Reliability analysis of reinforced soil slope system considering local reinforcement failure

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Abstract

Due to the existence of uncertainties in the parameters of reinforced materials and soil, the reinforced earth structures designed according to the deterministic code appear instability accidents from time to time. The existing research on the reliability of reinforced earth structures usually equates the probability of structural instability to the probability of failure of local reinforcements, or calculates the probability of the system failure by connecting multiple instability modes (external, internal instability, etc.) in series or in parallel. However, literature research found that the remaining reinforcements would redistribute the forces so as to maintain overall stability after the failure of local reinforcements. In addition, various kinds of instability modes are not mutually independent, and their mutual influence and conversion mechanism are complex so it cannot be simply handled in series or in parallel. Based on the total probability formula, this paper proposes a method for reliability analysis of reinforced soil slopes considering local failures of reinforcements. It divides the slope instability into mutually exclusive events of failures of different reinforcements, and calculates the probability of different combinations of failures of reinforcements by design point method and Monte Carlo method. And in this case, it calculates the conditional probability of the slope instability, and then through the total probability formula to obtain the system reliability of the reinforced slope instability. Applying this method to a typical reinforced slope case found: After the failure of the local reinforcement, the remaining reinforcement would share the stress, and the reinforced slope would still be possible to remain stable, but the probability of instability would increase significantly. Therefore, the analysis method that make probability of failure of the reinforced slope be equivalent to local reinforcement failure is too conservative. After the failure of local reinforcements, the potential sliding surface had a tendency to transfer to the failure reinforcements, which would increase the tension of the upper reinforcements and reduce the tension of the lower reinforcements. Overall, the slope was more unstable after the failure of the underlying reinforcement or adjacent reinforcements. With the increase of the correlation coefficient between the soil density and the internal friction angle, the probability of failure of the reinforced soil slope decreased as a whole, and the calculation results were more conservative without considering the correlation between the two.

Keywords: **reinforced slope, system reliability, total probability formula, Design point method, Monte Carlo method**