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AERODYNAMICS OF BIKER POSITION

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1 INTRODUCTION

The aerodynamic drag is the dominant resistant effect for a biker cycling at high speed (e.g. at about $50\ km/h$ the drag of a time trial biker is in the order of 90% of total resistant [1, 2], the rolling resistance being about 10%). Thus, specially for time trial competition, the drag reduction is a quite important goal to improve the chance of success. Wind tunnel testing can provide an accurated determination of test conditions and a large amount of recorded data that permit to look for the best biker position as well as for the best equipment. The biker drag is quite dominant respect to the bicycle drag [1], thus the biker position is the most important point in the cycling aerodynamics (nevertheless also bike and accessories can have non-negligible effects [3]).

In the past same extreme aero-position have been proposed, namely the most important are "O'Bree's position" and "superman position" [4] characterized, respectively, by the forearms curled up below the chest (O'Bree) and by the forearms completely stretched forward (superman) as can be seen in the sketches of Fig. 1.

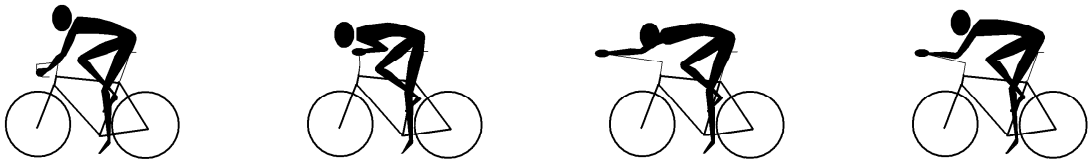
Both this positions have been banned by the international federation (UCI) and thus the best biker position has to found in the limits of the constraints imposed by the roles [5].

The position that normally time trial competitors assume now a day (complying the UCI roles) is called "time-trial position". This position looks to be the same for all the time-trial bikers but, nevertheless, also small differences in the position can produce valuable differences in the drag.

A series of systematic tests have been carried out in the large wind tunnel of Politecnico di Milano (GVPM) with the aim to investigate the effects of different biker positions. The tests were carried out with rather traditional equipment in order to focalize the attention on biker position.

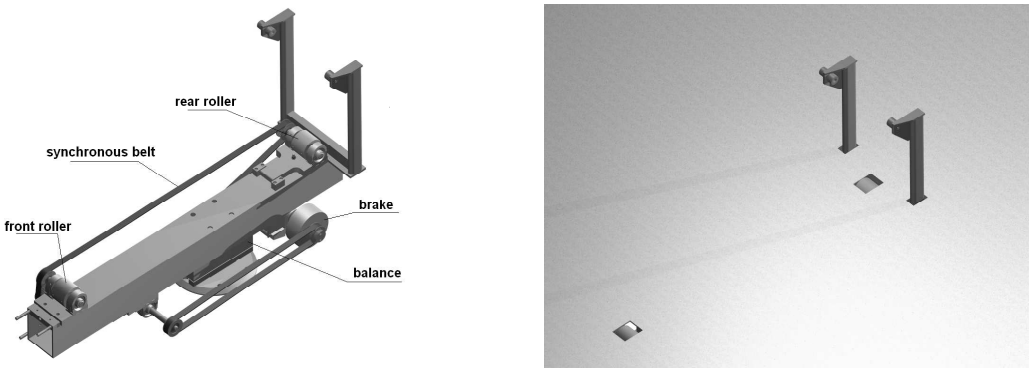
2 EXPERIMENTAL SETUP AND PROCEDURES

The tests were carried out in the $4\ m \times 3.84\ m$ aeronautical test section of GVPM and therefore with negligible blockage effects [6]. The biker was supported by a specifically designed system with balance and rollers (Fig. 2).



a) drops position. b) O'Bree's position c) superman position d) time-trial position.

Figure 1: Biker positions.



a) ground plane off. b) ground plane on.

Figure 2: The bicycle support.

