Shear bender

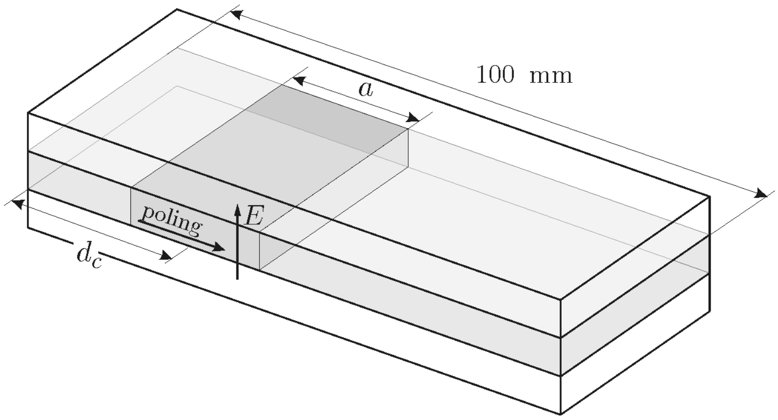

Figure 1: Shear bender

This is an example of a static analysis using piezoelectric volume elements. The use of the shear mode of piezoelectric materials has been investigated by Benjeddou et al. (1997, 1998). The proposed architecture consists in a sandwiched beam for which part of the core has been replaced by piezoelectric material. The proposed configuration is such that, this time, the d_{15} coupling coefficient dictates the design. The electric field is applied perpendicularly to the poling direction, inducing a transverse shear strain. A finite element solution using sandwich beam has been proposed by Benjeddou et al. and compared to analytical results.

The bender of Fig.1 is considered; it consists in a cantilever beam 100 mm long formed of a 2 mm rigid foam core sandwiched by two 8 mm thick aluminium skins. The core is partially replaced by PZT piezoceramics to form an actuator of length a at a distance d_c from the clamp. A 20 V voltage is applied between top and bottom surfaces of the piezoelectric layer. The material properties are summarized in Table 1.

As a first test case, the core is totally replaced by the piezoactuator (there is no rigid foam). The mesh is shown on Fig.2 and the static deformation on Fig.3. The comparison with the FE and analytical results from Benjeddou et al. (1997) shows a good agreement (tip deflection: 1.18 10^{-7} m (This study), 1.19 10^{-7} m (Benjeddou et al., 1997))

As a second case, an actuator of length $a = 10$ mm replace part of the core. Its position is set to vary between 10 mm and 90 mm. The mesh is shown on Fig.4 and resulting deformations for different locations of the actuator are shown on Fig.5. Tip deflection vs actuator position is compared to results found in (Benjeddou et al., 1997) on Fig.6.

Aluminium		
ρ	2690	(kg/m^3)
Y	70.3	(GPa)
ν	0.345	
Foam		
ρ	32	(kg/m^3)
Y	35.3	(MPa)
ν	0.383	
PZT-5H		
ρ	7730	(kg/m^3)
$[c]$	$\begin{bmatrix} 126 & 79.5 & 84.1 & 0 & 0 & 0 \\ 79.5 & 126 & 84.1 & 0 & 0 & 0 \\ 84.1 & 84.1 & 126 & 0 & 0 & 0 \\ 0 & 0 & 0 & 23.3 & 0 & 0 \\ 0 & 0 & 0 & 0 & 23.0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 23.0 \end{bmatrix}$	(GPa)
$[\varepsilon]$	$\begin{bmatrix} 1.503 & 0 & 0 \\ 0 & 1.503 & 0 \\ 0 & 0 & 1.3 \end{bmatrix} 10^{-8}$	(F/m)
$[e]$	$\begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 17 \\ 0 & 0 & 0 & 0 & 17 & 0 \\ -6.5 & -6.5 & 23.3 & 0 & 0 & 0 \end{bmatrix}$	(Cb/m)

Table 1: Material properties

References

Benjeddou, A., Trindade, M. A. & Ohayon, R., 1997, 'A unified beam finite element model for extension and shear piezoelectric actuation mechanisms', *Journal of Intelligent*

