

RESUMO N° 92

## MODELLING CRACK FAILURE AND REPAIR BY HYBRID-TREFFTZ STRESS FINITE ELEMENTS

**Maria José Quirino Rosa Duarte**, mjduarte@civil.ist.utl.pt

*Departamento de Engenharia Civil, Arquitectura e Georecursos, Técnico Lisboa, Universidade de Lisboa, Portugal*

**João António Teixeira de Freitas**, freitas@civil.ist.utl.pt

*Departamento de Engenharia Civil, Arquitectura e Georecursos, Técnico Lisboa, Universidade de Lisboa, Portugal*

**Keywords:** Stress Finite Elements, Trefftz Method, Fracture Mechanics, Crack Repair

A hybrid finite element method based on an equilibrium model is used to directly approximate the stress fields in linear elastic plates. The Trefftz basis functions automatically verify compatibility, equilibrium and constitutive relations in the element's sub-domain. The displacements on the static boundary are independently approximated by Tchebychev and Bernstein polynomials, and used to enforce the equilibrium in a weak sense. The kinematic boundary conditions are locally enforced by constraining the displacement approximation (1). Particular solutions added to the stress basis enhance the results and are essential to capture singular stress fields appearing in crack problems. The method gives directly the stress intensity factor and the opening displacement of cracks (2). The analytic solution of an infinite plate with a semi-infinite crack filled with an elastic material (3) has been used successfully to model problems of crack repair (4). Following the previous work, we use the solution of the Griffith's problem to model cracks embedded in finite elements. The extended problem of a center crack filled with an elastic material is solved by the Westergaard approach and the solution is applied to improve the stress approximation on the crack process zone. A parallelized C-language code was developed to produce the numerical tests.

(1) J.A. Teixeira de Freitas, J.P. Moitinho de Almeida and E.M.B. Ribeiro Pereira. Non-conventional formulations for the finite element method. *Comp. Mech.*, 23, 488-501 (1999).

(2) J.A. Teixeira de Freitas and Z.-Y. Ji. Hybrid-Trefftz equilibrium model for crack problems. *Int. J. Numer. Methods Eng.*, 39, 569-584 (1996).

(3) N. Fowkes, J.A. Teixeira de Freitas and R. Stacey. Crack repair using an elastic filler. *J. Mech. Phys. Solids*, 56, 2749-2758 (2008).

(4) M.J.Q.R. Duarte and J.A. Teixeira de Freitas. Crack modelling by hybrid-Trefftz stress finite elements. 11th World Congress on Comp. Mech. (Barcelona, 2014).