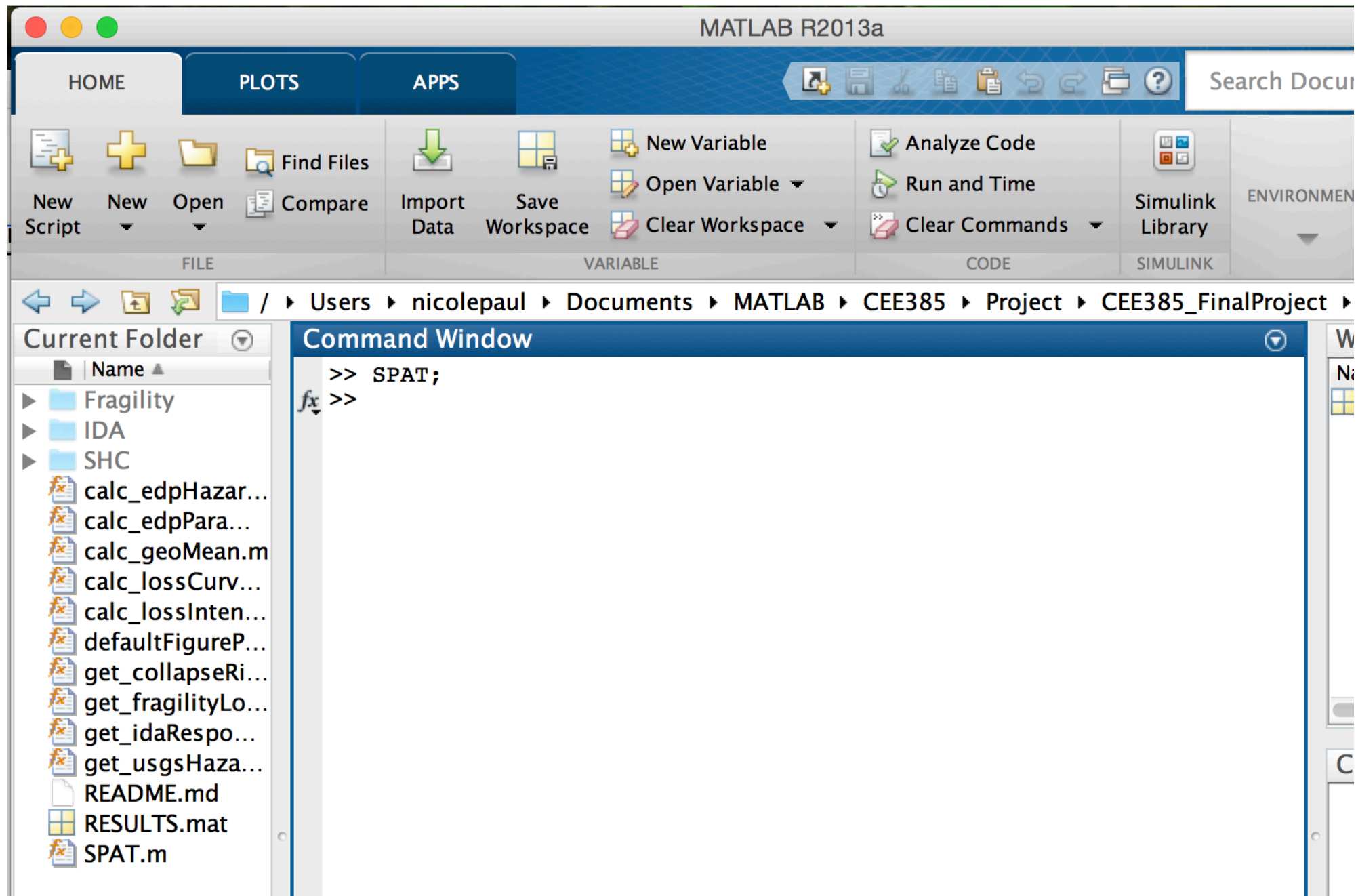


# Seismic Performance Assessment Tool (SPAT) User Manual

Nicole Paul

To open GUI, open the “CEE385\_FinalProject” directory in MATLAB and type the following into the command window:

```
>> SPAT;
```



# Hazard

## Inputs:

- Longitude
- Latitude
- Site class
- Period

## Outputs:

- Seismic hazard curve
- Rate for probability of exceedance in  $t$  years
- Ground motion for probability of exceedance in  $t$  years

Enter the longitude, latitude, site class, and period of structure in the left bar titled “Seismic Hazard Inputs”. When finished, click the “Update Hazard” button.

Seismic Performance Assessment Tool v1.0 - Nicole Paul

## SEISMIC PERFORMANCE ASSESSMENT TOOL

Created by Nicole Paul for CEE 385, Fall 2015 at Stanford University

**HAZARD**      **RESPONSE**      **COLLAPSE**      **DAMAGE**      **LOSS**

**SEISMIC HAZARD INPUTS:**

Import from USGS

Latitude: 37.785

Longitude: -122.440

Site Class: D (259 m/s)

Period: PGA

Update Hazard

**SEISMIC HAZARD OUTPUTS:**

Probability: 0.02

Time: 50

Rate:

IM Value:

To calculate the rate and ground motion at a targeted probability of exceedance in a given span of time, edit the “Probability” and “Time” textboxes and hit the enter key

## SEISMIC PERFORMANCE ASSESSMENT TOOL

Created by Nicole Paul for CEE 385, Fall 2015 at Stanford University

HAZARD

RESPONSE

COLLAPSE

DAMAGE

LOSS

### SEISMIC HAZARD INPUTS:

Import from USGS

Latitude: 37.785

Longitude: -122.440

Site Class: D (259 m/s)

