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Automatic Monitoring System Design and Failure Probability Analysis for River Dikes on Steep Channel

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The purposes of this study includes: (1) design an automatic monitoring system for river dike; and (2) develop a framework which enables the determination of dike failure probabilities for various failure modes during a rainstorm. The historical dike failure data collected in this study indicate that most dikes in Taiwan collapsed under the 20-years return period discharge, which means the probability of dike failure is much higher than that of overtopping. We installed the dike monitoring system on the Chiu-She Dike which located on the middle stream of Dajia River, Taiwan. The system includes: (1) vertical distributed pore water pressure sensors in front of and behind the dike; (2) Time Domain Reflectometry (TDR) to measure the displacement of dike; (3) wireless floating device to measure the scouring depth at the toe of dike; and (4) water level gauge. The monitoring system recorded the variation of pore pressure inside the Chiu-She Dike and the scouring depth during Typhoon Megi. The recorded data showed that the highest groundwater level insides the dike occurred 15 hours after the peak discharge. We developed a framework which accounts for the uncertainties from return period discharge, Manning's n, scouring depth, soil cohesion, and friction angle and enables the determination of dike failure probabilities for various failure modes such as overtopping, surface erosion, mass failure, toe sliding and overturning. The framework was applied to Chiu-She, Feng-Chou, and Ke-Chuang Dikes on Dajia River. The results indicate that the toe sliding or overturning has the highest probability than other failure modes. Furthermore, the overall failure probability (integrate different failure modes) reaches 50% under 10-years return period flood which agrees with the historical failure data for the study reaches.