tm PC-STRAN

A 1-,2- or 3-Dimensional
STRuctural ANalysis Program
For the IBM Personal Computer

by Joe Murphy,Ph.D.,P.E.

Version 6.0x

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Disclaimer

Use of this program acknowledges this disclaimer of warranty:

This program is supplied as-is. The Author disclaims all warranties, expressed or implied, including, without limitation, the warranties of merchantability and of fitness of this program for any purpose.

Although every effort has been made to ensure both theory and programming logic in this program are correct, no warranty, either expressed or implied is made by the Author that the analyses obtained from its use will be correct. In no event will the Author be liable to you for any damages, including any lost profits, lost savings or other incidental or consequential damages arising out of the use of or inability to use this program, even if the Author has been advised of the possibility of such damages, or for any claim by any other party.

Acknowledgements

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Catherine M. Marx, P.E.
Ron Wolfe, P.E.
Dave Gromala, P.E.
Ross M. Lanius, Jr., P.E.

They and users are entitled to credit for features you like in PC-STRAN.

General Information

PC-STRAN analyzes 2- or 3-Dimensional truss/frame structures or 1-D continuous beams. The general procedure is to recall three disk files:

1) a member PROPerty file containing:
   a) member type
   b) material properties
      i) density
      ii) Young's modulus
      iii) (torsional) shear modulus
   c) geometric properties
      i) cross sectional area
      ii) 2 (bending) moments of inertia
      iii) (rotational) torsion constant

2) a geometric 3 dimensional MESH file containing:
   a) structure's node information
      i) node number
      ii) 3 coordinates
      iii) 3 lateral restraints
      iv) 3 rotational restraints
   b) structure's member information
      i) beginning & end node numbers (2ai)
      ii) 2 member-joint fixity factors
      iii) roll angle
      iv) member type (1a)

3) a LOAD file with up to 8 load cases containing:
   a) loaded node number (2ai)
   b) loads at 3a) with:
      i) 3 applied forces
      ii) 3 applied moments .
   c) loaded member node numbers (2bi)
   d) linearly distributed loads at member nodes

PC-STRAN employs a matrix method of structural analysis, specifically the direct stiffness method of solution, which is sometimes called the displacement method. See section on References.

A truss/frame is defined as a structure whose members can be attached to joints (or nodes) where only axial forces are transmitted (a truss with frictionless swivel connections) OR where bending and twisting moments are also transmitted (a frame with rigid connections). A truss/frame member then can have one end of the member a swivel connection and the other end of the SAME member a rigid connection!

Concentrated loads may only be specified at nodes. If concentrated loads are to be applied at the interior of a member, insert a node at that point and divide the member into two. For member loads, the values of the linear distribution are specified at the members' nodes. Displacements are calculated only at the nodes. If you want displacements at the interior of a member, again insert a node at that point.

For more information see Section on Program details.

System Requirements

PC-STRAN requires:

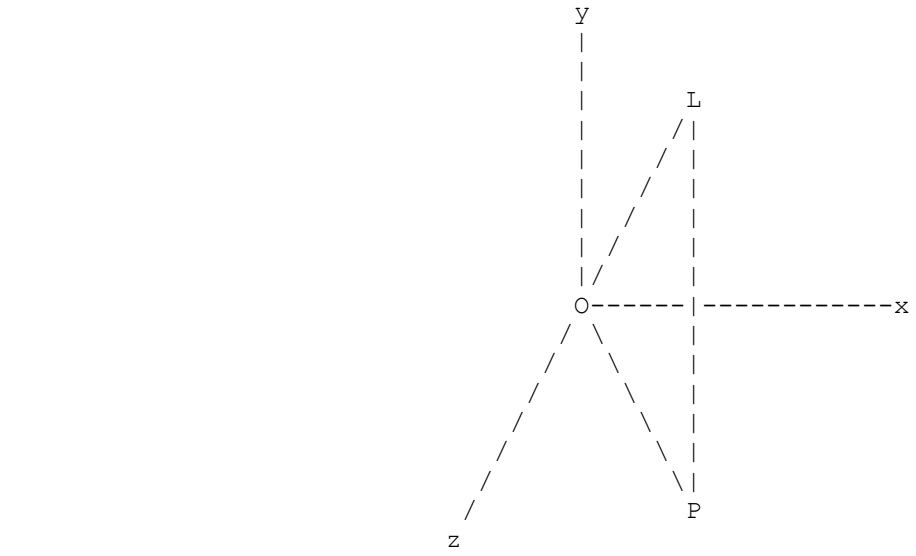
1) structural engineering knowledge
   (most IMPORTANT)

2) PC/MS DOS \Path\ knowledge
   MD\ : make subdirectory command
   CD\ : change subdirectory command
   COPY : copy file command
   (quite important)

3) IBM PC or clone or Virtual PC with:
   a) DOS 6.22 or higher
   b) Extended memory
      (dependent on problem size)
   c) CGA, EGA, VGA, HGC, or HGC+, MCGA,
      80 column monitor
   d) Hard disk and Ram drives
      Program subdirectory (drive)
      Data subdirectory (drive)
      Temporary subdirectory (drive)

Some Definitions

PC-MESH and PC-VIEW can view and rotate the 3 dimensional structure. Also, defining the coordinates of the nodes require defining a three dimensional, right handed, Cartesian coordinate system. This will be referred to as the GLOBAL system. Below is a representation:



The x,y,z coordinate system has the +z axis pointing at you, the +y axis pointing vertically up, and the +x axis pointing to your right. PC-MESH will initially (by default) view this way - you looking in the -z direction.

LONG & LAT angles

If you are looking from point L towards the origin O, the angle LO makes with its projection PO on the xz plane is defined the "LAT"itude angle, measured positive from the xz plane toward the +y axis. The angle PO makes with the z axis is defined the "LONG"itude angle measured positive from the +z axis toward the +x axis. These two angles are similar to LONGitude and LATitude on a globe of the world.

Installation

HARD DISK -

Manual Way

Have a program to unzip *.zip files like PKUnZip.exe or WinZip. Allways unzip with directory structure e.g., pkunzip -d zipfile.zip drive:

Unzipping with the directory structure will automatically put files in their correct directories.

Change to the PROG subdirectory. Run CFGSTRAN responding to the default paths that describe your system.
Copy PC-STRAN.EXE to be in your default path (usually your hard disk root directory.) This way you can type PC-STRAN at the DOS prompt > no matter what subdirectory or drive you are in. Run EFILECHK. You should get IBM extended character 251 (square root mark) if all the .EXE files are OK. If you get an IBM extended character 168 (upside down question mark), email Joe Murphy immediately.

Automatic Way

Unzip Install.Zip and run install.exe. Install.exe will ask you for your destination drive and will use PKUnZip.exe to place the files. Install.exe will also start CFGSTRAN for you.

