SPEED SCI MODULE

1. INTRODUCTION

The documentation related to necessary input files of the SPEED program can be found here: Link To Documentation.

The additional input parameters/ files that are needed to run the SPEED-SCI modules are explained here.

Note: The Mesh-partitioning subroutine is updated to METIS-5.1.0 (the SPEED-master branch uses older METIS-4.0.3)

2. INPUT FILES

A. SPEED.input

In addition to the definitions specified in official documentation, SPEED-SCI module needs the following tags/definitions.

SDOFFILE $Folder containing files related to Building Parameters (BLDINFO.txt file)

SDOFOUT $O1 $O2 $O3 $O4

The $O1 $O2 $O3 $O4, are logical values (0 or 1). This must be defined to request the Output files related to the structural response.

$O1:

0 = Output only the base shear forces, and structural response at top story.

1 = output the structural response at all the degrees of freedom in each building.

$O2 : 1 = Output the relative structural displacements.

$O3 : 1 = Output the relative structural Acceleration.

$O4 : 1 = Output the base reaction forces.

SYSLST (Similar to MLST in the main documentation, but to search for the nearest nodes to buildings.)

B. SYS.input

Currently in SPEED-SCI modules, the base reactions from the buildings are applied at a single spectral node in the MESH domain. The spectral node that is closest to the building is selected to apply the reaction forces.

This file contains the locations/ coordinates of the buildings.

Format:

First Line: $Total No. of Buildings

Second line onwards: $BldNo $Xcord $Ycord $Zcord $Rotation

$Xcord $Ycord $Zcord: X, Y and Z coordinates of the centroid of each building	
$Rotation:	The principal axes of the building can be different from the global X, Y and Z axes of the MESH domain. $Rotation is the angle measured in anticlockwise direction from global X-axis to the local X-axis of the building.

C. $SDOFFILE/BLDINFO.txt

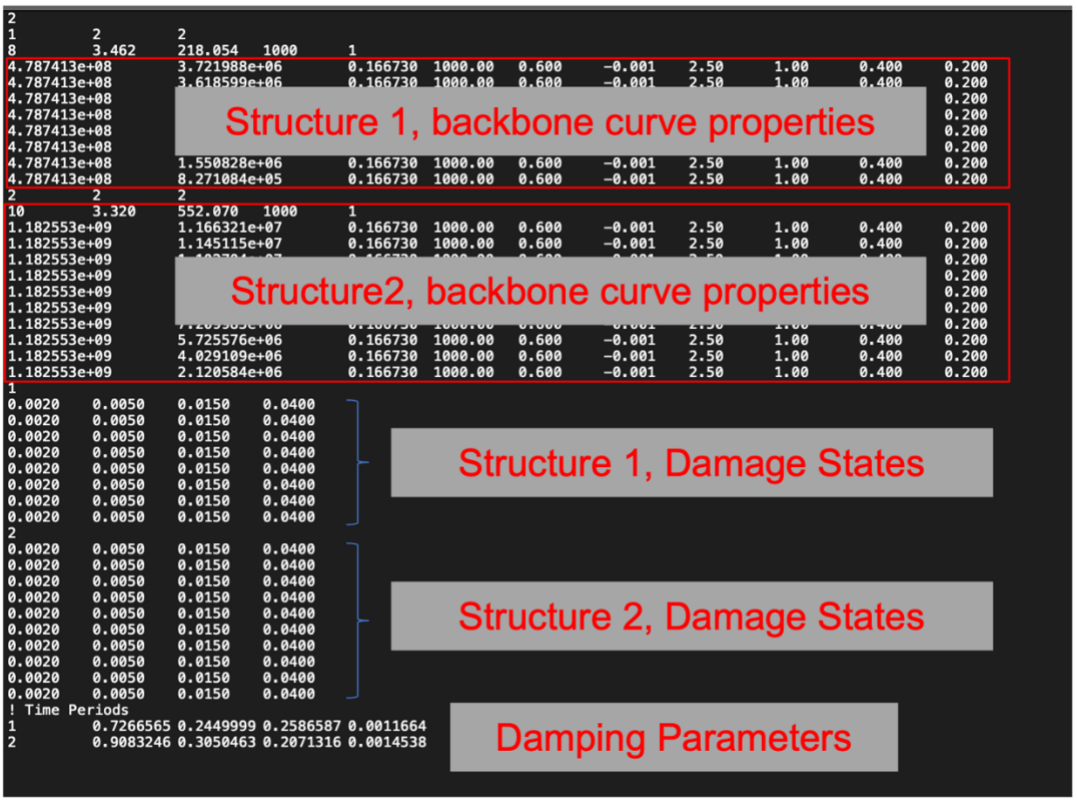
The is input file to specify the dynamic response characteristics of structural behavior.

