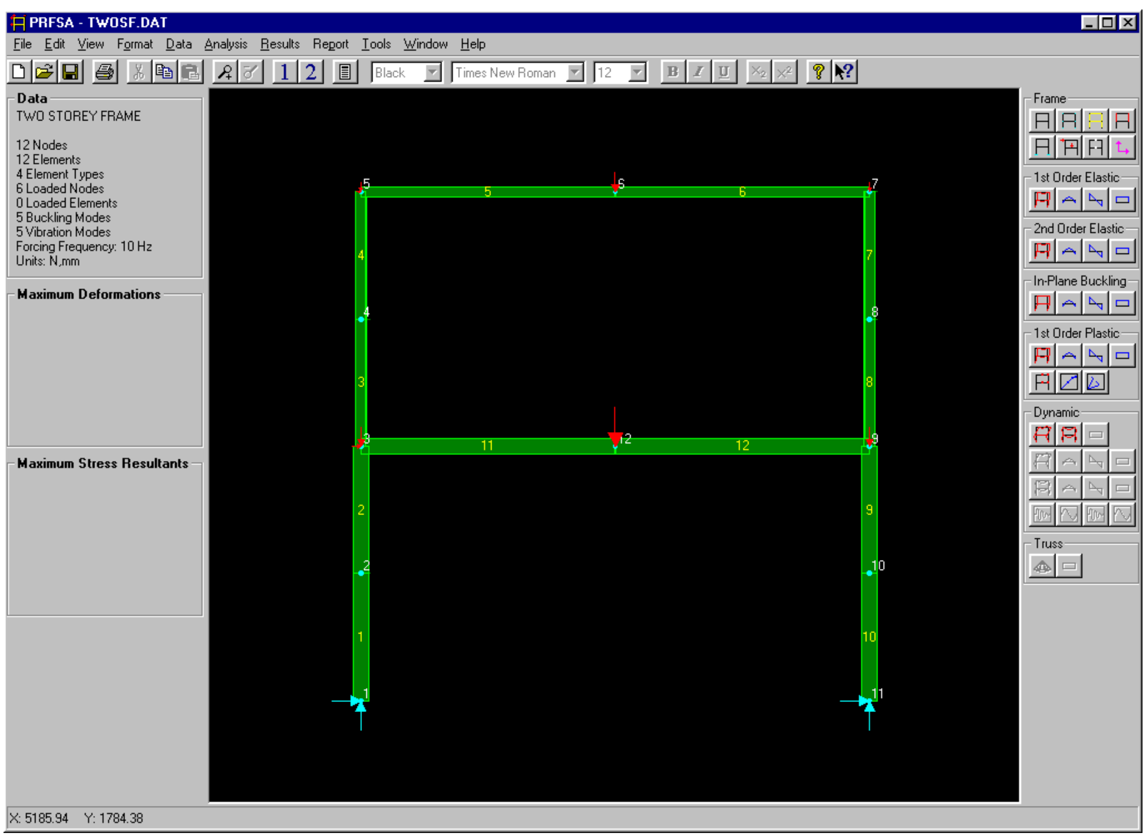
PRFSA

Centre for
Advanced
Structural
Engineering

http://www.civil.usyd.edu.au/case/software.shtml

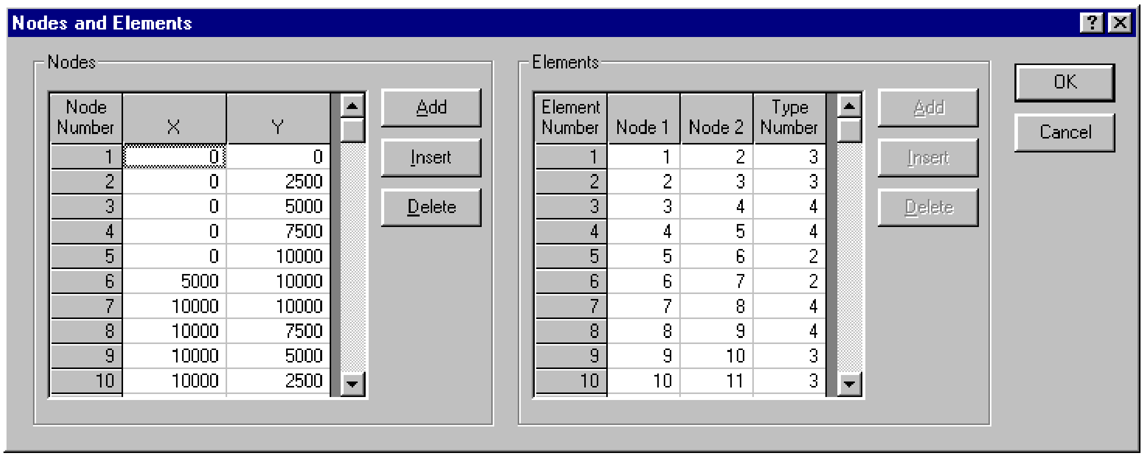
Introduction

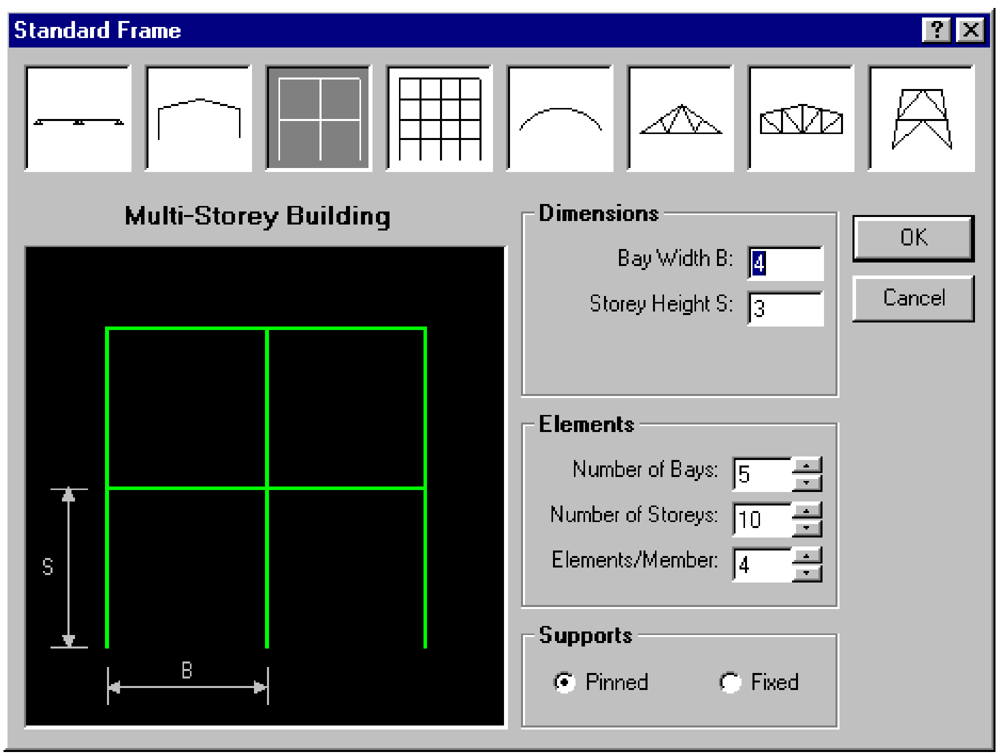
PRFSA (Plane Rigid Frame Structural Analysis) is a user-friendly computer program for predicting the in-plane behaviour of plane rigid frames. The input data for the program includes the geometry of the frame, the section and material properties of the frame elements, and the loading. When a 1st or 2nd order elastic analysis is performed, the program calculates the deformations and stress resultants of the frame. The axial force stress resultant can be used to perform an in-plane buckling analysis of the frame, which calculates the buckling load factor and the corresponding buckled shape. The 1st order elastic-plastic analysis can calculate the progressive formation of plastic hinges in the frame and the corresponding load factor, deformations and stress resultants. The natural vibration analysis calculates the natural frequencies of the frame and the corresponding vibration modes. The steady state analysis calculates the forced vibration response of the frame when the applied loads vary harmonically at a given forcing frequency. The transient analysis calculates the deformations and stress resultants of the frame due to ground excitation and force excitation. The truss analysis can calculate the deformations and axial force stress resultant of the frame by assuming the frame acts as a pin-jointed truss.

