The Effect of the Seams on a Baseball. Simulations and a Mathematical Model for the Lift and Lateral Forces.

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Abstract

The trajectory of a baseball depends on the forces acting on the ball. Within these forces, those caused by the asymmetry of the seams are so unpredictable that erratic movements are produced in real trajectories of baseballs with slow or without rotation. Most of researches about such effects consist on experimental measures in wind tunnels. There are not simulations of the process and only one phenomenological model that explains those forces has been reported in literature. We present an analysis of the surface (lift and lateral) forces produced by different seams' configurations and their connection with the behavior of the ball's boundary layers, when considering a typical professional baseball that does not spin or spins so slowly that Magnus force is not produced, at normal air conditions. Numerical proves was carried out by solving the Navier-Stokes equations via ZEUS-3D software, and using finite differences method with a uniform quadratic grid. Surface forces are computed by taking the average of the pressure along the up and down boundary layers. Results are similar to wind tunnel measurements for different ball velocities, which validates the experimentation. This togheter with the visual information of the boundary layer, which is obtained from the simulations, permit us to understand better the effect of a single seam, the set of seams and the interaction between them. In turn, the model for surface forces mentioned above has been improved from these observations by adding weights to the effect of each seam.

References

1. M.A. Aguirre-López and O. Díaz-Hernández and F-J. Almaguer and J. Morales-Castillo and G.J. Escalera Santos. A phenomenological model for the aerodynamics of the knuckleball. Applied Mathematics and Computation 311 (2017) 58-65.
2. J.P. Borg and M.P. Morrisey. Aerodynamics of the knuckleball pitch: Experimental measurements on slowly rotating baseballs. American Journal of Physics 82 (2014) 921-927.
3. H. Higuchi and T. Kiura. Aerodynamics of knuckle ball: Flow-structure interaction problem on a pitched baseball without spin. Journal of Fluids and Structures 32 (2012) 65–77.