Example Files:

(1) BLDINFO.txt File for 2 SDOF buildings:

```
2                                                                   !First Line
1       1       1                                                   !Structure-1, Line-1
0       0                                                           !Structure-1, Line-2
1.2527000E+04   7.4720000E+06  2.0000000E-02   0.2572675E+00       !Structure-1, Line-3
2       1       3                                                   !Structure-2, Line-1
0       0                                                           !Structure-2, Line-2
1.2527000E+04   7.4720000E+06  1.4944000E+06   0.0000000E+00   2.0000000E-02
7.0000000E+04   6.0000000E-02  1.0000000E-01   0.2572675E+00       !Structure-2, Line-3
```

(2) BLDINFO.txt File for 2 SDOF buildings:



Format:

First Line: $(Total No. of Buildings)

Second Line on wards: Structural dynamic properties of Structure No. 1, then Structure No. 2, and so on.

Structural Properties of a single Structure, Line 1:

$(Structure_ID) $(Struct_Type) $(ConstitutiveLaw)

$Struct_Type : 1 -SDOF; 2- MDOF

$ConstitutiveLaw : Behavior of interstory shear stress-displacement

For SDOF: (1-Linear Elastic [LE], 2-Elastic-perfectly-plastic[EPP], 3-Trilinear)

For MDOF: (1-Linear Elastic [LE], 2-Non-linear shear spring [NL])

The Nonlinear properties for MDOF systems are based on data from Hazus Technical Manual. The single-parameter hysteresis behavior is used, based on pinching factor. Rayleigh damping is assumed for structural damping.

Structural Properties of a single Structure, Line 2:

For SDOF: $(flag_SSI) $(flag_point_area_force)

For MDOF:

$NST $story_height $story_area $Mass_per_unit_area $(flag_point_area_force)

$flag_SSI : 0 (default); Under Development -> (1 – Soil Structure interaction enabled assuming 3DOF for soil-foundation system)

$flag_point_area_force: 1 (default value). (Apply reactions from Building onto Soil assuming: 1-PointForce, 2- [under development] ShearStress over an Area of ground surface)

$NST: No. of Stories/floors in structure

$Mass_per_unit_area: Mass per unit area.

(Floor Mass = $Mass_per_unit_area* $story_area)

Structural Properties of a single Structure, Line 3:

Depending on the chosen structural model, the structural parameters are displayed as follows:

- For LE SDOF (1 line, 4 parameters):
  $mass $stiffness $damping_factor $natura_ period
- For EPP SDOF (1 line, 5 parameters):
  $mass $stiffness $damping_factor $yield_strength $natural_period
- For trilinear SDOF model (1 line, 9 parameters):

  $mass $stiffness $hardening_coefficient $softening_coefficient $damping_factor $yield_strength $peak_displacement $ultimate_displacement $natural_period

- MDOF Structure: ($NST lines, each line corresponds to 10 strength parameters of corresponding structural floor/story)

  1st floor: properties (1,2,….10)

  2nd floor: properties (1,2,….10)

  …

  nth floor: properties (1,2,….10)

properties (1): Initial tangent stiffness. (For MDOF-Linear structure, only this property is read, remaining properties are dummy)

properties (2): Initial yield stress.

properties (3): Hardening stiffness ratio.

properties (4): Parameter for cumulative damage. (No cumulative damage is considered when this value is positive infinity)

properties (5): Pinching factor. (0 for very severe pinching, more elastic; 1 for no pinching, more energy dissipation)

properties (6): Softening stiffness ratio

properties (7): The ratio of peak strength over yielding strength

properties (8): The ratio of the yield strength between the negative and positive loading direction

properties (9): Parameter for unloading stiffness. (0 if the unloading stiffness equals initial stiffness; 1 if unloading path pointing to 0)

properties (10): Crack closure position.

