```
openseesPath = "C:\Users\Louis Lin\Workspace\Academic\UCSD\SE 201B\Opensees\bin\OpenSees.exe";

%% Monotonic with Single Axial Load
clc; close all;
RunName = '.\run.tcl';
loadControlName = 'loadControlStaticAnalysis.tcl';
analysisName = 'dispControlAnalysis.tcl';
modelName = 'model02.tcl';
curvatures = 0.03;
axialLoad = 0.0;

setupRun(RunName, loadControlName, analysisName, modelName, axialLoad, curvatures)
runTCLfile(RunName)
plotMK("Case (a.3) Cross Section"); grid minor;
[s1, s2] = addYield();
s1.HandleVisibility = 'on'; s1.DisplayName = 'Concrete Crushing';
s2.HandleVisibility = 'on'; s2.DisplayName = 'Steel Yielding';
print_figure("Part B MK", [13, 6], 18)

%% Monotonic with Varying Axial Load
clc; close all;
RunName = '.\run.tcl';
loadControlName = 'loadControlStaticAnalysis.tcl';
analysisName = 'dispControlAnalysis.tcl';
modelName = 'model01.tcl';
curvatures = 0.03;

for axialLoad = [0.0, 0.1, 0.2, 0.4, 0.6, 0.7]
    close all;
    setupRun(RunName, loadControlName, analysisName, modelName, axialLoad, curvatures)
    runTCLfile(RunName)
    plotMK("Axial Load Ratio = "+sprintf('%1.1f',axialLoad) );
    addYield();
    H = 15.748;
    K = [0.0013, 0.004, 0.008, 0.0130 0.0200]/H;
    plotStrainProfile(H, K)
    sgtitle("Strain Diagram of Axial Load Ratio "+num2str(axialLoad,'%1.1f'),'FontSize',18);
    print_figure("Part E iv Strain Diagram of Axial Load Ratio "+num2str(10*axialLoad), [13, 2.75], 10)
end
figure(1);
print_figure("Part E Moment Curvature Varying Axial Load", [13, 6], 18)
%% Monotonic & Cyclic Envelope
clc; close all;
RunName = '.\run.tcl';
loadControlName = 'loadControlStaticAnalysis.tcl';
analysisName = 'dispControlAnalysis.tcl';
modelName = 'model02.tcl';

for axialLoad = [0.0, 0.1, 0.2, 0.4, 0.6, 0.7]
    curvatures = [0.0, 0.005, -0.005, 0.01, -0.01, 0.02, -0.02, 0.03, -0.03, 0.0];
    setupRun(RunName, loadControlName, analysisName, modelName, axialLoad, curvatures, 0.001)
    runTCLfile(RunName)

    plotMK('Cyclic Moment Curvature', "Axial Load Ratio = "+sprintf('%1.1f',axialLoad) );
    addYield();
    hold on;
    curvatures = 0.03;
```

```
    setupRun(RunName, loadControlName, analysisName, modelName, axialLoad, curvatures, 0.001)
    runTCLfile(RunName)
    plotMK('Monotonic Moment Curvature',"Axial Load Ratio = "+sprintf('%1.1f',axialLoad) );
    addYield();

    figure(1);
    print_figure("Part L Moment Curvature Envelope Axial Load Ratio = "+10*axialLoad , [13,5], 18)
    close all;
end

%% Cyclic Moment Curvautre With Material 02
clc; close all;
RunName = '.\run.tcl';
loadControlName = 'loadControlStaticAnalysis.tcl';
analysisName = 'dispControlAnalysis.tcl';
modelName = 'model02.tcl';
curvatures = [0.0, 0.005, -0.005, 0.01, -0.01, 0.02, -0.02, 0.03, -0.03, 0.0];

for axialLoad = [0.0, 0.1, 0.2, 0.4, 0.6, 0.7]
    setupRun(RunName, loadControlName, analysisName, modelName, axialLoad, curvatures, 0.001)
    runTCLfile(RunName)
    close all;
    plotMK("Axial Load Ratio = "+sprintf('%1.1f',axialLoad) );
    print_figure("Part F i Cyclic Moment Curvature"+num2str(10*axialLoad), [13, 5], 18)

    plotEoK("Axial Load Ratio = "+sprintf('%1.1f',axialLoad),"Axial Strain Response");
    figure(2); print_figure("Part F ii Axial Strain Axial Load Ratio "+num2str(10*axialLoad), [7,5], 15)
