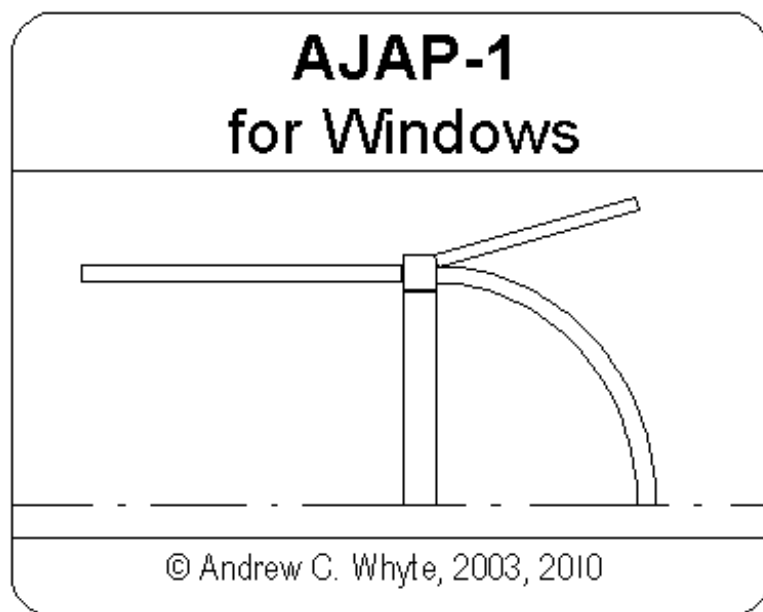


Addendum to BASIC DISCONTINUITY ANALYSIS
of Multishell Axisymmetric Junctions

by

Andrew C. Whyte



AJAP for Windows

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1. Scope.

This addendum describes the features of the Windows version of the Axisymmetric Junction Analysis Program AJAP-1. Information on running and using this Windows version is presented, and those parts of the textbook: 'Basic Discontinuity Analysis of Multishell Axisymmetric Junctions' (reference 1) that are not relevant to the Windows version are briefly discussed in Appendix 1.

2. Introduction.

AJAP-1 is an engineering stress analysis program that will carry out a classical multishell discontinuity analysis. The program is ideal for students, academics, design engineers and stress analysts in the pressure vessel, boiler, mechanical, civil engineering and aircraft industries who require an understanding of discontinuity analysis and a means of analysing the stresses on a microcomputer.

A DOS version (version 1.3) of the program has been available for many years. A new Windows version (version 1.4) has been developed and compiled using Microsoft Visual Basic that can replace the DOS version. Note however that the DOS version is still valid and bona fide as this Windows version does not do anything different, in an engineering sense, from the DOS version.

As before the program should be used with the textbook, reference 1. It is essential that the book sections on limitations, program defaults and input data instructions be read and understood before using the program for practical applications. It should also be mentioned that when carrying out an assessment to a pressure vessel code or specification, such as BS5500 (now BS PD 5500), reference to the latest version of the code should be followed as there will have been detailed changes and additions to the code since the textbook was written.

3. Additional Features.

The main additional features of this Windows version are:

1. A Graphic User Interface.
2. A compiled executable file i.e. a double click on file WINAJAP.EXE will start the program.
3. The Input data can be saved as a data file (.dat extension) for archive. The Input file can then be opened in AJAP-1 avoiding re-typing of the data.
4. The Input data and Results can be saved as an ASCII text file (.txt extension). This is useful for input to a word processor.
5. The Geometry and Result plots can be saved as a Windows bitmap file. This is useful for input to a paint program or word processor.
6. Some default parameters can be altered to give better presentation of results.

4. System Requirements.

The following are the minimum requirements:

1. 386/486/Pentium based IBM PC or compatible computer
2. VGA display or higher
3. CD disk drive
4. MS-DOS with Windows 3.1 or Windows 95/Me/XP Home Edition with SP2
5. Windows compatible mouse
6. 4 MB RAM, 80 MB hard disk space if installing files to hard disk

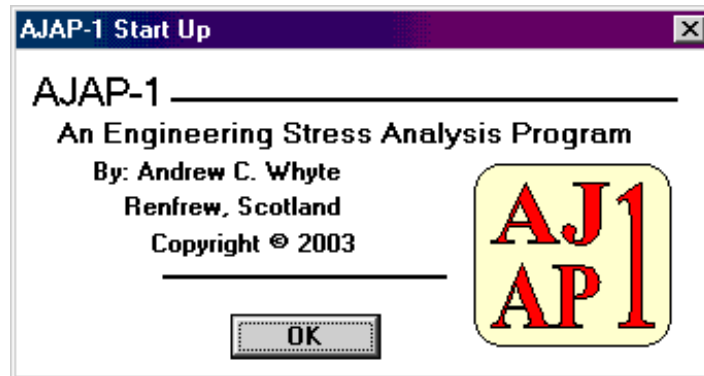
5. Disk Contents.

This disk contains a WinAJAP folder with the following files and folders (directories). These files and folders should be kept with the WINAJAP.EXE file:

1. Files: WINAJAP.EXE, VBRUN300.DLL, CMDIALOG.VBX, COMMDLG.DLL, GRID.VBX, README.TXT, HELPFILE.TXT, EXAMPLE.DAT
2. Folders: IMAGES, EXAMPLES

Files WINAJAP.EXE, VBRUN300.DLL, CMDIALOG.VBX, COMMDLG.DLL, GRID.VBX and the folder IMAGES are essential for running the program. The EXAMPLE.DAT file is an input data file for an example project that runs automatically on start up. The EXAMPLES folder contains input data files for the examples given in reference 1.

6. Running the Program.



The program can be run direct from the AJAP-1 CD or can be copied to your computer's hard disk.

