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AEROELASTIC ANALYSIS OF MOVING BLADE

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Abstract - *This research focuses on fluid-structure interaction (FSI), a popular numerical computation and simulation topic. FSI play an important role in a variety of engineering and scientific fields, but because to their transdisciplinary nature and strong non-linear behaviour, studying them remains difficult. When a unsolidified collides with a compacted construction, it applies compression on it, causing the structure to deform. In turn, the buckled figure has an effect on the flow field. The cyclic nature of the stirring watery causes a varied outline of strains on the construction.*

The FSI analysis was be in charge on a moving blade of a wind turbine in this project. Theinvestigation was successful because to the separation method, which used two types of interaction to simulate fluid-structural interactions. By using ANSYS APDL, the relevant calculation of the fluid and structural model can be obtained. As a pre-processing technique, transient structural and CFD fluent are used to perfect the full field of computational and volume mesh. The physical dynamic reaction of a structure under unsteady fluid pressure stresses is formed using ANSYS Mechanical (transient structural). The two software (ANSYS Fluent and Mechanical) are linked (data exchange) in ANSYS Workbench utilising System Coupling. A modal analysis was helpful in determining the dynamic reaction of a construct

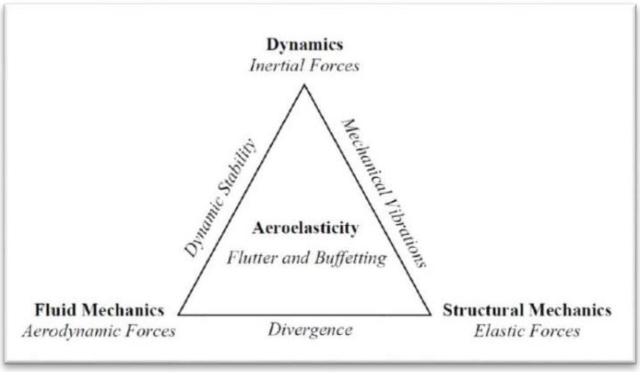
1. INTRODUCTION

We may deduce from the literature review that blade life is influenced by structural characteristics as well as fluid flow distribution. Blade life has been diminished due to high vibrations caused by air flow dispersion over it. The life of the supporting blade structure hasbeen reduced as a result of varied mode forms that evolve at different frequencies. Due to thevaried mode forms, the structures near the blade root will be subjected to extremely high amounts of stress. When we investigate the structure of the blade while assuming constant loads, we will notice a difference in stresses. The load will not be distributed evenly across the blade construction.

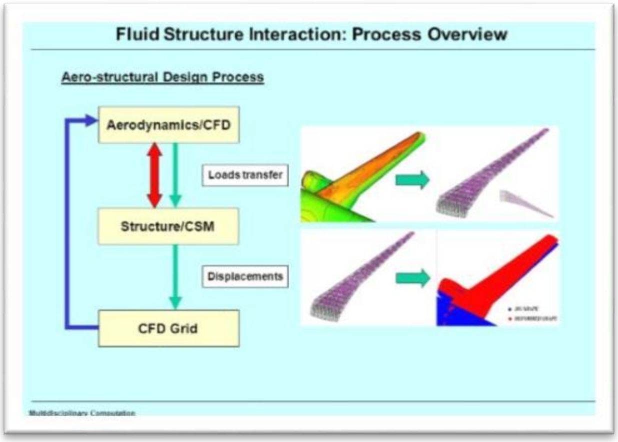
Loads will vary based on the pressure distribution over the blade due to the high-speed air flow. FSI plays a vital part in the complicated realm of multiphysics phenomena. The fundamental processes of interaction between fluid and solid structures create a variety of obstacles, therefore the true representative in FSI requires completely coupled numerical modelling. Bridges under high winds, structural strain and distortion in turbine blades, and aircraft wings are all well-known examples of dynamic instability in structural engineering. Several traditional FSI trials gradually simplify either the fluid or structural side, resulting in design accuracy that is insufficient. The advanced technique is based on the use of finite element formulations for solid structures and a finite volume model for fluids, which are the most well-developed and widely utilised techniques in their respective domains. On the other hand, there are substantial computational costs due to the necessity for global re-meshing at each time step, and challenges arise in particular with free surface flows or deformations superimposed on large rigid body motion on the structural side.

Starting with a broad overview of the problem situation and theoretical backdrop from both a solid and a fluid perspective, then moving on to the implementation and construction of a solution. To facilitate simulation and numerical analysis of coupled fluid structure problems, a mathematical model with an interface description is provided.

Aero elasticity (fig. 1) is the study of how elastic, inertial, and aerodynamic forces interact with an elastic construction bare to fluid flow. The distortion is frequently believed to be minimal in classical elasticity theory, and the often ignored the dimension change, and measurements are made on the foundation of the initial figure. Furthermore, in the case of aeroelasticity, the situation is different. Because distortion is included in the measurement, elastic distortion plays an essential part in the measurement of external force in this scenario. Aero elasticity has a significant role in blade .



When the fluid's movement impacts the solid structure while the fluid's flow is impacted by the solid structure, two-way coupling is applied.. Fig.4 demonstrates an efficient two-way coupling system's workflow. During the first stage, the converged fluid solution acquires forces applied to the solid structure. The resulting forces are then interpolated to the structural



2. METHODOLOGY

This section contains a brief description of the approach that was utilised to conduct the analysis. For both the fluid and structural domains, a geometry model with appropriate dimensions is first built. ANSYS Fluent is used to construct the meshes of surface and volume

the fluid domain, and ANSYS APDL script [8] is cast-off to produce the finite element mesh. In terms of mesh dimension and cell type, the two computation meshes differ from one another. Now, these two distinct meshes are put into their respective numerical solvers, where simulation phases begin with model setup.. Actions such as applying material attributes, boundary conditions, and the numerical scheme are all part of the simulation process. After completion of the simulation setup, two solvers are connected via system coupling to communicate the data.

Table -1: Shear web material definition.

Layer#	Material	Thickness
1	Triaxial Fabric	0.89 mm
2	Balsa	1.0% c
3	Triaxial Fabric	0.89 m

3. CONCLUSIONS

We came at the following conclusions after doing the 2-way fluid construction combination on the blade of wind tubine:

- The overall distortion contours in fig.21 and fig.25 reveal that the blade tip has the greatest amount of deflection. the overall distortion value gradually increases from blade root to tip.
- The corresponding stress outline in fig.22 and fig.26 reveal that stress greatest value is 26.7MPa at the blade root.
- There is an aerodynamic load at a particular velocity, causes stress on the construction. Because the supplied velocity is opposite the flank velocity, the oscillatory motion is dampenedby aeroelastic damping.

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