# Fundamentals of Structural Design, Exam 24th Feb 2023

i) Download and Install GeoGebra Classic 5 (https://www.geogebra.org/download)
ii) In mycourses Assignments>Retake Exam 24th of Feb you can download the GeoGebra files for the exam and you will need to return them in the same page.
iii) In addition, you need to return the exam questions and the handwritten answers SCANNED as PDF (use your mobile and a cable to upload your scanned files).

1. (40%) A series of trusses is given in GeoGebra (Truss.ggb) at distance of 3 m with a dead load of 3kN/m² and a wind load of 2kN/m² and the angle of roller support with the vertical is equal to 20 deg (the loads are scaled with scaling factor scfForm).

   a) Case 1: Find the reactions, the internal forces (denote blue for tension and red for compression) by drawing the force and the funicular polygons.
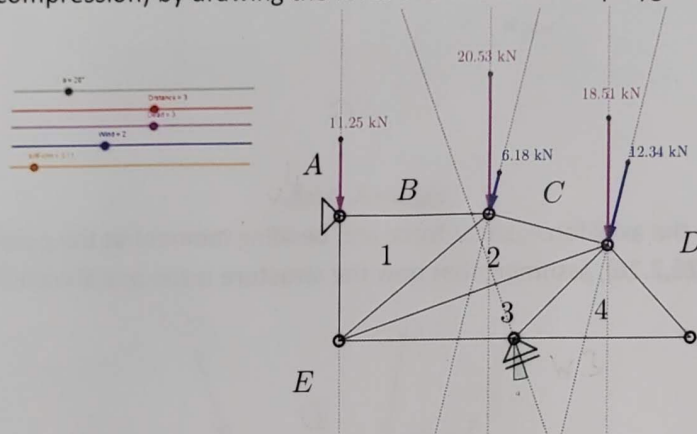


Figure 1. Case 1.

   b) Case 1: How are the reactions affected by the change of the angle of the roller support α?
   c) Case 2: After solving the question (a) from Case 1 save the file as 'Case2', hide the element 23 from case 1 (select the segment, right click and from short menu click 'Show Object'), and draw the 2'3' element and demote the spaces as 2' and 3' as shown in Fig. 2. Draw the internal forces (denote blue for tension and red for compression) by drawing the force polygon for Case 2 on top of Case 1.
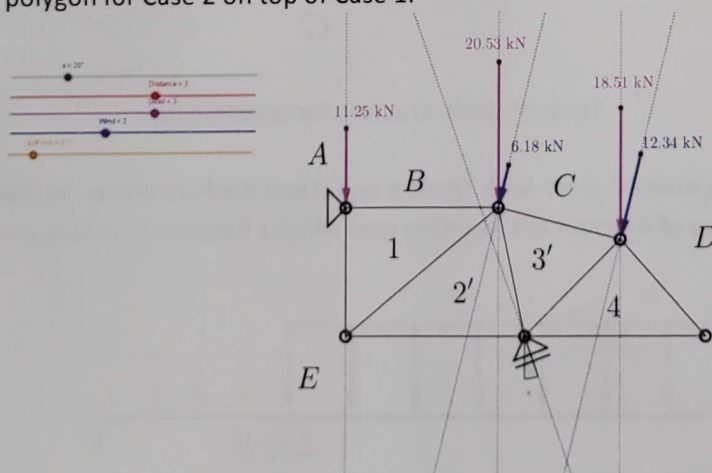


Figure 2. Case 2.

   d) Which of the two designs (Case 1 or Case 2) is more sufficient? Select one of the two and justify your choice.

2. (40%) A three-hinged arch needs to be designed through 3 points with coordinates (0,0), (4,4) and (8,2) in GeoGebra (Arch.ggb), see Fig.3 with various loads scaled with scaling factor scfForm.

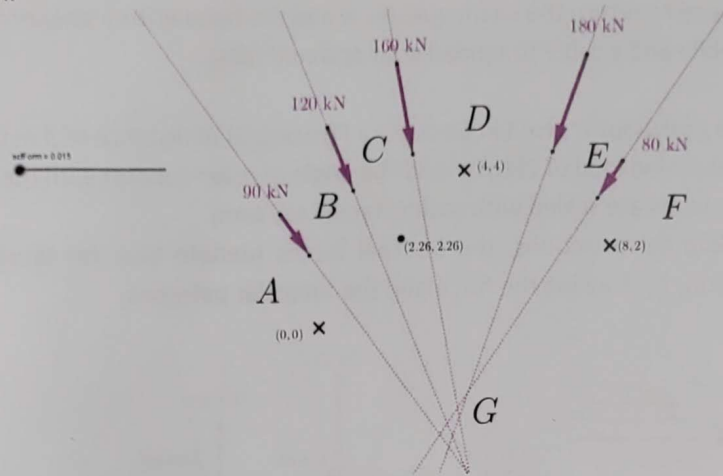   a) Design the optimal shape of the arch through these 3 points. Find the reactions of the arch.



Figure 3. Arch.

   b) What would be the axial force, shear force and bending moment at the point with coordinates (2.26,2.26), assuming that now the structure is the one shown in Fig.4?
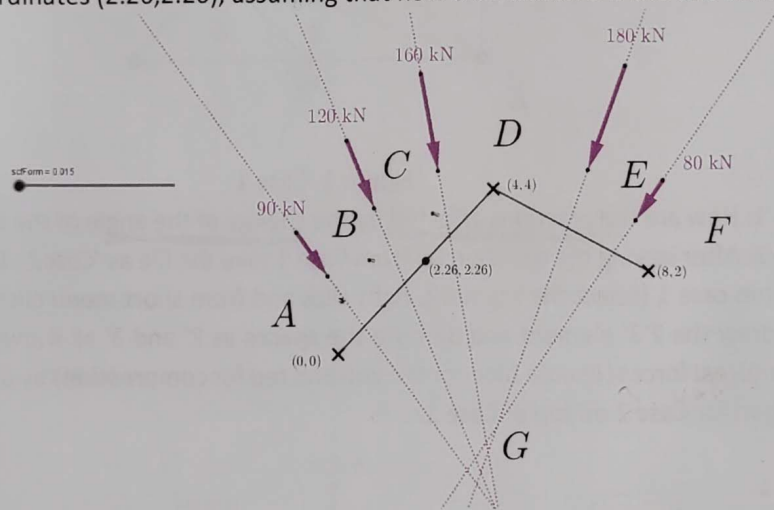


Figure 4. Arch structure for question (b).

3. (20%) An overhang beam is given with spans a and b and loads $q_a$ and $q_b$ as shown in Fig.5. Define the location x of the moment $M_{AB}=0$ in span AB as a function of a, b, $q_a$ and $q_b$.
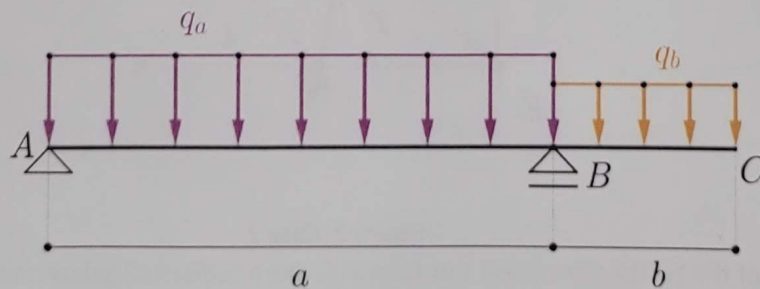


Figure 5. Overhang beam