Structural Optimization of Reinforced Concrete Building Grillages considering Cardinality Constraints

Moacir Kripka[a], Guilherme F. Medeiros[a] and Afonso C. C. Lemonge[b]

[a] *Programa de Pós-graduação em Engenharia, Universidade de Passo Fundo, RS, Brazil*
[b] *Departamento de Estruturas, Faculdade de Engenharia, Universidade Federal de Juiz de Fora, MG, Brazil*

Despite the advent of commercial software programs, which automate several design stages, the initial sizing of structural elements requires an engineer's direct and intellectual work, and the solution found is very unlikely to be the best among the several options compliant with safety and usage requirements. Nevertheless, by using optimization strategies coupled to the structural design, one seeks to find the best solution by means of a systemic search, based on a well-defined mathematical model, with the definition of objective functions, parameters, and constraints. Regarding reinforced concrete structures, the cost minimization in compliance with the ultimate and serviceability limit states and with other technical regulations, could mean remarkable cost savings, enabling construction companies and, especially, structural design offices, to stay ahead of their competitors. The aim of this work is to show the application of optimization strategies for the cost of beams in reinforced concrete buildings. In order for this goal to be met, an optimization software program was developed. The program combines the analysis of structures by the grid model, reinforced concrete sizing, and the simulated annealing optimization heuristic. Sizing is compliant with the NBR 6118 Brazilian standard, according to which flexural, shearing, torsion, and web reinforcements, and serviceability limit states (deflection and crack width limitation) are checked. Since the number of beams with different sizes must be limited due to practical reasons, cardinality constraints are also considered, in order identify the ideal grouping of elements. Some results obtained to different number of member groups are presented in order to illustrate the proposed procedure.

KEYWORDS: Optimization, Beams, Reinforced Concrete, Grid Model, Simulated Annealing.