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RIVERBED EFFECT INFLUENCE IN A RIVER DEBRIS REMOVAL SOLUTION FLOATING BARRIER

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INTRODUCTION

Brazil's power grid is based on hydroelectric energy, with some power plants installed in heavily polluted rivers, like the Tietê, in the São Paulo state, which carries great volume of debris, that damage the equipment of power plants, reducing availability and increasing cost. To address such an issue, EMAE and IPT, developed a debris collecting solution, which includes a floating vessel that collects floating debris, directed to it by two floating barriers (trash booms).

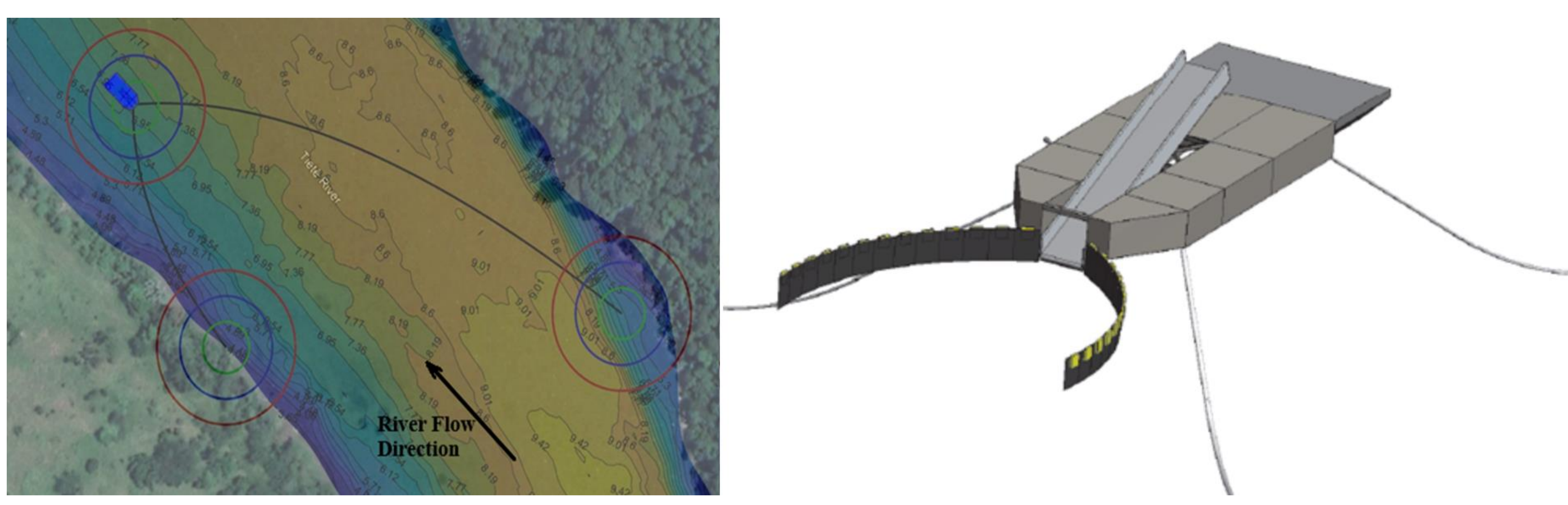

Figure 1 – Installation region of the solution and system developed.

Floating barriers have non-linear and complex dynamic, determined by internal and external (hydrodynamic) loads, the last one being influenced by flow speed, direction and water level. Once the solution is installed in a shallow region, a blockage effect occurs, intensifying the local flow speed and increasing the hydrodynamic loads. So, is necessary to determine the correlation of loads with depth variation, better predicting line loads to design the solution.

MATERIALS AND METHODS

A numerical model was developed to calculate the trash boom lines loads, which is a 3D truss-based FEM model applied for each module of the line. The coefficients for the hydrodynamic forces were calculated through CFD simulations, for several values of flow speed, incidence angle and depth.

The CFD model consists of an isolated trash boom module, with a hybrid mesh refined around the module and the free water surface, to capture turbulence and small eddies. A k-ω SST turbulence model was used along with a Volume of Fluid (VoF) model, which determines free surface behavior and waves.

