PREDICTION OF FLOW FIELD OF A CEILING FAN BY FLOW SINGULARITY MODELING

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DECLARATION OF THE CANDIDATE & SUPERVISOR

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K.K.M.N.P. Samaraweera Date

The above candidate has carried out research for the Masters thesis under my supervision

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Dr. A.G.T. Sugathapala Date

The work is dedicated to my parents

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Abstract

Three dimensional flow field of a ceiling fan is modelled numerically by assuming incompressible and inviscid flow. The fan blades modelled by vortex lattice method, in which surfaces are replaced by vortex boxes. The development of the wake is simulated by free wake method. Kutta condition, flow tangency at solid surfaces and zero fluid loading at the wake are taken as boundary conditions. The governing equations are solved by developing a computational code. The development of the flow field and the effects of the geometrical characteristics of fan blades and rotor parameters on the rotor performance are investigated. When the wake structure of the rotor evolves with time, the wake tends to flow upward at the root of the blade initially and wake instabilities, such as vortex pairing, occur in the tip vortex. But with time, the wake becomes ordered in the vicinity of the blade and wake distortions tend to flow downward. The wake contraction at the near wake was seen in fully developed wake structures. The comparison of the flow rates at different rotor speeds with that of experimental results shows a satisfactory agreement, indicating the validity of the present numerical model. Subsequently, effects of rotor speed, number of blades, blade aspect ratio, and blade profile on the ceiling fan performance are qualitatively and quantitatively analysed. Moreover numerical analysis is extended for investigating the effect of ceiling on the rotor performance. Presence of ceiling degrades the flow rate of a ceiling fan. It can be concluded that the present model is capable of modelling flow around ceiling fans including its aerodynamics performance.

Keywords: Ceiling fan, vortex lattice, free wake, near wake, ceiling effect

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