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Structural Damage Estimation of Cracked Concrete Beams

Manuel E. Ruiz-Sandoval*, G. Juarez

* *Presenting Author*

Corresponding Author: Manuel Ruiz-Sandoval
Contact Email: manuel.ruizsandoval@gmail.com

ABSTRACT
Civil infrastructure could suffer of structural deterioration during its life time. This may be due to aging, or occurrence of natural events that could undermine their structural capacity. It is important to determine the presence, location and extent of possible damage in a timely fashion and accurate manner. Thus, this helps to prevent the sudden loss of capacity of the structure that may lead to the loss of life and disruption of its structural functionality.

There are many techniques for damage detection; some of them base their results on parametric or nonparametric methods. A few other techniques study damage detection when the material undergoes into nonlinear behavior

The opening and closing of cracks in concrete elements is one of the non-linear behavior found in seismic events. Their presence is evident at a glance if the load cycle ends with the opening of the crack, however, this is not always the case.

This paper presents an analytical study of the location and quantification of damage occurred in concrete beams when nonlinear behavior is simulated. A finite element mesh was constructed to evaluate the presence of a crack in the middle point of a simple supported concrete beam. The model took into a count a discontinuity in the mesh using an energetic formulation that relates the crack area and the rotational stiffness of the element.

An auto-regression method for damage detection was used. This technique has the advantage that there is no need of a prior knowledge of a finite element model and therefore of a simple application. Also, it is well known for damage detection of nonlinear behavior.

Results of this study show that the numerical model of the crack using a variation of rotational stiffness allow to simplify the use of 3D or 2D solid models to unidimensional element, thus reducing computational effort. Also, the use of the auto-regression method allowed determining the presence and location of the crack in a simple supported concrete beam. The minimum level of crack length able to be detected was of 10% of the beam height.

KEYWORDS: