Consider a fixed-fixed beam as shown. All units are GPa, mm, KN. Model the beam using plane stress conditions.

Conduct a material nonlinear analysis using the following parameters: Plastic multilinear material: \( E = 70 \), \( \nu = 0.0 \), \( \epsilon_y = 0.0013571 \), \( \sigma_y = 0.095 \), \( \epsilon_u = 0.0227856 \), \( \sigma_u = 0.110 \). Assume perfectly plastic behavior to large strains after the ultimate point. Use a time function with \( t_0 = 0 \), \( t_1 = 1.0 \) and amplitude values of \( a_0 = 0 \), \( a_1 = 2.0 \). Use 100 time steps of size 0.01. Use Q9 elements with a point size of 10mm.

(a) Prepare a figure that shows the midspan displacement as a function of load magnitude in GPa. Plotting tip: you will have to define a model point for a midspan node and then use the list:value list command.

(b) Prepare a figure that shows plastic strain contours for 3 different times in the load history. Choose the times at which you plot contours carefully. Plotting tip: generate the contours with the display at t=0 and then step forward to the desired time before printing or capturing the contour. Consider using photo editing software if the colors, particularly the background, are not as you wish.

(c) Prepare a figure that shows the distribution of \( \sigma_{yy} \) along the left edge of the beam at three different times in the load history. Choose the times carefully. Plotting tip: follow the instructions in primer problem 2 for generating a plot of stresses. However, consider exporting the data to another plotting program using the list:value list:model line command.

(d) Prepare a figure that shows the deformed geometry at 3 different times in the load history. Choose the times carefully. Make sure to scale the displacements reasonably.

(e) Briefly describe what is happening during the course of the simulation.

Note: An excellent lab report may combine some or all of parts (a), (b), (c), and (d) above into a single graphic. Some handwriting of labels may also be effective.

Other things to investigate (these should not be included in the report): Mesh size and element type, time step, other plasticity material models . . .