

ABSTRACT

Samdariya, Ashish. M.S.C.E., Purdue University, May 2012. Application of Probabilistic and Multiple-Criteria Techniques in Economic Evaluation of Alternative Reinforcement Materials for Increasing Bridge Deck Life. Major Professor: Samuel Labi.

Managing the existing bridge infrastructure has become a major social and economic concern in North America. This is due to the critical conditions of the deteriorating bridges and the limited funds available to repair their deficiencies. To overcome such scenarios, bridge designers have to identify and implement cost-effective strategies that yield minimal preservation frequency and intensity over the bridge deck life and hence least life-cycle cost to the agencies with increased bridge deck life. Most of time these decisions are subjective in nature that easily raises questions about fair, equitable and systematic decisions. This thesis presents a decision support methodology developed for alternative reinforcement selection as a strategy for bridge decks in particular. In which it compares the cost, benefits, and cost-effectiveness of reinforcement alternatives versus traditional steel in stochastic manner. This method uses the Monte Carlo simulation technique to evaluate the initial and life-cycle costs borne by the agency and the users, and the service life of the bridge deck based on uncertainty associated with input variables and Analytic Hierarchy Process (AHP) to evaluate the weights for different agency and user costs associated with individual projects. Subsequent rank matrix comparison identifies the best alternative material on the basis of the multiple-criteria. The thesis exhibits, a case study incorporating selection of three reinforcement alternatives: epoxy coated steel, zinc clad and stainless steel rebars. The results highlight the short-term impact on initial costs, which significantly rises for rarer material but shows a drastic reduction in costs over the service life. Study suggests cost will be lower for if the preservation frequency and intensity are low. To minimize preservation expenditures, corrosion resistant reinforcing materials play a vital role. Particularly, in corrosive environments for bridges, the relative benefits of expensive but corrosion resistant reinforcements are expected to be even higher. Recognizing that the evaluation parameters are not deterministic, and they follow certain probability distribution. An excel based tool developed that allow user to choose a distribution pattern for all input variables like traffic volume, material prices, discount rates, life-cycle profiles etc. to do the life cycle cost analysis. This thesis thus creates a platform to analyze the claimed or tested superiority of reinforcing materials for bridge deck over its life.