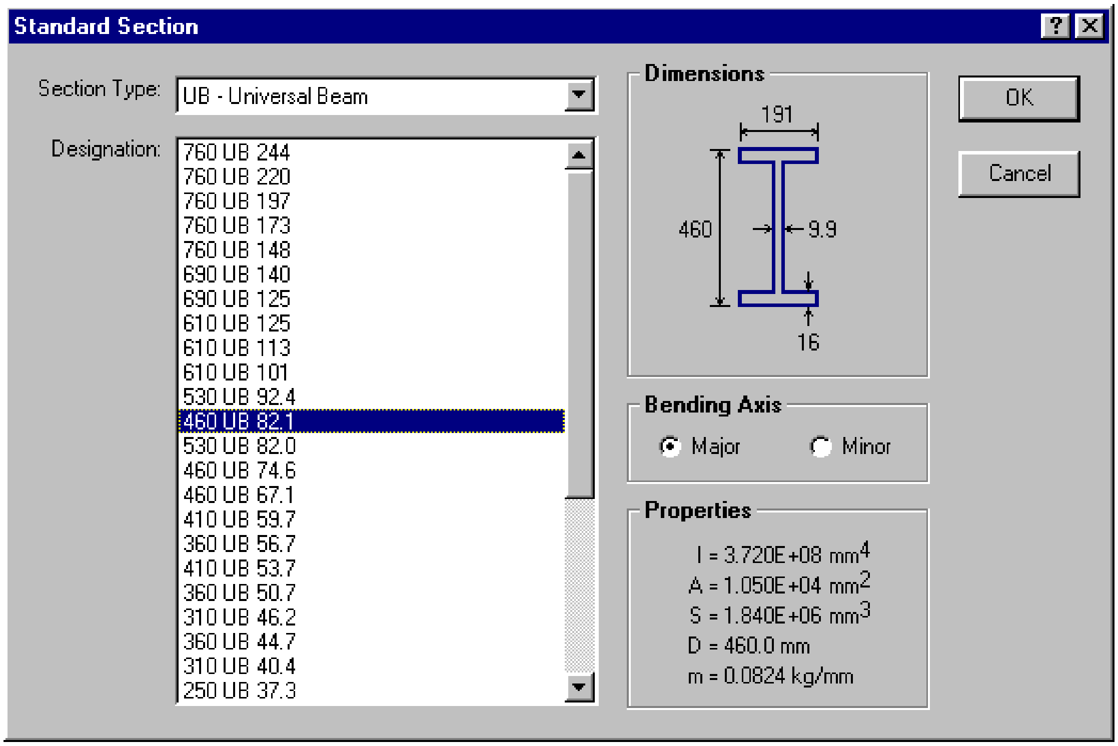


Data

The frame is modeled by subdividing it into a series of straight line elements. The ends of the elements intersect at nodes. The input data for the frame includes the geometry of the frame, the section and material properties of the frame elements, and the loading. A user-friendly data processor can be used for the creation of data for a new frame or for the modification of data for an existing frame. Help screens provide advice concerning the nature of the data required, and a facility exists for the automatic generation of the node and element numbers for some standard frames. The element properties can be input from a library of standard sections.

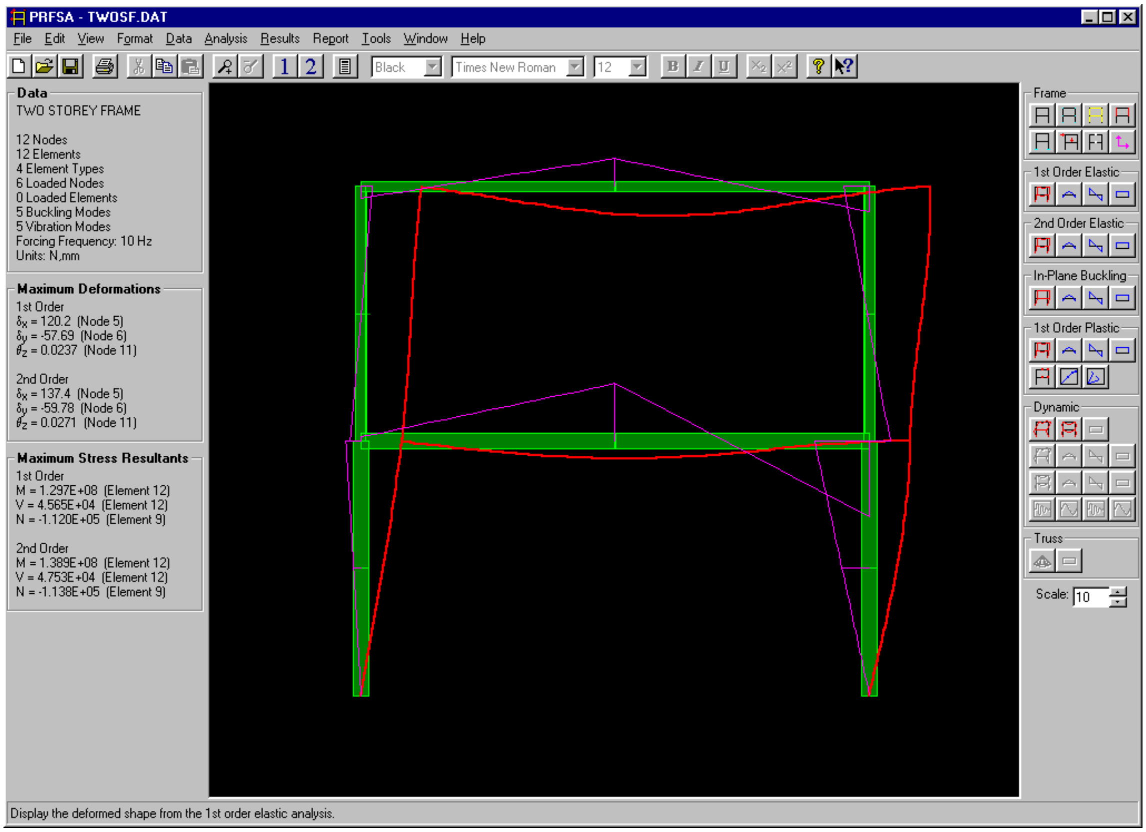





Standard Section
Section Type:
UB - Universal Beam
Designation:
760 UB 244
760 UB 220
760 UB 197
760 UB 173
760 UB 148
690 UB 140
690 UB 125
610 UB 125
610 UB 113
610 UB 101
530 UB 92.4
460 UB 82.1
530 UB 82.0
460 UB 74.6
460 UB 67.1
410 UB 59.7
360 UB 56.7
410 UB 53.7
360 UB 50.7
310 UB 46.2
360 UB 44.7
310 UB 40.4
250 UB 37.3
Dimensions
191
460
9.9
16
Bending Axis
Major
Minor
Properties
I = 3.720E+08 mm4
A = 1.050E+04 mm2
S = 1.840E+06 mm3
D = 460.0 mm
m = 0.0824 kg/mm
OK
Cancel