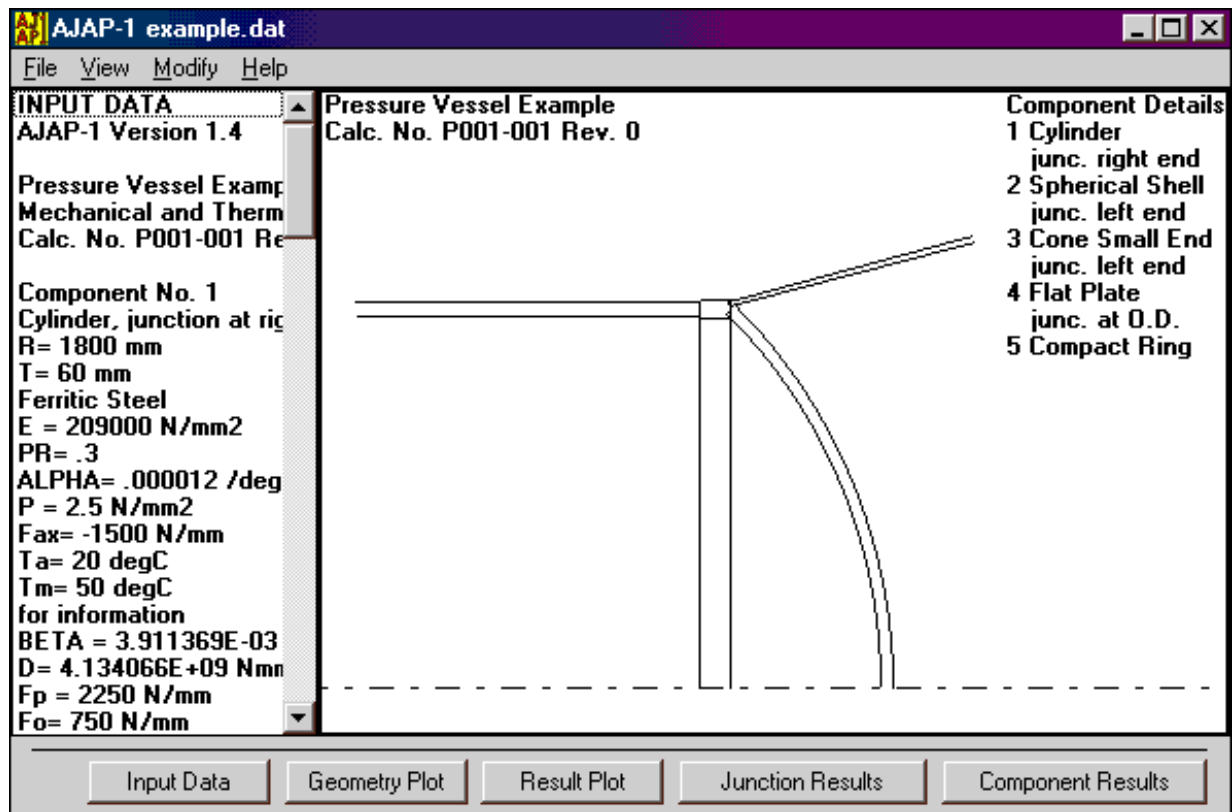
1. Start up Windows
2. Put the AJAP-1 CD into your PC and start-up the CD disk drive.
3. Open folder WinAJAP and double click on file WINAJAP.EXE to load and run the program. The main form will load and an example will run automatically.
4. To start a new project click on New Project from the File drop down menu and enter the information asked for.

Alternatively the folder WinAJAP should be copied to your computer's hard disk. The program can then be run by opening the WinAJAP folder and double clicking on file WinAJAP.EXE.

To uninstall AJAP-1, delete the WinAJAP folder from the hard disk.

7. Input Data.

When the program is run an example project is automatically input and results run and presented. To start a new project click on New Project from the File drop down menu.

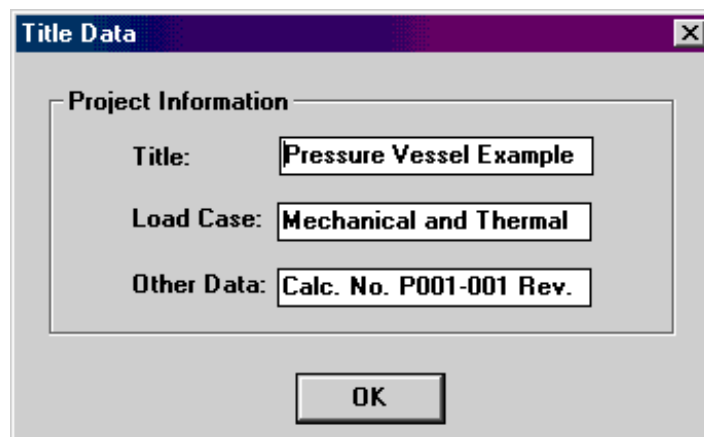


The input data is entered or selected from a series of dialog boxes. Valid geometry, material and loading data applicable to the project is essential. In many cases the sign (+ve or -ve) is important. Users are required to read and understand the input data instructions contained in reference 1. Error traps are provided for common input errors. Error message boxes will offer advice.

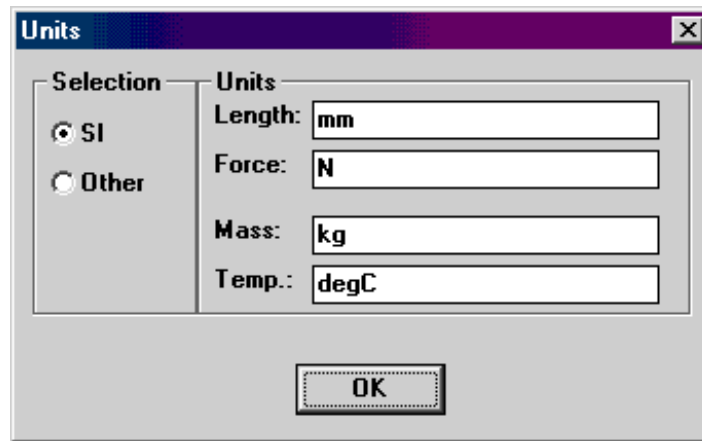


The following data can be input.

