Behaviour of laminar RC structures subjected to cyclic loading

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Abstract

When a concrete element is subjected to a multi-axial stress field, a suitable failure criterion is required to define the failure of concrete, e.g. Mohr-Columb, Drucker Prager, etc. This paper presents the modelling of laminar concrete structures like walls that can be considered as a plane stress problem, or 3D plane shells assumed as the assemblage of layers in plane stress state.

Some of the important aspects of the plane stress simulation are to address the following issues: the strength of concrete subjected to biaxial stresses; deviation in material properties before and after cracking; concrete cracking and, the crack propagation. As all these mechanical behaviours are critical to predict the behaviour of laminar structures, hence the issues are investigated by development of numerical model. Cyclic material constitutive laws were implemented in in-house finite element software – FEMIX. The material model matches the existing experimental evidence for the behaviour of reinforced concrete shear wall subjected to monotonic and cyclic loading. The implemented model does simulate the strength increase of concrete when submitted to biaxial compression, and the strength decrease when submitted to tension-compression and tension-tension, as was evidenced by experimental research.

Keywords: Concrete and Steel constitutive laws; Material modelling; Shells; Smeared Crack; Plane stress element

1. Introduction

Almost all reinforced concrete (RC) frames can be considered as a combination of beams, columns, shear-walls and slabs. In case of seismic analysis of multi-storey buildings, the approach followed that involves lumping of each storey at floors cannot predict the response of its sub-elements like beams and columns. In this case of multi-storey frame, beams, columns, beam-column joints and slabs need to be analysed independently for the purpose of detailing, as well as with other structural components inside a complete structure, for the overall response of structure to seismic loads. In the last decades researchers have proposed several ways of analysing these type of structures. The nonlinear finite element analysis (NLFEA) is one of the well accepted methods. By using computational tools of acceptable time consumption, the structural analysis problems which used to take very long time when using models of high sophistication, sometimes even

https://doi.org/10.2749/guimaraes.2019.0268
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