APPLICATION OF THE HIERARCHICAL SINGLE-SURFACE (HISS) PLASTICITY MODEL IN NONLINEAR FINITE ELEMENT ANALYSIS OF REINFORCED CONCRETE BEAMS UNDER MONOTONIC AND REVERSED CYCLIC LOADING

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The finite element method is widely used for examining and describing the nonlinear behavior of structures. Akhaveissy et al. (2013) proposed a nonlinear finite element method for predicting behavior of reinforced concrete structures under monotonic loading. Akhaveissy and Desai (2012) used of The disturbed state concept (DSC) and the hierarchical single surface (HISS) plasticity model to predict the behavior reinforced concrete structures subjected cyclic loading. Amiri and Akhaveissy (2011) proposed a constitutive model for prediction of the actual behavior of reinforced concrete structures subjected to quasi-statically cyclic loading. The purpose of this study is to simulate the nonlinear behavior of reinforced concrete beams under monotonic and reversed cyclic loading, which for predicting the nonlinear behavior of concrete under monotonic and cyclic loading, relatively Hierarchical Single Surface (HISS) and the proposed equations Desai was used. The yield function F (EQ. 1) is given by (Desai, 2001):

$$F = \bar{J}_{2D} - (-\alpha \bar{J}_1^n + \gamma \bar{J}_1^2)(1 - \beta S_r)^m = 0 \qquad (1)$$

Cyclic and repetitive loading involves loading, unloading and reloading. Cyclic loading without stress reversal is often referred to as one-way, while with stress reversals, it is referred to as two-way. (Figure 1). In both cases, the following constitutive equation is used: $d\sigma^a = R\, C^{DSC} d\varepsilon + (1-R) C^e d\varepsilon$.

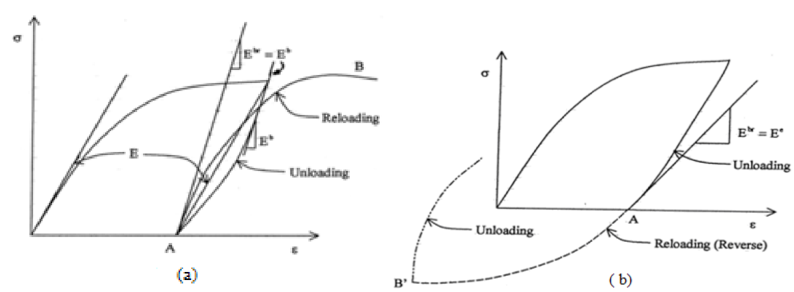
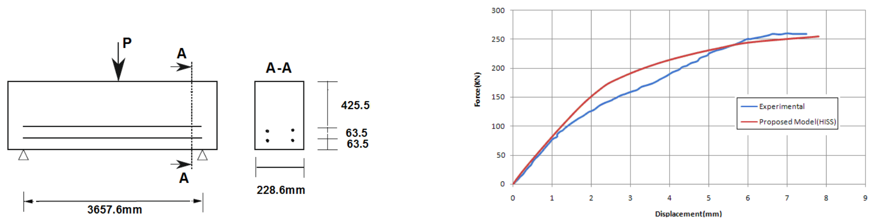


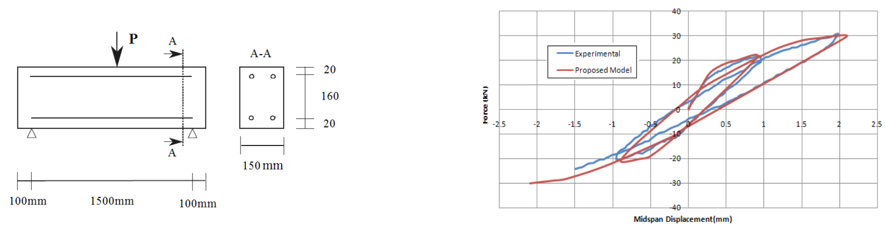
Figure 1. Two reloading cases: (a). one way and (b). Two ways (Desai, 2001)

A program was written in FORTRAN language in a framework of finite element. Where, used of eight-noded serendipity elements for concrete and two-noded elements for reinforced. In order to study the capability of the proposed, two beams has been modeled and the results of the load-displacement was found for them and were compared with experimental results (Figures 2 and 3). Comparison between the load-displacement obtained from these structures with laboratory results, show good agreement.



(a) (b)

Figure 2. (a). Details of the beam (Bresler and scordelis, 1964) (b). Load-displacement at mid-span of beam



(a) (b)

Figure 3. (a). Details of the beam (La Borderie, 1991) (b). Load- displacement at mid-span of beam

The following points can be concluded:

1- The hierarchical single-surface (HISS) plasticity model involves a single continuous yield surface, unlike some previous models that include multiple discontinuous yield surfaces.
2- Classical models such as von Mises, Mohr–Coulomb, and Drucker–Prager, can be derived as special cases of the HISS model.
3- One of the advantages of the HISS Model in Compared with other models, the ability of the model to be used in a wide range of materials. By setting parameters for materials such as soil types, stones, sands, ceramic, metals can be easily used.
4- The HISS model, in comparison with other classical plasticity models, is required for fewer number of the parameters, that it is easier to work with this model.
5- Based on the load-displacement curves obtained for monotonic and reversed cyclic loading in modeled samples observed that the proposed model has a good capability and potential to predict the nonlinear behavior of reinforced concrete structures.

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