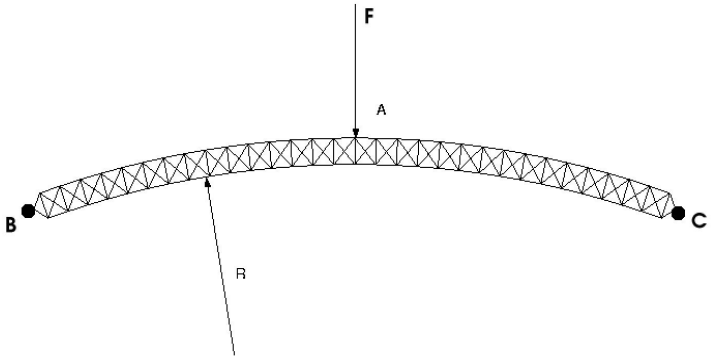
Exercise E9.1:



The geometry considered is shown about and is a shallow arch, i.e the same as in E8.1. The task is to determine the dynamic response of the structure. Three node triangle elements are used to define the finite element mesh. Assume that the strain energy for the material is given as in exercise E6.2. The mass density of the material is assumed to equal 7800kg/m^3 . Note that the coordinates defining the geometry is in (mm).

Implement the element command:

- **plan3gm.m**: Calculating the mass matrix. Use numerical integration for calculating the integrals, cf. Zienkiewicz and Taylor “The finite element method: Volume 1” or Dunavant quadrature rules for triangles on

  https://people.sc.fsu.edu/~jburkardt/m_src/triangle_dunavant_rule/triangle_dunavant_rule.html

  The file dunavant_rule.m will provide the integration points and weights used in

  $$\int_0^1 \int_0^{1-r} f(r,s)\,dr\,ds = A_e \sum_{i=1}^{n} f(r_i, s_i) W_i$$

  i.e. the triangle element is defined in the domain (r,s) and A_e , is the Area and W_i are the weight terms, see plot on the webpage.

Write a script file containing the Newmark algorithm. Choose suitable values for γ and β in the Newmark algorithm. Apply a loading that varies linearly with time, consider two different loading rates.