==========

Getting Started

First install your software. See Section on Installation.

1. Boot up the computer.

2. Type PC-STRAN at the prompt (e.g. >pc-stran)

3. You will be queried for the Path and PROBLEM filename for the DATA files, the Path for the PROGRAM files, the Path for the STORAGE files, and the Path for the WORK files. Give appropriate responses. You can use the destructive backspace key.

4. When in the PC-STRAN Main Menu, you can choose 1,2,3,4,5, 6, or 7 to transfer to PC-PROP, PC-MESH, PC-LOAD, PC-SOLVE, PC-VIEW, PC-RPT or restart PC-STRAN respectively.

5. Once you are done with PC-PROP, PC-MESH, PC-LOAD or PC-VIEW, you can transfer to the PC-STRAN Main Menu.

6. When you choose PC-SOLVE, option 4, the RESult and DEFormation files will be written using the Path and PROBLEM filename of the DATA files while the STORAGE and WORK files will be written and deleted on their specified Paths.

7. To start out, work through the example problem of a truss.

Example Problem -- a 3-D truss with 6 nodes & 12 members

1. Boot up the computer. Type PC-STRAN at the prompt (e.g. >pc-stran)

2. For this example and assuming you followed the above installation you should type:
example1.(enter)
(enter)
(enter)
(enter)
where (enter) means pressing the Enter key.

3. At PC-STRAN Main Menu select option 1 -- transferring to PC-PROP

4. At PC-PROP Main Menu select option "4) Print all ...records". When queried where to print, select option "s) Screen".

5. After viewing the records and returning to PC-PROP Main Menu try editing a record.

6. To file the updated records select option "9) FILE all records...".

7. When you want to return to the main menu, select option "0) END ... transfer...".

8. PC-MESH and PC-LOAD are similar to PC-PROP. Read the internal instructions for viewing the mesh in PC-MESH.

9. PC-SOLVE is fairly straightforward. After the analysis ends, you will return to the main menu. You can return to DOS or transfer to PC-VIEW to view the deflected structure. If you return to DOS the DATA Directory should have the following files on it. EXAMPLE1.PRP, .MSH, .LDS, .RES, .DEF.

10. To get a REPORT select Main Menu Option 6
PC-RPT adds the appropriatefilename extensions.

PC-RPT will prompt if you want to do a load factor analysis. EXAMPLE1.RPT is an ASCII file that you can send to a printer with the command (e.g. >print example1.rpt) or view on screen with the command (e.g. >more <example1.rpt).

PC-RPT will also make EXAMPLE1.HTM, an HTML file.

11. That's all there is to it.

CFGSTRAN

CFGSTRAN.EXE can be run at any time to change the default paths in PC-STRAN.EXE. Just make sure that CFGSTRAN.EXE and PC-STRAN.EXE are in the same default directory when you run CFGSTRAN.EXE.

Viruses, Corrupt files and File Integrity

EFILECHK checks if even one byte has been changed in the .EXE files developed and distributed by the author. EFILECHK checks the .EXE files in the default directory. You should get IBM extended character 251 (square root mark) if the .EXE file is OK. If you get an IBM extended character 168 (upside down question mark), email Joe Murphy immediately.

Tips & Techniques

Keep programs separate from data and documentation. If you use a hard disk, copy all .EXE, .COM and .BAS files into a separate PROG subdirectory. Copy .TXT and .BAT files into a separate DOCS subdirectory. Copy .PRP, .MSH and .LDS files into a separate DATA subdirectory. For each problem you could create a separate subdirectory.

Keep units CONSISTENT! All forces MUST have the same units! All length units MUST be the same!

If you have a RAM drive, designate it as the drive for the WORK files!

File records often (select option 9) when using PC-PROP, PC-MESH or PC-LOAD - you will not end the program but will save data if something should happen. Option 0 will NOT file data.

Rotating the structure in PC-MESH should flag obvious errors in geometry and in member end connectivity.

The default structure size in ViewMesh of PC-MESH and PC-VIEW allows the ENTIRE structure to be viewed from any angle. If the structure appears small use the zoom feature.

The default node restraints in PC-MESH is 0 (0 movement). The default member end connections in PC-MESH is 0 (0 fixity factor).

When minimizing the node bandwidth (option m in PC-MESH) use a target value of 2. After repeated passes, note the minimum bandwidth that was attained during a pass. Do NOT resequence the nodes. Choose option m again but now with the minimum bandwidth (you know it was attainable) as the target bandwidth. Resequence the nodes.

The experienced user does not have to use PC-PROP, PC-MESH or PC-LOAD to create or update the *.PRP, *.MSH or *.LDS files. Any ASCII word processor can be used. Use UPPER CASE letters! If in doubt about how the files should be set up check the .PRP, .MSH and .LDS data files!

Selection Techniques

There are three ways to make selections at the PC-STRAN Main Menu and PC-PROP, PC-MESH, PC-LOAD, PC-VIEW Menus:

1) Number and Letter Keys
2) Scrolling and pressing the Enter Key
3) Using a Mouse

Numbers and Letters

In the text menus, the user can press the number or letter in front of the close parenthesis ")" to enter that option.

Scrolling

In the text menus, the user can use the PgUp and PgDn keys to bounce the highlighted bar over the desired option. Pressing the Enter key selects the highlighted option.

Mouse

In the text menus, moving the mouse up or down moves the highlighted bar. Pressing the left mouse button selects the highlighted option.

In the PC-PROP, PC-MESH, and PC-LOAD file editor, the mouse movements and buttons correspond to the following keys:

right	- Tab
left	- Shift Tab
down	- PgDn
up	- PgUp
left button	- Enter
right button	- Esc

In the PC-MESH and PC-VIEW graphics mode, the mouse movements and buttons correspond to the following keys:

```
  no buttons pressed
    right          - Right Arrow  => +latitude
    left           - Left Arrow   => -latitude
    down           - Down Arrow   => -longitude
    up             - Up Arrow     => +longitude

  left button pressed before movement
         and released after movement
    right          - "r"          => +Xshift
    left           - "l"          => -Xshift
    down           - "d"          => -Yshift
    up             - "u"          => +Yshift

  right button pressed before movement
          and released after movement
    right          - "b"          => bigger displacements
    left           - "s"          => smaller displacements
    down           - "o"          => zoom out
    up             - "i"          => zoom in
```

\Paths\

Beginning with Version 4.00, PC-STRAN accepts Paths to DATA, PROGRAM, STORAGE and WORK files.

Hercules MonoGraphics

Beginning with Version 4.00, PC-STRAN graphics will work with the Hercules Graphic Card and Hercules Graphic Card Plus. One has to install a Hercules DRIVER by typing MSHERC at the DOS prompt before starting PC-STRAN. See the Information about the PC-STRAN files.

