## Nonlinear dynamics of continuous and discrete models of tall buildings

## Angelo Luongo, †\*Daniele Zulli

M&MOCS International Research Center on Mathematics and Mechanics of Complex Systems, University of L'Aquila, Italy

\*Presenting author: daniele.zulli@univaq.it †Corresponding author

## Abstract

Multi-story buildings are often modeled as multi d.o.f. systems for structural analysis purposes. Sometimes, the models may appear very complicate and difficult to dominate due to nonlinear effects which can be induced, for instance, by the extension of columns associated to large translation and twist of the floors. On the other hand, in case of the possible periodic nature of the buildings realized by a single cell (floor) repeated several times, an alternative way to address this kind of structures is to resort to homogenization techniques, and consider the building as an equivalent continuous beam. However, combined to their handiness, such continuous models entail approximations, mainly due to the substitution of finite differences with derivatives. Therefore, the evaluation of their reliability with respect to (more natural) discrete models, ruled by finite difference equations in space and ordinary differential in time, is an interesting and challenging task.

Here, a nonlinear model of continuous beam and, concurrently, a companion nonlinear model of discrete frame are considered, finalized to study the response of a tall building under the action of harmonic external excitation, acting along a plane of symmetry. The analyzed cases take into account different possible external and internal resonance conditions, and resort to a perturbation method to address both the continuous and discrete models is made. The aim is to determine frequency-response plots as well as bifurcation diagrams, and compare the results given by the two models. It is expected that the homogeneous model works well when the building is quite tall, and one is interested in deflections whose wave-length is considerably larger than the inter-floor height.

Keywords: Homogeneous model, discrete equations, nonlinear dynamics