1. Title Data



2. Units

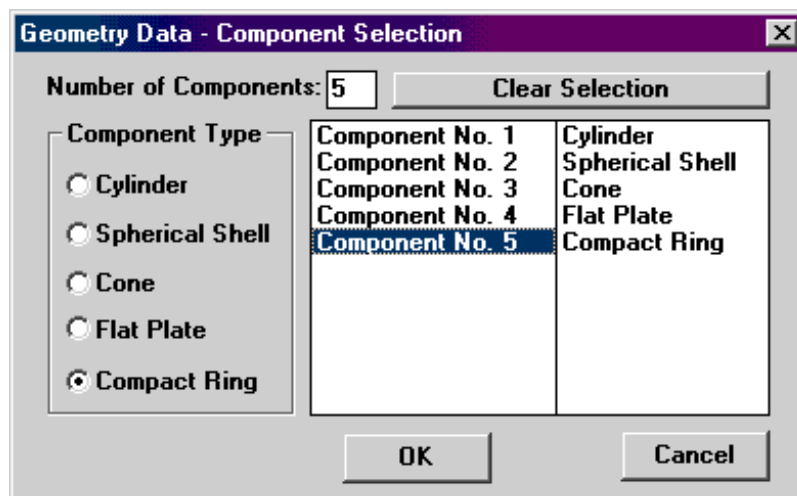


The 'Units' dialog box has a title bar with a close button. It contains a 'Selection' group with two radio buttons: 'SI' (selected) and 'Other'. To the right, under the 'Units' label, are four text input fields: 'Length:' with 'mm', 'Force:' with 'N', 'Mass:' with 'kg', and 'Temp.:' with 'degC'. An 'OK' button is at the bottom center.

Selection	Units
<input checked="" type="radio"/> SI	Length: mm
<input type="radio"/> Other	Force: N
	Mass: kg
	Temp.: degC

OK

3. Geometry Data - Component Selection

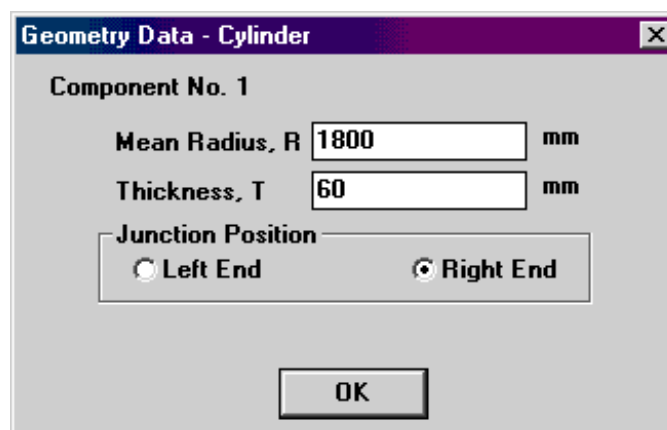


The 'Geometry Data - Component Selection' dialog box has a title bar with a close button. It features a 'Number of Components' field set to '5' and a 'Clear Selection' button. On the left, 'Component Type' has five radio buttons: 'Cylinder', 'Spherical Shell', 'Cone', 'Flat Plate', and 'Compact Ring' (selected). On the right, a table lists the selected components. 'OK' and 'Cancel' buttons are at the bottom.

Component No.	Component Type
Component No. 1	Cylinder
Component No. 2	Spherical Shell
Component No. 3	Cone
Component No. 4	Flat Plate
Component No. 5	Compact Ring

OK Cancel

4. Geometry Data - Cylinder



The 'Geometry Data - Cylinder' dialog box has a title bar with a close button. It is for 'Component No. 1'. It has two text input fields: 'Mean Radius, R' with '1800' mm and 'Thickness, T' with '60' mm. Below is a 'Junction Position' group with two radio buttons: 'Left End' and 'Right End' (selected). An 'OK' button is at the bottom center.

