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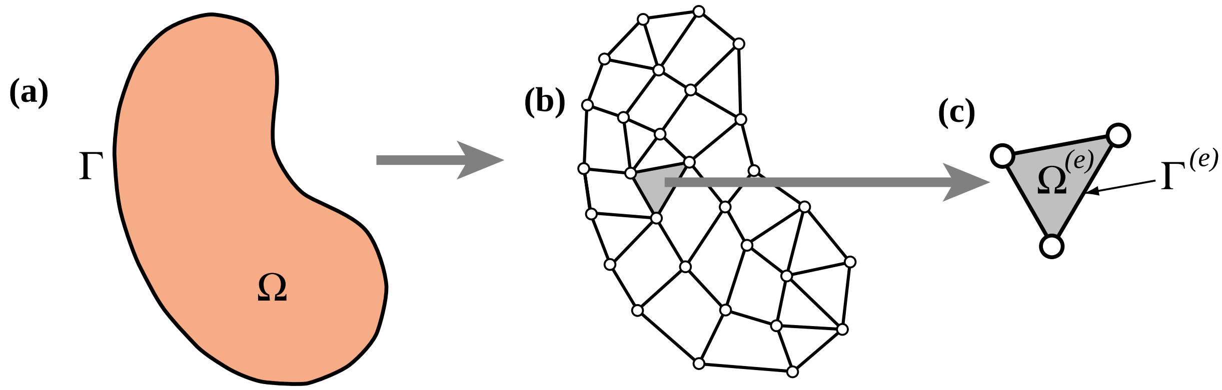
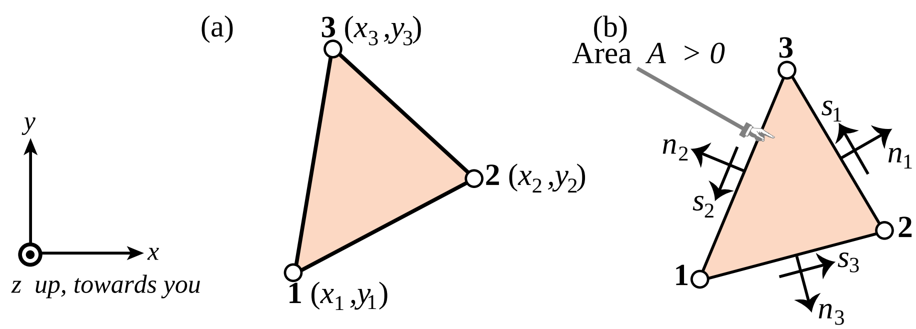
Thin Plate Elements: Overview

