On the Effect of Linear Distributed Loads acting on a RC Finite Element in the Prediction of Discrete Cracks Locations

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Gli Effetti di Carichi Distribuiti Agenti su un Elemento Finito in Calcestruzzo Armato sulla Predizione della Posizione di Cracks di Tipo Discreto

ABSTRACT

The development of a Finite Element Model capable to capture cracks formation and propagation in reinforced concrete structural elements in local and global environment, in an efficient computational framework and in a suitable completeness of modeling one, represents the object of the present work [1, 3, 4].

Carrying out the preliminary study of the mathematical model [2, 5], we have developed in *Mathematica* program the two cases of the uncracked element and the one where only one crack develops in a section depending on the boundary conditions, introducing the possibility to load the specimen on the outer surface of the concrete with distributed loads varying with a generic law. For our aims we have considered only the linear law for the distributed load variation, because such a law is able to represent the variation of the normal forces acting on the transversal sections in a fiber model, depending on typical variations of the bending moment in most common real RC structures.

The Elementary Finite Element - EFE mechanical model is represented in the following figure, where the distributed loads acting on the outer surface of the concrete cylinder and the equivalent nodal forces, introduced in the model presented in this paper, are underlined; there are also represented the non linear springs describing the local bond stress-slip relationship existing in the interface and related at nodal level.

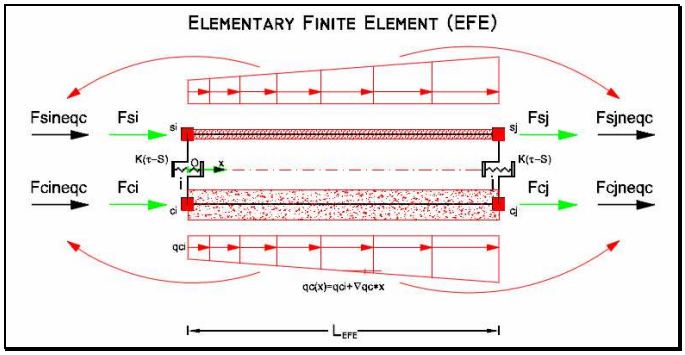

Figure 1: Equivalent nodal forces acting on a typical Elementary Finite Element.

The mechanical model in paper [5] has been enriched through the formulation of the problem of the equilibrium in terms of shape functions of displacements and the introduction of the distributed loads acting on the external surface of concrete element, with the analytical determination of the equivalent nodal forces in terms of work.

The proposed model is shown to predict the discrete cracks locations in axially loaded tension members under the aforesaid boundary conditions and loading cases.

For an illustration, we present some examples of RC members in tension and the results are shown in terms of displacements, stresses and elongation of the last member versus applied load; it has been observed a good agreement between the numerical results of model [5] and that of the present one, with an experimental provided difference in softening phase after first crack onset.

REFERENCES

[1] Dede T., Ayvaz Y., *"Nonlinear analysis of reinforced concrete beam with/without tension stiffening effect"* – Materials and Design, **30**, 3846-3851, 2009

[2] Lackner R., Mang H.A., *"Scale transition in steel-concrete interaction. I: Model"*, Journal of Engineering Mechanics ASCE, **129**(4), 393-402, 2003.

[3] Theiner Y., Hofstetter G., *"Numerical prediction of crack propagation and crack widths in concrete structures"* – Engineering Structures, **31**, 1832-1840, 2009.

[4] Wu H.Q., Gilbert R.I., *"Modeling short-term tension stiffening in reinforced concrete prisms using a continuum-based finite element model"* – Engineering Structures, **31**, 2380-2391, 2009.

[5] Yankelevsky D.Z., Jabareen M., Abutbul A.D., *"One-dimensional analysis of tension stiffening in reinforced concrete with discrete cracks"* – Engineering Structures, **30**, 206-217, 2008.