Maximums and Mass Storage

PC-STRAN 6.0x has the following maximums:

Number of member types	= 1000
Number of member types (MASTER).PRP	= 1000
Number of nodes (NN)	= 1000
Number of members (NM)	= 4000
Semibandwidth (IH)	= 6000
Number of degrees of freedom (DOF)	= 6000
Number of load cases (LC)	= 8
Number of members with linearly distributed loads (per load case)	= 4000
Number of records, K matrix (NR)	= 18M*

NR = [IH * (IH+1)]/2 + IH * (DOF - IH)

PC-STRAN needs the following mass storage:

On the WORK files (RAM) drive
ERASE-ME.TMP

On the STORAGE files drive, a maximum of 6.8Mb

ERASE-ME.ROT	1152 bytes * NM
ERASE-ME.MB#	72 bytes * NM * LC
ERASE-ME.ND#	24 bytes * NN * LC

*NOTE: Beginning with Version 6.00, PC-STRAN looks to store the K matrix in EXTENDED memory. If there is no EXTENDED memory or not enough, then PC-STRAN will end. See Section on Use of EXTENDED Memory and Section on EXTENDED Memory Files.

NON-normal Program Termination

If you have a non-normal program termination (normal is option 0 in PC-STRAN to DOS), please let me know if you think it is in the program. Before using PC-STRAN again check for and ERASE all the ERASE-ME.* files.

Use of EXTENDED Memory

To work with EXTENDED memory use an extended memory manager XMM such as HIMEM.SYS developed and distributed by Microsoft Corporation. An example CONFIG.SYS file is:

```
break=on
DEVICE=c:\misc\HIMEM.SYS
device=c:\misc\xmsdisk2.sys 32767K
device=c:\dos\ansi.sys
stacks=9,512
files=30
buffers=20,0
fcbs=20
```

The second device, XMSDISK2.SYS, creates a 32Mb "RAM" drive (electronic or virtual drive) in EXTENDED memory. The rest of EXTENDED memory will be used by PC-STRAN!

```
; XMSDISK2.SYS --- XMS-aware RAMdisk device driver
; Copyright (C) 1989 Ziff Davis Communications
; PC Magazine * Ray Duncan
;
; To install:   copy XMSDISK2.SYS to the boot disk, add
;
;               DEVICE=XMSDISK2.SYS  nnnnnK
;
;       to the CONFIG.SYS file.  This must follow
;       the DEVICE= line that loads the XMM (usually
;       HIMEM.SYS).  The parameter nnn is the desired
;       RAMdisk size in KB. If nnnnn is missing or zero,
;       all available extended memory is used.
```

NOTE: Both HIMEM.SYS (from MS DOS 7.10) and XMSDISK2.SYS are in the MISC subdirectory.

Information about PC-STRAN files

This information is provided so that you'll know the function of each file distributed to you or made by PC-STRAN, and whether or not each file is optional. The following files have a '+' if provided on the distribution diskettes and have a '*' if optional:

INSTALL files

+* INSTALL.EXE - Program to call PKUnZip.exe and CFGSTRAN.EXE.

+* PKUnZip.EXE - Program to copy files to copy the appropriate files into subdirectories \PROG\, \DATA\ and \DOCS\. Should be used with a hard disk.

DOC files

+* ADDED.TXT - If this file is present, it contains additional documentation.

+* INVOICE.TXT - A one-page ASCII text file form to be filled out and sent along with registration fee.

+* PC-STRAN.PDF - This is the main documentation file. It is not needed after the documentation has been printed.

+* PROBLEM.TXT - A ASCII text file form to be filled out and sent along with any INPUT files, if the author cannot resolve the problem by email. Also use the form for documentation errors or enhancement suggestions.

+* README1.TXT - A file on steps to use PC-STRAN.

+* README1.EXE - A program to display README1.TXT.

DATA files
---

* filename.DEF - file containing DEFlected node geometry of loaded structure. Together with filename.MSH, PC-VIEW can overlay loaded structure on top of non-loaded structure.

+* filename.LDS - file containing LoaDS for INput in PC-STRAN. example.LDS are provided as optional examples.

+* filename.MSH - file containing MeSH geometry - INput. example.MSH are provided as optional examples.

+* filename.PRP - file containing member PRoPerty data - INput. Maximum number of entries is 1000. example.PRP are provided as optional examples.

+* (MASTER).PRP - file containing member PRoPerty data - INput. Maximum number of entries is 1000. If PC-SOLVE does not find filename.PRP, PC-SOLVE looks for the member type in (MASTER).PRP. (MASTER).PRP must contain the member types in alphabetical order.

* filename.RES - file containing PC-STRAN RESults - OUTput. This file is INput to PC-RPT for writing "custom" reports.

* filename.RPT - file containing RePorT of analysis.
PC-RPT generates this as OUTput.

* filename.HTM - HTML file of filename.RPT.
PC-RPT generates this as OUTput.

PROGRAM files

+* CFGSTRAN.EXE - A stand-alone program to reconfigure the default \Paths\ in PC-STRAN.EXE. See Section CFGSTRAN.

+* EFILECHK.EXE - A stand-alone program that checks the file integrity of all the *.EXE files developed and distributed by the author. See Section on Viruses, Corrupt Files and File Integrity.

+* MSHERC.COM - A stand-alone, terminate-and-stay-resident (TSR), driver for monographics with Hercules HGC and HGC+ cards.

+ PC-DIR6.EXE - A program called by PC-STRAN to list all the files in the \DATA\ subdirectory in 6 columns. Files are in CAPITAL letters and subdirectories are in lower case with a "*" marking them.

+ PC-LOAD.EXE - A child program to create or update a file containing applied LOADs at the nodes of the structure. This program is called from PC-STRAN.

+ PC-MESH.EXE - A child program to create or update a file containing the unloaded structure geometry or MESH. Also the program is for VIEWING the structure (rotating & zooming). This program is also called from PC-STRAN.

+ PC-PAGE.EXE - A program called by PC-RPT to paginate the filename.RPT and filename.HTM files.

+ PC-PROP.EXE - A child program to create or update a file containing the PROPerties of the members of the structure. This program is also called from PC-STRAN.

+ PC-SOLVE.EXE - A child program that SOLVES the 1-,2- or 3-Dimensional STRuctural ANalysis of the structure using, as input, files created by PC-PROP, PC-MESH, and PC-LOAD.

+ PC-STRAN.EXE - A parent program that controls the 1-,2- or 3-Dimensional STRuctural ANalysis of the structure. After entering DOS to start, type in PC-STRAN (e.g. >PC-STRAN) See Section Command Line Switches.

+ PC-VIEW.EXE - A child program for VIEWing the loaded structure (dashed lines) over the original structure. Similar to PC-MESH. Also for viewing graphs of member load, shear, moment, slope and displacement diagrams. This program is also called from PC-STRAN.

