Non-linear modelling of composite CFT & SRC columns
taking account of bonding

G. Vergara¹, N. Domínguez¹

Introduction

The practice of steel-concrete composite construction has been growing in the worldwide due to some attractive advantages: adaptability for architectural design, good level of security and protection for fire events, and a good seismic structural response. In spite of this, local government codes provides bare information about this topic -even in countries placed in seismic regions-, adopting traditional and conservative rules for designing this kind of hybrid elements. In practice, it is very common to associate concrete and steel strengths as they were only one, without taking account of three essential points: (a) concrete and steel have different material behaviors, (b) there is a deformation incompatibility, and (c) bonding between them is not perfect. Due to all of these reasons, structural elements might be designed with an over calculated security factor, and the consequent over-cost. Motivated by developing more efficient composite structural elements, the aim of this work is to reproduce numerically the real structural response of composite columns by using a Finite Element code, and compare these results to the local practices of design.

Finite Element modelling

In order to reach our objectives, we simulated the realistic structural response of two basic kind of composite columns: Steel sections encased in concrete (Steel-Reinforced Concrete or SRC) and steel sections filled with concrete (Concrete Filled Tubes, or CFT). Before doing the numerical simulations, we took as reference the experimental results reported by Kim [2], who studied 1181 specimens of different columns (SRC, CCFT & RCFT). This campaign of tests was done in order to evaluate the last AISC 2005 provisions for this kind of structural elements. Combining different non linear material models for steel (elastoplastic, plasticity with strain hardening -Park’s model-, etc.), and concrete (University of Sidney’s "pipe-filled" model, Mander’s "pipe-filled" model, Whitney-ACI’s "rectangle" model, etc.), and considering a perfect bonding between them, we reconstructed the typical force-flexural moment interaction curve of the selected columns. From a preliminary comparison between these combinations, it was appreciated that non-linear models considering tension in concrete, predict better the observed experimental collapse behavior of hybrid columns. Because all these models are developed in the framework of Plasticity theory, we proposed to adopt for concrete a non-linear model based on Damage theory.

The finite element simulations were carried out in the FEAP code [4], where a non linear behavior for 3D damage in concrete (Mazars model [3]) was implemented, as well as a bonding deterioration model (Domínguez model [1]); to support this bond thermodynamic model, it was necessary to develop an special 3D interface finite element, in the same way as it is explained in [1] for 2D problems. For steel, we
adopted the already-integrated classical elastoplastic model with isotropic hardening. Because the experimental tests considered an external moment acting at the upper edge of the column, in the numerical model a distributed lateral load was applied on the upper surface of the mesh. In which concerns to the buckling effect, the incremental pseudo-static analysis was done using a finite deformation resolution.

**Preliminary conclusions**

Our preliminary work in SRC columns shows that influence of bonding is not so important while behavior of all materials rests in the elastic range. Nevertheless, as soon as shear stresses in steel-concrete reach an elastic limit stress (0.4MPa), bonding deterioration produces a redistribution of stresses in concrete body, and the steel coat takes more efforts than concrete. The study of CFT columns are still in process. The whole results obtained from this work will be presented and commented in the conference.

**References**


