Trona Pinnacles spire P006 basal stress distribution during Ridgecrest main shock

This notebook details how to generate stress plots as the one in Figure 7 panel (d) in the article named "Toppling of a Trona Pinnacles Spire following the M5.5 Ridgecrest Aftershock of June 2020".

Fix some parameters

Image style:

In[23]:=
```
texStyle = {FontFamily → "LM Roman 8", FontSize → 18, FontColor → Black};
```

The material properties (all units in International Systems, since distances are in meters):

Timestep and initial time:

In[24]:=
```
deltaT = 0.01;(*seconds*)
```

Load preliminary data

FEM mesh info

First, load the information concerning the FEM mesh (nodes locations "nodes.xls") and element connectivity ("elements.xls"). All the files mentioned can be found in the release associated to this repository, either add path to the files and run the notebook from the same directory where the files are.

```
(*dirResults="stresses pn06";
SetDirectory[dirResults];*)
```

Uncomment and modify above to set the right directory.

In[45]:=
```
nodes = Flatten[Import["nodes.xls"], 1];
```

In[46]:=
```
elements = Flatten[Import["elements.xls"], 1];
```

Cross-section geometry

```
regionOneScaled = Import["regionOneScaled.mx"]
```

Stress plot example

Load stress time-history results at the elements of the base

```
avSigmaZ = {}; (*array to save average over quadrature points*)
maxAvSigmaZ = {}; (*array to save most compressive values*)
minAvSigmaZ = {}; (*array to save most tensile values*)
Do[ (*for each of the 293 elements making up the basal region*)
  fileName = dirResults <> "/stress_base_" <> ToString[5778 + ii] <> ".1.txt";
  (*file name*)
  auxResults = #[[3 ;; -1]] &@Import[fileName, "Table"]; (*read file*)
  avSigmaZ = AppendTo[avSigmaZ, Mean[#[[Table[3 + 6 (jj - 1), {jj, 8}]]]] & /@ auxResults];
  (*take the value of σzz(t) at each integration point and average them*)
  minAvSigmaZ = AppendTo[minAvSigmaZ, Max[-avSigmaZ[[-1]]]];
  maxAvSigmaZ = AppendTo[maxAvSigmaZ, Max@Abs[avSigmaZ[[-1]]]](*take peaks*)
  , {ii, 1, 293}];

Ntime = Length@avSigmaZ[[1]];
tlist = deltaT * Range[0, Ntime - 1];
intervals = Table[(ii - 1) * 50, {ii, 1, 14}];
```

Prepare colorbar for stress legend

```
fullColorList = ColorData["DarkRainbow"] /@ Subdivide[14];
mylegend = BarLegend[{fullColorList, {#[[1]], #[[-1]]} &@intervals},
    intervals, LegendMarkerSize → 300,
    LabelStyle → texStyle, LegendLabel → Style["σzz[kPa]", texStyle]];
functionColor[sigma_] = Piecewise[
    Join[Table[{fullColorList[[ii]], intervals[[ii]] ≤ sigma < intervals[[ii + 1]]}
      , {ii, 1, -1 + Length[intervals]}],
     {{fullColorList[[-1]], sigma ≥ intervals[[-1]]}}]
  ];
```

Generate stress patches element-wise

In[47]:=
```
elems2D = {};
midpoints = {};
Do[
  corners = nodes[[#]] & /@ elements[[5778 + ii]][[5 ;; 8]];
  corners2D = #[[1 ;; 2]] & /@ corners;
  AppendTo[midpoints, Mean[corners2D]];
  colorIntensity = functionColor[2 maxAvSigmaZ[[ii]] / 1000];
  (*lightToDark[293][[ii]];*)
  AppendTo[elems2D, {colorIntensity, EdgeForm[None], Polygon[corners2D]}]
  , {ii, 1, 293}];
```

Display results with legends

In[51]:=
```
Legended[
 Graphics[{elems2D}
 ], mylegend]
```

Out[51]=