**: This is theoretical end rotation.

Control buttons: these buttons give the end user a choice of what to do with the software and the values presented on the screen. They are described in more detail as follows:

- **CALC**: When the inputs have been set, pressing this button will calculate the theoretical outputs.
- **NEW**: When this button is pressed it stops background processes and allows any of the inputs to be adjusted and then recalculated. You will have to wait a short time for the background processing to finish. When finished the CALC button becomes live and the NEW button becomes inactive.
- **LOG**: When the end user wishes to record ACTUAL data from the software during ONLINE running, they can press this button and the key input and output parameters will then be logged into the data file.
- **Data File NEW:** This tick box is used when the end user wishes to store the input and output data to a brand new file on the host computer. When this is ticked and the CALC button pressed you will be prompted to create a new data file. You can only choose this button or the append button, not both.
- **Data file APPEND:** If a data file has already been created then ticking this box will allow data to be added to this file rather than having to create a new file.

Graph: Each time a load position is set or another parameter changed a graph is drawn of the curvature of the cantilever. The same graph is created within the screen from the graph tab.

Slider: When the graph is created, the slider can be moved horizontally along the length of the cantilever to see the theoretical deflection at any point.

OPERATING THE SOFTWARE

The following procedure outlines the steps required to operate the software and to obtain outputs for the inputs chosen. It is one of many variations that could be followed.

It assumes that the end user has set up the HDA200 (if necessary) and installed the software correctly and all inputs are being undertaken using the keyboard of the host computer.

OFFLINE MODE – CHANNEL SPECIMEN

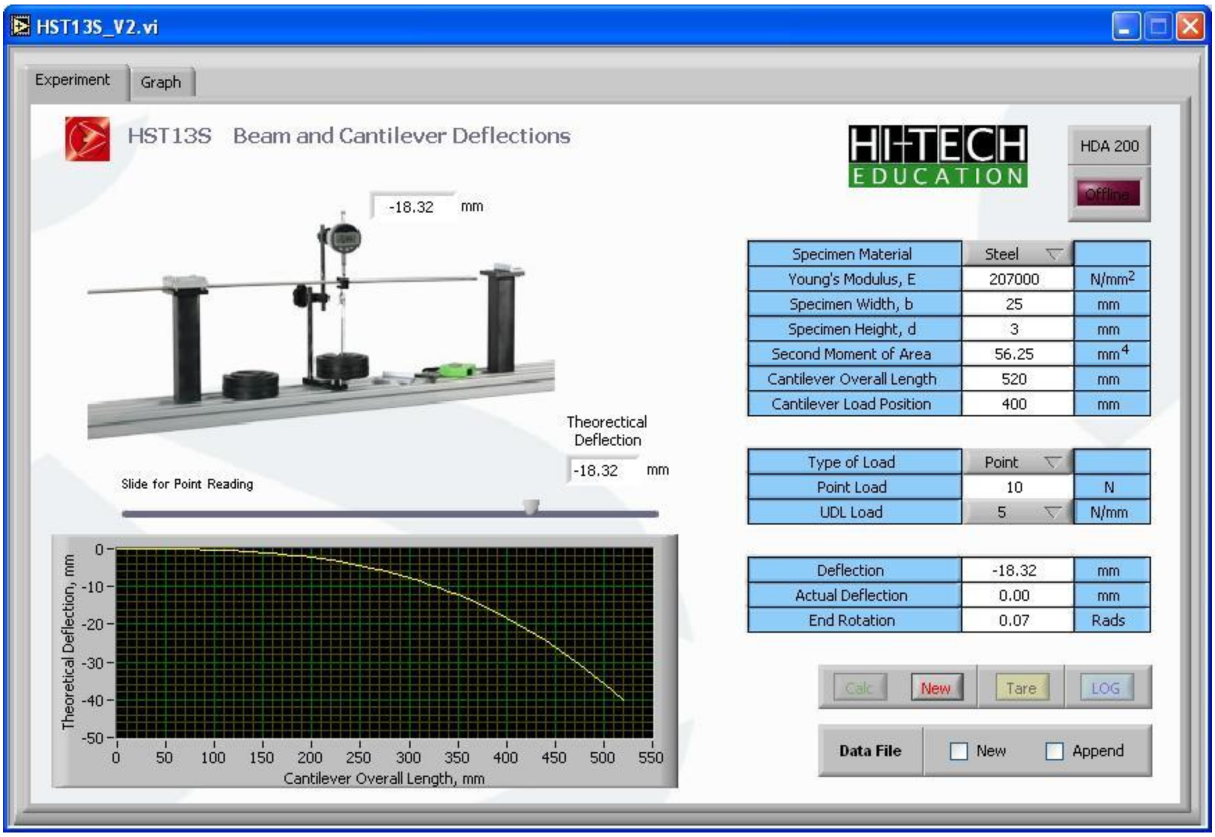
1. Load the experiment software by double clicking the **.exe** files supplied.
2. Choose ‘NO’ when the pop up window appears asking if the HDA200 is connected.
3. Choose Steel.
4. Enter 25 in the width, b input box.
5. Enter 3 in the height, d input box.
6. Enter 520 in the cantilever overall length input box.
7. Enter 400 in the cantilever load position input box.
8. Press the CALC button with no data file tick boxes ticked. The screen should appear as follows:

Specimen Material	Steel	
Young's Modulus, E	207000	N/mm^2
Specimen Width, b	25	mm
Specimen Height, d	3	mm
Second Moment of Area	56.25	mm^4
Cantilever Overall Length	520	mm
Cantilever Load Position	400	mm

Type of Load	Point	
Point Load	10	N
UDL Load	5	N/mm

Deflection	-18.32	mm
Actual Deflection	0.00	mm
End Rotation	0.07	Rads

9. The complete screen should look like the following image:



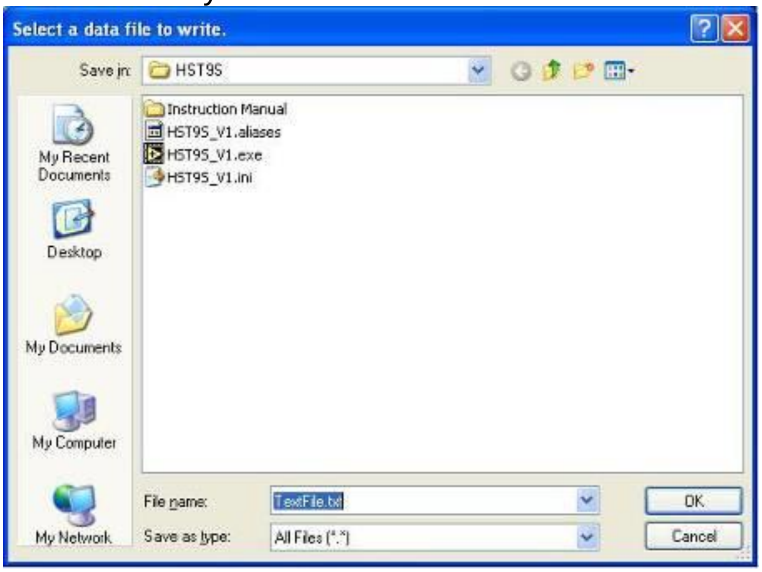
10. The theoretical deflection and end rotation will be shown in the first output box. Also note that the actual deflection and end rotation will be zero (0). This is because you are in 'OFFLINE' mode.

11. Press the NEW button.

12. Tick the Data File NEW box.

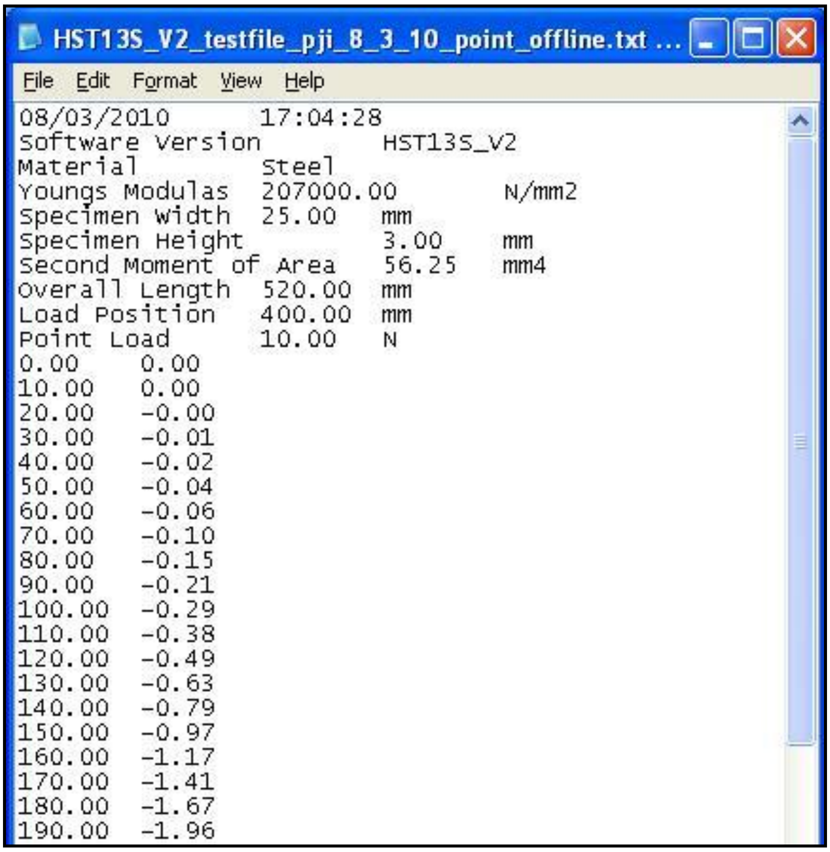
13. Press CALC.

14. You will then be shown the following window (the contents of this window will vary depending on the experiment running) and prompted to create a data file name in the location of your choice.



15. Either rename the default name of TextFile.txt or keep this default name. Its up to you. Ensure the file extension of ***.txt*** remains. Once the filename and location have been chosen then press **OK**.

16. The input and output data will now be saved in the data file created. To prove this open the text file in ***NOTEPAD*** that you have just created from its location and check the contents. It should look similar to the image below.


HST13S_V2_testfile_pji_8_3_10_point_offline.txt ...

File Edit Format View Help

08/03/2010 17:04:28
Software Version HST13S_V2
Material Steel
Youngs Modulas 207000.00 N/mm2
Specimen Width 25.00 mm
Specimen Height 3.00 mm
Second Moment of Area 56.25 mm4
Overall Length 520.00 mm
Load Position 400.00 mm
Point Load 10.00 N

0.00	0.00
10.00	0.00
20.00	-0.00
30.00	-0.01
40.00	-0.02
50.00	-0.04
60.00	-0.06
70.00	-0.10
80.00	-0.15
90.00	-0.21
100.00	-0.29
110.00	-0.38
120.00	-0.49
130.00	-0.63
140.00	-0.79
150.00	-0.97
160.00	-1.17
170.00	-1.41
180.00	-1.67
190.00	-1.96

17. If you wish to change the inputs then simply press the NEW button, change the input parameter, press the data file APPEND button and then press CALC. You will be given the data file to append to, choose this and then press ok.
18. The data file should now have the new data saved into it, AND added (appended) to the existing data.
19. In the OFFLINE mode the LOG button will be greyed out.
20. When finished with the software shut the software down.
21. You can continue to adjust the inputs and see what outputs are obtained by following the same process above.

<u>HDA200 CHANNEL SETTINGS and CONNECTIONS</u>

Prior to running this experiment software in ONLINE mode with the HDA200 you will have to make sure that the correct experiment hardware sensors/transducers are connected to the HDA200 and the correct channels are being displayed by the HDA200. Refer to the HDA200 instruction manual and use the following table as a reference also:

Sensor/Transducer	HDA200 Connector Number	HDA200 Channel number	Resolution
Dial Gauge	Dial gauge 1	28	0.01mm
Dial Gauge	Dial gauge 2	29	0.01mm
Dial Gauge	Dial gauge 3	30	0.01mm

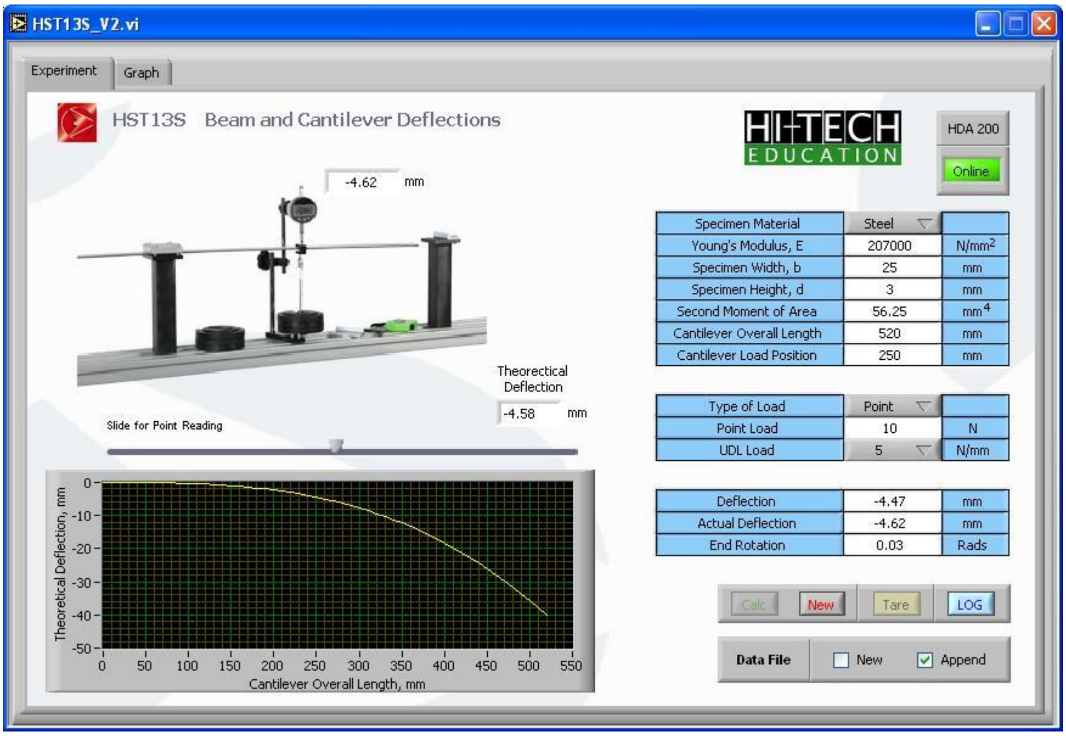
Run the HDA200 in LOCAL mode to check that the above channels only are being displayed. This will then ensure that the software collects the right data from the right channels.

NB: If the dial gauges (if used) are connected but not turned on then the software and HDA200 will not display the dial gauge values and the software and HDA200 screens will wait until they are turned on. Ensure the dial gauges are turned on when running the experiment and software.

If the above channels are not set correctly then you will have to enter the configuration of the HDA200 which will require reading and following the HDA200 instruction manual.

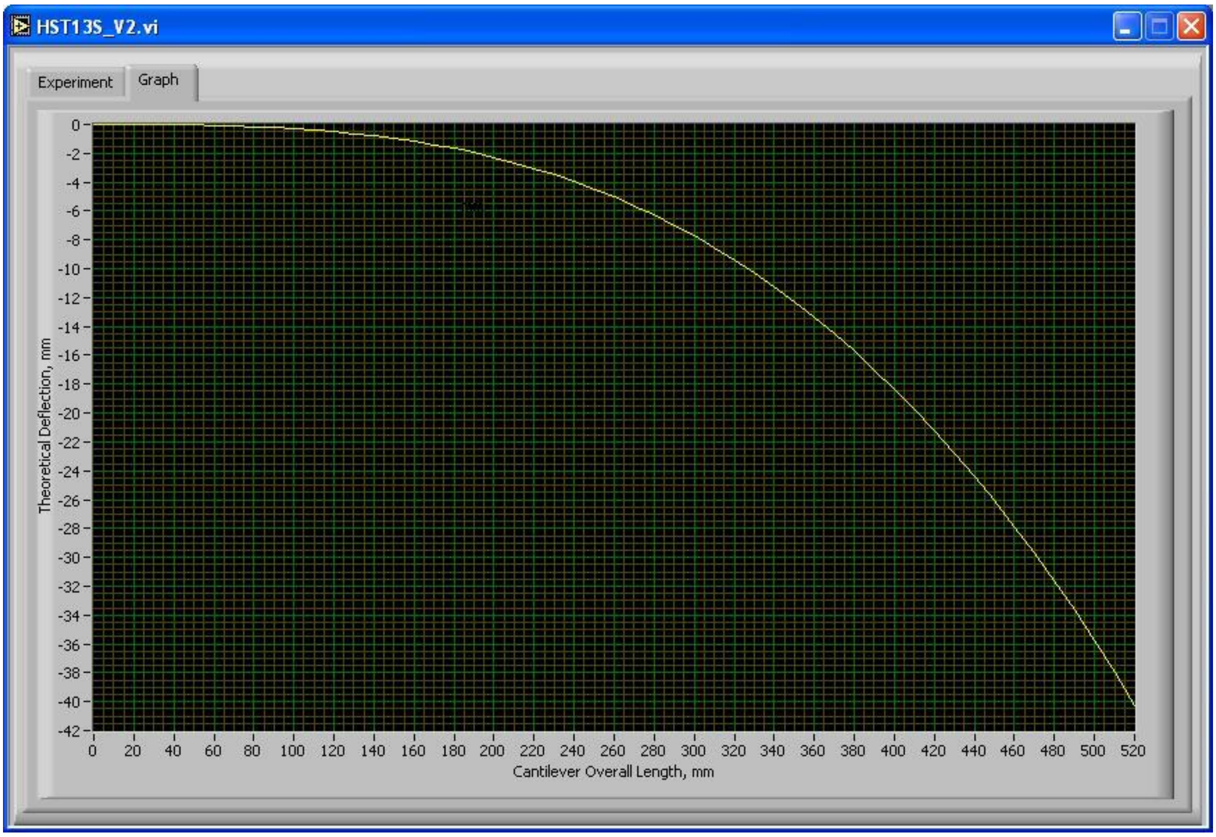
ONLINE MODE

1. Repeat the input parameters from the OFFLINE mode procedure above, press the CALC button and the software window should look like the image below:



2. In 'ONLINE' mode you will notice that the actual deflection and end rotation are no longer greyed out. These values will now start to change as they come in from the HDA200.
3. Load the hardware experiment to the same parameters as the input boxes. You should then be able to compare the actual values with theoretical values.
4. If you wish to save the data into a NEW or existing data file then press NEW to stop the software capturing data from the HDA200.
5. Tick the data file option required.
6. Press the CALC button and you will be prompted to create a new data file or append to the existing file. Choose the option required.
7. The input parameters will then be saved to the data file.
8. Press the LOG button to store the actual values to the data file.
9. The graph will be drawn automatically at each change of load position.

10. An image of the main graph on the graph tab is shown below

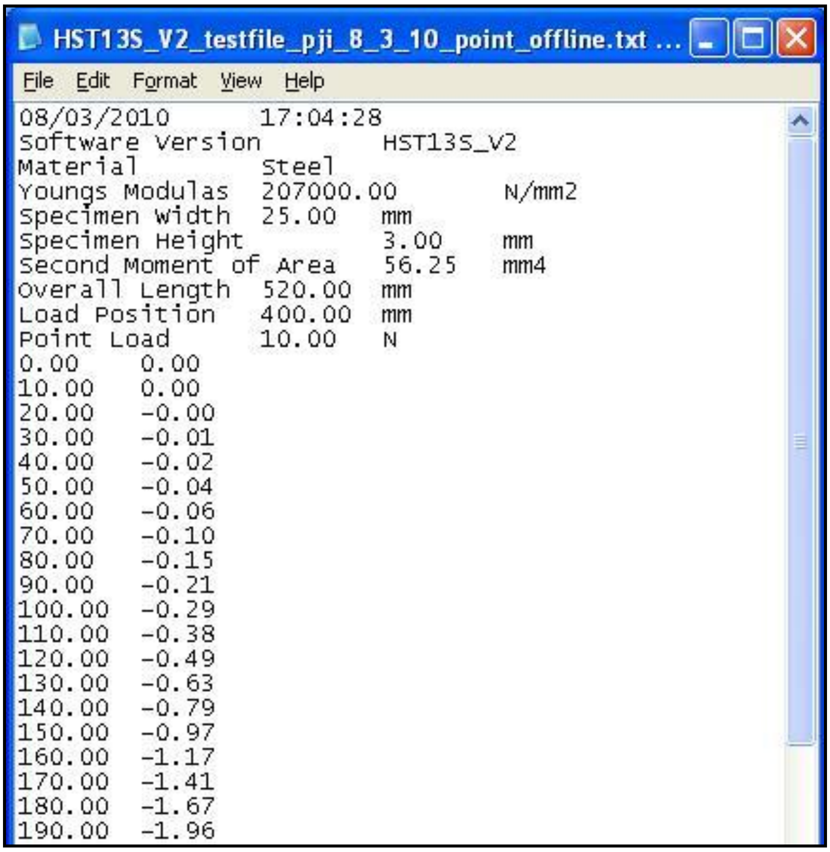


DATA FILE CONTENTS

The data file created contains information that is useful in allowing the end user to further manipulate the data in a spreadsheet software.

The image below shows the typical data at the start of the data file for this experiment when a new file has been created and the LOG button has been pressed at each load position increment:

The data is as follows:


HST13S_V2_testfile_pji_8_3_10_point_offline.txt ...

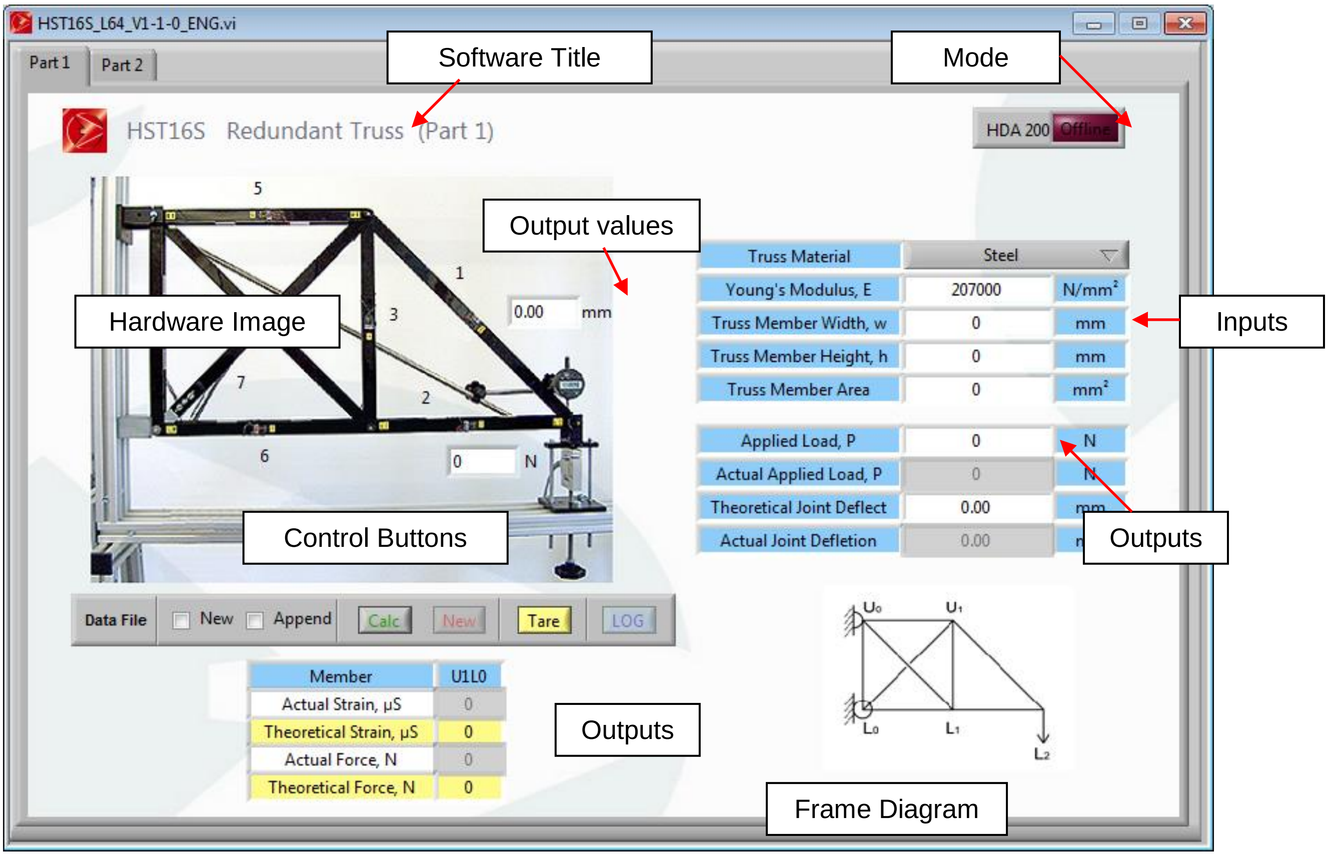
File Edit Format View Help

```
08/03/2010      17:04:28
Software Version        HST13S_V2
Material        Steel
Youngs Modulas  207000.00       N/mm2
Specimen Width  25.00   mm
Specimen Height         3.00    mm
Second Moment of Area   56.25   mm4
Overall Length  520.00  mm
Load Position   400.00  mm
Point Load      10.00   N
0.00    0.00
10.00   0.00
20.00   -0.00
30.00   -0.01
40.00   -0.02
50.00   -0.04
60.00   -0.06
70.00   -0.10
80.00   -0.15
90.00   -0.21
100.00  -0.29
110.00  -0.38
120.00  -0.49
130.00  -0.63
140.00  -0.79
150.00  -0.97
160.00  -1.17
170.00  -1.41
180.00  -1.67
190.00  -1.96
```

The information will then repeat itself depending on how many test points have been logged.

HST16S – REDUNDANT TRUSS

SOFTWARE WINDOW – Part 1



In either mode the details of what is presented in the software window is the same. These are highlighted in the above image and detailed as follows:

Hardware image: This is a true representation of the actual hardware thus ensuring consistency in viewing between software and hardware.

Software Title: The title and number of the software.

Mode: This highlights which mode the software is in, i.e. OFFLINE or ONLINE.

Inputs: These boxes allow the end user to input values for the specific parameters listed. The blue boxes on the left hand column show the description of the input and the right hand column blue boxes show the units for these parameters. The central column is where the value is input via the keyboard. It is possible to press the TAB button on the keyboard and the cursor will jump to the next parameter.

The inputs available are as follows:

- **Truss Material:** Choose the material which the truss members are made from. This varies between acrylic, aluminium, steel, stainless steel and brass.
- **Young's Modulus, E:** Depending on the material chosen above, will depend on what value is selected here. These values are defaults and cannot be changed.
- **Truss Member Width, w**: This is the value of the horizontal width of each member. Nominally this is 10mm. This value is entered via the keyboard of the host computer.
- **Truss Member Height, h**: This is value of the vertical depth of each member. Nominally this is 25mm. This value is entered via the keyboard of the host computer.
- **Truss Member Area**: This is a calculated value of the nominal cross sectional area of each truss member. It cannot be changed as it is a calculated value.
- **Applied Load, P**: This is the value of the applied force to the truss. It is entered by the end user via the keyboard. It can be used when comparing actual with theoretical values. This value will appear on the hardware image.
- **Actual Applied Load, P**: This is value of the applied load from the hardware itself. This value comes via the HDA200, and will only appear when the HDA200 is connected in 'ONLINE' mode.

Outputs: These are theoretical values and actual values from the hardware based on the input parameters chosen. This is where the end user can compare actual results with theoretical.

The outputs available are as follows:

- **Theoretical Joint Deflect:** This is the calculated theoretical joint deflection for part 1 of the hardware experiment. This value will appear on the hardware image.
- **Actual Joint Deflection:** This is the actual joint deflection for part 1 of the hardware experiment.

Table underneath the hardware image.:

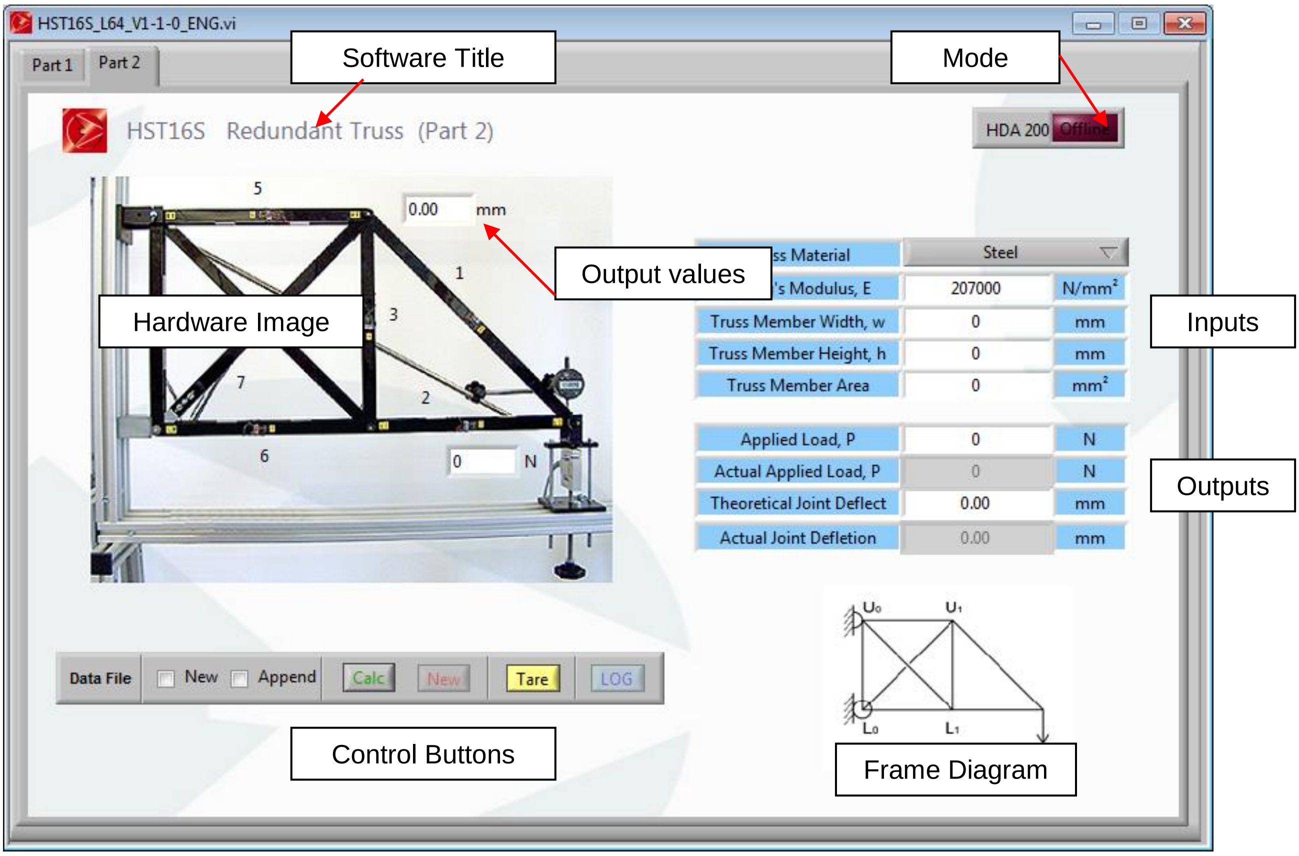
- **Actual Strain:** This is the actual strain from the redundant truss member only via the HDA200. In offline mode this value will be greyed out.
- **Theoretical Strain:** This is the theoretical strain from the redundant truss member only.
- **Actual Force:** This is the actual force value calculated from the actual strain values form the hardware for the redundant member only.
- **Theoretical Force:** This is the theoretical force calculated from the theoretical strain for the redundant member only.

Control buttons: these buttons give the end user a choice of what to do with the software and the values presented on the screen. They are described in more detail as follows:

- **CALC**: When the inputs have been set, pressing this button will calculate the theoretical outputs.
- **NEW**: When this button is pressed it stops background processes and allows any of the inputs to be adjusted and then recalculated. You will have to wait a short time for the background processing to finish. When finished the CALC button becomes live and the NEW button becomes inactive.
- **TARE**: This button is only valid when running in ONLINE mode as when pressed it zeroes (tares) the values from the hardware which are being used in the software.
- **LOG**: When the end user wishes to record ACTUAL data from the software during ONLINE running, they can press this button and the key input and output parameters will then be logged into the data file.
- **Data File NEW:** This tick box is used when the end user wishes to store the input and output data to a brand new file on the host computer. When this is ticked and the CALC button pressed you will be prompted to create a new data file.
- **Data file APPEND:** If a data file has already been created then ticking this box will allow data to be added to this file rather than having to create a new file.

Frame Diagram: This represents a schematic of the hardware arrangement and is a cross reference for the inputs. This will not be present on all experiment softwares.

SOFTWARE WINDOW – Part 2



In either mode the details of what is presented in the software window is the same. These are highlighted in the above image and detailed as follows:

Hardware image: This is a true representation of the actual hardware thus ensuring consistency in viewing between software and hardware.

Software Title: The title and number of the software.

Mode: This highlights which mode the software is in, i.e. OFFLINE or ONLINE.

Inputs: These boxes allow the end user to input values for the specific parameters listed. The blue boxes on the left hand column show the description of the input and the right hand column blue boxes show the units for these parameters. The central column is where the value is input via the keyboard. It is possible to press the TAB button on the keyboard and the cursor will jump to the next parameter.

The inputs available are as follows:

- **Truss Material:** Choose the material which the truss members are made from. This varies between acrylic, aluminium, steel, stainless steel and brass.
- **Young's Modulus, E:** Depending on the material chosen above, will depend on what value is selected here. These values are defaults and cannot be changed.
- **Truss Member Width, w**: This is the value of the horizontal width of each member. Nominally this is 10mm. This value is entered via the keyboard of the host computer.
- **Truss Member Height, h**:This is value of the vertical depth of each member. Nominally this is 25mm. This value is entered via the keyboard of the host computer.
- **Truss Member Area**: This is a calculated value of the nominal cross sectional area of each truss member. It cannot be changed as it is a calculated value.
- **Applied Load, P**: This is the value of the applied force to the truss. It is entered by the end user via the keyboard. It can be used when comparing actual with theoretical values. This value will appear on the hardware image.
- **Actual Applied Load, P**: This is value of the applied load from the hardware itself. This value comes via the HDA200, and will only appear when the HDA200 is connected in 'ONLINE' mode. In offline mode this value will be greyed out.

Outputs: These are theoretical values and actual values from the hardware based on the input parameters chosen. This is where the end user can compare actual results with theoretical.

The outputs available are as follows:

- **Theoretical Joint Deflect:** This is the calculated theoretical joint deflection for part 1 of the hardware experiment. This value will appear on the hardware image.
- **Actual Joint Deflection:** This is the actual joint deflection for part 1 of the hardware experiment. In offline mode this value will be greyed out.

Control buttons: these buttons give the end user a choice of what to do with the software and the values presented on the screen. They are described in more detail as follows:

- **CALC**: When the inputs have been set, pressing this button will calculate the theoretical outputs.
- **NEW**: When this button is pressed it stops background processes and allows any of the inputs to be adjusted and then recalculated. You will have to wait a short time for the background processing to finish. When finished the CALC button becomes live and the NEW button becomes inactive.
- **TARE**: This button is only valid when running in ONLINE mode as when pressed it zeroes (tares) the values from the hardware which are being used in the software.
- **LOG**: When the end user wishes to record ACTUAL data from the software during ONLINE running, they can press this button and the key input and output parameters will then be logged into the data file.

- **Data File NEW:** This tick box is used when the end user wishes to store the input and output data to a brand new file on the host computer. When this is ticked and the CALC button pressed you will be prompted to create a new data file.
- **Data file APPEND:** If a data file has already been created then ticking this box will allow data to be added to this file rather than having to create a new file.

Frame Diagram: This represents a schematic of the hardware arrangement and is a cross reference for the inputs. This will not be present on all experiment software.

OPERATING THE SOFTWARE

The following procedure outlines the steps required to operate the software and to obtain outputs for the inputs chosen. It is one of many variations that could be followed.

It assumes that the end user has set up the HDA200 (if necessary) and installed the software correctly and all inputs are being undertaken using the keyboard of the host computer.

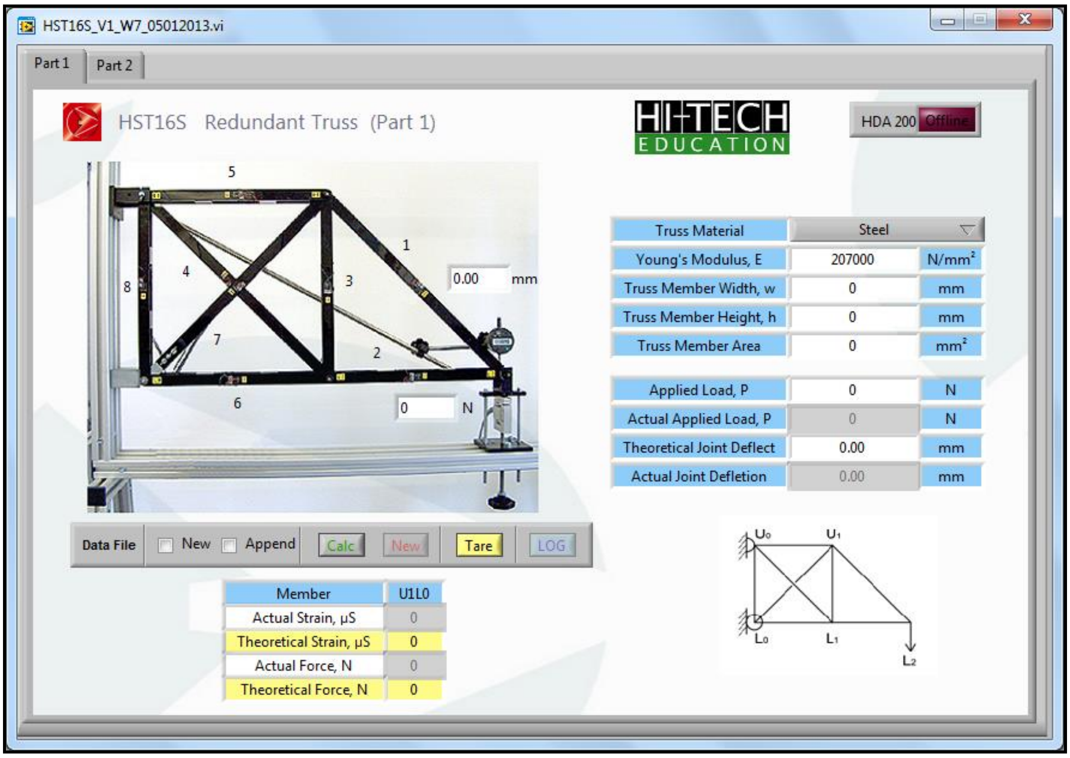
OFFLINE MODE – Part 1

1. Load the experiment software by double clicking the **.exe** files supplied.
2. Choose 'NO' when the pop up window appears asking if the HDA200 is connected.
3. Choose ACRYLIC from the drop down menu list.
4. Enter 10 in the width, w input box.
5. Enter 25 in the height, h input box.
6. The truss member area will be calculated automatically
7. Enter 100 in the Applied Force, F input box.
8. Press the CALC button with no data file tick boxes ticked. The screen should appear as follows:

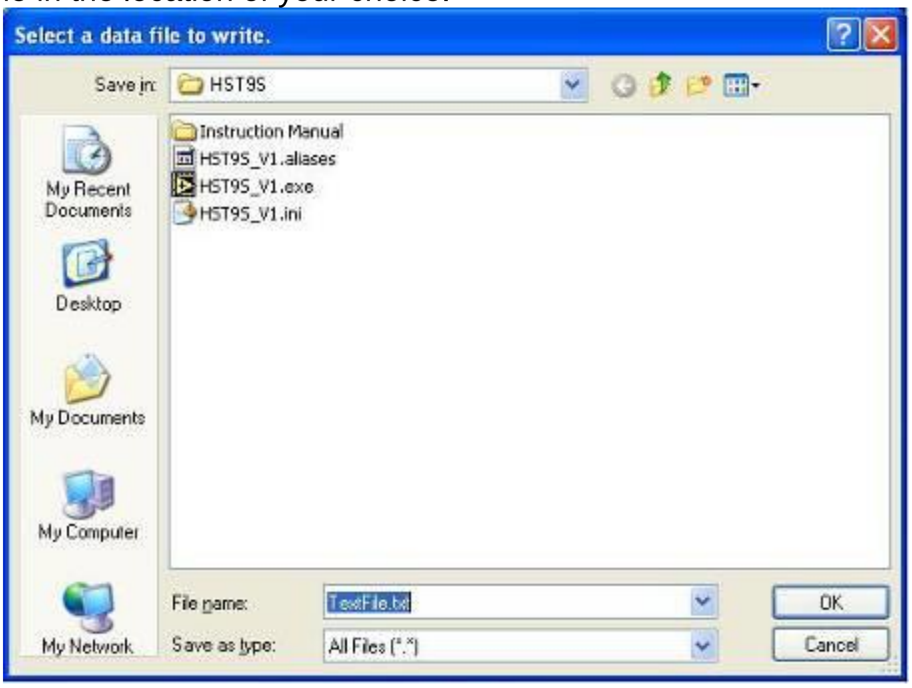
Truss Material	Acrylic	
Young's Modulus, E	2500	N/mm²
Truss Member Width, w	10	mm
Truss Member Height, h	25	mm
Truss Member Area	250	mm²

Applied Load, P	100	N
Actual Applied Load, P	0	N
Theoretical Joint Deflect	0.65	mm
Actual Joint Defletion	0.00	mm

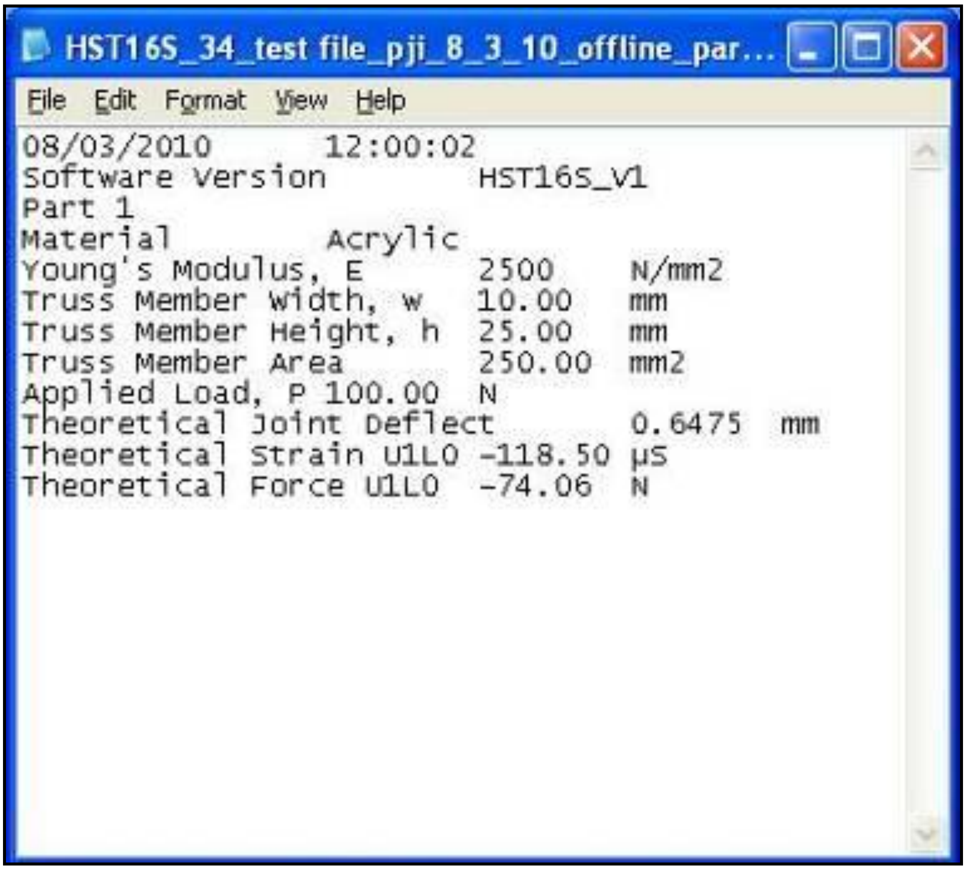
9. The complete screen should look like the following image:



10. The applied load value and theoretical joint deflection will be shown in the small output value next to the load cell of the hardware image. Also note that the actual applied load and the actual joint deflection are greyed out. This is because you are in 'OFFLINE' mode.
11. Tick the Data File NEW box.
12. Press CALC.
13. You will then be shown the following window (the contents of this window will vary depending on the experiment running) and prompted to create a data file name in the location of your choice.



14. Either rename the default name of TextFile.txt or keep this default name. Its up to you. Ensure the file extension of ***.txt*** remains. Once the filename and location have been chosen then press **OK**.
15. The input and output data will now be saved in the data file created. To prove this open the text file in ***NOTEPAD*** that you have just created from its location and check the contents. It should look similar to the image below.




```
08/03/2010      12:00:02
Software Version        HST16S_V1
Part 1
Material        Acrylic
Young's Modulus, E      2500    N/mm2
Truss Member Width, w   10.00   mm
Truss Member Height, h  25.00   mm
Truss Member Area       250.00  mm2
Applied Load, P 100.00  N
Theoretical Joint Deflect       0.6475  mm
Theoretical Strain U1L0 -118.50 µS
Theoretical Force U1L0  -74.06  N
```

16. If you wish to change the inputs then simply press change the input parameter (change applied force to 20N from 10N), press the data file NEW button to clear it, press the data file APPEND button and then press CALC. You will be given the data file to append to, choose this and then press ok.
17. In the OFFLINE mode the NEW and TARE buttons although live will not perform any function. The LOG button will not be live and greyed out but the data can still be stored by the use of the CALC button.
18. When finished with the software shut the software down.
19. You can continue to adjust the inputs and see what outputs are obtained by following the same process above.

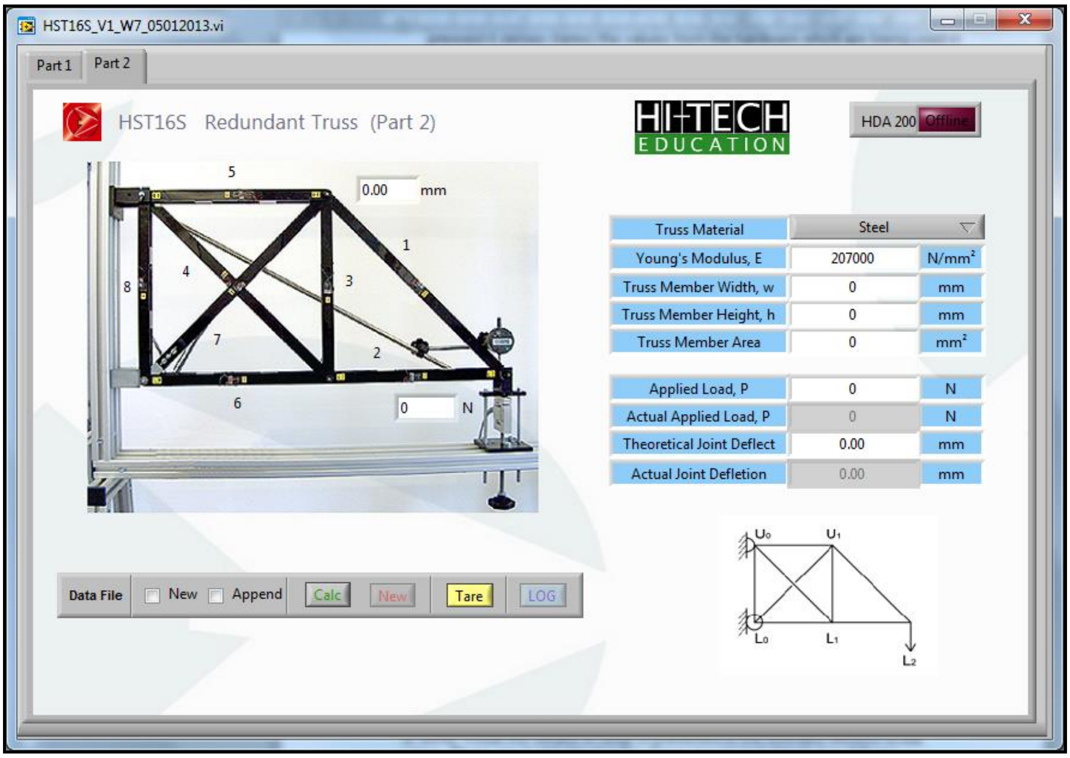
OFFLINE MODE – Part 2

1. Load the experiment software by double clicking the **.exe** files supplied.
2. Choose 'NO' when the pop up window appears asking if the HDA200 is connected.
3. Choose ACRYLIC from the drop down menu list.
4. Enter 10 in the width, w input box.
5. Enter 25 in the height, h input box.
6. The truss member area will be calculated automatically/
7. Enter 100 in the Applied Force, F input box.
8. Press the CALC button with no data file tick boxes ticked. The screen should appear as follows:

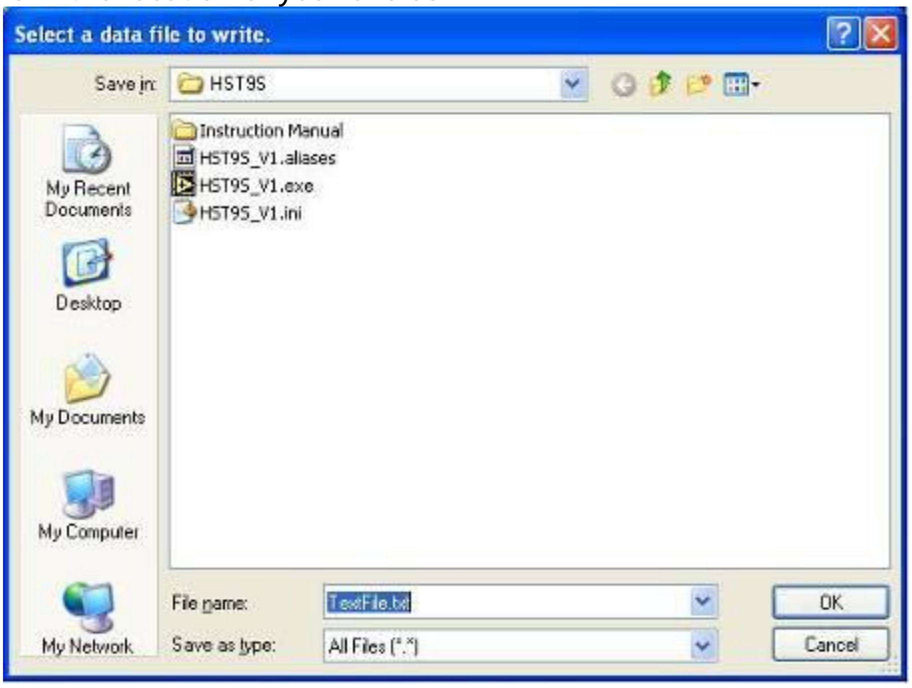
Truss Material	Acrylic	
Young's Modulus, E	2500	N/mm^2
Truss Member Width, w	10	mm
Truss Member Height, h	25	mm
Truss Member Area	250	mm^2

Applied Load, P	100	N
Actual Applied Load, P	0	N
Theoretical Joint Deflect	0.21	mm
Actual Joint Defletion	0.00	mm

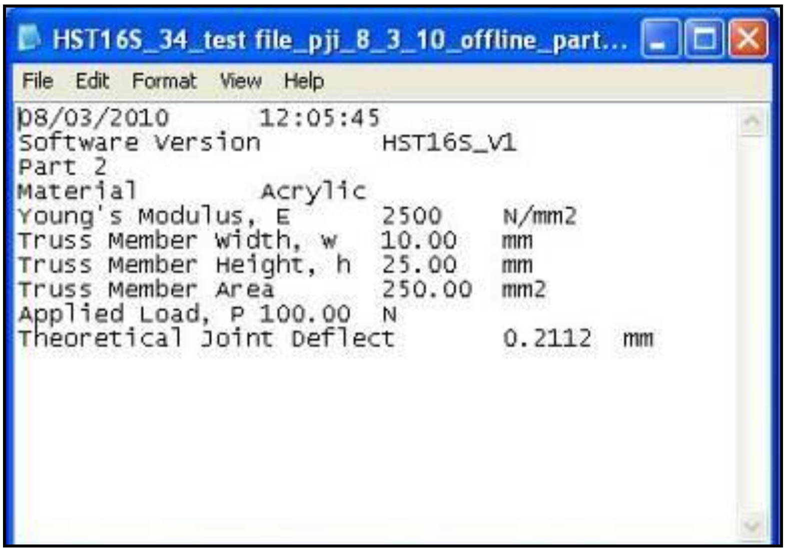
9. The complete screen should look like the following image:



10. The applied load value and theoretical joint deflection will be shown in the small output value next to the load cell of the hardware image. Also note that the actual applied load and the actual joint deflection are greyed out. This is because you are in ‘OFFLINE’ mode.
11. Tick the Data File NEW box.
12. Press CALC.
13. You will then be shown the following window (the contents of this window will vary depending on the experiment running) and prompted to create a data file name in the location of your choice.



14. Either rename the default name of TextFile.txt or keep this default name. Its up to you. Ensure the file extension of ***.txt*** remains. Once the filename and location have been chosen then press **OK**.
15. The input and output data will now be saved in the data file created. To prove this open the text file in ***NOTEPAD*** that you have just created from its location and check the contents. It should look similar to the image below.


HST16S_34_test file_pji_8_3_10_offline_part...

File Edit Format View Help

```
08/03/2010      12:05:45
Software Version        HST16S_V1
Part 2
Material        Acrylic
Young's Modulus, E      2500    N/mm2
Truss Member Width, w   10.00   mm
Truss Member Height, h  25.00   mm
Truss Member Area       250.00  mm2
Applied Load, P 100.00  N
Theoretical Joint Deflect       0.2112  mm
```

16. If you wish to change the inputs then simply press change the input parameter (change applied force to 20N from 10N), press the data file NEW button to clear it, press the data file APPEND button and then press CALC. You will be given the data file to append to, choose this and then press ok.

17. In the OFFLINE mode the NEW and TARE buttons although live will not perform any function. The LOG button will not be live and greyed out but the data can still be stored by the use of the CALC button.
18. When finished with the software shut the software down.
19. You can continue to adjust the inputs and see what outputs are obtained by following the same process above.

HDA200 CHANNEL SETTINGS and CONNECTIONS

Prior to running this experiment software in ONLINE mode with the HDA200 you will have to make sure that the correct experiment hardware sensors/transducers are connected to the HDA200 and the correct channels are being displayed by the HDA200. Refer to the HDA200 instruction manual and use the following table as a reference also:

Sensor/Transducer	HDA200 Connector Number	HDA200 Channel number	Resolution
Load cell	Force 1	17	
Dial Gauge	Dial gauge 1	28	0.01mm
Truss Member 1	Strain 1	1	
Truss Member 2	Strain 2	2	
Truss Member 3	Strain 3	3	
Truss Member 4	Strain 4	4	
Truss Member 5	Strain 5	5	
Truss Member 6	Strain 6	6	
Truss Member 7	Strain 7	7	

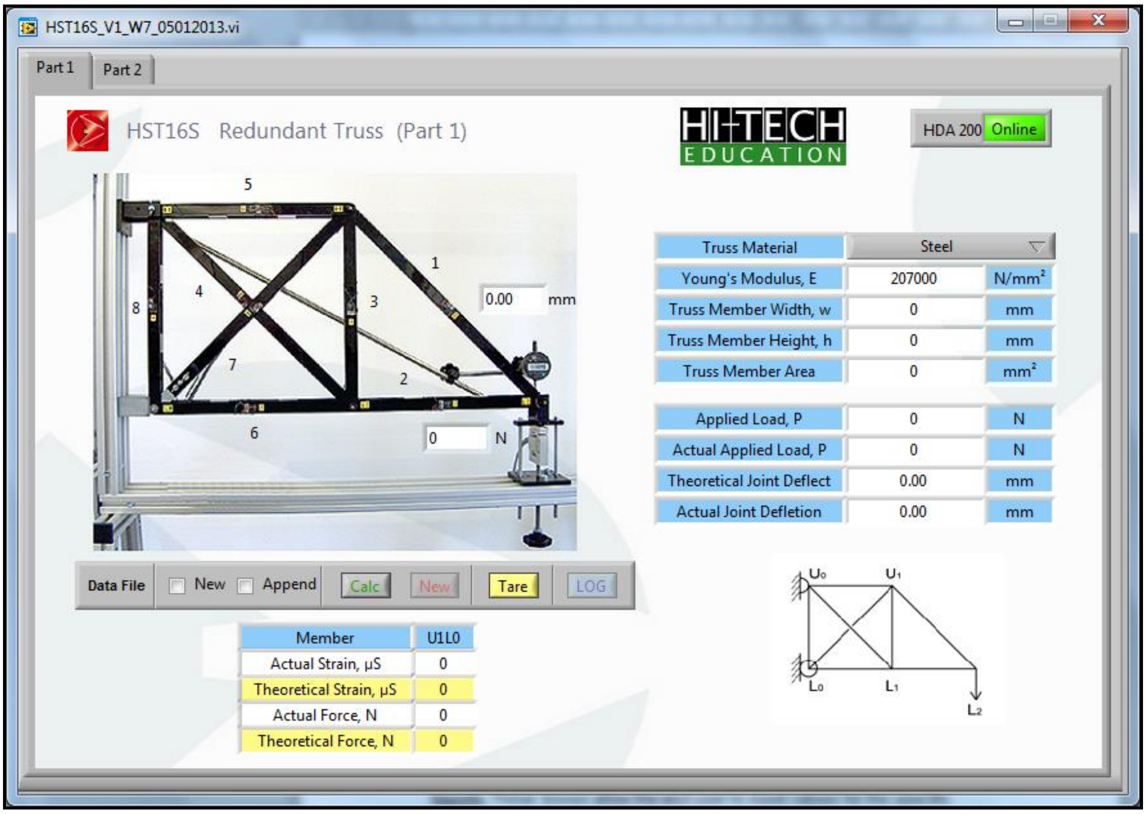
Run the HDA200 in LOCAL mode to check that the above channels only are being displayed. This will then ensure that the software collects the right data from the right channels.

NB: If the dial gauges (if used) are connected but not turned on then the software and HDA200 will not display the dial gauge values and the software and HDA200 screens will wait until they are turned on. Ensure the dial gauges are turned on when running the experiment and software.

If the above channels are not set correctly then you will have to enter the configuration of the HDA200 which will require reading and following the HDA200 instruction manual.

ONLINE MODE

1. Repeat the input parameters from the OFFLINE mode procedure above, press the CALC button and the software window should look like the image below:

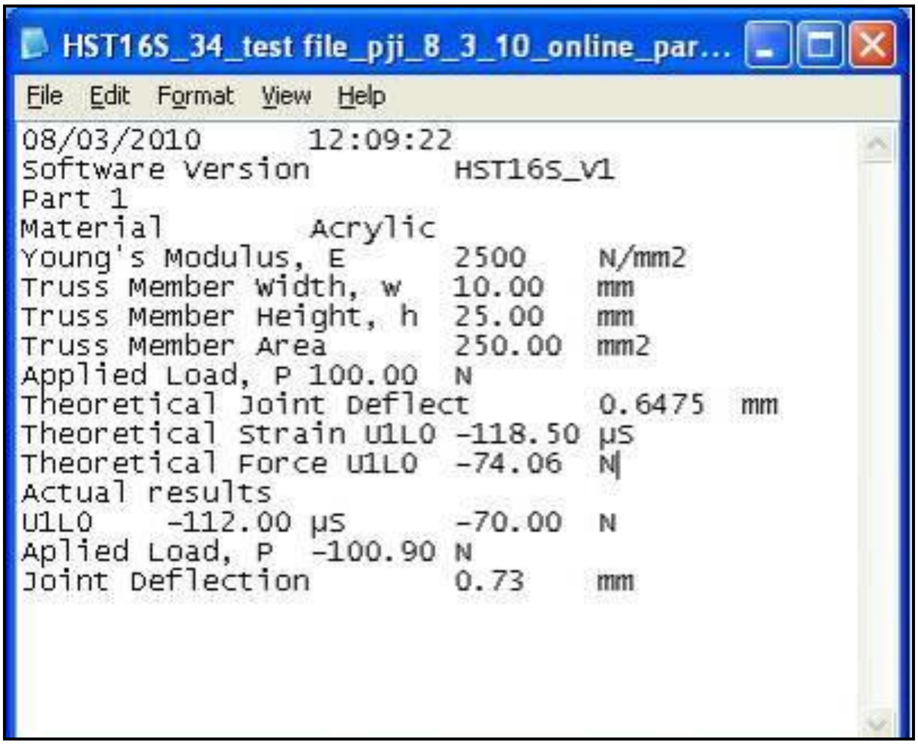


2. In ‘ONLINE’ mode you will notice that the actual applied load, deflection, and strains are not greyed out. These values will now start to change as they come in from the HDA200.
3. The strains and applied load will not be zero. To zero these readings simply press the TARE button. You may have to press it again if the reading does not return to zero. The deflection values will not zero. These have to be zeroed on the front of the dial gauge itself.
4. Load the hardware experiment to the same parameters as the input boxes. You should then be able to compare the actual values with theoretical values.
5. If you wish to save the data into a NEW or existing data file then press NEW to stop the software capturing data from the HDA200.
6. Tick the data file option required.
7. Press the CALC button and you will be prompted to create a new data file or append to the existing file. Choose the option required.
8. The current theoretical input and output values will then be saved to the data file.
9. Press the LOG button to store the actual values to the data file.
10. Should you change the hardware load to a new value and you wish to change the software inputs then adjust the hardware, press NEW, adjust the software inputs to be the same as the hardware, click the data file APPEND tick box and then press CALC.
11. You can then continue to create new inputs and obtain new outputs depending on how you set up the hardware and by following the procedure above.

DATA FILE CONTENTS

The data file created contains information that is useful in allowing the end user to further manipulate the data in a spreadsheet software.

The image below shows the typical data at the start of the data file for this experiment when a new file has been created and the LOG button has been pressed:



HST16S_34_test file_pji_8_3_10_online_par...

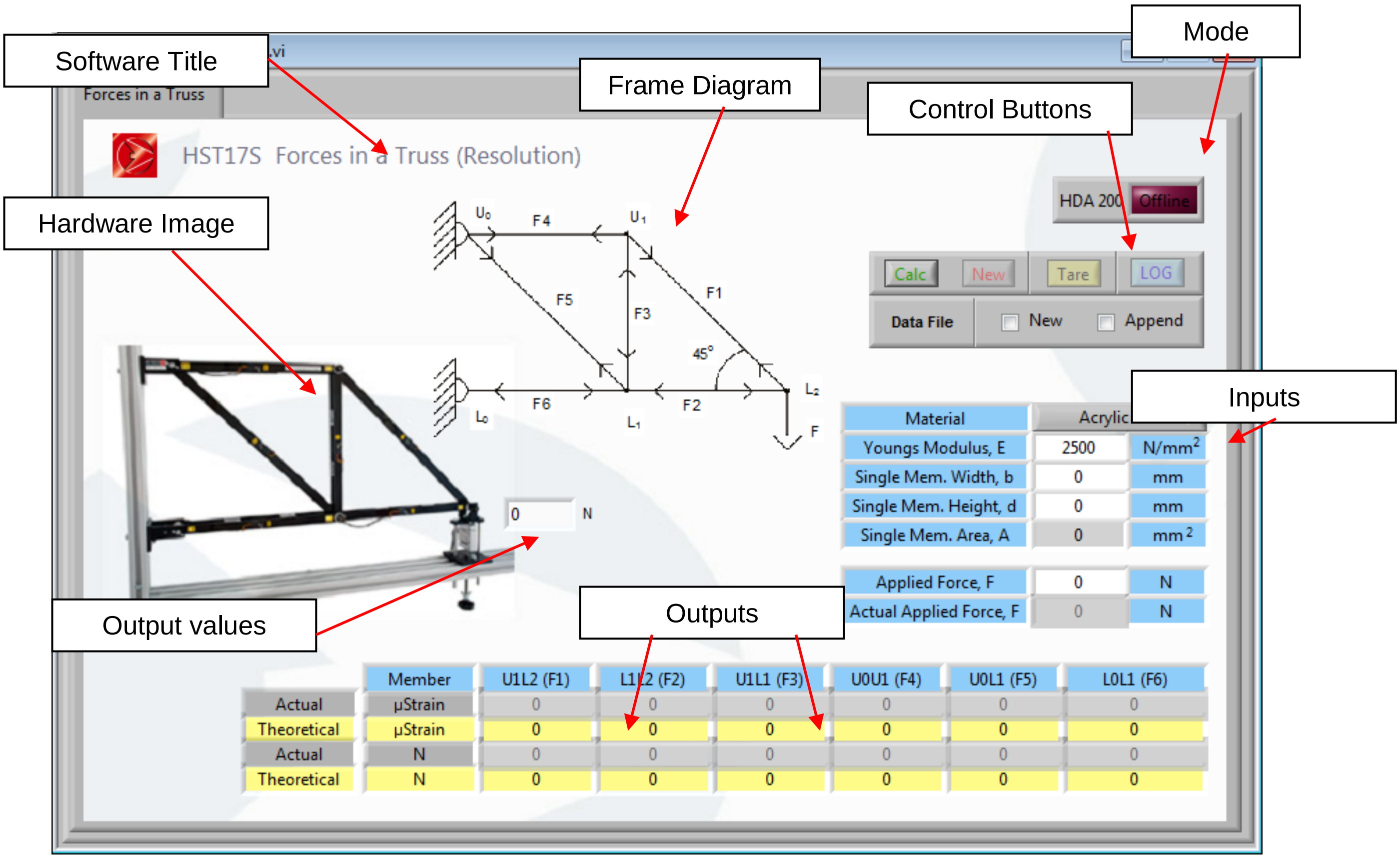
File Edit Format View Help

```
08/03/2010      12:09:22
Software Version        HST16S_V1
Part 1
Material        Acrylic
Young's Modulus, E      2500    N/mm2
Truss Member Width, w   10.00   mm
Truss Member Height, h  25.00   mm
Truss Member Area       250.00  mm2
Applied Load, P 100.00  N
Theoretical Joint Deflect       0.6475  mm
Theoretical Strain U1L0 -118.50 µS
Theoretical Force U1L0  -74.06  N
Actual results
U1L0    -112.00 µS      -70.00  N
Aplied Load, P  -100.90 N
Joint Deflection        0.73    mm
```

The information will then repeat itself depending on how many test points have been logged.

HST17S – FORCES in a TRUSS (RESOLUTION)

SOFTWARE WINDOW



In either mode the details of what is presented in the software window is the same. These are highlighted in the above image and detailed as follows:

Hardware image: This is a true representation of the actual hardware thus ensuring consistency in viewing between software and hardware.

Software Title: The title and number of the software.

Mode: This highlights which mode the software is in, i.e. OFFLINE or ONLINE.

Inputs: These boxes allow the end user to input values for the specific parameters listed. The blue boxes on the left hand column show the description of the input and the right hand column blue boxes show the units for these parameters. The central column is where the value is input via the keyboard. It is possible to press the TAB button on the keyboard and the cursor will jump to the next parameter.

The inputs available are as follows:

- **Material:** Choose the material which the truss members are made from. This varies between acrylic, aluminium, steel, stainless steel and brass.
- **Young's Modulus, E:** Depending on the material chosen above, will depend on what value is selected here. These values are defaults and cannot be changed.
- **Single Mem. Width, b**: This is the value of the horizontal width of each member. Nominally this is 10mm. This value is entered via the keyboard of the host computer.
- **Single Mem. Height, d**:This is value of the vertical depth of each member. Nominally this is 25mm. This value is entered via the keyboard of the host computer.
- **Single Mem. Area, A**: This is a calculated value of the nominal cross sectional area of each truss member. It cannot be changed as it is a calculated value.
- **Applied Force, F**: This is the value of the applied force to the truss. It is entered by the end user via the keyboard. It can be used when comparing actual with theoretical values.
- **Actual Applied Force, F**: This is value of the applied load from the hardware itself. This value comes via the HDA200, and will only appear when the HDA200 is connected in 'ONLINE' mode.

Outputs: These are theoretical values and actual values from the hardware based on the input parameters chosen. This is where the end user can compare actual results with theoretical.

The outputs available are as follows:

- **Member:** Each truss member joint is given a letter/number designation. The column headers to the right of this output title detail the truss member with the relevant joints. This also ties in with the frame diagram.
- **Actual µStrain**: This is the actual strain value from the hardware itself. It will only appear when the HDA200 is connected and the software is run in 'ONLINE' mode. It has the unit of microstrain.
- **Theoretical µStrain:** This is the calculated theoretical strain using the input parameters given. These value will appear when running in 'OFFLINE' or 'ONLINE' mode. It has the unit of microstrain.
- **Actual Force:** This is the calculated actual force based on the actual strain values from the hardware. These values will only appear when the HDA200 is connected in 'ONLINE' mode. It has units of Newton's (N).
- **Theoretical Force:** This is the calculated force based on the theoretical strain values. It has units of Newton's (N).

Control buttons: these buttons give the end user a choice of what to do with the software and the values presented on the screen. They are described in more detail as follows:

- **CALC**: When the inputs have been set, pressing this button will calculate the theoretical outputs.
- **NEW**: When this button is pressed it stops background processes and allows any of the inputs to be adjusted and then recalculated. You will have to wait a short time for the background processing to finish. When finished the CALC button becomes live and the NEW button becomes inactive.
- **TARE**: This button is only valid when running in ONLINE mode as when pressed it zeroes (tares) the values from the hardware which are being used in the software.
- **LOG**: When the end user wishes to record ACTUAL data from the software during ONLINE running, they can press this button and the key input and output parameters will then be logged into the data file.
- Data File **NEW:** This tick box is used when the end user wishes to store the input and output data to a brand new file on the host computer. When this is ticked and the CALC button pressed you will be prompted to create a new data file.
- Data file **APPEND:** If a data file has already been created then ticking this box will allow data to be added to this file rather than having to create a new file.

Frame Diagram: This represents a schematic of the hardware arrangement and is a cross reference for the inputs. This will not be present on all experiment softwares.

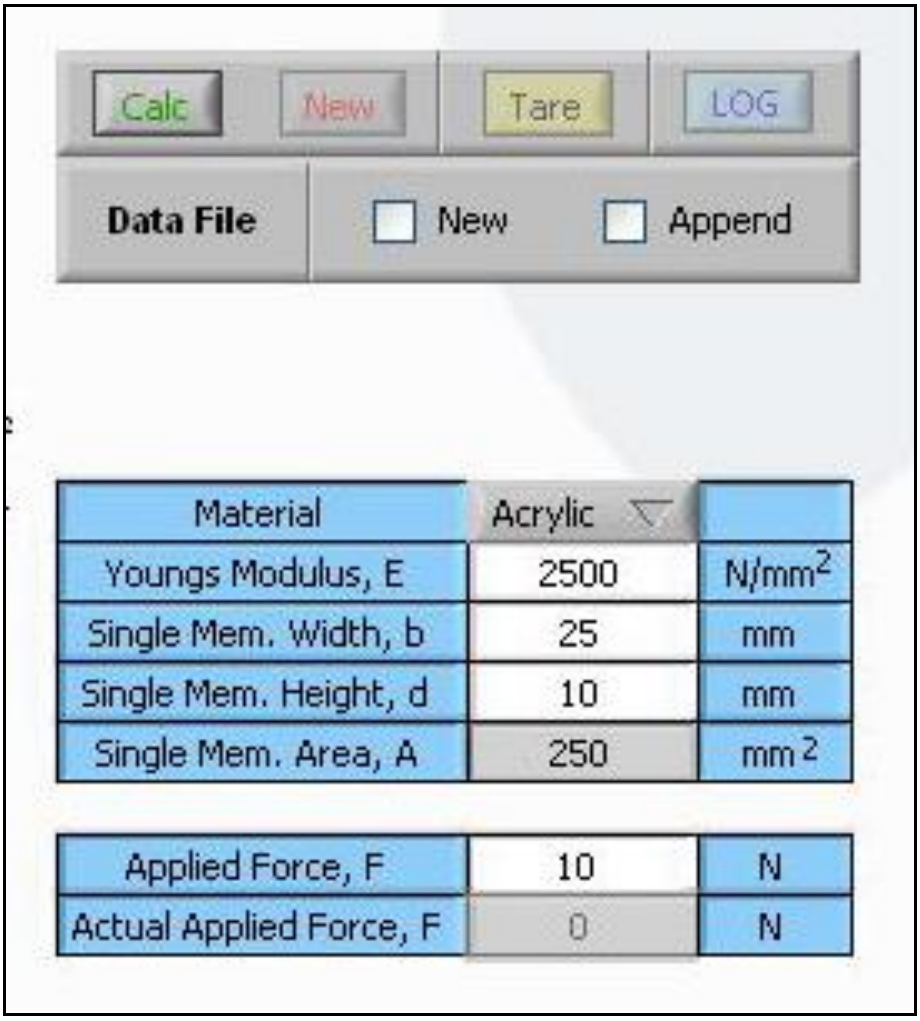
OPERATING THE SOFTWARE

The following procedure outlines the steps required to operate the software and to obtain outputs for the inputs chosen. It is one of many variations that could be followed.

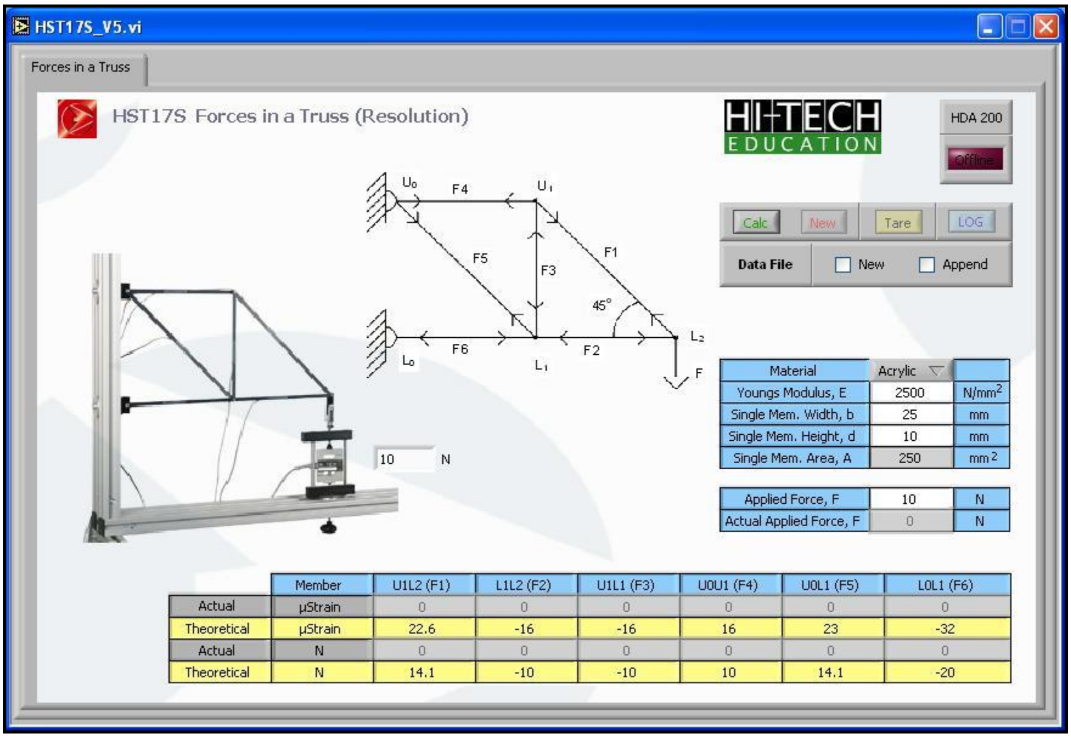
It assumes that the end user has set up the HDA200 (if necessary) and installed the software correctly and all inputs are being undertaken using the keyboard of the host computer.

OFFLINE MODE

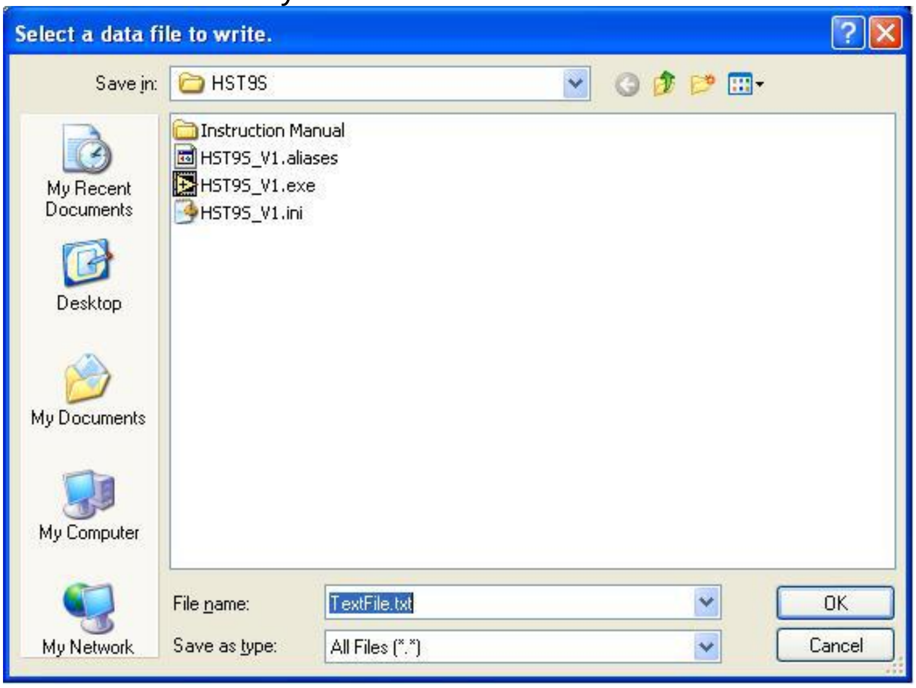
1. Load the experiment software by double clicking the **.exe** files supplied.
2. Choose 'NO' when the pop up window appears asking if the HDA200 is connected.
3. Choose the material from the drop down menu list.
4. Enter 25 in the width, b input box.
5. Enter 10 in the height, d input box.
6. Enter 10 in the Applied Force, F input box.
7. Press the CALC button with no data file tick boxes ticked. The screen should appear as follows:



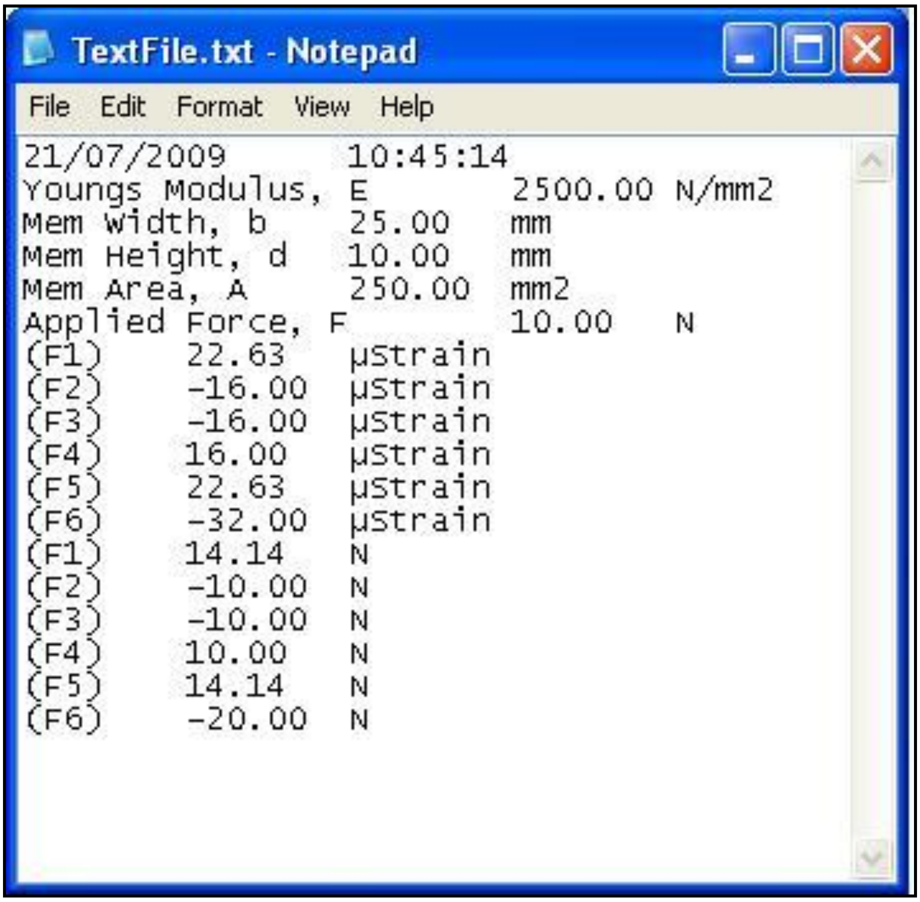
8. The complete screen should look like the following image:



9. The applied force value will be shown in the small output value next to the load cell of the hardware image. Also note that the actual applied force in the input parameters and the actual strain and actual force of the outputs are greyed out. This is because you are in ‘OFFLINE’ mode.
10. Tick the Data File NEW box.
11. Press CALC.
12. You will then be shown the following window (the contents of this window will vary depending on the experiment running) and prompted to create a data file name in the location of your choice.

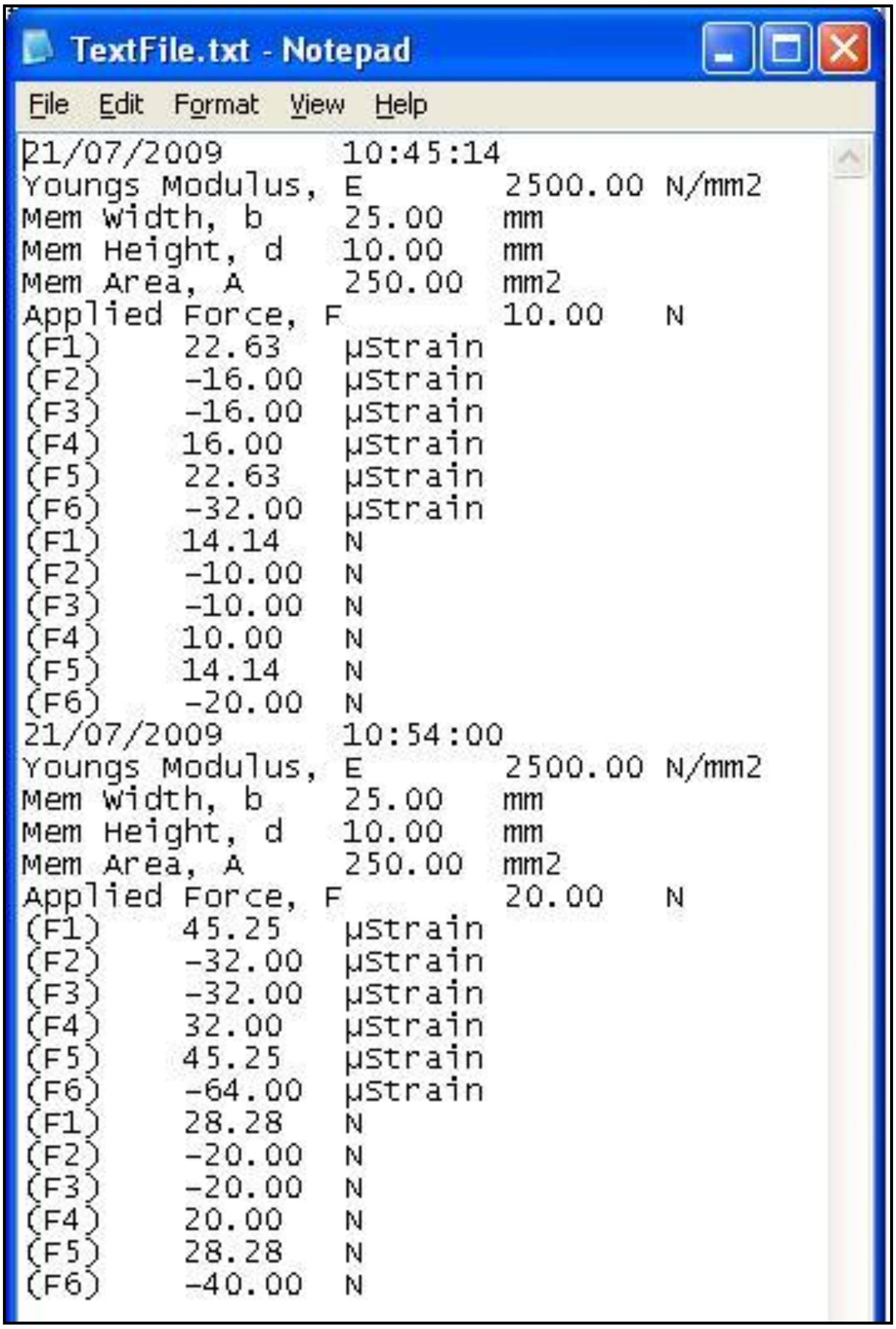


13. Either rename the default name of TextFile.txt or keep this default name. Its up to you. Ensure the file extension of ***.txt*** remains. Once the filename and location have been chosen then press **OK**.
14. The input and output data will now be saved in the data file created. To prove this open the text file in ***NOTEPAD*** that you have just created from its location and check the contents. It should look similar to the image below.



15. If you wish to change the inputs then simply press change the input parameter (change applied force to 20N from 10N), press the data file NEW button to clear it, press the data file APPEND button and then press CALC. You will be given the data file to append to, choose this and then press ok.

16. The data file should now have the new data saved into it and look like the following:



TextFile.txt - Notepad

File Edit Format View Help

```
21/07/2009      10:45:14
Youngs Modulus, E       2500.00 N/mm2
Mem Width, b    25.00   mm
Mem Height, d   10.00   mm
Mem Area, A     250.00  mm2
Applied Force, F        10.00   N
(F1)    22.63   µStrain
(F2)    -16.00  µStrain
(F3)    -16.00  µStrain
(F4)    16.00   µStrain
(F5)    22.63   µStrain
(F6)    -32.00  µStrain
(F1)    14.14   N
(F2)    -10.00  N
(F3)    -10.00  N
(F4)    10.00   N
(F5)    14.14   N
(F6)    -20.00  N
21/07/2009      10:54:00
Youngs Modulus, E       2500.00 N/mm2
Mem Width, b    25.00   mm
Mem Height, d   10.00   mm
Mem Area, A     250.00  mm2
Applied Force, F        20.00   N
(F1)    45.25   µStrain
(F2)    -32.00  µStrain
(F3)    -32.00  µStrain
(F4)    32.00   µStrain
(F5)    45.25   µStrain
(F6)    -64.00  µStrain
(F1)    28.28   N
(F2)    -20.00  N
(F3)    -20.00  N
(F4)    20.00   N
(F5)    28.28   N
(F6)    -40.00  N
```

17. In the OFFLINE mode the NEW and TARE buttons although live will not perform any function. The LOG button will not be live and greyed out but the data can still be stored by the use of the CALC button.

18. When finished with the software shut the software down.

19. You can continue to adjust the inputs and see what outputs are obtained by following the same process above.

HDA200 CHANNEL SETTINGS and CONNECTIONS

Prior to running this experiment software in ONLINE mode with the HDA200 you will have to make sure that the correct experiment hardware sensors/transducers are connected to the HDA200 and the correct channels are being displayed by the HDA200. Refer to the HDA200 instruction manual and use the following table as a reference also:

Sensor/Transducer	HDA200 Connector Number	HDA200 Channel number	Resolution
Load cell	Force 1	17	
Truss Member 1	Strain 1	1	
Truss Member 2	Strain 2	2	
Truss Member 3	Strain 3	3	
Truss Member 4	Strain 4	4	
Truss Member 5	Strain 5	5	
Truss Member 6	Strain 6	6	
Truss Member 7	Strain 7	7	

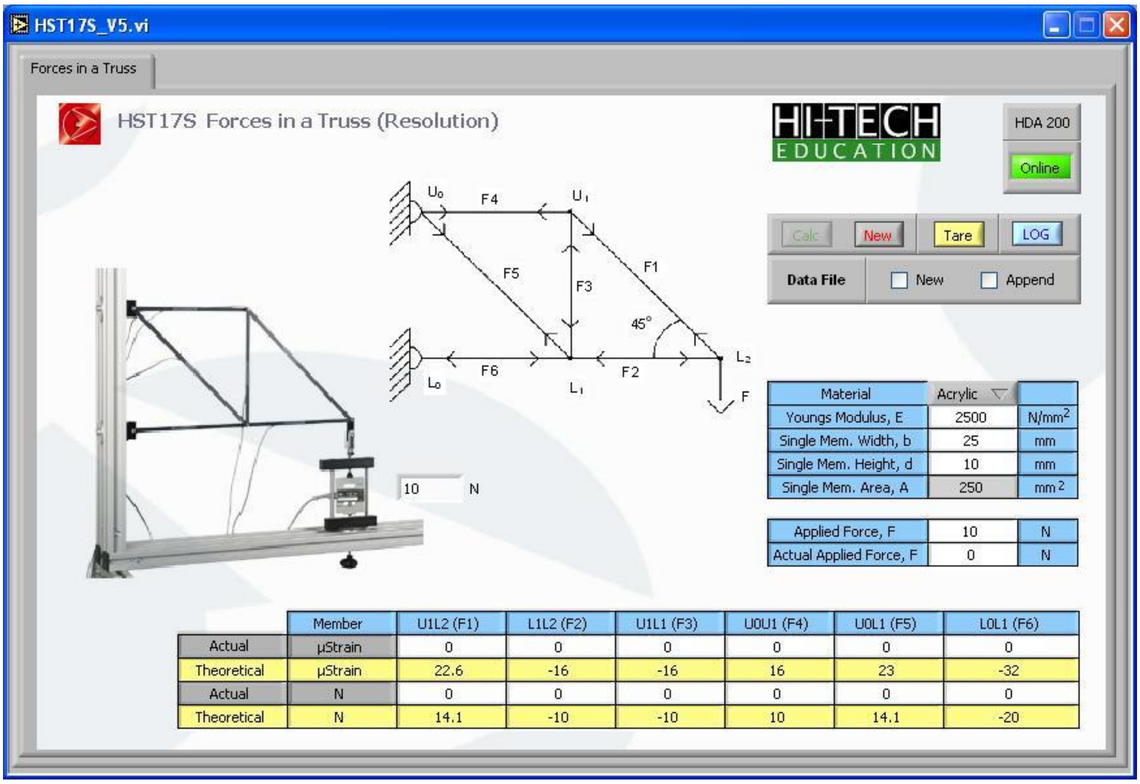
Run the HDA200 in LOCAL mode to check that the above channels only are being displayed. This will then ensure that the software collects the right data from the right channels.

NB: If the dial gauges (if used) are connected but not turned on then the software and HDA200 will not display the dial gauge values and the software and HDA200 screens will wait until they are turned on. Ensure the dial gauges are turned on when running the experiment and software.

If the above channels are not set correctly then you will have to enter the configuration of the HDA200 which will require reading and following the HDA200 instruction manual.

ONLINE MODE

1. Repeat the input parameters from the OFFLINE mode procedure above, press the CALC button and the software window should look like the image below:



2. In 'ONLINE' mode you will notice that the Actual applied force, actual strain and actual force lines are no longer greyed out. These values will now start to change as they come in from the HDA200.
3. These values will not be zero. To zero this reading simply press the TARE button. You may have to press it again if the reading does not return to zero.
4. Load the hardware experiment to the same parameters as the input boxes. You should then be able to compare the actual values with theoretical values.
5. If you wish to save the data into a NEW or existing data file then press NEW to stop the software capturing data from the HDA200.
6. Tick the data file option required.
7. Press the CALC button and you will be prompted to create a new data file or append to the existing file. Choose the option required.
8. The current theoretical input and output values will then be saved to the data file.
9. Press the LOG button to store the actual values to the data file.
10. Should you change the hardware load to a new value and you wish to change the software inputs then adjust the hardware, press NEW, adjust the software inputs to be the same as the hardware, click the data file APPEND tick box and then press CALC.
11. You can then continue to create new inputs and obtain new outputs depending on how you set up the hardware and by following the procedure above.

DATA FILE CONTENTS

The data file created contains information that is useful in allowing the end user to further manipulate the data in a spreadsheet software.

The image below shows the typical data at the start of the data file for this experiment when a new file has been created and the LOG button has been pressed:

The data is as follows:

new hda200 test 20_7_09.txt - Notepad

File Edit Format View Help

```
20/07/2009        15:53:33
Youngs Modulus, E         2500.00 N/mm2
Mem Width, b      10.00   mm
Mem Height, d     25.00   mm
Mem Area, A       250.00  mm2
Applied Force, F          12.20   N
(F1)    27.61   µStrain
(F2)    -19.52  µStrain
(F3)    -19.52  µStrain
(F4)    19.52   µStrain
(F5)    27.61   µStrain
(F6)    -39.04  µStrain
(F1)    17.25   N
(F2)    -12.20  N
(F3)    -12.20  N
(F4)    12.20   N
(F5)    17.25   N
(F6)    -24.40  N
Actual results
(F1)    37.00   µStrain
(F2)    -24.00  µStrain
(F3)    -24.00  µStrain
(F4)    24.00   µStrain
(F5)    37.00   µStrain
(F6)    -50.00  µStrain
(F1)    23.12   N
(F2)    -15.00  N
(F3)    -15.00  N
(F4)    15.00   N
(F5)    23.12   N
(F6)    -31.25  N
Applied Force     12.10   N
20/07/2009        15:55:00
Youngs Modulus, E         2500.00 N/mm2
Mem Width, b      10.00   mm
Mem Height, d     25.00   mm
Mem Area, A       250.00  mm2
Applied Force, F          12.20   N
```

Date and time.
E value
Width b
Height d
Area A
Force
Theoretical Strains

Theoretical Forces

Actual Strains

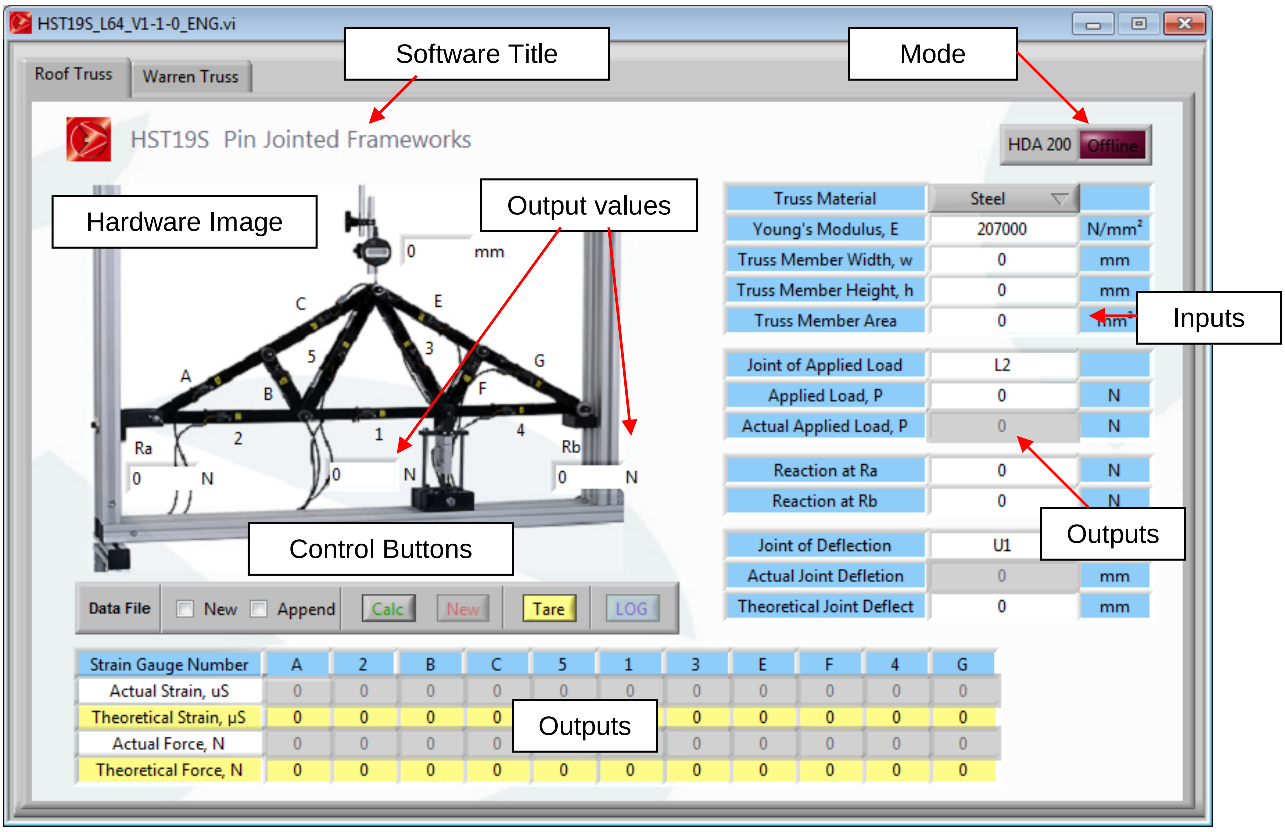
Actual Forces

Actual Applied Force

The information will then repeat itself depending on how many test points have been logged.

HST19S – PIN JOINTED FRAMEWORKS

SOFTWARE WINDOW – Roof Truss



In either mode the details of what is presented in the software window is the same. These are highlighted in the above image and detailed as follows:

Hardware image: This is a true representation of the actual hardware thus ensuring consistency in viewing between software and hardware.

Software Title: The title and number of the software.

Mode: This highlights which mode the software is in, i.e. OFFLINE or ONLINE.

Inputs: These boxes allow the end user to input values for the specific parameters listed. The blue boxes on the left hand column show the description of the input and the right hand column blue boxes show the units for these parameters. The central column is where the value is input via the keyboard. It is possible to press the TAB button on the keyboard and the cursor will jump to the next parameter.

The inputs available are as follows:

- **Truss Material:** Choose the material which the truss members are made from. This varies between acrylic, aluminium, steel, stainless steel and brass.
- **Young's Modulus, E:** Depending on the material chosen above, will depend on what value is selected here. These values are defaults and cannot be changed.
- **Truss Member Width, w**: This is the value of the horizontal width of each member. Nominally this is 10mm. This value is entered via the keyboard of the host computer.
- **Truss Member Height, h**: This is value of the vertical depth of each member. Nominally this is 25mm. This value is entered via the keyboard of the host computer.
- **Truss Member Area**: This is a calculated value of the nominal cross sectional area of each truss member. It cannot be changed as it is a calculated value.
- **Joint of Applied Load**: This is the joint at which the applied load will be added. As default this is set at L2 and cannot be changed.
- **Applied Load, P**: This is the value of the applied force to the truss. It is entered by the end user via the keyboard. It can be used when comparing actual with theoretical values. This value will appear on the hardware image.
- **Reaction at Ra**: The theoretical reaction at Ra as calculated by the software.
- **Reaction at Rb**: The theoretical reaction at Rb as calculated by the software.
- **Joint of Deflection**: This is the default joint at which deflection will be taken from the hardware. This cannot be changed.

Outputs: These are theoretical values and actual values from the hardware based on the input parameters chosen. This is where the end user can compare actual results with theoretical.

The outputs available are as follows:
- **Actual Applied Load, P**: This is value of the applied load from the hardware itself. This value comes via the HDA200, and will only appear when the HDA200 is connected in 'ONLINE' mode.
- **Actual Joint Deflection:** This is the actual joint deflection for part 1 of the hardware experiment.
- **Theoretical Joint Deflect:** This is the calculated theoretical joint deflection for part 1 of the hardware experiment. This value will appear on the hardware image.

Table underneath the hardware image.:

- **Actual Strain:** This is the actual strain from the redundant truss member only via the HDA200. In offline mode this value will be greyed out.
- **Theoretical Strain:** This is the theoretical strain from the redundant truss member only.
- **Actual Force:** This is the actual force value calculated from the actual strain values form the hardware for the redundant member only.
- **Theoretical Force:** This is the theoretical force calculated from the theoretical strain for the redundant member only.

Control buttons: these buttons give the end user a choice of what to do with the software and the values presented on the screen. They are described in more detail as follows:

- **CALC**: When the inputs have been set, pressing this button will calculate the theoretical outputs.
- **NEW**: When this button is pressed it stops background processes and allows any of the inputs to be adjusted and then recalculated. You will have to wait a short time for the background processing to finish. When finished the CALC button becomes live and the NEW button becomes inactive.
- **TARE**: This button is only valid when running in ONLINE mode as when pressed it zeroes (tares) the values from the hardware which are being used in the software.
- **LOG**: When the end user wishes to record ACTUAL data from the software during ONLINE running, they can press this button and the key input and output parameters will then be logged into the data file.
- **Data File NEW:** This tick box is used when the end user wishes to store the input and output data to a brand new file on the host computer. When this is ticked and the CALC button pressed you will be prompted to create a new data file.
- **Data file APPEND:** If a data file has already been created then ticking this box will allow data to be added to this file rather than having to create a new file.

SOFTWARE WINDOW – WARREN TRUSS

The Warren truss tab will gain access to the Warren Truss element of this software. Everything is exactly the same as per the Roof Truss above, except for the hardware image, and the option to choose either U0 or U1 for the joint of deflection.

OPERATING THE SOFTWARE

The following procedure outlines the steps required to operate the software and to obtain outputs for the inputs chosen. It is one of many variations that could be followed.

It assumes that the end user has set up the HDA200 (if necessary) and installed the software correctly and all inputs are being undertaken using the keyboard of the host computer.

OFFLINE MODE – ROOF TRUSS

1. Load the experiment software by double clicking the **.exe** files supplied.

2. Choose 'NO' when the pop up window appears asking if the HDA200 is connected.

3. Choose ACRYLIC from the drop down menu list.

4. Enter 10 in the width, w input box.

5. Enter 25 in the height, h input box.

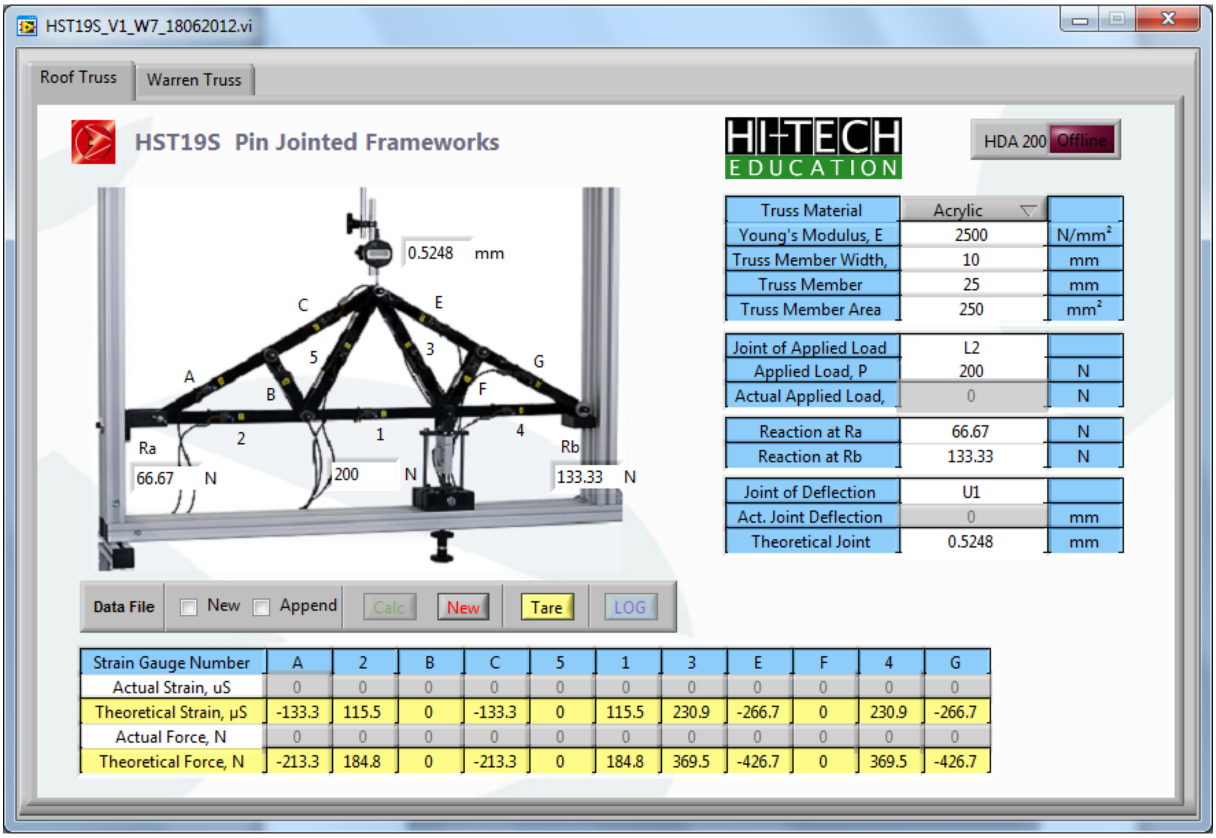
6. The truss member area will be calculated automatically.

