JUACEP Special Lecture <1>

By Prof. Shaker Meguid, University of Toronto

Containment of Blade Shedding in Aviation Gas Turbine Engines

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Abstract

Blades are used in fan disks, compressors and turbines to carry out specific functions. Of particular interest to this investigation is the release of the fan blades from the disc because of their exposure to damage. This damage is caused by ingested foreign objects, very high thermo-mechanical loads as well as fatigue failure and poor maintenance practices. The release of one of the blades in gas turbine engines, commonly referred to as blade shedding or blade out, is one of the most serious safety hazards for engine manufacturers. Strict design requirements are imposed by aviation authorities to ensure the safety of the engine and the aircraft in the event of blade shedding. Despite these requirements, accidents resulting from blade shedding remain a challenge to gas turbine engine manufacturers to date, indicating the need for further research and development in this area. In this presentation, Meguid will outline the background for blade shedding, the design of a scaled down instrumented test rig (Fig. 1) to validate the significant numerical work conducted in blade shedding and a proposed blade containment strategy.

Keywords: blade shedding, 3D printing, scaled down design, dimensional analysis, imaging, sensory, instrumentation, finite element simulations and containment.

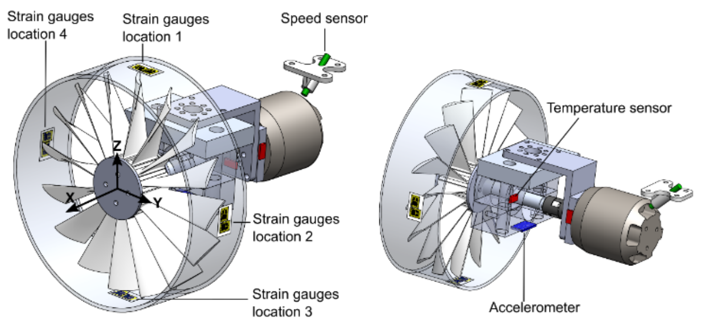

Fig. 1 Locations of different sensors in novel test rig

Nonlinear multibody dynamics and finite element modeling of occupant response to vehicle collision

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Abstract

With the dramatic rise in vehicle ownership, there is an urgent need to reduce the risk of injury among vehicle occupants that arises from vehicle collisions. This is important to occupants, insurers, manufacturers and policy makers alike. The human head and neck are of special interest, due to their vulnerable nature and the severity of potential injury in these collisions leading. In this presentation, Meguid will focus his attention on modeling vehicle collisions that could lead to whiplash. Specifically, two multibody dynamics (MBD) models of the cervical spine of the 50th percentile male are developed using realistic geometries, accelerations and biofidelic variable intervertebral rotational stiffness. Furthermore, nonlinear finite element (FE) simulations of a generic compact sedan vehicle subject to different collision scenario are performed. Using the acceleration profiles measured at the driver's seat of the colliding vehicles, FE simulations of a seated and restrained numerical occupant (Fig. 1) in vehicle collisions were performed to determine the occupant response. The resultant accelerations, measured at the T1 vertebra of the occupant model, were used as an input to the MBD models to obtain their kinematic response. Validation of the MBD models shows great agreement with experimentally published data. Comparison between the MBD and FE simulations for a 32 km/h vehicle-to-vehicle impact shows similar trends in head trajectory. However, the MBD models reported less peak head displacements compared to the FE model. This is attributed to the failure of the anterior longitudinal ligament at the mid cervical spine leading to increased intervertebral rotation in the FE model. Meguid will also address crash management systems and strategies in car safety.

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