Component No. 1

Mean Radius, R 1800 mm

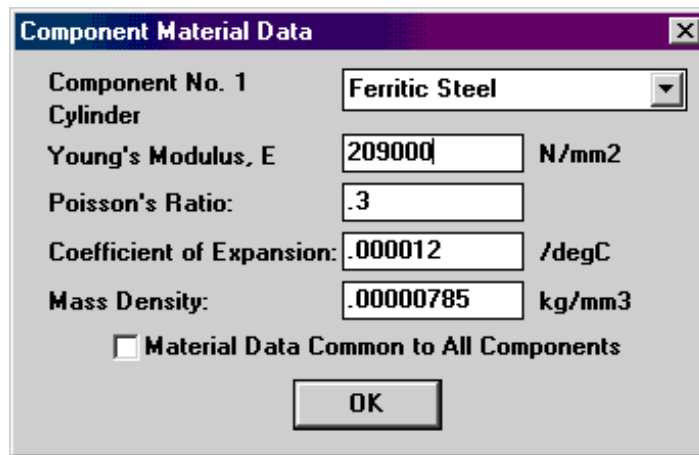
Thickness, T 60 mm

Junction Position

☐ Left End ☒ Right End

OK

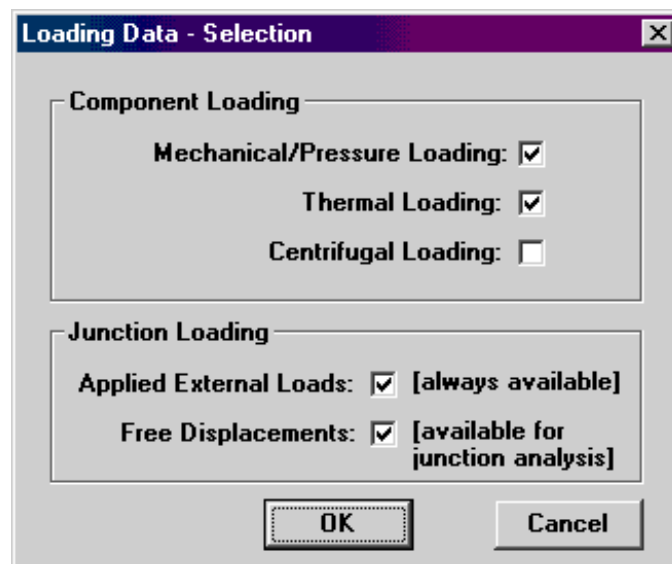
5. Material Data



The 'Component Material Data' dialog box is shown. It has a title bar with a close button. The content includes a dropdown menu for 'Component No. 1' set to 'Ferritic Steel', a label 'Cylinder', and input fields for 'Young's Modulus, E' (209000 N/mm2), 'Poisson's Ratio' (.3), 'Coefficient of Expansion' (.000012 /degC), and 'Mass Density' (.00000785 kg/mm3). There is an unchecked checkbox for 'Material Data Common to All Components' and an 'OK' button at the bottom.

Component No. 1	Ferritic Steel
Cylinder	
Young's Modulus, E	209000 N/mm2
Poisson's Ratio:	.3
Coefficient of Expansion:	.000012 /degC
Mass Density:	.00000785 kg/mm3
<input type="checkbox"/> Material Data Common to All Components	
OK	

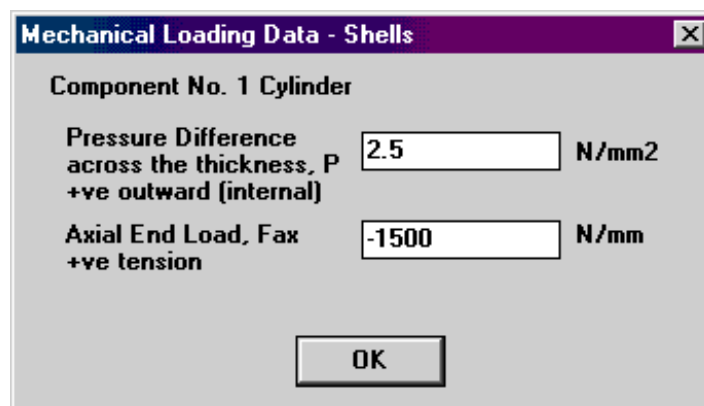
6. Loading Data - Selection



The 'Loading Data - Selection' dialog box is shown. It has a title bar with a close button. It contains two sections: 'Component Loading' with checkboxes for 'Mechanical/Pressure Loading' (checked), 'Thermal Loading' (checked), and 'Centrifugal Loading' (unchecked); and 'Junction Loading' with checkboxes for 'Applied External Loads' (checked, with note '[always available]') and 'Free Displacements' (checked, with note '[available for junction analysis]'). There are 'OK' and 'Cancel' buttons at the bottom.

Loading Data - Selection	
Component Loading	
Mechanical/Pressure Loading:	<input checked="" type="checkbox"/>
Thermal Loading:	<input checked="" type="checkbox"/>
Centrifugal Loading:	<input type="checkbox"/>
Junction Loading	
Applied External Loads:	<input checked="" type="checkbox"/> [always available]
Free Displacements:	<input checked="" type="checkbox"/> [available for junction analysis]
OK	Cancel

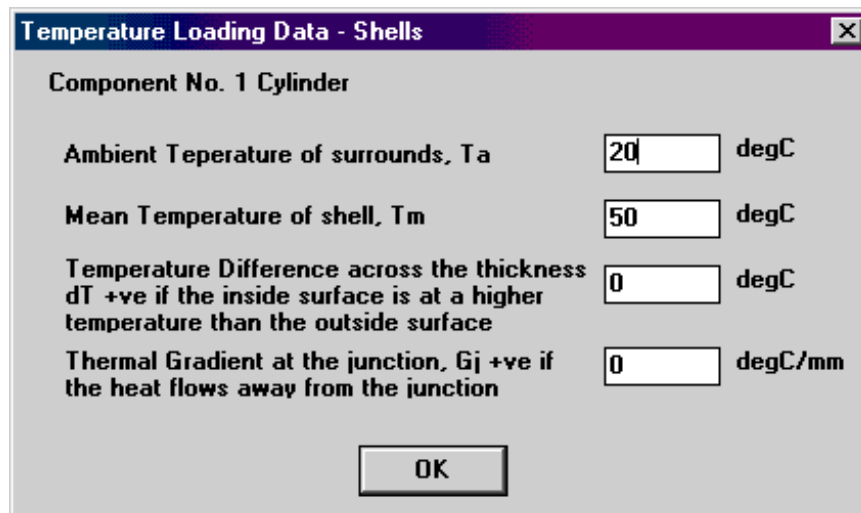
7. Loading Data - Mechanical Loads



The 'Mechanical Loading Data - Shells' dialog box is shown. It has a title bar with a close button. It contains input fields for 'Pressure Difference across the thickness, P' (2.5 N/mm2, with note '+ve outward (internal)') and 'Axial End Load, Fax' (-1500 N/mm, with note '+ve tension'). There is an 'OK' button at the bottom.