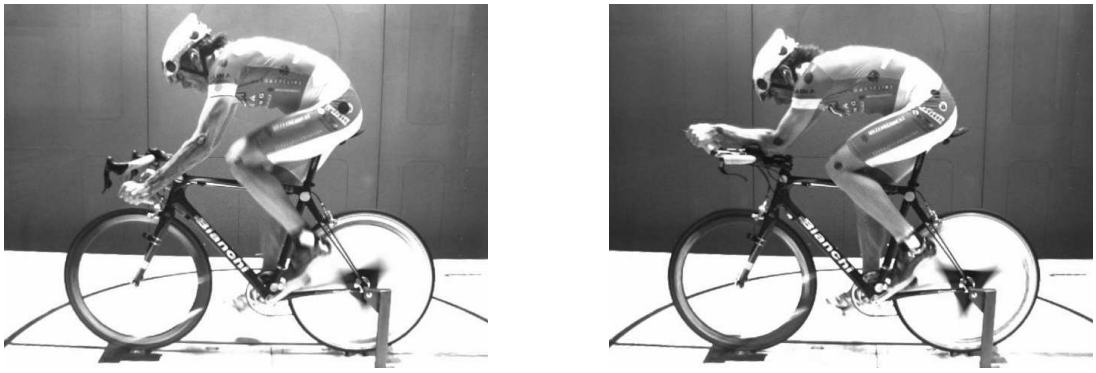
This system has a fork to hold the rear axle while the front wheel is leaved completely free. Thus it is a biker task to keep the front wheel in the correct position on the front roller. Surely this system (respect to other ones that hold the front axle too) leads to more problems in term of position repeatibility and maintaining but, on the other hand, this larger 'freedom' for bike and biker motion is, in the opinion of the authors, more representative of the real way of cycling. The front roller is made turning by the rear one (that is moved by the rear wheel action) via a trapezoidal belt.

The bike support was fixed on the test chamber floor under the ground plane representing the road soil. The tests have been carried out at $50\ km/h$. To set the different biker positions, different handlebars regulations were set while for the head position the biker was required to keep it in the same position for all the tests (he gazed upon a marker $1\ m$ upstream the front wheel). The biker height was $1.8\ m$ and he used a traditional helmet. A traditiona frame was used but with a couple of aerodynamic wheels (a lens shaped rear disc wheel and a front wheel with deep rim and 16 aero-spokes)

The different handlebars settings producing the different biker positions where obtained by changing the following parameters: the handlebars vertical position (changing the height of the rings on the steering axle), the handles longitudinal position (the handle tubes could slide forward or aftward) and the lateral position of the forearm holds (theses had holes to fix them in three different positions).

3 RESULTS

In order to provide a term of comparison previos tests with the traditional drops positions (with the traditional handlebar) have been carried out. Then a wide test campaign has been carried out changing all the possible handlebars settings looking for the optimal position. The optimal position is presented in Fig. 3b and produced a drag area of $0.223\ m^2$, quite lower than



a) drops position. b) time-trial position.

Figure 3: The biker inside the wind tunnel

the reference value of $0.275m^2$ obtained with the traditional drops position presented in Fig. 3a. By comparison of the two diffrerent projected frontal area was possible to deduce that the 19% gain in drag area is due both to projected frontal area reduction (13%) and to drag coefficient reduction (7%).

It's interesting to compare the present results with the results obtained by Grappe et al. [2] by means of in field measurements in a similar configuration (they too used a traditional frame with a traditional helmet but, differently from the present tests, they used traditional wheels and a $1.75\ m$ biker). Thus, despite same differences, we can considere the comparison meaningfull. The comparison between the present results and the values found by Grappe et al. is presented in Fig. 4 where it can be seen that the same drag area has been found for drop position while for the regular time trial position (the aero-position) Grappe et al. found an advantage quite lower. The opinion of the authors is that Grappe et al. were mainly interested in the study of O'Bree's position and thus they didn't carried out a complete optimization of time-trial position.

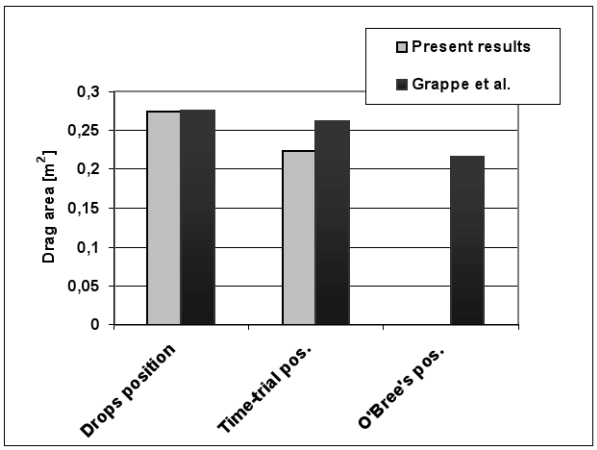


Figure 4: Drag area at different biker position: a comparison between present results and results of Grappe et al. [2]

4 CONCLUSIONS

A system for realistic cycling aerodynamic tests inside the wind tunnel has been set up at Politecnico di Milano and used for an investigation on biker position aerodynamics. The drag

value obtained in the traditional position agrees very well with the result found in the literature [2] obtained with in-field measurements. The test results on time-trial positions showed that an accuraltely adjusted time-trial position (still complying the UCI roles) can produce a drag reduction in the order of 20% (respect to the traditional position) that is the same order of advantage that can be obtained by the more "exotic" O'Bree's position (not complying the UCI roles) [2].

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