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A model for damage analysis of concrete

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Abstract. The damage level in structures (global scale), elements (intermediate scale) and sections (local scale) can be evaluated using a single parameter called the "Damage Index". Part of the damage attributed to the local scale relates to the damage sustained by the materials of which the section is made. This study investigates the damage of concrete subjected to monotonic compressive loading using four different damage models – one proposed here for the first time and three other well-known models. The analytical results show that the proposed model is promising yet simple and effective for evaluating the damage of concrete. The proposed damage model of concrete with its promising characteristics indicated, appears to be a useful tool in the damage assessment of structures made of concrete.

Keywords: damage model; concrete; damage assessment

1. Introduction

It is common to evaluate the damage level in structures (global scale), elements (intermediate scale) and sections (local scale) (Amziane and Dubé 2008) with a single parameter called the "Damage Index" (DI). In the local scale, the damage can be addressed based on the damage of materials of which sections are made (Amziane and Dubé 2008, Paredes *et al.* 2011). Concrete is one of the most common materials used in construction due to its many useful characteristics such as durability, forming convenience, etc. However, high compressive strength of concrete is probably its most striking feature which allows the construction of buildings, bridges, even today's high-rises with ease when combined with steel as tensile reinforcing or prestressing element. In some structural members where concrete is the major player such as columns subjected to large axial loads, or beams-columns with high compressive loads and low bending moments, the load capacity mainly depends on the concrete. Hence, the damage mechanism of these members relates mostly to the concrete. Damage of concrete has been studied over the past years by many researchers such as Cao and Chung (2001), Puri and Weiss (2006) and recently Malecot *et al.* (2010), Markovich *et al.* (2011) and Poinard *et al.* (2010).

Available damage models for concrete in the literature include those of Yu *et al.* (2010), Soh and Bhalla (2005), Chen *et al.* (2011), Amziane and Dubé (2008), as reviewed in Section 3.1. The parameters employed in these damage models are stress, stiffness and modulus. Instead of using

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