7. Enter 200 in the Applied Force, F input box.

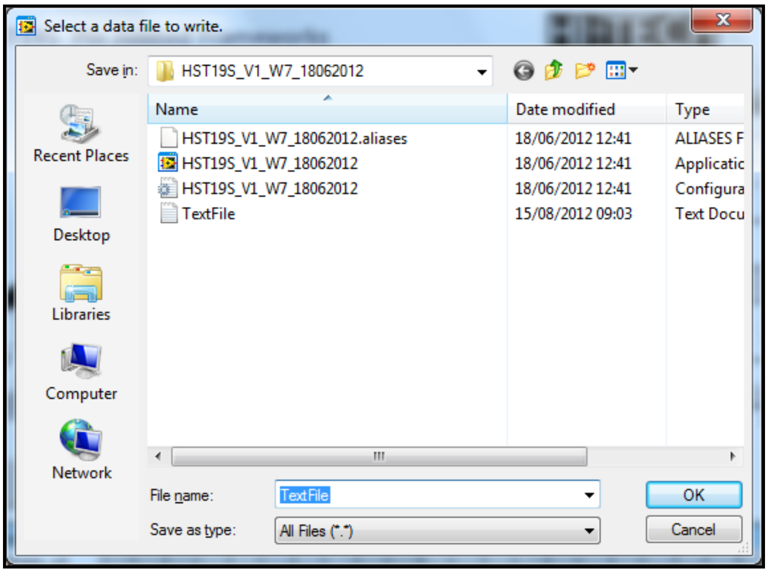
8. Press the CALC button with no data file tick boxes ticked. The screen should appear as follows:

Truss Material	Acrylic	
Young's Modulus, E	2500	N/mm^2
Truss Member Width,	10	mm
Truss Member	25	mm
Truss Member Area	250	mm^2
Joint of Applied Load	L2	
Applied Load, P	200	N
Actual Applied Load,	0	N
Reaction at Ra	66.67	N
Reaction at Rb	133.33	N
Joint of Deflection	U1	
Act. Joint Deflection	0	mm
Theoretical Joint	0.5248	mm

9. The complete screen should look like the following image:

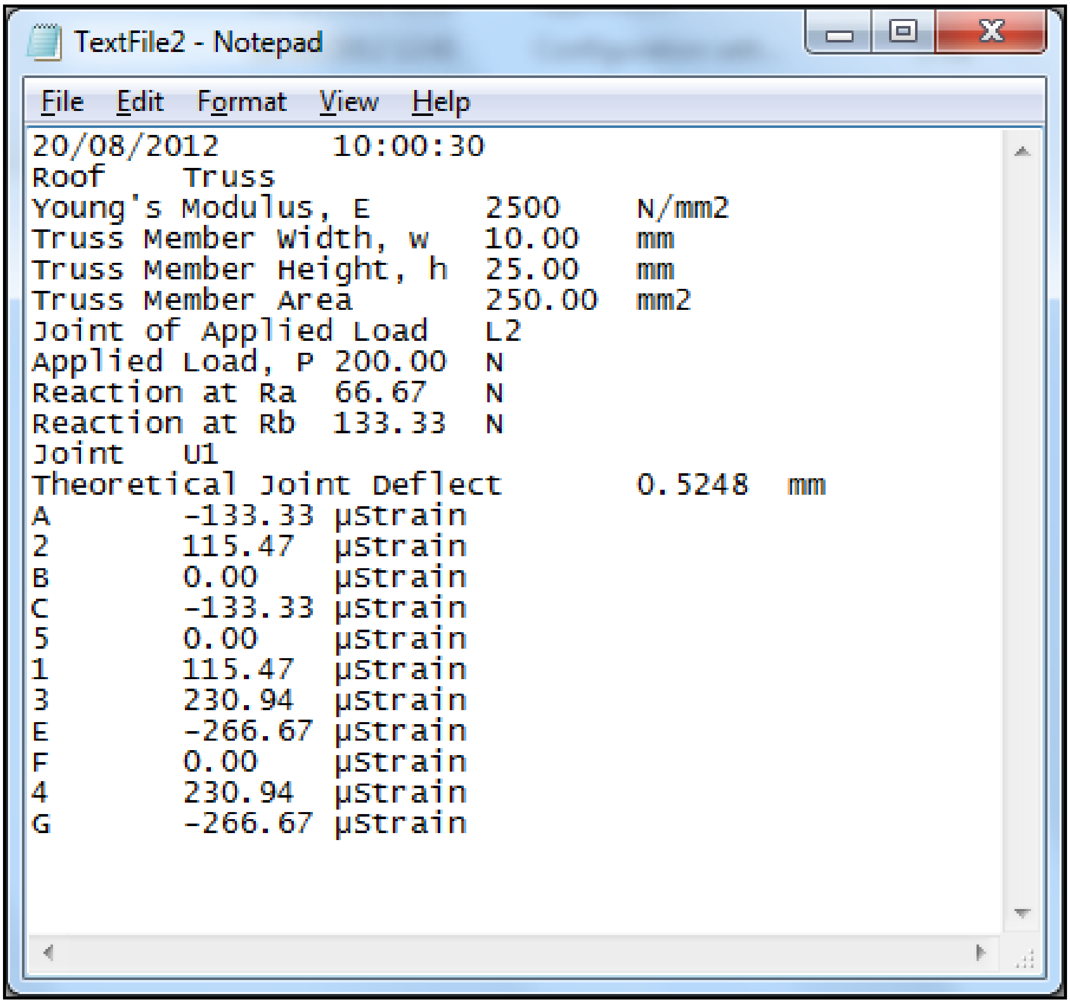


10. The applied load value and theoretical joint deflection will be shown in the small output value next to the load cell of the hardware image. Also note that the actual applied load and the actual joint deflection are greyed out. This is because you are in 'OFFLINE' mode.
11. Press NEW
12. Tick the Data File NEW box.
13. Press CALC.
14. You will then be shown the following window (the contents of this window will vary depending on the experiment running) and prompted to create a data file name in the location of your choice.



15. Either rename the default name of TextFile.txt or keep this default name. It's up to you. Ensure the file extension of ***.txt*** remains. Once the filename and location have been chosen then press **OK**.

16. The input and output data will now be saved in the data file created. To prove this open the text file in ***NOTEPAD*** that you have just created from its location and check the contents. It should look similar to the image below.




```
20/08/2012      10:00:30
Roof    Truss
Young's Modulus, E      2500    N/mm2
Truss Member Width, w   10.00   mm
Truss Member Height, h  25.00   mm
Truss Member Area       250.00  mm2
Joint of Applied Load   L2
Applied Load, P 200.00  N
Reaction at Ra  66.67   N
Reaction at Rb  133.33  N
Joint   U1
Theoretical Joint Deflect       0.5248  mm
A       -133.33 µStrain
2       115.47  µStrain
B       0.00    µStrain
C       -133.33 µStrain
5       0.00    µStrain
1       115.47  µStrain
3       230.94  µStrain
E       -266.67 µStrain
F       0.00    µStrain
4       230.94  µStrain
G       -266.67 µStrain
```

17. If you wish to change the inputs then simply press the NEW button, change the input parameter, press the data file NEW button to clear it, press the data file APPEND button and then press CALC. You will be given the data file to append to, choose this and then press ok.

18. In the OFFLINE mode the TARE button although live will not perform any function. The LOG button will not be live and greyed out but the data can still be stored by the use of the CALC button.

19. When finished with the software shut the software down.

20. You can continue to adjust the inputs and see what outputs are obtained by following the same process above.

<u>OFFLINE MODE – WARREN TRUSS</u>

1. Load the experiment software by double clicking the **.exe** files supplied.

2. Choose 'NO' when the pop up window appears asking if the HDA200 is connected.

3. Choose ACRYLIC from the drop down menu list.

4. Enter 10 in the width, w input box.

5. Enter 25 in the height, h input box.

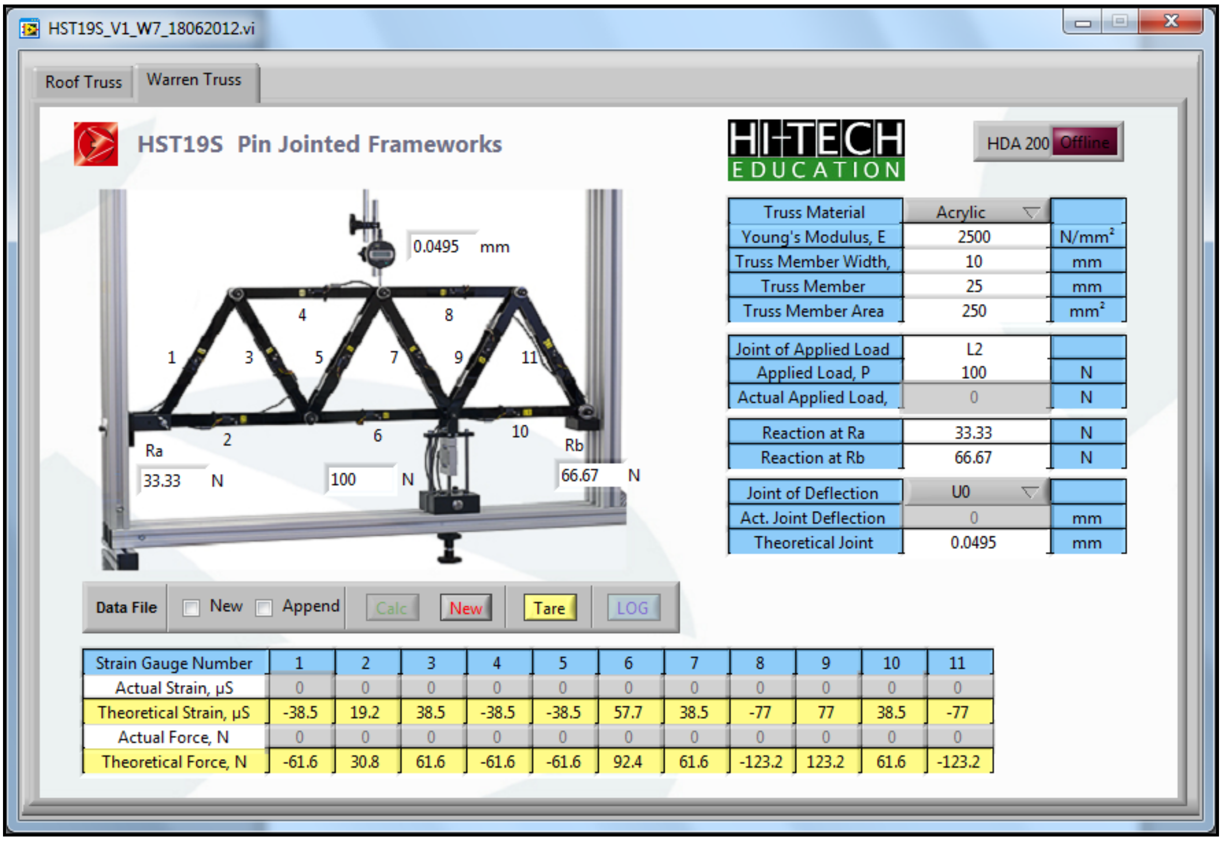
6. The truss member area will be calculated automatically.
7. Enter 100 in the Applied Force, F input box.

8. Choose U0 as the joint of deflection.

9. Press the CALC button with no data file tick boxes ticked. The screen should appear as follows:

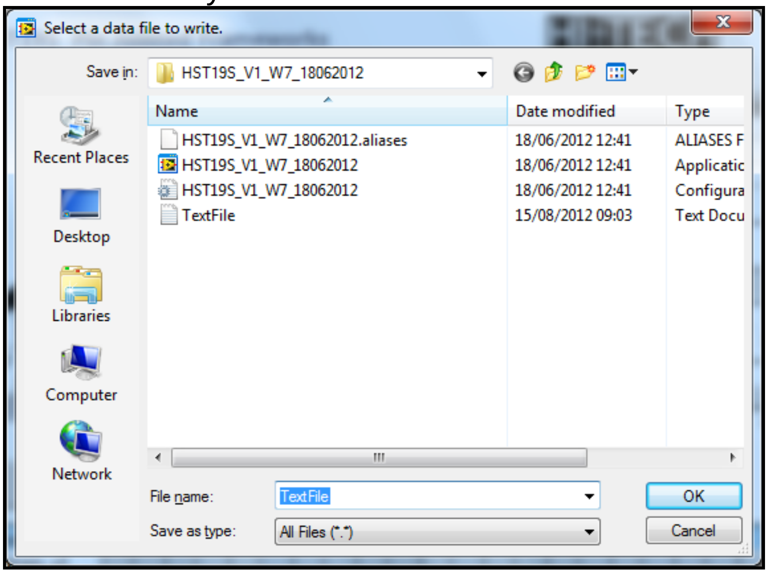
Truss Material	Acrylic	
Young's Modulus, E	2500	N/mm²
Truss Member Width,	10	mm
Truss Member	25	mm
Truss Member Area	250	mm²
Joint of Applied Load	L2	
Applied Load, P	100	N
Actual Applied Load,	0	N
Reaction at Ra	33.33	N
Reaction at Rb	66.67	N
Joint of Deflection	U0	
Act. Joint Deflection	0	mm
Theoretical Joint	0.0495	mm

10. The complete screen should look like the following image:



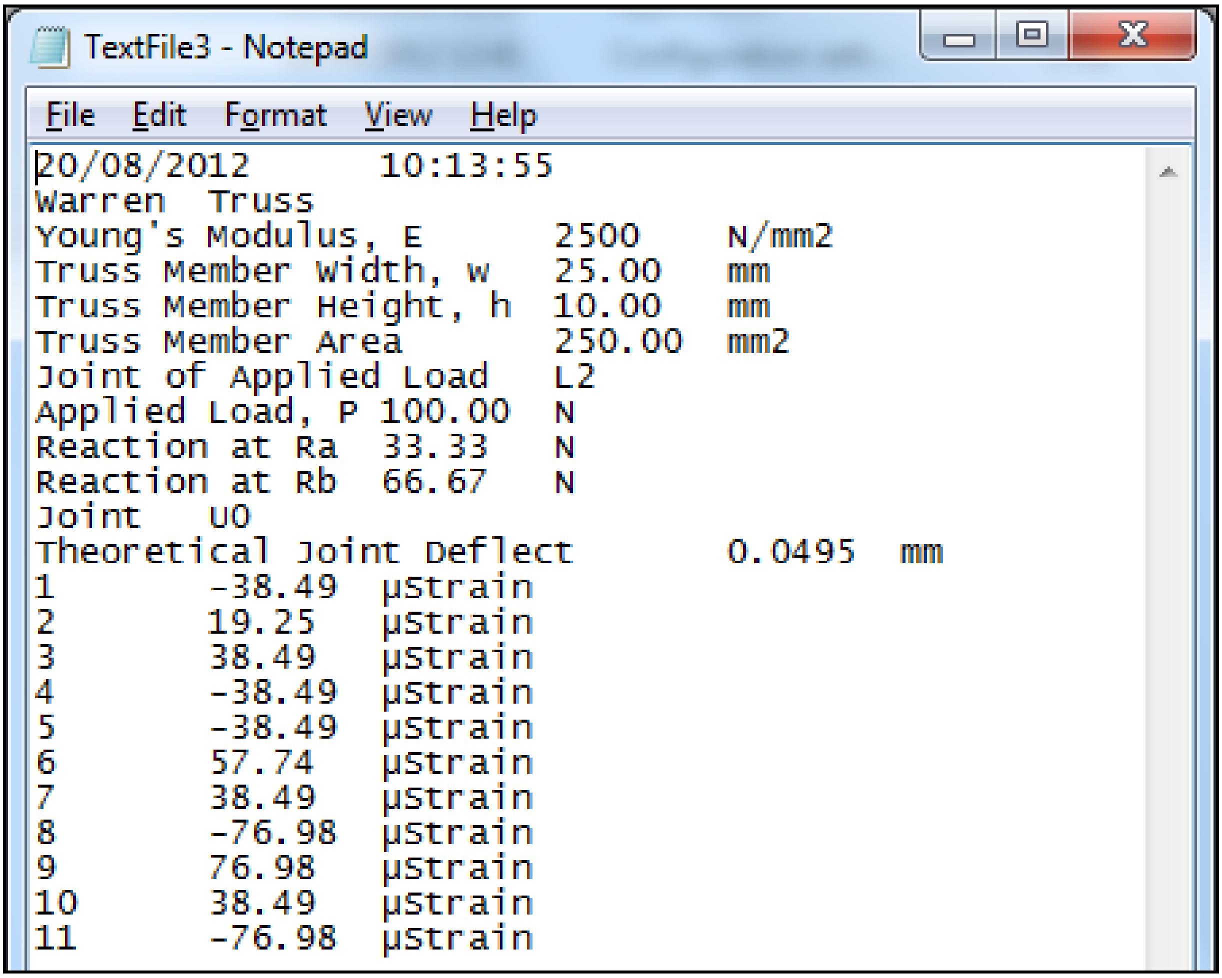
Strain Gauge Number	1	2	3	4	5	6	7	8	9	10	11
Actual Strain, µS	0	0	0	0	0	0	0	0	0	0	0
Theoretical Strain, µS	-38.5	19.2	38.5	-38.5	-38.5	57.7	38.5	-77	77	38.5	-77
Actual Force, N	0	0	0	0	0	0	0	0	0	0	0
Theoretical Force, N	-61.6	30.8	61.6	-61.6	-61.6	92.4	61.6	-123.2	123.2	61.6	-123.2

11. The applied load value and theoretical joint deflection will be shown in the small output value next to the load cell of the hardware image. Also note that the actual applied load and the actual joint deflection are greyed out. This is because you are in ‘OFFLINE’ mode.
12. Press the NEW button.
13. Tick the Data File NEW box.
14. Press CALC.
15. You will then be shown the following window (the contents of this window will vary depending on the experiment running) and prompted to create a data file name in the location of your choice.



16. Either rename the default name of TextFile.txt or keep this default name. Its up to you. Ensure the file extension of ***.txt*** remains. Once the filename and location have been chosen then press **OK**.

17. The input and output data will now be saved in the data file created. To prove this open the text file in ***NOTEPAD*** that you have just created from its location and check the contents. It should look similar to the image below.



```
TextFile3 - Notepad
File  Edit  Format  View  Help
20/08/2012      10:13:55
Warren  Truss
Young's Modulus, E      2500    N/mm2
Truss Member Width, w   25.00   mm
Truss Member Height, h  10.00   mm
Truss Member Area       250.00  mm2
Joint of Applied Load   L2
Applied Load, P 100.00  N
Reaction at Ra  33.33   N
Reaction at Rb  66.67   N
Joint   U0
Theoretical Joint Deflect       0.0495  mm
1       -38.49  µStrain
2       19.25   µStrain
3       38.49   µStrain
4       -38.49  µStrain
5       -38.49  µStrain
6       57.74   µStrain
7       38.49   µStrain
8       -76.98  µStrain
9       76.98   µStrain
10      38.49   µStrain
11      -76.98  µStrain
```

18. If you wish to change the inputs then simply press NEW, change the input parameter, press the data file NEW button to clear it, press the data file APPEND button and then press CALC. You will be given the data file to append to, choose this and then press ok.

19. In the OFFLINE mode the TARE button although live will not perform any function. The LOG button will not be live and greyed out but the data can still be stored by the use of the CALC button.

20. When finished with the software shut the software down.

21. You can continue to adjust the inputs and see what outputs are obtained by following the same process above.

HDA200 CHANNEL SETTINGS and CONNECTIONS

Prior to running this experiment software in ONLINE mode with the HDA200 you will have to make sure that the correct experiment hardware sensors/transducers are connected to the HDA200 and the correct channels are being displayed by the HDA200. Refer to the HDA200 instruction manual and use the following table as a reference also:

Sensor/Transducer	HDA200 Connector Number	HDA200 Channel number	Resolution
Load cell	Force 1	17	
Dial Gauge	Dial gauge 1	28	0.01mm
Truss Member 1	Strain 1	1	
Truss Member 2	Strain 2	2	
Truss Member 3	Strain 3	3	
Truss Member 4	Strain 4	4	
Truss Member 5	Strain 5	5	
Truss Member 6	Strain 6	6	
Truss Member 7	Strain 7	7	
Truss Member 8	Strain 8	8	
Truss Member 9	Strain 9	9	
Truss Member 10	Strain 10	10	
Truss Member 11	Strain 11	11	

Run the HDA200 in LOCAL mode to check that the above channels only are being displayed. This will then ensure that the software collects the right data from the right channels.

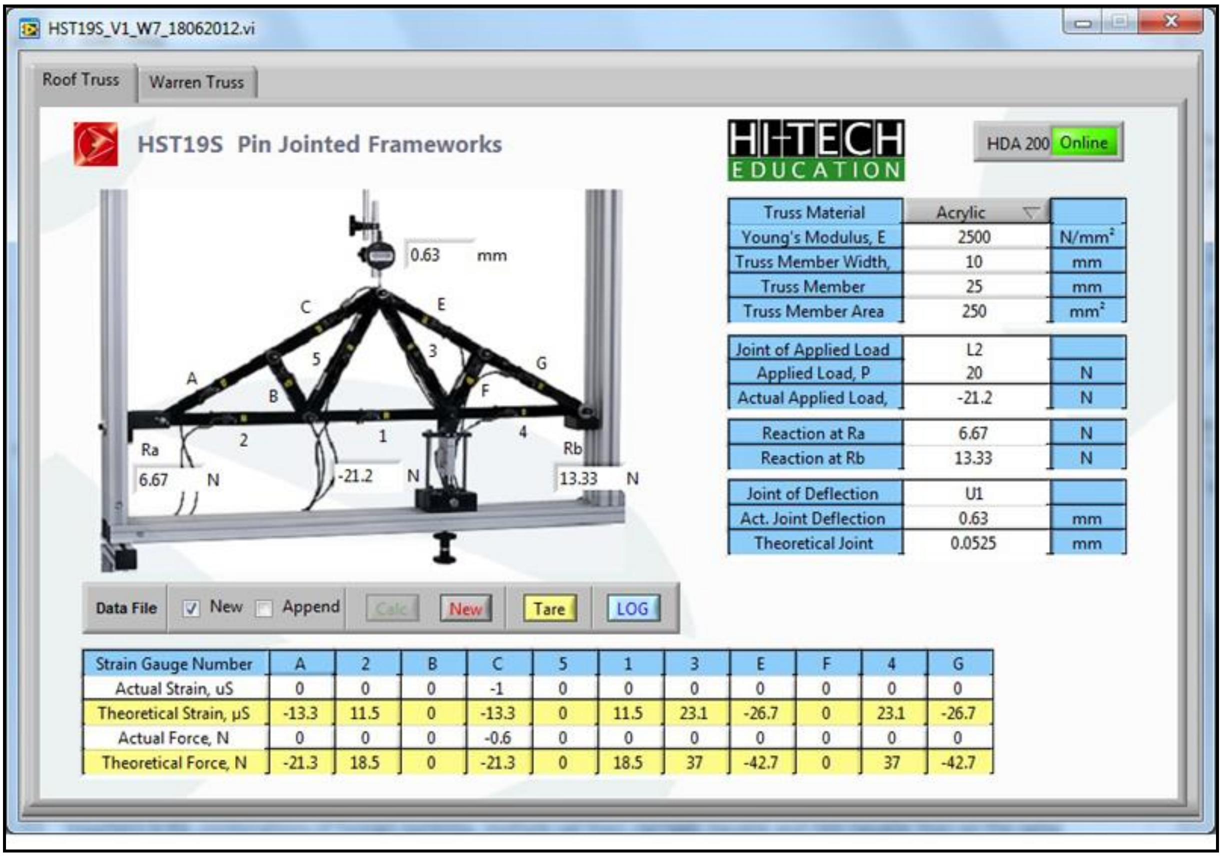
NB: If the dial gauges (if used) are connected but not turned on then the software and HDA200 will not display the dial gauge values and the software and HDA200 screens will wait until they are turned on. Ensure the dial gauges are turned on when running the experiment and software.

If the above channels are not set correctly then you will have to enter the configuration of the HDA200 which will require reading and following the HDA200 instruction manual.

ONLINE MODE – ROOF TRUSS

1. Start the software and when the pop window appears asking if the HDA200 is connected, press the 'YES' button.

2. Repeat the input parameters from the OFFLINE mode procedure above, press the CALC button and the software window should look like the image below:



3. In 'ONLINE' mode you will notice that the actual applied load, deflection, force and strains are not greyed out. These values will now start to change as they come in from the HDA200.

4. The strains and applied load will not be zero. To zero these readings simply press the TARE button. You may have to press it again if the reading does not return to zero. The deflection values will not zero. These have to be zeroed on the front of the dial gauge itself.

5. Load the hardware experiment to the same parameters as the input boxes. You should then be able to compare the actual values with theoretical values.

6. If you wish to save the data into a NEW or existing data file then press NEW to stop the software capturing data from the HDA200.

7. Tick the data file option required.

8. Press the CALC button and you will be prompted to create a new data file or append to the existing file. Choose the option required.

9. The current theoretical input and output values will then be saved to the data file.

10. Press the LOG button to store the actual values to the data file.

11. Should you change the hardware load to a new value and you wish to change the software inputs then adjust the hardware, press NEW, adjust the software inputs to be the same as the hardware, click the data file APPEND tick box and then press CALC.

12. You can then continue to create new inputs and obtain new outputs depending on how you set up the hardware and by following the procedure above.

DATA FILE CONTENTS

The data file created contains information that is useful in allowing the end user to further manipulate the data in a spreadsheet software.

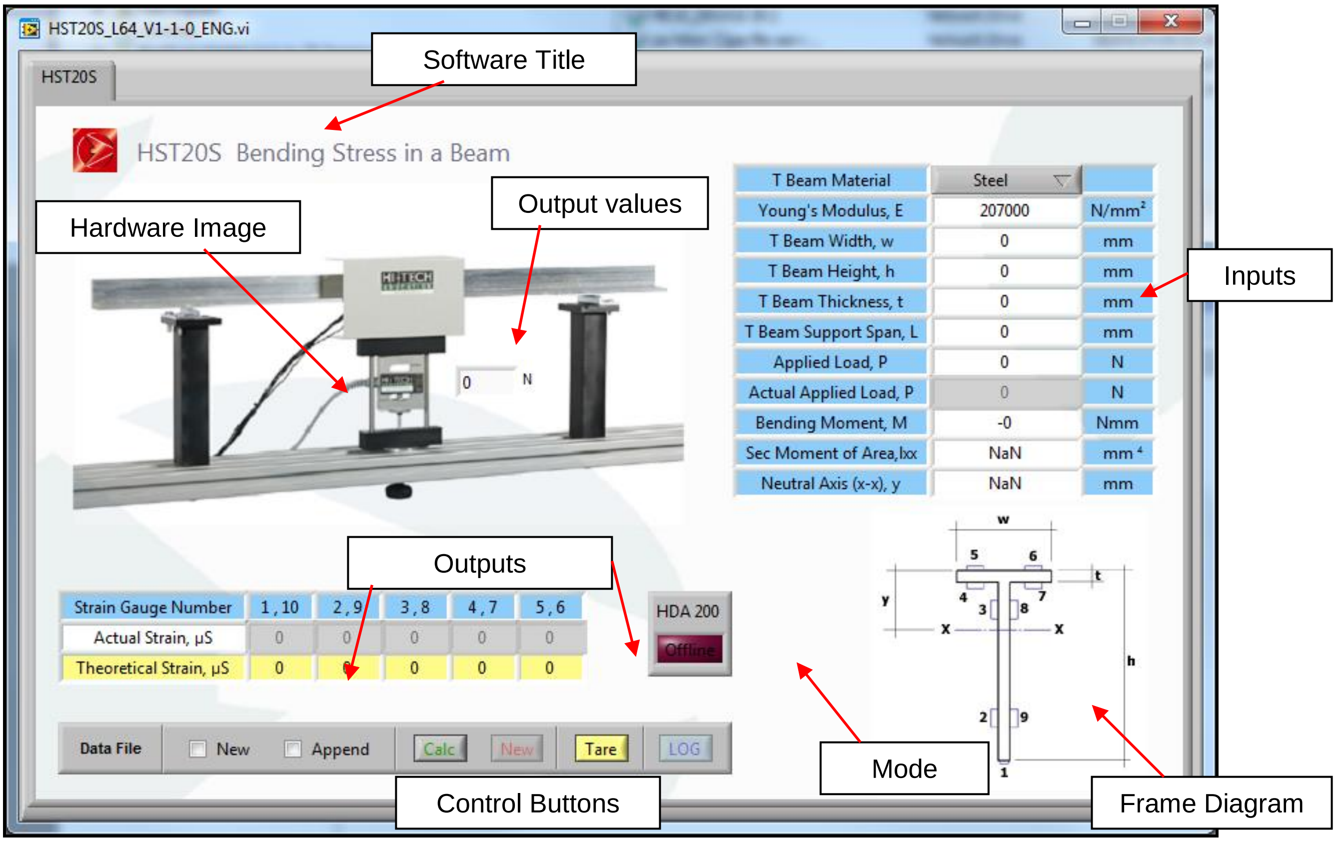
The image below shows the typical data at the start of the data file for this experiment when a new file has been created and the LOG button has been pressed:

```
TextFile - Notepad
File  Edit  Format  View  Help
15/08/2012      08:31:05
Roof    Truss
Young's Modulus, E      2500    N/mm2
Truss Member Width, w   10.00   mm
Truss Member Height, h  25.00   mm
Truss Member Area       250.00  mm2
Joint of Applied Load   L2
Applied Load, P 20.00   N
Reaction at Ra  6.67    N
Reaction at Rb  13.33   N
Joint   U1
Theoretical Joint Deflect       0.0525  mm
A       -13.33  µStrain
2       11.55   µStrain
B       0.00    µStrain
C       -13.33  µStrain
5       0.00    µStrain
1       11.55   µStrain
3       23.09   µStrain
E       -26.67  µStrain
F       0.00    µStrain
4       23.09   µStrain
G       -26.67  µStrain
Actual results
A       0.00    µStrain
2       0.00    µStrain
B       0.00    µStrain
C       -1.00   µStrain
5       0.00    µStrain
1       0.00    µStrain
3       0.00    µStrain
E       0.00    µStrain
F       0.00    µStrain
4       0.00    µStrain
G       0.00    µStrain
Actual Aplied Load, P   -21.20  N
Actual Joint Deflection 0.63    mm
Actual results
A       -1.00   µStrain
2       -2.00   µStrain
B       -2.00   µStrain
C       -2.00   µStrain
5       -2.00   µStrain
1       -2.00   µStrain
3       -2.00   µStrain
E       -2.00   µStrain
F       -2.00   µStrain
4       -3.00   µStrain
```

The information will then repeat itself depending on how many test points have been logged.

HST20S – BENDING STESS in a BEAM

SOFTWARE WINDOW



In either mode the details of what is presented in the software window is the same. These are highlighted in the above image and detailed as follows:

Hardware image: This is a true representation of the actual hardware thus ensuring consistency in viewing between software and hardware.

Software Title: The title and number of the software.

Mode: This highlights which mode the software is in, i.e. OFFLINE or ONLINE.

Inputs: These boxes allow the end user to input values for the specific parameters listed. The blue boxes on the left hand column show the description of the input and the right hand column blue boxes show the units for these parameters. The central column is where the value is input via the keyboard. It is possible to press the TAB button on the keyboard and the cursor will jump to the next parameter.

The inputs available are as follows:

- **T Beam Material:** Choose the specimen material. The Young's Modulus, E will change automatically depending on the material chosen.
- **Young's Modulus, E:** Depending on the material chosen above, will depend on what value is selected here. These values are defaults and cannot be changed.
- **T Beam width, w**: This is the T beam width in millimetres.
- **T Beam Height, h**: This is T beam height in millimetres.
- **T Beam thickness, t**: This is the T beam thickness in millimetres.
- **T Beam support span, L**: This is the T beam support span distance in millimetres..
- **Applied Load, F**: This is the value of the applied load being added to the T beam in Newton's.

Outputs: These are theoretical values and actual values from the hardware based on the input parameters chosen. This is where the end user can compare actual results with theoretical.

The outputs available are as follows:

- **Actual Applied Load, P:** This is the actual applied load from the hardware when running the hardware through the HDA200.
- **Bending Moment, M**: This is a calculated value based on the parameters input already.
- **Sec. Moment of Area, Ixx:** This is a calculated value and depends on the T beam geometry entered previously.
- **Neutral Axis:** This is a calculated based on the T beam geometry entered previously.
- **Actual Strain, με:** This is the actual strain from each strain gauge on the T beam.
- **Theoretical Strain, με:** This is the theoretical strain from each strain gauge on the T beam.

Control buttons: these buttons give the end user a choice of what to do with the software and the values presented on the screen. They are described in more detail as follows:

- **CALC**: When the inputs have been set, pressing this button will calculate the theoretical outputs.
- **NEW**: When this button is pressed it stops background processes and allows any of the inputs to be adjusted and then recalculated. You will have to wait a short time for the background processing to finish. When finished the CALC button becomes live and the NEW button becomes inactive.
- **TARE**: This button is only valid when running in ONLINE mode as when pressed it zeroes (tares) the values from the hardware which are being used in the software.
- **LOG**: When the end user wishes to record ACTUAL data from the software during ONLINE running, they can press this button and the key input and output parameters will then be logged into the data file.
- **Data File NEW:** This tick box is used when the end user wishes to store the input and output data to a brand new file on the host computer. When this is

ticked and the CALC button pressed you will be prompted to create a new data file. **You can only choose this option or append. You cannot choose both.**

- **<u>Data file APPEND:</u>** If a data file has already been created then ticking this box will allow data to be added to this file rather than having to create a new file.

<u>Frame Diagram:</u> This represents the T beam cross section, neutral axis (X-X) and the strain gauge positions.

<u>OPERATING THE SOFTWARE</u>

The following procedure outlines the steps required to operate the software and to obtain outputs for the inputs chosen. It is one of many variations that could be followed.

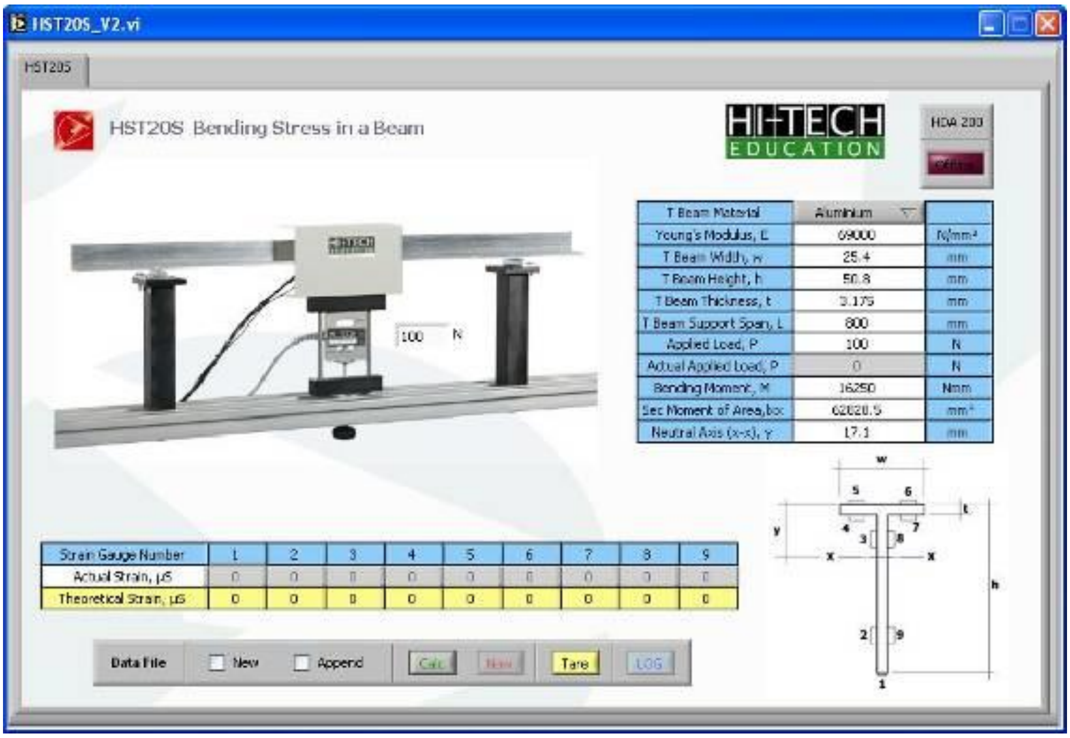
It assumes that the end user has set up the HDA200 (if necessary) and installed the software correctly and all inputs are being undertaken using the keyboard of the host computer.

<u>OFFLINE MODE</u>

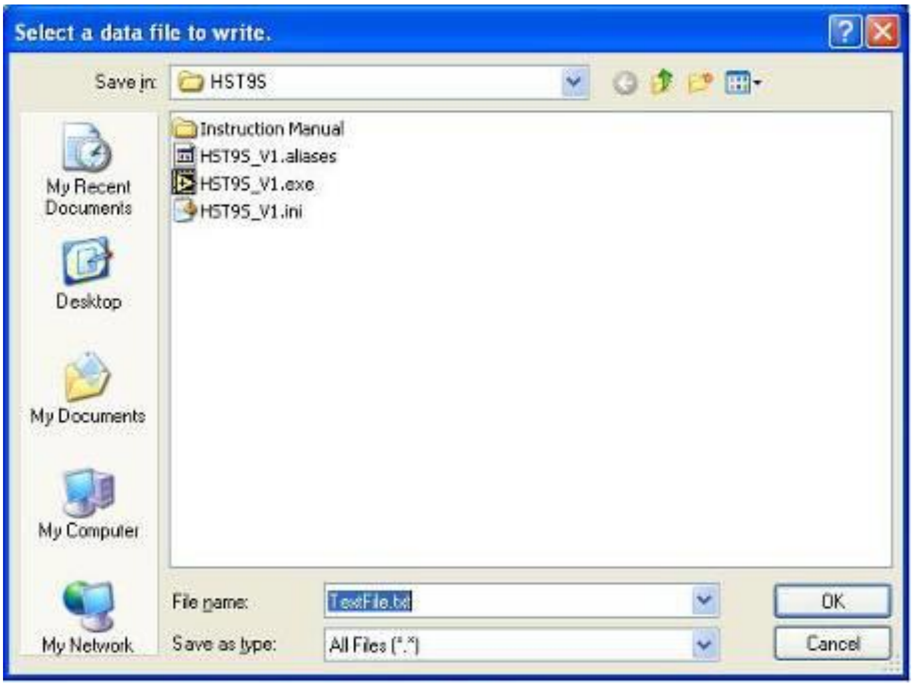
1. Load the experiment software by double clicking the **.exe** files supplied.
2. Choose 'NO' when the pop up window appears asking if the HDA200 is connected.
3. Choose the material from the drop down menu list.
4. Enter 25 in the width, b input box.
5. Enter 10 in the height, d input box.
6. Enter 10 in the Applied Force, F input box.
7. Press the CALC button with no data file tick boxes ticked. The screen should appear as follows:

T Beam Material	Aluminium	
Young's Modulus, E	69000	N/mm²
T Beam Width, w	25.4	mm
T Beam Height, h	50.8	mm
T Beam Thickness, t	3.175	mm
T Beam Support Span, L	800	mm
Applied Load, P	100	N
Actual Applied Load, P	0	N
Bending Moment, M	16250	Nmm
Sec Moment of Area,Ixx	62828.5	mm⁴
Neutral Axis (x-x), y	17.1	mm

8. The complete screen should look like the following image:

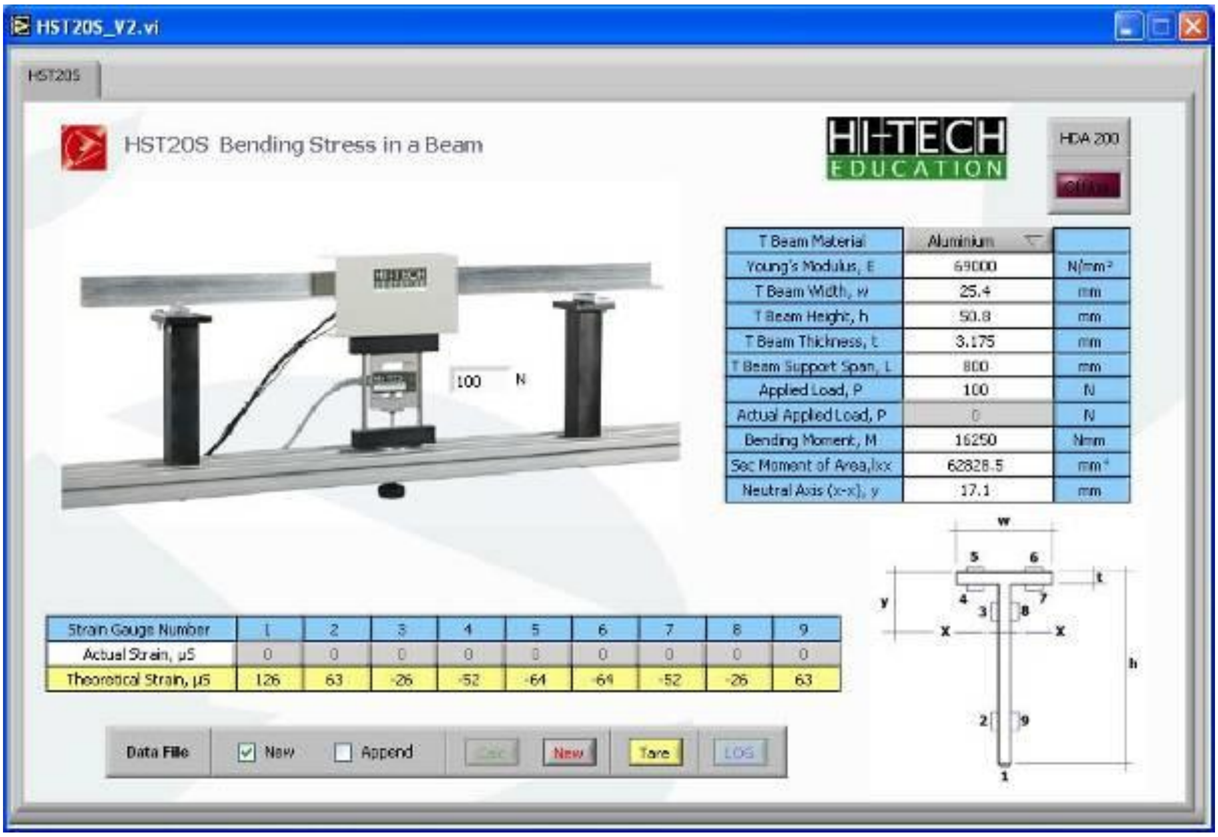


9. The applied force value will be shown in the small output value next to the load cell of the hardware image. Also note that the actual applied load and actual strain are greyed out. This is because you are in 'OFFLINE' mode.
10. Tick the Data File NEW box.
11. Press CALC.
12. You will then be shown the following window (the contents of this window will vary depending on the experiment running) and prompted to create a data file name in the location of your choice.



13. Either rename the default name of TextFile.txt or keep this default name. Its up to you. Ensure the file extension of ***.txt*** remains. Once the filename and location have been chosen then press **OK**.

14. The theoretical strains will now appear in the output table at the bottom of the screen as in the following image:



15. The input and output data will now be saved in the data file created. To prove this open the text file in ***NOTEPAD*** that you have just created from its location and check the contents. It should look similar to the image below.

```
HST20S_test file_1_3_10_pji_offline.txt - Notepad
File  Edit  Format  View  Help
01/03/2010       15:38:30
Modulus 69000    N/mm2
Width   25.40    mm
Height  50.80    mm
Thickness        3.175    mm
Support Span     800.00   mm
Applied Load     100.00   N
Bending Moment   16250.00         Nmm
Second Moment of Area    62828.52         mm4
Neutral Axis     17.1     mm
G1      126      µStrain
G2      63       µStrain
G3      -26      µStrain
G4      -52      µStrain
G5      -64      µStrain
G6      -64      µStrain
G7      -52      µStrain
G8      -26      µStrain
G9      63       µStrain
```

16. If you wish to change the inputs then simply press change the input parameter (change applied force to 20N from 10N), press the data file NEW button to clear it, press the data file APPEND button and then press CALC. You will be given the data file to append to, choose this and then press ok.

17. The data file should now have the new data saved into it and look like the following:

```
HST20S_test file_1_3_10_pji_offline.txt - Notepad
File  Edit  Format  View  Help
01/03/2010       15:38:30
Modulus 69000    N/mm2
Width   25.40    mm
Height  50.80    mm
Thickness        3.175    mm
Support Span     800.00   mm
Applied Load     100.00   N
Bending Moment   16250.00         Nmm
Second Moment of Area    62828.52         mm4
Neutral Axis     17.1     mm
G1      126      µStrain
G2      63       µStrain
G3      -26      µStrain
G4      -52      µStrain
G5      -64      µStrain
G6      -64      µStrain
G7      -52      µStrain
G8      -26      µStrain
G9      63       µStrain
01/03/2010       15:47:28
Modulus 69000    N/mm2
Width   25.40    mm
Height  50.80    mm
Thickness        3.175    mm
Support Span     800.00   mm
Applied Load     200.00   N
Bending Moment   32500.00         Nmm
Second Moment of Area    62828.52         mm4
Neutral Axis     17.1     mm
G1      252      µStrain
G2      126      µStrain
G3      -52      µStrain
G4      -105     µStrain
G5      -128     µStrain
G6      -128     µStrain
G7      -105     µStrain
G8      -52      µStrain
G9      126      µStrain
```

18. In the OFFLINE mode the TARE button although live will not perform any function. The LOG button will not be live and greyed out but the data can still be stored by the use of the CALC button.

19. When finished with the software shut the software down.

20. You can continue to adjust the inputs and see what outputs are obtained by following the same process above.

HDA200 CHANNEL SETTINGS and CONNECTIONS

Prior to running this experiment software in ONLINE mode with the HDA200 you will have to make sure that the correct experiment hardware sensors/transducers are connected to the HDA200 and the correct channels are being displayed by the HDA200. Refer to the HDA200 instruction manual and use the following table as a reference also:

Sensor/Transducer	HDA200 Connector Number	HDA200 Channel number	
Strain Gauge 1	Strain 01	01	
Strain Gauge 2	Strain 02	02	
Strain Gauge 3	Strain 03	03	
Strain Gauge 4	Strain 04	04	
Strain Gauge 5	Strain 05	05	
Strain Gauge 6	Strain 06	06	
Strain Gauge 7	Strain 07	07	
Strain Gauge 8	Strain 08	08	
Strain Gauge 9	Strain 09	09	
Force	Force 1	17	

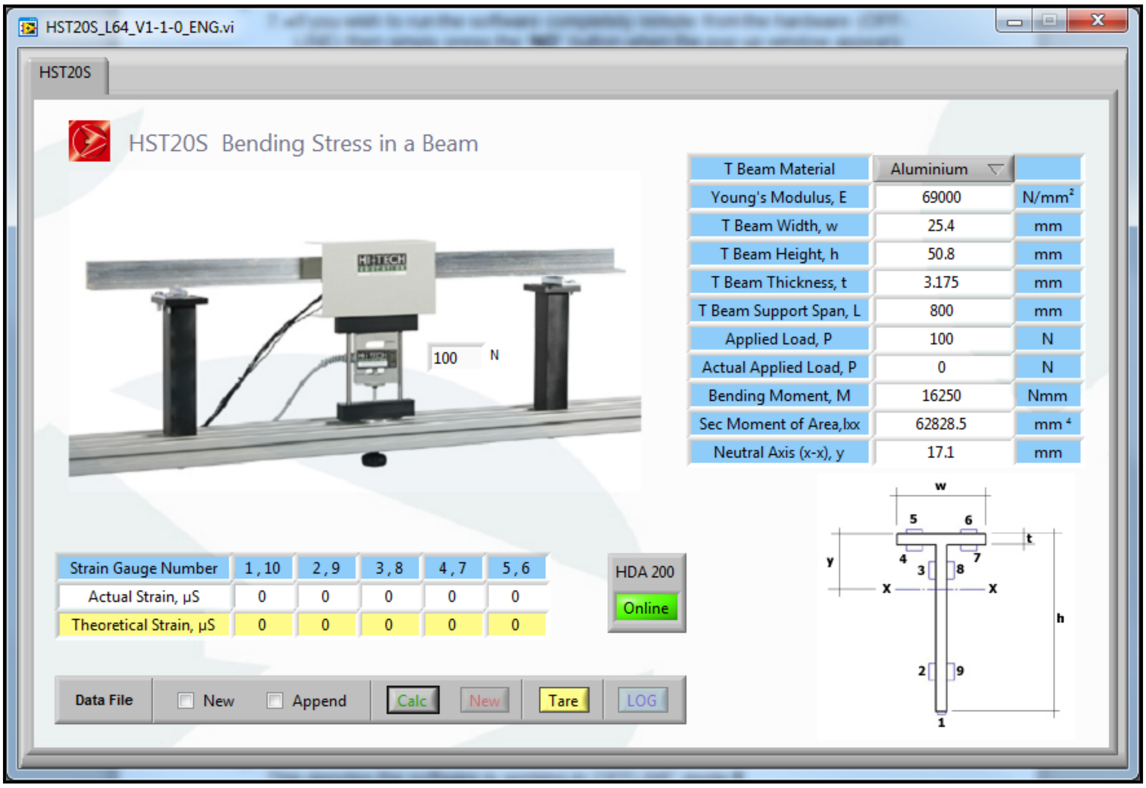
Run the HDA200 in LOCAL mode to check that the above channels only are being displayed. This will then ensure that the software collects the right data from the right channels.

NB: If the dial gauges (if used) are connected but not turned on then the software and HDA200 will not display the dial gauge values and the software and HDA200 screens will wait until they are turned on. Ensure the dial gauges are turned on when running the experiment and software.

If the above channels are not set correctly then you will have to enter the configuration of the HDA200 which will require reading and following the HDA200 instruction manual.

