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Scour Protection for TOMBIA-Bridge at NUN River (Nigeria)

In cooperation with HYCON (Hydraulic & Coastal Engineers, Hannover)

Client: Bilfinger & Berger Nigeria GmbH

Location: Nun River, Nigeria

Construction: Tombia Bridge

Scope of Work: Setup of a 3D numerical model, simulation of bridge scour

Methodology: Numerical 3D model

INTRODUCTION

The NUN River, the main branch in the delta of River Niger in the Southeast of Nigeria, shall be crossed by a bridge over a river bend near Tombia. Pile foundations have been brought down about 20 years ago. But works were postponed. Meanwhile the outer river bend shifted approx. 70 m, making intended foundations obsolete and endangering the abutment of the bridge at the western bank.

METHODOLOGY

No information or data on discharges and flow velocities were available for NUN River. Thus, local measurements were taken over a limited period of 4 months during the dry season of 2001. The variation of flows had to be determined. Taking the correlation with the upstream ABOH Gauge to TOMBIA river bend and using the velocity (ADCP) measurements for calibration, a 3-dimensionnal Finite Difference Model was setup (Fig. 1). The bathymetry was reproduced with a grid spacing of $\Delta x / \Delta y = 10$ m and a vertical spacing of $\Delta z = 0.5$ m.

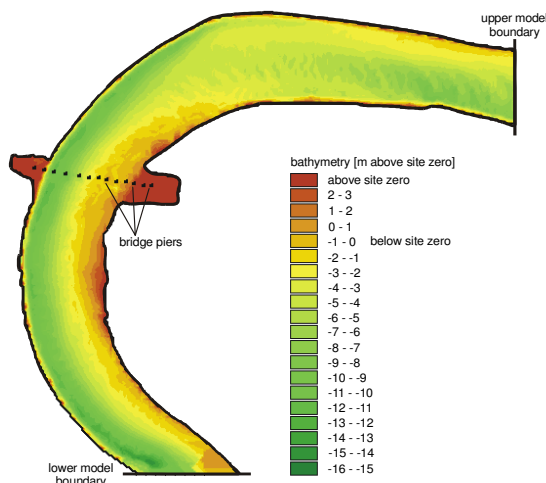


Figure 1: Bathymetry of 3D hydrodynamic Model

RESULTS

Fig. 2 shows increased flow velocities around and downstream of TOMBIA-Bridge during higher discharges. This results from the constrictions of the pillar and barges on the site.

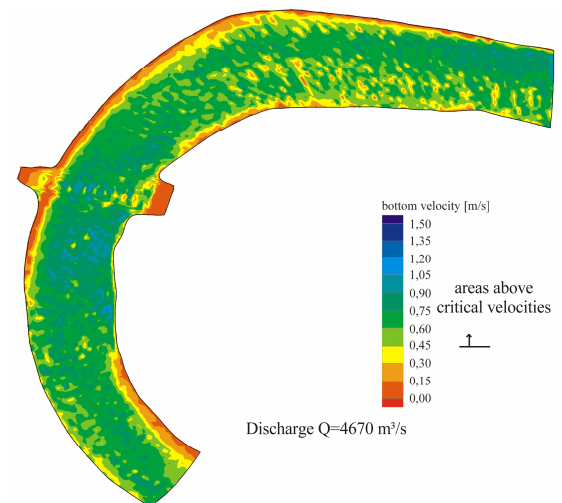


Figure 2: Critical Velocities in the River Bend at TOMBIA Bridge at High Waters

According to model calculations there is a continuing strong erosion of the outer river bank during higher discharges of Niger and NUN Rivers each year.

The lateral shift over the last 20 years is appr. 70 m and results in an average annual lateral bank shift: ~ 3.5 m/a. Scours estimated by formula (ZIMMERMANN & KENNEDY, 1978) can reach depths of - 13.49 m LCD.

CONCLUSIONS

It is recommended to prevent erosion of the outer bend and thus the threat to the bridge foundations at the west bank through sheet pilings around last pile foundation reaching back appr. to the pile foundation Axis 120. The sheet piles should reach below the maximum calculated scour depth. The upstream wall should allow a flow deflection.