Period: PGA

Update Hazard

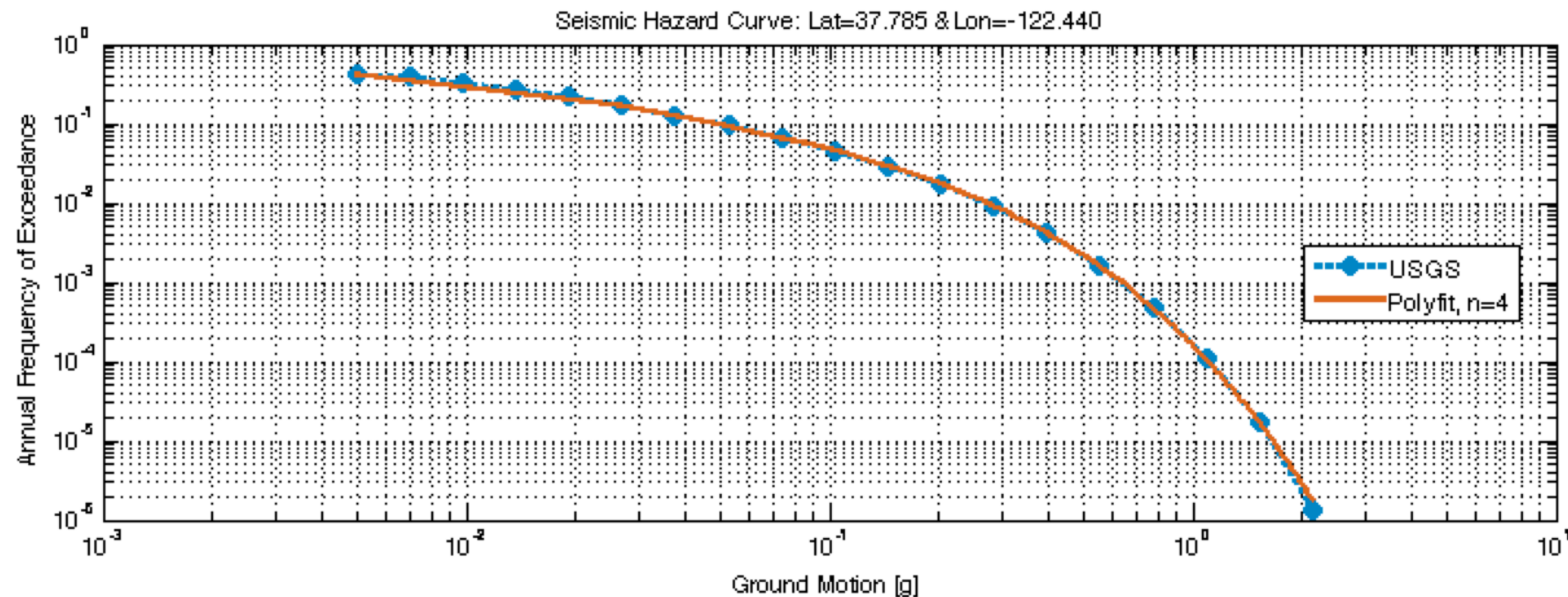
### SEISMIC HAZARD OUTPUTS:

Probability: 0.02

Time: 50

Rate: 0.0004040

IM Value: 0.8109



☒ Grid On

☒ Log (y-axis)

☒ Log (x-axis)

# Response

## Inputs:

- Results from stripe analysis

- Expected to be a directory containing one csv file for each stripe

- Expected format:

- Number of GMs

- Number of floors

- Number of EDPs

	A	B	C	D	E	F	G	H	
1	Sa=0.8g	GM1	GM2	GM3	GM4	GM5	GM6	GM7	GM
2	IDR1	0.02090217	0.03077716	0.02358009	0.05944868	0.03476269	0.03077716	0.02540993	0.0
3	IDR2	0.01936072	0.02826501	0.01807428	0.05283268	0.02811035	0.02826501	0.02326474	0.0
4	IDR3	0.01150203	0.02115476	0.01473636	0.01445974	0.02143113	0.02115476	0.00943804	0.0
5	IDR4	0.00402769	0.01086085	0.00766096	0.00793558	0.01194064	0.01086085	0.0042405	0.0
6	RIDR1	0.00299397	0.00348859	0.01190119	0.04615261	0.02072044	0.00348859	0.01365162	0.0
7	RIDR2	0.0025168	0.00272322	0.00775637	0.03883975	0.01537663	0.00272322	0.01150783	0.0

(Note: This corresponds to the number of rows with EDP information, so for the SampleStripe given it will be 13 since there are 4 IDR rows, 4 RIDR rows, and 5 PFA rows = 4 + 4 + 5 = 13)

## Outputs:

- Plot of all stripe analysis results and geomean for each EDP
- Plot of the lognormal standard deviation of each EDP
- Mean annual frequency of each EDP with and without collapse
- Probability density of each EDP given IM, assuming lognormal

Switch to the Response tab by clicking the “Response” button. Click “Open” to locate the directory which contains the stripe analysis result csv files. Enter in the number of floors, EDPs, and GMs from the stripe analyses and then hit “Update Response”

## SEISMIC PERFORMANCE ASSESSMENT TOOL

Created by Nicole Paul for CEE 385, Fall 2015 at Stanford University

HAZARD

RESPONSE

COLLAPSE

DAMAGE

LOSS

### SEISMIC RESPONSE INPUTS:

Open directory...

Open

Number of stripes found: #

Number of floors:

4

Number of EDPs:

13

Number of GMs:

20

Update Response

### SEISMIC RESPONSE OUTPUTS:

Linear interp. / Plateau ex...



Plot MAF(edp)

IM value

Plot PDF(edplim)



Toggle EDP of interest using the dropdown menu to the right of the smaller axes

## SEISMIC PERFORMANCE ASSESSMENT TOOL

Created by Nicole Paul for CEE 385, Fall 2015 at Stanford University

HAZARD

RESPONSE

COLLAPSE

DAMAGE

LOSS

### SEISMIC RESPONSE INPUTS:

/Users/nicolepaul/Documents/MATLAB

Open

Number of stripes found in SampleStripe: 5

Number of floors: 4

Number of EDPs: 13

Number of GMs: 20

Update Response

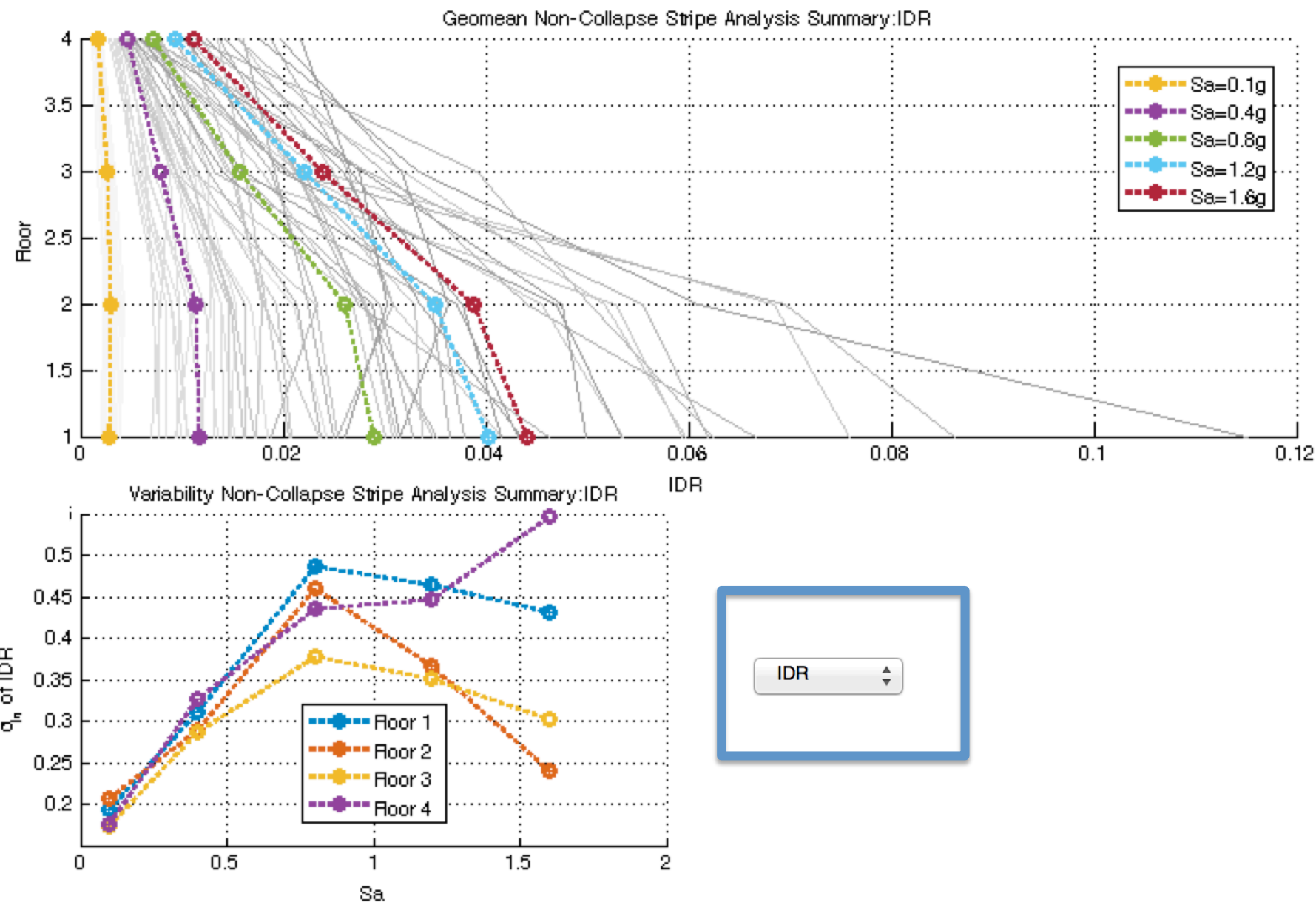
### SEISMIC RESPONSE OUTPUTS:

