# A Fiber-Optic-Vibration-String Based Bridge Foundation Scouring Monitoring Sensor

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Foundation scour is one of major causes of bridge failures, which accounts for about one third of bridge failure accidents in China. Scour occur below water level and is difficult to be directly observed by people; hence, bridge scour failures tend to occur suddenly without prior warning particularly during flood events. Thus, developing high-efficient bridge scour monitoring technology plays a critical role in ensuring bridge structural safety. In this paper, a novel bridge scour monitoring sensor is presented. The sensor looks like a bridge foundation pile, and has several serially connected standardized scour monitoring units (SSMUs) on the top and a fixing unit at the bottom. The sensor will be installed like bridge foundation piles by driving into sediment on the riverbed. The SSMU is the sensor's key component to monitor the scour depth. The SSMU consists of a circular steel pile, which has several square holes on the surface. The holes allow water and sediment to come inside the pile. In the middle of the SSMU, there is a fiber-optic-vibration-string (FOVS), the two ends of which are fixed to the top and bottom plates of the SSMU. FOVS consists of a stainless-steel vibration string and an optical fiber that are sticked together, the outside of which is protected by polymer materials. A fiber Brigg grate (FBG) is carved in the optical fiber to measure dynamic strain of the FOVS. When scour occurs, the sediment around the FOVS will be washed away, and the FOVS will begin to vibrate due to the impact of water flow. Moreover, with the increase of scour depth, the vibration length of the FOVS will increase, leading to the decrease of vibration frequency of the FOVS. Since the dynamic strain of the FOVS can be measured by the FBG, which can be utilized to estimate the FOVS's frequency. Therefore, the scour depth could be indirectly estimated from the information of the FOVS's frequency. In this paper, the detailed structure of the scour sensor is introduced. Then, the dynamic model of the FOVS is formulated, based on which the method to estimate the scour depth from the measured dynamic strain is derived. Next, an experiment is conducted to verify the effectiveness of the proposed scour sensor to estimate the scour depth. Finally, the main finding of this paper is summarized.