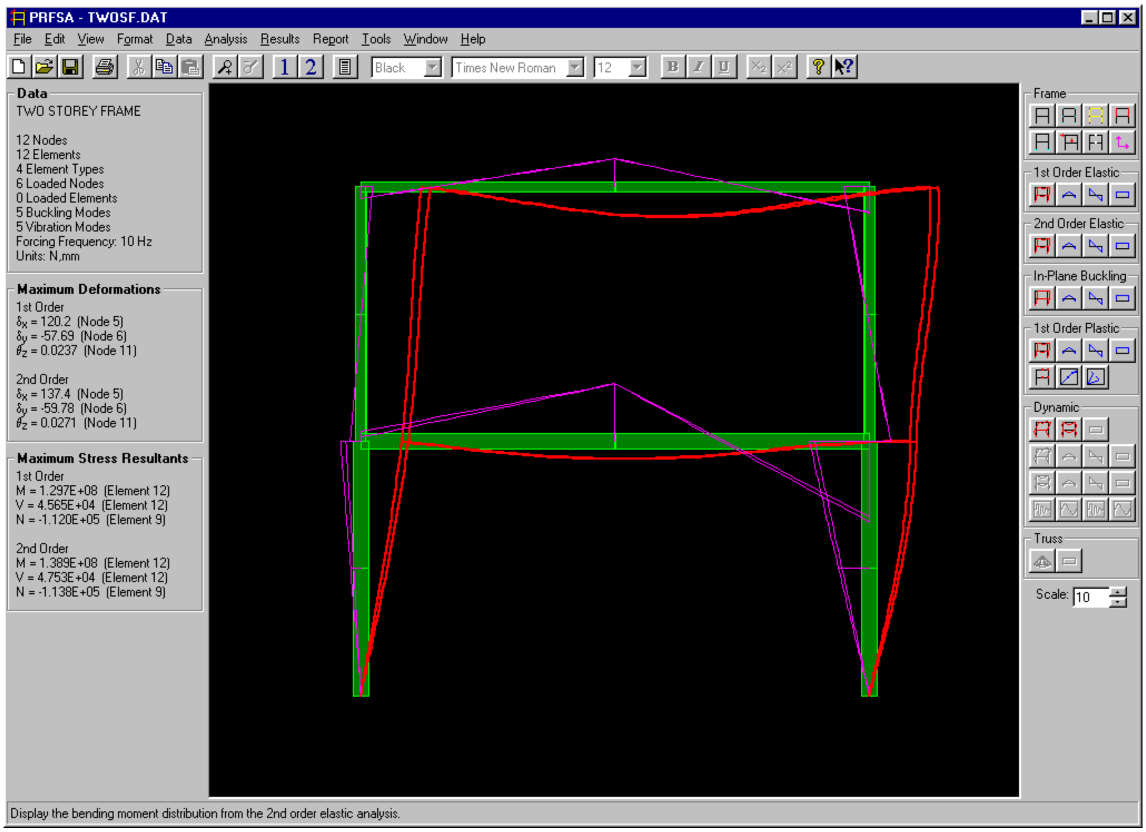
1st Order Elastic Analysis

A number of different methods of structural analysis can be used to predict the in-plane behaviour of plane rigid frames. The 1st order elastic analysis of PRFSA is based on equilibrium calculations on the undeformed shape of the structure and assumes that the material behaves linear-elastically. It ignores 2nd order moments caused both by the deflected shape of the members (PΔ effects) and the joint deflections (Pδ effects), and material non-linearities caused by yielding. In PRFSA, the results of the 1st order elastic analysis include the deformations and the moment and axial force stress resultants of the frame.



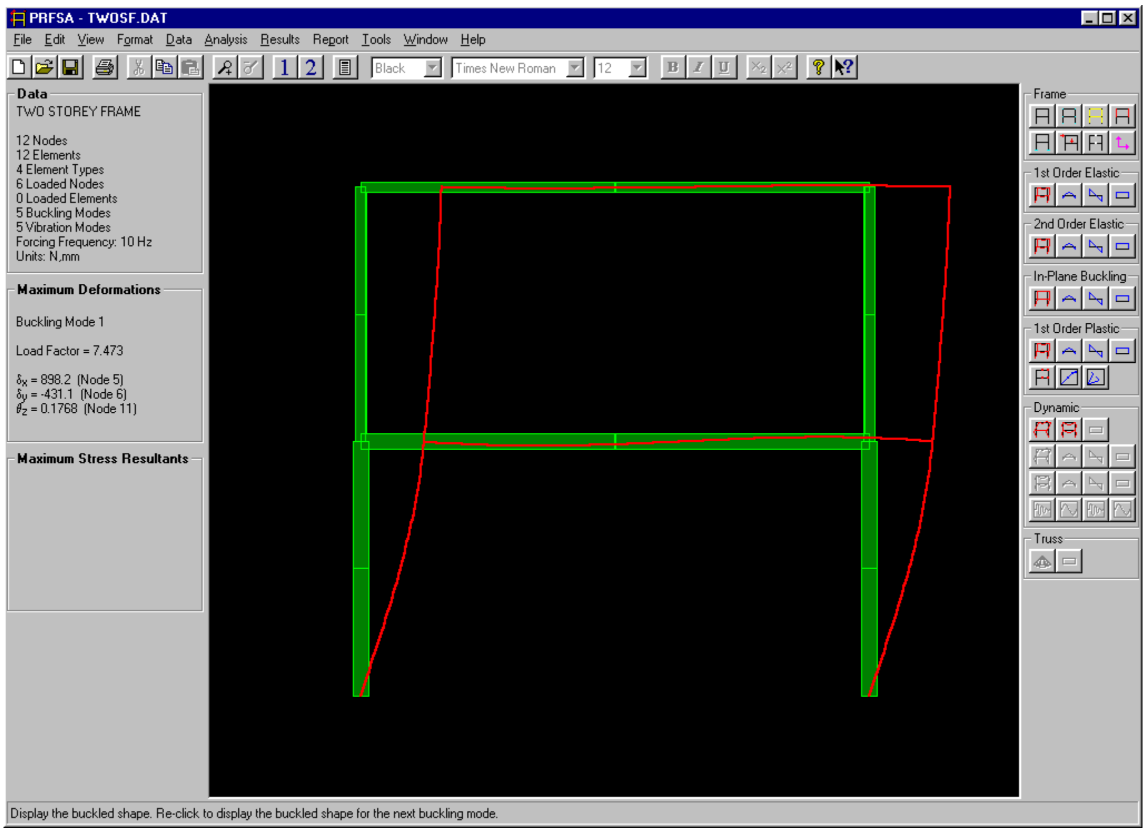
2nd Order Elastic Analysis

In a 2nd order elastic analysis, the members are assumed to remain stressed in the linear-elastic range and changes in the frame geometry under the design loads and changes in the effective stiffnesses of the members due to axial force are taken into account. Because of this, elastic instability is automatically taken into account in the analysis. Compared with a 2nd order elastic analysis, a 1st order elastic analysis will underestimate the deformations of and hence the moments in a structure. In PRFSA, the results of the 2nd order elastic analysis include the deformations and the moment and axial force stress resultants of the frame.