ONLINE MODE

1. Repeat the input parameters from the OFFLINE mode procedure above, press the CALC button and the software window should look similar to the image below but not exact (example only):



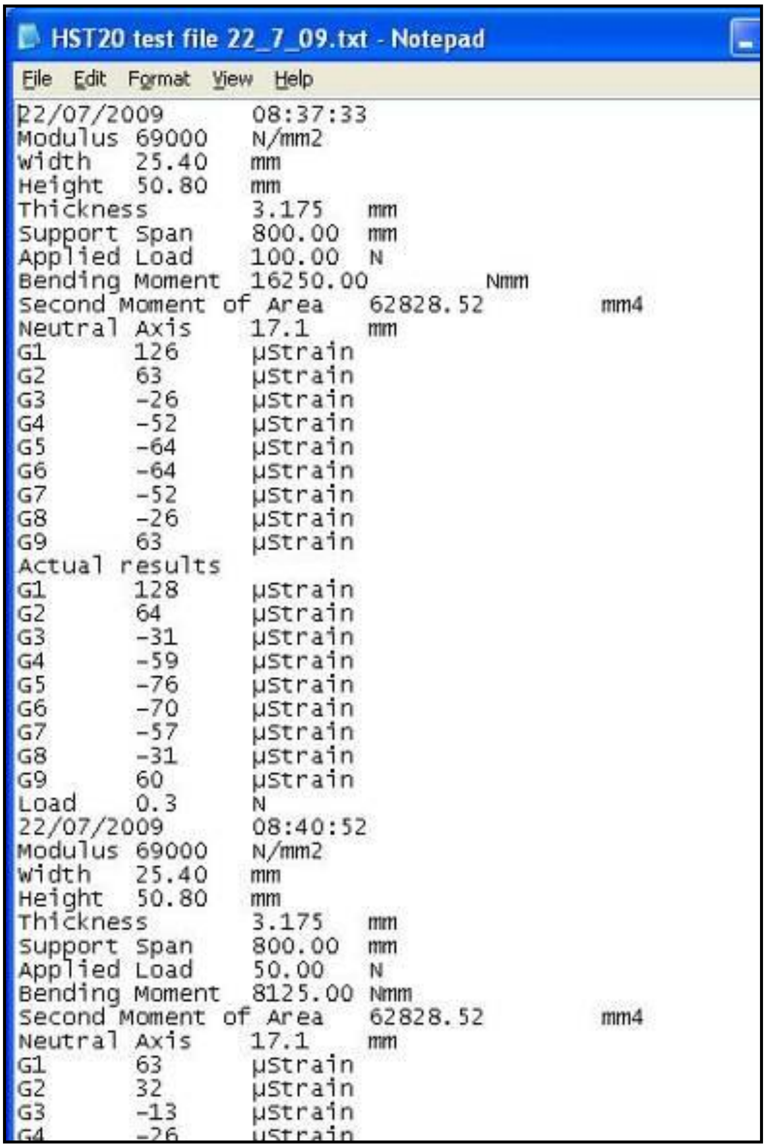
2. In 'ONLINE' mode you will notice that the Actual applied force and actual strains are no longer greyed out. These values will now start to change as they come in from the HDA200.
3. These values will not be zero. To zero this reading simply press the TARE button. You may have to press it again if the reading does not return to zero.
4. Load the hardware experiment to the same parameters as the input boxes. You should then be able to compare the actual values with theoretical values.
5. If you wish to save the data into a NEW or existing data file then press NEW to stop the software capturing data from the HDA200.
6. Tick the data file option required.
7. Press the CALC button and you will be prompted to create a new data file or append to the existing file. Choose the option required.
8. The current theoretical input and output values will then be saved to the data file.
9. Press the LOG button to store the actual values to the data file.
10. Should you change the hardware load to a new value and you wish to change the software inputs then adjust the hardware, press NEW, adjust the software inputs to be the same as the hardware, click the data file APPEND tick box and then press CALC.
11. You can then continue to create new inputs and obtain new outputs depending on how you set up the hardware and by following the procedure above.

DATA FILE CONTENTS

The data file created contains information that is useful in allowing the end user to further manipulate the data in a spreadsheet software.

The image below shows the typical data at the start of the data file for this experiment when a new file has been created and the LOG button has been pressed:

The data is as follows:



HST20 test file 22_7_09.txt - Notepad

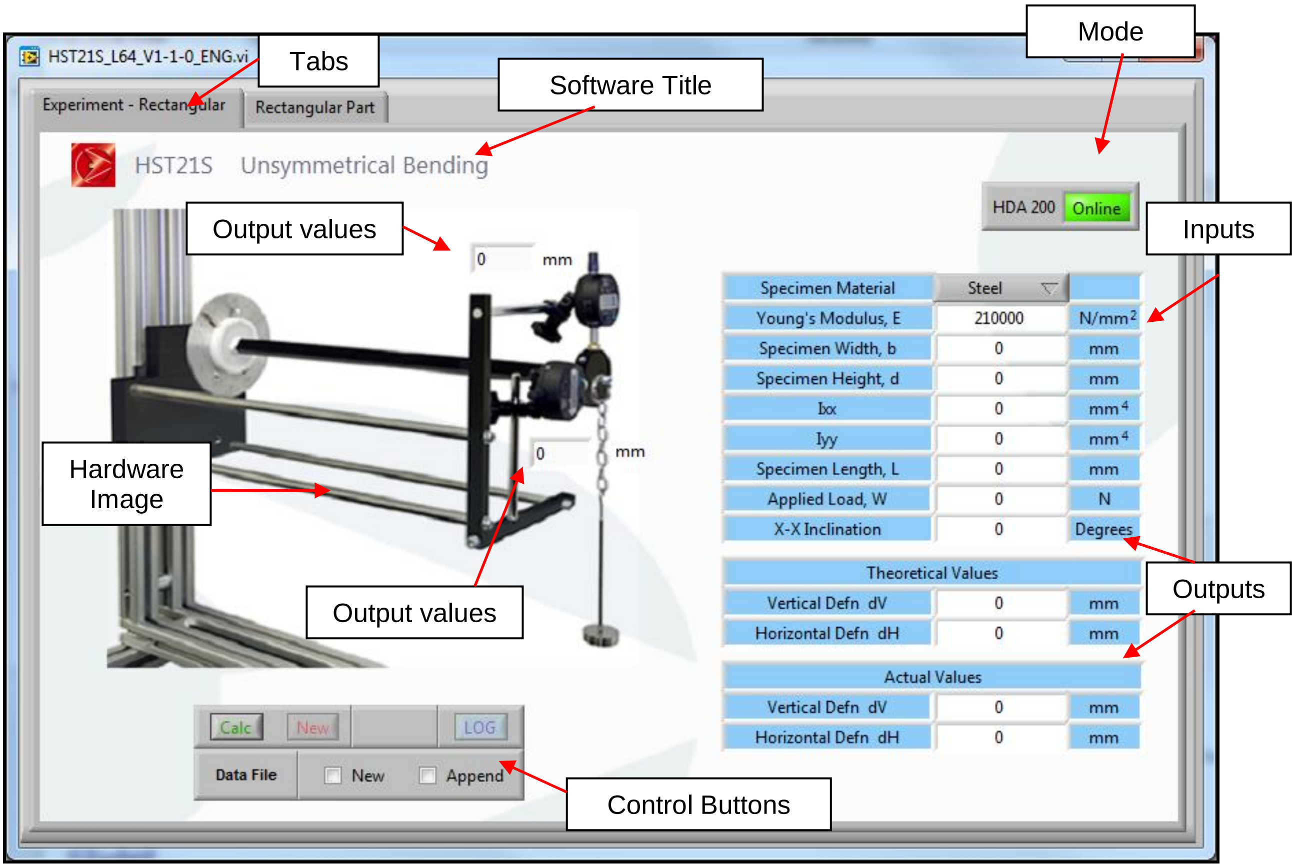
File Edit Format View Help

```
22/07/2009      08:37:33
Modulus 69000   N/mm2
Width   25.40   mm
Height  50.80   mm
Thickness       3.175   mm
Support Span    800.00  mm
Applied Load    100.00  N
Bending Moment  16250.00        Nmm
Second Moment of Area   62828.52        mm4
Neutral Axis    17.1    mm
G1      126     µStrain
G2      63      µStrain
G3      -26     µStrain
G4      -52     µStrain
G5      -64     µStrain
G6      -64     µStrain
G7      -52     µStrain
G8      -26     µStrain
G9      63      µStrain
Actual results
G1      128     µStrain
G2      64      µStrain
G3      -31     µStrain
G4      -59     µStrain
G5      -76     µStrain
G6      -70     µStrain
G7      -57     µStrain
G8      -31     µStrain
G9      60      µStrain
Load    0.3     N
22/07/2009      08:40:52
Modulus 69000   N/mm2
Width   25.40   mm
Height  50.80   mm
Thickness       3.175   mm
Support Span    800.00  mm
Applied Load    50.00   N
Bending Moment  8125.00 Nmm
Second Moment of Area   62828.52        mm4
Neutral Axis    17.1    mm
G1      63      µStrain
G2      32      µStrain
G3      -13     µStrain
G4      -26     µStrain
```

The information will then repeat itself depending on how many test points have been logged.

HST21S – UNSYMMETRICAL BENDING

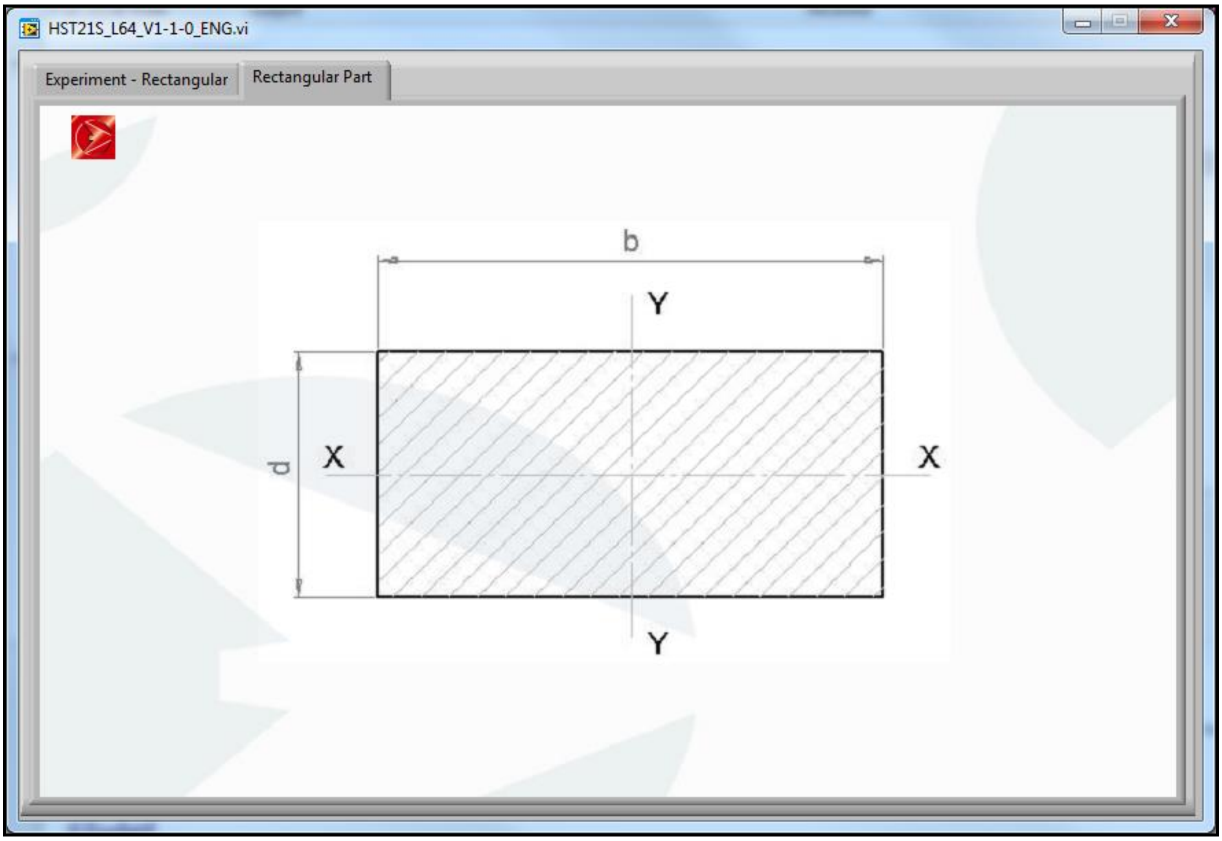
SOFTWARE WINDOW



In either mode the details of what is presented in the software window is the same. These are highlighted in the above image and detailed as follows:

Hardware image: This is a true representation of the actual hardware thus ensuring consistency in viewing between software and hardware.

Tabs: This software allows the rectangular specimen only to be presented. The experiment tab is where the main software is shown. The Rectangular tab shows the actual cross section of the specimen and the dimensions that are being reference in the main software screen. The following image shows the image on this tab.



Software Title: The title and number of the software.

Mode: This highlights which mode the software is in, i.e. OFFLINE or ONLINE.

Inputs: These boxes allow the end user to input values for the specific parameters listed. The blue boxes on the left hand column show the description of the input and the right hand column blue boxes show the units for these parameters. The central column is where the value is input via the keyboard. It is possible to press the TAB button on the keyboard and the cursor will jump to the next parameter.

The inputs available are as follows:

- **Specimen Material:** Choose the specimen material desired.
- **Young's Modulus, E:** When the material is chosen the E value is chosen automatically.
- **Specimen Width, b**: Enter the specimen width in millimetres. Refer to the rectangular tab for further details.
- **Ixx**: This value of second moment of area about the X-X axis is calculated automatically using the parameters entered. Refer to the rectangular tab for further details.

- **Iyy**: This value of second moment of area about the Y-Y axis is calculated automatically using the parameters entered. Refer to the rectangular tab for further details.
- **Specimen Length**: Enter the length of the specimen that protrudes from the back plate of the hardware to the point of loading.
- **Applied Load, W**: Enter the value of the applied load in Netwon's.
- **X-X inclination**: Enter the angular inclination of the X-X axis. This is referenced from the horizontal plane, which is zero (0) degrees. Positive angles from this plane are in the clockwise direction.

Outputs: These are theoretical values and actual values from the hardware based on the input parameters chosen. This is where the end user can compare actual results with theoretical.

The outputs available are as follows:

- **Vertical Defn, dV:** This the theoretical value of the vertical deflection of the free end of the specimen under the applied load and with the cross section details entered earlier.
- **Horizontal Defn, dH:** This the theoretical value of the horizontal deflection of the free end of the specimen under the applied load and with the cross section details entered earlier.
- **Vertical Defn, dV:** This the actual value of the vertical deflection of the free end of the specimen under the applied load and with the cross section details entered earlier. This value comes from the dial gauge on the apparatus.
- **Horizontal Defn, dH:** This the actual value of the horizontal deflection of the free end of the specimen under the applied load and with the cross section details entered earlier. This value comes from the dial gauge on the apparatus.

Control buttons: these buttons give the end user a choice of what to do with the software and the values presented on the screen. They are described in more detail as follows:

- **CALC**: When the inputs have been set, pressing this button will calculate the theoretical outputs.
- **NEW**: When this button is pressed it stops background processes and allows any of the inputs to be adjusted and then recalculated. You will have to wait a short time for the background processing to finish. When finished the CALC button becomes live and the NEW button becomes inactive.
- **LOG**: When the end user wishes to record ACTUAL data from the software during ONLINE running, they can press this button and the key input and output parameters will then be logged into the data file.
- **Data File NEW:** This tick box is used when the end user wishes to store the input and output data to a brand new file on the host computer. When this is ticked and the CALC button pressed you will be prompted to create a new data file. **You can only choose this button or the append button, not both.**
- **Data file APPEND:** If a data file has already been created then ticking this box will allow data to be added to this file rather than having to create a new file.

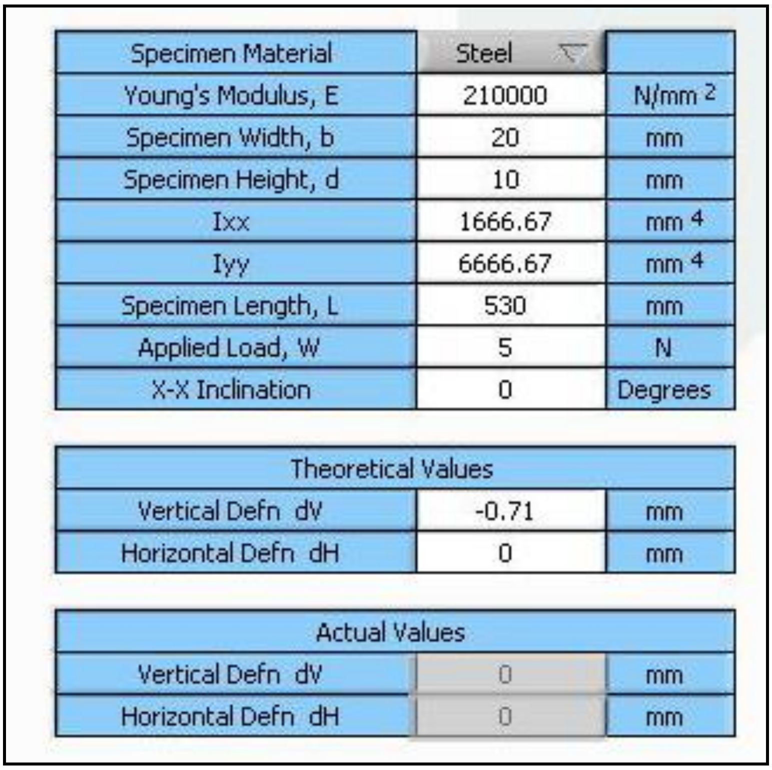
OPERATING THE SOFTWARE

The following procedure outlines the steps required to operate the software and to obtain outputs for the inputs chosen. It is one of many variations that could be followed.

It assumes that the end user has set up the HDA200 (if necessary) and installed the software correctly and all inputs are being undertaken using the keyboard of the host computer.

OFFLINE MODE

1. Load the experiment software by double clicking the **.exe** files supplied.
2. Choose ‘NO’ when the pop up window appears asking if the HDA200 is connected.
3. Select the specimen material. The E value will change automatically.
4. Enter 20 in the specimen width, b input box.
5. Enter 10 in the specimen height, d input box.
6. The Ixx and Iyy values will be calculated automatically when the CAL button is pressed.
7. Enter 530 in the specimen length, L input box.
8. Leave the value as zero (0) in the X-X inclination input box.
9. Press the CALC button with no data file tick boxes ticked. The screen should appear as follows:

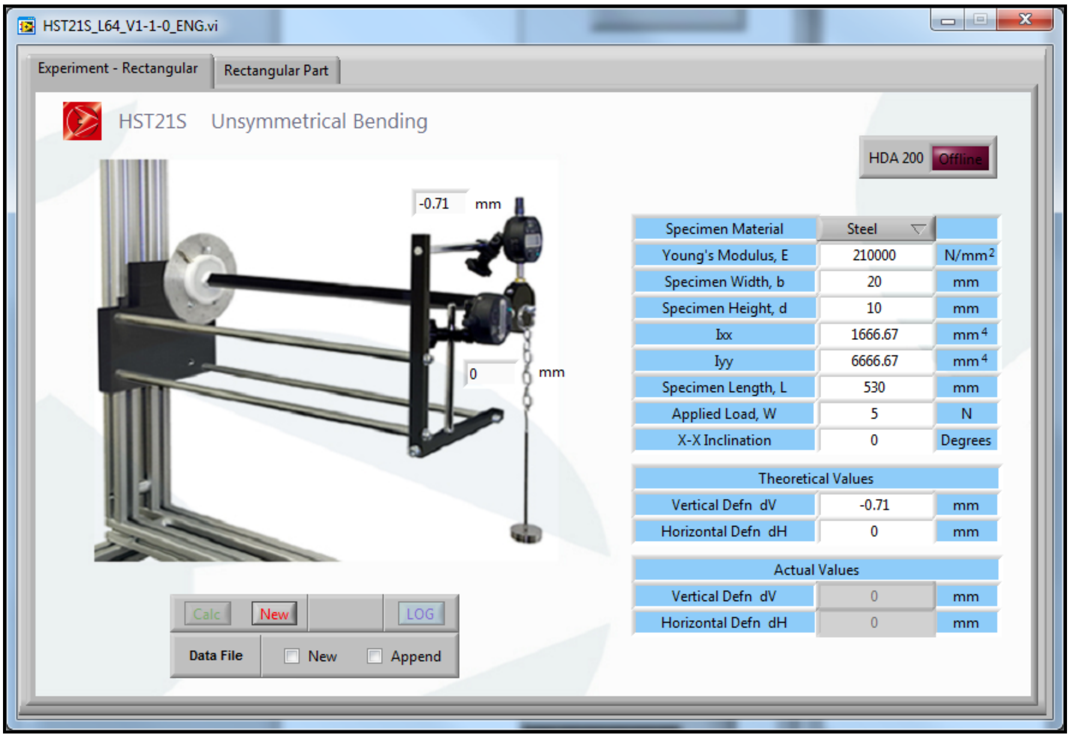


Specimen Material	Steel	
Young's Modulus, E	210000	N/mm 2
Specimen Width, b	20	mm
Specimen Height, d	10	mm
Ixx	1666.67	mm 4
Iyy	6666.67	mm 4
Specimen Length, L	530	mm
Applied Load, W	5	N
X-X Inclination	0	Degrees

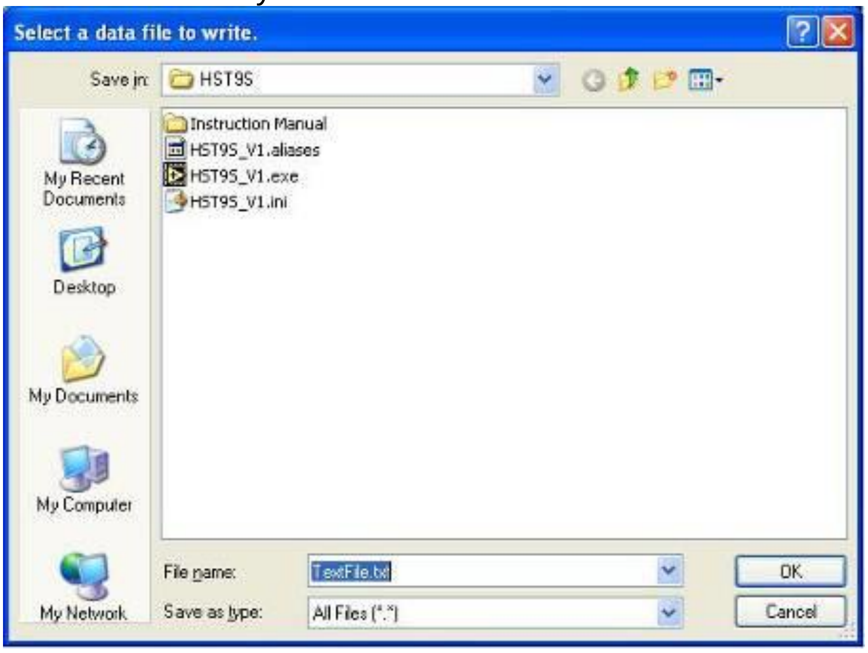
Theoretical Values		
Vertical Defn dV	-0.71	mm
Horizontal Defn dH	0	mm

Actual Values		
Vertical Defn dV	0	mm
Horizontal Defn dH	0	mm

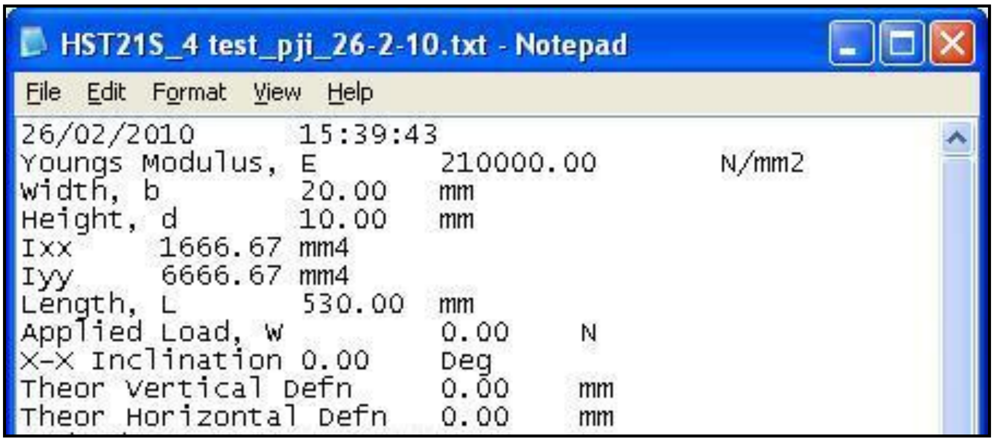
10. The complete screen should look like the following image:



11. The theoretical vertical and horizontal deflection for the specimen geometry input will be shown in the first output box. These values will also be shown on the hardware image. Also note that the actual vertical and horizontal deflection values are greyed out. This is because you are in 'OFFLINE' mode.
12. Press the NEW button
13. Tick the Data File NEW box.
14. Press CALC.
15. You will then be shown the following window (the contents of this window will vary depending on the experiment running) and prompted to create a data file name in the location of your choice.



16. Either rename the default name of TextFile.txt or keep this default name. Its up to you. Ensure the file extension of ***.txt*** remains. Once the filename and location have been chosen then press **OK**.
17. The input and output data will now be saved in the data file created. To prove this open the text file in ***NOTEPAD*** that you have just created from its location and check the contents. It should look similar to the image below.



```
HST21S_4 test_pji_26-2-10.txt - Notepad
File Edit Format View Help
26/02/2010      15:39:43
Youngs Modulus, E       210000.00       N/mm2
Width, b        20.00   mm
Height, d       10.00   mm
Ixx     1666.67 mm4
Iyy     6666.67 mm4
Length, L       530.00  mm
Applied Load, W         0.00    N
X-X Inclination 0.00    Deg
Theor Vertical Defn     0.00    mm
Theor Horizontal Defn   0.00    mm
```

18. If you wish to change the inputs then simply press the NEW button, change the input parameter, press the data file APPEND button and then press CALC. You will be given the data file to append to, choose this and then press ok.
19. The data file should now have the new data saved into it, AND added (appended) to the existing data.
20. In the OFFLINE mode the LOG button will be greyed out.
21. When finished with the software shut the software down.
22. You can continue to adjust the inputs and see what outputs are obtained by following the same process above.

HDA200 CHANNEL SETTINGS and CONNECTIONS

Prior to running this experiment software in ONLINE mode with the HDA200 you will have to make sure that the correct experiment hardware sensors/transducers are connected to the HDA200 and the correct channels are being displayed by the HDA200. Refer to the HDA200 instruction manual and use the following table as a reference also:

Sensor/Transducer	HDA200 Connector Number	HDA200 Channel number	Resolution
Horizontal Dial Gauge	Dial gauge 1	28	0.01mm
Vertical Dial Gauge	Dial gauge 2	29	0.01mm

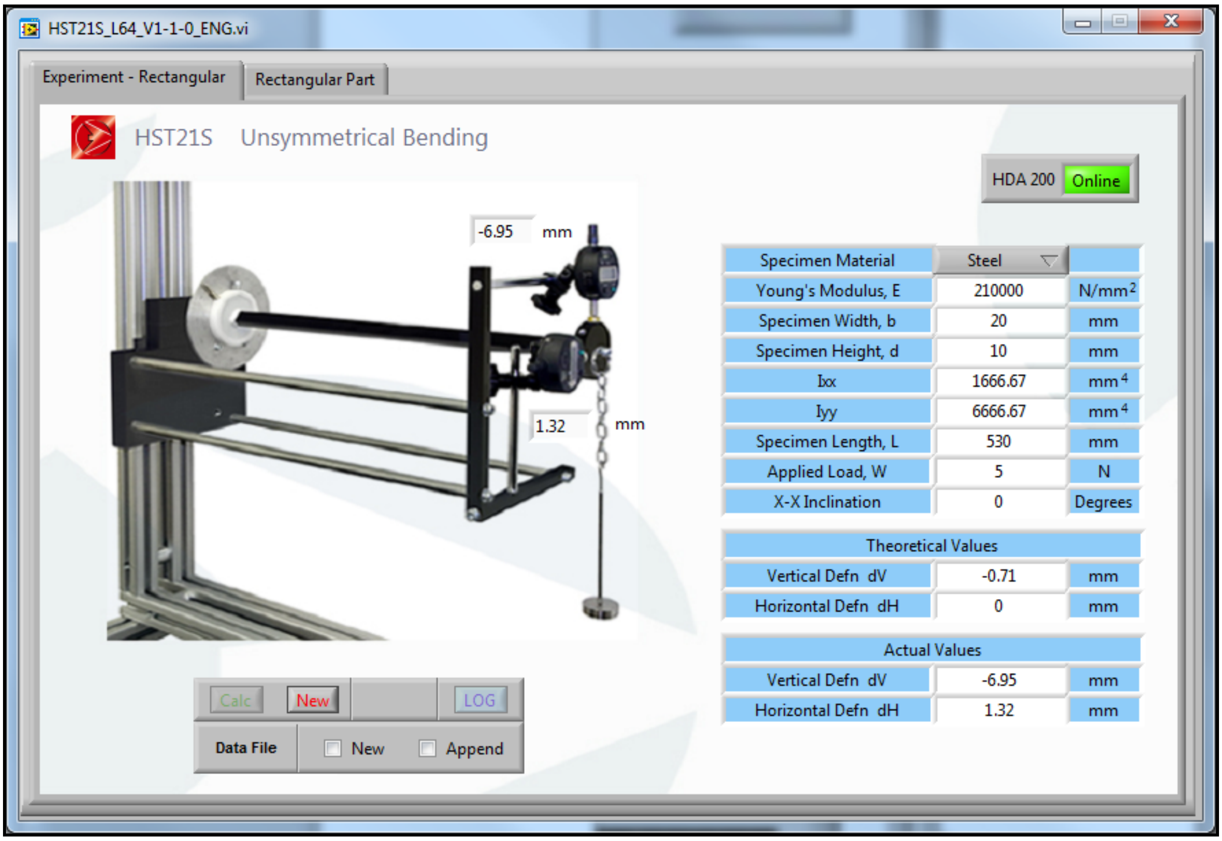
Run the HDA200 in LOCAL mode to check that the above channels only are being displayed. This will then ensure that the software collects the right data from the right channels.

NB: If the dial gauges (if used) are connected but not turned on then the software and HDA200 will not display the dial gauge values and the software and HDA200 screens will wait until they are turned on. Ensure the dial gauges are turned on when running the experiment and software.

If the above channels are not set correctly then you will have to enter the configuration of the HDA200 which will require reading and following the HDA200 instruction manual.

ONLINE MODE

1. Repeat the input parameters from the OFFLINE mode procedure above, press the CALC button and the software window should look like the image below:



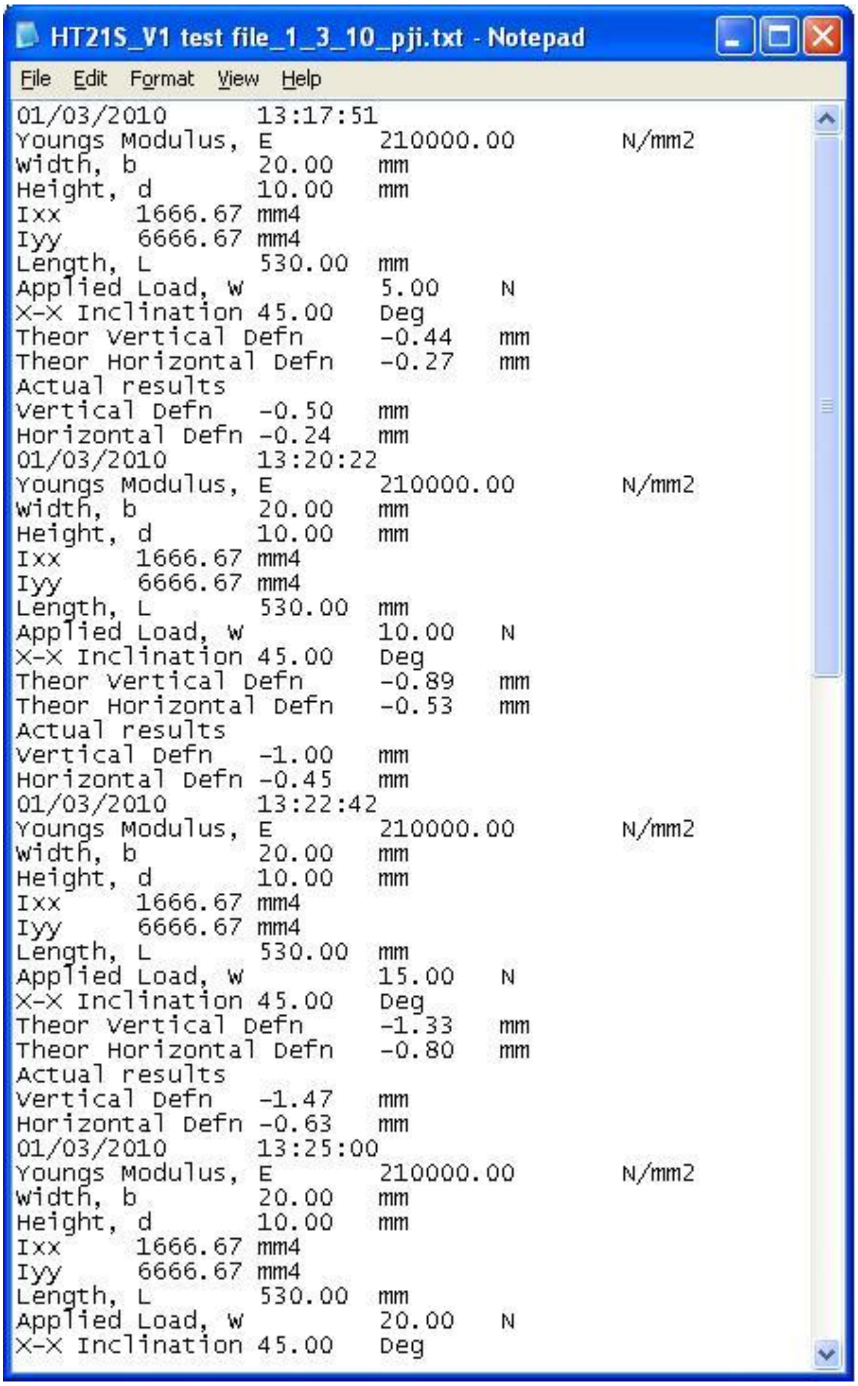
2. In 'ONLINE' mode you will notice that the actual vertical and horizontal deflection values are no longer greyed out. These values will now start to change as they come in from the HDA200.
3. Load the hardware experiment to the same parameters as the input boxes. You should then be able to compare the actual values with theoretical values.
4. If you wish to save the data into a NEW or existing data file then press NEW to stop the software capturing data from the HDA200.
5. Tick the data file option required.
6. Press the CALC button and you will be prompted to create a new data file or append to the existing file. Choose the option required.
7. The input parameters will then be saved to the data file.
8. Press the LOG button to store the actual values to the data file.
9. Should you change the hardware load to a new value and you wish to change the software inputs then adjust the hardware, press NEW, adjust the software inputs to be the same as the hardware, click the data file APPEND tick box and then press CALC.
10. You can then continue to create new inputs and obtain new outputs depending on how you set up the hardware and by following the procedure above.
11. The graph will be drawn automatically at each load position point, but you must follow the load position points in turn otherwise the graph will appear incorrect and the actual shear centre will not be correct.

DATA FILE CONTENTS

The data file created contains information that is useful in allowing the end user to further manipulate the data in a spreadsheet software.

The image below shows the typical data at the start of the data file for this experiment when a new file has been created and the LOG button has been pressed:

The data is as follows:


HT21S_V1 test file_1_3_10_pji.txt - Notepad

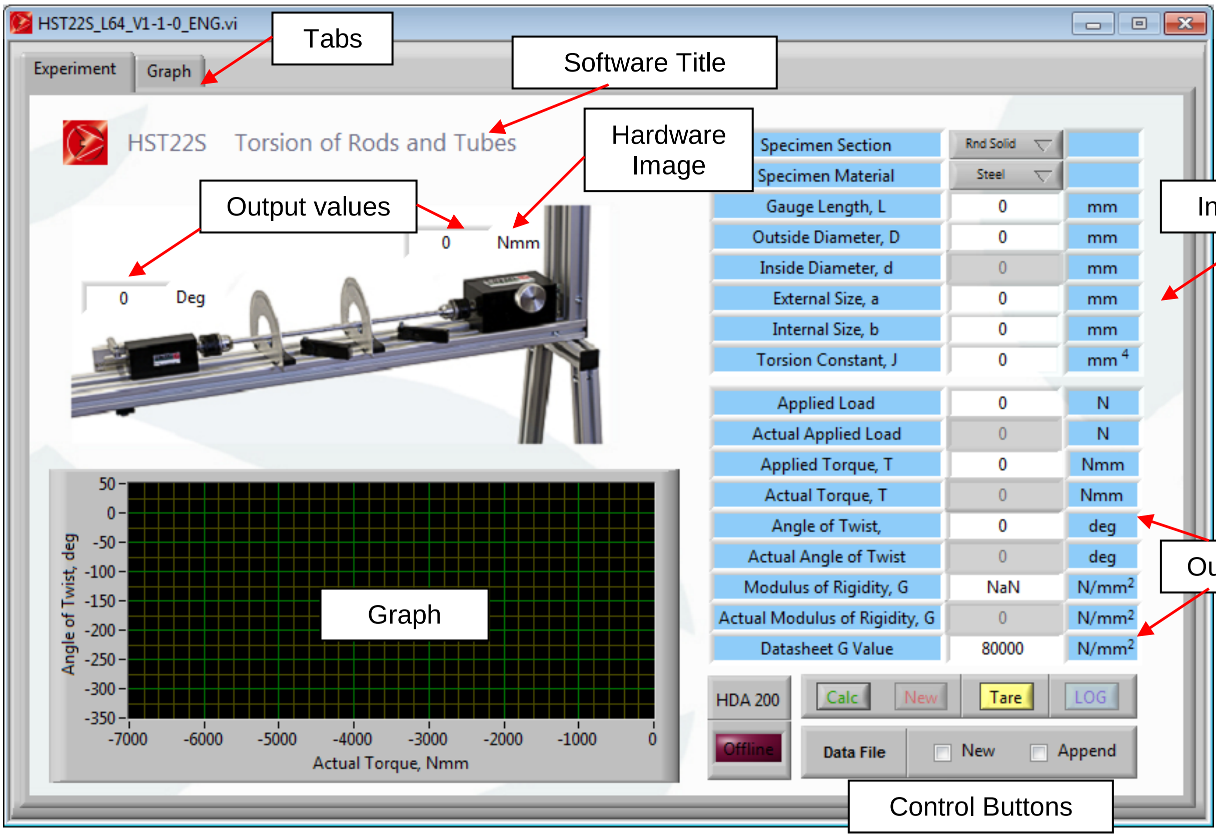
File Edit Format View Help

```
01/03/2010      13:17:51
Youngs Modulus, E       210000.00       N/mm2
Width, b        20.00   mm
Height, d       10.00   mm
Ixx     1666.67 mm4
Iyy     6666.67 mm4
Length, L       530.00  mm
Applied Load, W         5.00    N
X-X Inclination 45.00   Deg
Theor Vertical Defn     -0.44   mm
Theor Horizontal Defn   -0.27   mm
Actual results
Vertical Defn   -0.50   mm
Horizontal Defn -0.24   mm
01/03/2010      13:20:22
Youngs Modulus, E       210000.00       N/mm2
Width, b        20.00   mm
Height, d       10.00   mm
Ixx     1666.67 mm4
Iyy     6666.67 mm4
Length, L       530.00  mm
Applied Load, W         10.00   N
X-X Inclination 45.00   Deg
Theor Vertical Defn     -0.89   mm
Theor Horizontal Defn   -0.53   mm
Actual results
Vertical Defn   -1.00   mm
Horizontal Defn -0.45   mm
01/03/2010      13:22:42
Youngs Modulus, E       210000.00       N/mm2
Width, b        20.00   mm
Height, d       10.00   mm
Ixx     1666.67 mm4
Iyy     6666.67 mm4
Length, L       530.00  mm
Applied Load, W         15.00   N
X-X Inclination 45.00   Deg
Theor Vertical Defn     -1.33   mm
Theor Horizontal Defn   -0.80   mm
Actual results
Vertical Defn   -1.47   mm
Horizontal Defn -0.63   mm
01/03/2010      13:25:00
Youngs Modulus, E       210000.00       N/mm2
Width, b        20.00   mm
Height, d       10.00   mm
Ixx     1666.67 mm4
Iyy     6666.67 mm4
Length, L       530.00  mm
Applied Load, W         20.00   N
X-X Inclination 45.00   Deg
```

The information will then repeat itself depending on how many test points have been logged.

HST22S – TORSION of RODS & TUBES

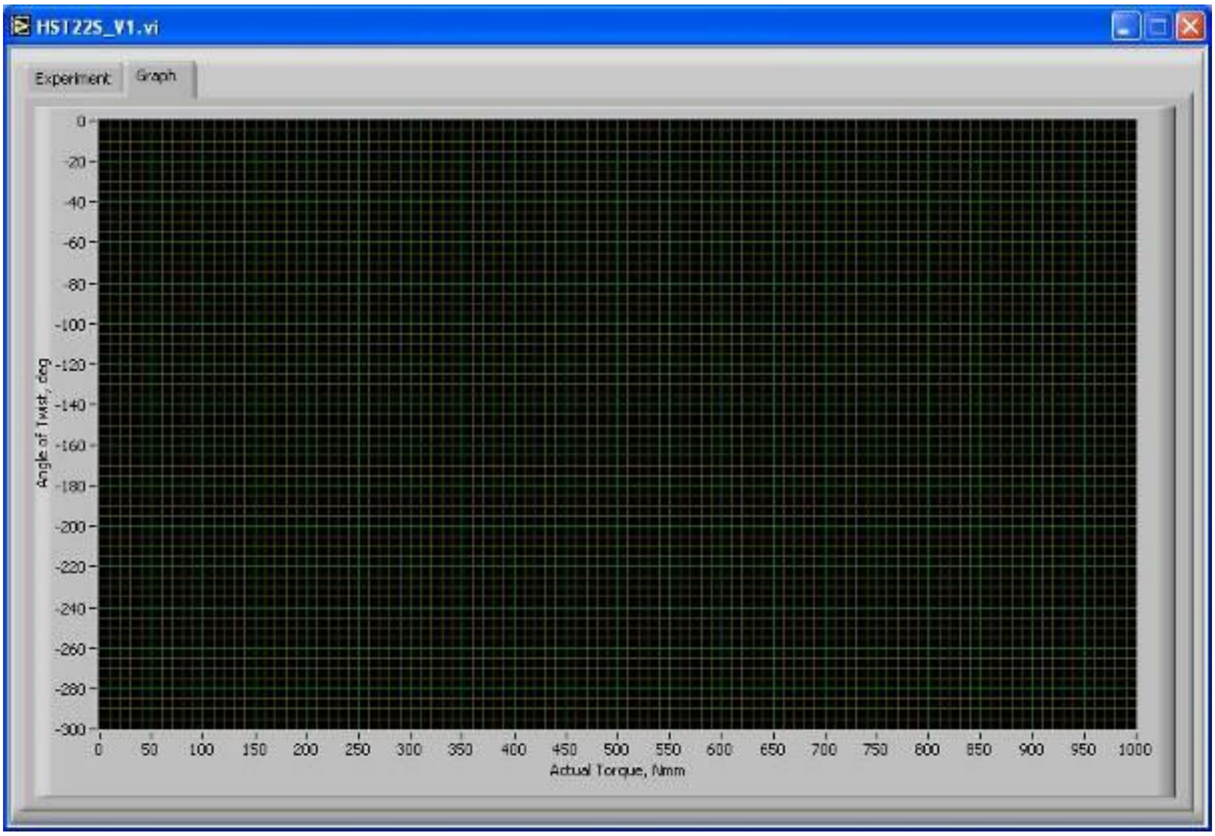
SOFTWARE WINDOW



In either mode the details of what is presented in the software window is the same. These are highlighted in the above image and detailed as follows:

Hardware image: This is a true representation of the actual hardware thus ensuring consistency in viewing between software and hardware.

Tabs: The tabs at the top allow the main software screen to be shown and also a larger version of the graph. The following image shows the graph on this tab.



Software Title: The title and number of the software.

Mode: This highlights which mode the software is in, i.e. OFFLINE or ONLINE.

Inputs: These boxes allow the end user to input values for the specific parameters listed. The blue boxes on the left hand column show the description of the input and the right hand column blue boxes show the units for these parameters. The central column is where the value is input via the keyboard. It is possible to press the TAB button on the keyboard and the cursor will jump to the next parameter.

The inputs available are as follows:

- **Specimen section:** Choose the specimen section. This ranges from round solid, round hollow and square hollow.
- **Specimen Material:** Choose the specimen material desired.
- **Gauge Length, L:** Choose the gauge length over which the angle of twist is to be measured.
- **Outside diameter, D**: Enter the specimen outside diameter in millimetres.
- **Inside diameter, d**: Enter the specimen inside diameter in millimetres. This is only available for the round hollow section. If this is not chosen then this input will remain greyed out and not selectable.
- **External Size, a:** This is used for the square hollow section only. This is the length of one side of the outside length of the square hollow section in millimetres.

- **Internal Size, b:** This is used for the square hollow section only. This is the length of one of the inside faces of the square hollow section in millimetres.
- **Torsion Constant, J**: Depending on the specimen section chosen this value will change. It also takes into consideration the geometry of the specimen given.
- **Applied Load**: Enter the value of the applied load in Netwon's.

Outputs: These are theoretical values and actual values from the hardware based on the input parameters chosen. This is where the end user can compare actual results with theoretical.

The outputs available are as follows:

- **Actual Applied Load:** This the actual applied load from the force channel being used by the HDA200 which will have the load cell form the hardware attached.
- **Applied Torque, T:** This the calculated applied torque which uses the applied load value above.
- **Actual Torque, T:** This the actual applied torque value which used the actual applied load value from above.
- **Angle of Twist:** This is a theoretical value to be entered by the end user when running in offline mode. It is also the value that can be obtained from running the hardware experiment with the analogue protractors.
- **Actual Angle of Twist:** This is the actual angle of twist that comes from the hardware via the HDA200 Interface.
- **Modulus of Rigidity, G:** This is a theoretical calculated value.
- **Actual Modulus of Rigidity, G:** This is an actual value which uses the values entered above.
- **Datasheet G value:** Based on the material chosen this value will change accordingly. It is based on datasheet values for materials supplied with the standard hardware.

Control buttons: these buttons give the end user a choice of what to do with the software and the values presented on the screen. They are described in more detail as follows:

- **CALC**: When the inputs have been set, pressing this button will calculate the theoretical outputs.
- **NEW**: When this button is pressed it stops background processes and allows any of the inputs to be adjusted and then recalculated. You will have to wait a short time for the background processing to finish. When finished the CALC button becomes live and the NEW button becomes inactive.
- **LOG**: When the end user wishes to record ACTUAL data from the software during ONLINE running, they can press this button and the key input and output parameters will then be logged into the data file.
- **Data File NEW:** This tick box is used when the end user wishes to store the input and output data to a brand new file on the host computer. When this is ticked and the CALC button pressed you will be prompted to create a new data file. **You can only choose this button or the append button, not both.**
- **Data file APPEND:** If a data file has already been created then ticking this box will allow data to be added to this file rather than having to create a new file.

OPERATING THE SOFTWARE

The following procedure outlines the steps required to operate the software and to obtain outputs for the inputs chosen. It is one of many variations that could be followed.

It assumes that the end user has set up the HDA200 (if necessary) and installed the software correctly and all inputs are being undertaken using the keyboard of the host computer.

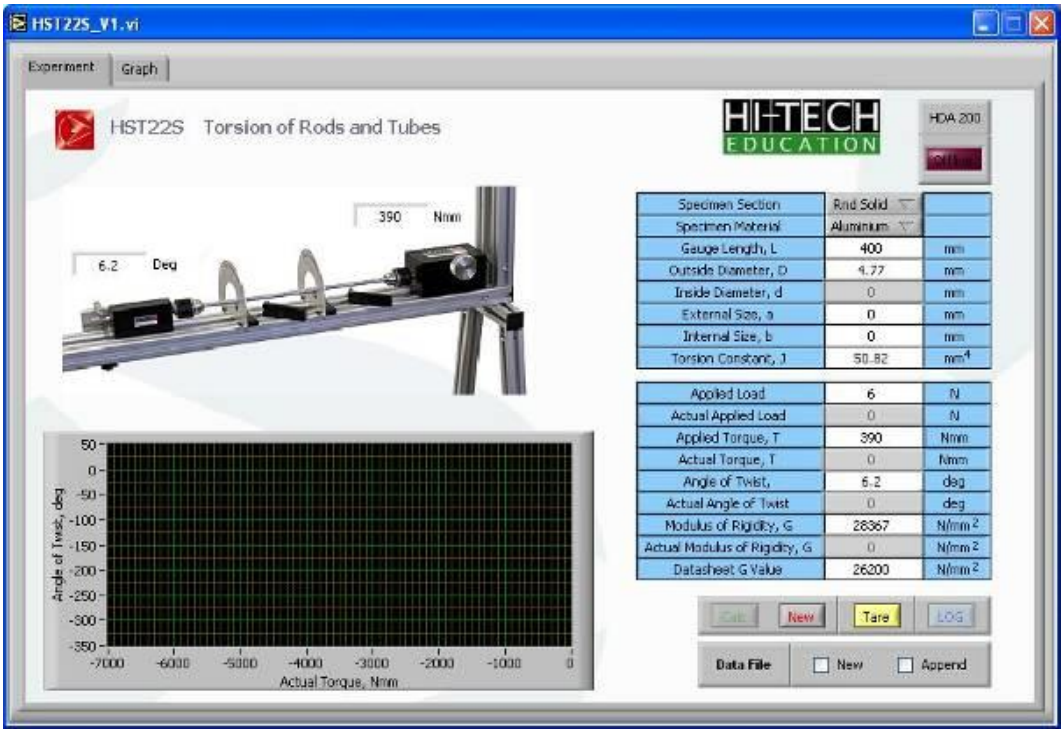
OFFLINE MODE

1. Load the experiment software by double clicking the **.exe** files supplied.
2. Choose 'NO' when the pop up window appears asking if the HDA200 is connected.
3. Select the specimen section as Rnd Solid.
4. Select the specimen material as Aluminium.
5. Enter the gauge length as 400.
6. Enter the outside diameter as 4.77.
7. The inside diameter will be greyed out.
8. Do not enter values for the external and internal size. They are not required for this specimen.
9. The J value will be calculated automatically.
10. Enter 6 for the applied load.
11. The actual applied load will be greyed out because you are in offline mode.
12. The applied torque will be calculated automatically.
13. The actual torque will be greyed out.
14. Enter the angle of twist as 6.2.
15. Press the CALC button with no data file tick boxes ticked. The screen should appear as follows:

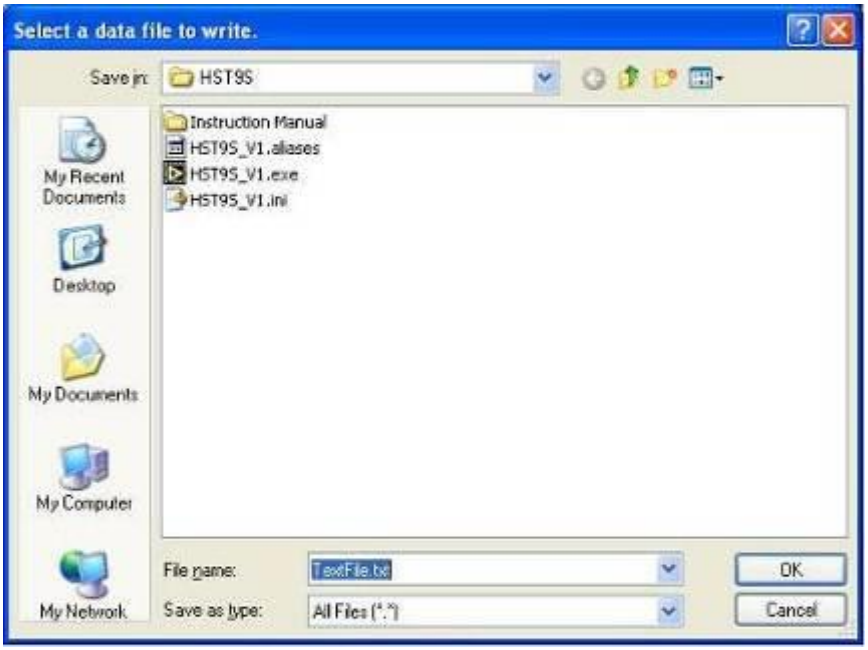
Specimen Section	Rnd Solid	
Specimen Material	Aluminium	
Gauge Length, L	400	mm
Outside Diameter, D	4.77	mm
Inside Diameter, d	0	mm
External Size, a	0	mm
Internal Size, b	0	mm
Torsion Constant, J	50.82	mm^4

Applied Load	6	N
Actual Applied Load	0	N
Applied Torque, T	390	Nmm
Actual Torque, T	0	Nmm
Angle of Twist,	6.2	deg
Actual Angle of Twist	0	deg
Modulus of Rigidity, G	28367	N/mm^2
Actual Modulus of Rigidity, G	0	N/mm^2
Datasheet G Value	26200	N/mm^2

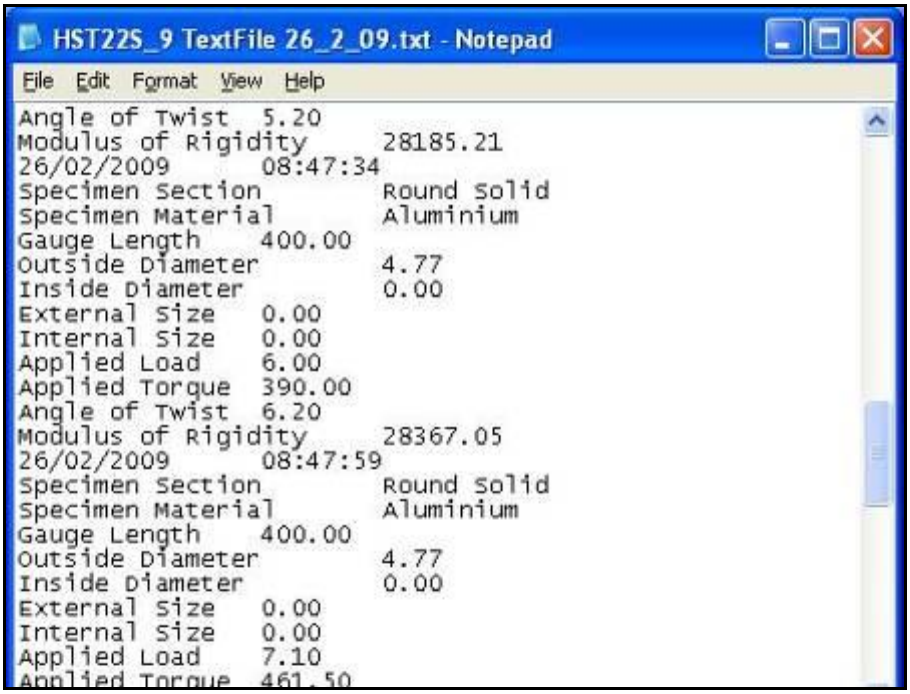
16. The complete screen should look like the following image:



17. The angle of twist and Applied torque will be presented on the hardware image also.
18. The TARE button, although live will not operate in offline mode.
19. Press the NEW button
20. Tick the Data File NEW box.
21. Press CALC.
22. You will then be shown the following window (the contents of this window will vary depending on the experiment running) and prompted to create a data file name in the location of your choice.