Mechanical Loading Data - Shells	
Component No. 1 Cylinder	
Pressure Difference across the thickness, P +ve outward (internal)	2.5 N/mm2
Axial End Load, Fax +ve tension	-1500 N/mm
OK	

8. Loading Data - Thermal Loads



Temperature Loading Data - Shells

Component No. 1 Cylinder

Ambient Temperature of surrounds, T_a degC

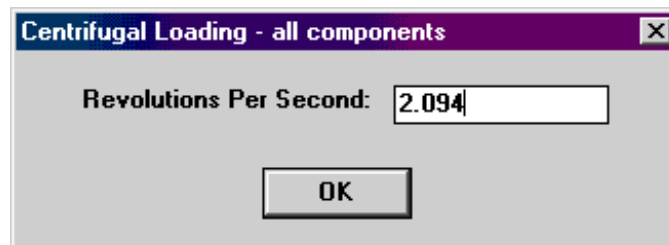
Mean Temperature of shell, T_m degC

Temperature Difference across the thickness dT +ve if the inside surface is at a higher temperature than the outside surface degC

Thermal Gradient at the junction, G_j +ve if the heat flows away from the junction degC/mm

OK

9. Loading Data - Centrifugal Loads

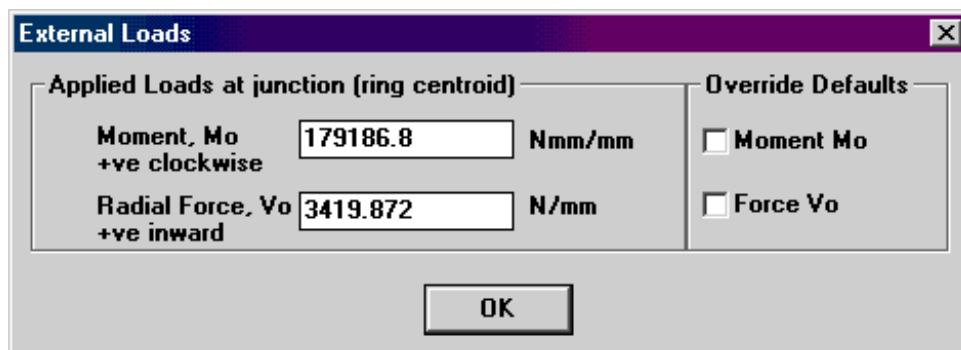


Centrifugal Loading - all components

Revolutions Per Second:

OK

When the last of the required input data is entered, the program calculates default external loads, free displacements and stiffness coefficients. These defaults are presented in a series of dialog boxes. An option is available to allow the defaults to be altered if required.



External Loads

Applied Loads at junction (ring centroid)

Moment, M_o Nmm/mm
+ve clockwise

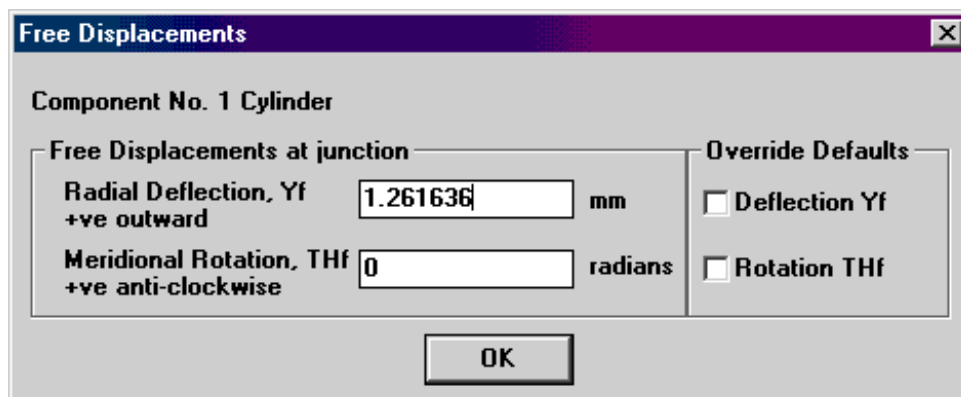
Radial Force, V_o N/mm
+ve inward

Override Defaults

☐ Moment M_o

☐ Force V_o

OK



Free Displacements

Component No. 1 Cylinder

Free Displacements at junction

Radial Deflection, Y_f mm
+ve outward

Meridional Rotation, TH_f radians
+ve anti-clockwise

Override Defaults

☐ Deflection Y_f

☐ Rotation TH_f

OK

Stiffness Coefficients [X]

Component No. 1 Cylinder

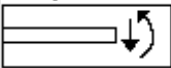
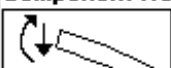
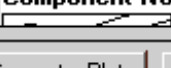
Stiffness Coefficients at junction		Override Defaults
Coefficient K(1)	494.7591 (N/mm)/mm	<input type="checkbox"/> Coefficient K(1)
Coefficient K(2)	126492.6 (Nmm/mm)/mm	<input type="checkbox"/> Coefficient K(2)
Coefficient K(3)	126492.6 (N/mm)/radian	<input type="checkbox"/> Coefficient K(3)
Coefficient K(4)	1.616986E+07 (Nmm/mm)/radian	<input type="checkbox"/> Coefficient K(4)

OK

Once a valid input data set is input the program automatically presents a geometry plot. Users can then proceed to view the results.