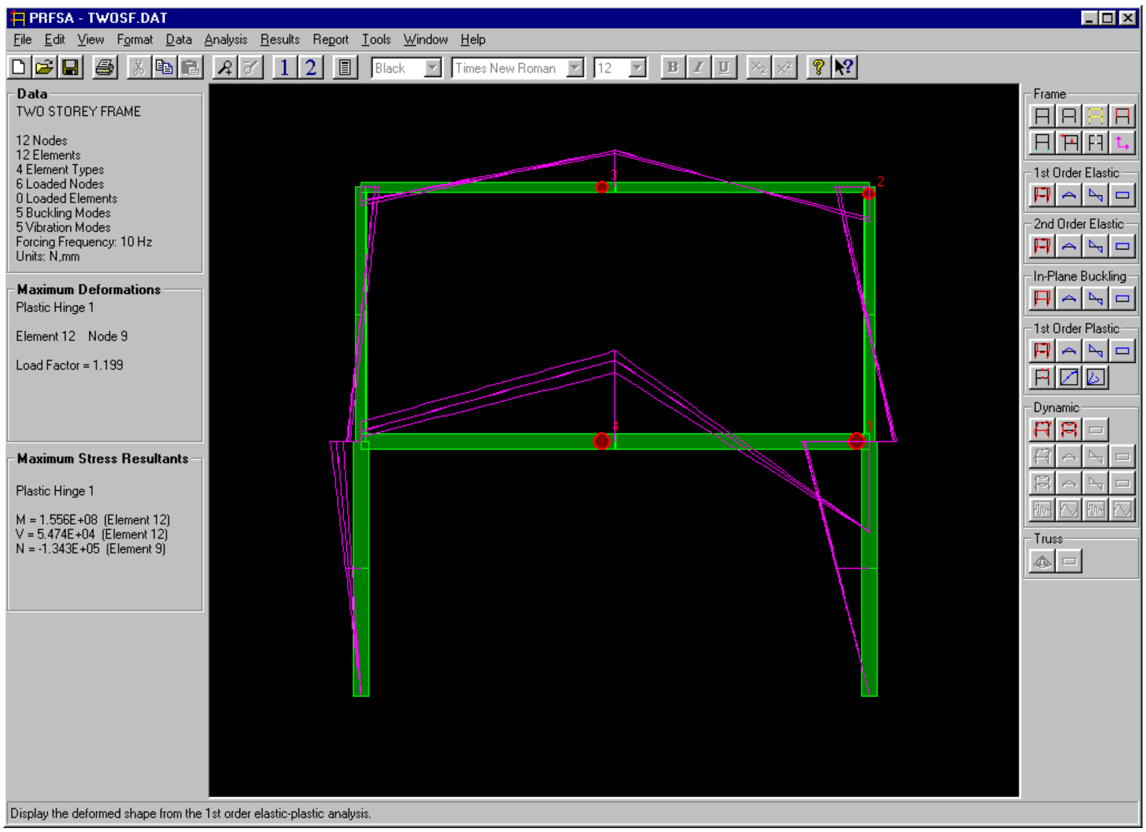
In-Plane Buckling Analysis

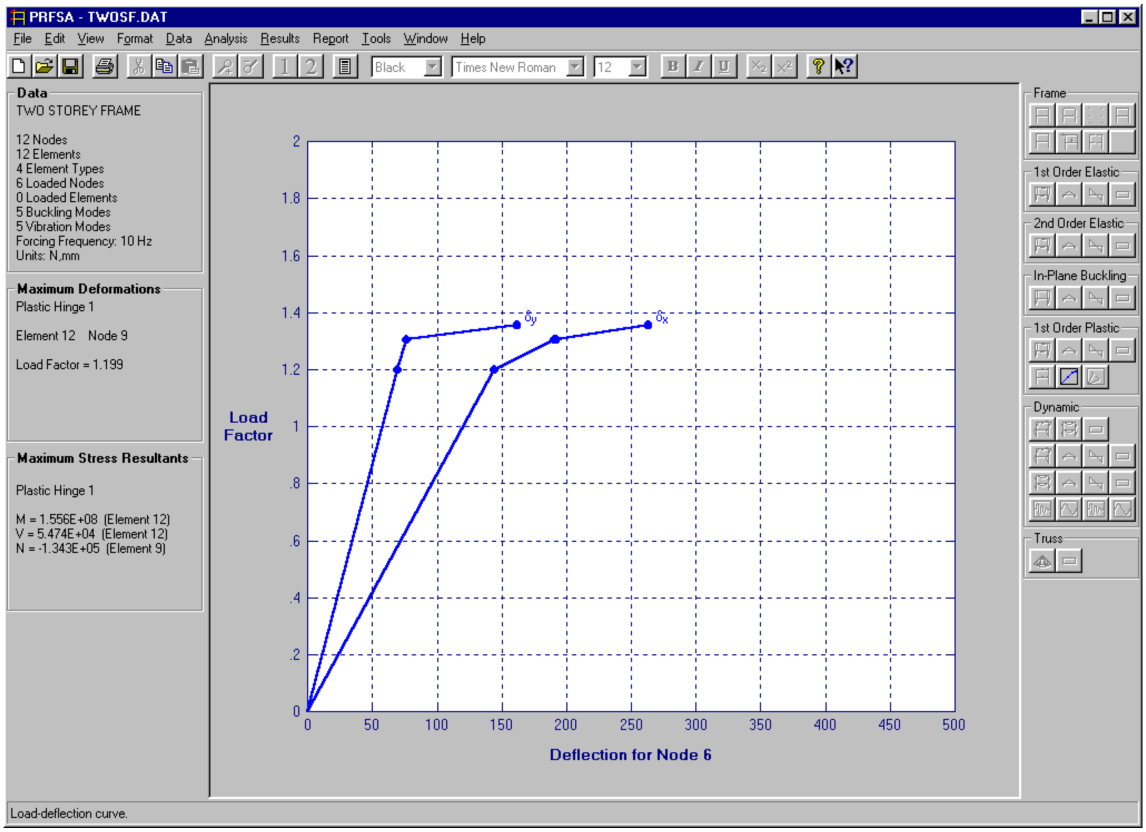
The upper limit to a 1st order elastic analysis is the elastic buckling limit of the frame. For the analysis of elastic in-plane buckling, all member bending actions are ignored and only the member axial force actions are considered. As the member axial forces are increased, there will be no flexural deformations until a critical value is reached at which in-plane buckling of the members will occur. The frame elastic buckling load factor is defined as the ratio of the axial force in a member at elastic frame buckling to its design axial force. Because the members of a frame interact during buckling, this ratio is the same for all members. In PRFSA, the results of the in-plane buckling analysis include the frame elastic buckling load factor and the corresponding buckling mode.



