Bridge damage

Environment, Water

Every year, many types of failures affect structures as a result of hydraulic action. In fact, hydraulic damage is unpredictable, so protecting bridges from this type of damage is essential. Every year, a huge sum ofmoneyand a lot of time are spent in repairing bridges because of hydraulic damages. In the past two decades, the quick deterioration of bridge structures has become a serious technical and economical problem in a lot of countries especially in highly developed ones. A better way to prevent these additional expenditures is by protecting bridges from this type of damage through correct design and construction.

The purpose of this study is to summarise information about hydraulic damage and identify various methods of bridge pier design and construction that might help prevent hydraulic damage. The study also examined various causes of bridgefailuredue to hydraulic damage and tried to determine factors such as what would be the best shape for the bridge to avoid hydraulic damage, the most useful types of materials for constructing bridges, and the methods of construction most conducive to protecting bridge piers from this type of damage.

The study aims to explain the factors that affect hydraulic damage resulting in bridge failure and come up with clear type methods to protect bridge piers from hydraulic damage. Generally, the loss of pier stability results more from the subsoil factors rather than force factor. This section reassesses the types of failures that may happen to bridges as a result of Hydraulic action and it can be divided into five major categories, namely, Scouring, Bank Erosion, Hydraulic forces on piers, Failure due to ice forces, and Failure due to debris.

Scouring is one of the most common causes of hydraulic damage and it is estimated that nearly 60% of all failed bridges failed because of this. When the speed of flowing water is more than it should be, it may reduce the bed level by excavating and removing the bed materials and making large holes around the piers that gradually cause bridge failure. Local scour removes bed material from around the piers and abutments, also at bridge piers. The effect is usually greatest near the upstream nose of the piers, which may lead to the pier being damaged first at the upstream end and thus sloping.

Geometric parameters are important in the estimation of localised scour, including degree of flow contraction caused by the bridge restricting the flow area, and foundation geometry. The geometry of piers can be illustrated by the shape, length, width and alignment with the flow of individual piers. Bank erosion and channel migration are other factors; several rivers tend to change their route with time. A bridge that is located to suit one location of the main channel may become progressively at risk to scour failure as the river changes.

Abutments or piers placed on the original floodplain, if not designed to accommodate channel migration, may be undermined or otherwise weakened if this occurs. Protection repairs involving the placing of rock guard around bridge piers can reduce the flow area of the main p and direct to flow being diverted on the way to other channels. For example, a river with a sharp longitudinal gradient and high flowing velocity will be more prone to bank erosion than a flat slope river with low velocity.

Flowing water (Hydraulic Force) applies force on bridge piers. One such force works alongside the route of flow, and is referred to as drag force. The other force is typically applied to the direction of flow, and is referred to as lift force. If the flow aligns with a pier and has a lift force equal to zero, the capacity of the pier to withstand lift and drag forces might be reduced during a flood if scouring also occurred around the base of the pier. Debris has an effect on hydraulic acts of bridge performance.

Debris can limit flow leading to significant scour levels around piers. Assembled debris can negatively impact the passageway under a bridge by increasing the hydraulic load on the bridge and this can also affect the hydrostatic forces which may cause structural failure. Ice can also inflict forces against structures due to its extension during freezing, but this appears improbable in the fluvial location. The impact of sheets of ice on the piers probably is the greater risk.

Crushing is a common type of ice failure as it results in high forces or loads on a bridge pier. The main cause of bridges failure due to hydraulic damages is scour. Several methods are available to protect bridge piers from hydraulic damages, however the first step of pier design is estimating the depth of scour, but it is recommended that the overall design should involve the calculation of afflux, depth of scour and various type of hydraulic loads. Scour protection measures should also be considered during the designing process.

Generally, the methods relevant to both the piers and the abutments can be classified into two most important groups, namely: methods consisting of strengthening the subsoil and methods consisting of strengthening the foundations. Foundation of bridge piers on floodplains should be placed at the same depth as the piers foundation in the stream channel. Also, streamline pier shapes helps to reduce scour and minimise the potential of debris build up. Many types of bed materials scour at different rates but loose granular soils have lower resistance to scour.

Scour in sand bed stream will be as deep as scour in cohesive or cemented soils. Scour will achieve its highest depth in sand and gravel bed materials in hours, cohesive material in days, limestone in years and dense granites in centuries. Massive rock configuration is highly anti-scour during the lifetime of a typical bridge. In different types of foundations, especially piled foundations, using less significant number of long piles to extend bearing resistance will provide greater resistance to pile failure due to scour compared to shorter piles.

The top of the pile cap should be placed at a depth below the existing river bed level and at the same level as estimated general scour depth. Stone aprons (Riprap) are situated around piers and abutments as a flexible way to avoid local scour development; the specific parameter that should be considered here is using a large enough stone because it should remain stable under maximum velocities. Also, the stone should be located in a pre-excavated position beneath the bed of the river so the velocities are not increased by its existence.

Constructing bridge piers deep enough to avoid this requires a riprap. This means that while increasing the depth of the pier’s and abutments’ foundation from the bed surface, it becomes more efficient in withstanding a high velocity of flood flow. Another thing to be considered is supplying a roadway that comes close to the profile so it will be overtopped before the submergence of the bridge superstructure. This is useful in reducing scour at the bridge piers. Another method of preventing hydraulic damage is through a process called Enlargements.

Enlarging the base of piers may limit the depth of local scour. Additional protection method is positioned at the bridge pier foundation on floodplains and it should be at the same depth as the pier foundation in the stream channel because there is uncertainty in predicting the level of scour. Using extreme limitations in foundation design if there is any likelihood that the channel will shift its location onto the floodplain over the life of the bridge is a good policy.

There are many more types of bed and bank protection including gabions and gabion mattresses and proprietary systems of interlocking blocks, alteration of a pier’s nosing shape and provision of piles of a smaller diameter than the width of the pier. The benefit of a stone protective covering layer, roughly the nose of a pier, is easy to situate and it does not need any extensive dewatering or diversion work. However, it is not always cost effective The Oreti River Road Bridge is a two lane-bridge built in 1995. It holds Highway 99 crossways. It involves 20 ps of 12 m.

with eight ps which are placed over the main channel and each pier was designed with two rows of six 7. 6 m. driven RC piles; largest size of bed materials has been reduced by 100mm to 50mm at present. In 1975, scour occurred and four central piles in each group of 12 gone from 5 of the piers and survey shows that scour bed level was 1 to 5 m. below the scour depth that was predicted. To repair damage, they put protective rocks below the bridge with a top elevation of 1. 7 m. beneath the underside of pile caps and they built a rock weir about 60 m. downstream of the bridge.