Abstract

The beam-slab layout design task is an ill-defined problem, meaning that it is even not clear how to express explicitly the objectives of the layout design process. As a result, it is difficult to delegate this task to computers. This study proposes a new genetic algorithm (GA) to be used to perform this design task. The input of the proposed GA is an architectural floor plan with given positions of columns and walls. To make the proposed GA simple and, as a result, more attractive, the simple GA is employed as a core algorithm. Adaptive penalty and elitism processes are added to the simple GA to obtain the GA used in this study. In the development of the proposed GA, first, a new coding scheme for beam-slab layouts is developed. The proposed coding scheme allows beam-slab layouts to be represented as binary chromosome strings. The coding scheme requires that a grid be laid over the floor plan. Each line segment of the grid represents a possible position of a beam segment. The employed coding scheme is able to represent all possible beam-slab layouts with rectangular slabs, including those with T-shaped junctions of beams. Later, the beam-slab layout design problem is written as an optimization problem by establishing a proper objective that is written based on how efficiently slabs are supported by columns. Constraints based on the positions of walls, the maximum slab dimensions as well as the total floor area are also developed. This representative optimization problem can then be solved by the GA.

To show the validity of the proposed GA for beam-slab layout design, the algorithm is used to solve nine beam-slab layout problems. The test problems are rectangular floor plans and rectilinear floor plans with some rectangular openings. The obtained results show that the proposed GA can successfully find good beam-slab layouts for the given floor plans. The obtain beam-slab layouts in the example problems are practical layouts that can really be used in the next structural design step. Although it may be argued that the beam-slab layouts of all example problems can be designed without much difficulty by humans, this study intends to demonstrate that this particular design task, which is highly heuristic, can be performed acceptably by computers.