1st Order Plastic Analysis

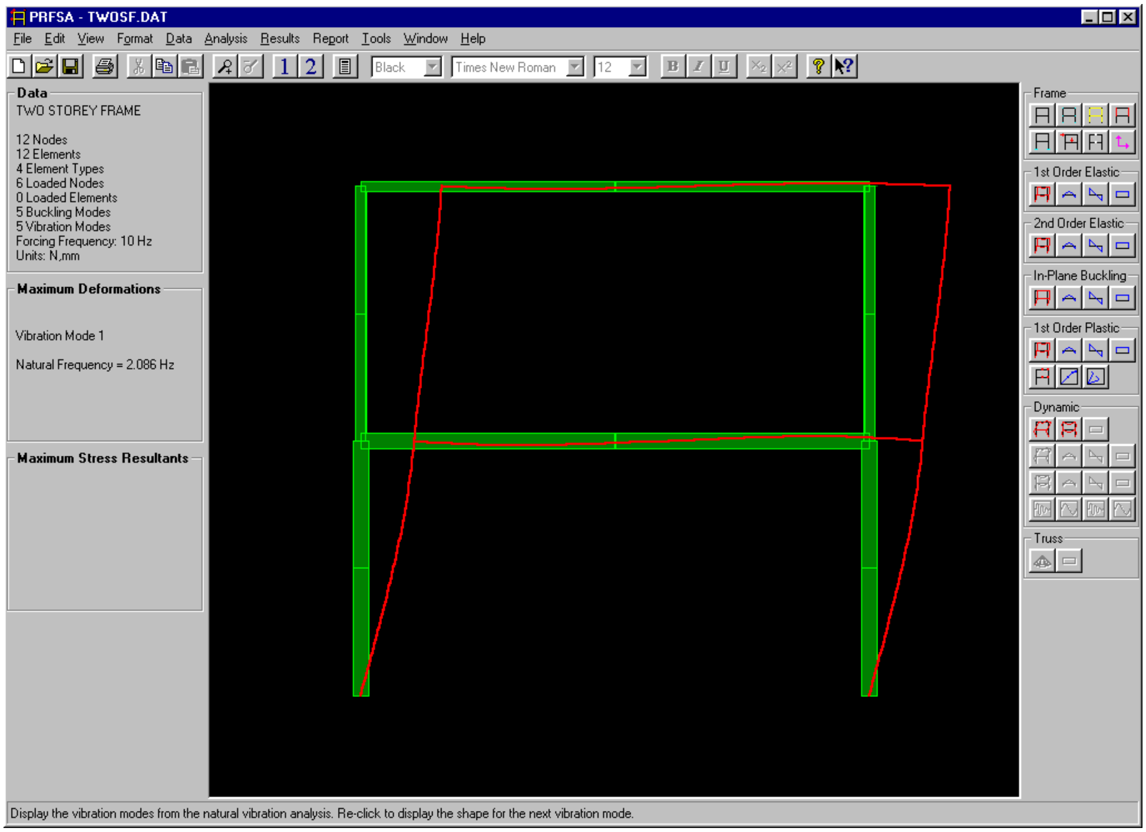
Non-linear response can also be caused by material yielding. In some frames, failure can be associated with full plasticity (plastic hinges) occurring at a sufficient number of locations for a plastic mechanism to form. This response is predicted by a 1st order elastic-plastic analysis. In this type of analysis, the lowest load factor which causes a plastic collapse mechanism to form in the structure is determined. The plastic moment capacity of a plastic hinge is reduced by the presence of axial force, and this effect is included in PRFSA through the use of a linear interaction surface. In PRFSA, the results of the 1st order elastic-plastic analysis include the load factor and location of each plastic hinge, the deformed shape of the frame, a load-deflection curve for each node, and a force-point trace for each element.




PRFSA - TWOSF.DAT
File Edit View Format Data Analysis Results Report Tools Window Help
Data
TWO STOREY FRAME
12 Nodes
12 Elements
4 Element Types
6 Loaded Nodes
0 Loaded Elements
5 Buckling Modes
5 Vibration Modes
Forcing Frequency: 10 Hz
Units: N,mm
Maximum Deformations
Plastic Hinge 1
Element 12 Node 9
Load Factor = 1.199
Maximum Stress Resultants
Plastic Hinge 1
M = 1.556E+08 (Element 12)
V = 5.474E+04 (Element 12)
N = -1.343E+05 (Element 9)
Load Factor
Deflection for Node 6
Frame
1st Order Elastic
2nd Order Elastic
In-Plane Buckling
1st Order Plastic
Dynamic
Truss
Load-deflection curve.

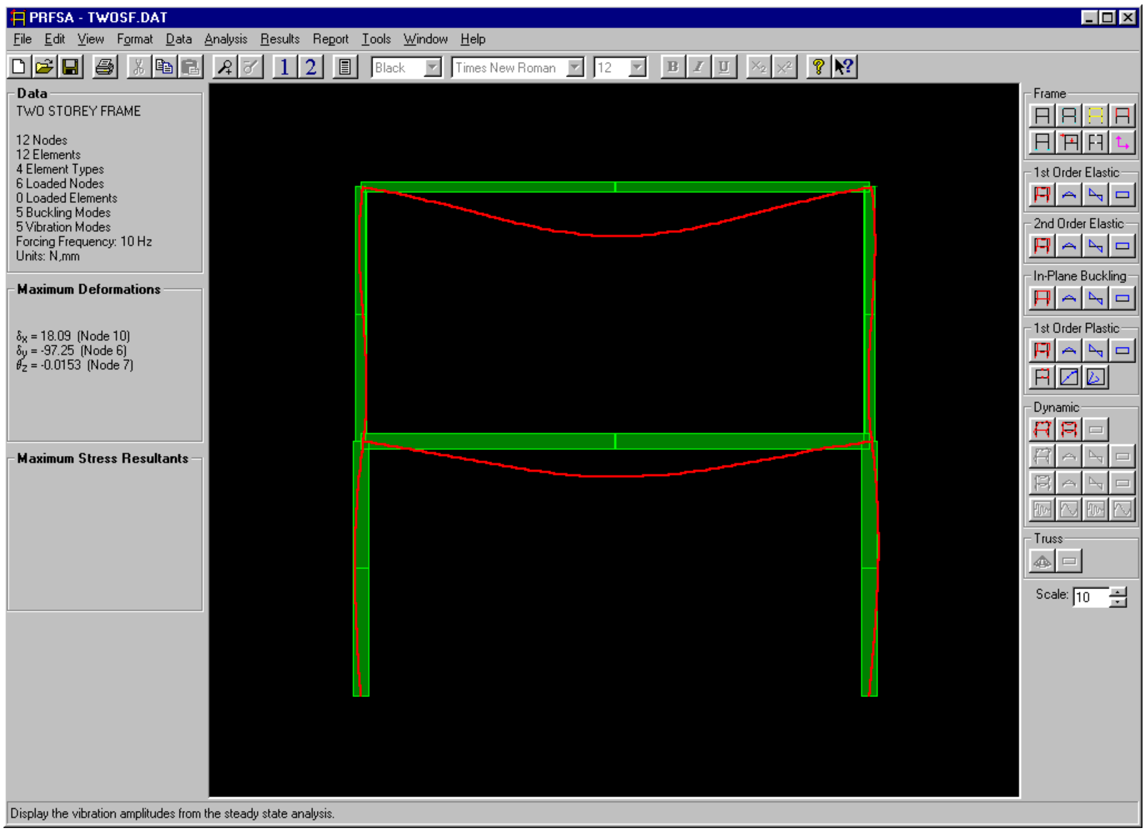
Natural Vibration Analysis

The dynamic analysis in PRFSA is based on the stiffness matrix formulation of general structural dynamic response problems. In the natural vibration analysis of PRFSA, the natural frequencies and corresponding vibration modes of the structure are computed with no damping and no excitation (undamped free vibration).



