Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Student number\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Assignment 3**

Consider a bar element when *A* and *E* are constants. Distributed external force  is piecewise constant with values  when  and  when . Derive the virtual work expression of a linear bar element. Use the virtual work density expression  and approximation .

*x*

*h*



*z*







**Solution template**

The concise representation of the element contribution consists of a virtual work density expression and approximations to the displacement and rotation components. Approximations are first substituted into the density expression which is followed by integration over the domain occupied by the element (line segment, triangle etc.). For the two-node bar element the two building blocks are

 and .

The quantities needed in the virtual work density are the axial displacement, variation of the axial displacement, and variation of the derivative of the axial displacement

  ,

  .

When the approximation is substituted there, virtual work densities of the internal and external forces take the forms

,

 where 

Integration over the element gives the virtual work expressions of the internal and external forces

,

.

Virtual work expression of bar element is the sum of internal and external parts

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