Linear interp. / Plateau ex...

IM value

Plot MAF(edp)

Plot PDF(edplim)





Plot mean annual frequency of EDP of interest using the “Plot MAF(edp)” button

## SEISMIC PERFORMANCE ASSESSMENT TOOL

Created by Nicole Paul for CEE 385, Fall 2015 at Stanford University

HAZARD

RESPONSE

COLLAPSE

DAMAGE

LOSS

### SEISMIC RESPONSE INPUTS:

/Users/nicolepaul/Documents/MATLAB

Open

Number of stripes found in SampleStripe: 5

Number of floors: 4

Number of EDPs: 13

Number of GMs: 20

Update Response

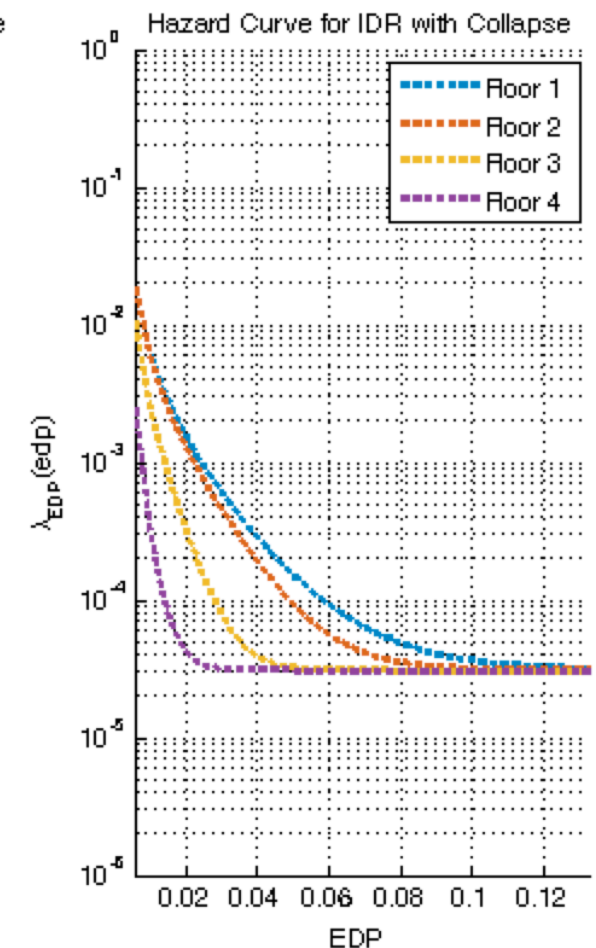
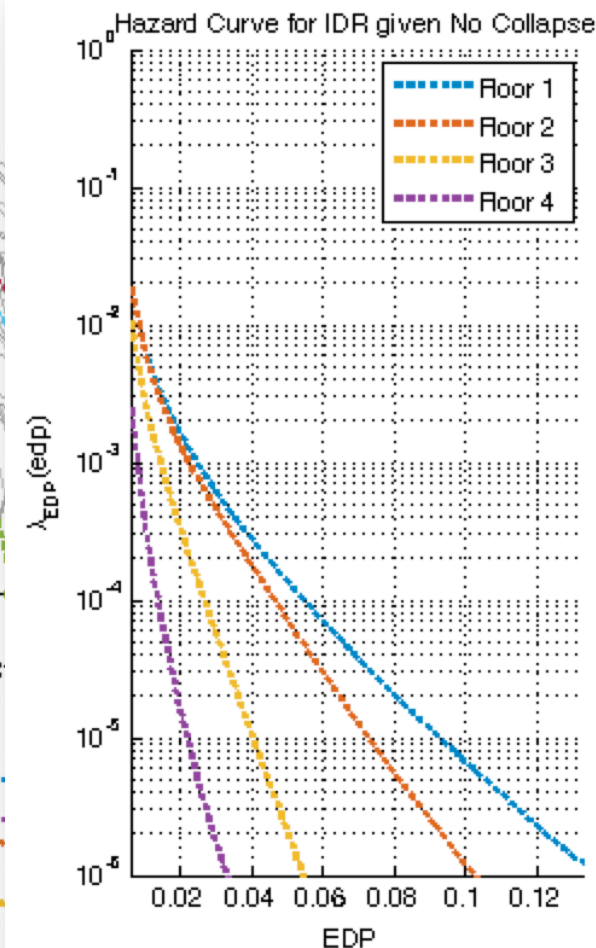
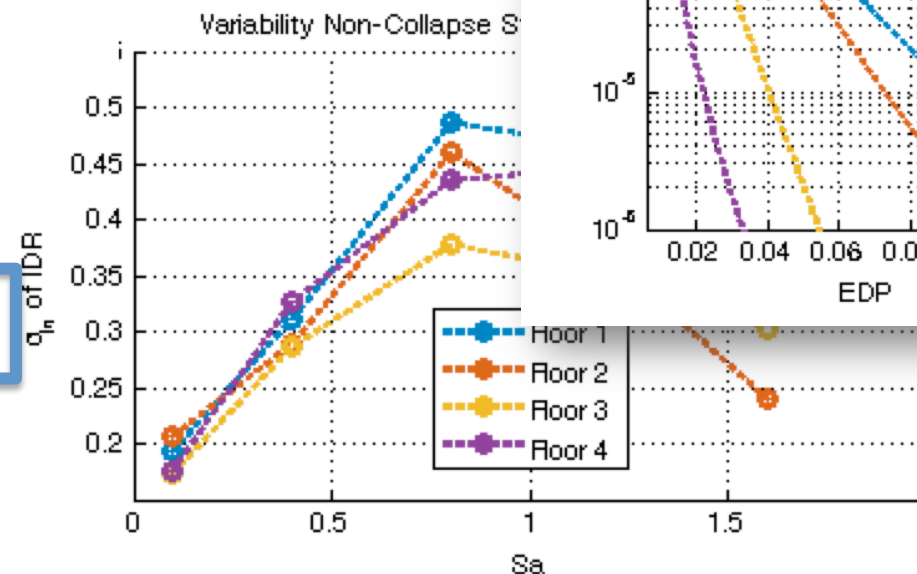
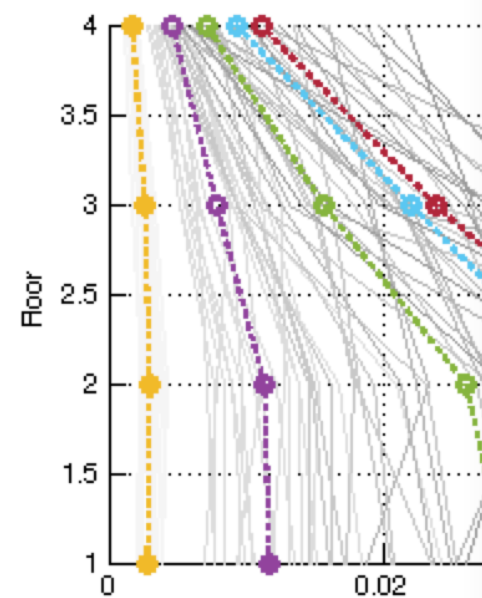
### SEISMIC RESPONSE OUTPUTS:

Linear interp. / Plateau ex...

Plot MAF(edp)

IM value

Plot EDP(edp)



Plot probability density of EDP of interest by entering an IM value of interest into the editbox and clicking the “Plot PDF(edp|im)” button.

## SEISMIC PERFORMANCE ASSESSMENT TOOL

Created by Nicole Paul for CEE 385, Fall 2015 at Stanford University

HAZARD

RESPONSE

COLLAPSE

DAMAGE

LOSS

### SEISMIC RESPONSE INPUTS:

/Users/nicolepaul/Documents/MATLAB

Open

Number of stripes found in SampleStripe: 5

Number of floors: 4

Number of EDPs: 13

Number of GMs: 20

Update Response

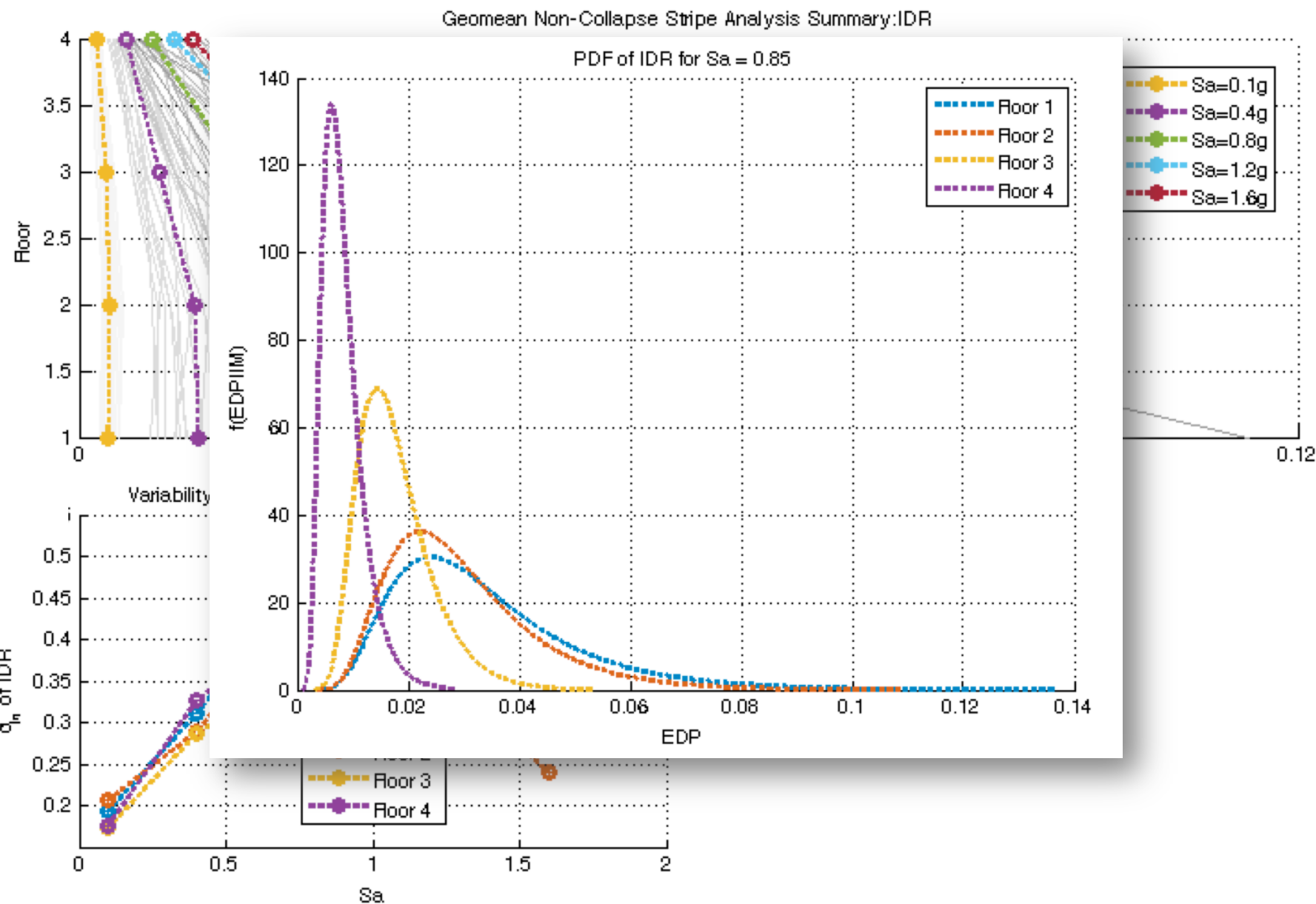
### SEISMIC RESPONSE OUTPUTS:

Linear interp. / Plateau ex...

Plot MAF(edp)

0.85

Plot PDF(edp|im)



# Collapse

## Inputs:

- Inputs from Hazard window
- Inputs from Response window

## Outputs:

- Probability of collapse from each stripe analysis
- Fitted collapse fragility to stripe results (MLE or least squares)
- Collapse deaggregation curve

Switch to the Collapse tab by hitting the “Collapse” button. Use dropdown menu to select fit type of interest, either MLE or least squares. Then hit the “Update Collapse” button.

## SEISMIC PERFORMANCE ASSESSMENT TOOL

Created by Nicole Paul for CEE 385, Fall 2015 at Stanford University

HAZARD

RESPONSE

COLLAPSE

DAMAGE

LOSS

### COLLAPSE RISK OUTPUTS:

MLE

MAF of Collapse:

n/a

p(Collapse) in 50yr:

n/a

Update Collapse

The mean annual frequency of collapse of probability of collapse in 50 years are shown in the greyed out edit boxes below the dropdown menu.

