# RC simulation using concrete elements with embedded reinforcements within the framework of the hybrid-mixed stress finite element model

**Luís A. M. Mendes* and Luís M. S. S. Castro†**

* Civil Engineering Research and Innovation for Sustainability (CERIS)
Instituto Superior Técnico – Universidade de Lisboa
Av. Rovisco Pais, 1049-001 Lisboa, Portugal
e-mail: luis.marcos.mendes@tecnico.ulisboa.pt, web page: http://www.ceris.pt

† Civil Engineering Research and Innovation for Sustainability (CERIS)
Instituto Superior Técnico – Universidade de Lisboa
Av. Rovisco Pais, 1049-001 Lisboa, Portugal
e-mail: luis.santos.castro@tecnico.ulisboa.pt, web page: http://www.ceris.pt

## ABSTRACT

In the hybrid-mixed stress (HMS) model used in this paper, both stress and displacement fields are simultaneously and independently approximated in the domain of each element and also the displacements on the static boundary, which is considered to include the inter-element boundaries. The HMS model is characterized by imposing all field equations in a weighted residual form [1], which allows for using efficient hierarchical approximation bases. When compared to the traditional displacement-based formulation, the HMS model has proven to be a feasible alternative for the analysis of plate stretching and bending problems [2,3], in which the quality for the resulting stress fields is usually higher and the results are given on the safe side, as the formulation is equilibrium-based.

The HMS is also characterized by the use of courser meshes (macro-elements), which greatly facilitates the mesh generation phase. On the other hand, considering the reinforcements located on concrete element boundaries will have a huge impact in the mesh layout, resulting in the introduction of additional elements, some of those with very unbalanced dimensions, *e.g.* cover concrete elements. In this case, the HMS model becomes much less efficient and one of its best advantages is lost.

The main goal of the work presented in this paper is to develop, implement and validate the use of concrete elements with embedded reinforcements. This approach allows removing the previous constraints posed on concrete elements and makes it possible to have reinforcements positioned within the concrete domain without any restriction, besides being along one of the local coordinate system axes. The theoretical framework is presented and the proposed model is validated in group of test cases. The results confirm that the use of domain embedded reinforcements is a feasible method that fulfils the initial expectations and gives good quality results.

## REFERENCES

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