Levels of reliability (safety) for civil engineering designs are normally established from historical precedent, by specification committees, or based on the variability of loads and resistances. It is common to establish a single target level of reliability for all structures of similar type based on general consideration of costs and anticipated performance. While establishing a single target value makes implementation straightforward, it requires that target values be established based on broad consideration of many structures rather than more refined consideration of individual structures. In some cases, use of broadly established target levels of reliability can lead to excessive costs for construction, while in other cases use of broadly established targets may lead to poorer performance than is desired.

The research reported herein proposes an approach to establish target levels of reliability from combined consideration of socially acceptable risk and economic optimization. Socially acceptable risk is generally represented through FN curves, which describe socially acceptable relations between frequency of failure (F) and number of lives lost (N), or some other undesired consequence. Economic optimization involves minimization of total infrastructure cost through evaluation of the potential costs of failure or unacceptable performance and the required investment to reduce the likelihood of unacceptable performance. Total cost (life cycle cost) is expressed as a function of the probability of failure using the concept of the expected monetary value. The economic optimization analysis includes mathematical minimization of a total cost function and, in the present work, probabilistic analysis of the likelihood of unacceptable performance for bridge foundations and approach embankments.

Cost functions were developed using reliability analyses and estimated or historical costs for pile groups, drilled shafts, spread footings and bridge approach embankments for different consequence levels. The minimum values from these functions were used to establish optimum probabilities of failure that minimize expected total cost as a function of consequences. These economically optimized probabilities of failure were plotted on FN charts and compared and evaluated with respect to socially acceptable risk boundaries. Recommended target levels of reliability were established from these comparisons using engineering judgment.