+ PC-RPT.BAS - A stand-alone source program that can be user modified for custom report writing. INput is filename.MSH and filename.RES and OUTput is filename.RPT.

+ PC-RPT.EXE - A child program for RePorT and HTMl writing. This program can be called from PC-STRAN.

+* ROLLANGL.BAS - A stand-alone source program for interactively computing the roll angle of a member in three dimensions.

+* ROLLANGL.EXE - An executable ROLLANGL.BAS.

TEMPORARY files

ERASE-ME.ROT - A temporary STORAGE file for the member stiffness matrices and local-to-global ROTation matrices. It should be killed or erased by PC-STRAN upon successful termination.

ERASE-ME.ND#, .MB# - Temporary STORAGE files for NoDe and MemBer loads of load case #. It is killed by PC-STRAN.

ERASE-ME.TMP - A TeMPorary WORK file for PC-STRAN results. The results are reformatted for filename.RES. It is killed by PC-STRAN. Also TeMPorary WORK for PC-VIEW. It is erased by PC-VIEW.

EXTENDED Memory Files

HIMEM.SYS - An extended memory manager developed and distributed by Microsoft Corporation. Use the HIMEM.SYS from MS-DOS 7.10, 4 Gb limitation. The one from MS-DOS 6.22 has a 64 Mb limitation. PC-STRAN requires extended memory to store the global stiffness matrix K. See Section on Use of EXTENDED Memory. It is in \MISC\ subdirectory.

XMSDISK2.SYS - An extended memory aware RAMdisk device driver. Use for tempory STORAGE and WORK files. Saves wear and tear on mechanical disk drives. See Section on Use of EXTENDED Memory. It is in \MISC\ subdirectory.

Program details

PC-PROP

PC-PROP creates a catalog of member properties. The created file is stored on disk and used as an input file for PC-STRAN. This eliminates specifying member properties every time an analysis is run. Substituting a member in an analysis requires changing only the member type field in PC-MESH. (MASTER).PRP is searched for if there is no filename.PRP.

PC-PROP can recall a member PROPerty file from disk, and modify member records, add records, delete records, print all the records to disk, printer or screen, and/or file the updated records.

PC-PROP is menu driven with scroll record data entry. There are 8 fields in each member type record. They are:

1) Member Type name - alphanumeric characters
   (NOTE: Must not be NODE2NODE, See Section on Tieing Nodes Together)
2) Density - force/length cubed
3) Young's Modulus - force/length squared
4) (torsional) Shear Modulus - force/length squared
5) Cross Sectional Area - length squared
6) (bending) Moment of Inertia about local y axis - length fourthed
7) (bending) Moment of Inertia about local z axis - length fourthed
8) (rotation) Torsion Constant about local x axis - length fourthed

Fields 1,3,5 MUST be defined. Fields 6,7 are necessary when bending moments are to be transmitted. Fields 4,8 are necessary when twisting moments are to be transmitted.

Estimating Torsion Constants

If field 8 is left blank it will be approximated by PC-STRAN using information in fields 5,6,7 by:

$$TC = \frac{4A^4}{(2*PI)\,(Iyy+Izz)^2} \qquad PI=3.141593$$

This approximation can be applied with an error of no more than about 12%, even when the cross section is a triangle or narrow rectangle. The cross section must have no projecting arms or reentrant angles. Also this approximation is useless for tubes whether they are closed or slit open lengthwise.

To compute the approximate torsion constant for thin-walled closed tubes of any cross-sectional shape and of constant wall thickness, t, use the following formula:

$$TC = \frac{4\,a^2\,t}{p}$$

where a is the whole area bounded by the centerline of the perimeter, p, of the tube. The area a is approximately the average of the two areas enclosed by the inside and the outside surfaces of the tube. It is the area enclosed by the centerline of the wall's contour. This equation applies only to thin-walled closed tubes with constant wall thickness.

To compute the approximate torsion constant for thin-walled closed tubes of any cross-sectional shape and of varying wall thickness, t, use the following formula:

$$TC = \frac{4\,a^2}{\Sigma_i\,(L/t)}$$

where a is the whole area bounded by the centerline of the perimeter, p, of the tube. The area a is approximately the average of the two areas enclosed by the inside and the outside surfaces of the tube. It is the area enclosed by the centerline of the wall's contour. The summation Σ adds all the ratios of length/thickness. This equation applies only to thin-walled closed tubes with varing wall thickness.

To compute the approximate torsion constant for thin-walled open cross sections with varying wall thickness, t, use the following formula:

$$TC = \frac{1}{3}\,\Sigma_i\,L\,t^3$$

where the summation Σ adds all the products of length times thickness cubed. This equation applies only to thin-walled open cross sections with varing wall thickness. This equation applies to cross section shapes resembling C,L,T,I,H,X,Z, etc.

See References section for computing Torsion Constants.

PC-MESH

PC-MESH creates a file of the geometry of the structure to be analyzed. The created file is stored on disk and used as an input file to PC-STRAN. The program allows the user to view the structure from any angle (see Some Definitions section). The program is divided into two general parts; one for specifying node (or joint) information and the other for specifying member information.

PC-MESH can recall a geometric MESH file from disk, and modify node or member records, add nodes or members, delete nodes or members, print all node or member records to disk, printer or screen, and/or file the updated node and member records.

PC-MESH is menu driven with scroll record data entry. There are 10 fields in each node record. They are:

1) Node Number - 1 to 3 digits
2) Global x coordinate - length
3) Global y coordinate - length
4) Global z coordinate - length
5) Node restraint in global x direction | 0=restrained
6) Node restraint in global y direction | 0=default
7) Node restraint in global z direction | 1=NOT
8) Rotation restraint about global x axis | restrained
9) Rotation restraint about global y axis |
10) Rotation restraint about global z axis |

There are 6 fields in each member record. They are:

1) Beginning Node number - 1 to 3 digits
2) Ending Node number - 1 to 3 digits
3) Member connection to beginning node | see
4) Member connection to ending node | below
5) Member roll angle - degrees
6) Member type name - alphanumeric characters
   (NOTE: Can be NODE2NODE, See Section on
   Tieing Nodes Together)

Member-to-node connection values can have one of ten single digit values.

0 is for a swivel connection and is the default value.

1 is for a fixed or rigid connection.

2-9 are for semirigid connections (see References) with fixity factors of .2 to .9 (i.e. the fixity factor is the specified single digit divided by ten). The semirigid connection can be thought of as two rotational and one torsional springs at the member ends, with:

$$\text{spring constant} = \frac{\text{flexural (or torsional) rigidity}}{\text{element length}} \times \frac{3\,FF}{1 - FF}$$

Note: The fixity factor (FF) is the same for the two bending axes AND the torsional axis.