AJAP-1 example.dat [X]

File View Modify Help

INPUT DATA	JUNCTION RESULTS
AJAP-1 Version 1.4	Discontinuity Forces & Moments
Pressure Vessel Example	Pressure Vessel Example
Mechanical and Thermal	Mechanical and Thermal Loads
Calc. No. P001-001 Rev.	Calc. No. P001-001 Rev. 0
Component No. 1	Component No. 1 Cylinder
Cylinder, junction at right	
R= 1800 mm	Mj1= 157352.7 Nmm/mm anti-clockwise
T= 60 mm	Vj1= 1254.044 N/mm inward
Ferritic Steel	Component No. 2 Spherical Shell
E = 209000 N/mm2	
PR= .3	Mj2= 114852.7 Nmm/mm clockwise
ALPHA= .000012 /degC	Vj2= 1045.895 N/mm inward
P = 2.5 N/mm2	Component No. 3 Cone
Fax= -1500 N/mm	
Ta= 20 degC	
Tm= 50 degC	
for information	
BETA = 3.911369E-03 /m	
D= 4.134066E+09 Nmm	
Fp = 2250 N/mm	
Fo= 750 N/mm	

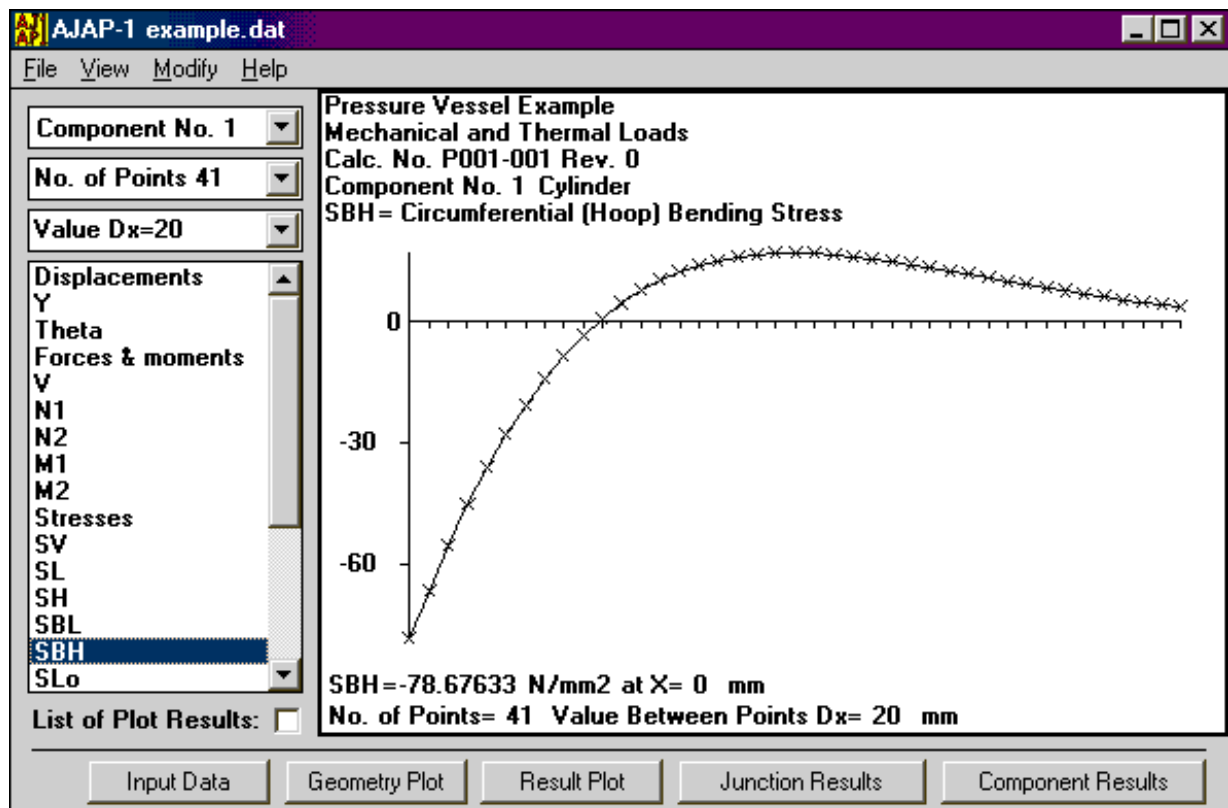
Input Data Geometry Plot Result Plot **Junction Results** Component Results

AJAP-1 example.dat

File View Modify Help

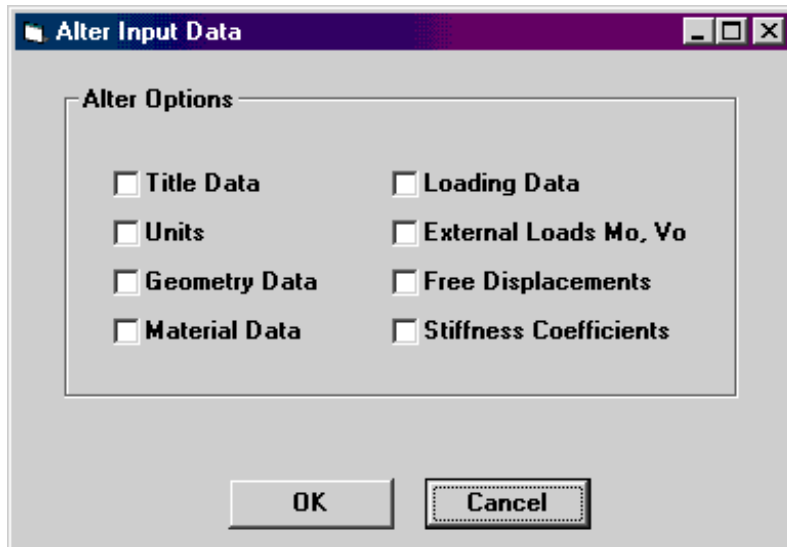
INPUT DATA AJAP-1 Version 1.4 Pressure Vessel Example Mechanical and Thermal Calc. No. P001-001 Rev. 0 Component No. 1 Cylinder, junction at right R= 1800 mm T= 60 mm Ferritic Steel E = 209000 N/mm2 PR= .3 ALPHA= .000012 /degC P = 2.5 N/mm2 Fax= -1500 N/mm Ta= 20 degC Tm= 50 degC for information BETA = 3.911369E-03 /m D= 4.134066E+09 Nmm Fp = 2250 N/mm Fo= 750 N/mm	RESULTS Component No. 1 Cylinder Pressure Vessel Example Mechanical and Thermal Loads Calc. No. P001-001 Rev. 0 X= 0 mm Y= -2.905252E-02 mm Theta= -1.827436E-04 radians V= -1254.044 N/mm N1= 750 N/mm N2= -4491.799 N/mm M1= 157352.7 Nmm/mm M2= 47205.8 Nmm/mm STRESSES N/mm2 SV= -20.90074 SL= 12.5 SH= -74.86332 SBL=+or- 262.2544 SBH=+or- 78.67633 SLo= -249.7544 SLi= 274.7544 SHo= -153.5396 SHi= 3.813009	Component No. 1 Component No. 2 Component No. 3 Component No. 4 Component No. 5 Distance X
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Input Data Geometry Plot Result Plot Junction Results Component Results



