Session Chair : Prof. M. H. Sohn, KAFA/Korea

W-2D-1. VORTEX BREAKDOWN DUE TO FLAPS ON A 60°DELTA WING- BODY

N. GOPINATH, R. SRIDHARAN, *National Trisonic Aerodynamic Facilities National Aerospace Laboratories, Bangalore, India,* Pitch up is a major concern for aircrafts with delta plan forms. One of the characteristics of slender delta wings is a sudden loss in lift due to vortex breakdown at the trailing edge region of the wing. The corresponding sudden increase in pitching moment gives rise to pitch up. In a tailless delta wing aircraft flaps/ elevons play, a dual role firstly acts as a lift-enhancing surfaces and secondly as a control device Depending on their chord-wise and span-wise extent vis a vis primary vortex, when deflected, the flaps alter the vortex flow as well as the inboard attached flow on the wing. This leads to early vortex breakdown, which directly influences the basic aerodynamic characteristics of the configuration. To investigate the effect of these parameters a flat plate, cropped 60° delta wing body with sharp leading edge was fitted with part span flaps with three different types of geometries. Areas of all these flaps are kept constant around 13.5 cm^2. These tests were conducted in the 0.6 m transonic wind tunnel at N.A.L in the Mach Numbers range of 0.3 to 1.2 and through incidence range of –4° to 20°. The flaps were deflected through 0°to 25° in step of 5°. Force and moments were measured, surface flow visualization tests using oil flow were also conducted. This paper presents results on rectangular plan form flaps/elevons on the delta wing at three flap deflections 5°, 15° and 25°. Results show that vortex breakdown is induced due to flap deflection, resulting in mild to severe pitch up depending on angle of attack, geometry of the flap and Mach number.

W-2D-2. INVERSE DESIGN OF 2D DUCTS USING FLEXIBLE STRING ALGORITHM

M. Nili. A, *Sharif University*, *Iran*, M. DURALI, *Sharif University*, *Iran*, A. HAJILOUY, *Sharif University*, *Iran,* F. GHADAK, *Emam Hossein University, Iran,* The duct inverse design in fluid flow problems usually involves finding the wall shape associated with a prescribed distribution of wall pressure or velocity. In this investigation, an iterative inverse design method for 2D ducts with incompressible flow is presented. In the proposed method, the duct walls shape is changed under an algorithm based on deformation of a virtual flexible string in flow. The deformation of the string due to the local flow conditions resulting from changes in wall geometry is observed until the target shape satisfying the prescribed walls pressure distribution is reached. At each iteration step, the difference between current and target wall pressure distributions is applied to the string. The flow field at each step is analyzed using Navier-Stokes equations and collocated solution method. The method is quick converging and can utilize commercial flow analysis software easily and efficiently.

W-2D-3. A STEP FORWARD IN STEALTH TECHNOLOGY – THEORATICAL INVESTIGATION OF PRESSURE DIFFERENTIAL ANGLE OF ATTACK MEASURING SYSTEM

U. N. MUGHAL, *Department of Mechanical Engineering, NED UET, Karachi, Parkistan,* J. MASUD*, Institute of Avionics & Aeronautics, Air University, Islamabad, Pakistan,* This paper is towards identifying the location to install Flush Port Air Data System (FADS) on various aerodynamic shapes which is typically used on Stealth Aircraft. ADS are required on aircraft as part of the flight control system which further require the addition of air data pressure sensors on exterior of aircraft to measure AOA. FADS systems have typically in excess of 10 pressure ports/sensors. Flush Port Pressure Sensors are symmetrically placed on the airframe. Pressure measured at each port varies as airframe manoeuvres. Pressure differences, ΔP between symmetrical ports correspond to changes in angle of attack. Pressure data is derived from wind tunnel and flight tests. The air data computation routines in the FCC then determine AOA and various other parameters. Potential flow theory is used for the analysis of aerodynamic shapes e.g. rankine half body, cylinders, wedges and aerofoil. Various locations on aerospace vehicles can be locally approximated by these simple shapes. These flow patterns are simulated in MatLab to calculate the non-dimensialized ΔP variation w.r.t AOA. These ΔP variations are then compared with one another to check whether the front part of these surfaces correspond to the same non dimensialized ΔP or not. On the basis of this, the location to install the Pressure Differential Angle of Attack measuring instrument is suggested. It is concluded from the Non-Dimensialized ΔP Curves w.r.t AOA on different aerodynamic bodies at different Mach Numbers that, ΔP varies linearly with AOA on all bodies & Non Dimensialized ΔP w.r.t P_o-P gives most favourable results.