end


%% Cyclic Moment Curvautre With Material 01
clc; close all;
RunName = '.\run.tcl';
loadControlName = 'loadControlStaticAnalysis.tcl';
analysisName = 'dispControlAnalysis.tcl';
% modelName = 'model01.tcl';
curvatures = [0.0, 0.005, -0.005, 0.01, -0.01, 0.02, -0.02, 0.03, -0.03, 0.0];
tic
for axialLoad = [0.0]
        close all;
        modelName = 'model01.tcl';
        setupRun(RunName, loadControlName, analysisName, modelName, axialLoad, curvatures, 0.00001)
        runTCLfile(RunName)
        plotMK('Concrete01 & Steel01',["Moment Curvature", "With Axial Load Ratio = "+sprintf('%1.1f',axialLoad)]);
        plotEoK('Mat01',["Axial Strain Response","With Axial Load Ratio = "+num2str(axialLoad,'%1.1f')]);

        modelName = 'model02.tcl';
        setupRun(RunName, loadControlName, analysisName, modelName, axialLoad, curvatures, 0.001)
        runTCLfile(RunName)
        plotMK('Concrete02 & Steel02',["Moment Curvature", "With Axial Load Ratio = "+sprintf('%1.1f',axialLoad)]);
        plotEoK('Mat02',["Axial Strain Response","With Axial Load Ratio = "+num2str(axialLoad,'%1.1f')]);

        figure(1); print_figure("Part G Cyclic MK Axial Load Ratio "+num2str(10*axialLoad), [13,5], 18);
        savefig(1,"../figures/"+"Part G Cyclic MK Axial Load Ratio "+num2str(10*axialLoad),'compact')
        figure(2); print_figure("Part G Axial Strain Axial Load "+num2str(10*axialLoad), [7,5], 18)
        savefig(2,"../figures/"+"Part G Axial Strain Axial Load "+num2str(10*axialLoad),'compact')
end
```

```
toc
%% X. Li Test 1
clc; close all;
[K1, M1] = getXLisheet('Response U1', "B10:F64");

RunName = '.\run.tcl';
loadControlName = 'loadControlStaticAnalysis.tcl';
analysisName = 'dispControlAnalysis.tcl';
modelName = 'modelLI1.tcl';

curvatures1 = [0.0, 0.0210457, -0.019193, 0.0205331];
for axialLoad = .2953
    setupRun(RunName, loadControlName, analysisName, modelName, axialLoad, curvatures1,0.001)
    runTCLfile(RunName);
    plt = plotMK("4 Step Curvatures"); plt.LineWidth =2;
end

plot(K1/15.748,M1*12,'DisplayName','Test U1','LineWidth',2);
[s1, s2] = addYield();
s1.HandleVisibility = 'on'; s1.DisplayName = 'Concrete Crushing';
s2.HandleVisibility = 'on'; s2.DisplayName = 'Steel Yielding';
set(gcf,'Position',[0,0,1300,500])
figure(1); print_figure("Part H X Li Test 1", [13,5], 18);
%% Curvature of X. Li
clc; close;

figure(5); hold on; box on;
K = K1;
yyaxis left;
plot(K,1:length(K),'LineWidth',2,'DisplayName','Experimental');
ylabel('Measurement Steps'); xlabel('Curvature [1/in]');
yyaxis right; ylabel('Model Steps'); yticks(0:1:length(curvatures1));
plot(curvatures1,1:length(curvatures1),'LineWidth',2,'DisplayName','Model');
title('Experiment U1'); legend('Location','southeast');
set(gca,'FontSize',18);

print_figure("Part H Curvature", [13,5], 18);
%% PM Diagrams for Concrete01 and Steel01
close all; clc;

runTCLfile('.\runPM_NZ_01.tcl');
PlotPM(6, 'NZ Criterion = -0.004' );
runTCLfile('.\runPM_ACI_01.tcl');
PlotPM(6, 'ACI Criterion = -0.003' );
grid minor
print_figure("Part I i PM Mat01", [6.5,5], 18);
%% PM Diagrams for Concrete02 and Steel02
close all; clc;
runTCLfile('.\runPM_NZ_02.tcl');
PlotPM(7, 'NZ Criterion = -0.004' );
runTCLfile('.\runPM_ACI_02.tcl');