## SEISMIC PERFORMANCE ASSESSMENT TOOL

Created by Nicole Paul for CEE 385, Fall 2015 at Stanford University

HAZARD

RESPONSE

COLLAPSE

DAMAGE

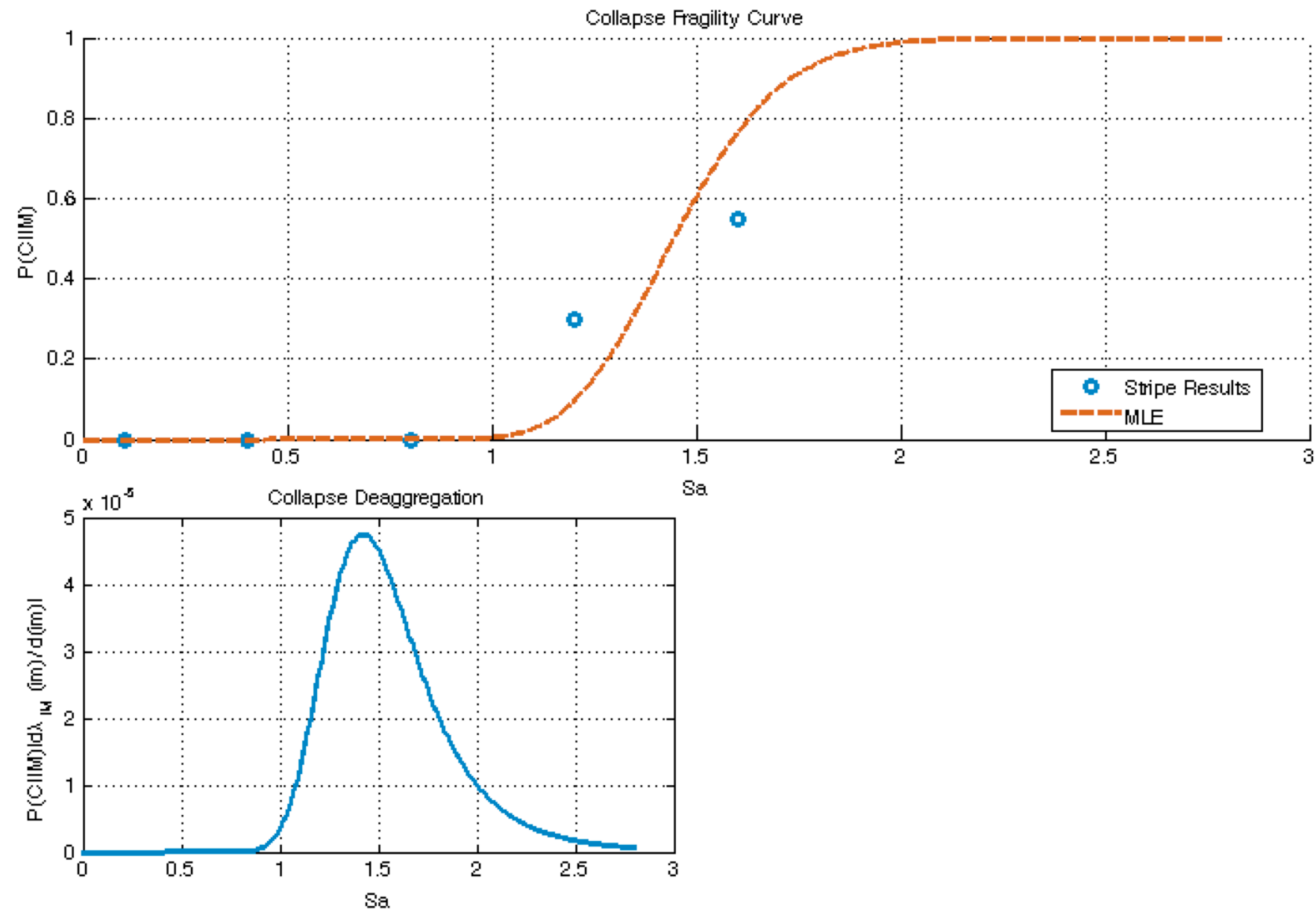
LOSS

### COLLAPSE RISK OUTPUTS:

MLE

MAF of Collapse: 3.0962e-05  
p(Collapse) in 50yr: 0.0015469

Update Collapse



# Damage

## Inputs:

- Fragility curve parameters
  - Expected to be a csv containing all damage and loss parameters
  - Expected format:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	PG	EDP_Type	DS1_Fra_Me	DS1_Fra_LnS	DS2_Fra_Me	DS2_Fra_LnS	DS3_Fra_Me	DS3_Fra_LnS	DS1_Loss_M	DS1_Loss_Ln	DS2_Loss_M	DS2_Loss_Ln	DS3_Loss_M	DS3_Loss_Ln	StDev
2	PG1	IDR	0.03	0.3	0.04	0.3	0.05	0.3	17400	0.35	29300	0.31	29300	0.31	
3	PG2	IDR	0.03	0.3	0.04	0.3	0.05	0.3	30000	0.28	61000	0.28	52300	0.28	
4	PG3	PFA	0.1	0.25	0.15	0.3	0.5	0.35	10000	0.4	30000	0.3	45000	0.3	

- Number of DS
  - Number of fragilities (performance groups)
- Demolition fragility curve (median RIDR, dispersion)

## Outputs:

- Fragility curves,  $p(\text{DM} | \text{EDP})$
- Loss curves,  $p(\text{Loss} | \text{DM})$

Switch to the Damagetab by hitting the “Damage” button. Click “Open” to locate the csv file with all fragility and loss parameters. Use the edit boxes to enter the number of fragility curves (performance groups) and damage states for each fragility curve. Enter in the median RIDR and dispersion for demolition fragility. Hit “Update Fragility” when finished.

## SEISMIC PERFORMANCE ASSESSMENT TOOL

Created by Nicole Paul for CEE 385, Fall 2015 at Stanford University

HAZARD

RESPONSE

COLLAPSE

DAMAGE

LOSS

### COMPONENT INPUTS:

Open file...

Open

Number of fragility curves:

Number of damage states:

Update Fragility

### DEMOLITION INPUTS:

Median

Dispersion:



Toggle performance group of interest using the dropdown menu to the right of the smaller axes

## SEISMIC PERFORMANCE ASSESSMENT TOOL

Created by Nicole Paul for CEE 385, Fall 2015 at Stanford University

HAZARD

RESPONSE

COLLAPSE

DAMAGE

LOSS

### COMPONENT INPUTS:

/Users/nicolepaul/Documents/MATLAB

Open

Number of fragility curves:

3

Number of damage states:

