

Review on Lateral Stability of Piled Riverine Structures in the Estuaries of Sarawak

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Abstract

Soft soil conditions with very soft and deep silty clay have constantly endangered the stability of the riverine and estuarine structures in Sarawak. There have been many failures of jetties, wharves and bridges in Sarawak. In many cases of failures, the piles were not designed to resist the lateral movement, unless they were included to stabilize unstable slopes or potential landslides. This practice may be due to reasons such as erroneously judging the river bank as stable in slope stability analysis or simply due to the inexperience of designers. Also, when the river bank approaches the limiting stability in its natural state any construction activity on the river bank could result in lateral soil movement. This paper highlights this important geotechnical problem in Sarawak. Then it presents the details of a few failures of estuarine structures. A review of situations causing lateral loading of piles is then presented. The results of the in-soil and in-pile displacement measurements are shown in this paper and it is found that the computation made to compare between field and 3D modelling is agreeable.

Keywords: Bridges; Foundation; Lateral stability; Modelling; Soft soils.

1. Introduction

River banks located in the southern region's coastal area of Sarawak are mostly underlain with very soft and deep sedimentary soil (SPT-N value less than 2). The soft soil conditions at the banks and beds of rivers and estuaries have constantly endangered the stability of the riverine and estuarine structures such as wharves, jetties, ferry ramps, and bridges in Sarawak. These structures are invariably supported on long piles. Many cases of estuarine structures which experienced distress due to soil movement have been reported in Sarawak. Some of them even collapsed when lateral forces induced by the soil movement were greater than lateral load capacity of the pile [1]. Most of the investigations carried out in the past to determine the reasons of failure showed that the failure was due to the pile foundation being not able to resist the lateral load induced by the riverbank soil movement.

Generally, the piles of the estuarine structures are designed to support only the vertical load. This practice is perhaps due to reasons such as judging the river bank erroneously as stable in the slope stability analysis or simply due to the inexperience of designers. Also, when the river bank approaches the limiting stability in its natural state, any construction activity on the river bank could result in lateral soil movement. Other reasons for lateral soil movement are, scouring of soil in front of the riverine structure, dredging of river bed and the effects due to tidal fluctuation in the water level. Followings are some examples of failures in wharves, jetties and bridges.

The remains of the collapsed reinforced concrete wharves at Sg. Saribas (Pusa) and Batang Lupar (Lingga) are shown in Figs. 1 and 2, respectively. The distress on the piles due to large fluctuations in the river water level and river bank erosion resulted in the collapse of the two wharves. A jetty at Kpg. Hulu Sebuyau suf-

fered creep movement towards the river causing structural distress to the main deck and it had to be demolished (Fig. 3). A bridge at Sg. Palasan collapsed just before it was opened for public use (Fig. 4). The failure of the bridge pier was due to lateral soil movement caused by a layer of silt deposited at the bottom of the pier. The piles were also not designed to resist the lateral movement of the river bank. A bridge in Sg. Menyan located at Kanowit collapsed 10 years after construction (Fig. 5). The collapse was initiated by the toppling of one of the piers, which caused the progressive collapse of the spans. The reasons of the failure of pier were, first there was local scour at the base of the pier and second the pile was not designed to resist lateral movement.



Fig. 1: Remains of collapsed wharf at Sg. Saribas



Fig. 1: Remains of a collapsed wharf at Batang Lupar



Fig. 3: Failure of a jetty at Kpg. Hulu, Samarahan Division



Fig. 4: Collapsed Sg. Palasan Bridge in Betong Division