23. Either rename the default name of TextFile.txt or keep this default name. Its up to you. Ensure the file extension of ***.txt*** remains. Once the filename and location have been chosen then press **OK**.
24. The input and output data will now be saved in the data file created. To prove this open the text file in ***NOTEPAD*** that you have just created from its location and check the contents. It should look similar to the image below.



25. If you wish to change the inputs then simply press the NEW button, change the input parameter, press the data file APPEND button and then press CALC. You will be given the data file to append to, choose this and then press ok.
26. The data file should now have the new data saved into it, AND added (appended) to the existing data.
27. In the OFFLINE mode the LOG button will be greyed out.
28. When finished with the software shut the software down.
29. You can continue to adjust the inputs and see what outputs are obtained by following the same process above.

HDA200 CHANNEL SETTINGS and CONNECTIONS

Prior to running this experiment software in ONLINE mode with the HDA200 you will have to make sure that the correct experiment hardware sensors/transducers are connected to the HDA200 and the correct channels are being displayed by the HDA200. Refer to the HDA200 instruction manual and use the following table as a reference also:

Sensor/Transducer	HDA200 Connector Number	HDA200 Channel number	
Load Cell	Force 1	17	
Angle	Angle 1	21	

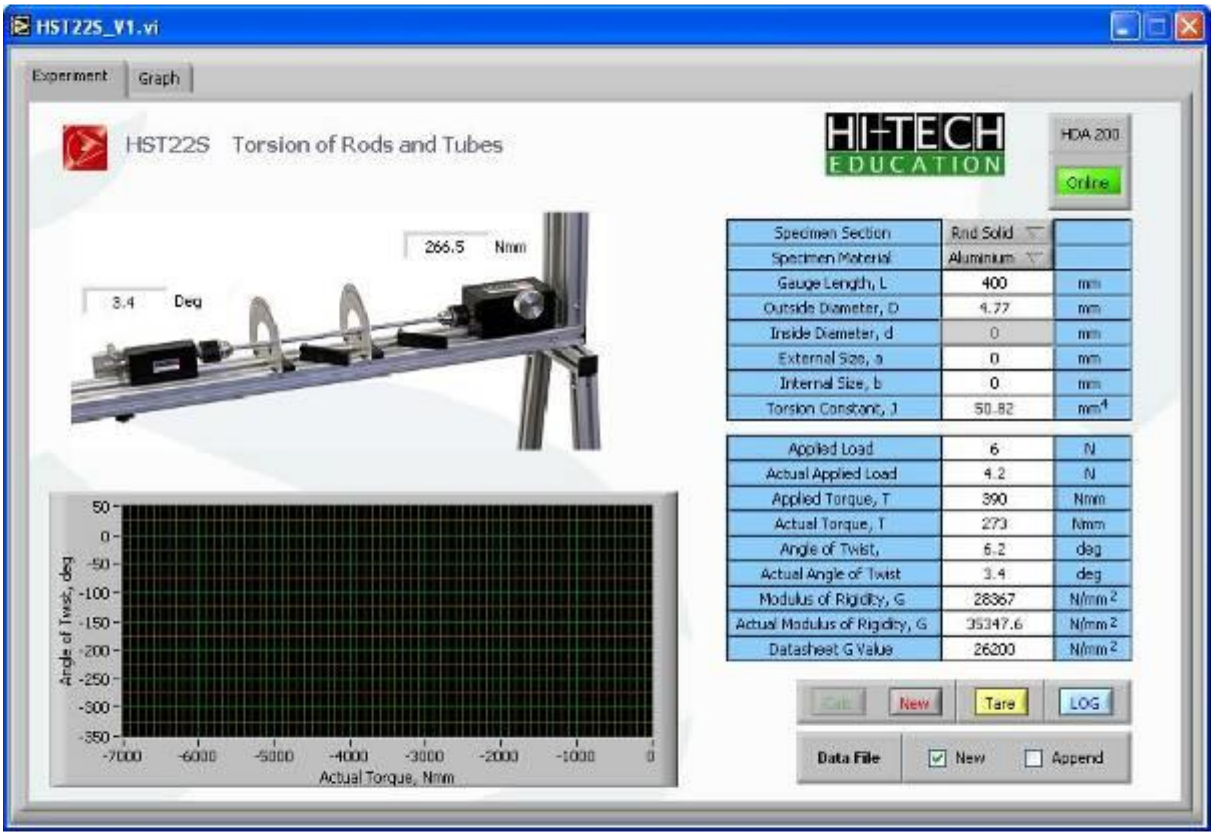
Run the HDA200 in LOCAL mode to check that the above channels only are being displayed. This will then ensure that the software collects the right data from the right channels.

NB: If the dial gauges (if used) are connected but not turned on then the software and HDA200 will not display the dial gauge values and the software and HDA200 screens will wait until they are turned on. Ensure the dial gauges are turned on when running the experiment and software.

If the above channels are not set correctly then you will have to enter the configuration of the HDA200 which will require reading and following the HDA200 instruction manual.

ONLINE MODE

1. Repeat the input parameters from the OFFLINE mode procedure above, press the CALC button and the software window should look like the image below:



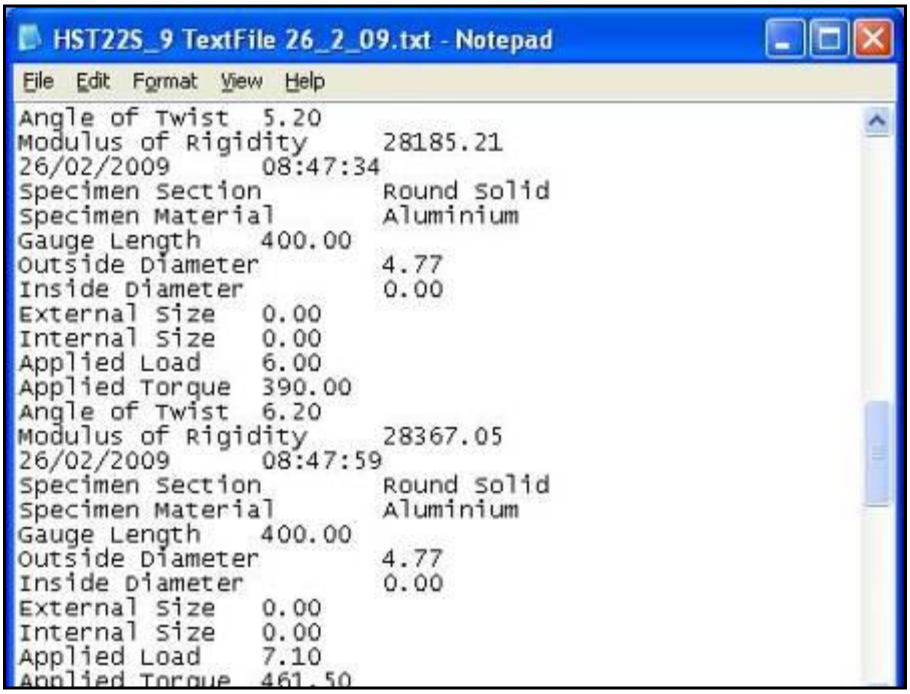
2. In 'ONLINE' mode you will notice that the actual applied load, actual torque, actual angle of twist and actual modulus of rigidity are no longer greyed out. These values will now start to change as they come in from the HDA200.
3. Load the hardware experiment to the same parameters as the input boxes. You should then be able to compare the actual values with theoretical values.
4. If you wish to save the data into a NEW or existing data file then press NEW to stop the software capturing data from the HDA200.
5. Tick the data file option required.
6. Press the CALC button and you will be prompted to create a new data file or append to the existing file. Choose the option required.
7. The input parameters will then be saved to the data file.
8. Press the LOG button to store the actual values to the data file.
9. Should you change the hardware load to a new value and you wish to change the software inputs then adjust the hardware, press NEW, adjust the software inputs to be the same as the hardware, click the data file APPEND tick box and then press CALC.
10. You can then continue to create new inputs and obtain new outputs depending on how you set up the hardware and by following the procedure above.
11. The graph will be drawn automatically each time the actual applied load and hence actual applied torque are changed.

DATA FILE CONTENTS

The data file created contains information that is useful in allowing the end user to further manipulate the data in a spreadsheet software.

The image below shows the typical data at the start of the data file for this experiment when a new file has been created and the LOG button has been pressed:

The data is as follows:


HST22S_9 TextFile 26_2_09.txt - Notepad

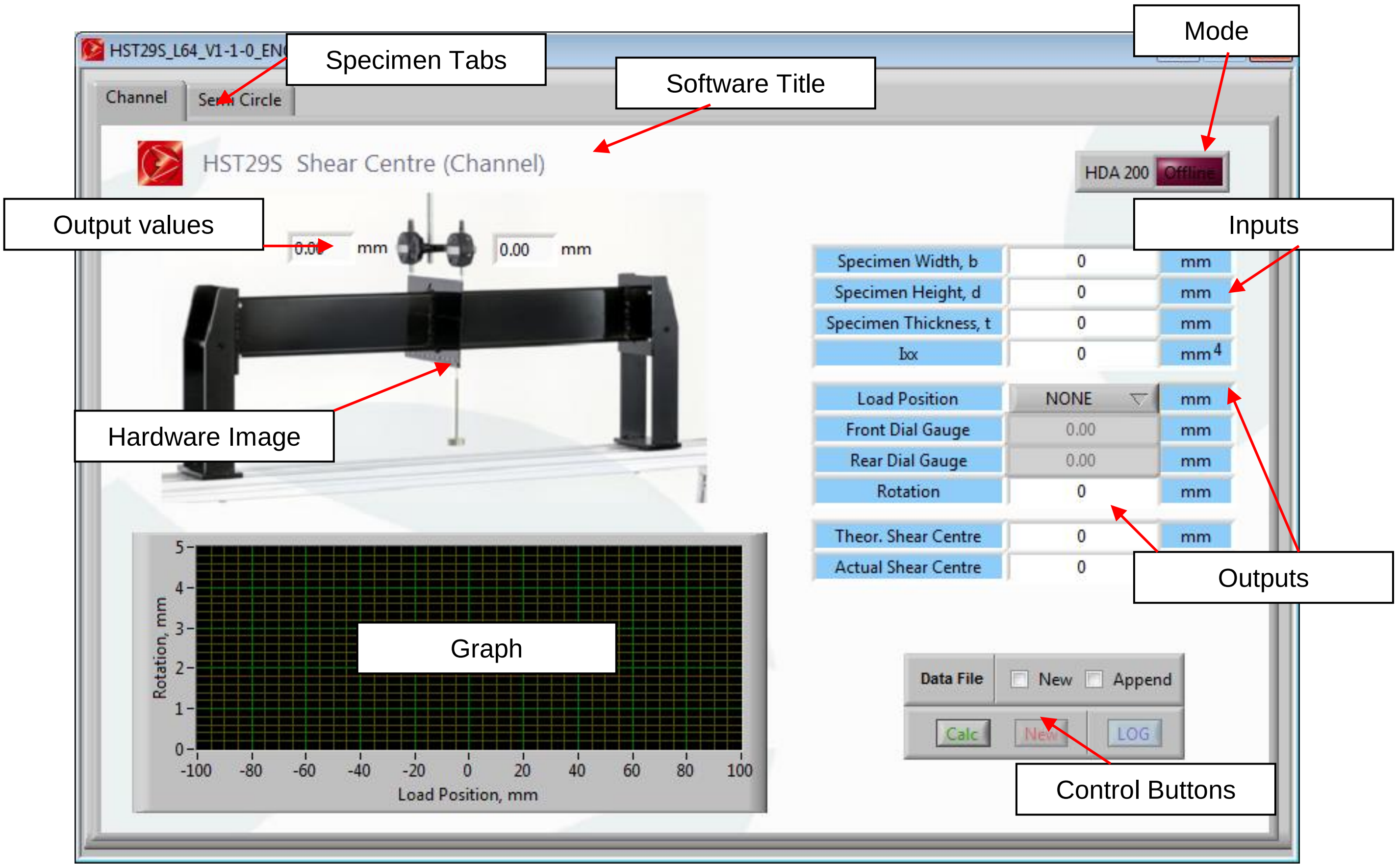
File Edit Format View Help

```
Angle of Twist   5.20
Modulus of Rigidity     28185.21
26/02/2009      08:47:34
Specimen Section        Round Solid
Specimen Material       Aluminium
Gauge Length    400.00
Outside Diameter        4.77
Inside Diameter         0.00
External Size   0.00
Internal Size   0.00
Applied Load    6.00
Applied Torque  390.00
Angle of Twist  6.20
Modulus of Rigidity     28367.05
26/02/2009      08:47:59
Specimen Section        Round Solid
Specimen Material       Aluminium
Gauge Length    400.00
Outside Diameter        4.77
Inside Diameter         0.00
External Size   0.00
Internal Size   0.00
Applied Load    7.10
Applied Torque  461.50
```

The information will then repeat itself depending on how many test points have been logged.

HST29S – SHEAR CENTRE

SOFTWARE WINDOW – CHANNEL SPECIMEN ONLY



In either mode the details of what is presented in the software window is the same. These are highlighted in the above image and detailed as follows:

Hardware image: This is a true representation of the actual hardware thus ensuring consistency in viewing between software and hardware.

Specimen Tabs: This software allows the channel and semicircle specimens to be presented.

Software Title: The title and number of the software.

Mode: This highlights which mode the software is in, i.e. OFFLINE or ONLINE.

Inputs: These boxes allow the end user to input values for the specific parameters listed. The blue boxes on the left hand column show the description of the input and the right hand column blue boxes show the units for these parameters. The central column is where the value is input via the keyboard. It is possible to press the TAB button on the keyboard and the cursor will jump to the next parameter.

The inputs available are as follows:

- **Specimen width, b:** Choose the specimen width in millimetres.
- **Specimen Height, d:** Choose the specimen height in millimetres.
- **Specimen Thickness, t**: Choose the specimen thickness in millimetres.

Outputs: These are theoretical values and actual values from the hardware based on the input parameters chosen. This is where the end user can compare actual results with theoretical.

The outputs available are as follows:

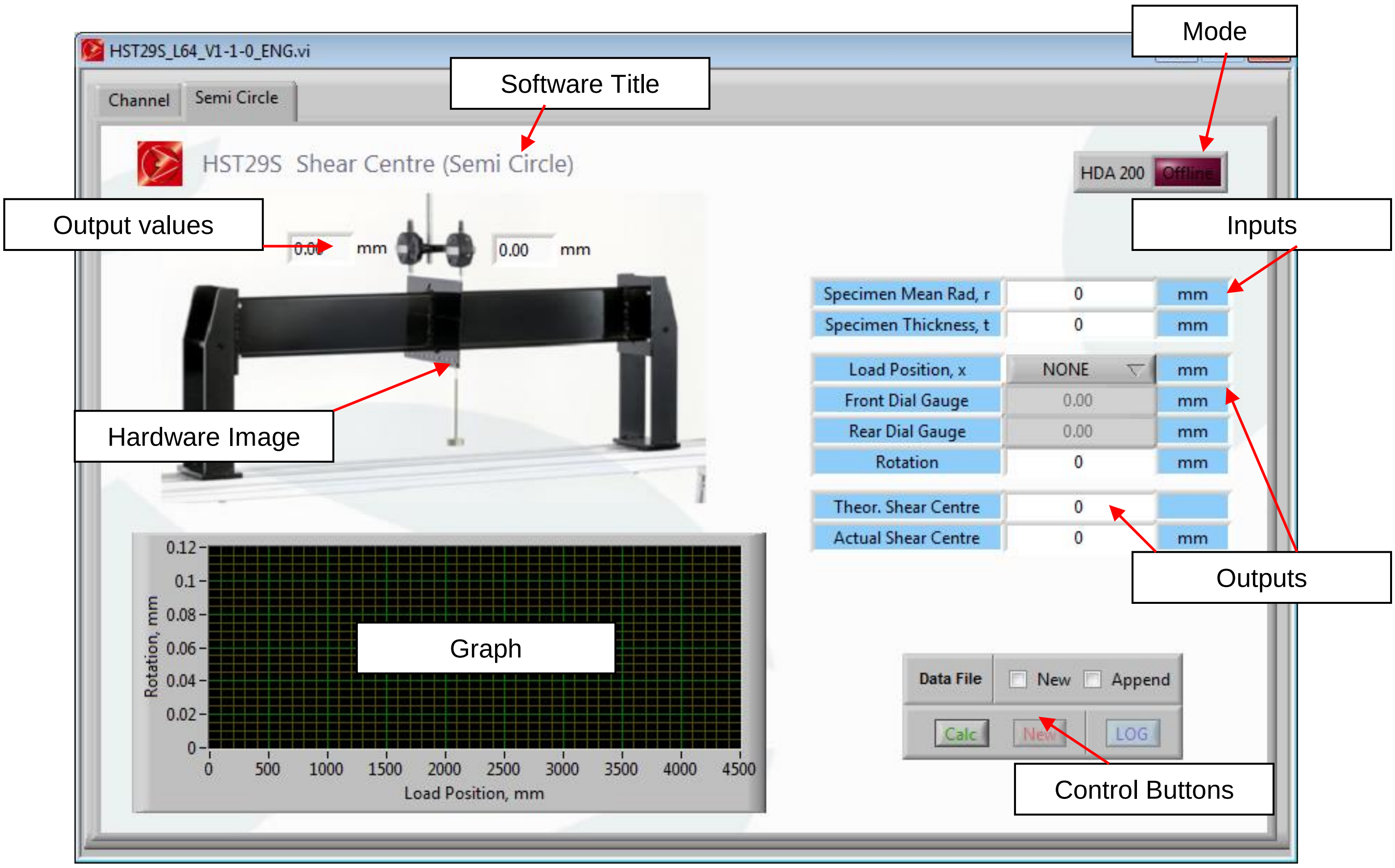
- **Load Position:** The load positions are the positions at which the load is placed on the hardware (see experiment hardware manual). The options that can be chosen from the drop down list are as follows: NONE, 100, 80, 60, 40, 20, 0, -20, -40, -60, -80, -100mm. This replicates the hardware experiment.
- **Front Dial Gauge**: This is the actual dial gauge value from the hardware. This should be the dial gauge connected into channel 28 of the HDA200. It has the units of millimetres.
- **Rear Dial Gauge**: This is the actual dial gauge value from the hardware. This should be the dial gauge connected into channel 29 of the HDA200. It has the units of millimetres.
- **Rotation:** At each load position the rotation is calculated. It has units of millimetres.
- **Theoretical Shear Centre:** This is the calculated theoretical shear centre for the channel specimen based on the specimen geometry given in the inputs. It has units of millimetres.
- **Actual Shear Centre:** This is the actual shear centre for the channel specimen. It is calculated from the graph that is plotted at every load position point. The more points obtained the more accurate the shear centre value. It has units of millimetres.

Control buttons: these buttons give the end user a choice of what to do with the software and the values presented on the screen. They are described in more detail as follows:

- **CALC**: When the inputs have been set, pressing this button will calculate the theoretical outputs.
- **NEW**: When this button is pressed it stops background processes and allows any of the inputs to be adjusted and then recalculated. You will have to wait a short time for the background processing to finish. When finished the CALC button becomes live and the NEW button becomes inactive.
- **LOG**: When the end user wishes to record ACTUAL data from the software during ONLINE running, they can press this button and the key input and output parameters will then be logged into the data file.
- **Data File NEW:** This tick box is used when the end user wishes to store the input and output data to a brand new file on the host computer. When this is ticked and the CALC button pressed you will be prompted to create a new data file. You can only choose this button or the append button, not both.
- **Data file APPEND:** If a data file has already been created then ticking this box will allow data to be added to this file rather than having to create a new file.

Graph: Each time a load position is set and the LOG button pressed the graph will be plotted of rotation against load position. Each rotation value will be added to the graph and hence a straight line should be produced. The point at which the line crosses the y-axis is the actual shear centre value of the specimen. You can clear the graph by right clicking on the graph and choosing clear graph.

SOFTWARE WINDOW – SEMICIRCLE SPECIMEN ONLY



In either mode the details of what is presented in the software window is the same. These are highlighted in the above image and detailed as follows:

Hardware image: This is a true representation of the actual hardware thus ensuring consistency in viewing between software and hardware.

Software Title: The title and number of the software.

Mode: This highlights which mode the software is in, i.e. OFFLINE or ONLINE.

Inputs: These boxes allow the end user to input values for the specific parameters listed. The blue boxes on the left hand column show the description of the input and the right hand column blue boxes show the units for these parameters. The central column is where the value is input via the keyboard. It is possible to press the TAB button on the keyboard and the cursor will jump to the next parameter.

The inputs available are as follows:

- **Specimen Mean Radius, r:** Choose the specimen mean radius in millimetres.
- **Specimen Thickness, t**: Choose the specimen thickness in millimetres.

Outputs: These are theoretical values and actual values from the hardware based on the input parameters chosen. This is where the end user can compare actual results with theoretical.

The outputs available are as follows:

- **Load Position:** The load positions are the positions at which the load is placed on the hardware (see experiment hardware manual). The options that can be chosen from the drop down list are as follows: NONE, 100, 80, 60, 40, 20, 0, -20, -40, -60, -80, -100mm. This replicates the hardware experiment.
- **Front Dial Gauge**: This is the actual dial gauge value from the hardware. This should be the dial gauge connected into channel 28 of the HDA200. It has the units of millimetres.
- **Rear Dial Gauge**: This is the actual dial gauge value from the hardware. This should be the dial gauge connected into channel 29 of the HDA200. It has the units of millimetres.
- **Rotation:** At each load position the rotation is calculated. It has units of millimetres.
- **Theoretical Shear Centre:** This is the calculated theoretical shear centre for the channel specimen based on the specimen geometry given in the inputs. It has units of millimetres.
- **Actual Shear Centre:** This is the actual shear centre for the channel specimen. It is calculated from the graph that is plotted at every load position point. The more points obtained the more accurate the shear centre value. It has units of millimetres.

Control buttons: these buttons give the end user a choice of what to do with the software and the values presented on the screen. They are described in more detail as follows:

- **CALC**: When the inputs have been set, pressing this button will calculate the theoretical outputs.
- **NEW**: When this button is pressed it stops background processes and allows any of the inputs to be adjusted and then recalculated. You will have to wait a short time for the background processing to finish. When finished the CALC button becomes live and the NEW button becomes inactive.
- **LOG**: When the end user wishes to record ACTUAL data from the software during ONLINE running, they can press this button and the key input and output parameters will then be logged into the data file.
- Data File **NEW:** This tick box is used when the end user wishes to store the input and output data to a brand new file on the host computer. When this is ticked and the CALC button pressed you will be prompted to create a new data file.
- Data file **APPEND:** If a data file has already been created then ticking this box will allow data to be added to this file rather than having to create a new file.

Graph: Each time a load position is set and the LOG button pressed the graph will be plotted of rotation against load position. Each rotation value will be added to the graph and hence a straight line should be produced. The point at which the line crosses the y-axis is the actual shear centre value of the specimen. You can clear the graph by right clicking on the graph and choosing clear graph.

OPERATING THE SOFTWARE

The following procedure outlines the steps required to operate the software and to obtain outputs for the inputs chosen. It is one of many variations that could be followed.

It assumes that the end user has set up the HDA200 (if necessary) and installed the software correctly and all inputs are being undertaken using the keyboard of the host computer.

OFFLINE MODE – CHANNEL SPECIMEN

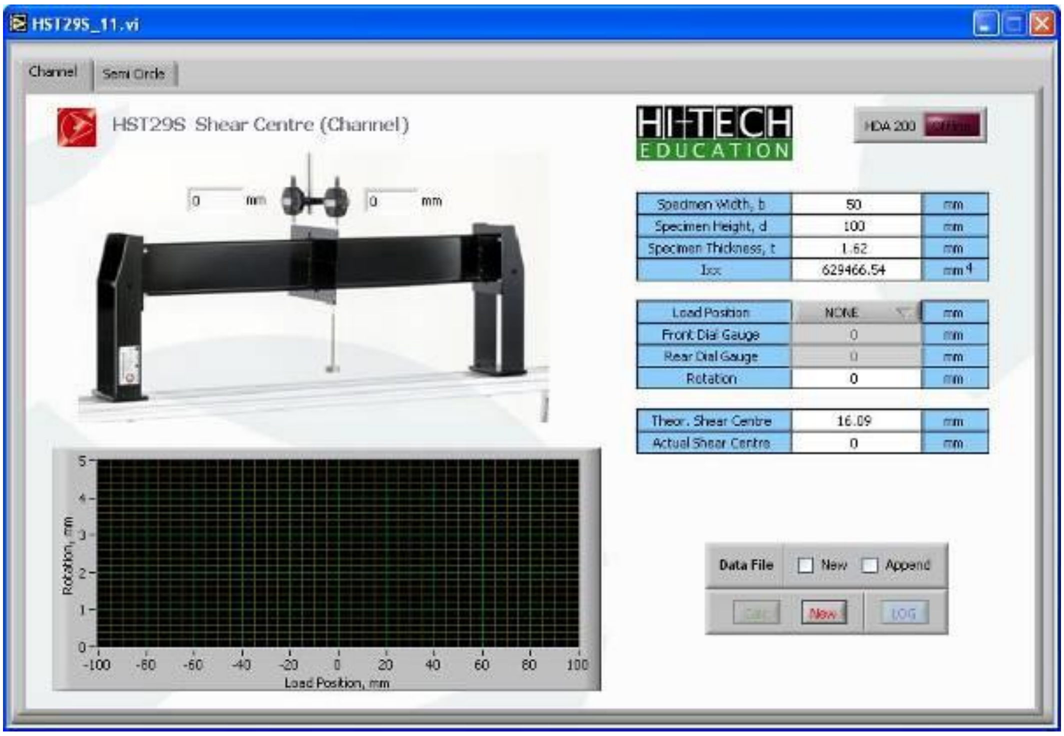
1. Load the experiment software by double clicking the **.exe** files supplied.
2. Choose 'NO' when the pop up window appears asking if the HDA200 is connected.
3. Select the Channel specimen tab at the top of the software screen.
4. Enter 50 in the width, b input box.
5. Enter 100 in the height, d input box.
6. Enter 1.62 in the thickness input box.
7. Press the CALC button with no data file tick boxes ticked. The screen should appear as follows:

Specimen Width, b	50	mm
Specimen Height, d	100	mm
Specimen Thickness, t	1.62	mm
Ixx	629466.54	mm^4

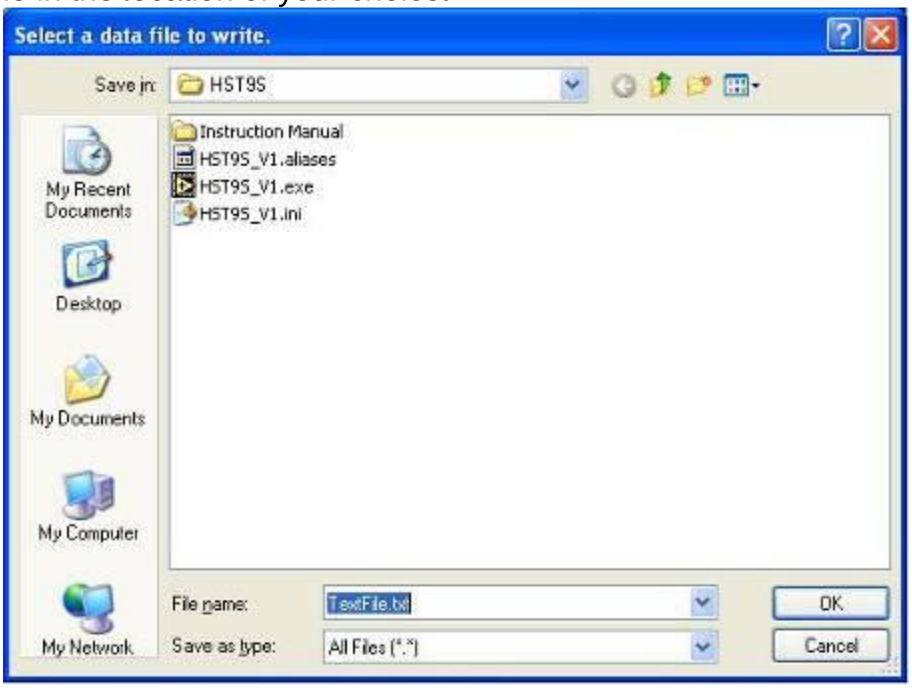
Load Position	NONE	mm
Front Dial Gauge	0	mm
Rear Dial Gauge	0	mm
Rotation	0	mm

Theor. Shear Centre	16.09	mm
Actual Shear Centre	0	mm

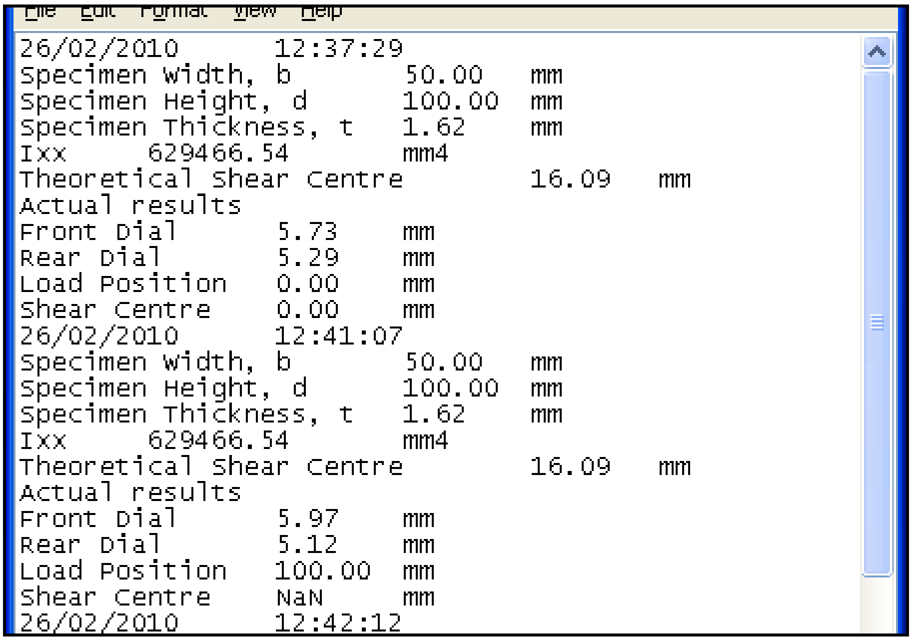
8. The complete screen should look like the following image:



9. The theoretical shear centre for the specimen geometry input will be shown in the first output box. Also note that the front and rear dial gauge values are greyed out. This is because you are in ‘OFFLINE’ mode.
10. Press the NEW button
11. Tick the Data File NEW box.
12. Press CALC.
13. You will then be shown the following window (the contents of this window will vary depending on the experiment running) and prompted to create a data file name in the location of your choice.



14. Either rename the default name of TextFile.txt or keep this default name. Its up to you. Ensure the file extension of ***.txt*** remains. Once the filename and location have been chosen then press **OK**.
15. The input and output data will now be saved in the data file created. To prove this open the text file in ***NOTEPAD*** that you have just created from its location and check the contents. It should look similar to the image below.

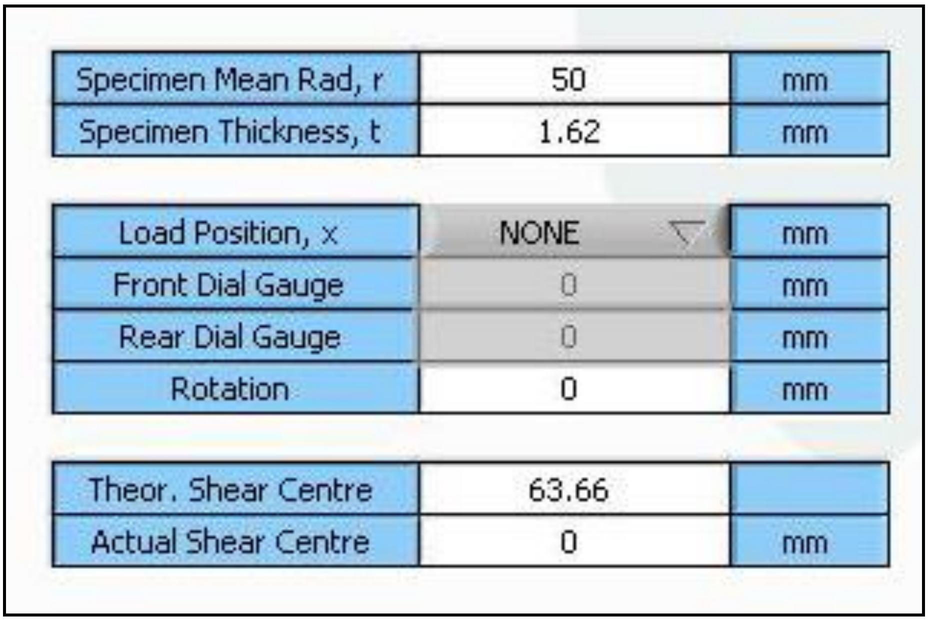


```
File  Edit  Format  View  Help
26/02/2010      12:37:29
Specimen Width, b       50.00   mm
Specimen Height, d      100.00  mm
Specimen Thickness, t   1.62    mm
Ixx     629466.54       mm4
Theoretical Shear Centre        16.09   mm
Actual results
Front Dial      5.73    mm
Rear Dial       5.29    mm
Load Position   0.00    mm
Shear Centre    0.00    mm
26/02/2010      12:41:07
Specimen Width, b       50.00   mm
Specimen Height, d      100.00  mm
Specimen Thickness, t   1.62    mm
Ixx     629466.54       mm4
Theoretical Shear Centre        16.09   mm
Actual results
Front Dial      5.97    mm
Rear Dial       5.12    mm
Load Position   100.00  mm
Shear Centre    NaN     mm
26/02/2010      12:42:12
```

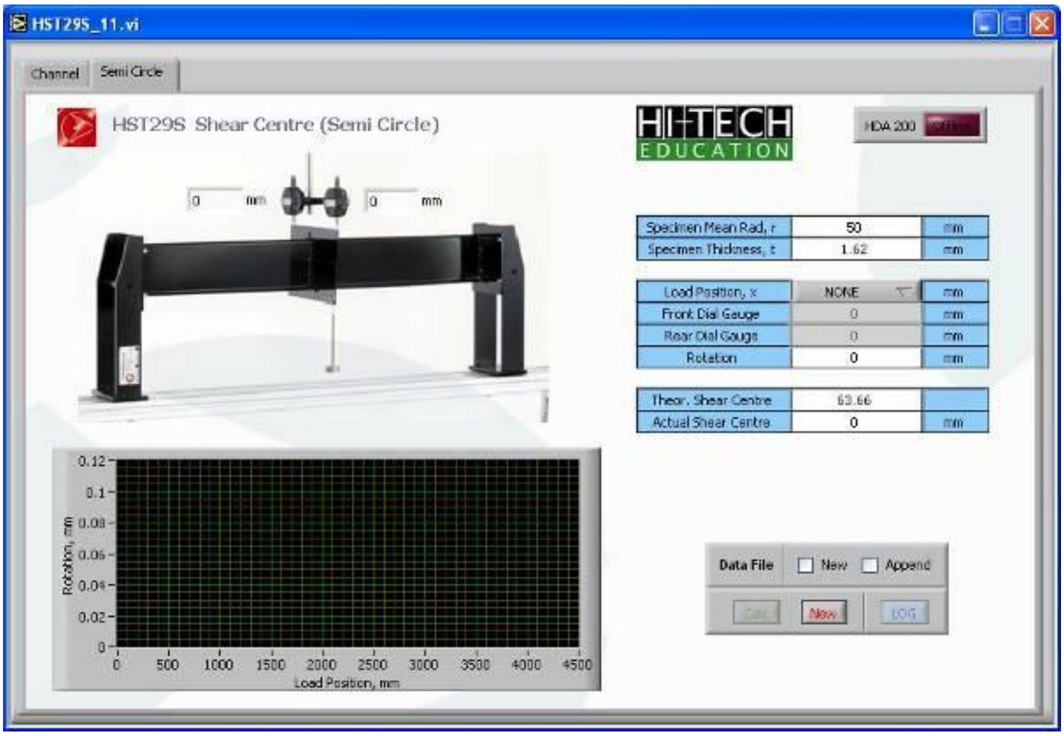
16. If you wish to change the inputs then simply press the NEW button, change the input parameter, press the data file APPEND button and then press CALC. You will be given the data file to append to, choose this and then press ok.
17. The data file should now have the new data saved into it, AND added (appended) to the existing data.
18. In the OFFLINE mode the LOG button will be greyed out.
19. When finished with the software shut the software down.
20. You can continue to adjust the inputs and see what outputs are obtained by following the same process above.

OFFLINE MODE – SEMICIRCLE SPECIMEN

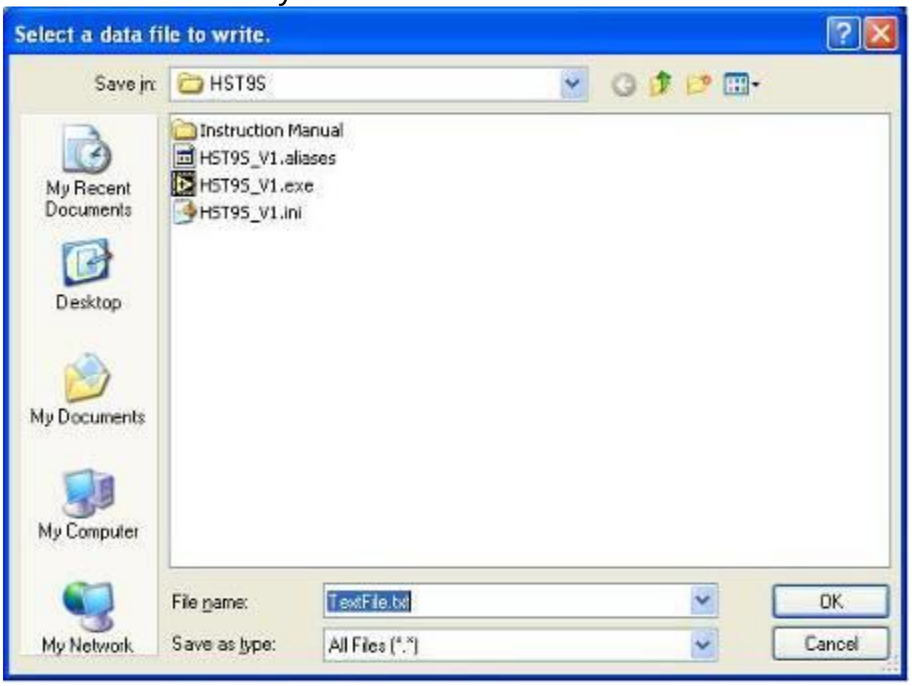
1. Load the experiment software by double clicking the **.exe** files supplied.
2. Choose ‘NO’ when the pop up window appears asking if the HDA200 is connected.
3. Select the semicircle specimen tab at the top of the software screen.
4. Enter 50 in the width, b input box.
5. Enter 100 in the height, d input box.
6. Enter 1.62 in the thickness input box.
7. Press the CALC button with no data file tick boxes ticked. The screen should appear as follows:



8. The complete screen should look like the following image:



9. The theoretical shear centre for the specimen geometry input will be shown in the first output box. Also note that the front and rear dial gauge values are greyed out. This is because you are in 'OFFLINE' mode.
10. Press the NEW button
11. Tick the Data File NEW box.
12. Press CALC.
13. You will then be shown the following window (the contents of this window will vary depending on the experiment running) and prompted to create a data file name in the location of your choice.



14. Either rename the default name of TextFile.txt or keep this default name. Its up to you. Ensure the file extension of ***.txt*** remains. Once the filename and location have been chosen then press **OK**.
15. The input and output data will now be saved in the data file created.
16. If you wish to change the inputs then simply press the NEW button, change the input parameter, press the data file APPEND button and then press CALC. You will be given the data file to append to, choose this and then press ok.
17. The data file should now have the new data saved into it, AND added (appended) to the existing data.
18. In the OFFLINE mode the LOG button will be greyed out.
19. When finished with the software shut the software down.
20. You can continue to adjust the inputs and see what outputs are obtained by following the same process above.

HDA200 CHANNEL SETTINGS and CONNECTIONS

Prior to running this experiment software in ONLINE mode with the HDA200 you will have to make sure that the correct experiment hardware sensors/transducers are connected to the HDA200 and the correct channels are being displayed by the HDA200. Refer to the HDA200 instruction manual and use the following table as a reference also:

Sensor/Transducer	HDA200 Connector Number	HDA200 Channel number	Resolution
Front Dial Gauge	Dial gauge 1	28	0.01mm
Rear Dial Gauge	Dial gauge 2	29	0.01mm

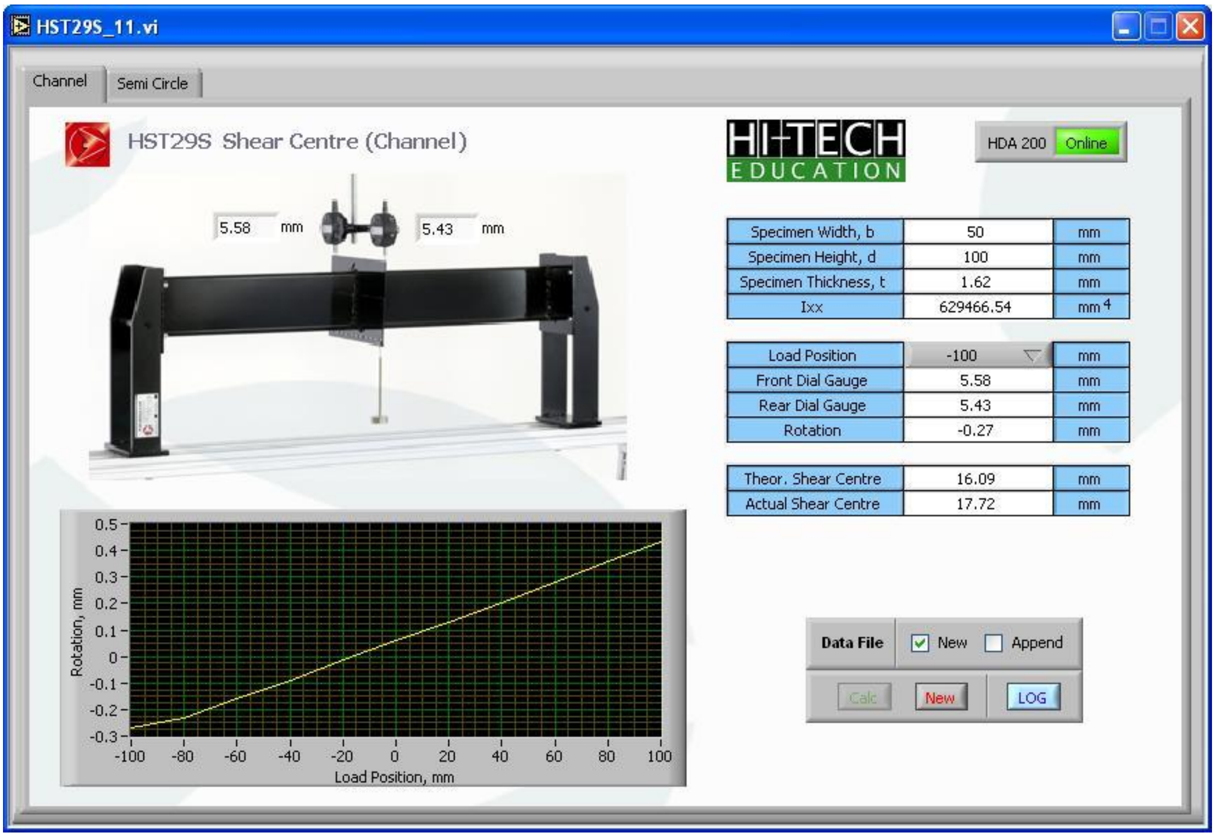
Run the HDA200 in LOCAL mode to check that the above channels only are being displayed. This will then ensure that the software collects the right data from the right channels.

NB: If the dial gauges (if used) are connected but not turned on then the software and HDA200 will not display the dial gauge values and the software and HDA200 screens will wait until they are turned on. Ensure the dial gauges are turned on when running the experiment and software.

If the above channels are not set correctly then you will have to enter the configuration of the HDA200 which will require reading and following the HDA200 instruction manual.

ONLINE MODE

1. Repeat the input parameters from the OFFLINE mode procedure above, press the CALC button and the software window should look like the image below:



2. In ‘ONLINE’ mode you will notice that the front and rear dial gauge values are no longer greyed out. These values will now start to change as they come in from the HDA200.
3. Load the hardware experiment to the same parameters as the input boxes. You should then be able to compare the actual values with theoretical values.
4. If you wish to save the data into a NEW or existing data file then press NEW to stop the software capturing data from the HDA200.
5. Tick the data file option required.

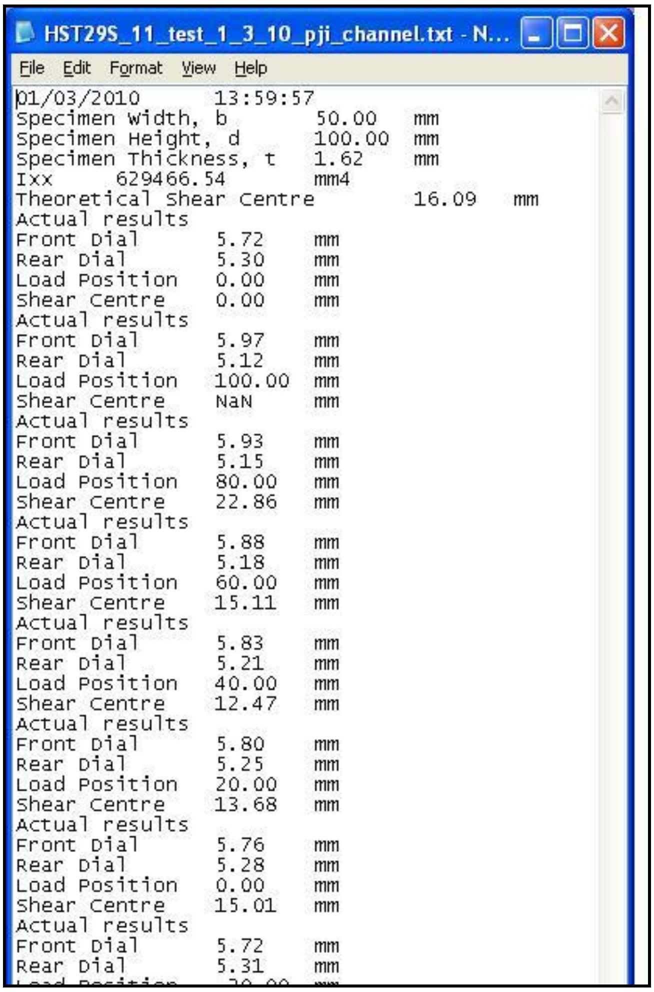
6. Press the CALC button and you will be prompted to create a new data file or append to the existing file. Choose the option required.
7. The input parameters will then be saved to the data file.
8. Press the LOG button to store the actual values to the data file.
9. Incrementally change the load position from NONE right through to -100mm, and at each increment press the LOG button.
10. The graph will be drawn automatically at each load position point, but you must follow the load position points in turn otherwise the graph will appear incorrect and the actual shear centre will not be correct.

DATA FILE CONTENTS

The data file created contains information that is useful in allowing the end user to further manipulate the data in a spreadsheet software.