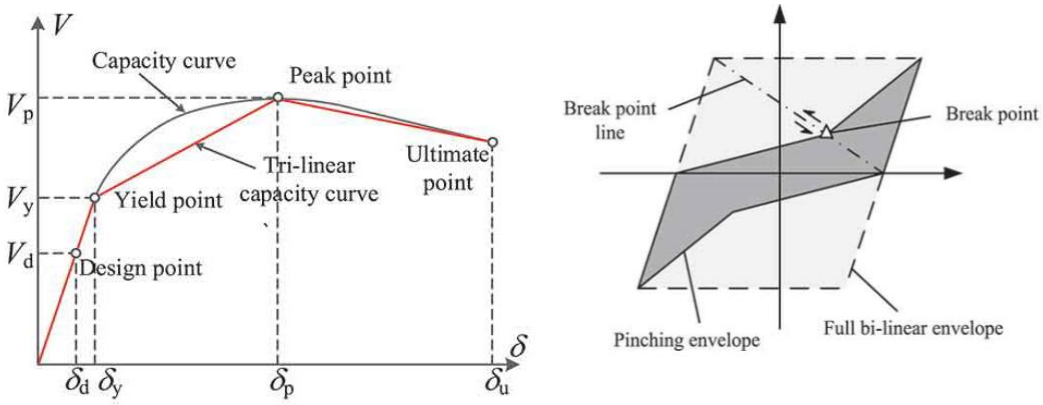


Figure 1 (a) Non-linear backbone curve for shear force-displacement, (b) Hysteresis Behavior based on single parameter

After defining Structural Strength Properties:

For MDOF, 4 Damage states based on inter-story drift ratios:

BLD1:

$BLD_ID

1st floor: $DS1 $DS2 $DS3 $DS4

2nd floor: $DS1 $DS2 $DS3 $DS4

...

nth floor: $DS1 $DS2 $DS3 $DS4

BLD2....

BLD_N....

[$DS4 = complete damage]

After defining Structural Damage states:

For MDOF, Time periods corresponding to first two modes of vibration, and Rayleigh damping coefficients:

$BLD_ID $period_of_first_mode $period_of_second_mode $rayleighdamping_alpha $rayleighdamping_beta

3. OUTPUT FILES

SPEED-SCI modules saves the output files containing structural response, in the same folder as SPEED (folder defiled under 'MONFILE' in SPEED.input file). The output is saved in SDOF000000.* files. Depending on the user request in SPEED.input file, the saved outputs are:

1. *Structural displacements relative to ground motion (SDOF000000.[DX, DY,DZ] files) and Ground displacement under the structure (GDX, GDY, GDZ files).*
2. *Structural accelerations relative to ground motion (SDOF000000.[AX, AY,AZ] files) and Ground accelerations under the structure (GAX, GAY, GAZ files).*
3. *Base reaction Forces (or) inter-story shear forces (SDOF000000.[FX,FY,FZ] files)*

Also depending on the user request in SPEED.input file, the output either contains (i) response at just one-degree-of freedom(response at top floor for displacements/accelerations; structure base reactions in FX,FY,FZ files), (ii) response at all the DOFs. The format of output files is as follows:

(i) For Response at just one-degree-of freedom

Column 1 = time array

Column 2 = Disp/Acc/Force in X/Y/Z direction of Structure 1.

Column 3 = Disp/Acc/Force in X/Y/Z direction of Structure 2.

…

Column End = Disp/Acc/Force in X/Y/Z direction of Last Structure

(ii) For Response at all the degrees of freedom.

Column 1 = time array

Column 2 to Column (1+ndof) = Disp/Acc/Force in X/Y/Z direction of Structure 1. Each Column represents response at each DOF.

Column (2+ndof) = Disp/Acc/Force in X/Y/Z direction of Structure 2. Each Column represents response at each DOF

…

Column N… = Disp/Acc/Force in X/Y/Z direction of Last Structure