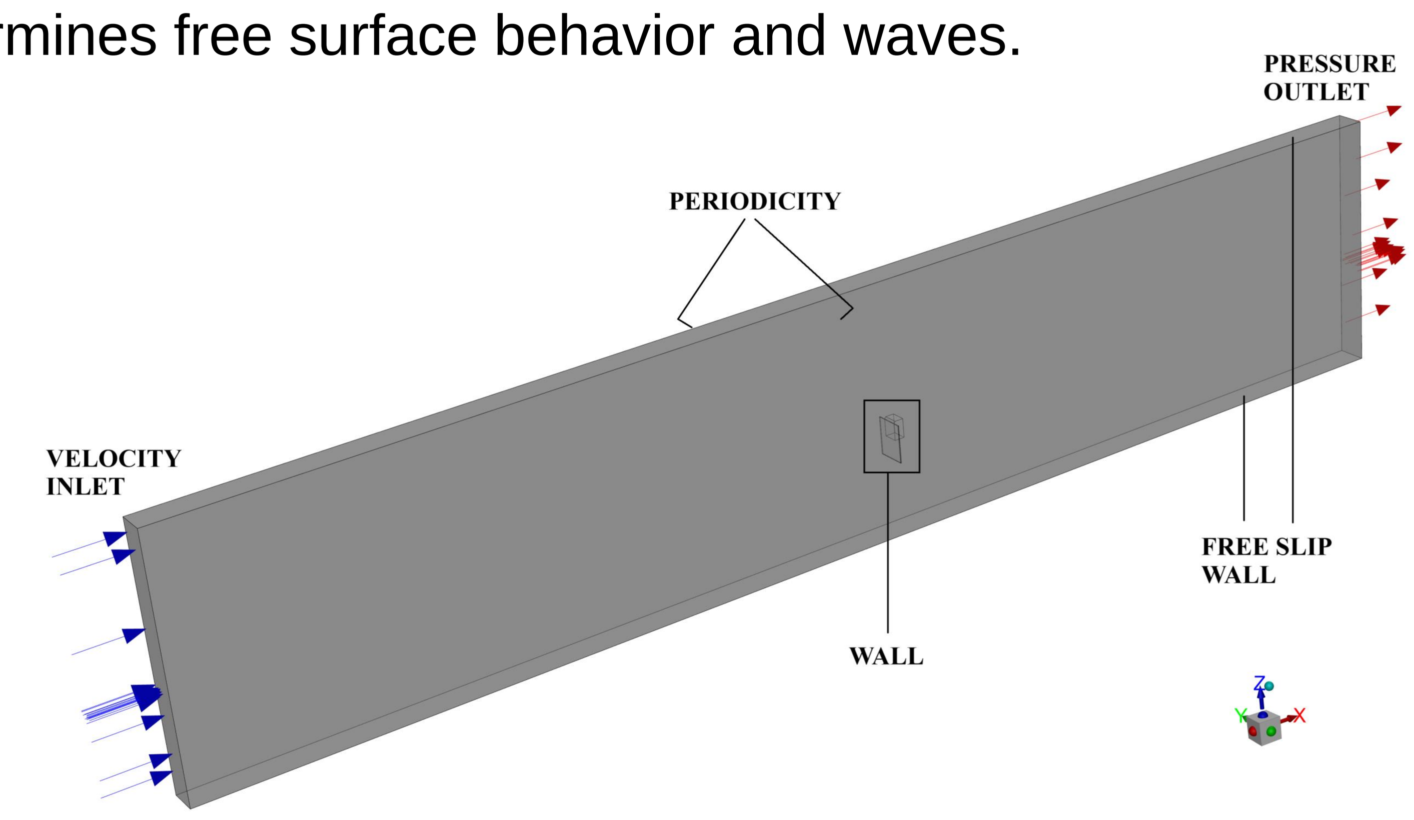

Figure 2 - Domain representation and boundary conditions of CFD model

The CFD simulations were performed varying velocity module (0.5, 1.0 and 1.5 m/s), velocity incidence angle (0º, 30º, 45º, 60º and 75º) and depth (3.5, 5, 7, 9, 11, 13 and 15 m), resulting in 105 scenarios. 15 m is the reference depth, meaning all the magnifying factors will be in relation to the loads at 15 m depth.

RESULTS AND DISCUSSION

The normal load is the most affected by the riverbed effect. At the depth of 3.5 m, the force is 2.4 times higher than at the reference depth and, at around 11 m, the force is nearly independent from depth. Since the riverbed coefficient was implemented into the model, it was made dependent only of depth, by taking the average value of all scenarios in each depth, the values shown in Table 1.

