

# Effect of Tidal Fluctuation on the Stability of Estuarine Structures in Sarawak

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**Abstract** – Several incidents of lateral movement and failures of estuarine structures have been reported in Sarawak. These structures located in very soft and deep sedimentary soils are usually supported on pile foundations. There is a 4 to 7 m daily tidal fluctuation in these locations, the effect of which on the ground and the piles is usually neglected in design. A study has been undertaken to formulate improved approaches for the design of riverine and estuarine structures. The validation of a theoretical model requires data on ground movement and pore water pressure changes due to tidal fluctuation. Accordingly, piezometers and inclinometer casings were installed at the sites of two structures where a bridge and jetty are proposed to be constructed. The inclinometers measure the lateral movement of the river banks and a pile installed in the riverbed. The piezometer and inclinometer readings are being recorded periodically. The paper explains the background of the study, case histories of failures, soil conditions at the two sites, details of instrumentation, results of measurement, and the interpretations.

**Keywords:** inclinometer, piezometer, pile, soft soil, tidal fluctuation

## I. INTRODUCTION

THERE had been several incidents of failures of estuarine structures such as bridges, jetties and wharves in Sarawak. Figure 1 shows two such collapsed structures. More examples are listed in Table 1 [1]-[2]. The estuarine structures are usually supported on pile foundations as the soil profile is generally very soft and deep sedimentary soils. There is also a 4 to 7 m daily tidal fluctuation in these locations. The failures were attributed to unstable riverbank slopes and the pile foundation not being able to resist the lateral load induced by the soil movement. Lateral movement of soil can also occur due to other reasons such as construction activities at the riverbank, scouring of soil below the structure, dredging of the riverbed in front of the structure and more importantly the effects due to changes in the water level caused by tidal fluctuations.



Figure 1 Failure of (a) wharf at the Lupar River and (b) jetty at Kpg. Hulu, Samarahan Division [1]-[2]

In the design of piles generally only the vertical load is considered and no provision is made for any lateral load. This practice could be due to the inexperience of the designers or the erroneous assumption that the river banks are stable. Despite the failures of several estuarine structures, there is a lack of research to formulate appropriate design guidelines. Therefore, a

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