Patterns of Scour and Methods of Remediation of Impacted Infrastructure Facilities

Ashraf Ghaly, Ph.D., P.E.
Professor of Engineering,
Union College
Schenectady, NY 12308

The Mohawk River's waters usually freeze during winter time due mainly to lower temperatures and lesser discharge. Annual events of ice jams due to the melting of ice have resulted in significant damage to infrastructure along the river. Some of the reported ice jams had disastrous consequences that required considerable amount of funds toward the reparation effort. Ice jams are not the only source of problems for the Mohawk River. An accelerated rate of discharge may also cause irreversible damage to the foundations of piers and abutments of bridges and other infrastructure along the banks of the river. The scoured soils become another problems for structures such as dams where they are deposited and result in a build up of additional pressure on the upstream face of the dam. All these problems are interconnected and require preventive measures to ensure that scour does not occur in the first place.

Scour is mainly affected by the type and gradation of soil, site physical and geometrical conditions, flow rate, and to a lesser extent by many other factors such as orientation of infrastructure with respect to the direction of flow. With the variability and complexity of the problem under consideration, it is extremely difficult to predict scour depth or the time line it takes to reach a dangerous level. Simulating scour in a laboratory environment oversimplify the problem and ignores many field complexities. The US Federal Highway Administration (FHWA) in cooperation with many State Transportation Agencies have been collecting field data on scour at bridges at 79 sites located in 17 States, one of which is the State of New York. This data has been compiled to identify and isolate pier scour, contraction scour, and abutment scour. In 1995, the national database contained 493 local pier scour measurements, 18 contraction scour measurements, and 12 abutment scour measurements.

There have been 17 damaged or destroyed bridges due to scour in the NYS and New England states between 1985 and 1995. The April 1987 failure of the two spans of the New York State Thruway Bridge over the Schoharie Creek, Amsterdam, NY is widely attributed to the scour effect on the midspan pier supporting the bridge. Further investigations confirmed that the piers were not adequately protected against scour for long-term service conditions. The failure of that bridge occurred after 30 years of service and was not preceded by any measurable symptoms. Five vehicles fell into the flooded river, killing ten people. Immediately after this accident, many states initiated extensive inspection programs of their inventory of bridges to ensure their safety. The FHWA issued more guidelines related to scour inspection to help states assure the public that infrastructure facilities were safe. According to FHWA, the following are the three major types of scour:

1. *Degradation scour:* long-term changes in streambed elevation due to natural or human-induced causes, which can affect the reach of the river near the bridge.
2. *Contraction scour:* removal of material from the bed and banks across all or most of the channel width, resulting from the contraction of the flow area.
3. *Local scour:* removal of bed material from around piers, abutments, spurs, and embankments. Local scour is caused by the acceleration of flow and by vortices resulting

In: Cockburn, J.M.H. and Garver, J.I., Proceedings from the 2009 Mohawk Watershed Symposium, Union College, Schenectady NY, 27 March 2009

from flow around an obstruction.

There has been many experimental, field, and numerical studies on the scour effect on bridge piers and abutments. There has also been extensive modeling of the scour phenomenon done using computational methods. This presentation will attempt to summarize the causes, patterns, and remediation methods of scour as related to infrastructure facilities. It will show that predicting scour pattern and depth with reasonable accuracy is possible, though difficult. It will also demonstrate that effective remediation and rehabilitation methods of deteriorating infrastructure can help lengthen the life of otherwise failing structures.

Reference
http://seamless.fhwa.gov
(report FHWA-03052.pdf)