3

Update Fragility

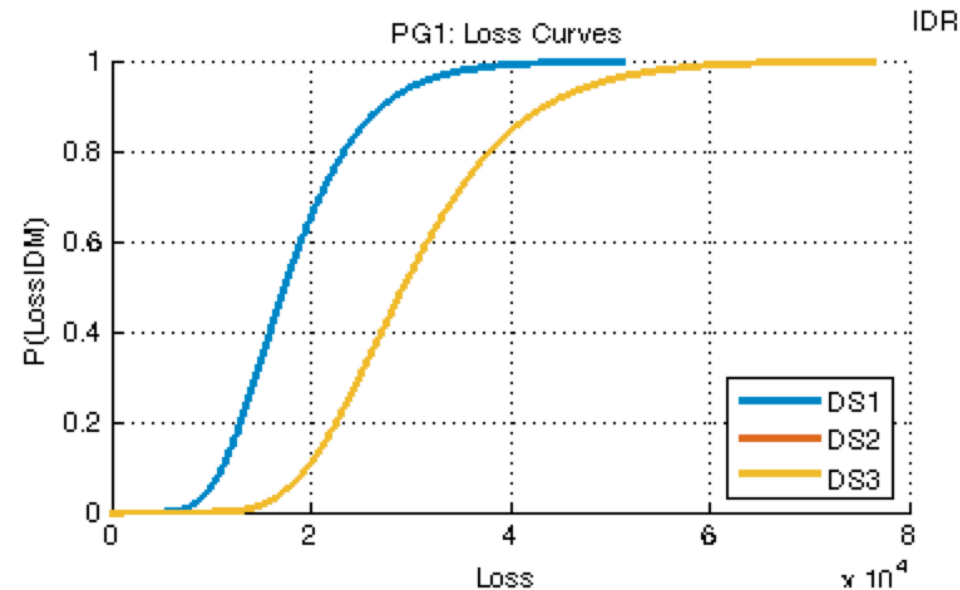
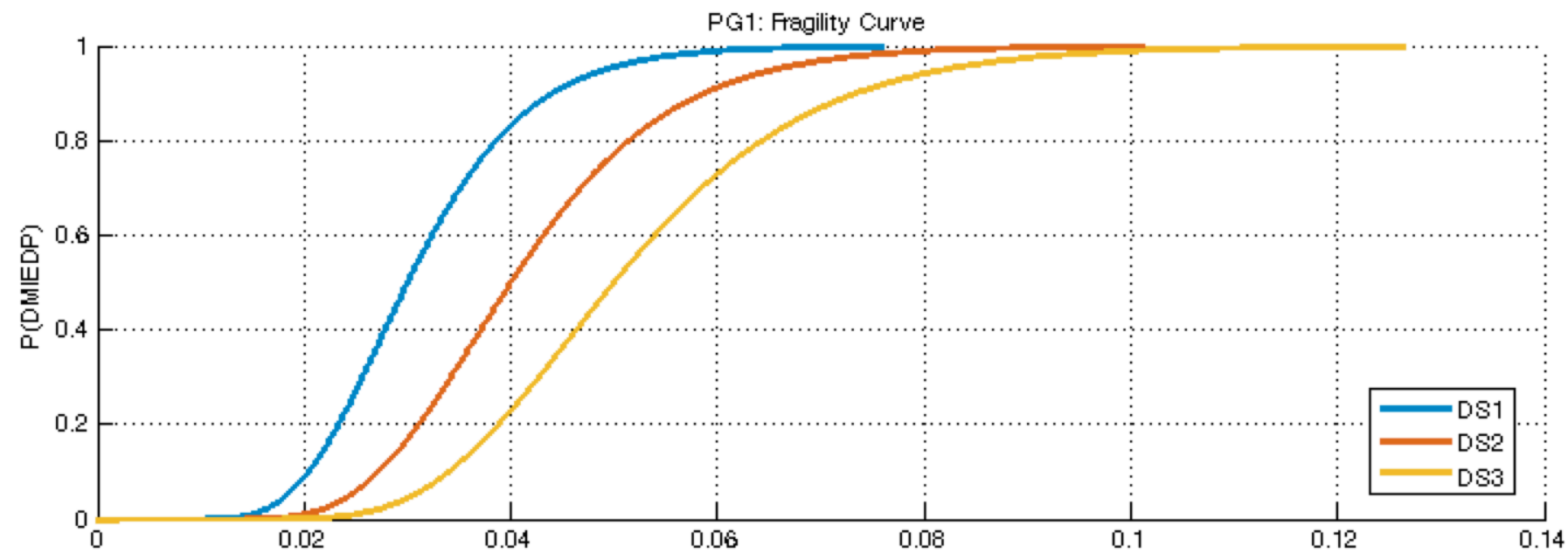
### DEMOLITION INPUTS:

Median

0.015

Dispersion:

0.3



PG1



# Loss


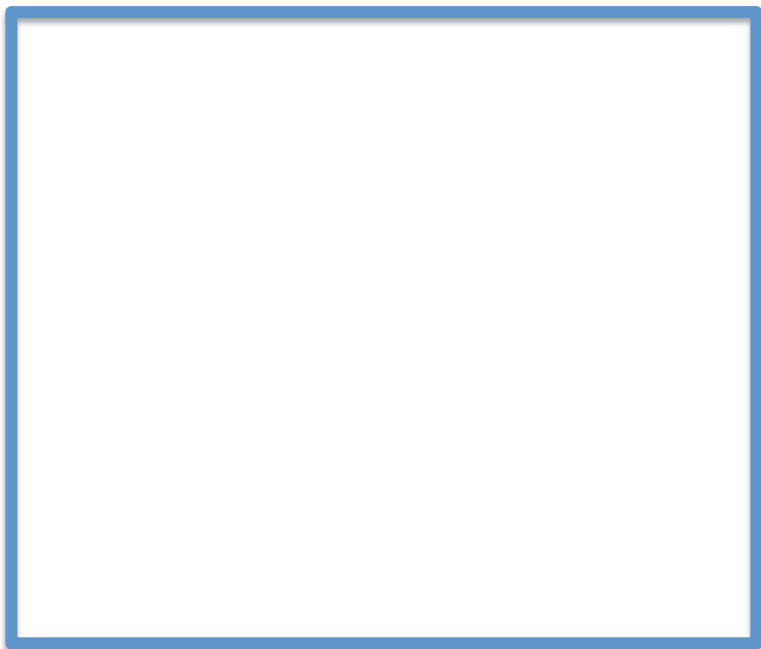
## Inputs:

- Replacement cost new (RCN)
- Demolition cost (expected)
- Collapse cost (expected)
- Quantity of each performance group on each floor for each EDP

## Outputs:

- Average annual loss (total, repair, demolition, collapse)
- Expected loss, given IM (total, repair, demolition, collapse)
- Curves as a function of IM:
  - Deaggregation of  $E[L|IM]$
  - $E[L|IM]$  as value and percentage of RCN
  - Probability and contribution of each case (R, D, C) to total expected loss
- Pie charts showing %age of case, EDP, story, and performance group to:
  - AAL
  - $E[L|IM]$

Switch to the Collapse tab by hitting the “Collapse” button. Use dropdown menu to select fit type of interest, either MLE or least squares. Then hit the “Update Collapse” button.

A small rectangular button with a blue border, likely representing the "Collapse" button mentioned in the text.A large square button with a blue border, likely representing the "Update Collapse" button mentioned in the text.

Switch to the Loss tab by hitting the “Loss” button. Enter replacement, demolition, and collapse cost.

