World Academy of Science, Engineering and Technology
International Journal of Aerospace and Mechanical Engineering
Vol:11, No:01, 2017

Modelling of a Biomechanical Vertebral System for Seat Ejection in Aircrafts Using Lumped Mass Approach

Authors : R. Unnikrishnan, K. Shankar

Abstract : In the case of high-speed fighter aircrafts, seat ejection is designed mainly for the safety of the pilot in case of an emergency. Strong windblast due to the high velocity of flight is one main difficulty in clearing the tail of the aircraft. Excessive G-forces generated, immobilizes the pilot from escape. In most of the cases, seats are ejected out of the aircrafts by explosives or by rocket motors attached to the bottom of the seat. Ejection forces are primarily in the vertical direction with the objective of attaining the maximum possible velocity in a specified period of time. The safe ejection parameters are studied to estimate the critical time of ejection for various geometries and velocities of flight. An equivalent analytical 2-dimensional biomechanical model of the human spine has been modelled consisting of vertebrae and intervertebral discs with a lumped mass approach. The 24 vertebrae, which consists of the cervical, thoracic and lumbar regions, in addition to the head mass and the pelvis has been designed as 26 rigid structures and the intervertebral discs are assumed as 25 flexible joint structures. The rigid structures are modelled as mass elements and the flexible joints as spring and damper elements. Here, the motions are restricted only in the mid-sagittal plane to form a 26 degree of freedom system. The equations of motions are derived for translational movement of the spinal column. An ejection force with a linearly increasing acceleration profile is applied as vertical base excitation on to the pelvis. The dynamic vibrational response of each vertebra in time-domain is estimated.

Keywords : biomechanical model, lumped mass, seat ejection, vibrational response
Conference Title : ICAMAME 2017 : International Conference on Aerospace, Mechanical, Automotive and Materials Engineering
Conference Location : London, United Kingdom
Conference Dates : January 19-20, 2017