W-2D-4. PHASE-LOCKED PIV STUDIES ON AN OSCILLATING AIRFOIL

R. MUKUND, L. VENKATAKRISHNAN and K. T. MADHAVAN*, Experimental Aerodynamics Division, National Aerospace Laboratories, India,* The study of oscillating airfoils is of interest in order to gain a deeper understanding of the unsteady flow aerodynamics present in such flows as well as the dynamic stall mechanism occurring at high incidence angles of the airfoil. Flow field measurements were conducted using phase locked 2D PIV on an oscillating airfoil at low speeds. The measurements were made at different phase angles during both up stroke and down stroke of the airfoil yielding statistically significant number of velocity fields. The phase-averaged velocity field clearly shows the formation of the dynamic vortex, its growth and its shedding. An interesting feature is that the measurements reveal a secondary vortex at the maximum angle. The spatial correlation of vorticity was calculated from the phase-averaged velocity field data and the results show strong negative correlation with the reference point which decreases with increasing incidence up to the maximum angle and reappears during the down stroke. The reappearance of the ensemble-averaged correlation in the separated region indicates that the flow field is not totally irreproducible as was indicated by earlier studies.

10:40 ~ 12:00 (Room105)

Geophysical Fluid Dynamics (I)

Session Chair : Prof. N. Sekishita, Toyohashi Univ of Tech/Japan

W-2E-1. WIND RESOURCE ASSESSMENT OF THE ANTARCTIC KING SEJONG STATION BY COMPUTATIONAL FLOW ANALYSIS

S. W. KIM, *KIER, Korea Institute of Energy Research, Korea*, H. G. KIM, *KIER, Korea,* It was 17 February 1988 when the King Sejong Station (62º13'S, 58º47'W) located in Barton Peninsular, King George Island commenced to function as a permanent research station for Korea Antarctic Research Program. According to the Protocol on Environmental Protection to the Antarctic Treaty known as the Madrid Protocol, many Antarctic stations are actively accommodating a wind power system. In fact, most stations are heavily depending on fossil fuel use for power production, but it would contaminate the environment by oil spill, soil pollution and exhaust gas. In this regard, renewable energy such as wind and solar could be a practical alternative at the Antarctic. KIER (Korea Institute of Energy Research) has performed wind resource micrositing around the met-masts in 2005 and has installed an 10kW wind turbine in February 2006. The wind turbine has been successfully operated and produced about 32MWh of electricity so far. At the beginning of the project, the wind turbine was planned to install near by the wharf but the site was moved during the detail engineering to near the warehouse, which was about 625m away from the main building of the station along the costal line in east. The previous candidate site near the wharf was too close to the oil tanks so that it could be a great danger, especially in a winter season because of icing on blades. Ice on rotor blade would subsequently be thrown away during operation with high speed and it could damage the fuel tanks. The current location of the wind turbine has different geographic surroundings from the previous candidate site considered in 2005 and that makes re-evaluation of wind resource at the current site including geographic effects necessary. Especially, strong wind flow derived by steep and complex terrain is dominant in the Antarctica so that CFA(Computational Flow Analysis) is required. In this study, CFA based micrositing software, WindSim is employed and a grid system of 140x130x25 covering 5km x 5km area is used after testing grid dependency. The wind rose measured at the previous and current installation location are identical with strong meteorological correlation but prevailing directions of wind power density are different because of local wind acceleration due to complex terrain. Numerical analysis explains which effects bring this discordance between the two sites, and a design guideline required for additional wind turbine installation has been secured.

W-2E-2. WIND ACCELERATION PROCESS IN THE DUNE FIELD MODEL

BO Tianli, ZHU Wei, ZHENG Xiaojing, *Key Laboratory of Mechanics on Western Disaster and Environment, Lanzhou University, China,* A modification of existing dune field model with particular emphasis on the influence of the windward slope on the wind acceleration process in dune's windward side will be proposed in terms of the variance of windward slope with dune height, and the effect of wind speed on the thickness and transport length of sand slabs in the dune field model. In the existing model, the wind speed-up factor is introduced as a function of migration speed of