# SEISMIC PERFORMANCE ASSESSMENT TOOL

Created by Nicole Paul for CEE 385, Fall 2015 at Stanford University

HAZARD

RESPONSE

COLLAPSE

DAMAGE

LOSS

## LOSS INPUTS:

Replacement Cost New:

Demolition Cost:

Collapse Cost:

Set Quantities\*

Update Losses

## LOSS OUTPUTS:

IM Value:

E[LIIM]:

AAL

Case

AAL:

x	x	x
x	x	x

Enter quantities of each performance group by selecting the “Set Quantities\*” tab. By default, each performance group will have one unit on each floor that has data for the EDP it is sensitive to. Edit quantities if desired, then hit “Set Quantities”

SEISMIC PERFORMANCE ASSESSMENT TOOL

Created by Nicole Paul for CEE 385, Fall 2015 at Stanford University

HAZARD

RESPONSE

COLLAPSE

DAMAGE

LOSS

LOSS INPUTS:

Replacement Cost New:

2000000

Demolition Cost:

2500000

Collapse Cost:

2600000

Set Quantities\*

Update Losses

LOSS OUTPUTS:

IM Value:

E[LIIM]:

AAL:

x

x

x

x

x

x

	IDR1	IDR2	IDR3	IDR4	RIDR1	RIDR2	RIDR3	RIDR4	PFA1	PFA2	PFA3	PFA4	PFA5
PG1	1	1	1	1	0	0	0	0	0	0	0	0	0
PG2	1	1	1	1	0	0	0	0	0	0	0	0	0
PG3	0	0	0	0	0	0	0	0	1	1	1	1	1

Set Quantities

Hit the “Update Losses” button and two windows will pop up. One will have the  $E[L|IM]$  as value and percentage of RCN, as well as the probability and contribution of each case to  $E[L|IM]$ . The other window will have the deaggregation of loss.

## SEISMIC PERFORMANCE ASSESSMENT TOOL

Created by Nicole Paul for CEE 385, Fall 2015 at Stanford University

HAZARD

RESPONSE

COLLAPSE

DAMAGE

LOSS

### LOSS INPUTS:

Replacement Cost New:

750000

Demolition Cost:

1500000

Collapse Cost:

3000000

Set Quantities\*

Update Losses

### LOSS OUTPUTS:

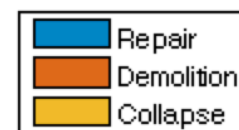
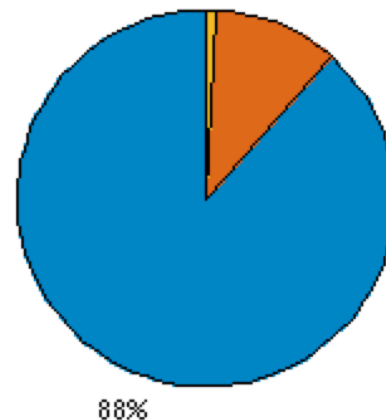
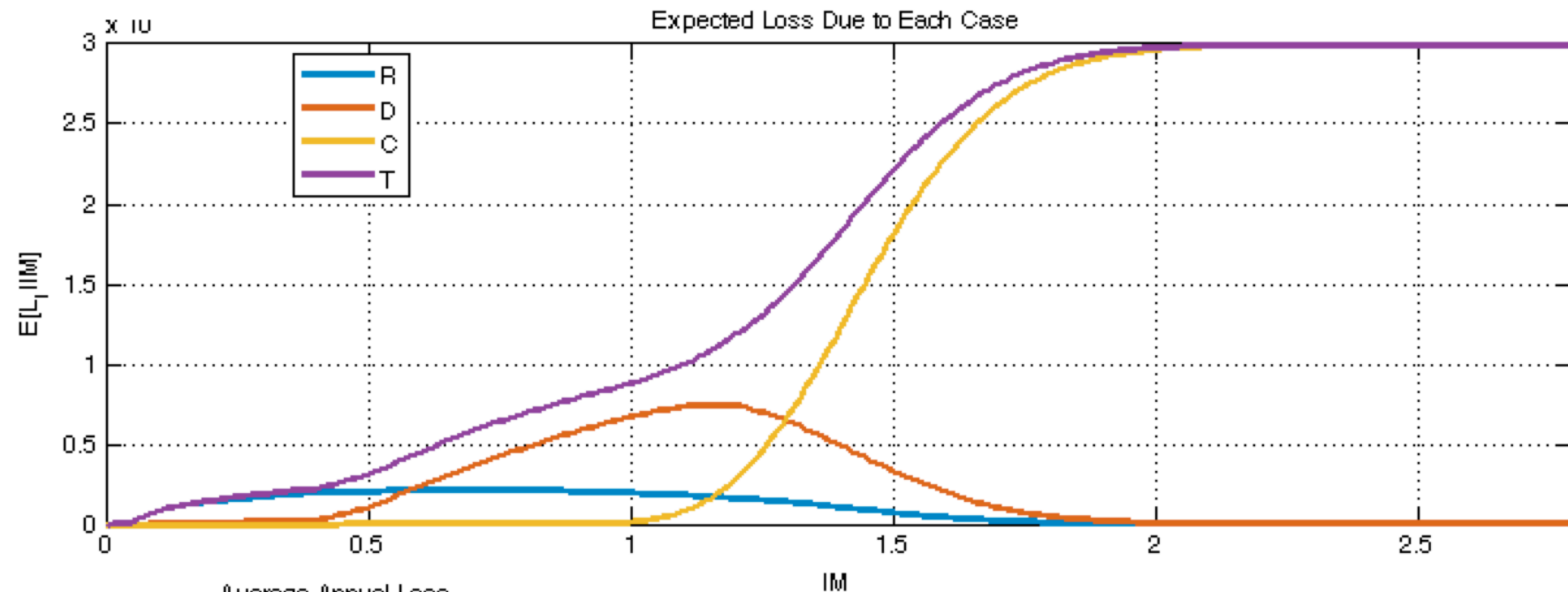
IM Value:

$E[L|IM]$ :