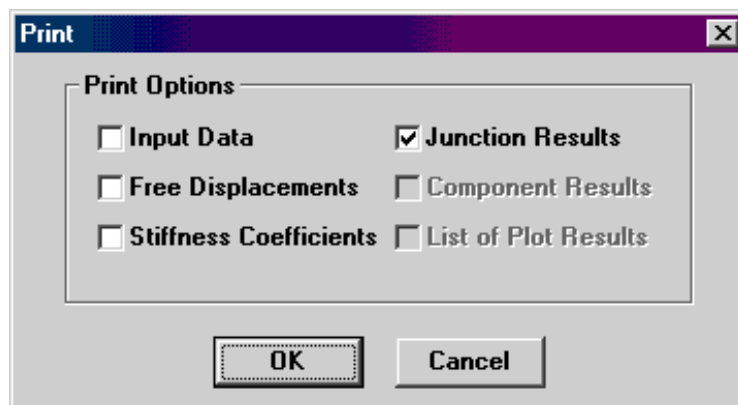
8. Modifying Input Data.

A dialog box giving options for altering the input data is available under the Modify drop down menu.



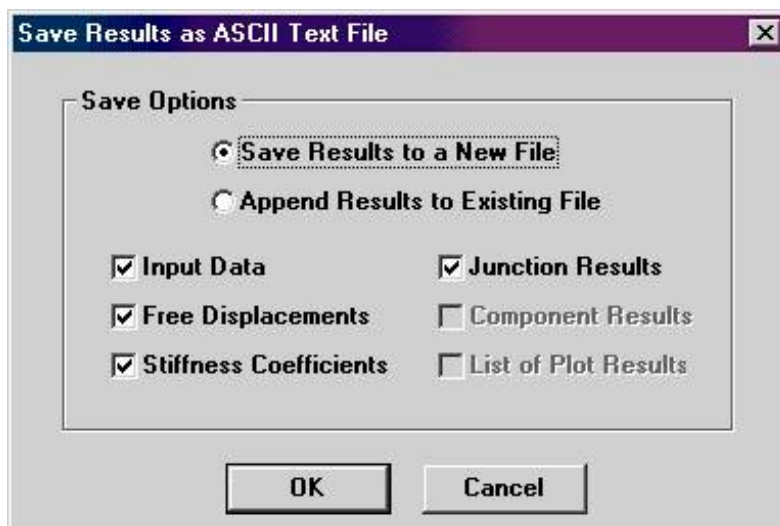
9. Printing Results.

A dialog box giving options for printing are available under the File drop down menu. A print of the geometry or results plot can also be obtained.

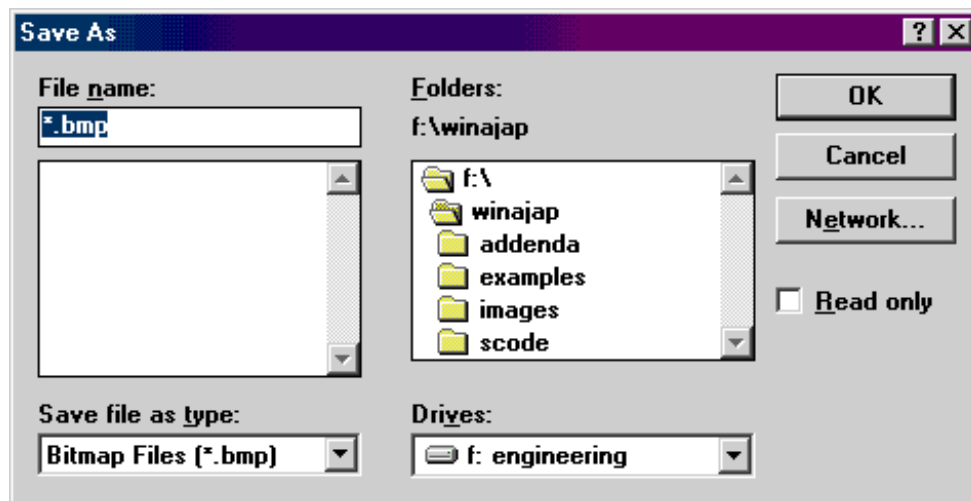


10. Saving Results.

A dialog box giving options for saving the results is available under the File drop down menu. The results can be saved as an ASCII text file (i.e. with a .txt extension).