The image below shows the typical data at the start of the data file for this experiment when a new file has been created and the LOG button has been pressed at each load position increment:

The data is as follows:

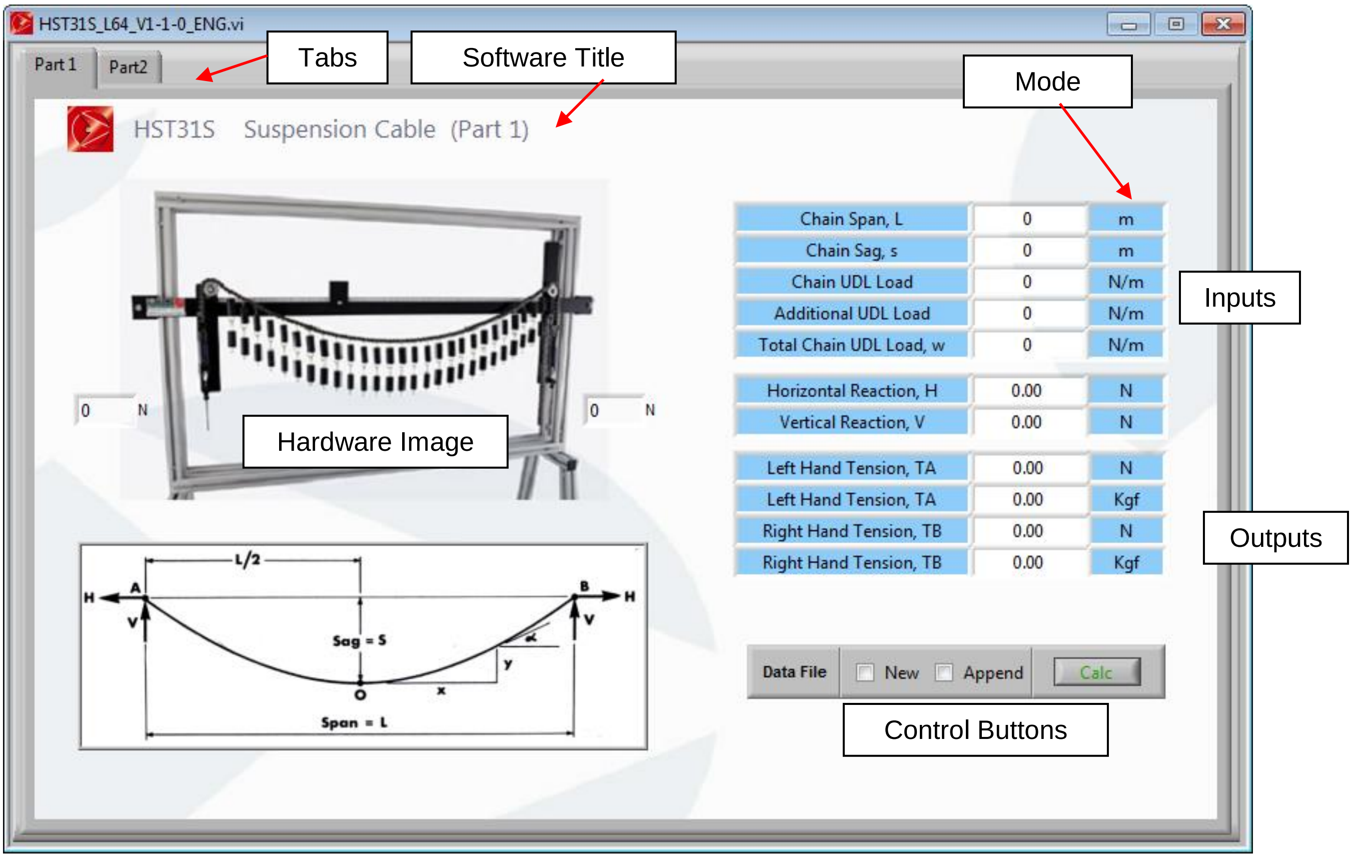



```
01/03/2010          13:59:57
Specimen Width, b           50.00    mm
Specimen Height, d          100.00   mm
Specimen Thickness, t       1.62     mm
Ixx      629466.54          mm4
Theoretical Shear Centre            16.09    mm
Actual results
Front Dial          5.72     mm
Rear Dial           5.30     mm
Load Position       0.00     mm
Shear Centre        0.00     mm
Actual results
Front Dial          5.97     mm
Rear Dial           5.12     mm
Load Position       100.00   mm
Shear Centre        NaN      mm
Actual results
Front Dial          5.93     mm
Rear Dial           5.15     mm
Load Position       80.00    mm
Shear Centre        22.86    mm
Actual results
Front Dial          5.88     mm
Rear Dial           5.18     mm
Load Position       60.00    mm
Shear Centre        15.11    mm
Actual results
Front Dial          5.83     mm
Rear Dial           5.21     mm
Load Position       40.00    mm
Shear Centre        12.47    mm
Actual results
Front Dial          5.80     mm
Rear Dial           5.25     mm
Load Position       20.00    mm
Shear Centre        13.68    mm
Actual results
Front Dial          5.76     mm
Rear Dial           5.28     mm
Load Position       0.00     mm
Shear Centre        15.01    mm
Actual results
Front Dial          5.72     mm
Rear Dial           5.31     mm
```

The information will then repeat itself depending on how many test points have been logged.

HST31S – SUSPENSION CABLE

SOFTWARE WINDOW



In either mode the details of what is presented in the software window is the same. These are highlighted in the above image and detailed as follows:

Hardware image: This is a true representation of the actual hardware thus ensuring consistency in viewing between software and hardware.

Software Title: The title and number of the software.

Mode: This highlights which mode the software is in, i.e. OFFLINE or ONLINE.

Inputs: These boxes allow the end user to input values for the specific parameters listed. The blue boxes on the left hand column show the description of the input and the right hand column blue boxes show the units for these parameters. The central column is where the value is input via the keyboard. It is possible to press the TAB button on the keyboard and the cursor will jump to the next parameter.

The inputs available are as follows:

- **Chain Span, L:** Enter the span of the chain in metres.
- **Chain Sag, s:** Enter the chain sag in metres.
- **Chain UDL Load**: Enter the Chain UDL load being applied to the chain in Newton per metres. This is the self weight of the chain.
- **Additional UDL Load**: Enter the additional UDL load that can be applied to the chain via the suspension weights supplied with the hardware.
- **Total Chain UDL Load, w**: This is the combined UDL load on the chain.

Outputs: These are theoretical values and actual values from the hardware based on the input parameters chosen. This is where the end user can compare actual results with theoretical. Again the format of the columns is the same as the inputs except that the central column is automatically updated depending on the inputs chosen and cannot be adjusted via the keyboard.

The outputs available are as follows:

- **Horizontal Reaction, H**: This is a calculated value in Newton's.
- **Vertical Reaction, V**: This is a calculated value in Newton's.
- **Left Hand Tension, TA**: This is a calculated value in Newton's.
- **Left Hand Tension, TA**: This is a calculated value in kilogram Force
- **Right Hand Tension, TB**: This is a calculated value in Newton's.
- **Right Hand Tension, TB**: This is a calculated value in kilogram Force
-

Control buttons: these buttons give the end user a choice of what to do with the software and the values presented on the screen. They are described in more detail as follows:

- **CALC**: When the inputs have been set, pressing this button will calculate the theoretical outputs.
- **Data File NEW:** This tick box is used when the end user wishes to store the input and output data to a brand new file on the host computer. When this is ticked and the CALC button pressed you will be prompted to create a new data file.
- **Data file APPEND:** If a data file has already been created then ticking this box will allow data to be added to this file rather than having to create a new file.

OFFLINE MODE

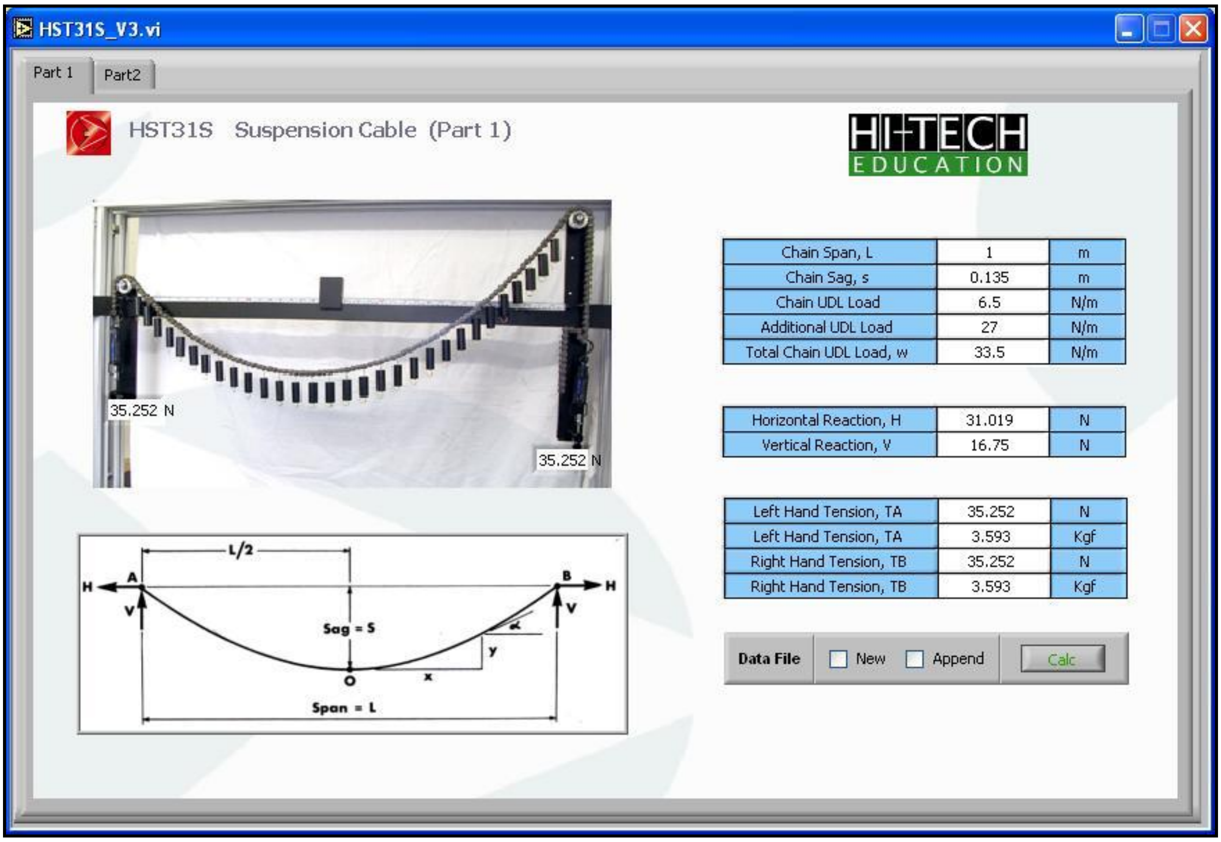
1. Input the following parameters:

Chain Span, L	1	m
Chain Sag, s	0.135	m
Chain UDL Load	6.5	N/m
Additional UDL Load	27	N/m
Total Chain UDL Load, w	33.5	N/m

Horizontal Reaction, H	31.019	N
Vertical Reaction, V	16.75	N

Left Hand Tension, TA	35.252	N
Left Hand Tension, TA	3.593	Kgf
Right Hand Tension, TB	35.252	N
Right Hand Tension, TB	3.593	Kgf

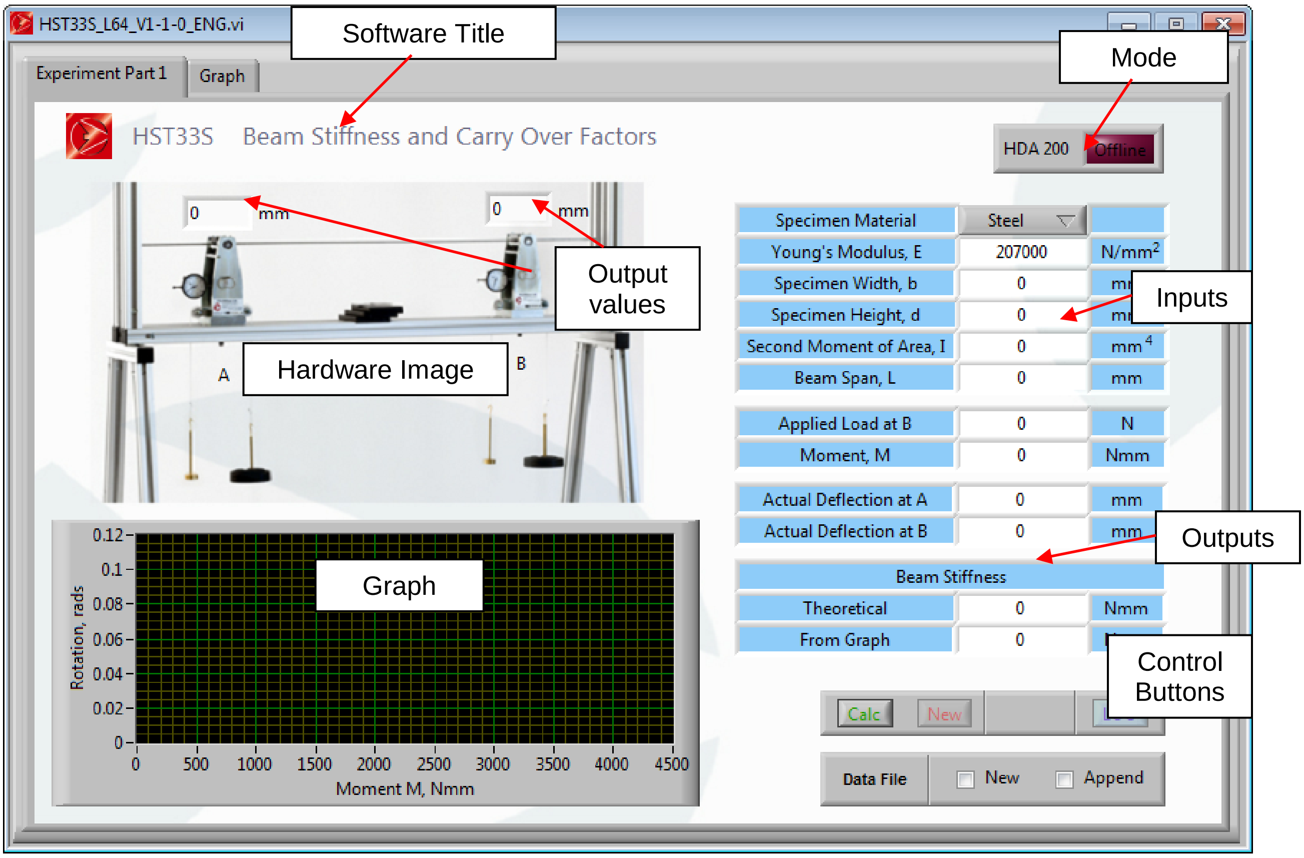
2. Press the CALC button and the software window should look like the image below:



3. You will now see the left and right hand tensions and reactions displayed on the screen.
4. Repeat the same process for the part 2 experiment on the other tab.

HST33S – BEAM STIFFNESS & CARRY OVER FACTORS

SOFTWARE WINDOW



In either mode the details of what is presented in the software window is the same. These are highlighted in the above image and detailed as follows:

Hardware image: This is a true representation of the actual hardware thus ensuring consistency in viewing between software and hardware.

Software Title: The title and number of the software.

Mode: This highlights which mode the software is in, i.e. OFFLINE or ONLINE.

Inputs: These boxes allow the end user to input values for the specific parameters listed. The blue boxes on the left hand column show the description of the input and the right hand column blue boxes show the units for these parameters. The central column is where the value is input via the keyboard. It is possible to press the TAB button on the keyboard and the cursor will jump to the next parameter.

The inputs available are as follows:

- **Material:** The user can choose the frame material. Choices range from steel, aluminium and brass. When a material is chosen the young's modulus is automatically chosen and displayed in the input box below.
- **Specimen Width, b:** This is the width of the beam. Typically this will be 25mm. It has the units of millimetres (mm).
- **Specimen Height, d**: This is the height of the beam. Typically this is 3 or 5mm. It has the units of millimetres (mm).
- **Second Moment of Area, I:** This is the calculated value based on the figures input for b and d above.
- **Beam span, L**: This is the span of the beam. It has the units of millimetres (mm).

Outputs: These are theoretical values and actual values from the hardware based on the input parameters chosen. This is where the end user can compare actual results with theoretical. Again the format of the columns is the same as the inputs except that the central column is automatically updated depending on the inputs chosen and cannot be adjusted via the keyboard.

The outputs available are as follows:

- **Applied Load at B**: This is the load applied at B only. It has the units of Newton (N).
- **Moment, M**: This is the calculated moment being applied at B by the applied load chosen. It is calculated using the applied load x 150mm. It has the units of Newton-millimetres (Nmm).
- **Actual Deflection at A**: This is the actual deflection reading from the dial gauge mounted on pier A. It has the units of millimetres (mm).
- **Actual Deflection at B**: This is the actual deflection reading from the dial gauge mounted on pier B. It has the units of millimetres (mm).
- **Theoretical**: This is the theoretical Beam Stiffness using the parameters input above. It has the units of Newton-millimetres (Nmm).
- **From Graph:** This is the actual value of beam stiffness taken from the gradient of the graph that is produced when running in ONLINE mode only.

Control buttons: these buttons give the end user a choice of what to do with the software and the values presented on the screen. They are described in more detail as follows:

- **CALC**: When the inputs have been set, pressing this button will calculate the theoretical outputs.
- **NEW**: When this button is pressed it stops background processes and allows any of the inputs to be adjusted and then recalculated.
- **LOG**: When the end user wishes to record any data from the software during ONLINE running, they can press this button and the key input and output parameters will then be logged into the data file.
- **Data File NEW:** This tick box is used when the end user wishes to store the input and output data to a brand new file on the host computer. When this is

ticked and the CALC button pressed you will be prompted to create a new data file.

- **Data file APPEND:** If a data file has already been created then ticking this box will allow data to be added to this file rather than having to create a new file.

Graph: This graph is created when in ONLINE mode only. It will plot the rotation against moment. Each time the LOG button is pressed the graph will update with new points. At the top of the software screen is a tab stating GRAPH. When pressing this tab a new software window will appear with the same graph as shown in the main software window.

OPERATING THE SOFTWARE

The following procedure outlines the steps required to operate the software and to obtain outputs for the inputs chosen. It is one of many variations that could be followed.

It assumes that the end user has set up the HDA200 (if necessary) and installed the software correctly and all inputs are being undertaken using the keyboard of the host computer.

NB: BEFORE RUNNING THE SOFTWARE IN ONLINE MODE MAKE SURE THERE IS A DIAL GAUGE CONNECTED INTO DIAL GAUGE CHANNEL1 and DIAL GAUGE CHANNEL 2 OF THE HDA200.

THIS EXPERIMENT WILL UNDERTAKE THE BEAM STIFFNESS ELEMENT PF PART 1 OF THE HARDWARE INSTRUCTION MANUAL.

HDA200 CHANNEL SETTINGS and CONNECTIONS

Prior to running this experiment software in ONLINE mode with the HDA200 you will have to make sure that the correct experiment hardware sensors/transducers are connected to the HDA200 and the correct channels are being displayed by the HDA200. Refer to the HDA200 instruction manual and use the following table as a reference also:

Sensor/Transducer	HDA200 Connector Number	HDA200 Channel number	Resolution
Dial Gauge	Dial gauge 1	28	0.01mm
Dial Gauge	Dial gauge 2	29	0.01mm

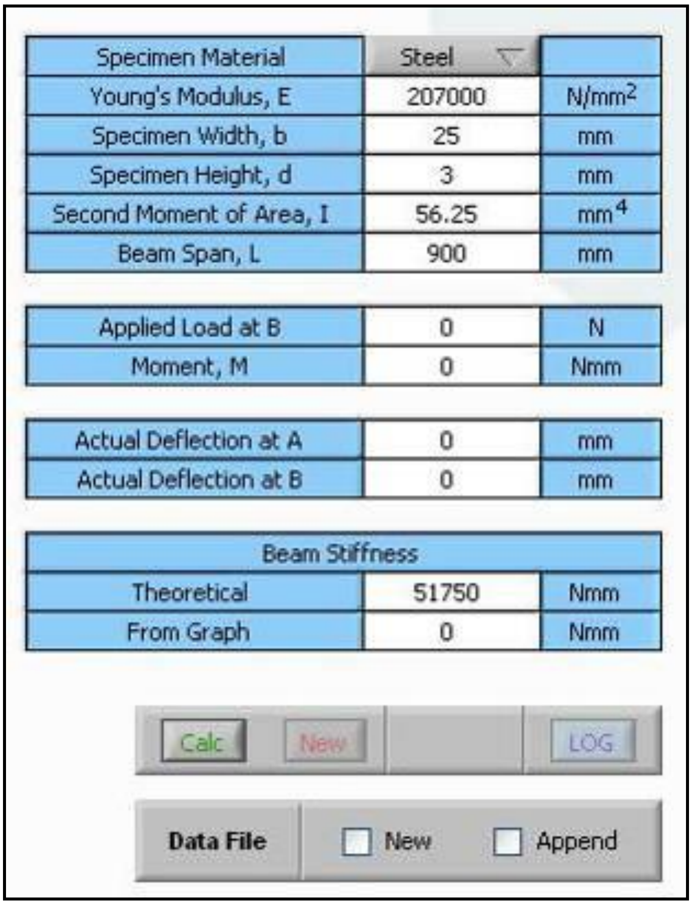
Run the HDA200 in LOCAL mode to check that the above channels only are being displayed. This will then ensure that the software collects the right data from the right channels.

NB: If the dial gauges (if used) are connected but not turned on then the software and HDA200 will not display the dial gauge values and the software and HDA200 screens will wait until they are turned on. Ensure the dial gauges are turned on when running the experiment and software.

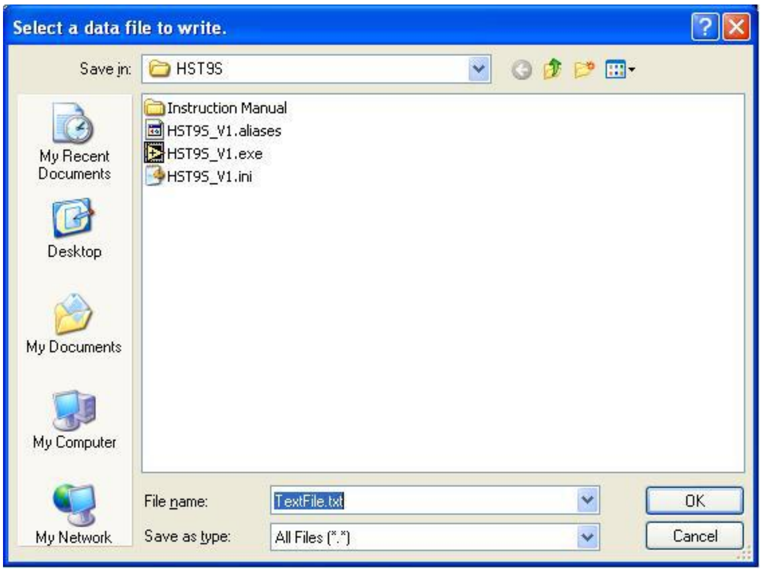
If the above channels are not set correctly then you will have to enter the configuration of the HDA200 which will require reading and following the HDA200 instruction manual.

<u>ONLINE MODE</u>

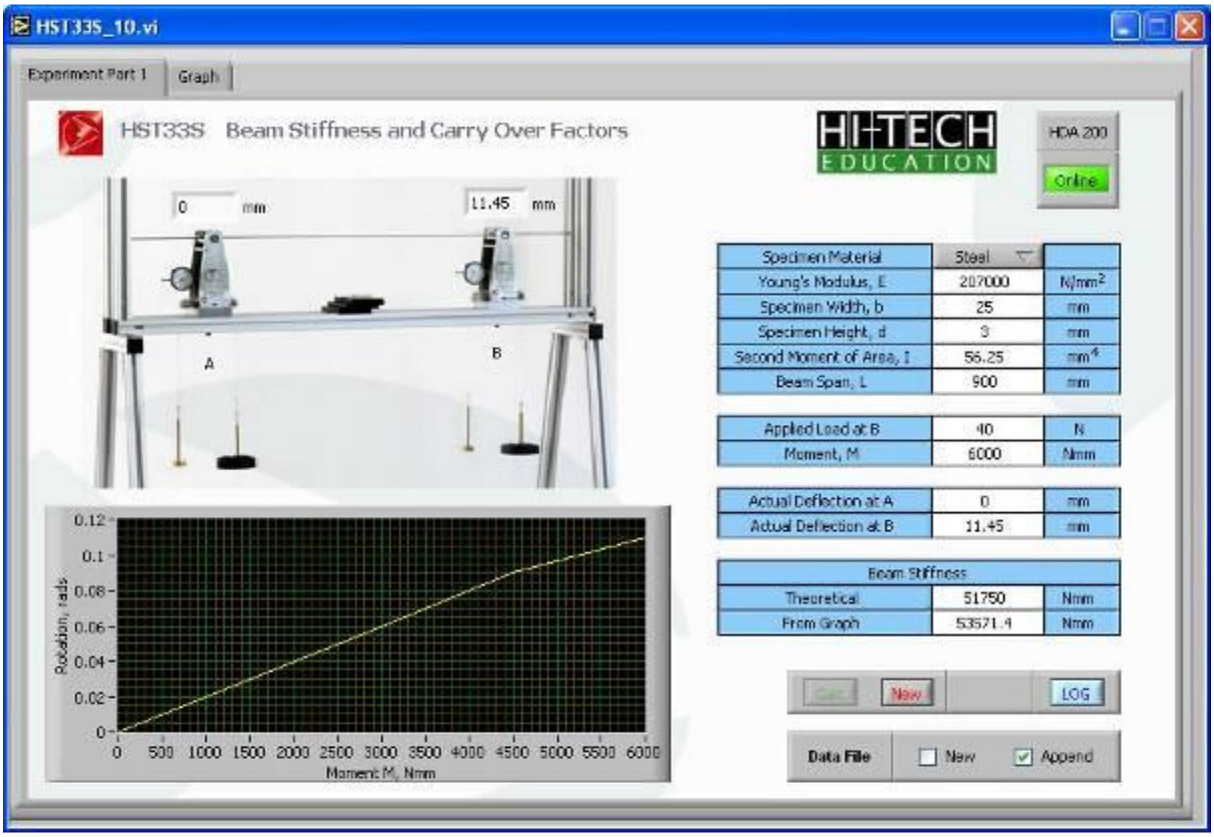
1. Load the experiment software by double clicking the **.exe** files supplied.
2. Choose ‘YES’ when the pop up window appears asking if the HDA200 is connected.
3. Choose the beam material.
4. Enter 25 in the specimen width input box.
5. Enter 3 in the specimen height input box.
6. Enter 900 in the beam span input box.
7. Enter 0 in the Applied Load at B input box. The screen should now have inputs that look like the following image:



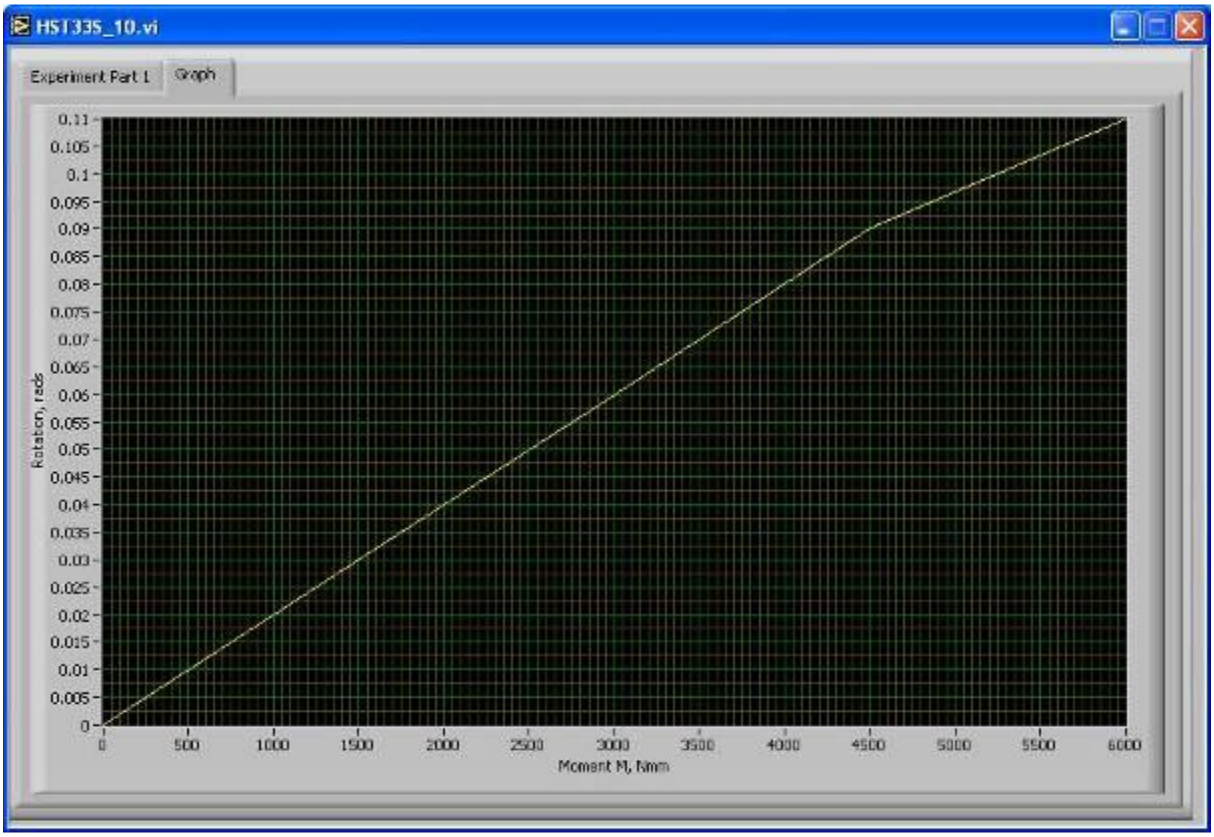
8. Tick the Data File NEW box.
9. Press CALC.
10. You will then be shown the following window (the contents of this window will vary depending on the experiment running) and prompted to create a data file name in the location of your choice.



11. Either rename the default name of TextFile.txt or keep this default name. Ensure the file extension of ***.txt*** remains. Once the filename and location have been chosen then press **OK**.
12. The input and output data will now be saved in the data file created.
13. Press the LOG button.
14. Zero the dial gauges on both piers as outlined in the hardware instruction manual.
15. Load the hanger of Pier B with 10N. Input 10 in the Applied Load input box. The dial gauge will change accordingly following loading.
16. Press LOG. Both graphs should start to be plotted.
17. Load the hanger of pier B with 20N. Input 20 in the Applied Load Input box. The dial gauge will change accordingly following loading.
18. Press LOG. Both graphs should update.
19. Load the hanger of pier B with 30N. Input 30 in the Applied Load Input box. The dial gauge will change accordingly following loading.
20. Press LOG. Both graphs should update.
21. Load the hanger of pier B with 40N. Input 40 in the Applied Load Input box. The dial gauge will change accordingly following loading.
22. Press LOG. Both graphs should update.
23. The software screen should look the like the following image.



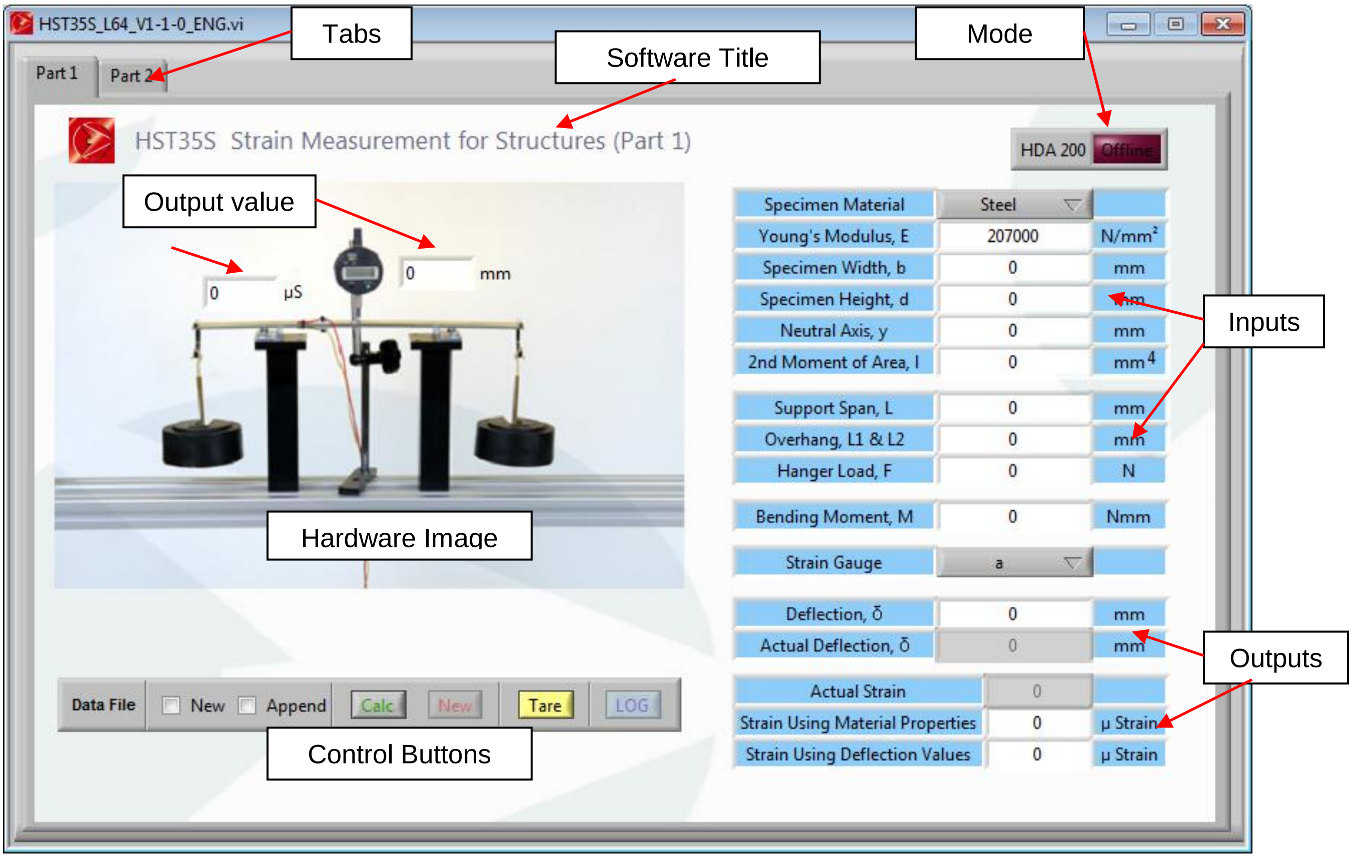
24. The graph page should also look like the following:



25. You should find that the theoretical and actual beam stiffness values appear in the bottom of the software screen.
26. If you wish to change the beam parameters or start the test again, then press the NEW button. Right click on both graphs and choose clear chart. This will remove the plotted points.
27. Change the parameters, choose whether to create a new data file or append to an existing one. Press the CALC button and start the loading process again.

HST35S – STRAIN MEASUREMENT for STRUCTURES

SOFTWARE WINDOW – Part 1



In either mode the details of what is presented in the software window is the same. These are highlighted in the above image and detailed as follows:

Hardware image: This is a true representation of the actual hardware thus ensuring consistency in viewing between software and hardware.

Tabs: The two parts of this experiment are presented on two individual tabs and software screens. The two parts represent the actual hardware experiments parts also. Part 1 is shown above.

Software Title: The title and number of the software.

Mode: This highlights which mode the software is in, i.e. OFFLINE or ONLINE.

Inputs: These boxes allow the end user to input values for the specific parameters listed. The blue boxes on the left hand column show the description of the input and the right hand column blue boxes show the units for these parameters. The central column is where the value is input via the keyboard. It is possible to press the TAB button on the keyboard and the cursor will jump to the next parameter.

The inputs available are as follows:

- **Specimen material:** Choose the material for the specimen.
- **Young's Modulus, E:** This changes automatically depending on the specimen material chosen.
- **Specimen width, b**: Input the width of the specimen in millimetres.
- **Specimen Height, d**: Input the height of the specimen in millimetres.
- **Neutral Axis, y**: This is calculated automatically based on the specimen height input above in millimetres.
- **2nd Moment of Area, I**: This is calculated automatically based on the specimen width and height input above.
- **Support Span, L**: Input the distance between the specimen supports in millimetres.
- **Overhang, L1 & L2**: Input the overhang distances for this specimen in millimetres.
- **Hanger Load, F**: Input the load applied to each hanger in Newton's.
- **Bending Moment, M**: This is calculated automatically in Newton-millimetres.

The specimens used in Part1 of the HST35 hardware experiment have strain gauges attached to their upper and lower surfaces. These are labelled a, b and c. Only a and b are tested here because c is a repeat of a. The drop down list for **Strain Gauge** allows the end user to select which strain gauges they wish to compare results with. It is possible to choose from the list a, b or a+b.

Outputs: These are theoretical values and actual values from the hardware based on the input parameters chosen. This is where the end user can compare actual results with theoretical.

The outputs available are as follows:

- **Deflection, δ:** This is the theoretical deflection at the midspan of the specimen under test in millimetres.
- **Actual Deflection, δ**: This is the actual deflection at the midspan of the specimen under test in millimetres. This will be inactive (greyed out) in offline mode only.
- **Actual Strain**: this is the actual strain readings from the hardware via the HDA200.t the coordinates chosen the theoretical bending stress is given here. It has the units of Newton's per millimetre squared. This will be inactive (greyed out) in offline mode only.
- **Strain using Material Properties:** This is the theoretical calculated strain using the material properties given above.
- **Strain using Deflection values:** This is the theoretical calculated strain using the deflection values produced above. In offline mode this will be the deflection values. In online mode this will be the actual deflection values.

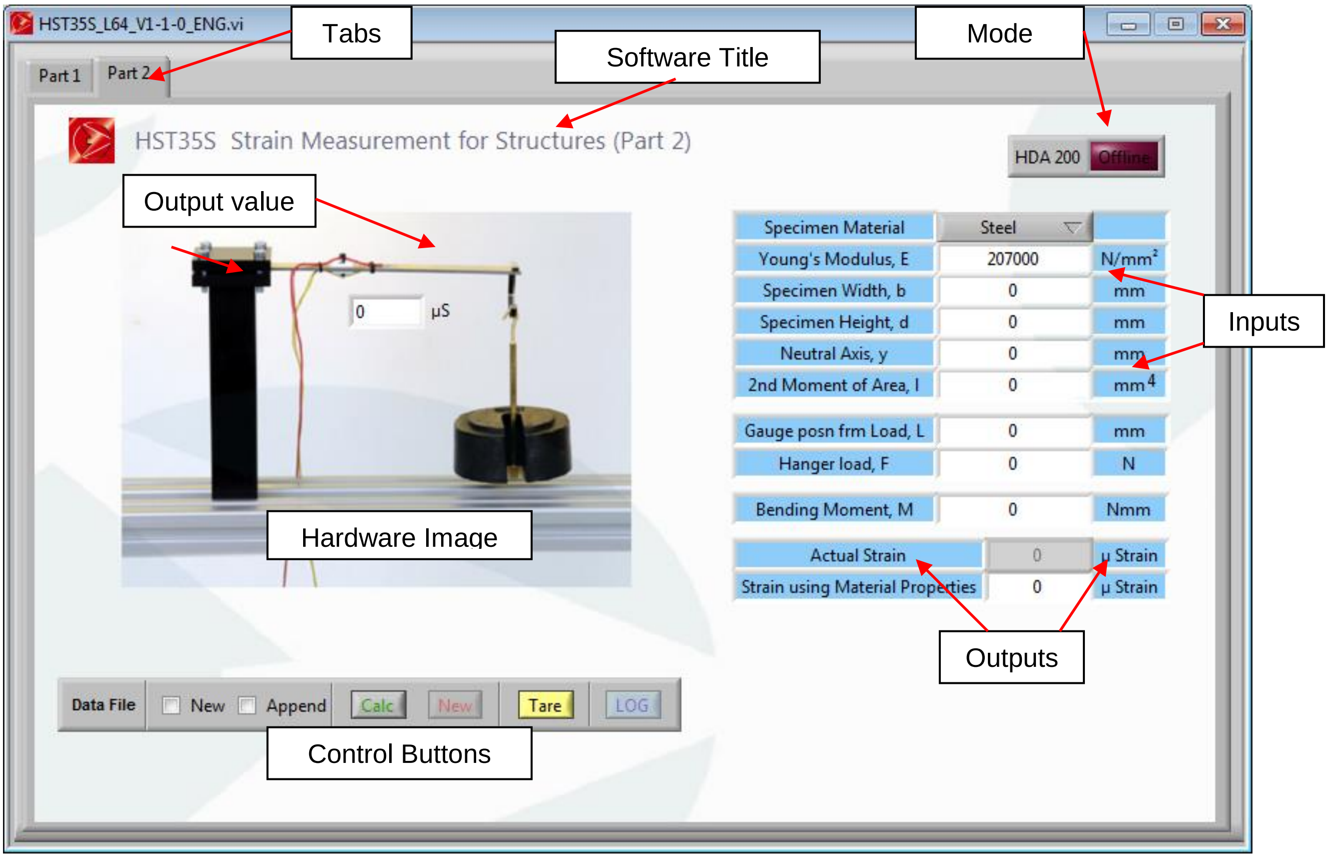
Control buttons: these buttons give the end user a choice of what to do with the software and the values presented on the screen. They are described in more detail as follows:

- **CALC**: When the inputs have been set, pressing this button will calculate the theoretical outputs.
- **NEW**: When this button is pressed it stops background processes and allows any of the inputs to be adjusted and then recalculated. You will have to wait a short time for the background processing to finish. When finished the CALC button becomes live and the NEW button becomes inactive.
- **Tare**: Pressing this button in ON-LINE mode will tare, zero the actual strain gauge value.
- **LOG**: When the end user wishes to record ACTUAL data from the software during ONLINE mode, they can press this button and the key input and output parameters will then be logged into the data file.
- **Data File NEW:** This tick box is used when the end user wishes to store the input and output data to a brand new file on the host computer. When this is ticked and the CALC button pressed you will be prompted to create a new data file. The current input parameters will then be added to the data file chosen.
- **Data file APPEND:** If a data file has already been created then ticking this box will allow data to be added to this file rather than having to create a new file.

NB: You will only be able to choose the New or Append options. You cannot choose both at the same time. It is one or the other.

On the hardware image itself you will see that the strain will appear to the left of the dial gauge while the deflection will appear to the right of the dial gauge. When in OFFLINE mode these values will be the theoretical values. When in ONLINE mode these values will be actual.

SOFTWARE WINDOW – Part 2



In either mode the details of what is presented in the software window is the same. These are highlighted in the above image and detailed as follows:

Hardware image: This is a true representation of the actual hardware thus ensuring consistency in viewing between software and hardware.

Tabs: The two parts of this experiment are presented on two individual tabs and software screens. The two parts represent the actual hardware experiments parts also. Part 2 is shown above.

Software Title: The title and number of the software.

Mode: This highlights which mode the software is in, i.e. OFFLINE or ONLINE.

Inputs: These boxes allow the end user to input values for the specific parameters listed. The blue boxes on the left hand column show the description of the input and the right hand column blue boxes show the units for these parameters. The central column is where the value is input via the keyboard. It is possible to press the TAB button on the keyboard and the cursor will jump to the next parameter.

The inputs available are as follows:

- **<u>Specimen material:</u>** Choose the material for the specimen.
- **<u>Young's Modulus, E:</u>** This changes automatically depending on the specimen material chosen.
- **<u>Specimen width, b</u>**: Input the width of the specimen in millimetres.
- **<u>Specimen Height, d</u>**: Input the height of the specimen in millimetres.
- **<u>Neutral Axis, y</u>**: This is calculated automatically based on the specimen height input above in millimetres.
- **<u>2nd Moment of Area, I</u>**: This is calculated automatically based on the specimen width and height input above.
- **<u>Gauge posn frm Load, L</u>**: As this specimen is a cantilever the distance of the centreline of the strain gauge to the load position is input here in millimetres.
- **<u>Hanger Load, F</u>**: Input the load applied to each hanger in Newton's.
- **<u>Bending Moment, M</u>**: This is calculated automatically in Newton-millimetres.

<u>Outputs</u>: These are theoretical values and actual values from the hardware based on the input parameters chosen. This is where the end user can compare actual results with theoretical.

The outputs available are as follows:

- **<u>Actual Strain</u>**: this is the actual strain readings from the hardware via the HDA200.t the coordinates chosen the theoretical bending stress is given here. It has the units of Newton's per millimetre squared. This will be inactive (greyed out) in offline mode only.
- **<u>Strain using Material Properties</u>:** This is the theoretical calculated strain using the material properties given above.

<u>Control buttons:</u> these buttons give the end user a choice of what to do with the software and the values presented on the screen. They are described in more detail as follows:

- **<u>CALC</u>**: When the inputs have been set, pressing this button will calculate the theoretical outputs.
- **<u>NEW</u>**: When this button is pressed it stops background processes and allows any of the inputs to be adjusted and then recalculated. You will have to wait a short time for the background processing to finish. When finished the CALC button becomes live and the NEW button becomes inactive.
- **<u>Tare</u>**: Pressing this button in ON-LINE mode will tare, zero the actual strain gauge value.
- **<u>LOG</u>**: When the end user wishes to record ACTUAL data from the software during ONLINE mode, they can press this button and the key input and output parameters will then be logged into the data file.
- **<u>Data File NEW:</u>** This tick box is used when the end user wishes to store the input and output data to a brand new file on the host computer. When this is ticked and the CALC button pressed you will be prompted to create a new data file. The current input parameters will then be added to the data file chosen.
- **<u>Data file APPEND:</u>** If a data file has already been created then ticking this box will allow data to be added to this file rather than having to create a new file.

NB: You will only be able to choose the New or Append options. You cannot choose both at the same time. It is one or the other.

On the hardware image itself you will see that the strain will appear to the left of the dial gauge while the deflection will appear to the right of the dial gauge. When in OFFLINE mode these values will not appear in these boxes. When in ONLINE mode these values will be actual.

OPERATING THE SOFTWARE

The following procedure outlines the steps required to operate the software and to obtain outputs for the inputs chosen. It is one of many variations that could be followed.

It assumes that the end user has set up the HDA200 (if necessary) and installed the software correctly and all inputs are being undertaken using the keyboard of the host computer.

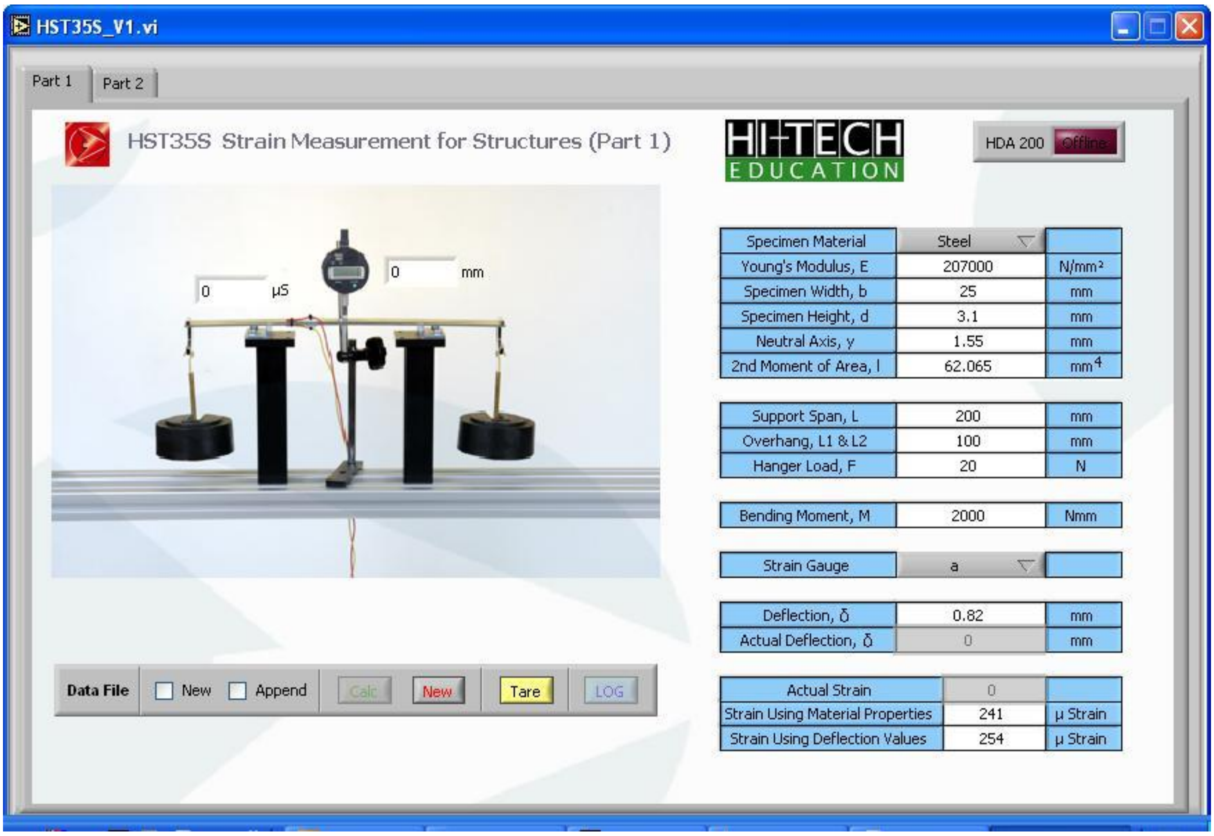
OFFLINE MODE – Part 1

1. Load the experiment software by double clicking the **.exe** files supplied.
2. Choose ‘NO’ when the pop up window appears asking if the HDA200 is connected.
3. Select the Part 1 tab at the top of the software screen.
4. Choose steel at the material. The E value will change automatically.
5. Enter 25 in the specimen width input box.
6. Enter 3.1 in the specimen height input box.
7. The neutral axis and 2nd moment of area will be calculated automatically when the CALC button is pressed later.
8. Enter 200 in the support span, L input box.
9. Enter 100 in the Overhang L1 & L2 input box.
10. Enter 20 in the Hanger Load, F input box.
11. Keep the strain gauge a selected.
12. Enter 0.82 in the deflection input box.