PlotPM(7, 'ACI Criterion = -0.003' );
grid minor
print_figure("Part I i PM Mat02", [6.5,5], 18);
%% PMM Diagram
close all; clc;
hold on;
```

```
172 runTCLfile('.\runPMM.tcl')
173 plotPMM(8)
174 print_figure("Part I ii PMM", [8,7], 18);
175
176 %% FUNCTION Runs a TCL File
177 function runTCLfile(filename)
178     openseesPath = "C:\Users\Louis Lin\Workspace\Academic\UCSD\SE 201B\Opensees\bin\OpenSees.exe";
179     [filepath,name,ext] = fileparts(filename);
180     [filepath,name,ext,openseesPath] = convertStringsToChars(filepath,name,ext,openseesPath);
181     currpath = pwd;
182     cd(filepath)
183     system(['"',openseesPath,'" "' name, ext, '"']);
184     cd(currpath);
185 end
186 %% FUNCTION Plot Moment Curvature
187 function plt = plotMK(legName, titleName)
188     arguments
189         legName = 'Moment Curvature';
190         titleName = 'Moment Curvature'
191     end
192     figure(1); hold on;
193     load('./AnalysisResults/MK.txt');
194     plt = plot(MK(:,3),MK(:,1),'LineWidth',2,"DisplayName",legName);
195     grid on; box on;
196     title(titleName); ylabel('Moment [kip-in]'); xlabel('Curvature [1/in]');
197     legend("Location","Southeast"); xline(0,"HandleVisibility",'off'); yline(0,"HandleVisibility",'off');
198 end
199
200 %%  FUNCTION Adds in Crushing and Yielding of Steel
201 function [scat1, scat2] = addYield(~)
202     fy = 65.9;
203     ecu = -0.003;
204     load('./AnalysisResults/ConcFib2_SS.txt');
205     load('./AnalysisResults/SteelFib1_SS.txt');
206     load('./AnalysisResults/MK.txt');
207     [~, yield] = min(abs(SteelFib1_SS(:,2) - fy));
208     [~, crush] = min(abs(ConcFib2_SS(:,3) - ecu));
209
210     scat1 = plot(MK(crush,3), MK(crush,1),'ko','MarkerSize',10, 'LineWidth', 1.5,'HandleVisibility','off');
211     scat2 = plot(MK(yield,3), MK(yield,1),'kd','MarkerSize',10,'LineWidth',1.5,'HandleVisibility','off');
212 end
213
214 %% FUNCTION  Plot Strain Profile
215 function [] = plotStrainProfile(H, K)
216     close;
217     figure(4); set(gcf,'DefaultAxesFontSize', 10)
218     load('./AnalysisResults/MK.txt');
219     sectionCoord = linspace(-H/2,H/2,100);
220     plotYLim = [0,0];
221     for i = 1:length(K)
222         subplot(1,length(K),i); hold on; box on
223         [~, indK] = min(abs(MK(:,3) - K(i)));
224         eps = MK(indK,2) - sectionCoord*K(i);
225         plot(sectionCoord,eps,'LineWidth',1.,'Color','k')
226         plot(sectionCoord,zeros(size(sectionCoord)),'b-','LineWidth',2);
227         plot([sectionCoord(1),sectionCoord(1)], [0, eps(1)], 'LineWidth',1.,'Color','k')
228         plot([sectionCoord(end),sectionCoord(end)], [0, eps(end)], 'LineWidth',1.,'Color','k')
```

```
229         yLim = get(gca,'yLim');
230         if yLim(1) < plotYLim(1)
231             plotYLim(1) = yLim(1);
232         end
233         if yLim(2) > plotYLim(2)
234             plotYLim(2) = yLim(2);
235         end
236         [~,indNA] = min(abs(eps - 0));
237         depthNA = H/2 - sectionCoord(indNA);
238         plot([sectionCoord(indNA),sectionCoord(end)],[0,0],'r-','LineWidth',2);
239         title(["NA = " + num2str(depthNA,3)],'FontSize',12)
240     end
241     figure(4)
242     for i = 1:length(K)
243         subplot(1,length(K),i)
244         set(gca,'yLim',plotYLim)