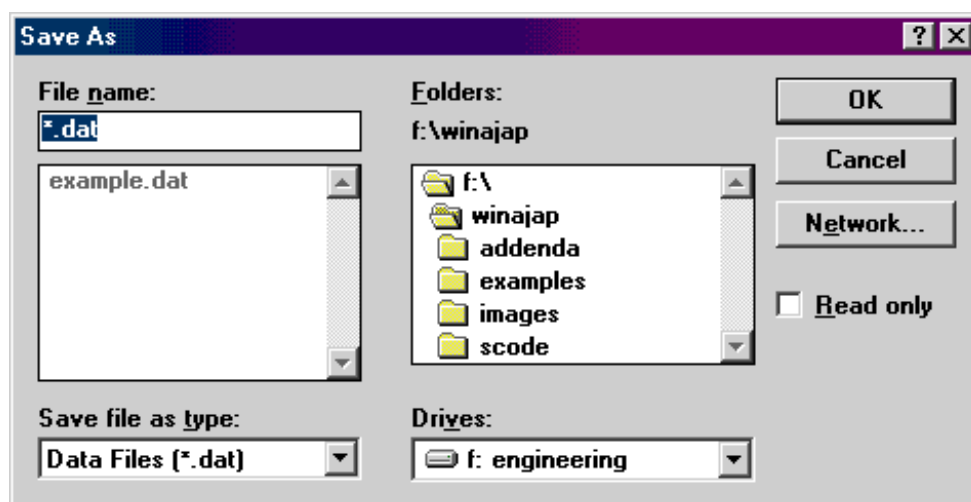


Plots can be saved as a Windows bitmap file (i.e. with .bmp extension).



11. Saving an Input File.

To save your input data so that it can be archived and read back into AJAP-1. Use the 'Save As Input File...' option under the File drop down menu. This allows the input data to be saved as a specified data file (i.e. with a .dat extension).

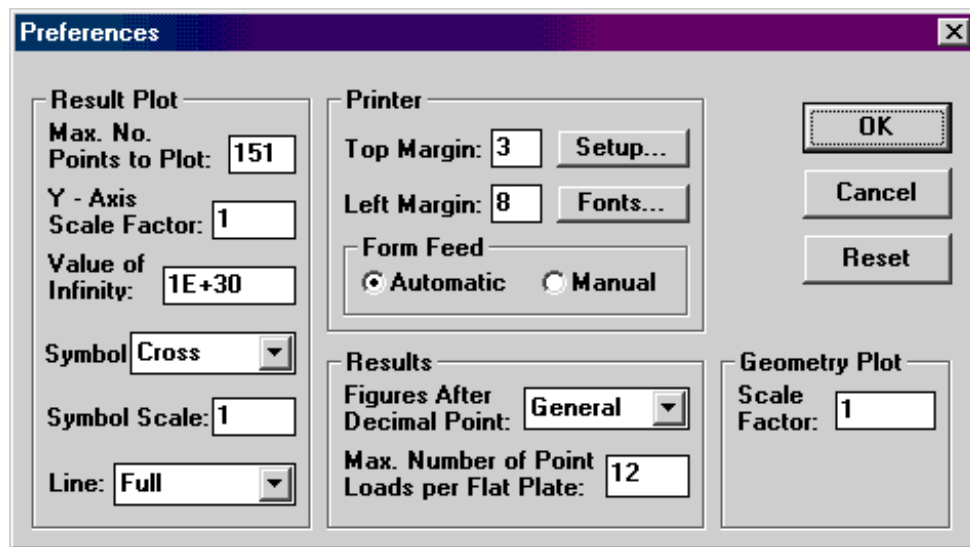


12. Precision.

Calculations are carried out in double precision internally. By default the output results are displayed in general single precision format. An option is available under preferences to set the number of figures after the decimal point.

13. Preferences.

These can be accessed from the View drop down menu and provide some control over printing and presentation of results.



1. The top and left margins for printing can be set.
2. The form feed can be set to manual. This may avoid some paper wastage when printing text. The form feed can be activated from the File drop down menu.
3. The number of figures after the decimal point can be set.
4. The result plot will automatically scale the Y-axis. This works most of the time. In some cases an adjustment to the Y-axis scale factor may be beneficial.
5. The value of infinity can be set.
6. The result plot symbol, symbol scale and line type can be set.
7. The geometry plot scale factor can be adjusted.

14. Bugs.

There are no known bugs, if any come to light the author would like to know about them.

15. Limit of Liability.

The author does not guarantee that the program will function correctly in every hardware or software environment. The program has been carefully tested. All reasonable precautions have been taken to ensure that the program supplied is correct. Results have been run and compared against well known textbook and technical paper solutions. However, the author can accept no responsibility for any loss or damage as a result of the user's use of the program. The author reserves the right to revise and improve the product. This text describes the product at the time of publication and may not reflect the product at all times in the future.

16. References.

1. Whyte, Andrew C., '*Basic Discontinuity Analysis of Multishell Axisymmetric Junctions*', Self-published 1994.

Appendix 1.

When the textbook: 'Basic Discontinuity Analysis of Multishell Axisymmetric Junctions' (reference 1) was originally written the Windows version of AJAP-1 was not available. Most of the textbook is still valid however some of the text is only applicable to the DOS version. This Appendix briefly discusses some of the text that is not applicable to the Windows version.

1. **The Computer Program.** The use of a RUNME program is not required as the Windows version is compiled into an executable file. A double click on file WinAJAP.EXE will load and run the program. The program will display at normal size for the current Windows display. The program can be maximised, minimised or closed in the usual Windows manner.
2. **Program Line Numbers.** These are mentioned throughout the textbook. They are not relevant to the Windows version, as modern versions of BASIC (like Microsoft Visual Basic) no longer require the use of program line numbers.
3. **Program Listing.** The Windows version is compiled into an executable file. The use of LIST or LLIST commands are not applicable.
4. **Component Type No.** Menu Tables 2.1(a) and (b). Due to a different system of selecting component types the Windows version does not refer to component type numbers.
5. **Input Data Instructions.** Enter the data asked for, essentially as detailed in the textbook. The Windows version uses a series of dialog boxes to allow users to enter or select data, rather than have menu number lists and screen clearing.
6. **Printer Hardware.** Control of the printer parameters, e.g. margins, fonts, print setup, orientation etc. is controlled from a Preferences dialog box from the View drop down menu.

Graphical Options. Graphics are an integral part of the Windows version. To control the screen resolution use the Windows Control Panel display settings.