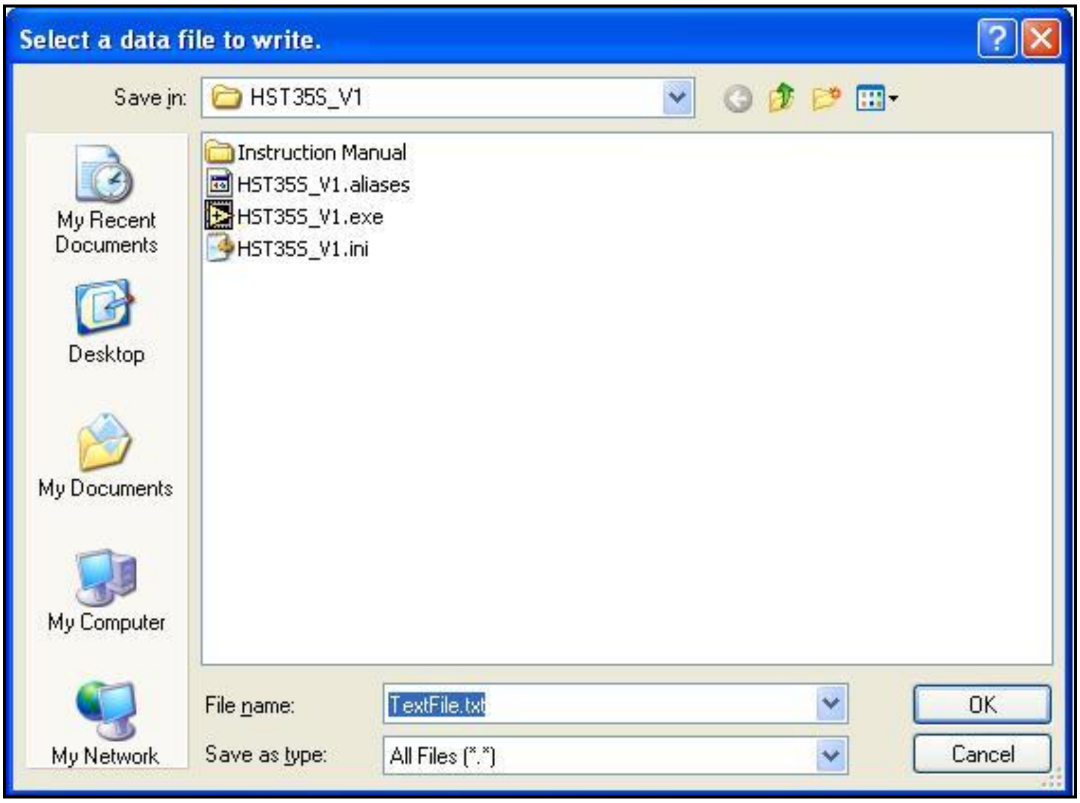
13. Press the CALC button with no data file tick boxes ticked. The screen should appear as follows:

Specimen Material	Steel	
Young's Modulus, E	207000	N/mm²
Specimen Width, b	25	mm
Specimen Height, d	3.1	mm
Neutral Axis, y	1.55	mm
2nd Moment of Area, I	62.065	mm⁴
Support Span, L	200	mm
Overhang, L1 & L2	100	mm
Hanger Load, F	20	N
Bending Moment, M	2000	Nmm
Strain Gauge	a	
Deflection, δ	0.82	mm
Actual Deflection, δ	0	mm
Actual Strain	0	
Strain Using Material Properties	241	μ Strain
Strain Using Deflection Values	254	μ Strain

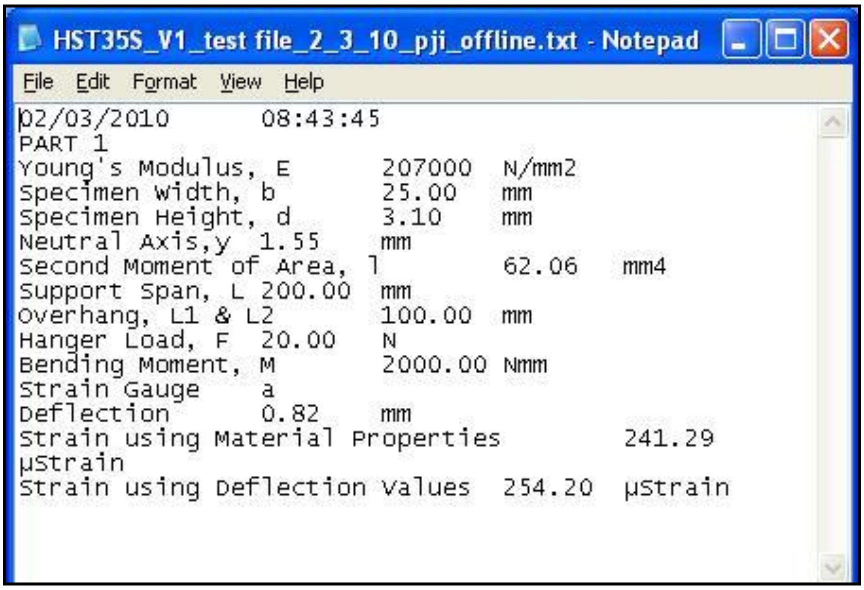
14. The complete screen should look like the following image:



15. The strain using material properties and deflection values will be shown in the relevant output boxes. Also note that the actual deflection and strain values are greyed out. This is because you are in 'OFFLINE' mode.
16. Press the NEW button and then tick the Data File NEW box.
17. Press CALC.
18. You will then be shown the following window (**the contents of this window will vary depending on the experiment running**) and prompted to create a data file name in the location of your choice.



19. Either rename the default name of TextFile.txt or keep this default name. Its up to you. Ensure the file extension of ***.txt*** remains. Once the filename and location have been chosen then press **OK**.
20. The input and output data will now be saved in the data file created. To prove this open the text file in ***NOTEPAD*** that you have just created from its location and check the contents. It should look similar to the image below.



HST35S_V1_test file_2_3_10_pji_offline.txt - Notepad

File Edit Format View Help

```
02/03/2010      08:43:45
PART 1
Young's Modulus, E      207000  N/mm2
Specimen Width, b       25.00   mm
Specimen Height, d      3.10    mm
Neutral Axis,y  1.55    mm
Second Moment of Area, I        62.06   mm4
Support Span, L 200.00  mm
Overhang, L1 & L2       100.00  mm
Hanger Load, F  20.00   N
Bending Moment, M       2000.00 Nmm
Strain Gauge    a
Deflection      0.82    mm
Strain using Material Properties        241.29
µStrain
Strain using Deflection Values  254.20  µStrain
```

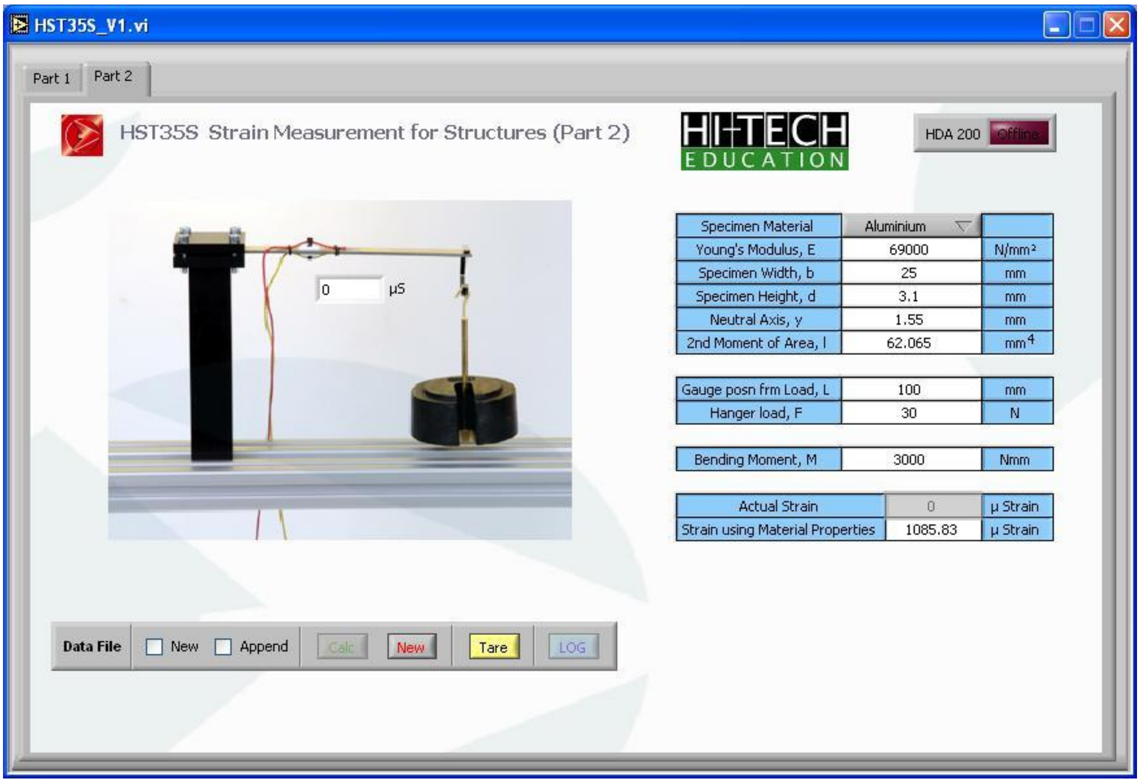
21. If you wish to change the inputs then simply press the NEW button, change the input parameter, press the data file APPEND button and then press CALC. You will be given the data file to append to, choose this and then press ok.
22. The data file should now have the new data saved into it, AND added (appended) to the existing data.
23. In the OFFLINE mode the LOG button will be greyed out. The TARE button although live will not have any function.
24. When finished with the software shut the software down.
25. You can continue to adjust the inputs and see what outputs are obtained by following the same process above.

OFFLINE MODE – Part 2

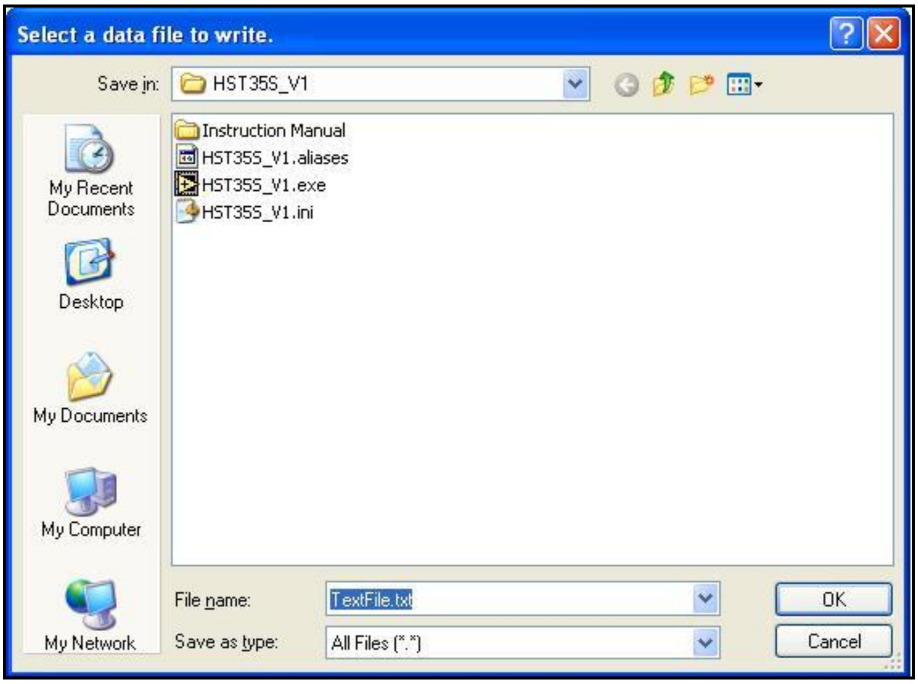
1. Load the experiment software by double clicking the **.exe** files supplied.
2. Choose 'NO' when the pop up window appears asking if the HDA200 is connected.
3. Select the Part 1 tab at the top of the software screen.
4. Choose aluminium as the material. The E value will change automatically.
5. Enter 25 in the specimen width input box.
6. Enter 3.1 in the specimen height input box.
7. The neutral axis and 2nd moment of area will be calculated automatically when the CALC button is pressed later.
8. Enter 100 in the gauge posn frm load, L input box.
9. Enter 30 in the Hanger Load, F input box.
10. Press the CALC button with no data file tick boxes ticked. The screen should appear as follows:

Specimen Material	Aluminium	
Young's Modulus, E	69000	N/mm²
Specimen Width, b	25	mm
Specimen Height, d	3.1	mm
Neutral Axis, y	1.55	mm
2nd Moment of Area, I	62.065	mm⁴
Gauge posn frm Load, L	100	mm
Hanger load, F	30	N
Bending Moment, M	3000	Nmm
Actual Strain	0	µ Strain
Strain using Material Properties	1085.83	µ Strain

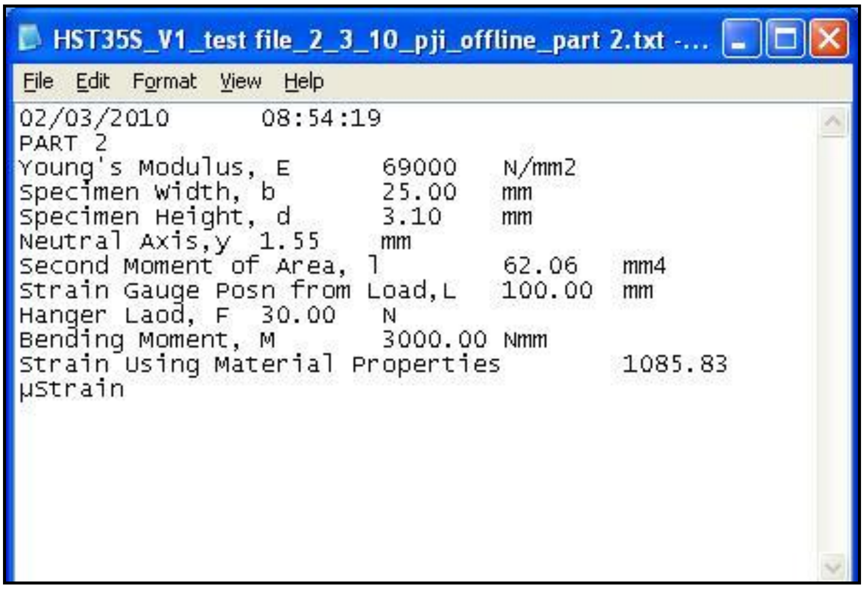
11. The complete screen should look like the following image:



12. The strain using material properties value will be shown in the relevant output box. Also note that the actual strain values are greyed out. This is because you are in 'OFFLINE' mode.
13. Press the NEW button and then tick the Data File NEW box.
14. Press CALC.
15. You will then be shown the following window (**the contents of this window will vary depending on the experiment running**) and prompted to create a data file name in the location of your choice.



16. Either rename the default name of TextFile.txt or keep this default name. Its up to you. Ensure the file extension of ***.txt*** remains. Once the filename and location have been chosen then press **OK**.
17. The input and output data will now be saved in the data file created. To prove this open the text file in ***NOTEPAD*** that you have just created from its location and check the contents. It should look similar to the image below.



18. If you wish to change the inputs then simply press the NEW button, change the input parameter, press the data file APPEND button and then press CALC. You will be given the data file to append to, choose this and then press ok.
19. The data file should now have the new data saved into it, AND added (appended) to the existing data.
20. In the OFFLINE mode the LOG button will be greyed out. The TARE button although live will not have any function.
21. When finished with the software shut the software down.
22. You can continue to adjust the inputs and see what outputs are obtained by following the same process above.

HDA200 CHANNEL SETTINGS and CONNECTIONS

Prior to running this experiment software in ONLINE mode with the HDA200 you will have to make sure that the correct experiment hardware sensors/transducers are connected to the HDA200 and the correct channels are being displayed by the HDA200. Refer to the HDA200 instruction manual and use the following table as a reference also:

Part 1, Strain gauge a:

When running in online mode with strain gauge a only it is important you choose the experiment number HST35a from the menu on the HDA200 (see instruction manual). The screen on the HDA200 to choose the HST35a is shown below:

Sensor/Transducer	HDA200 Connector Number	HDA200 Channel number	Resolution
Strain	Strain 1	01	N/A
Dial Gauge	Dial gauge 1	28	0.01mm

Run the HDA200 in LOCAL mode to check that the above channels only are being displayed. This will then ensure that the software collects the right data from the right channels.

NB: If the dial gauges (if used) are connected but not turned on then the software and HDA200 will not display the dial gauge values and the software and HDA200 screens will wait until they are turned on. Ensure the dial gauges are turned on when running the experiment and software.

If the above channels are not set correctly then you will have to enter the configuration of the HDA200 which will require reading and following the HDA200 instruction manual.

Part 1, Strain gauge b:

When running in online mode with strain gauge a only it is important you choose the experiment number HST35b from the menu on the HDA200 (see instruction manual). The screen on the HDA200 to choose the HST35b is shown below:

Sensor/Transducer	HDA200 Connector Number	HDA200 Channel number	Resolution
Strain	Strain 1	01	N/A

Run the HDA200 in LOCAL mode to check that the above channels only are being displayed. This will then ensure that the software collects the right data from the right channels.

NB: If the dial gauges (if used) are connected but not turned on then the software and HDA200 will not display the dial gauge values and the software and HDA200 screens will wait until they are turned on. Ensure the dial gauges are turned on when running the experiment and software.

If the above channels are not set correctly then you will have to enter the configuration of the HDA200 which will require reading and following the HDA200 instruction manual.

Part 1, Strain gauge b:

When running in online mode with strain gauge a only it is important you choose the experiment number HST35c from the menu on the HDA200 (see instruction manual). The screen on the HDA200 to choose the HST35c is shown below:

Sensor/Transducer	HDA200 Connector Number	HDA200 Channel number	Resolution
Strain	Strain 1	1	
Strain	Strain 2	2	

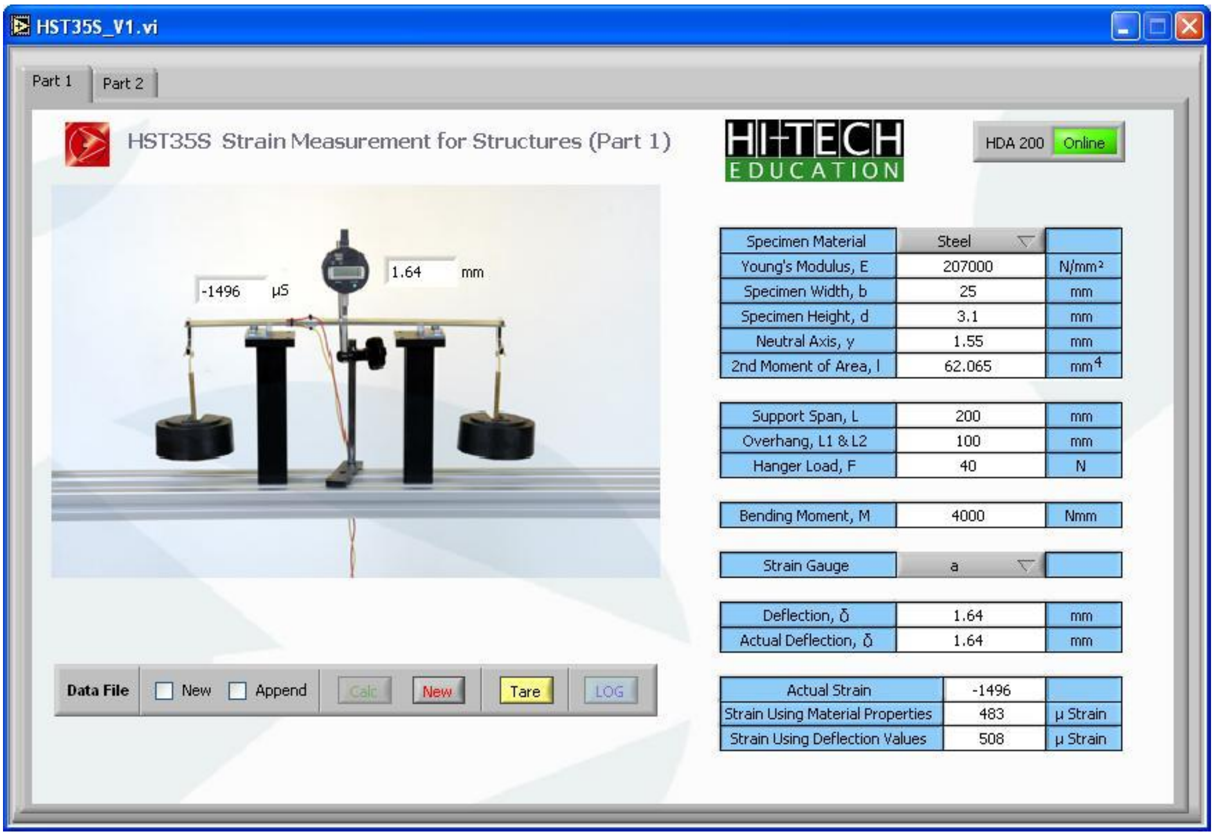
Run the HDA200 in LOCAL mode to check that the above channels only are being displayed. This will then ensure that the software collects the right data from the right channels.

NB: If the dial gauges (if used) are connected but not turned on then the software and HDA200 will not display the dial gauge values and the software and HDA200 screens will wait until they are turned on. Ensure the dial gauges are turned on when running the experiment and software.

If the above channels are not set correctly then you will have to enter the configuration of the HDA200 which will require reading and following the HDA200 instruction manual.

ONLINE MODE

1. Repeat the input parameters from the OFFLINE mode procedure above, press the CALC button and the software window should look like the image below:



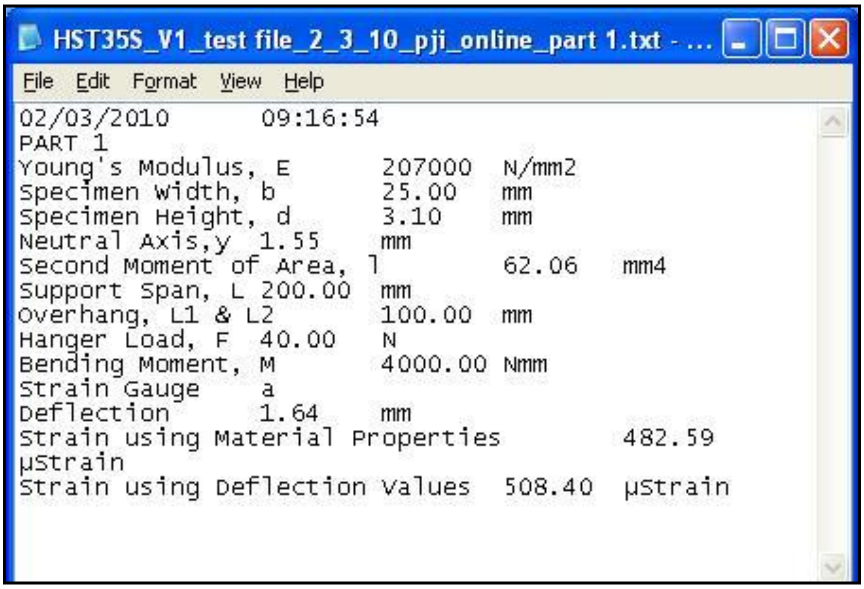
2. In 'ONLINE' mode you will notice that the actual deflection and strain values are no longer greyed out. These values will now start to change as they come in from the HDA200.
3. Load the hardware experiment to the same parameters as the input boxes. You should then be able to compare the actual values with theoretical values.
4. If you wish to save the data into a NEW or existing data file then press NEW to stop the software capturing data from the HDA200.
5. Tick the data file option required.
6. Press the CALC button and you will be prompted to create a new data file or append to the existing file. Choose the option required.
7. The input parameters will then be saved to the data file.
8. Press the LOG button to store the actual values to the data file.
9. Should you change the hardware load to a new value and you wish to change the software inputs then adjust the hardware, press NEW, adjust the software inputs to be the same as the hardware, click the data file APPEND tick box and then press CALC.
10. You can then continue to create new inputs and obtain new outputs depending on how you set up the hardware and by following the procedure above.
11. The graph will be drawn automatically at each load position point, but you must follow the load position points in turn otherwise the graph will appear incorrect and the actual shear centre will not be correct.

DATA FILE CONTENTS

The data file created contains information that is useful in allowing the end user to further manipulate the data in a spreadsheet software.

The image below shows the typical data at the start of the data file for this experiment when a new file has been created and the LOG button has been pressed:

The data is as follows:

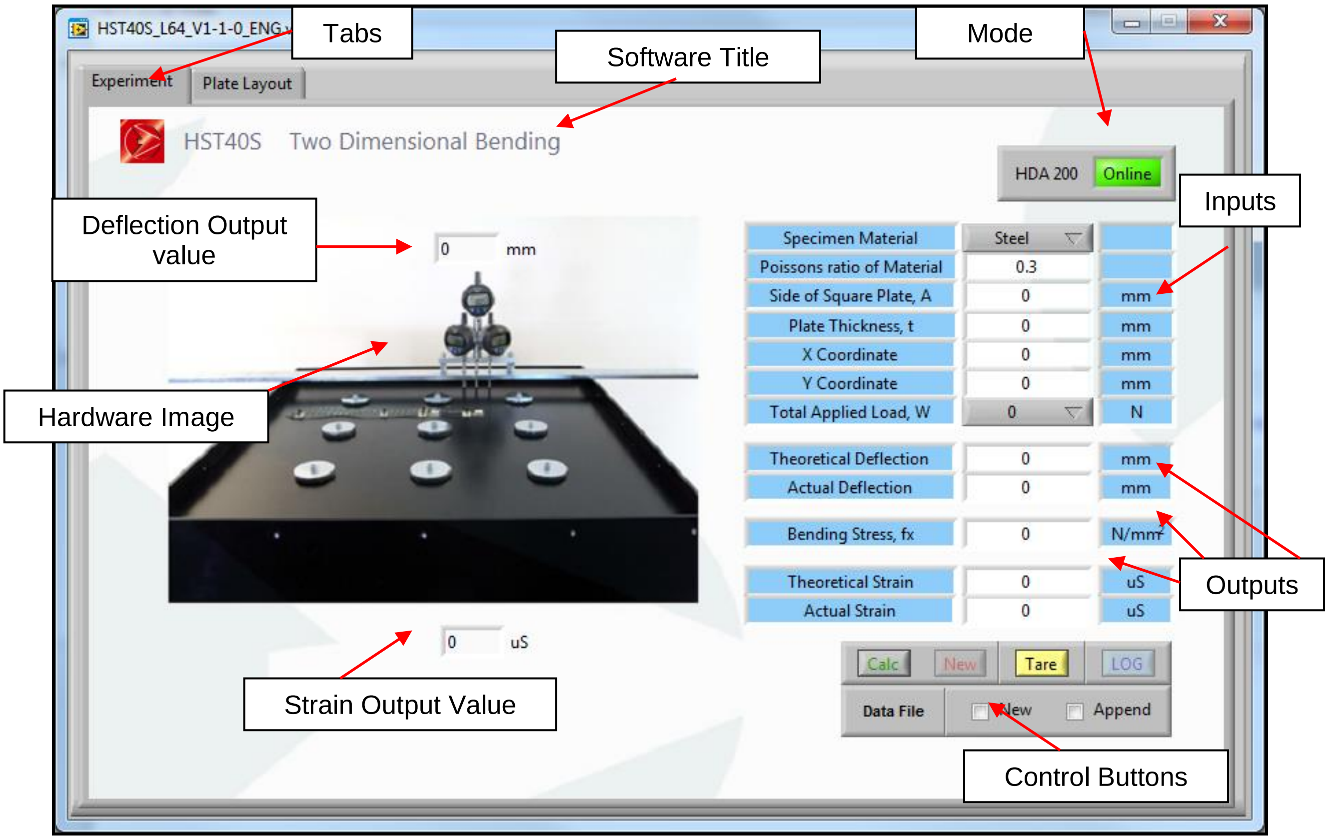



```
02/03/2010      09:16:54
PART 1
Young's Modulus, E      207000  N/mm2
Specimen Width, b       25.00   mm
Specimen Height, d      3.10    mm
Neutral Axis,y  1.55    mm
Second Moment of Area, I        62.06   mm4
Support Span, L 200.00  mm
Overhang, L1 & L2       100.00  mm
Hanger Load, F  40.00   N
Bending Moment, M       4000.00 Nmm
Strain Gauge    a
Deflection      1.64    mm
Strain using Material Properties        482.59
µStrain
Strain using Deflection Values  508.40  µStrain
```

The information will then repeat itself depending on how many test points have been logged.

HST40S – TWO DIMENSIONAL BENDING

SOFTWARE WINDOW – CHANNEL SPECIMEN ONLY

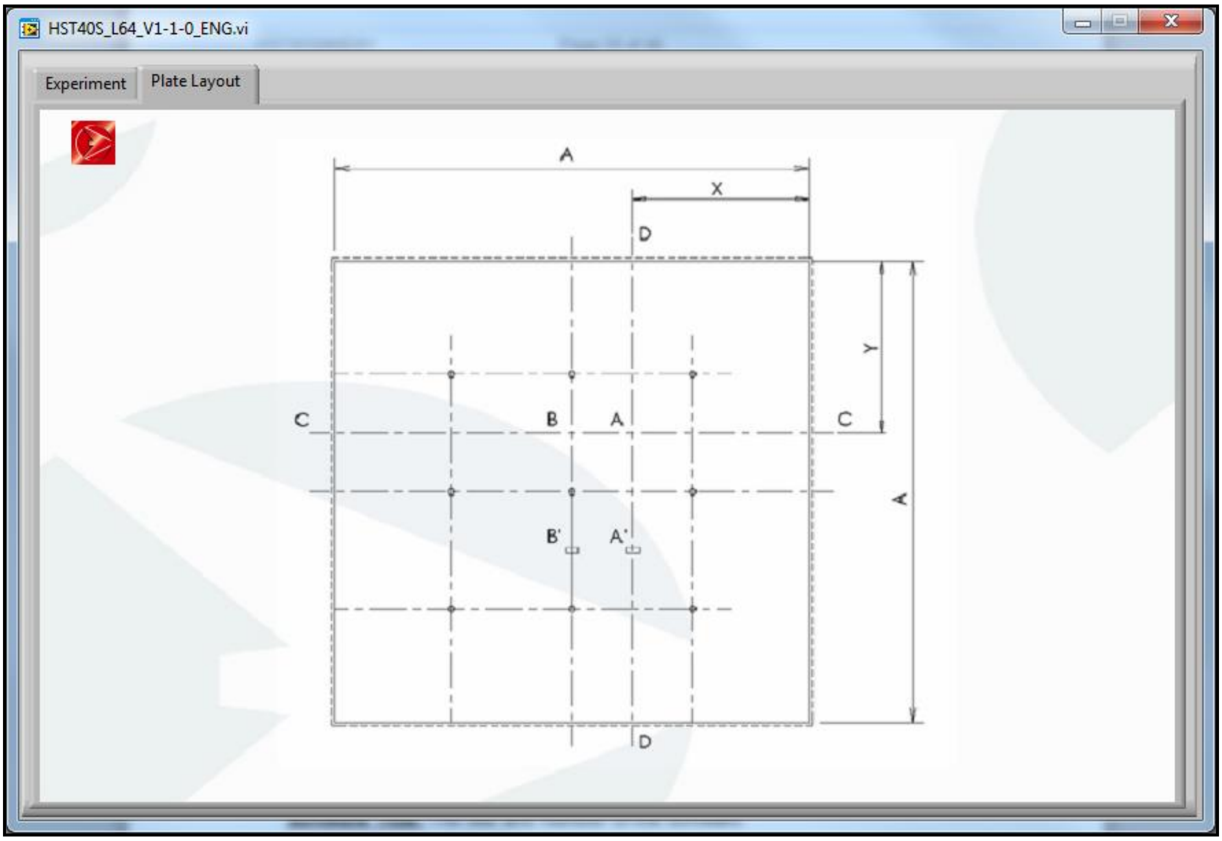


In either mode the details of what is presented in the software window is the same. These are highlighted in the above image and detailed as follows:

Hardware image: This is a true representation of the actual hardware thus ensuring consistency in viewing between software and hardware.

Tabs: The experiment is presented on the tab labelled experiment. The tab labelled Plate layout gives the dimension references. Pressing the tab will jump between one screen and the other.

The plate layout screen is shown below.



Software Title: The title and number of the software.

Mode: This highlights which mode the software is in, i.e. OFFLINE or ONLINE.

Inputs: These boxes allow the end user to input values for the specific parameters listed. The blue boxes on the left hand column show the description of the input and the right hand column blue boxes show the units for these parameters. The central column is where the value is input via the keyboard. It is possible to press the TAB button on the keyboard and the cursor will jump to the next parameter.

The inputs available are as follows:

- **Specimen material:** Choose the material for the specimen.
- **Poissons Ratio:** When the material is chosen, the poisons ratio changes automatically.
- **Side of square plate, A**: Input the side length of the square plate in millimetres.
- **Plate thickness, t**: Input the plate thickness in millimetres.
- **X coordinate**: Input the X coordinate of the strain gauge in millimetres.
- **Y coordinate**: Input the Y coordinate of the strain gauge in millimetres.
- **Total Applied Load, W**: Choose from the list of loads available in Newton's.

Outputs: These are theoretical values and actual values from the hardware based on the input parameters chosen. This is where the end user can compare actual results with theoretical.

The outputs available are as follows:

- **Theoretical Deflection, A:** This is the theoretical deflection at the X and Y coordinates, with units of millimetre.
- **Actual Deflection, A**: This is the actual dial gauge value from the hardware for the X and Y coordinates chosen. It has the units of millimetres.
- **Bending Stress, fx**: At the coordinates chosen the theoretical bending stress is given here. It has the units of Newton's per millimetre squared.
- **Theoretical Strain:** This is the theoretical strain at the X and Y coordinates chosen. This obviously has to be at the X and Y coordinates of the actual strain gauges on the hardware. The units are microstrain (με).
- **Actual Strain:** This is the actual strain value from strain gauge on the harware itself at the X and Y coordinates of the strain gauge chosen. It has units of microstrain (με).

Control buttons: these buttons give the end user a choice of what to do with the software and the values presented on the screen. They are described in more detail as follows:

- **CALC**: When the inputs have been set, pressing this button will calculate the theoretical outputs.
- **NEW**: When this button is pressed it stops background processes and allows any of the inputs to be adjusted and then recalculated. You will have to wait a short time for the background processing to finish. When finished the CALC button becomes live and the NEW button becomes inactive.
- **Tare**: Pressing this button in ON-LINE mode will tare, zero the actual strain gauge value.
- **LOG**: When the end user wishes to record ACTUAL data from the software during ONLINE mode, they can press this button and the key input and output parameters will then be logged into the data file.
- **Data File NEW:** This tick box is used when the end user wishes to store the input and output data to a brand new file on the host computer. When this is ticked and the CALC button pressed you will be prompted to create a new data file. The current input parameters will then be added to the data file chosen.
- **Data file APPEND:** If a data file has already been created then ticking this box will allow data to be added to this file rather than having to create a new file.

NB: You will only be able to choose the New or Append options. You cannot choose both at the same time. It is one or the other.

On the hardware image itself you will see that the deflection will appear above the image and the strain will appear below the image. When in OFFLINE mode these values will remain zero (0). When in ONLINE mode these values will be actual.

OPERATING THE SOFTWARE

The following procedure outlines the steps required to operate the software and to obtain outputs for the inputs chosen. It is one of many variations that could be followed.

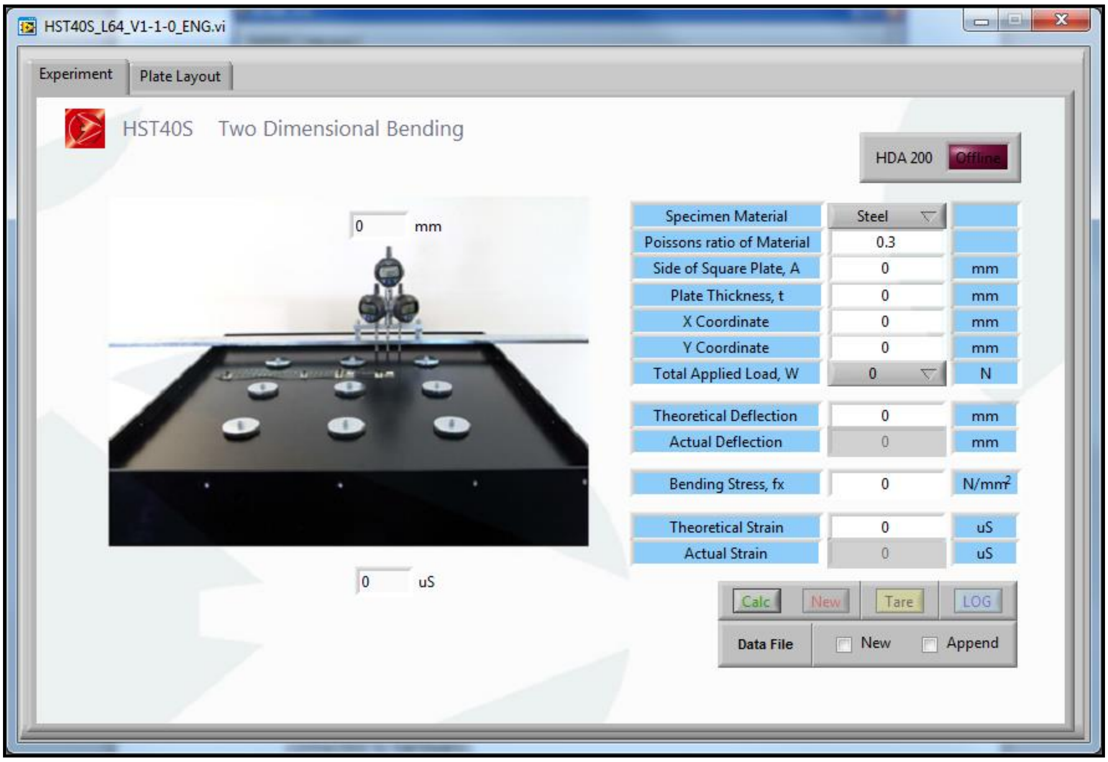
It assumes that the end user has set up the HDA200 (if necessary) and installed the software correctly and all inputs are being undertaken using the keyboard of the host computer.

OFFLINE MODE – CHANNEL SPECIMEN

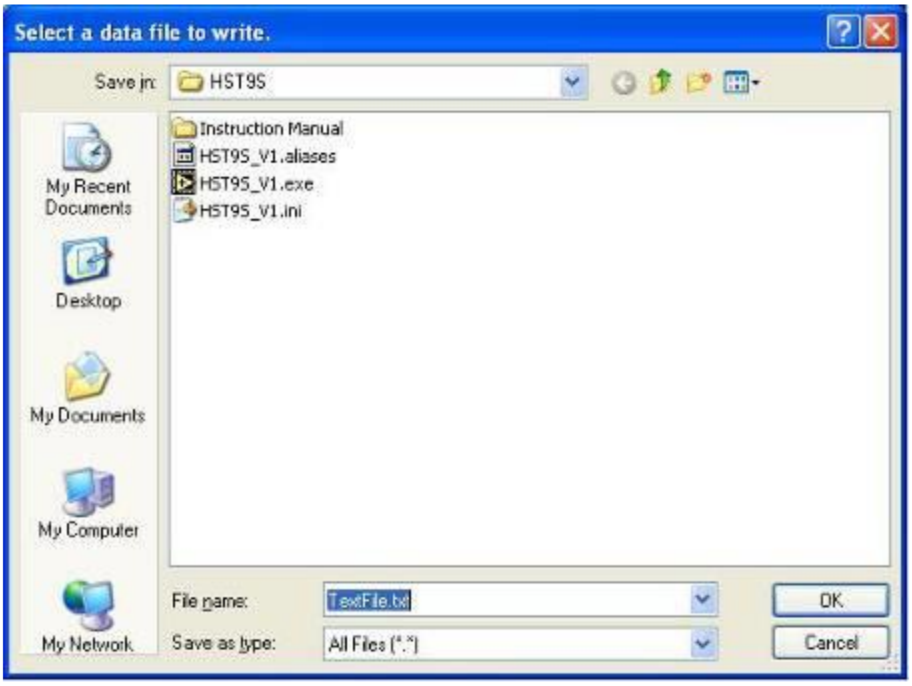
1. Load the experiment software by double clicking the **.exe** files supplied.
2. Choose ‘NO’ when the pop up window appears asking if the HDA200 is connected.
3. Select the experiment tab at the top of the software screen.
4. Choose steel at the material. The poisons ratio will change automatically.
5. Enter 600 in the side of square Plate, A input box.
6. Enter 3.25 in the plate thickness, t input box.
7. Enter 220 in the X coordinate input box.
8. Enter 220 in the Y coordinate input box.
9. Choose 90 from the Total Applied Load, W drop down list.
10. Press the CALC button with no data file tick boxes ticked. The screen should appear as follows:

Specimen Material	Steel	
Poissons ratio of Material	0.3	
Side of Square Plate, A	600	mm
Plate Thickness, t	3.25	mm
X Coordinate	220	mm
Y Coordinate	220	mm
Total Applied Load, W	90	N
Theoretical Deflection, A	0.27	mm
Actual Deflection, A	0	mm
Bending Stress, fx	3.47	N/mm 2
Theoretical Strain	16.9	uS
Actual Strain	0	uS

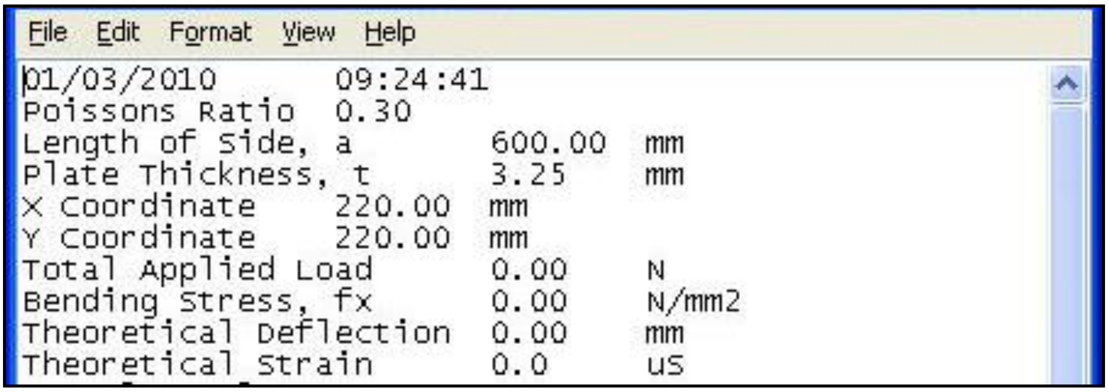
11. The complete screen should look like the following image:



12. The theoretical deflection and strain and bending stress will be shown in the relevant output boxes. Also note that the actual deflection and strain values are greyed out. This is because you are in ‘OFFLINE’ mode.
13. Press the NEW button and then tick the Data File NEW box.
14. Press CALC.
15. You will then be shown the following window (**the contents of this window will vary depending on the experiment running**) and prompted to create a data file name in the location of your choice.



16. Either rename the default name of TextFile.txt or keep this default name. Its up to you. Ensure the file extension of ***.txt*** remains. Once the filename and location have been chosen then press **OK**.
17. The input and output data will now be saved in the data file created. To prove this open the text file in ***NOTEPAD*** that you have just created from its location and check the contents. It should look similar to the image below.



```
File  Edit  Format  View  Help
01/03/2010      09:24:41
Poissons Ratio  0.30
Length of Side, a       600.00  mm
Plate Thickness, t      3.25    mm
X Coordinate    220.00  mm
Y Coordinate    220.00  mm
Total Applied Load      0.00    N
Bending Stress, fx      0.00    N/mm2
Theoretical Deflection  0.00    mm
Theoretical Strain      0.0     uS
```

18. If you wish to change the inputs then simply press the NEW button, change the input parameter, press the data file APPEND button and then press CALC. You will be given the data file to append to, choose this and then press ok.
19. The data file should now have the new data saved into it, AND added (appended) to the existing data.
20. In the OFFLINE mode the LOG button will be greyed out.
21. When finished with the software shut the software down.
22. You can continue to adjust the inputs and see what outputs are obtained by following the same process above.

HDA200 CHANNEL SETTINGS and CONNECTIONS

Prior to running this experiment software in ONLINE mode with the HDA200 you will have to make sure that the correct experiment hardware sensors/transducers are connected to the HDA200 and the correct channels are being displayed by the HDA200. Refer to the HDA200 instruction manual and use the following table as a reference also:

Sensor/Transducer	HDA200 Connector Number	HDA200 Channel number	Resolution
Strain	Strain 1	1	
Strain	Strain 2	2	
Strain	Strain 3	3	
Strain	Strain 4	4	
Dial Gauge	Dial gauge 1	28	0.01mm
Dial Gauge	Dial gauge 2	29	0.01mm
Dial Gauge	Dial gauge 3	30	0.01mm

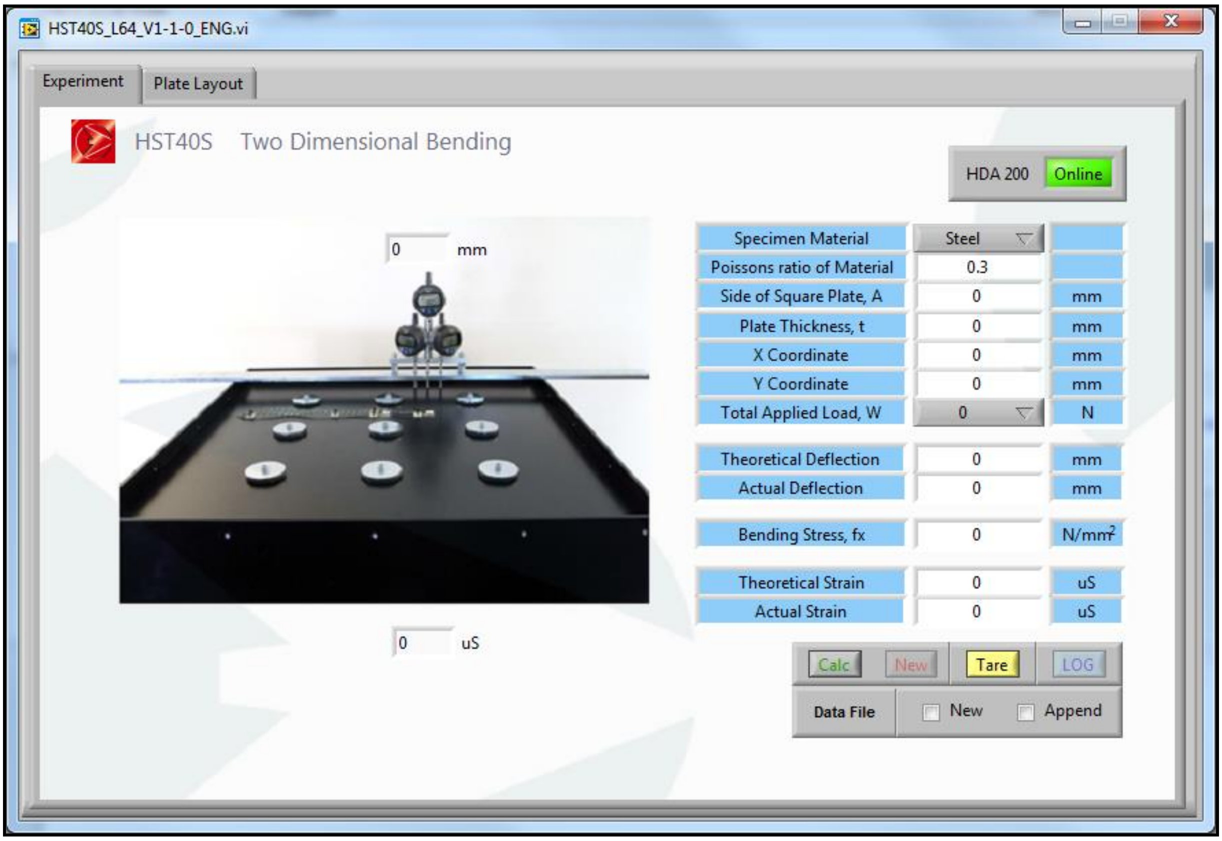
Run the HDA200 in LOCAL mode to check that the above channels only are being displayed. This will then ensure that the software collects the right data from the right channels.

NB: If the dial gauges (if used) are connected but not turned on then the software and HDA200 will not display the dial gauge values and the software and HDA200 screens will wait until they are turned on. Ensure the dial gauges are turned on when running the experiment and software.

If the above channels are not set correctly then you will have to enter the configuration of the HDA200 which will require reading and following the HDA200 instruction manual.

ONLINE MODE

1. Repeat the input parameters from the OFFLINE mode procedure above, press the CALC button and the software window should look like the image below:



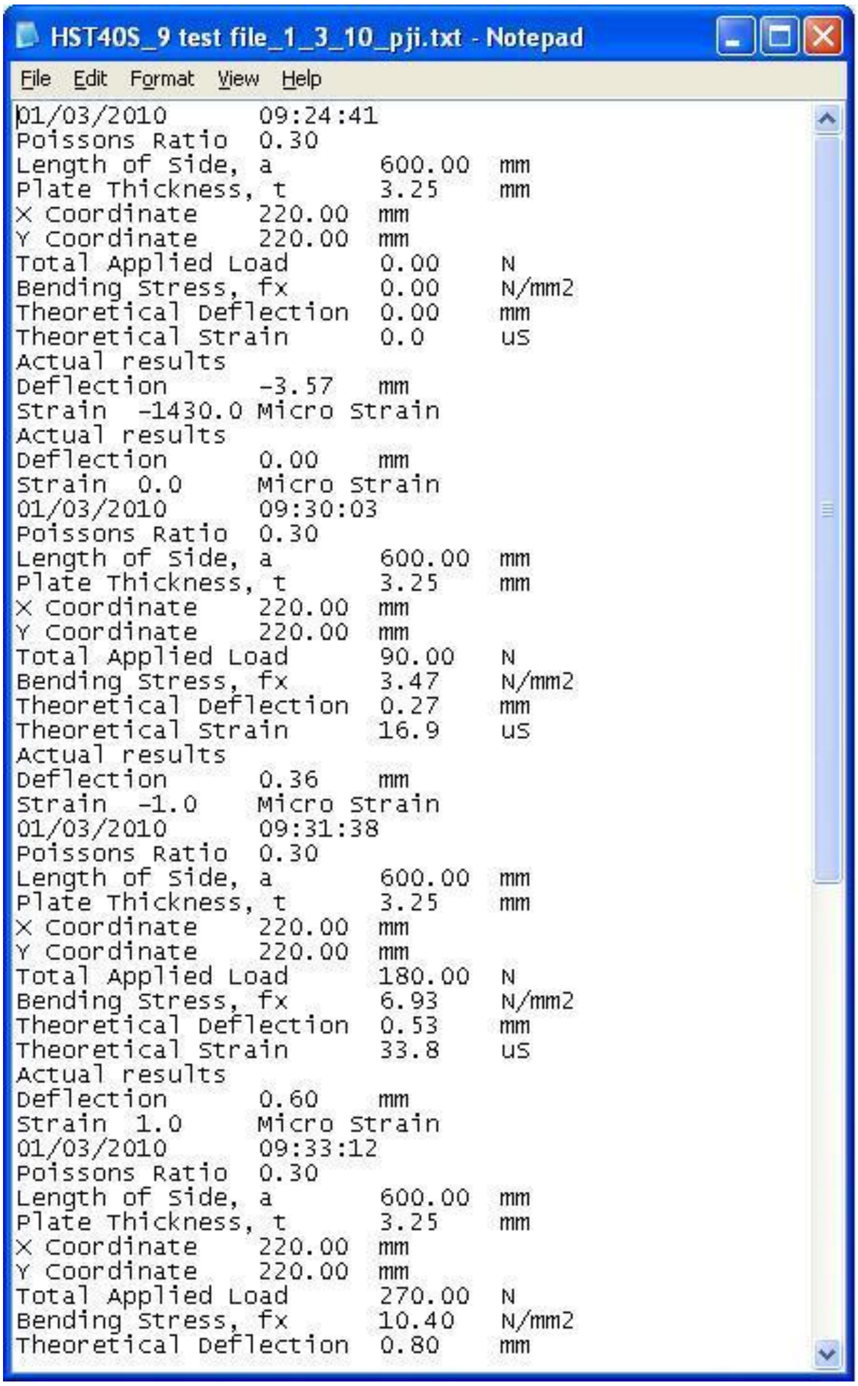
2. In ‘ONLINE’ mode you will notice that the actual deflection and strain values are no longer greyed out. These values will now start to change as they come in from the HDA200.
3. Load the hardware experiment to the same parameters as the input boxes. You should then be able to compare the actual values with theoretical values.
4. If you wish to save the data into a NEW or existing data file then press NEW to stop the software capturing data from the HDA200.
5. Tick the data file option required.
6. Press the CALC button and you will be prompted to create a new data file or append to the existing file. Choose the option required.
7. The input parameters will then be saved to the data file.
8. Press the LOG button to store the actual values to the data file.
9. Should you change the hardware load to a new value and you wish to change the software inputs then adjust the hardware, press NEW, adjust the software inputs to be the same as the hardware, click the data file APPEND tick box and then press CALC.
10. You can then continue to create new inputs and obtain new outputs depending on how you set up the hardware and by following the procedure above.
11. The graph will be drawn automatically at each load position point, but you must follow the load position points in turn otherwise the graph will appear incorrect and the actual shear centre will not be correct.

DATA FILE CONTENTS

The data file created contains information that is useful in allowing the end user to further manipulate the data in a spreadsheet software.