AAL: 9847.10

R: 8709.34 D: 1044.90 C: 92.86

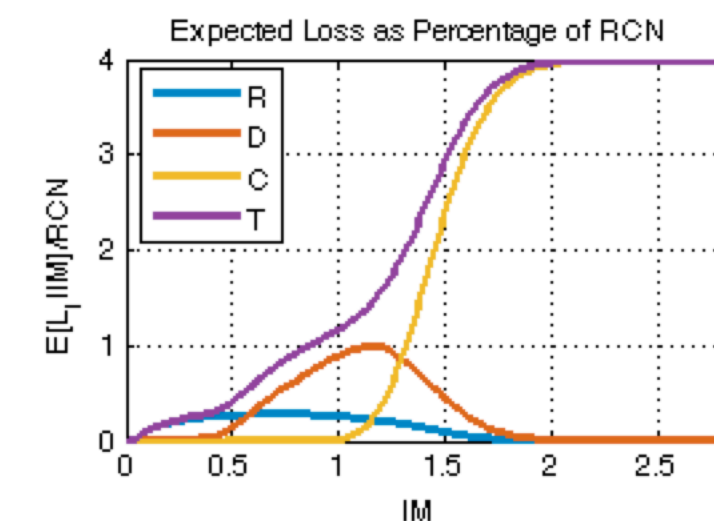
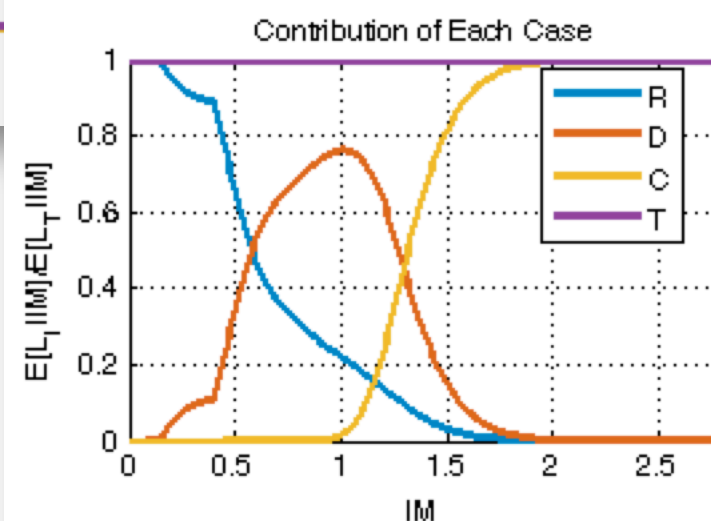
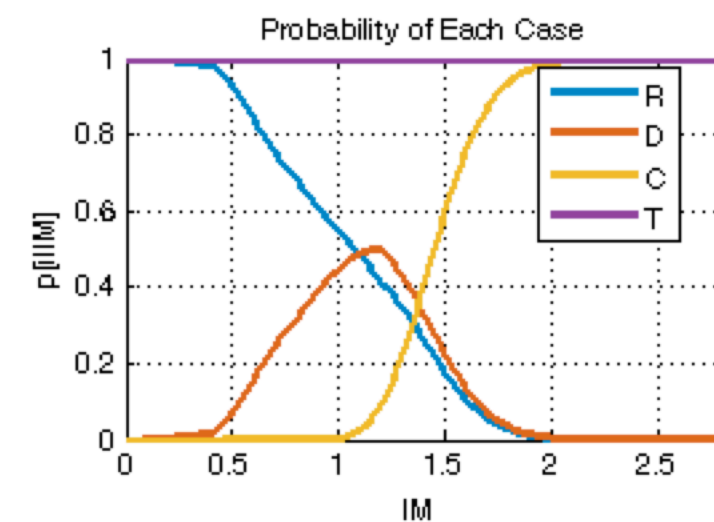
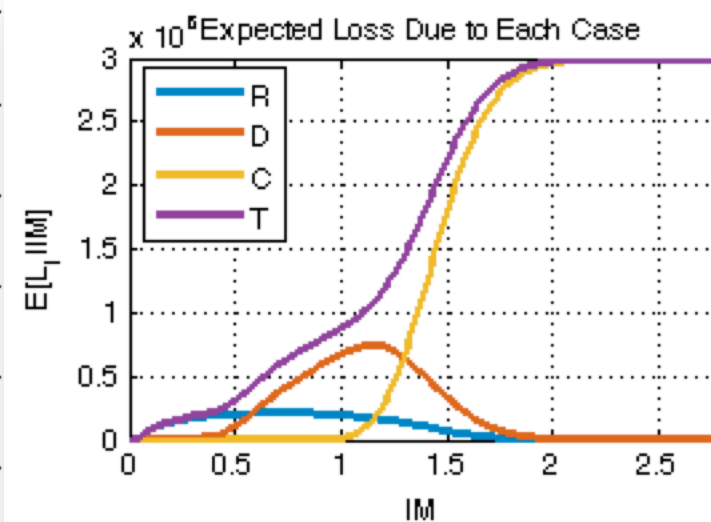
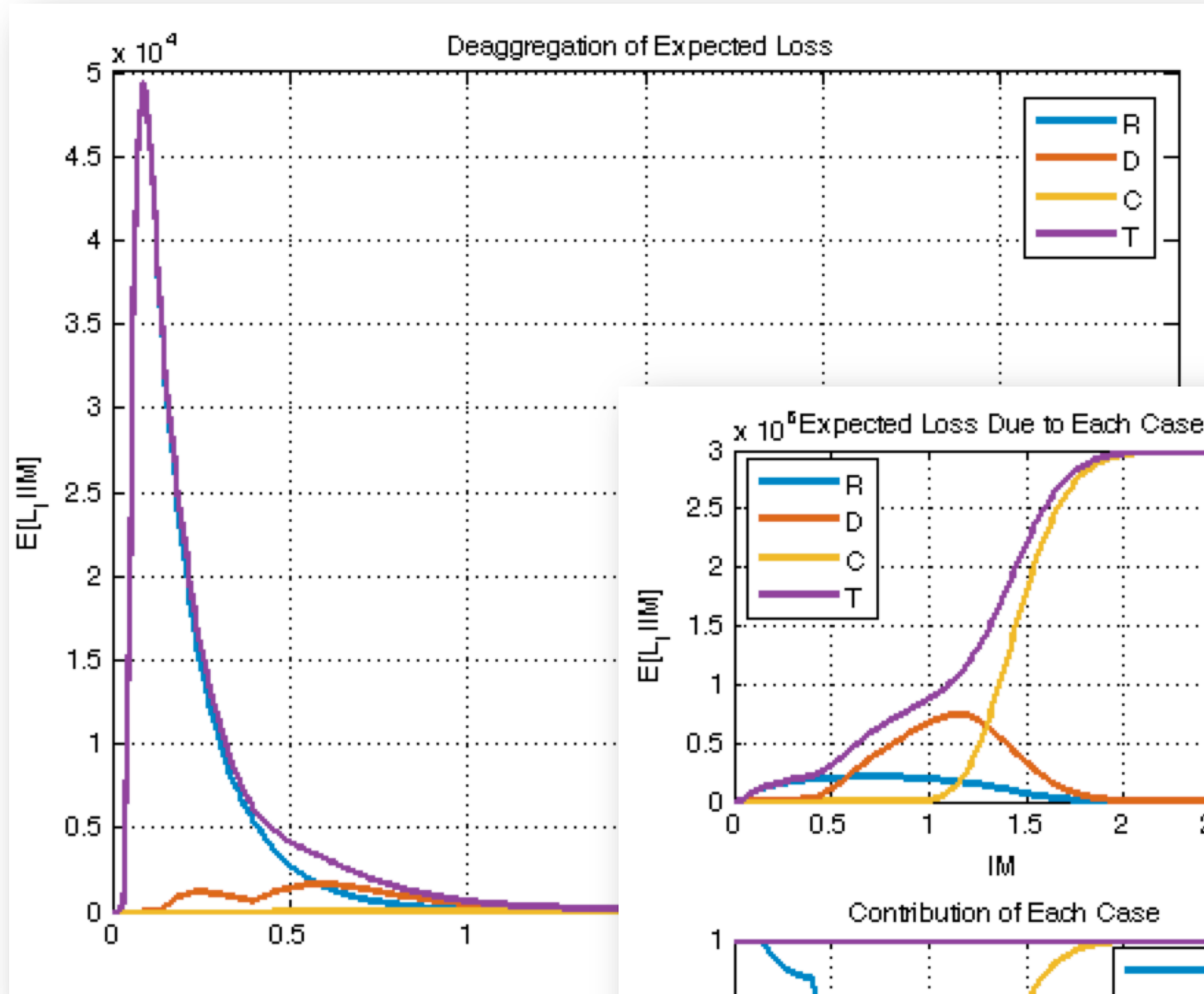
R: 88.4% D: 10.6% C: 0.9%



AAL

Case

These are the figures that will pop up.



Enter IM of interest in edit box under “Loss Outputs”. Toggle pie chart using the drop down menus to the right of the pie chart.

