EFFECT OF ROUGHNESS INDUCED TRANSITION IN A VERY HIGH LIFT LOW PRESSURE TURBINE CASCADE

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In highly loaded low-pressure turbines operating at low Reynolds number, the laminar boundary layer is usually not able to overcome the adverse pressure gradient existing along the rear suction side and tends to separate, increasing the amount of losses and decreasing the efficiency of the profile. One way to overcome this problem is to induce the transition from laminar to turbulent flow using an artificial local roughness element. This research was conducted in the low speed cascade facility C-1 of the "Jacques Chauvin Laboratory"at the VKI. The main flow parameters under investigation were the freestream turbulence and the inlet incidence. Two airfoils were considered : a smooth one and one equipped with a local roughness element.
At low Reynolds number the effect of the roughness is favourable; a small separation bubble is nevertheless still present. This benefit however decreases when increasing the Reynolds number, and for high values of the latter, the situation is inverted (figure 1).

When increasing the freestream turbulence, an earlier transition is promoted so that the onset of transition moves upstream; in addition the length of the separation bubble is reduced. The losses decrease at low Reynolds number but increase at high Reynolds number due to the effect of the higher friction (figure 2). This phenomenon is observed for both the smooth and the rough airfoil. In all cases, the smooth blade remains more efficient than the rough one at high Reynolds number.

Changing the incidence from zero to a positive angle, the roughness is able to induce the transition and to avoid the separation also at low Reynolds numbers, but the losses are higher because of the increased deceleration.

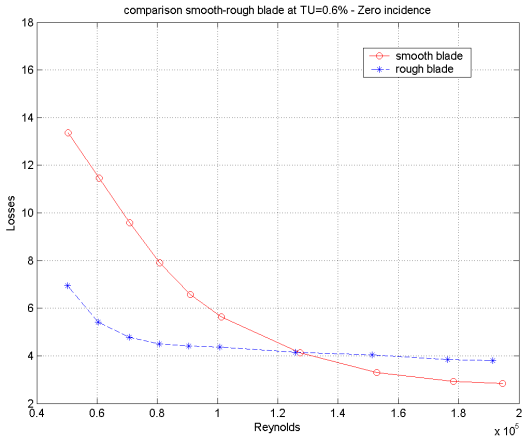

Figure 1: Losses distribution for smooth and rough blade.

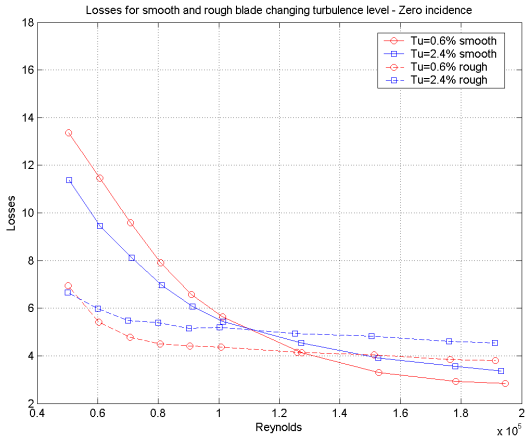

Figure 2: Effect of turbulence intensity on losses distribution