FINITE ELEMENT ANALYSIS OF IMPACTS ON SOFT SOIL AND ITS APPLICATION TO AIRCRAFT CRASHWORTHINESS AND OCCUPANT SAFETY

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ABSTRACT

The current crashworthiness design criteria only address crash impacts on rigid surfaces. However, accident statistics indicate that up to 80 percent of civil and military aircraft crashes occur on soft soil and water. There is very little data on crash impacts on soft soil. The development of the soil model is an important issue in soil impact simulation and vehicle/aircraft crashworthiness. In this thesis, a finite element model of soil is developed. The soil model is validated using the actual test data available. The sphere and cone test vehicles were modeled using MSC.Patran software. The aluminum impactor is modeled using the Belytschko-Lin- Tsay four node shell elements. There is close agreement between experimental and analytical results of the drop tests. A finite element model of an airplane is generated and is used for the simulation of airplane impact on soft soil. An actual crash test of airplane will be simulated using a model having identical mass of the actual airplane impacting the developed soil model at predetermined test velocity and angles. The development of soil model and also the simulation of crash impacts are conducted using non-linear finite element analysis code LS-DYNA. The soil was modeled using solid elements and the aircraft model had shell elements. A Master-slave contact algorithm was used for the impact. Appropriate data were used to simulate the soil eroding effect. The entire fuselage was badly damaged and the tail also got crushed. Finally the response of an occupant for the above crash test is analyzed using the MADYMO code and utilizing accelerations developed in the airplane model. The lumbar load, most crucial mode of injury in these types of crash, was above the safe limit of 1500 pounds for this aircraft model.