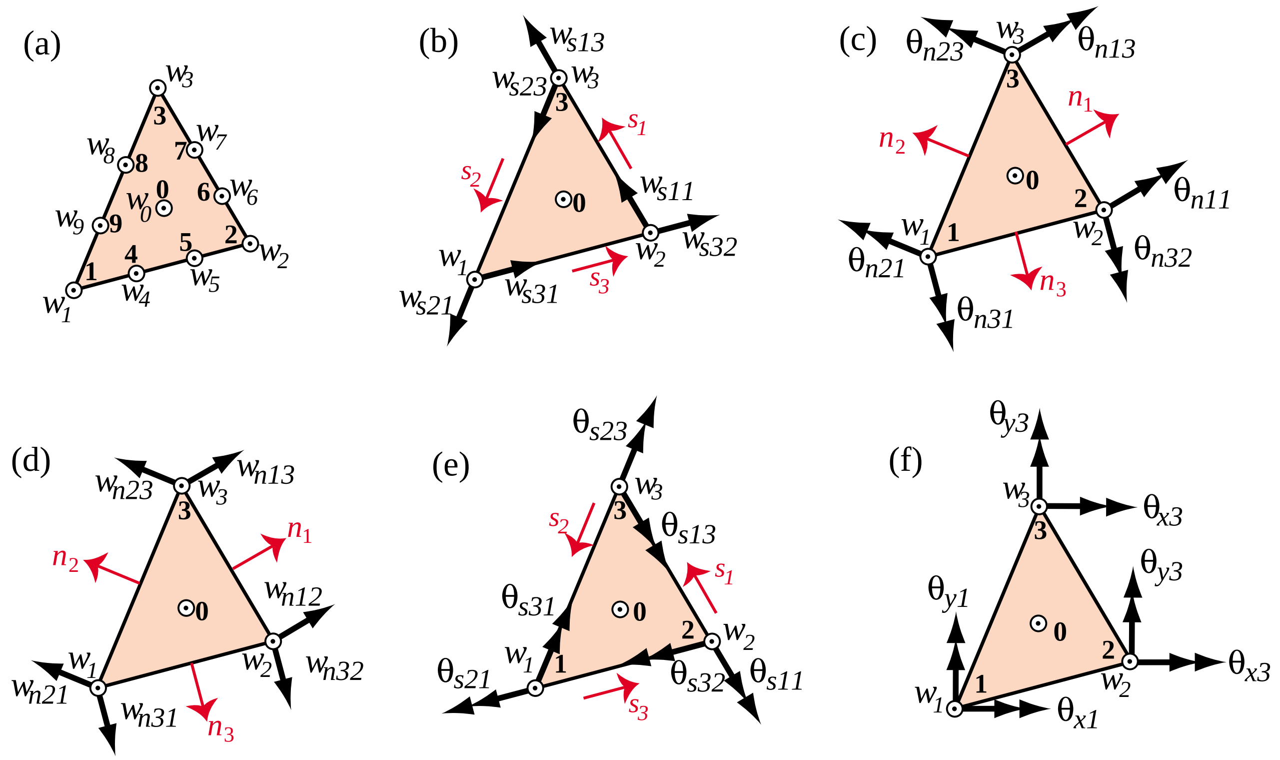
FEM Discretization of Thin Plate Structures