The image below shows the typical data at the start of the data file for this experiment when a new file has been created and the LOG button has been pressed:

The data is as follows:



HST40S_9 test file_1_3_10_pji.txt - Notepad

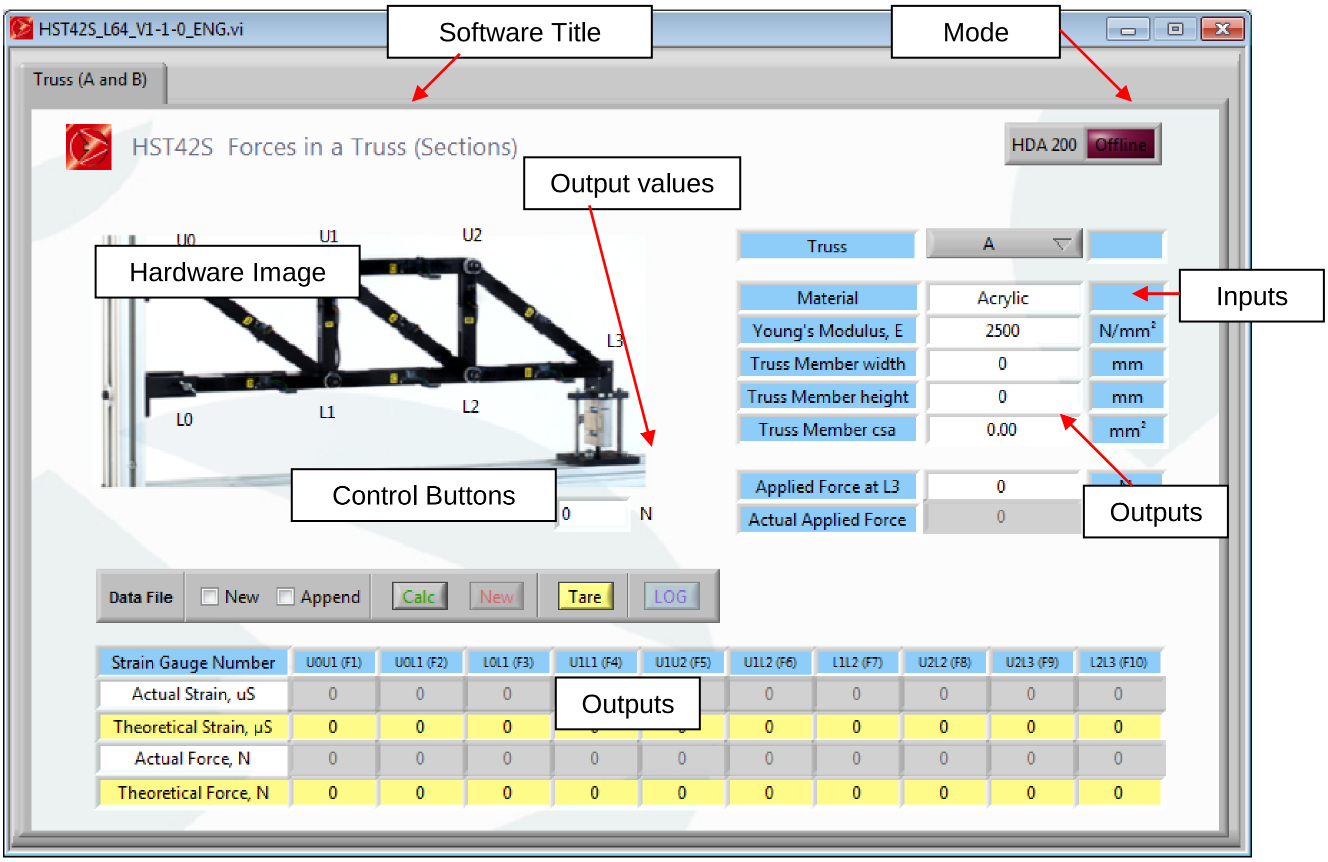
File Edit Format View Help

```
01/03/2010      09:24:41
Poissons Ratio  0.30
Length of Side, a       600.00  mm
Plate Thickness, t      3.25    mm
X Coordinate    220.00  mm
Y Coordinate    220.00  mm
Total Applied Load      0.00    N
Bending Stress, fx      0.00    N/mm2
Theoretical Deflection  0.00    mm
Theoretical Strain      0.0     us
Actual results
Deflection      -3.57   mm
Strain  -1430.0 Micro Strain
Actual results
Deflection      0.00    mm
Strain  0.0     Micro Strain
01/03/2010      09:30:03
Poissons Ratio  0.30
Length of Side, a       600.00  mm
Plate Thickness, t      3.25    mm
X Coordinate    220.00  mm
Y Coordinate    220.00  mm
Total Applied Load      90.00   N
Bending Stress, fx      3.47    N/mm2
Theoretical Deflection  0.27    mm
Theoretical Strain      16.9    us
Actual results
Deflection      0.36    mm
Strain  -1.0    Micro Strain
01/03/2010      09:31:38
Poissons Ratio  0.30
Length of Side, a       600.00  mm
Plate Thickness, t      3.25    mm
X Coordinate    220.00  mm
Y Coordinate    220.00  mm
Total Applied Load      180.00  N
Bending Stress, fx      6.93    N/mm2
Theoretical Deflection  0.53    mm
Theoretical Strain      33.8    us
Actual results
Deflection      0.60    mm
Strain  1.0     Micro Strain
01/03/2010      09:33:12
Poissons Ratio  0.30
Length of Side, a       600.00  mm
Plate Thickness, t      3.25    mm
X Coordinate    220.00  mm
Y Coordinate    220.00  mm
Total Applied Load      270.00  N
Bending Stress, fx      10.40   N/mm2
Theoretical Deflection  0.80    mm
```

The information will then repeat itself depending on how many test points have been logged.

HST42S – FORCES in a TRUSS (SECTIONS)

SOFTWARE WINDOW



The detail of what is presented in the software window is highlighted in the above image and detailed as follows:

Hardware image: This is a true representation of the actual hardware thus ensuring consistency in viewing between software and hardware.

Software Title: The title and number of the software.

Mode: This highlights which mode the software is in, i.e. OFFLINE or ONLINE.

Inputs: These boxes allow the end user to input values for the specific parameters listed. The blue boxes on the left hand column show the description of the input and the right hand column blue boxes show the units for these parameters. The central column is where the value is input via the keyboard. It is possible to press the TAB button on the keyboard and the cursor will jump to the next parameter.

The inputs available are as follows:

- **Truss:** choose which truss you wish to compare. Truss A and B are selectable.
- **Truss Material:** This is fixed for acrylic only and cannot be changed.
- **Young's Modulus, E:** this is fixed for the acrylic material only and cannot be changed.
- **Truss Member Width, w**: This is the value of the horizontal width of each member. Nominally this is 10mm. This value is entered via the keyboard of the host computer.
- **Truss Member Height, h**: This is value of the vertical depth of each member. Nominally this is 25mm. This value is entered via the keyboard of the host computer.
- **Truss Member Area**: This is a calculated value of the nominal cross sectional area of each truss member. It cannot be changed as it is a calculated value.

Outputs: These are theoretical values and actual values from the hardware based on the input parameters chosen. This is where the end user can compare actual results with theoretical.

The outputs available are as follows:

- **Applied Force at L3**: This is the value of the applied force being applied at joint L3 on the hardware. It is enter by the end user via the keyboard. It can be used when comparing actual with theoretical values. In OFFLINE mode this value will appear on the hardware image near joint L3.
- **Actual Applied Load at L3**: This is the value of the applied force to the truss at joint L3, from the actual hardware itself. This will only appear in ONLINE mode, and this value will also appear on the hardware image in ONLINE mode only.

Table underneath the hardware image:

- **Actual Strain:** This is the actual strain from the truss members via the HDA200. In offline mode this value will be greyed out.
- **Theoretical Strain:** This is the theoretical strain from the truss members.
- **Actual Force:** This is the actual force value calculated from the actual strain values form the hardware for the truss members.
- **Theoretical Force:** This is the theoretical force calculated from the theoretical strain for the truss members.

Control buttons: these buttons give the end user a choice of what to do with the software and the values presented on the screen. They are described in more detail as follows:

- **CALC**: When the inputs have been set, pressing this button will calculate the theoretical outputs.
- **NEW**: When this button is pressed it stops background processes and allows any of the inputs to be adjusted and then recalculated. You will have to wait a short time for the background processing to finish. When finished the CALC button becomes live and the NEW button becomes inactive.

- **TARE**: This button is only valid when running in ONLINE mode as when pressed it zeroes (tares) the values from the hardware which are being used in the software.
- **LOG**: When the end user wishes to record ACTUAL data from the software during ONLINE running, they can press this button and the key input and output parameters will then be logged into the data file.
- **Data File NEW:** This tick box is used when the end user wishes to store the input and output data to a brand new file on the host computer. When this is ticked and the CALC button pressed you will be prompted to create a new data file.
- **Data file APPEND:** If a data file has already been created then ticking this box will allow data to be added to this file rather than having to create a new file.

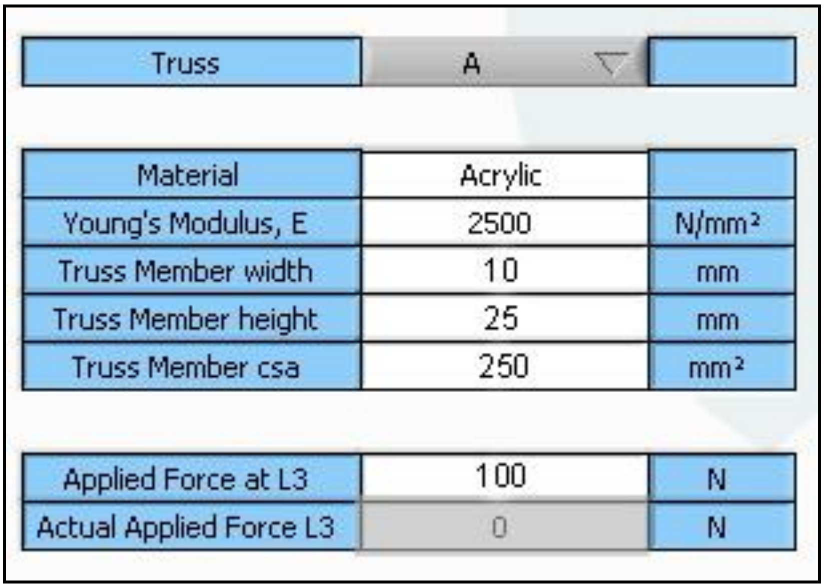
OPERATING THE SOFTWARE

The following procedure outlines the steps required to operate the software and to obtain outputs for the inputs chosen. It is one of many variations that could be followed.

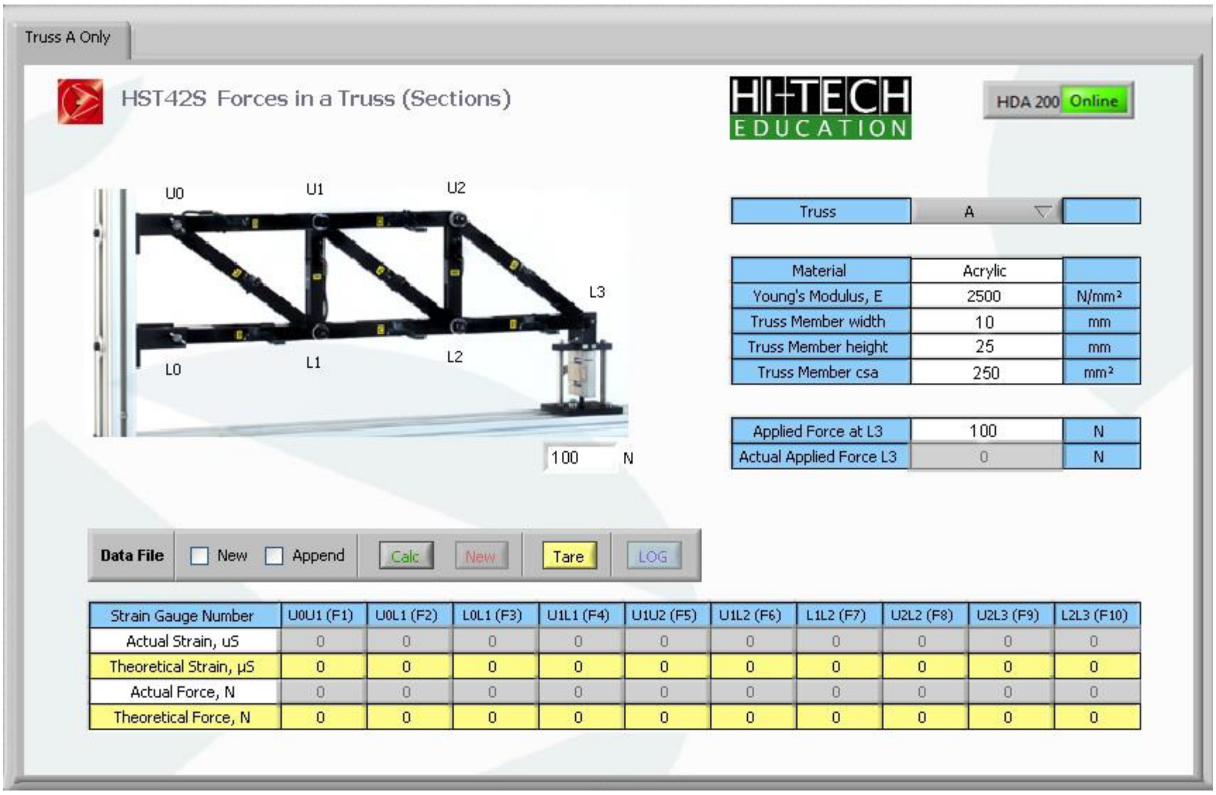
It assumes that the end user has set up the HDA200 (if necessary) and installed the software correctly and all inputs are being undertaken using the keyboard of the host computer.

OFFLINE MODE

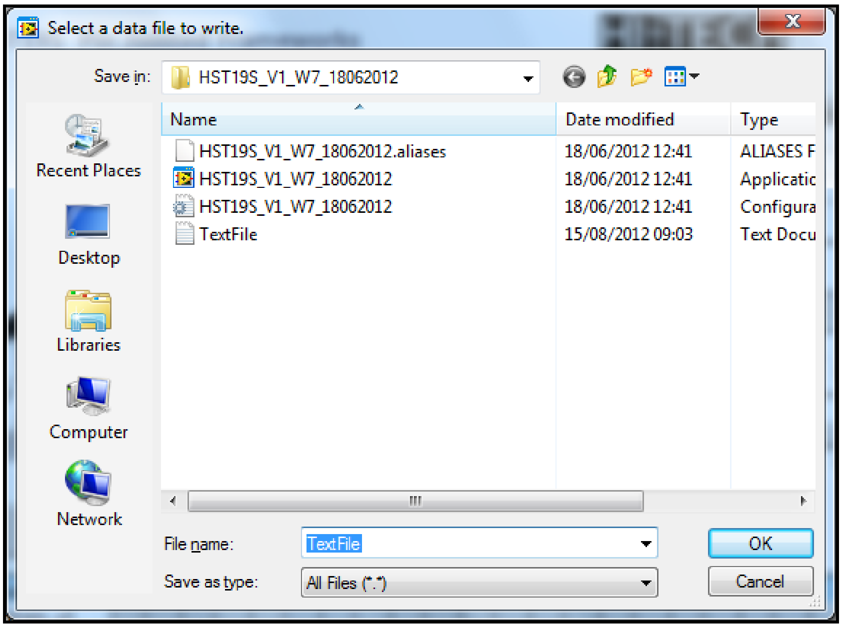
1. Load the experiment software by double clicking the **.exe** files supplied.
2. Choose ‘NO’ when the pop up window appears asking if the HDA200 is connected.
3. Choose which truss you wish to test.
4. Enter 10 in the width, w input box.
5. Enter 25 in the height, h input box.
6. The truss member area will be calculated automatically
7. Enter 100 in the Applied Force, F input box.
8. Press the CALC button with no data file tick boxes ticked. The screen should appear as follows:



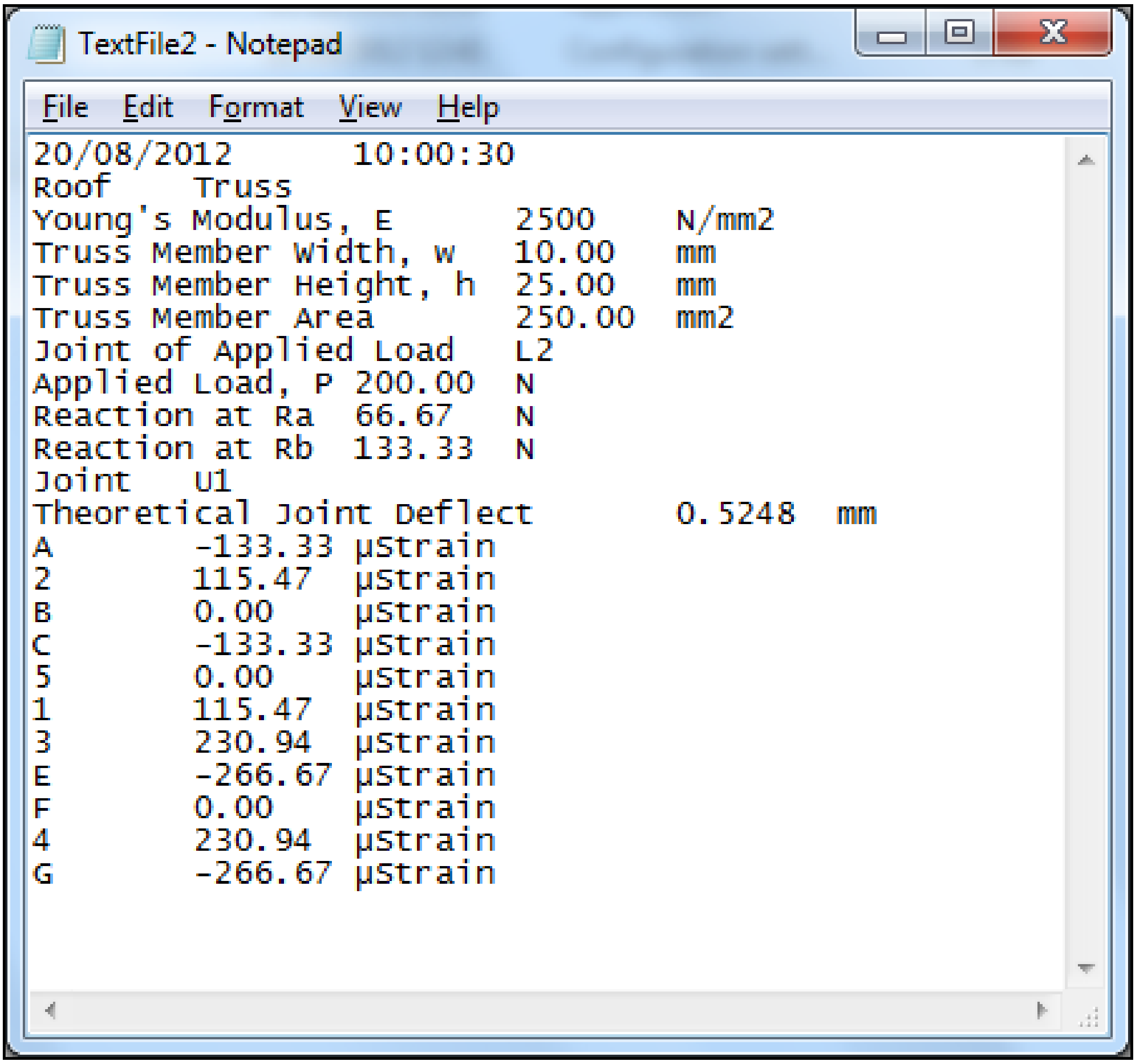
9. The complete screen should look like the following image:



10. The applied load value will be shown on the hardware image next to joint L3. Also note that the actual applied load is greyed out. This is because you are in 'OFFLINE' mode.
11. Press NEW
12. Tick the Data File NEW box.
13. Press CALC.
14. You will then be shown the following window (the contents of this window will vary depending on the experiment running) and prompted to create a data file name in the location of your choice.



15. Either rename the default name of TextFile.txt or keep this default name. It's up to you. Ensure the file extension of ***.txt*** remains. Once the filename and location have been chosen then press **OK**.
16. The input and output data will now be saved in the data file created. To prove this open the text file in ***NOTEPAD*** that you have just created from its location and check the contents. It should look similar to the image below.



20/08/2012	10:00:30		
Roof	Truss		
Young's Modulus, E	2500	N/mm2	
Truss Member Width, w	10.00	mm	
Truss Member Height, h	25.00	mm	
Truss Member Area	250.00	mm2	
Joint of Applied Load	L2		
Applied Load, P	200.00	N	
Reaction at Ra	66.67	N	
Reaction at Rb	133.33	N	
Joint	U1		
Theoretical Joint Deflect		0.5248	mm
A	-133.33	µStrain	
2	115.47	µStrain	
B	0.00	µStrain	
C	-133.33	µStrain	
5	0.00	µStrain	
1	115.47	µStrain	
3	230.94	µStrain	
E	-266.67	µStrain	
F	0.00	µStrain	
4	230.94	µStrain	
G	-266.67	µStrain	

17. If you wish to change the inputs then simply press the NEW button, change the input parameter, press the data file NEW button to clear it, press the data file APPEND button and then press CALC. You will be given the data file to append to, choose this and then press ok.
18. In the OFFLINE mode the TARE button although live will not perform any function. The LOG button will not be live and greyed out but the data can still be stored by the use of the CALC button.
19. When finished with the software shut the software down.
20. You can continue to adjust the inputs and see what outputs are obtained by following the same process above.

HDA200 CHANNEL SETTINGS and CONNECTIONS

Prior to running this experiment software in ONLINE mode with the HDA200 you will have to make sure that the correct experiment hardware sensors/transducers are connected to the HDA200 and the correct channels are being displayed by the HDA200. Refer to the HDA200 instruction manual and use the following table as a reference also:

Sensor/Transducer	HDA200 Connector Number	HDA200 Channel number	
Strain Gauge 1	Strain 01	01	
Strain Gauge 2	Strain 02	02	
Strain Gauge 3	Strain 03	03	
Strain Gauge 4	Strain 04	04	
Strain Gauge 5	Strain 05	05	
Strain Gauge 6	Strain 06	06	
Strain Gauge 7	Strain 07	07	
Strain Gauge 8	Strain 08	08	
Strain Gauge 9	Strain 09	09	
Strain Gauge 10	Strain 10	10	
Force	Force 1	17	

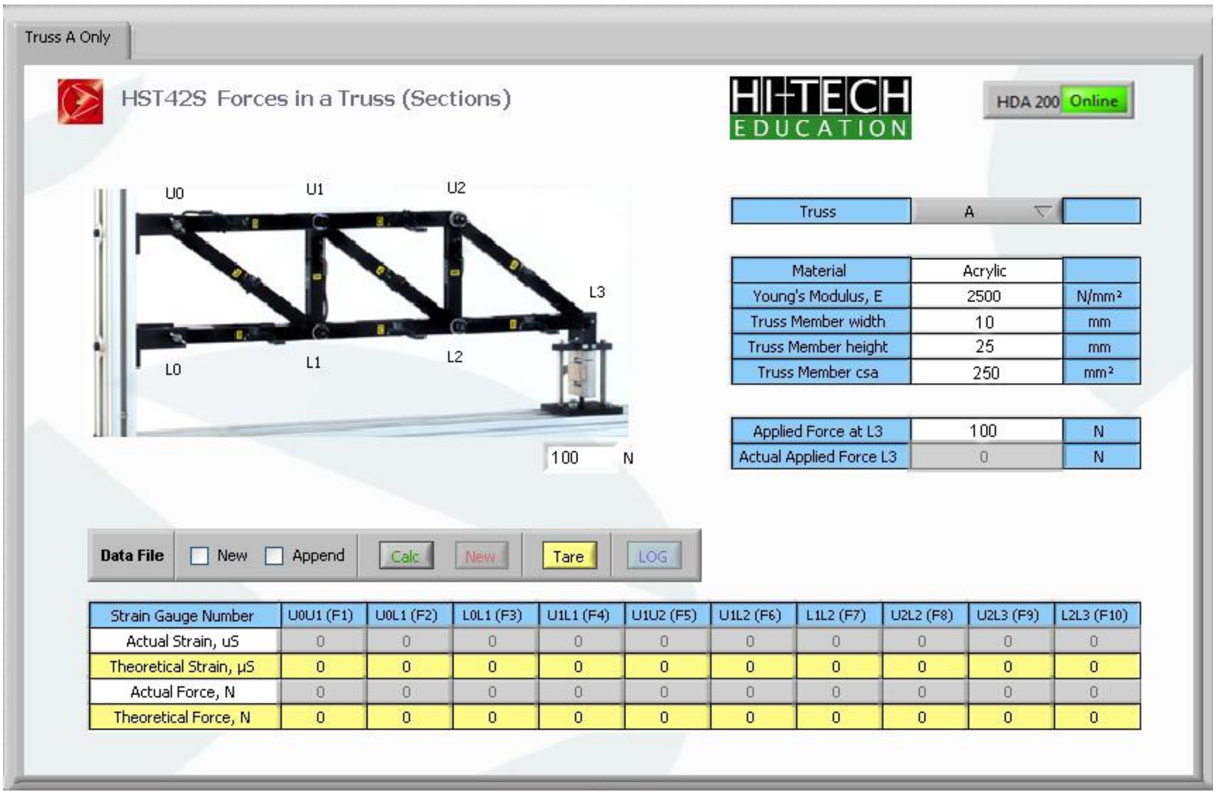
Run the HDA200 in LOCAL mode to check that the above channels only are being displayed. This will then ensure that the software collects the right data from the right channels.

NB: If the dial gauges (if used) are connected but not turned on then the software and HDA200 will not display the dial gauge values and the software and HDA200 screens will wait until they are turned on. Ensure the dial gauges are turned on when running the experiment and software.

If the above channels are not set correctly then you will have to enter the configuration of the HDA200 which will require reading and following the HDA200 instruction manual.

ONLINE MODE

1. Repeat the input parameters from the OFFLINE mode procedure above, press the CALC button and the software window should look like the image below:



2. In ‘ONLINE’ mode you will notice that the actual applied load, deflection, force and strains are not greyed out. These values will now start to change as they come in from the HDA200.
3. The strains and applied load will not be zero. To zero these readings simply press the TARE button. You may have to press it again if the reading does not return to zero. The deflection values will not zero. These have to be zeroed on the front of the dial gauge itself.
4. Load the hardware experiment to the same parameters as the input boxes. You should then be able to compare the actual values with theoretical values.
5. If you wish to save the data into a NEW or existing data file then press NEW to stop the software capturing data from the HDA200.
6. Tick the data file option required.
7. Press the CALC button and you will be prompted to create a new data file or append to the existing file. Choose the option required.
8. The current theoretical input and output values will then be saved to the data file.
9. Press the LOG button to store the actual values to the data file.
10. Should you change the hardware load to a new value and you wish to change the software inputs then adjust the hardware, press NEW, adjust the software inputs to be the same as the hardware, click the data file APPEND tick box and then press CALC.
11. You can then continue to create new inputs and obtain new outputs depending on how you set up the hardware and by following the procedure above.

DATA FILE CONTENTS

The data file created contains information that is useful in allowing the end user to further manipulate the data in a spreadsheet software.

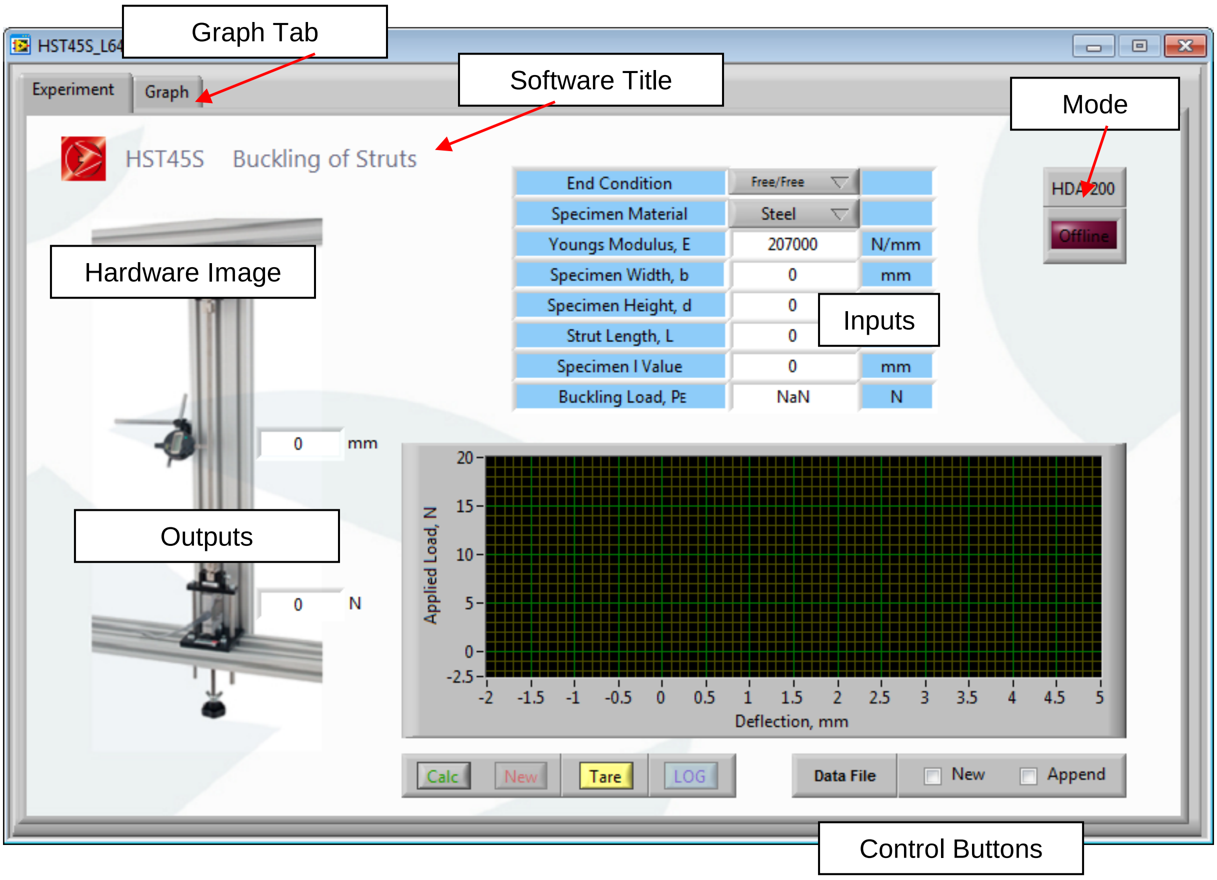
The image below shows the typical data at the start of the data file for this experiment when a new file has been created and the LOG button has been pressed:

```
TextFile - Notepad
File  Edit  Format  View  Help
15/08/2012      08:31:05
Roof    Truss
Young's Modulus, E      2500    N/mm2
Truss Member Width, w   10.00   mm
Truss Member Height, h  25.00   mm
Truss Member Area       250.00  mm2
Joint of Applied Load   L2
Applied Load, P 20.00   N
Reaction at Ra  6.67    N
Reaction at Rb  13.33   N
Joint   U1
Theoretical Joint Deflect       0.0525  mm
A       -13.33  µstrain
2       11.55   µstrain
B       0.00    µstrain
C       -13.33  µstrain
5       0.00    µstrain
1       11.55   µstrain
3       23.09   µstrain
E       -26.67  µstrain
F       0.00    µstrain
4       23.09   µstrain
G       -26.67  µstrain
Actual results
A       0.00    µstrain
2       0.00    µstrain
B       0.00    µstrain
C       -1.00   µstrain
5       0.00    µstrain
1       0.00    µstrain
3       0.00    µstrain
E       0.00    µstrain
F       0.00    µstrain
4       0.00    µstrain
G       0.00    µstrain
Actual Aplied Load, P   -21.20  N
Actual Joint Deflection 0.63    mm
Actual results
A       -1.00   µstrain
2       -2.00   µstrain
B       -2.00   µstrain
C       -2.00   µstrain
5       -2.00   µstrain
1       -2.00   µstrain
3       -2.00   µstrain
E       -2.00   µstrain
F       -2.00   µstrain
4       -3.00   µstrain
```

The information will then repeat itself depending on how many test points have been logged.

HST45S – BUCKLING of STRUTS

SOFTWARE WINDOW



In either mode the details of what is presented in the software window is the same. These are highlighted in the above image and detailed as follows:

Hardware image: This is a true representation of the actual hardware thus ensuring consistency in viewing between software and hardware.

Graph Tab: This allows a larger version of the captured graph to be displayed.

Software Title: The title and number of the software.

Mode: This highlights which mode the software is in, i.e. OFFLINE or ONLINE.

Inputs: These boxes allow the end user to input values for the specific parameters listed. The blue boxes on the left hand column show the description of the input and the right hand column blue boxes show the units for these parameters. The central column is where the value is input via the keyboard. It is possible to press the TAB button on the keyboard and the cursor will jump to the next parameter.

The inputs available are as follows:

- **End condition:** Choose the end condition applied to the strut specimen. Choices are Free/Free, Fixed/Free and Fixed/Fixed.
- **Specimen material:** Choose the specimen material.
- **Young's Modulus, E**: This changes automatically with the material choice.
- **Specimen Width, b**: Enter the specimen width in millimetres.
- **Specimen Height, d**: Enter the specimen height in millimetres.
- **Strut Length**: Enter the length of the strut specimen being tested.
- **Specimen I value**: Calculated value based on the width and height of the material entered.
- **Buckling Load, P_E**: Calculated automatically.

Outputs: These are actual values from the hardware. The end user can use these values to log them into the data file and plot a graph, thus observing the buckling load and comparing it with the theoretical value.

The outputs available are as follows:

- **Deflection:** This is the actual deflection from the hardware dial gauge
- **Applied Force:** This is the actual applied force from the hardware.

Control buttons: these buttons give the end user a choice of what to do with the software and the values presented on the screen. They are described in more detail as follows:

- **CALC**: When the inputs have been set, pressing this button will calculate the theoretical outputs.
- **NEW**: When this button is pressed it stops background processes and allows any of the inputs to be adjusted and then recalculated. You will have to wait a short time for the background processing to finish. When finished the CALC button becomes live and the NEW button becomes inactive.
- **LOG**: When the end user wishes to record ACTUAL data from the software during ONLINE running, they can press this button and the key input and output parameters will then be logged into the data file.
- **Data File NEW:** This tick box is used when the end user wishes to store the input and output data to a brand new file on the host computer. When this is ticked and the CALC button pressed you will be prompted to create a new data file. You can only choose this button or the append button, not both.
- **Data file APPEND:** If a data file has already been created then ticking this box will allow data to be added to this file rather than having to create a new file.

OPERATING THE SOFTWARE

The following procedure outlines the steps required to operate the software and to obtain outputs for the inputs chosen. It is one of many variations that could be followed.

It assumes that the end user has set up the HDA200 (if necessary) and installed the software correctly and all inputs are being undertaken using the keyboard of the host computer.

OFFLINE MODE

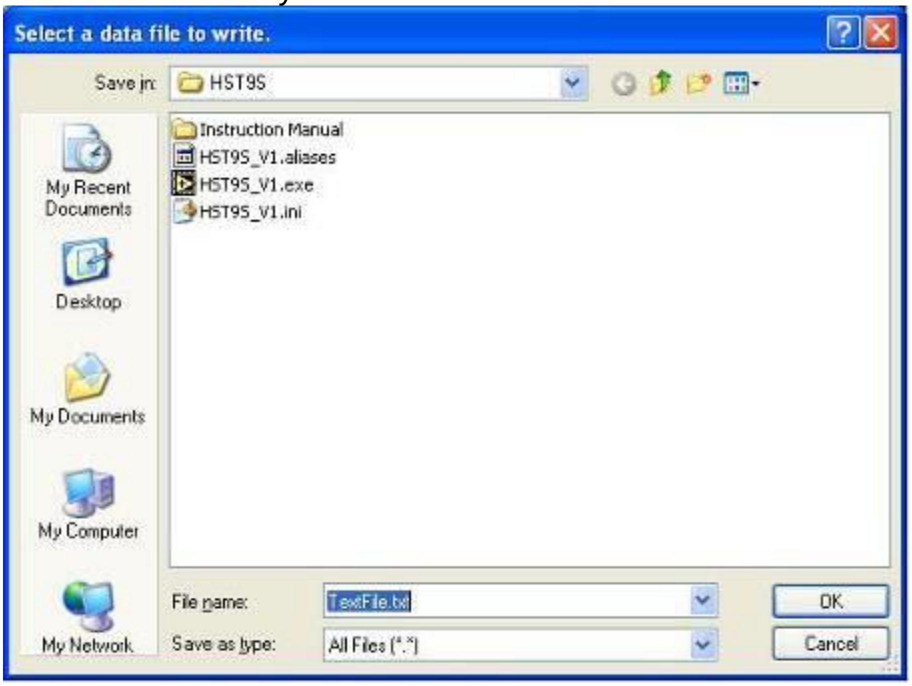
1. Load the experiment software by double clicking the **.exe** files supplied.
2. Choose ‘NO’ when the pop up window appears asking if the HDA200 is connected.
3. Select the end condition as Free/Free.
4. Select the specimen material. The E value will change automatically.
5. Enter 25.08 in the specimen width input box.
6. Enter 1.64 in the specimen height input box.
7. Enter 500 in the strut length input box.
8. Press the CALC button with no data file tick boxes ticked. The screen should appear as follows:

End Condition	Free/Free	
Specimen Material	Steel	
Youngs Modulus, E	207000	N/mm
Specimen Width, b	25.08	mm
Specimen Height, d	1.64	mm
Strut Length, L	500	mm^4
Specimen I Value	9.22	mm
Buckling Load, P_E	75.34	N

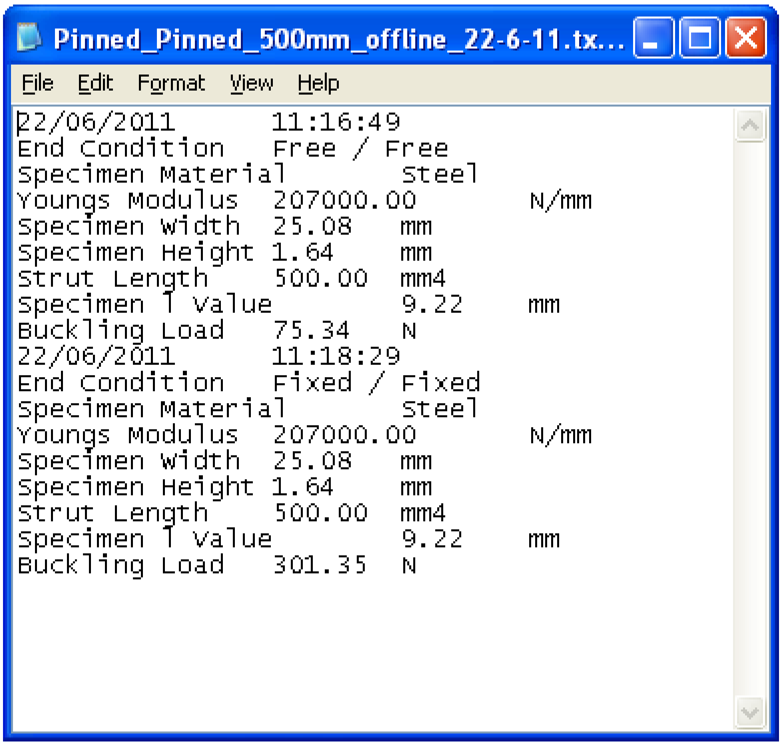
You will notice that the specimen I value and the buckling load, P_E will be filled in.

9. By varying the input parameters and end conditions the user can obtain theoretical PE values for a wide variety of conditions.
10. Press the NEW button
11. Tick the Data File NEW box.
12. Press CALC.

13. You will then be shown the following window (the contents of this window will vary depending on the experiment running) and prompted to create a data file name in the location of your choice.



14. Either rename the default name of TextFile.txt or keep this default name. Its up to you. Ensure the file extension of ***.txt*** remains. Once the filename and location have been chosen then press **OK**.
15. The input and output data will now be saved in the data file created. To prove this open the text file in ***NOTEPAD*** that you have just created from its location and check the contents. It should look similar to the image below.


Pinned_Pinned_500mm_offline_22-6-11.tx...

File Edit Format View Help

```
22/06/2011      11:16:49
End Condition   Free / Free
Specimen Material       Steel
Youngs Modulus  207000.00       N/mm
Specimen Width  25.08   mm
Specimen Height 1.64    mm
Strut Length    500.00  mm4
Specimen I Value        9.22    mm
Buckling Load   75.34   N
22/06/2011      11:18:29
End Condition   Fixed / Fixed
Specimen Material       Steel
Youngs Modulus  207000.00       N/mm
Specimen Width  25.08   mm
Specimen Height 1.64    mm
Strut Length    500.00  mm4
Specimen I Value        9.22    mm
Buckling Load   301.35  N
```

16. If you wish to change the inputs then simply press the NEW button, change the input parameter, press the data file APPEND button and then press CALC. You will be given the data file to append to, choose this and then press ok.

17. The data file should now have the new data saved into it, AND added (appended) to the existing data.
18. In the OFFLINE mode the LOG button will be greyed out.
19. When finished with the software shut the software down.
20. You can continue to adjust the inputs and see what outputs are obtained by following the same process above.

HDA200 CHANNEL SETTINGS and CONNECTIONS

Prior to running this experiment software in ONLINE mode with the HDA200 you will have to make sure that the correct experiment hardware sensors/transducers are connected to the HDA200 and the correct channels are being displayed by the HDA200. Refer to the HDA200 instruction manual and use the following table as a reference also:

Sensor/Transducer	HDA200 Connector Number	HDA200 Channel number	Resolution
Load Cell	Force 1	17	
Gauge	Dial gauge 1	28	0.01mm

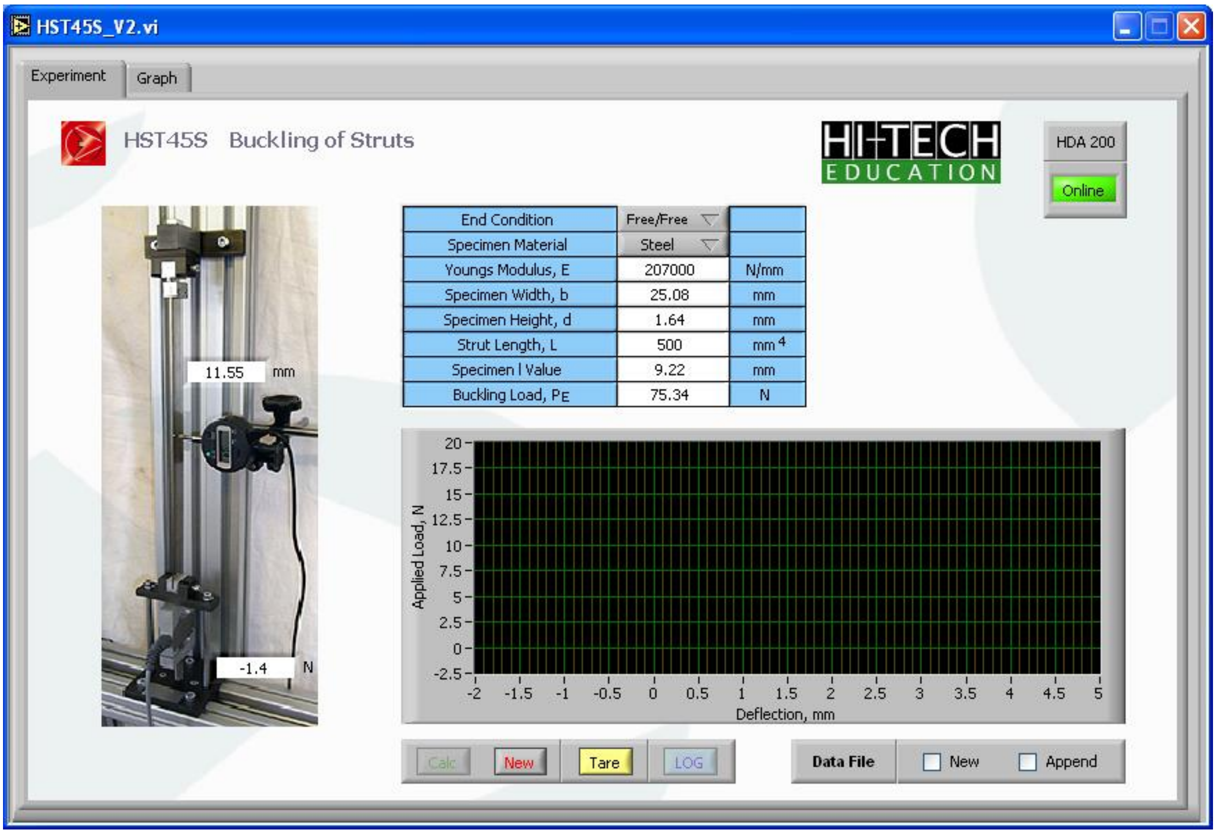
Run the HDA200 in LOCAL mode to check that the above channels only are being displayed. This will then ensure that the software collects the right data from the right channels.

NB: If the dial gauges (if used) are connected but not turned on then the software and HDA200 will not display the dial gauge values and the software and HDA200 screens will wait until they are turned on. Ensure the dial gauges are turned on when running the experiment and software.

If the above channels are not set correctly then you will have to enter the configuration of the HDA200 which will require reading and following the HDA200 instruction manual.

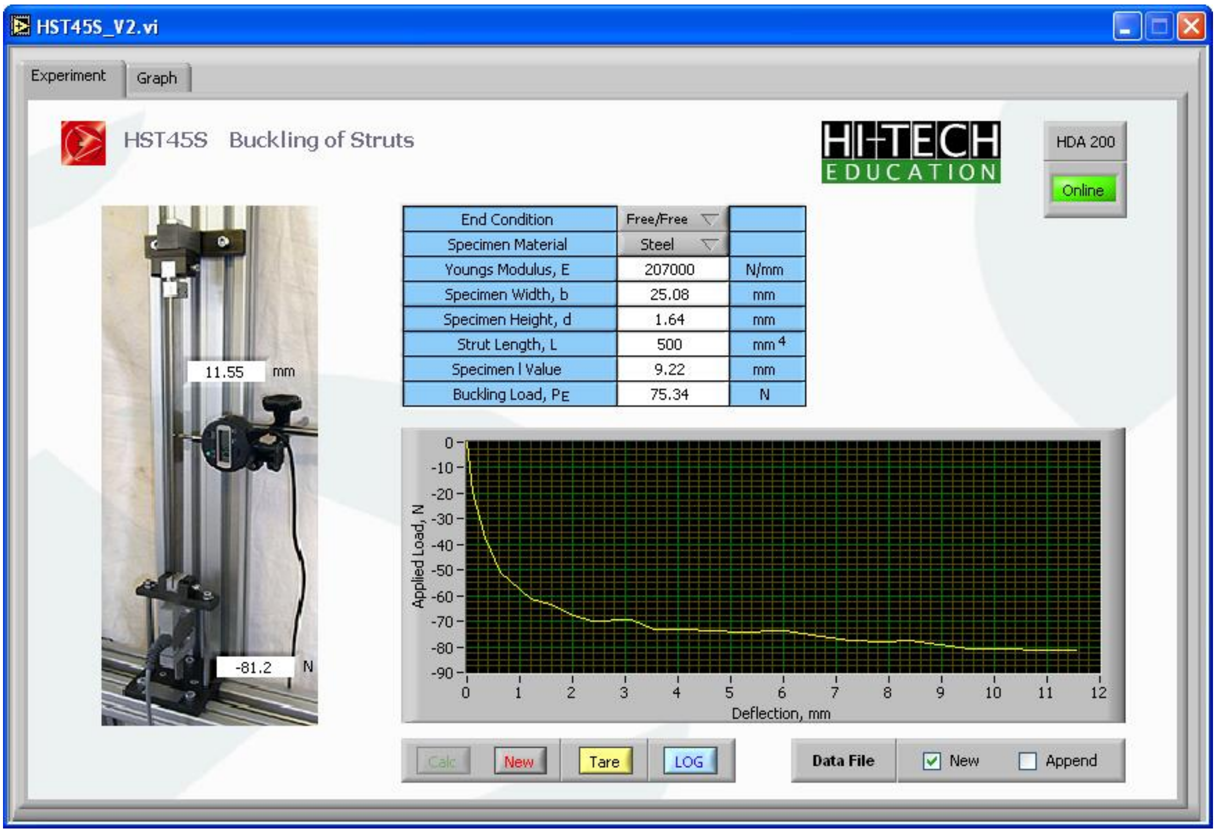
ONLINE MODE

1. Repeat the input parameters from the OFFLINE mode procedure above, press the CALC button and the software window should look like the image below:



2. Load the hardware experiment as per a procedure within the HST45 instruction manual.
3. If you wish to save the data into a NEW or existing data file then press NEW to stop the software capturing data from the HDA200.
4. Tick the data file option required.
5. Press the CALC button and you will be prompted to create a new data file or append to the existing file. Choose the option required.
6. The input parameters will then be saved to the data file.
7. Press the LOG button to store the actual values to the data file.
8. A graph will start to be created as you run through the test. A data point is created on the graph each time the LOG button is pressed.
9. A larger version of the graph is created and can be viewed if the Graph tab is pressed.

10. An example of a graph created during online mode is as follows:

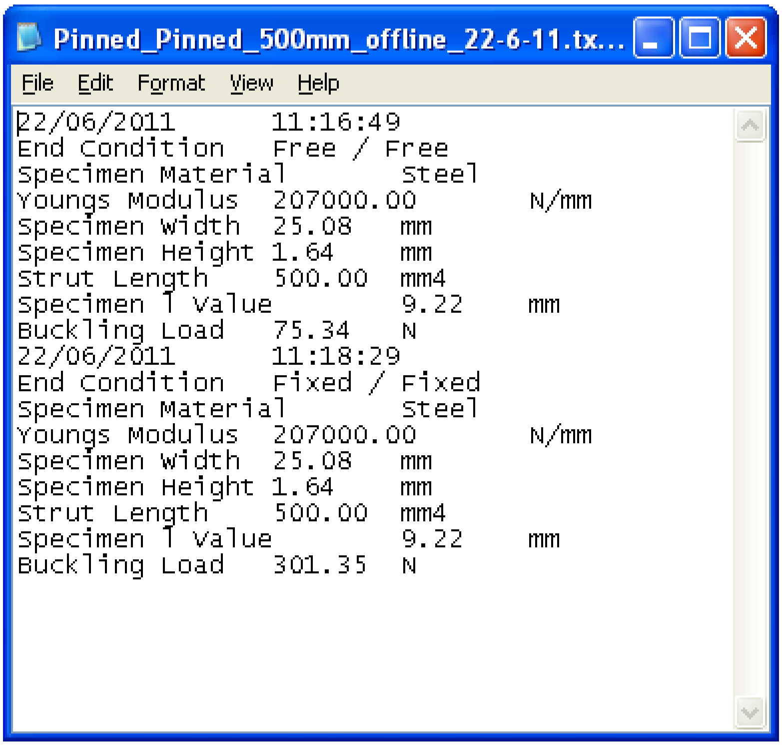


DATA FILE CONTENTS

The data file created contains information that is useful in allowing the end user to further manipulate the data in a spreadsheet software.

The image below shows the typical data at the start of the data file for this experiment when a new file has been created and the LOG button has been pressed at each load position increment:

The data is as follows:




```
22/06/2011      11:16:49
End Condition   Free / Free
Specimen Material       Steel
Youngs Modulus  207000.00       N/mm
Specimen Width  25.08   mm
Specimen Height 1.64    mm
Strut Length    500.00  mm4
Specimen I Value        9.22    mm
Buckling Load   75.34   N
22/06/2011      11:18:29
End Condition   Fixed / Fixed
Specimen Material       Steel
Youngs Modulus  207000.00       N/mm
Specimen Width  25.08   mm
Specimen Height 1.64    mm
Strut Length    500.00  mm4
Specimen I Value        9.22    mm
Buckling Load   301.35  N
```

The information will then repeat itself depending on how many test points have been logged.

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