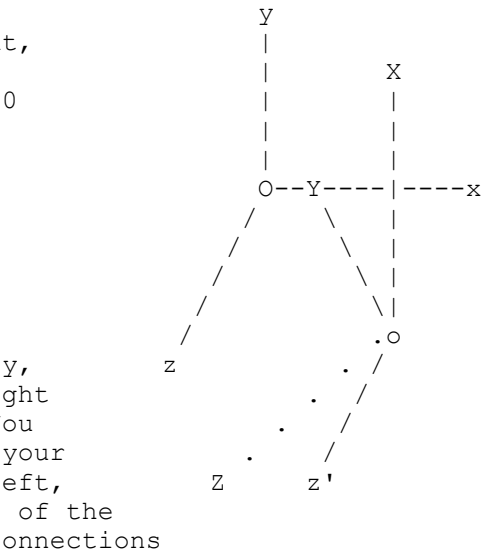
To understand the definition of a roll angle consider that a member has a LOCAL set of coordinate axes. The X (caps for LOCAL) axis runs + from the beginning of the member to its end passing through the member's centroid. The member's Y and Z axes define the member's Moments of Inertia Iyy and Izz. Remember that the LOCAL coordinate system has to be right-handed too. To obtain the roll angle translate the member's beginning node to the Global origin and move the member's end node to the +x global axis WITHOUT twisting the member about its' X LOCAL axis. The angle measured from the +z global axis to the +Z LOCAL axis is the member's roll angle. Special rules are required for vertical members. Foremost is that end nodes have to be higher (in the y direction) than beginning nodes. Note the roll angle is measured + from +z (toward +x) to +Z.

Roll angle (RA) is the angle the local +Z axis makes with a line (call it P) which lies in the cross-section (i.e., local Y-Z plane) and is parallel to the global x-z (i.e., horizontal) plane. The angle is measured positive from line P toward the local +Z axis. Mathematically:

$$[\ y \times (\ Y \times Z\ )\ ] \cdot Z = \cos(RA)$$

where x is cross product
. is dot product
^ is vector

In the example on the right, the vertical member runs o to X. It would have a -10 degree roll angle or +350 degrees. In the picture z'o is parallel to zO. Also Zo is perpendicular to Yo. See also Section on Computing Roll Angle.



With PC-MESH you can view the structure interactively, specifying your line of sight (see Some Definitions). You can rotate and also shift your line of sight, up, down, left, right, and zoom in and out of the structure. Fixed member connections are drawn to its nodes while swivel connections stop short of its nodes. Instructions are given with the ViewMesh option in PC-MESH.

See also Section on Command Line Switches/n, and Section on Video Override Switch.

PC-MESH has an option to reduce or minimize the node bandwidth. See Advanced Feature. The node bandwidth is linearly related to the stiffness matrix semibandwidth. The time required to solve a linear system increases as the stiffness matrix bandwidth squared (for the same number of degrees of freedom). Also because the number of records is limited to 18,003,000 , a minimum bandwidth means the fastest solution and maximum problem size.

Computing Roll Angle

Because of the possible difficulty with computing roll angle, the following is a BASIC listing of ROLLANGL.BAS for computing roll angle. The program is supplied on disk along with an executable version ROLLANGL.EXE.

```
10 REM interpretive basic program to calculate rollangle ***
20 DEFINT I : DIM X(8),Y(8),Z(8)
30 PI#=3.141596253#
40 INPUT "    beginning node coordinates: ",X(1),Y(1),Z(1)
50 INPUT "       ending node coordinates: ",X(2),Y(2),Z(2)
60 INPUT "coord's which lie on +XY plane: ",X(3),Y(3),Z(3)
70 X(4)=0 : Y(4)=1 : Z(4)=0       'global vertical or y axis
80 X(6)=0 : Y(6)=0 : Z(6)=1       'global z axis
90 REM ************************************************
100 I3=5 : I2=2 : I1=1 : GOSUB 260 'shift local X, normalize
110 I3=3 : I2=3 : I1=1 : GOSUB 260 'shift (+XYplane), norm
120 IF X(5)=0 AND Z(5)=0  GOTO 140 'vertical member?
130 I3=6 : I2=4 : I1=5 : GOSUB 290 'horizontal-Z vector,norm
140 I3=7 : I2=3 : I1=5 : GOSUB 290 'local Z vector, norm
150        I2=7 : I1=6 : GOSUB 340 'angl between the two Z's
160 IF (RA=0) OR (RA=180) GOTO 200 'special case Z's paralel
170 I3=8 : I2=7 : I1=6 : GOSUB 290 'is normal = X?
180 I3=8 : I2=8 : I1=5 : GOSUB 260 'subtract to find out
190 IF 1<VL THEN RA=-RA            'if identical=0 else =2
200 PRINT USING "                    roll angle= ####.##";RA
210 GOTO 60                       'try different +XY plane
220 REM ********** normalize vector i3 *********************
230 VL = SQR(X(I3)*X(I3) + Y(I3)*Y(I3) + Z(I3)*Z(I3))
240 IF 0 = VL THEN RETURN
250 X(I3)=X(I3)/VL: Y(I3)=Y(I3)/VL: Z(I3)=Z(I3)/VL : RETURN
260 REM ***** subtract i1 from i2 to get i3, normalize i3 **
270 X(I3)=X(I2)-X(I1): Y(I3)=Y(I2)-Y(I1): Z(I3)=Z(I2)-Z(I1)
280 GOSUB 220 : RETURN
290 REM ***** cross i1 toward i2 to get i3, normalize i3 ***
300 X(I3) =             - Z(I1)*Y(I2) + Y(I1)*Z(I2)
310 Y(I3) = Z(I1)*X(I2)               - X(I1)*Z(I2)
320 Z(I3) =-Y(I1)*X(I2) + X(I1)*Y(I2)
330 GOSUB 220 : RETURN
340 REM ******* get angle between unit vectors : i1,i2 *****
350 DOT = X(I1)*X(I2) + Y(I1)*Y(I2) + Z(I1)*Z(I2)
360 IF DOT = -1 THEN RA = 180 : RETURN
370 IF DOT =  1 THEN RA =   0 : RETURN
380 RA = 90# - ATN(DOT/SQR(1-DOT*DOT)) * 180#/PI# : RETURN
```

Tieing Nodes Together

The situation occurs that two continuous members cross and where they cross, they have equal displacement but not equal rotation. Essentially they are connected with a zero length pin with swivel connections at both ends. Think of a scissors. Up until Version 5.00, PC-STRAN could not connect members in such a fashion. If one connected everything rigidly to a node, the members would have equal displacements AND rotations. Pinning members to the node would render some members noncontinuous.

