Optimizing Link Strengthening Decisions to Improve Post-Disaster Road Network Accessibility

Eda Yucel*†[1], Sibel Salman[2], and Idil Arşık[3]

[1]TOBB University of Economics and Technology (TOBB ETU) – Söğütözü Caddesi No:43, Söğütözü, Ankara, 06560, Turkey

[2]Koç University (Koç University) – Rumelifeneri Yolu 34450 Sarıyer Istanbul Turkey, Turkey

[3]Georgia Institute of Technology (GATECH) – North Ave. Atlanta, Georgia 30332, United States

Abstract

We study a pre-disaster investment problem to strengthen the links of an urban disaster-risk-prone highway network structurally. The goal is to improve the expected post-disaster accessibility. Given the marginal survival probabilities of the links, we propose a new link failure dependency model to predict the post-disaster status of the network. We generate a family of joint probability distributions for the random surviving network by means of a control parameter with varying levels of spatial and structural correlation. We show that the probability of any network realization can be computed using a Bayesian network but the computational effort becomes immense as the problem size increases. Using the proposed dependency model in a sampling algorithm and three dissimilar path generation methods for the selection of reliable and short routes, we estimate the expected weighted average distance between the supply and demand points. We minimize this accessibility measure and decide on the links that should be strengthened in a two-stage stochastic programming framework. A tabu search heuristic is proposed to solve the two-stage stochastic program and tested in a case study of Istanbul under earthquake risk. Sensitivity analyses are conducted to derive insights for the decision-makers.

*Speaker

†Corresponding author: edatyucel@gmail.com