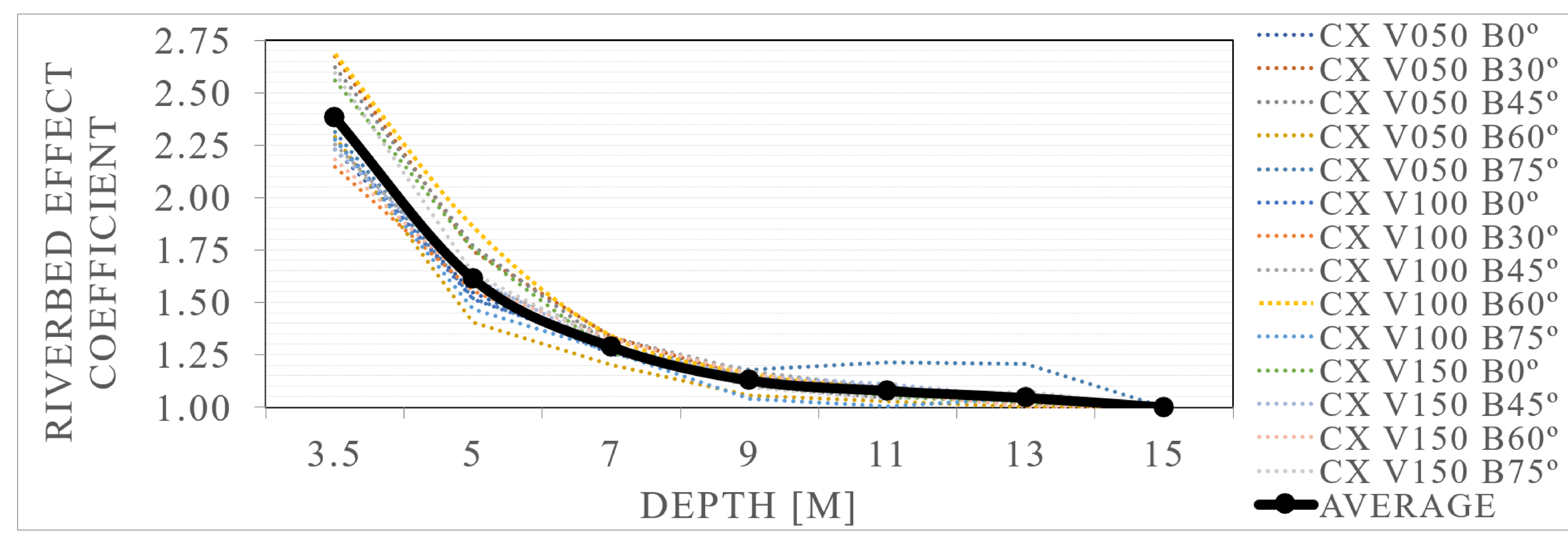

Figure 3 - Riverbed effect coefficients for every scenario simulated.

Table 1 – Values of riverbed effect factor implemented into the code.

Depth [m]	3.5	5	7	9	11	13	15
Coefficient	2.38	1.62	1.29	1.13	1.08	1.04	1

The blockage also affects the water level around the modules. In shallow water, the upstream level rises and the downstream level decreases. The higher unbalance between the water levels alters the buoyance and stability of the module, causing it to pitch ahead and achieve stability in an overturned orientation.

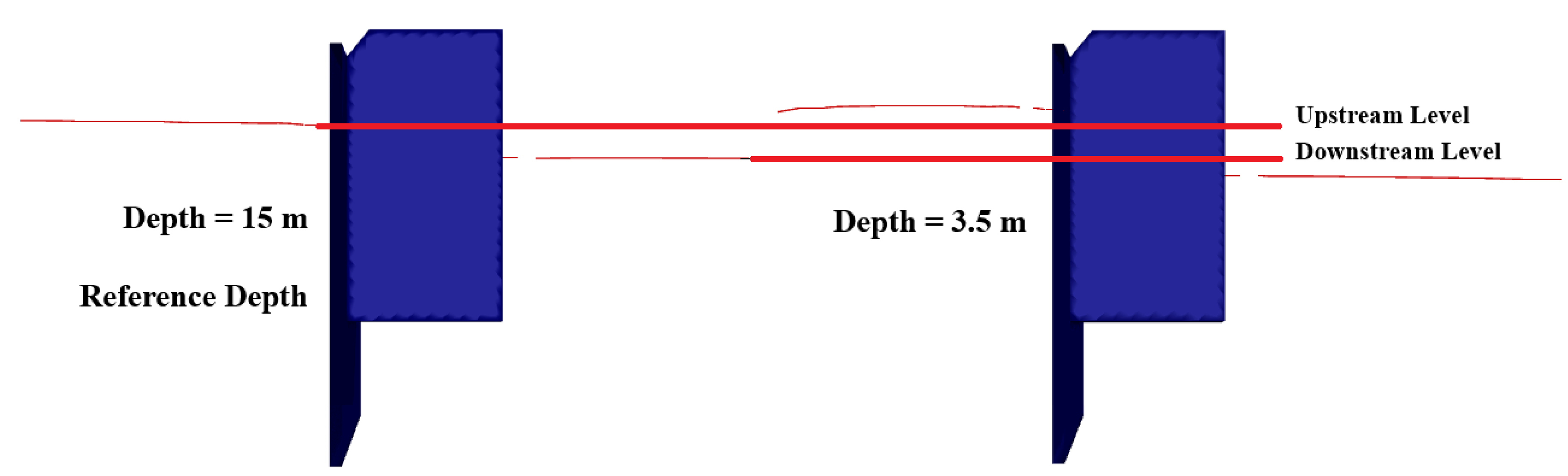

Figure 4 - Water level on the module for 15 and 3.5 m depth.

CONCLUDING REMARKS

- *The hydrodynamic forces are influenced by change in depth,*
- *The normal load is the most affected and is the one to be corrected into the code,*
- *Ignoring the riverbed effect in a shallow channel can lead to problems with the designed solution.*

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