This report describes a system model for assessing and updating the condition state and reliability of bridge structures utilizing inspection and monitoring data. The system model was developed on the basis of an existing continuous single-cell prestressed concrete box girder. The system model consists of two integrated sub-models: a condition model for predicting the deterioration state of the box girder and a structural model for evaluating the overall system reliability. To model the stochastic deterioration state of bridge structures, we utilize dynamic Bayesian networks (DBN). DBN are a computational framework suitable for modeling all relevant stochastic deterioration processes and their stochastic dependencies. Bayesian updating of stochastic deterioration models with monitoring and inspections data can be performed robustly and efficiently on the basis of DBN. The DBN framework is therefore ideally suited for developing software for the management of deteriorating structures that can be applied by engineers who are not experts in reliability analysis. We adopt a simplified approach which considers global bending failure of the box girder to determine the system failure probability of an aging box girder. The ultimate capacity of a box girder conditional on a certain system deterioration state is estimated on the basis of plastic hinge theory. System failure occurs if sufficient plastic hinges develop under the applied loads such that a kinematic collapse mechanism of the continuous box girder is formed. This approach accounts for
structural redundancies of the continuous box girder with respect to its plastic cross-sectional capacity and its static indeterminacy. To prove the concept, a software prototype has been developed which couples an easy-to-use graphical user interface (front-end) with a computational engine (back-end). The current version of the prototype implements a model of chloride-induced reinforcement corrosion and a structural model which performs the plastic limit analysis for determining the ultimate capacity of the box girder on the basis of a finite element model. The prototype implements the likelihood weighting algorithm to perform Bayesian updating of the deterioration state on the basis of the DBN model. The developed software architecture allows an extension of the software to include further deterioration process. The developed software prototype provides the functionality for quantifying the effect of inspection and monitoring data on the condition state and reliability of a single-cell prestressed concrete box girder. It can be applied by engineers who are not experts in reliability analysis. It can be concluded that the current prototype provides the basis for identifying efficient inspection and monitoring strategies and optimizing the management of aging structures.