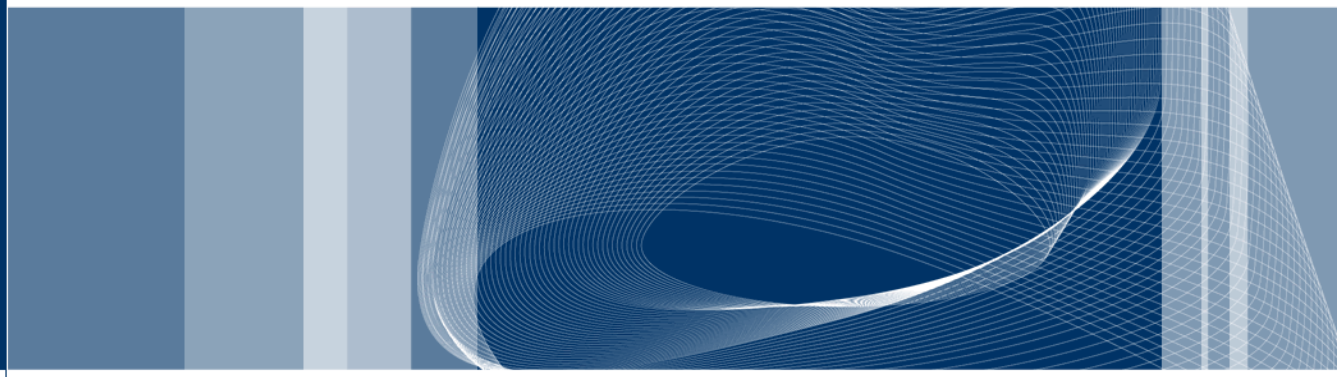
POLITECNICO DI MILANO



Finite Element Simulation For Mechanical Design

Plate and Shell elements: boundary conditions

A. Bernasconi

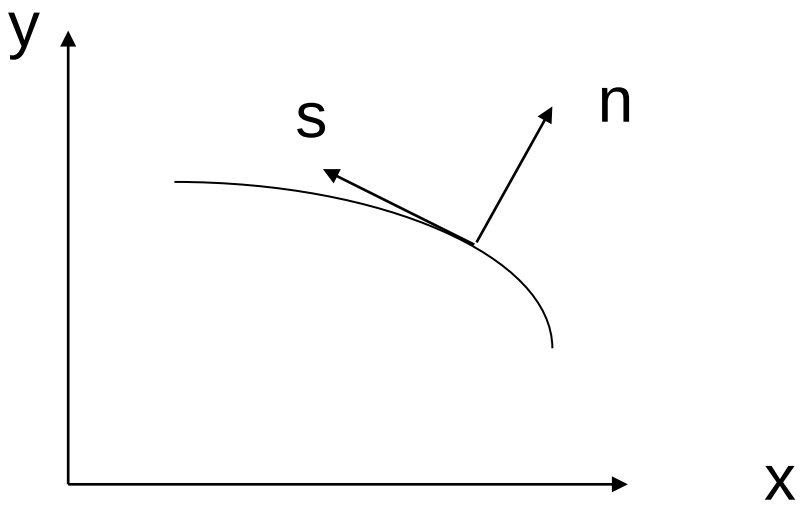
Boundary conditions

$$D\left(\frac{\partial^4 w}{\partial x^4} + 2\frac{\partial^4 w}{\partial x^2 \partial y^2} + \frac{\partial^4 w}{\partial y^4}\right) = q$$

Equation q = D(…)…, once integrated, needs being completed with boundary conditions, that can be expressed in terms of:

- Displacement and rotations
- Moments and forces

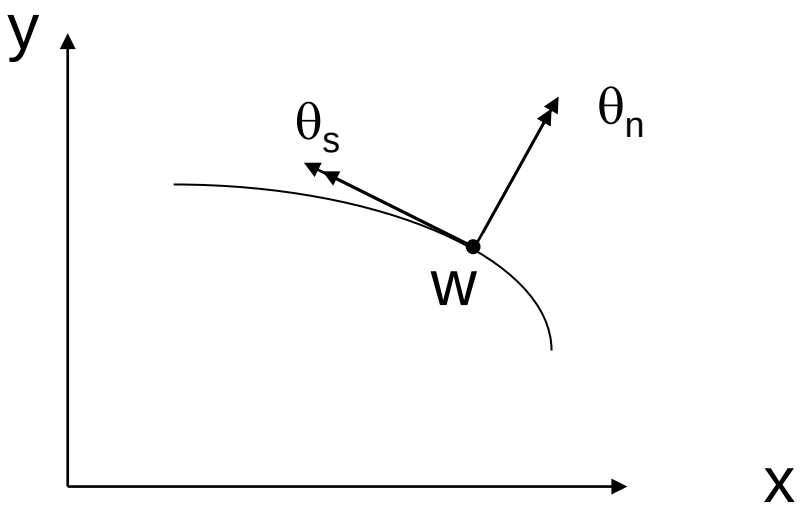
The edge of a plate can have any shape: it is advisable to refer to *n*, normal and *s*, tangential directions



Boundary conditions in terms of displacements and rotations

Examples:

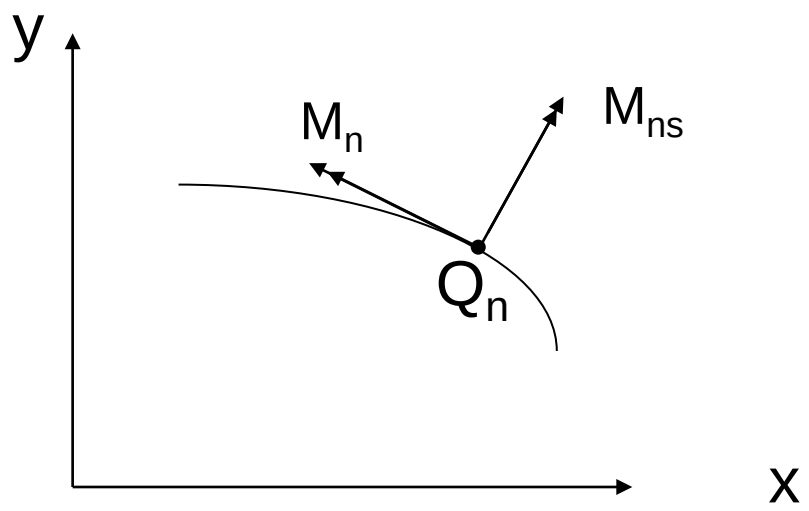
- Supported edge: w=0, θ_n=0, theoretically (hard constraints); in FE, the “soft” condition w=0 has to be preferred, to avoid overconstrain at corner of edges not intersecting at 90°.
- Clamped edge: w=0, θ_n=0, θ_s=0



Boundary conditions in terms of internal forces

Example:

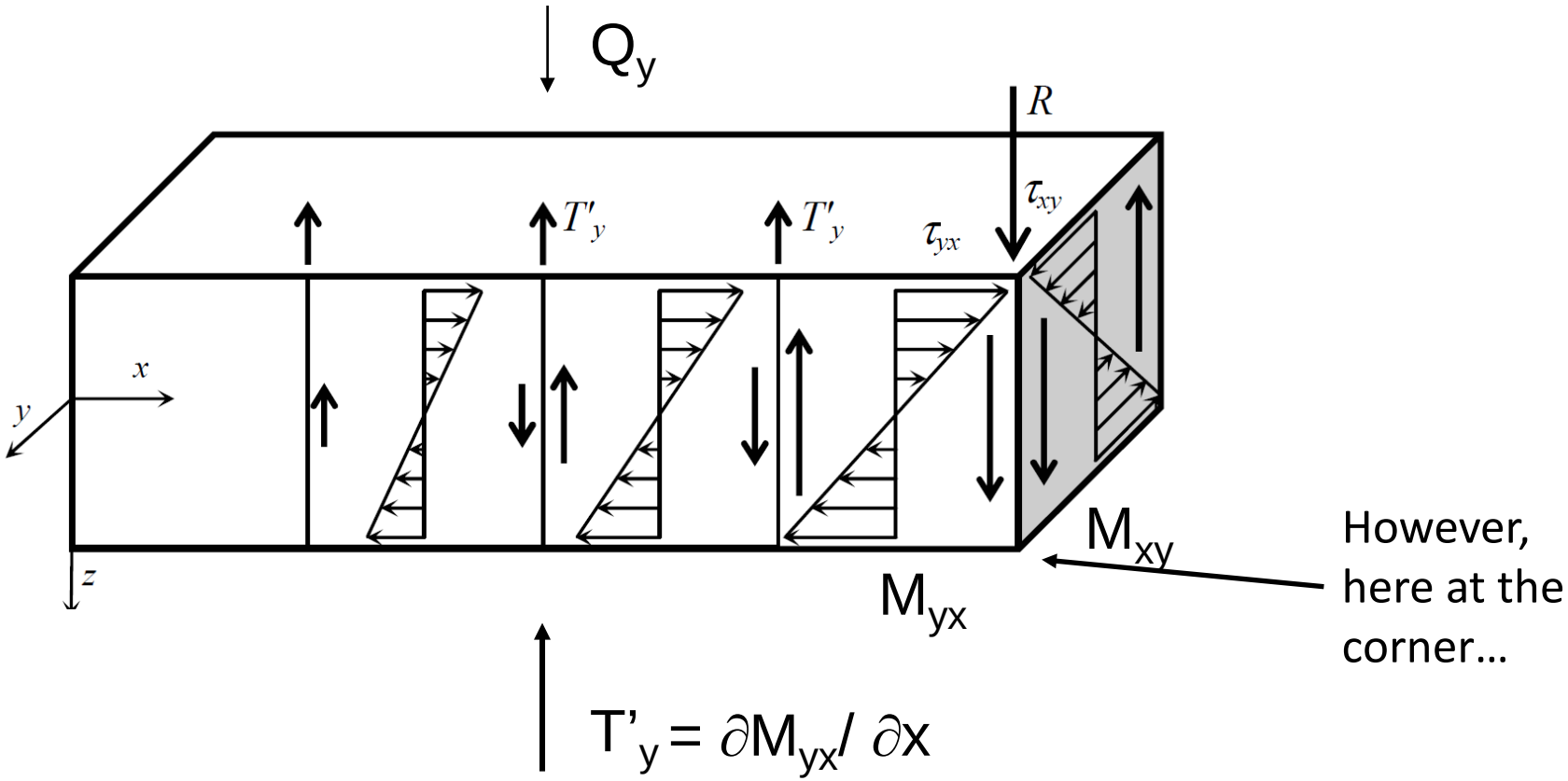
Free edge: $Q = M_n = M_{ns} = 0$



Observations about the reaction forces at corners

Along edges, shear adds to Q_y if there is an increment of the torsional moment.

The additional reaction force is T'_y , expressed as:



Observations about the reaction forces at corners

At corners, torsional moments can be seen a force couples that sum at corners, generating a concentrated reaction force R.