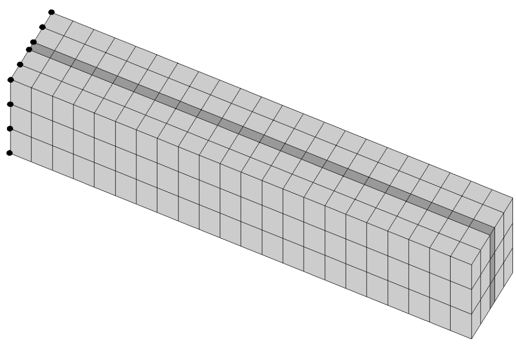

Figure 2: *FE* mesh

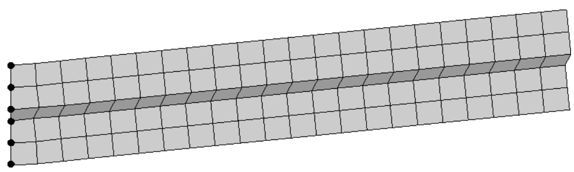

Figure 3: Static deformation

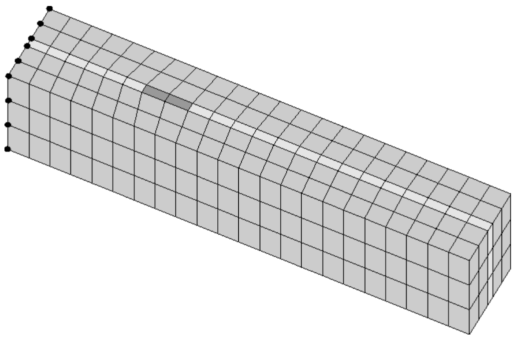

Figure 4: *FE* mesh

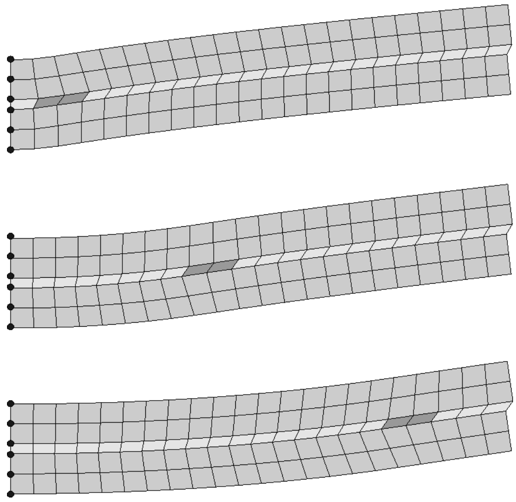

Figure 5: Resulting deformation

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Benjeddou, A., Trindade, M. A. & Ohayon, R., 1998, 'A new shear actuated smart structure beam element', AIAA 98-1922.

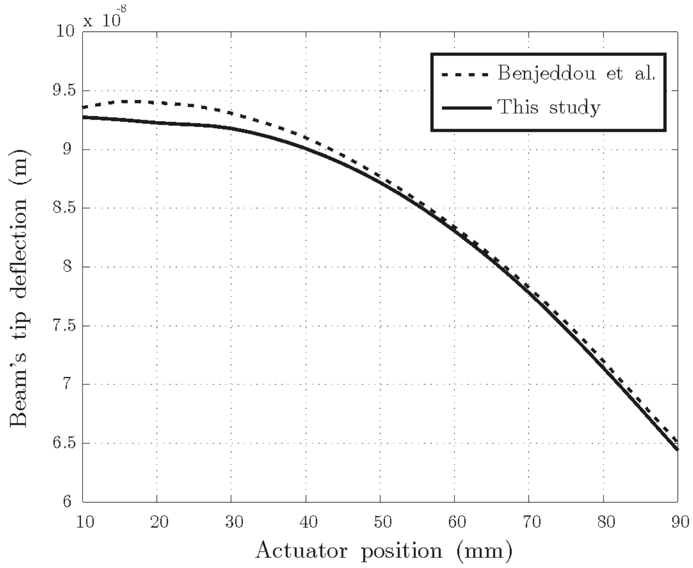

Figure 6: Tip deflection vs actuator position