With Version 5.00, more than one node can have the same position in space. To tie the nodes together (lateral displacements not rotations) enter in PC-MESH edit Members the following:

Member Nodes beg-end		end Fixity factor beg	end	member Roll Angle	Member Type
###-###		#	#	###.##	---------
2	5	0	0	0	NODE2NODE

For this example we "tie" node 5 to node 2. Then proceed normally:

NOTE: The USER must follow three rules to tie node B to A.

1) Nodes B and A must have identical coordinates (i.e., zero length member.)
2) Nodes B and A must have identical lateral node restraints (rotational restraints can be different.)
3) A- B Member Type must be NODE2NODE.

The nodes will have identical displacements and forces will sum to the applied forces at the "tied" nodes. Applied moments will go the respective nodes. (See References.)

Advanced Feature

Besides having the option to reduce the bandwidth by resequencing the nodes. PC-MESH also has the option of RELABELING the nodes and the members. PC-MESH has the option of reordering the members. The RELABEL option should be used with EXTREME CAUTION since the node labels and member labels in the .LDS files are NOT changed.

!!!!! USER BE WARNED! !!!!!

It is suggested that the user apply the loads AFTER using this RELABEL feature.

PC-LOAD

PC-LOAD creates a file of applied loads to a specific structure. The created file is stored on disk and used as an input file to PC-STRAN. This eliminates specifying loads every time an analysis is run. Eight different loading cases for the same structure can be specified in one file. For each loading case, the members' weight can be INCLUDED or IGNORED. The members' weight load is calculated by:

member weight = density * cross sectional area * length

acting in the -y GLOBAL direction.

PC-LOAD can recall a LOAD file from disk, and for each case modify load records, add loads, delete loads, print all the load records to disk, printer or screen, and/or file the updated load records.

PC-LOAD is menu driven with scroll record data entry. There are 7 fields in each applied node load record. They are:

1) Node number - 1 to 3 digits
2) Force in global +x direction - force
3) Force in global +y direction - force
4) Force in global +z direction - force
5) Moment about global x axis, + going from y to z - force*length
6) Moment about global y axis, + going from z to x - force*length
7) Moment about global z axis, + going from x to y - force*length

There are 5 fields in each applied member load record. They are:

1) Beginning Node number - 1 to 3 digits
2) Ending Node number - 1 to 3 digits
3) Value of linearly distributed load at the beginning node - force/length
4) Value of linearly distributed load at the ending node - force/length
5) Distributed Load Type - alphabetic characters

Nine different choices of distributed load type are permitted:

XA refers to a linearly distributed load in the GLOBAL x direction per unit of member Actual length. YA and ZA are similar.

XP refers to a linearly distributed load in the GLOBAL x direction per unit of member Projected length on the yz plane. YP and ZP are similar.

XL refers to a linearly distributed load in the LOCAL X direction per unit of member actual length. YL and ZL are similar.

Gravity loads would be YA with negative values. Snow loads would be YP with negative values. Uplift wind pressure loads might be YL with positive values.

PC-STRAN (General) PC-SOLVE (Particular)

PC-STRAN analyzes 3 dimensional structures whose members are essentially one dimensional connected together at joints or nodes. The connectivity of members to the nodes can either be frictionless swivels or fixed or semirigid. One end of a member can be fixed and the other swivel. PC-STRAN requires as input the following 3 files:

1) a PROPerty file on member types
2) a geometric MESH file with node and member information
3) a LOAD file specifying loads at the nodes and members

Because each node can have 6 possible degrees of freedom - 3 translation and 3 rotation - care must be taken in PC-MESH to release the nodes. Consider the following types of structures:

1) Rigid beam - dx=dz=rx=ry=0 2 DOF's/node (010 001)
2) Plane truss - dz=rx=ry=rz=0 2 DOF's/node (110 000)
3) Plane frame - dz=rx=ry=0 3 DOF's/node (110 001)
4) Space truss - ry=rx=rz=0 3 DOF's/node (111 000)
5) Space frame - 6 DOF's/node (111 111)

Since PC-STRAN can handle part frame and part truss structures the maximum records of the K matrix is not a multiple of number of nodes but is a separate maximum (see Maximums). After PC-STRAN reads in the input files and checks that the information is consistent (e.g. member types in MESH file exist in PROPerty file, LOADed nodes exist in MESH file, etc.) the total number of records is calculated and printed. Output is directed to a user specified file and includes the following for all load cases:

1) all the input
2) degrees of freedom of the structure
   semibandwidth of K matrix
   number of records in K matrix
3) equivalent node loads for member loads
4) member end forces in local coordinate system
5) node movement and forces (reaction & applied) in global coordinate system

As PC-STRAN is analyzing, messages are printed to the monitor (e.g. as member stiffnesses are added to the global matrix). Member stiffness matrices, in local coordinates, and local-to-global coordinate transformation matrices, are stored in a temporary STORAGE file, so they only have to be calculated once thereby reducing computer time. The global matrix file is stored in available EXTENDED DOS memory.

Limitations

PC-STRAN assumes small deformations and member direction cosines to remain the same throughout the loading and deformation history. The global matrix (17 digits precision) is solved using Crout reduction and Gauss-Jordan elimination, with matrix skyline profiling. Buckling mechanisms, collapse mechanisms, and unstable mechanisms are NOT taken into account. PC-STRAN does a linear elastic structural analysis.

PC-VIEW

PC-VIEW views the deflected loaded structure over the original unloaded structure. PC-VIEW needs as input a file with extension DEF created by PC-STRAN during the structural analysis. The loaded structure is drawn with dashed lines. Two additional features are incorporated in PC-VIEW not found in PC-MESH. They are a SCALE adjustment to make the node displacements bigger or smaller and the LOAD CASE specification (0 to 8 max). Only node displacements are graphed not member bending. Instructions are given with the ViewMesh option in PC-VIEW.

PC-VIEW has option f) to define the load factors multiplying the results for load cases 1-8. The combination is load case 0.

PC-VIEW also has a graphics option with instructions to view load, shear, moment, slope and displacement diagrams of the structure's members.

See also Section on Command Line Switches/n, and Section on Video Override Switch.

PC-RPT

PC-RPT writes the structural analysis report. PC-RPT needs as input a file with extension RES created by PC-STRAN during the structural analysis. PC-RPT creates a file with extension RPT and HTM which are an ASCII files. These files can be sent to a printer with the DOS print command (e.g. >print filename.RPT) or to screen with the DOS more command (e.g. >more<filename.RPT). PC-RPT is provided in BASIC source code so you can "customize" your reports. To run PC-RPT you have to be in BASIC (e.g >basica). When in BASIC, LOAD"pc-rpt" and press the RUN key. Before you customize PC-RPT it is suggested you make a copy of the one provided and customize the copy. REMEMBER you have to read everything from filename.RES in the order given in PC-RPT but you can write to filename.RPT in any fashion you wish.

Member forces are in relation to LOCAL member coordinate systems. Internal minimum and maximum forces along the length of a member are only printed if there is a linearly distributed load (otherwise they occur at the ends of the member.)