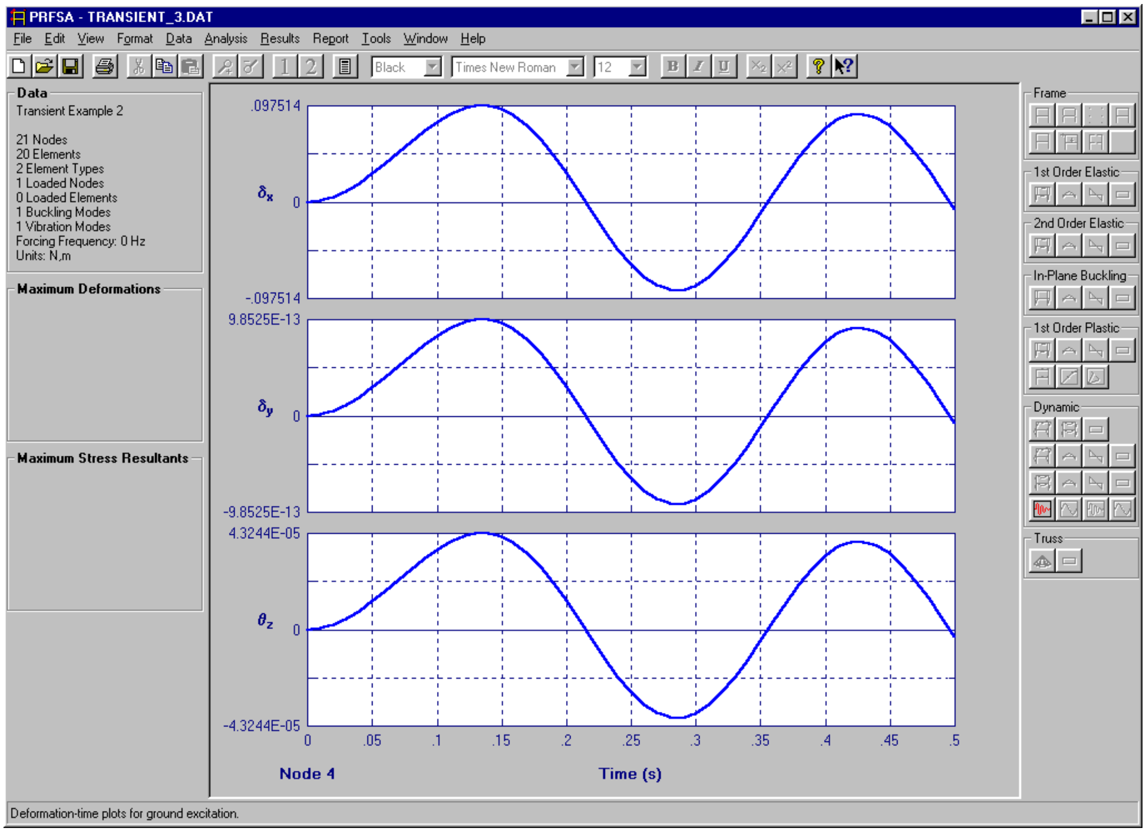
Steady State Analysis

PRFSA can also perform a steady state forced vibration analysis of a frame structure in which the applied loads varying harmonically with the same forcing frequency. The response amplitudes induced by forced vibration are computed by summation over a series with the number of terms equal to the number of modes for which natural frequencies are computed. More modes lead to more accurate forced vibration analyses. The modal damping of each mode, which is a fraction of critical, is used when computing the forced excitation series term corresponding to a particular mode. In PRFSA, the results of the steady state analysis include the vibration amplitudes.



Transient Analysis

In the transient dynamic analysis of PRFSA, the frame is subjected to either ground or force excitation over a specified period of time. In the ground excitation analysis, the frame is subjected to ground acceleration in the horizontal and vertical directions. In the force excitation analysis, the nodal loads on the frame are factored by a scalar force function. The output from the transient analysis includes the deformations and stress resultants calculated at specified time stations.



Spectral Analysis

In the spectral dynamic analysis of PRFSA, the frame is subjected to spectral acceleration. The spectral acceleration can be determined from spectral response curves found in earthquake design standards. The spectral analysis calculates equivalent static forces which are used in a 1st order elastic analysis to obtain the stress resultants caused by ground motion.

Equivalent Static Forces

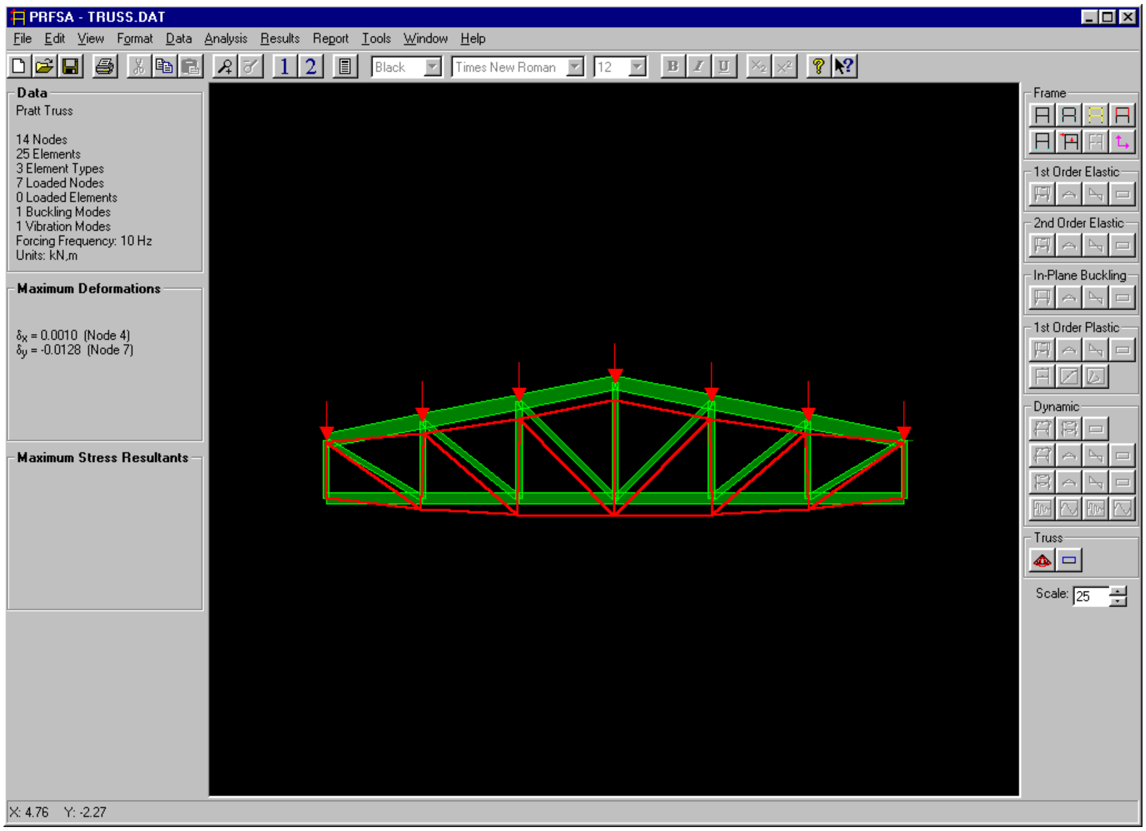
Node Number	F_x	F_y	M_z
1	Fixed	Fixed	Fixed
2	0.2015	0.0039	0.0242
3	0.3312	0.0034	0.0241
4	0.4252	0.0029	0.0241
5	0.5038	0.0021	0.0244
6	0.4481	0.0021	0.0792
7	Fixed	Fixed	Fixed
8	0.2015	0.0039	0.0242
9	0.3312	0.0034	0.0241
10	0.4252	0.0029	0.0241

