A network flow model for optimal pavement rehabilitation planning with least risks under a budget constraint

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The regular road maintenance and rehabilitation (M&R) plan is important to keep the surface in a good shape. In practice, a road is divided into a set of contiguous segments, where each set is a pavement project treated by the same M&R plan. With limited budget, we investigate an optimal pavement rehabilitation plan that seeks an optimal combination of road segments and their rehabilitation plan such that the total risks are minimized with limited budget.

By treating each segment as a customer and a pavement project as a warehouse, this problem can be formulated as a difficult uncapacitated facility location problem (UFLP) by integer program (IP). Then, we formulate this problem as a network flow model where a segment and a project is represented by a node and an arc, respectively. Thus, solving for the optimal M&R plan equals to seeking a constrained shortest path (CSP). In particular, an optimal M&R plan corresponds to a path of minimum risks that obeys additional feasibility constraints associated with arcs and path lengths. Finally, we proposed three solution methods for solving the CSP: Lagrangian relaxation (LR), the K shortest path (KSP), and a hybrid algorithm exploiting the simulated annealing (SA) framework to select segments to be treated and then solve for their M&R plans by LR. Results of our computational experiments indicate some of our proposed heuristic solution methods are both effective and efficient.

***Keywords*:** Pavement rehabilitation, Integer program, Constrained shortest path, Lagrangian relaxation, K shortest path

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