Node forces and movement are in relation to the GLOBAL coordinate system.

Load Factor Analysis

PC-RPT can also provide limitless linear combinations of the eight possible load cases. This is quite useful for Loadand Resistance Factor Design (LRFD). After the individual load cases are printed to file, PC-RPT will prompt forfactors to multiply each load case and print the linear additions of the results into the *.RPT file. The user might designate load case 1 for permanent loads, load case 2 for floor live loads, load case 3 for snow loads, etc. This then allows the user to combine the load cases in any way desired. Entering ALL zeroes for the load factorsterminates PC-RPT.

[Note: To get just the weight of the structure as a load case, put on a zero force concentrated load and specify weight included option!]

PC-VIEW has option f) to define the load factors for the different load cases 1-8. The load combination becomes load case 0.

Screen Hardcopy

Graphic Screens in PC-STRAN

The following files in the \MISC\ subdirectory are used to make GIF file from the graphic screens. The Hot-Key is Alt-F10.

BW.CMP - black/white colors used by RAW2GIF

GRABSCRN.COM - the TSR grabs graphic screen makes RAW files
GRABSCRN.TXT - describes use of GRABSCRN

LXPIC.COM - program to view GIF files in DOS
LXPIC.TXT - descibes use of LXPIC

RAW2GIF.EXE - makes GIF file from RAW file
RAW2GIF.TXT - describes use of RAW2GIF

VGA16.CMP - 16 colors used by RAW2GIF not used by PC-STRAN

Text Screens in PC-STRAN

Then following files in the \MISC\ subdirectory are used to append text to the file date.TXT. The Hot-Key is PRinTSCReen.

FDATE.EXE - grabs date and puts it in environment variable
FDATE.TXT - describes use of FDATE
FDATEBEG.TXT - more useful documentation
FDATE_NT.TXT - for NT operating systems

INT5BEEP.COM - beeps after text screen is appended
INT5BEEP.TXT - decribes use of INT5BEEP

PRTSCR.COM - the TSR to capture the text screen
PRTSCR.TXT - describes use of PRTSCR

Run-Time Errors

To reduce the size of the .EXE modules QuickBASIC's ON ERROR GOTO was eliminated. Check to make sure drive doors are closed, printer is turned on, etc. The modules do check for input files existing, as well as, 87 math coprocessor exception conditions (invalid operation, underflow, overflow, divide by zero, etc.)

If you get a divide by zero, overflow or any 87 math coprocessor error during "Crout reduction & Gauss-Jordan elimination" then your stiffness matrix is most likely singular. Check your fixity factors and node restraints. A member has to be restrained from spinning about its own X axis! A member that intersects another member but is given a fixity factor of zero does NOT prevent either member from spinning about their own X axes! Watch out also for collapse mechanisms in trusses as well as any buckling mechanisms!

If you get the error - Bad file number at 710 - when using PC-RPT.BAS, load BASICA with the switch /f:4, i.e., A>BASICA/f:4 .

References

Przemieniecki, J.S.
1968. Theory of Matrix Structural Analysis.
McGraw-Hill Book Co., Inc.,
New York. (see pp.61-82)

Timoshenko, S. and J.N. Goodier
1951. Theory of Elasticity.
Second Edition, McGraw-Hill Book Co., Inc.,
New York. (see p.267)

Seely, F.B. and J.O. Smith
1955. Advanced Mechanics of Materials.
Second Edition, John Wiley & Sons, Inc.,
New York. (see pp.276-279)

Popov, E.P.
1968. Introduction to Mechanics of Solids.
Prentice-Hall, Inc.,
Englewood Cliffs.

Isaacson, E. and H.B. Keller
1966. Analysis of Numerical Methods.
John Wiley & Sons, Inc.,
New York. (see pp.50-52)

Willems, N. and W.M. Lucas, Jr.
1978. Structural Analysis for Engineers.
McGraw-Hill Book Co., Inc.,
New York. (see Appendix D - torsional constants)

Grooms, H.R.
Algorithm for Matrix Bandwidth Reduction.
1972. Journal of the Structural Division,
Proceedings of the American Society of Civil Engineers,
Vol. 98, No. ST1, pp.203-214.

Wang, C.K.
1983. Intermediate Structural Analysis.
McGraw-Hill Book Co., Inc.,
New York. (see Chapter 20, Rigid Frames with Semirigid Connections)

Cook, R.D.
1974. Concepts and Applications of Finite Element Analysis.
John Wiley and Sons, Inc.,
New York. (see Section 11.8 - Enforcing Equality of Displacements)

Cook, R.D. and W.C. Young
1985. Advanced Mechanics of Materials.
Macmillan Publishing Company
New York. (see pp.292-296 - torsion formulas)

PC-STRAN Versions / Enhancements

- 1.0 - First documented stand alone programs
  - PC-PROP, PC-MESH, PC-LOAD, PC-3DSA
  - 64 member types,64 nodes,64 members,80 dof's
- 1.2 - PC-3DSA renamed to PC-STRAN
  - programs chained
  - 128 nodes,256 members,254 dof's
  - disk storage of WORK files
- 1.4 - upgrade of 1.2
  - 192K of memory
- 2.0 - add PC-VIEW, PC-WRITE
  - 255 dof's,8 load cases
  - transfer information between programs
- 2.5 - upgrade of graphics
  - linearly distributed member loads (128)
  - members' weight load option (for all members)
  - moment/shear diagrams for members (256)
  - scroll method of selection
  - greater than 255 dof's
- 2.57 - 8087 version of 2.5
- 3.00 - add PC-SOLVE as subprogram to PC-STRAN
  - direct memory allocation algorithm for K matrix & load vectors (resulting in significant speed improvement)
  - use of 16 bytes 0:04F0-0:04FF for data passing between program modules
  - autocheck and autoutilization of 87 math coprocessing chip
- 3.10 - show nodes option in PC-MESH and PC-VIEW
  - finer Zoom increments in PC-MESH and PC-VIEW
  - course and fine Shift adjustments in PC-MESH and PC-VIEW
  - assembly language profile routine in PC-SOLVE
- 3.20 - PC-WRITE renamed to PC-RPT
  - node bandwidth minimization (reduction) option in PC-MESH
  - capabilities for semirigid joints
- 3.22 - command line switches for non-8087 and non-EGA compatibles
- 3.50 - expanded drive letters A-Z
  - compiled with QuickBASIC 4.0 (runs faster though larger programs)
  - infinite number of linear combinations of load cases in PC-RPT (useful in load factor analysis)
  - PC-STRAN Main Menu in each program module