Update

Cancel

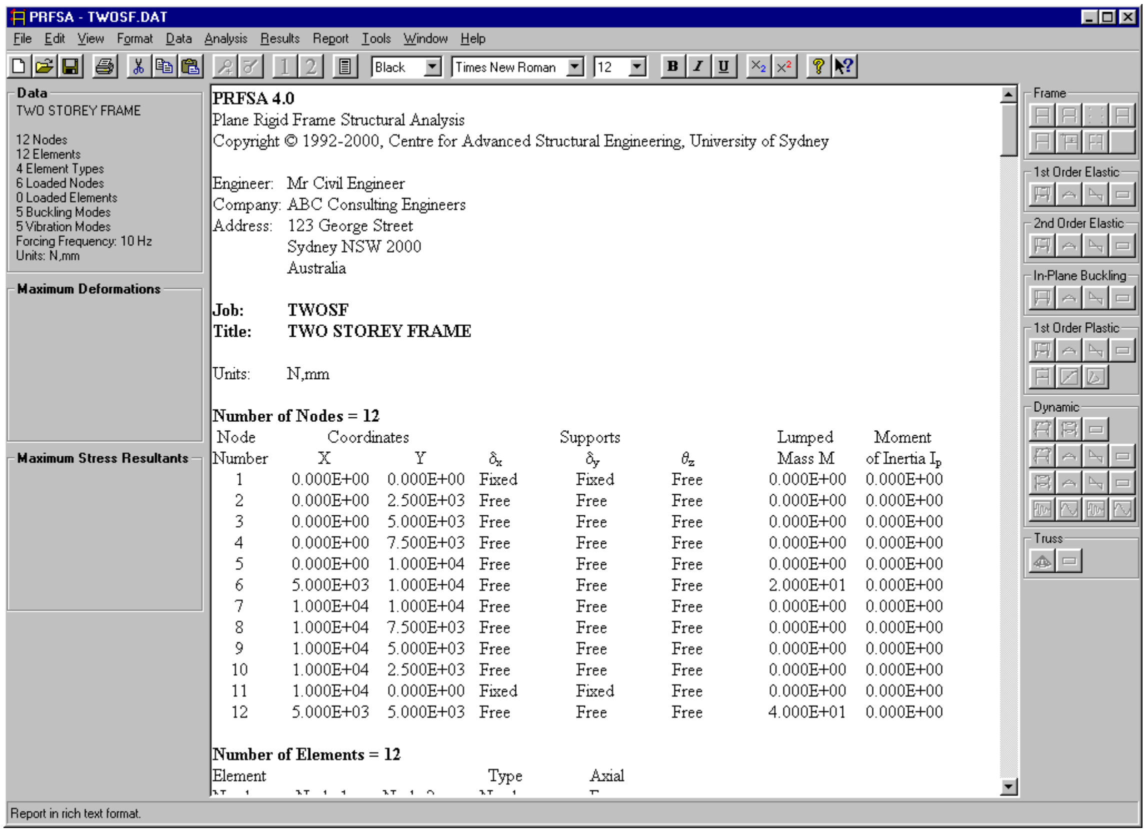
Truss Analysis

The truss analysis in PRFSA uses the same matrix stiffness method of analysis as in the 1st order elastic analysis. However, in a truss analysis only the displacements of the nodes and the axial force stress resultant are calculated.



Report

PRFSA can generate a report which contains the data and results for the frame. The report can also be edited from within PRFSA with the usual Windows commands such as Cut, Copy and Paste. The text colour, font type and size can also be changed. The user can also add comments to or delete certain parts of the report. The amount of information in the report can also be controlled. The report can either be printed from within PRFSA or saved to a file in rich text format. This file can be further edited using a sophisticated word-processing program such as Word.



PRFSA 4.0
Plane Rigid Frame Structural Analysis
Copyright © 1992-2000, Centre for Advanced Structural Engineering, University of Sydney

Engineer: Mr Civil Engineer
Company: ABC Consulting Engineers
Address: 123 George Street
Sydney NSW 2000
Australia

Job: **TWOSF**
Title: **TWO STOREY FRAME**

Units: N,mm

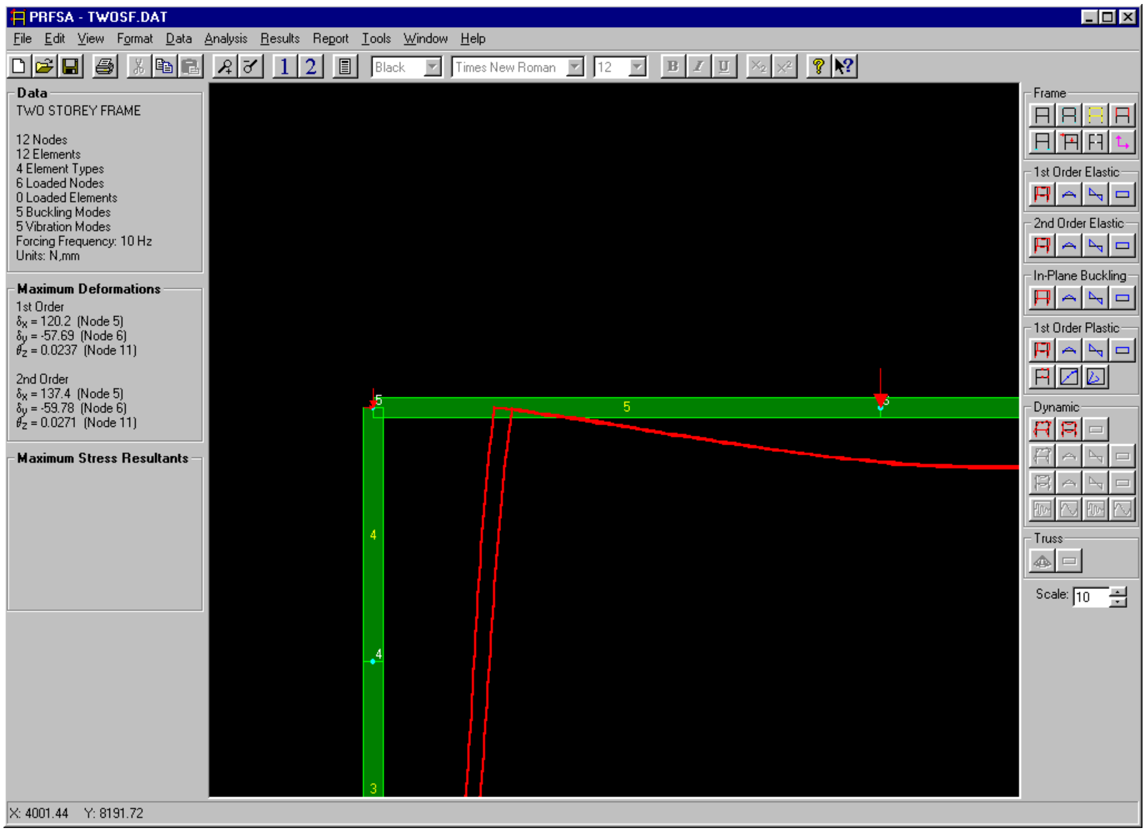
Number of Nodes = 12

Node Number	Coordinates X	Y	Supports δ_x	δ_y	θ_z	Lumped Mass M	Moment of Inertia I_p
1	0.000E+00	0.000E+00	Fixed	Fixed	Free	0.000E+00	0.000E+00
2	0.000E+00	2.500E+03	Free	Free	Free	0.000E+00	0.000E+00
3	0.000E+00	5.000E+03	Free	Free	Free	0.000E+00	0.000E+00
4	0.000E+00	7.500E+03	Free	Free	Free	0.000E+00	0.000E+00
5	0.000E+00	1.000E+04	Free	Free	Free	0.000E+00	0.000E+00
6	5.000E+03	1.000E+04	Free	Free	Free	2.000E+01	0.000E+00
7	1.000E+04	1.000E+04	Free	Free	Free	0.000E+00	0.000E+00
8	1.000E+04	7.500E+03	Free	Free	Free	0.000E+00	0.000E+00
9	1.000E+04	5.000E+03	Free	Free	Free	0.000E+00	0.000E+00
10	1.000E+04	2.500E+03	Free	Free	Free	0.000E+00	0.000E+00
11	1.000E+04	0.000E+00	Fixed	Fixed	Free	0.000E+00	0.000E+00
12	5.000E+03	5.000E+03	Free	Free	Free	4.000E+01	0.000E+00

