

# A DYNAMIC MULTI-STAGE FRAMEWORK FOR DEVELOPING OPTIMAL PAVEMENT LIFE-CYCLE ACTIVITY PROFILES

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## ABSTRACT

Highway pavement managers seek optimal life-cycle activity profiles or the most cost-effective maintenance and rehabilitation (M&R) strategies over pavement life-cycle. A typical profile comprises M&R treatments applied at specific points in time. The benefits of each profile can be measured in terms of the service life, increase in average performance compared to the do-nothing profile, or the area bounded by the performance curve that corresponds to the profile. These benefits may be monetized or un-monetized. The cost of each profile comprises the agency costs (of construction and maintenance) and user costs during workzones and during normal operations of the pavement. In a departure from existing literature on this subject, this dissertation addresses the issue of M&R optimization by explicitly considering the benefits and costs corresponding to each individual constituent treatment of a given profile. The treatment-specific performance and cost models were calibrated using data from in-service pavements in a mid western state in the United States. For each pavement family (functional class and surface type), the optimal solution was identified using a framework that utilizes dynamic programming and stage-wise recursion. This involves a decomposition of the optimization problem into temporal interrelated stages. The framework was applied to determine the optimal life-cycle activity profile for a case study involving an interstate pavement section. It was found that the optimal profile consists of thin HMA overlay at the 12<sup>th</sup> year followed by functional HMA overlay at the 22<sup>nd</sup> year after initial construction over a 35-year, two-stage analysis period. Different optimal solutions were obtained when only preventive maintenance or only rehabilitation was considered, and also for different functional classes and pavement types. To investigate the consequences of variability in the input parameters on the choice of optimal profile, probabilistic distributions of the inputs were established and Monte Carlo simulation was carried out. It was observed that optimal solution was generally robust for the range of realistic values of traffic and climate variables encountered in the study area.