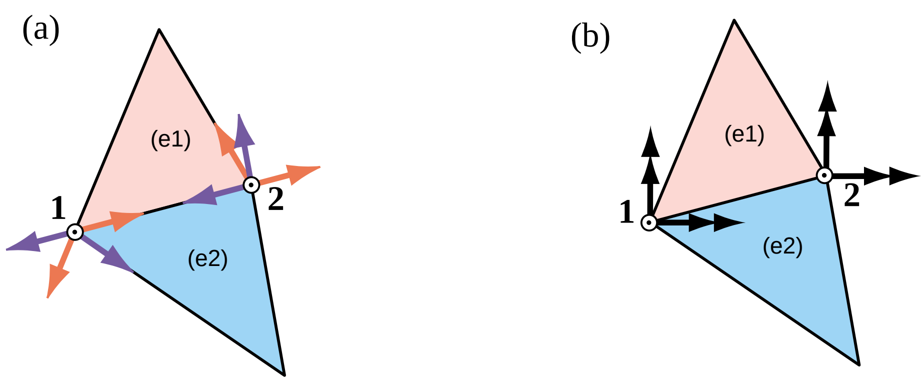
Triangular Plate Elements



Triangular Plate Elements: DOF Configurations

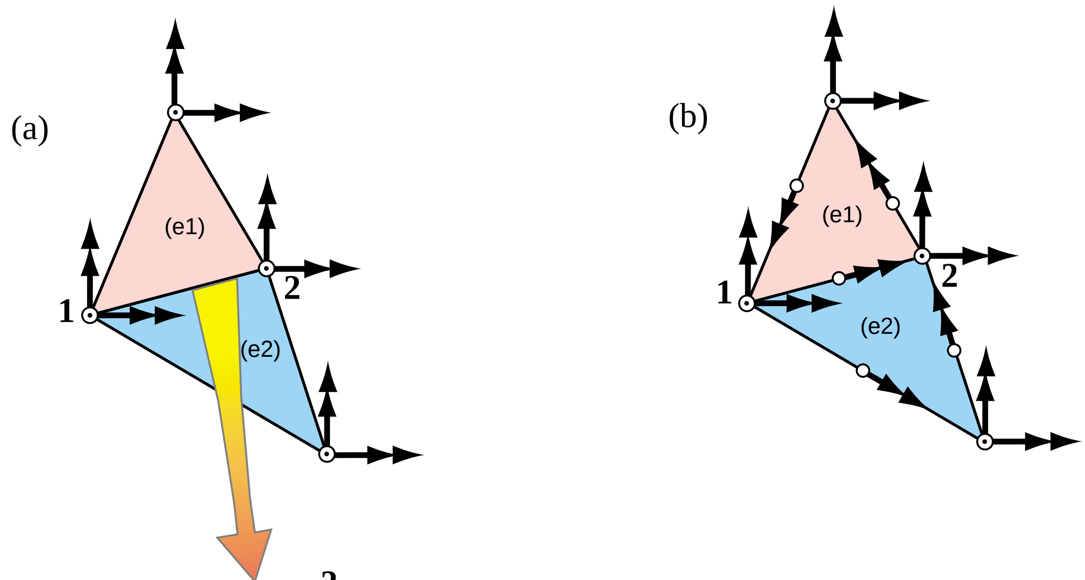


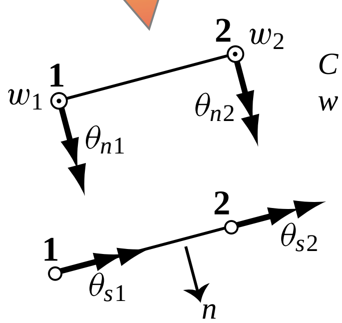
Triangular Plate Elements: DOF Connectors



Interelement Continuity

Advanced FEM

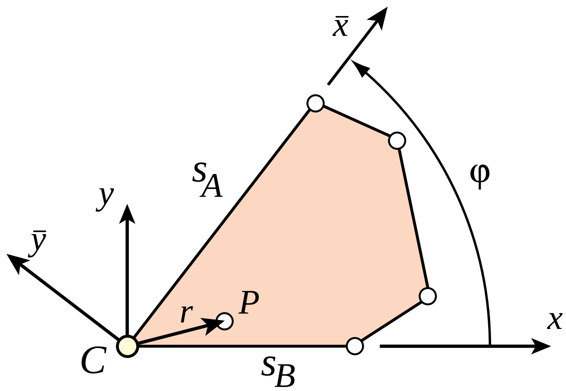




C^0 continuity over 1-2:
w cubic defined by 4 DOF, pass

C^1 continuity over 1-2:
$\partial w/\partial n$ quadratic defined by 2 DOF, fail

Limitation Theorems Make the Continuity Game a Difficult One



Limitation Theorems Make the Continuity Game a Difficult One

Limitation Theorem I   Assumptions:

(I) A w Taylor series at an element coner C is valid; thus the deflection w has second derivatives at C.

(II) Three nodal values are chosen at C: $w_C = a_0$, $\theta_{xC} = (\partial w/\partial y)_C = a_1$ and $\theta_{yC} = -(\partial w/\partial x)_C = -a_2$. This is the standard choice for plate elements.

(III) Completeness is satisfied in that the six states $w = \{1, x, y, x^2, xy, y^2\}$ are exactly representable over the element.

(IV) The variation of the normal slope $\partial w/\partial n$ along the element sides is linear.

A KPB element cannot satisfy (I), (II), (III) and (IV) simultaneously.

Limitation Theorems Make the Continuity Game a Difficult One

Limitation Theorem II

Any C^1-compatible, non rectangular KPB element that satisfies conditions (I) and (II) cannot represent exactly all constant curvature states.

Limitation Theorem III

Suppose that a simple complete polynomial expansion of order $n \geq 3$ is assumed for w over a triangle. At each corner i the deflection w_i, the slopes w_{xi}, w_{yi} and all midsurface derivatives up to order $m \geq 1$ are taken as degrees of freedom.
Then C^1 continuity requires $m \geq 2$ and $n \geq 5$.