Objective
The primary objective of this assignment is to acquire some familiarity with the application of strength of materials to the analysis of the column-architrave system. Specific goals:
• Learn how to analyze and design an architrave acting as a simply supported beam.
• Learn how to analyze and design a corbel acting as a cantilever beam.
• Analyze the validity of an archeological reconstruction.

Reading assignment
1. Read Cotterell/Kamminga: Ch. 5, Structures.

Problems
Problem sets must be clear, legible, and well organized. Write your name and problem set number on all pages you turn in. Please use 8”x11” paper - engineering computation paper recommended - and write only on one side of the sheet. All problems in the problem set should be labeled, and all pages must be stapled together.

Show all your work. Use pencil sketches and diagrams to show the geometrical information of the problem. Show dimensions of geometries. Sketches and diagrams must be clear, concise, not crowded, with clearly marked symbols such as forces etc. (Use different color pencils if you prefer).

We will study design issues in the architrave-column system of the Second Temple of Hera at Paestum in Southern Italy (also called the Temple of Poseidon.) Built about 460-440 BC in Doric style, this is one of the best preserved early Greek temples – see Appendix. The material is tufa, a conchitic or shell-rich limestone similar to Roman travertine, with average density $2500$ kg/m$^3$ and modulus of rupture of $17$ MPa.

Problem1: Consider the façade of the Second Temple of Hera at Paestum with the dimensions shown schematically in Fig. 1. Consider the architrave as a prismatic beam spanning from center-column to center-column.

(i) Calculate the maximum load (dead weight) carried by an architrave, including all stone elements above the architrave (from center-column to center-column) but excluding the self-weight of the architrave.
(ii) Calculate the self-weight of the architrave.

Problem2: Use the loads from Problem 1 as concentrated forces acting at the midpoint of the architrave. Consider the architrave a simply supported beam spanning from center-column to center-column.

(i) Find the maximum tensile stresses in the architrave due to the dead weight.
(ii) Now find the maximum tensile stresses in the architrave due to self-weight.
(iii) Compare the total maximum tensile stress with the modulus of rupture. What is the factor of safety in this case?

**Problem 3:** Continue to use the loads from Problem 1 as concentrated forces acting at the midpoint of the architrave. Now consider the architrave a shorter beam, still simply supported but spanning from the inner edge of the abacus.

(i) Find the maximum tensile stresses in the architrave due to the dead weight.
(ii) Now find the maximum tensile stresses in the architrave due to self-weight.
(iii) Compare the total maximum tensile stress with the modulus of rupture. What is the factor of safety in this case? What is the effect of the abacus on the safety of the architrave?

**Problem 4:** Let us now consider two alternative configurations for the same architrave of the Second Temple of Hera. Model the architrave as a 4.3 m. long simply supported beam subjected to a concentrated mid-span force representing the total load acting on the beam, including self-weight. Fig. 2 (a) shows the actual cross section of the architrave analyzed in Problems 1-3.

(i) Consider that the architrave has the cross section shown in Fig. 2 (b) (this is the same as (a) but rotated by 90 degrees. What is the maximum tensile stress in this case? Is it different from what you found in Problem 2? Explain your results.
(ii) Consider now that the architrave has the cross section shown in Fig. 2 (c) (this corresponds to the two pieces fused together. What is the maximum tensile stress in this case? Is it different from what you found in Problem 2? Explain your results.

**Problem 5:** We want to install the stone block used for the architrave in Problem 1 as a corbel. What is the maximum safe projecting length of the corbel? Consider the corbel as a cantilever beam loaded by its own weight only and cross section as shown in Fig 2 (a). Use a factor of safety of 10.
Fig. 1. Second temple of Hera - Paestum. Schematic representation of façade (elevation and middle cross section.)
Fig. 2. Second Temple of Hera - Paestum. Alternative configurations for the architrave. Figure shows cross sections.