An hydraulic monitoring system on a Bridge over river Po

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Introduction: Scour around bridge piers is one of the major causes for bridge failure and, unfortunately, models for accurate and robust predictions of scour levels are presently not available. This gap can be overcame using large safety factor while designing new structures but vulnerability and risk assessment for existing bridges are often not achievable. Indeed no device can be considered "standard" for scour measurements [1]. The work presents the first real-time monitoring system installed on a road bridge over river Po, in Borgoforte (Province of Mantova), Italy.

Methods: The estimation of structure vulnerability is the goal of this monitoring system, in other words the computation of the bridge safety factor. The monitoring system is made of many devices and measures the basic environmental parameters in order to assess the bridge vulnerability: water level (hydrometer), wind intensity and direction (anemometer) accumulation of debris upstream the pier (video camera) and scour depth (echo-sounder and BLESS, see below). The acquired data are used to evaluate the main loads acting on the bridge. A structural model has been created to transfer these loads down to the base of the pier. Finally, the load stresses of the pile section are used to calculate the real-time safety factor of the structure.
Two different devices have been used to measure scour depth. The echo-sounder is probably the best choice to measure the riverbed level. It is a good compromise between price, easy installation and reliability but it does not guarantee satisfactory measurement accuracy during floods [1], witch are the most critical events for pier scour. To overcome the mentioned drawback it is installed an innovative sedimeter BLESS (Bed LEvel Seeking System) patented by Politecnico di Milano [2], based on fiber optic technique. In a nutshell, the sedimeter is composed by an array of Fiber Bragg Gratings (FBGs) which act as temperature sensors. The underlying concept of the measurement is that a sensor within the sediment bed and a sensor in flowing water will be subject to different environment temperature, and/or different heat dispersion capacity when some power is dissipated along the fiber by electric resistance [3].

Results: The monitoring system has been working since March 2011. The work describes all the devices installed, the structural model and the data acquired. Some malfunctioning made the data discontinuous; however, the available data permit to evaluate the potential of the system. A comparison is presented between the river bed levels measured by the echo-sounder and BLESS devices.

Discussion: Although the limited amount of collected data, the characteristics for the innovative system BLESS clearly appear, especially with respect to accuracy and reliability of the output signals. Considerations are also given about the physical resistance of the instruments to high stage events, that potentially is one of the most critical issues for scour monitoring. It has been interesting to define the hypothesis and limitations of this monitoring system to develop future improvements.

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