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Hydrodynamic conditions on the slope apron of a rapid hydraulic structure (RHS) and within the influence of it - an example from the Czarny Dunajec River, Polish Carpathians.

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The paper focuses on understanding some basic hydrodynamic conditions along a regulated river engineered with rapid hydraulic structures (RHS) – the modern hydraulic structure used in river engineering works, to reduce slope of the river bed, stabilize it and reducing river channel bed erosion, at the same time structures being friendly to river environment, allowing fish and invertebrate to migrate and built according the expectations of River Framework Directive EU. The measurements were performed upstream and downstream of RHS within the influence of the structure as well as on the slope apron of the structure where the artificial roughness is created by fixing along all the apron very coarse gravel and small boulders to make the RHS similar to natural rapids in a gravel river. It the field, we measured water depth h, average velocity V_a, maximum velocity V_m for different discharges, near bed velocities and all geometry of the RHS. The value of these parameters were used to calculate the shear velocity V_*, shear stresses τ, Reynolds number and Froude number.

Using our results, we observed that there is a greater range of the values of hydrodynamic parameters downstream of the RHS, where braids and small channels are formed, although this section of a river was engineered. The values of velocities were varied here as follows: V_a = 0.194 – 2.210 m •s^{-1} for a high water level and V_a = 0.104 – 1.720 m •s^{-1} for a low water level. Consequently, the values of shear stresses were varied here between τ = 0.106 – 4.720 N •$m^{-2}$and τ = 0.013 – 6.084 N •m^{-2} respectively for a high and a low water level. Then, upstream of the RHS, the values of these parameters were comparable. The values of velocities were here as follows: V_a = 0.264 – 0.590 m •s^{-1} for a high water level and V_a = 0.066 – 0.346 m •s^{-1} for a low water level. And, the values of shear stresses were noticed here as: τ = 0.067 – 0.660 N •m^{-2} and τ = 0.009 – 0.269 N •m^{-2} respectively for high and low water level.

Downstream of RHS, the length between river bank embankments was higher than at the upstream channel. It can be concluded that the best solution for engineering works here is to remove existing embankments, due to create a free migration corridor of the river channel.

On the slope apron of the rapid hydraulic structure, depending on the location of the measurement points, the values of water velocities and shear stresses were very high during all measurement campaigns. The values of velocities were here as follows: V_a = 1.780 – 3.780 m •s^{-1} (V_m = 4.000 m •s^{-1}) for a high water level and V_a = 0.840 – 3.020 m •s^{-1} (V_m = 3.540 m •s^{-1}) for a low water level. Then, the values of maximum shear stresses we calculated were as follows: τ = 32.000 N •m^{-2} and τ = 5.000 N •m^{-2} respectively for a high and low water level. At all the places on the slope apron, there was supercritical flow noticed, as demonstrated by the values of Froude numbers greater than 1.