4.00 - path capabilities for DATA, PROGRAM, STORAGE and WORK files
- PC-STRAN is a parent process with children, PC-PROP, PC-MESH, PC-LOAD, PC-SOLVE and PC-VIEW
- PC-RPT incorporates user-defined header and page numbering
- data entry uses scrolling of records in editing window, data is not reformatted
- graphics and HiResPix (screen dump driver) works with CGA, EGA, VGA, HGC and HGC+ and 100% compatibles

4.01 - fixes bug in the creation of .PRP, .MSH and .LDS files

4.02 - fixes bug (only on 8088 machines) in editing features
- checks for errors before writing .PRP, .MSH and .LDS files
  zeroes blank fields before writing files
- fixes bug in diagrams in PC-VIEW for HGC and HGC+ graphics

4.10 - fixes bugs in PC-LOAD and PC-MESH
- load combination in PC-VIEW as Load Case #0
- RELABEL option in PC-MESH
- more consistent Editing and Scrolling Keys
- major revision of Documentation with INDEX
- separate INVOICE.DOC and PROBLEM.DOC
- CFGSTRAN to configure default \Paths\ in PC-STRAN.EXE
- EFILECHK for .EXE file integrity check
- VIDFIX.EXE for early-IBM BIOS video bug
- works with MCGA graphics
- horizontal-to-vertical scaling override switch
- checks 87 math coprocessor for exception conditions (i.e. errors)

4.30 - (Microsoft) mouse support
- min and max forces are calculated in PC-RPT
- PC-RPT.EXE and PC-RPT.BAS are provided
- start new problem w/o leaving PC-STRAN
- large (MASTER).PRP file w/ max 512 entries
- higher resolution in MCGA graphics
- INSTALL.BAT for hard disk users
- compressed EXE files
- \DATA\ subdirectory listing
- PC-PROP, PC-MESH and PC-LOAD will not prompt "Do you want to return ...?" if you file the records after editing them
- beeps in editing window changed to low beeps and eliminated for field widths of 1

4.31 - correct density in distributed (MASTER).PRP
- correct PC-RPT.BAS and PC-RPT.EXE for load factor analysis

5.00 - add ability to use EXTENDED memory thereby relaxing Number of Records limitation
- add ability to TIE nodes together (i.e., zero length truss member)
- ROLLANGL.BAS and ROLLANGL.EXE programs to calculate member rollangle.

6.00 - greatly increase maximums for problem size requires extended memory, DOS 6.22 or greater works in MS Virtual PC 2004 and 2007

Obtaining the Latest Version

The latest version of PC-STRAN will be posted on www.joeinmadison.com

Some Questions Answered

1. "Will it help if I buy more RAM memory for my PC?". ANSWER: Yes, if with enough memory and purchase of the appropriate software you can create a "RAM" (electronic) disk drive to hold the TEMPorary storage WORK files needed by PC-STRAN (See Section on Use of EXTENDED Memory).

2. "In what language was PC-STRAN written?". ANSWER: It was written in Microsoft QuickBASIC, then compiled with Microsoft's QuickBASIC 4.5 Compiler and linked with Cresent Software's QuickPak Professional Library.

3. "Can I obtain the source code for the program?". ANSWER: No.

4. "What is your update policy?". ANSWER: Presently you can mail me a check for $25, every six to nine months or so, and I will send you the then-current version.

5. "Do you have any other programs that you are distributing?". ANSWER: Yes, PCBRIDGE(tm) is a structural analysis program for a continuous beam with moving vehicle load envelopes.

6. "Is there a version of PC-STRAN for other computers?" ANSWER: No.

7. "What about program support?". ANSWER: I will give support and reply to written questions from registered users. I will also post any program problems.

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3. That distribution of programs should be encouraged, rather than restricted.

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Shareware is a unique method of marketing software based on the try-before-you-buy concept. The authors of shareware programs retain all rights to the software (copyright), and they require a "license fee" from those persons who continue to use the software. The term shareware goes back to the early 1980's when there was a column in Infoworld by that name describing programs available through electronic Bulletin Board Systems. In 1984, Nelson Ford had a contest in his Softalk column on user-supported and public domain software. The purpose of this contest was to find a better name than "user-supported" for this software genre. The overwhelming favorite was shareware and he announced shareware the winner. Since then, the name has increased in use by the common public. Shareware is a concept that has wide respect among part of the user community who never doubted that it is a generic term.

Documenting Problems

If in using this shareware software you encounter a problem, (software bugs, documentation errors, or suggested enhancements) and after rereading the documentation and after calling the author for help, send DOCumentation of the problem with input files (on disk) to the author along with the filled out form in PROBLEM.TXT. This way the author can try to resolve the problem.

Invoice

If you have need for an invoice so that you can initiate payment through your company accounting system, an invoice is provided in INVOICE.TXT. For those of you in this category, or for those who wish an invoice for your tax records, it should serve the purpose.

8087 Version

PC-STRAN v6.00 checks if a 87 math coprocessing chip is available. If PC-STRAN does not detect it, PC-STRAN ends. PC-STRAN uses subroutines written for the 87 chip during the number crunching Crout reduction & Gauss-Jordan elimination in PC-SOLVE. See below.

Command Line Switches/n

tm
PC-STRAN has an override switch at the command line. To use the override option, type at the command line

pc-stran/n

n	[100% IBM CGA]	[transfer prompts]
1	no	
4		no
5	no	no

[100% IBM CGA]

On some non-IBM CGA and EGA cards and MCGA the node number option in PC-MESH and PC-VIEW produces numbers with lines through the numbers. If this is the case use option 1 or 5.

[transfer prompts]

When returning to PC-STRAN main menu the program default prompts "Do you want to return ...? Y/N". To turn these default prompts off use option 4 or 5.

Video Override Switch

PC-MESH and PC-VIEW automatically sense the monitor and graphics card adapter and assign a horizontal-to-vertical scaling factor so that a square box will be close to being square. The default horizontal-to-vertical scaling factors are:

2.40 for CGA and MCGA adapters and monitors,
1.37 for EGA and VGA adapters and monitors,
1.43 for Hercules adapter and monochrome monitor.

If you want to fine tune or override the default horizontal-to-vertical scaling factor, type at the command line

pc-stran (h2v)

where h2v is the horizontal-to-vertical scaling factor (a floating point number).

[NOTE: The two override switches can be used together or separately, e.g., pc-stran/4 (1.20), pc-stran/4, pc-stran (1.20), etc.]

Mouse Switch

To use PC-STRAN mouse (Microsoft-compatible) capabilities, invoke the program either with an "m" or "M" on the command line (e.g., C>pc-stran/m) if the mouse driver is not installed PC-STRAN will beep but will continue.

Test Machines

PC-STRAN version 6.00 has been developed and tested with the following:

Windows 2000 and MS Virtual PC 2004

Windows XP and MS Virtual PC 2007

MS Virtual PC is posted on www.joeinmadison.com

NOTE: See autoexec.bat and config.sys in zip file.