Number of Elements = 12
Element Type Axial

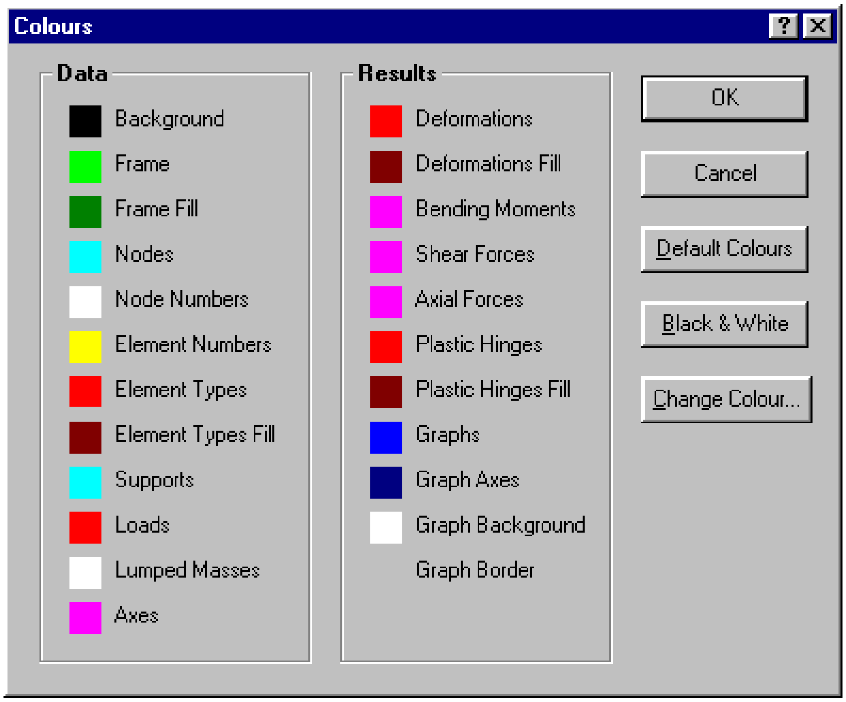
Zooming

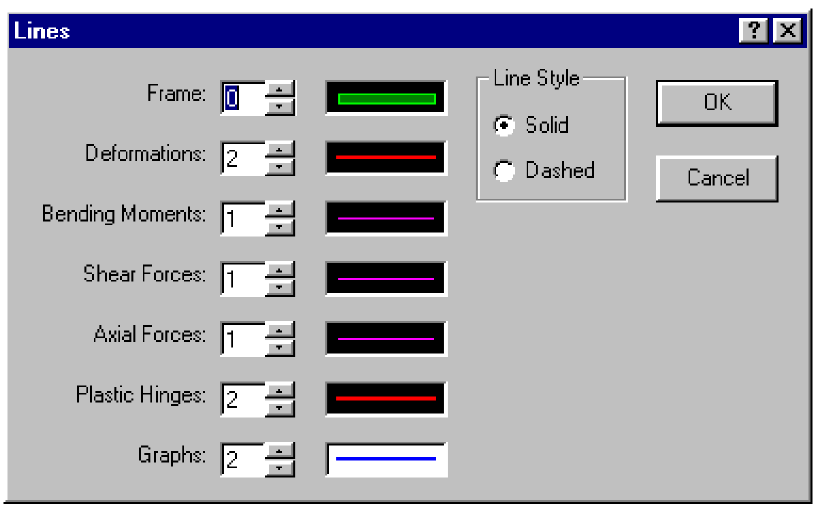
PRFSA allows the user to zoom in and enlarge an area of the frame. This feature is useful in checking the node and element data for frames with a large number of elements.



Colours and Lines

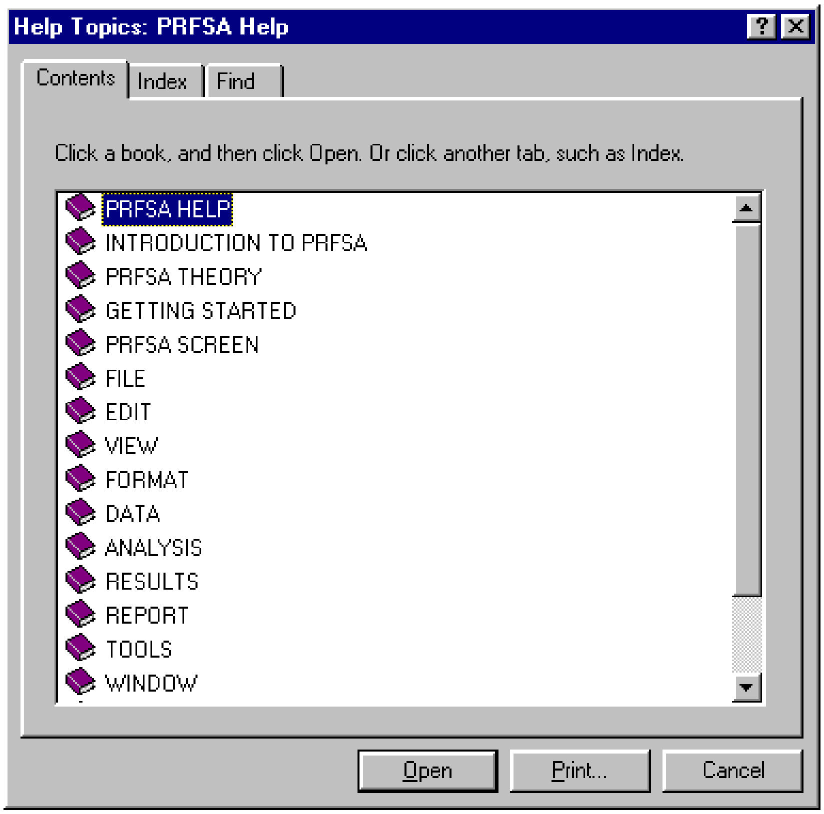
The appearance of the frame and graphs can be changed by adjusting the colours and lines. The entire Windows colour palette can be used as well as black and white colours for printing. PRFSA also allows the true thickness of the frame elements to be drawn.





On-Line Help

PRFSA has a fully documented on-line help system like other Windows programs. This help system can be accessed through the help topics or pop-up help. The help topics include a table of contents, index and search facility, and act very much like an on-line users manual. When the question mark button at the top right corner of a form is clicked, the program allows the user to display pop-up help for a particular item. A tutorial is also available which shows a step-by-step guide on how to use PRFSA.



System Requirements

PRFSA has been developed to run under Windows 95/98/ME/NT/2000/XP.

Download a Demonstration Copy & Demo

Visit our website: http://ww.civil.usyd.edu.au/case/software.shtml

SALES INQUIRIES

Information about computer software and prices is available from:

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Fax: 61 2 9351 3343
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