245         xline(0);
246     end
247 end
248
249 %% FUNCTION Plot Axial Strain Curvature
250 function plt = plotEoK(displayName, titleName)
251     arguments
252         displayName = 'Axial Strain Response';
253         titleName = 'Axial Strain Response';
254     end
255     figure(2); hold on;
256     load('./AnalysisResults/MK.txt');
257     plt = plot(MK(:,3),MK(:,2),'LineWidth',2,'DisplayName',displayName);
258     grid on; box on;
259     title(titleName); ylabel('Strain [-]'); xlabel('Curvature [1/in]'); legend('Location','southeast');
260      xline(0,"HandleVisibility",'off'); yline(0,"HandleVisibility",'off');
261 end
262 %% FUNCTION Get X. Li's
263 function [K,M] = getXLisheet(sheet, range)
264     opts = spreadsheetImportOptions("NumVariables", 5);
265     opts.Sheet = sheet;
266     opts.DataRange = range;
267     opts.VariableNames = ["K", " "," "," ", "M"];
268     opts.SelectedVariableNames = ["K", "M"];
269     opts.VariableTypes = ["double", "char", "char", "char", "double"];
270     tbl = readtable("C:\Users\Louis Lin\Workspace\Academic\UCSD\SE 201B\HW\HW3\files\XLi Units 1 and 2.xlsx", opts, "UseExcel", false);
271     K = tbl.K;
272     M = tbl.M;
273 end
274 %% FUNCTION Plot PM Diagram
275 function plt = PlotPM(figNum, displayName)
276     load 'AnalysisResults/PM_Results.txt';
277     figure(figNum);  hold on;
278     plt = plot(PM_Results(:,2),PM_Results(:,1),'LineWidth',2,'DisplayName',displayName);
279     grid on; box on; legend();
280     xlabel('Moment [kip-in]')
281     ylabel('Axial load [lbf]')
282     title('PM Interaction Diagram')
283     set(gcf,'Position',[0,0,600,500])
284 end
285 %% FUNCTION Plot PMM Diagram
```

```
286 function plotPMM(figNum)
287     name='AnalysisResults/PM';
288 
289     numFiles = 21;
290     for iFile = 1:numFiles
291         fileLoad = [name num2str(iFile) '.txt'];
292         mp{iFile} = load(fileLoad);
293     end
294 
295     figure(figNum)
296     for iFile = 1:21
297         if iFile == 1
298             h1 = plot3(mp{iFile}(:,11),mp{iFile}(:,12),mp{iFile}(:,1),'b','LineWidth',2);hold on
299         else
300             plot3(mp{iFile}(:,11),mp{iFile}(:,12),mp{iFile}(:,1),'b','LineWidth',2);hold on
301         end
302     end
303     for ii = 1:size(mp{iFile}(:,11),1)
304         for iFile = 1:20
305             plot3(...
306                 [mp{iFile}(ii,11) mp{iFile+1}(ii,11)], ...
307                 [mp{iFile}(ii,12) mp{iFile+1}(ii,12)],...
308                 [mp{iFile}(ii,1) mp{iFile+1}(ii,1)],...
309                 'r','LineWidth',0.5);hold on
310         end
311     end
312 
313     grid on
314     box on
315 
316     title('PMM Interaction Diagram')
317     xlabel('My [kip-in]')
318     ylabel('Mz [kip-in]')
319     zlabel('Axial Load [lbf]')
320     view([120 15]);
321 end
322 %% FUNCTION Print Section
323 function printSectionTag(tag, name)
324     secDefFilePath = "./Model/modelData.txt";
325     grid off;
326     figNum = 3;
327     secTag = tag;
328     camroll(90)
329     fibColor = [1 0 0 1 0.5; 2 1 0 0 0.5; 3 0 0 0 1];
330     plot_fiberSection(secDefFilePath, secTag, figNum, fibColor)
331     camroll(90)
332     title(["Case (a." + secTag+")"]);
333     ylabel('Y [in]');
334     zlabel('Z [in]');
335 end
```