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Risk Assessment of Flood Defences by Utilising Condition Grade Based Probabilistic Approach

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Abstract : Management and maintenance of coastal defence structures during the expected life cycle have become a real challenge for decision makers and engineers. Accurate evaluation of the current condition and future performance of flood defence structures is essential for effective practical maintenance strategies on the basis of available field inspection data. Moreover, as coastal defence structures age, it becomes more challenging to implement maintenance and management plans to avoid structural failure. Therefore, condition inspection data are essential for assessing damage and forecasting deterioration of ageing flood defence structures in order to keep the structures in an acceptable condition. The inspection data for flood defence structures are often collected using discrete visual condition rating schemes. In order to evaluate future condition of the structure, a probabilistic deterioration model needs to be utilised. However, existing deterioration models may not provide a reliable prediction of performance deterioration for a long period due to uncertainties. To tackle the limitation, a time-dependent condition-based model associated with a transition probability needs to be developed on the basis of condition grade scheme for flood defences. This paper presents a probabilistic method for predicting future performance deterioration of coastal flood defence structures based on condition grading inspection data and deterioration curves estimated by expert judgement. In condition-based deterioration modelling, the main task is to estimate transition probability matrices. The deterioration process of the structure related to the transition states is modelled according to Markov chain process, and a reliability-based approach is used to estimate the probability of structural failure. Visual inspection data according to the United Kingdom Condition Assessment Manual are used to obtain the initial condition grade curve of the coastal flood defences. The initial curves then modified in order to develop transition probabilities through non-linear regression based optimisation algorithms. The Monte Carlo simulations are then used to evaluate the future performance of the structure on the basis of the estimated transition probabilities. Finally, a case study is given to demonstrate the applicability of the proposed method under no-maintenance and medium-maintenance scenarios. Results show that the proposed method can provide an effective predictive model for various situations in terms of available condition grading data. The proposed model also provides useful information on time-dependent probability of failure in coastal flood defences.

Keywords : condition grading, flood defense, performance assessment, stochastic deterioration modelling
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