

# DESIGN AND EVALUATION OF CHILD RESTRAINT SYSTEMS USING LATCH IN FORWARD FACING UPRIGHT CONFIGURATION

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## ABSTRACT

Studies conducted at the National Highway Transport Safety Authority (NHTSA) and at the Federal Aviation Administration's (FAA) Civil Aeromedical Institute (CAMI) have shown that when used in automobiles or in aircrafts, Child Restraint Systems (CRS) do not always provide the level of safety desired. The need to provide and improve crash protection system for children traveling in automobiles is the subject of much interest and research. The National Highway Transport Safety Authority is responsible for developing certification criteria for both cars and aircrafts. Children traveling in automobiles experience different dynamic responses during a crash. Even though children are restrained securely in an automobile, they still are subjected to many injuries due to poor performance of seat belt anchor location, cushion stiffness, child seat design, and child seat positioning systems used. Therefore, there is a lot of scope for improvement in the design of Child Restraint Systems in automobiles so that they are safer for children.

An analytical model of a CRS has been developed in this study for modeling the dynamic responses in a crash scenario. This analytical model is used to validate sled test data and the model is used for study of occupant biodynamic responses in automobile environments. Occupant simulations are studied for a standard child seat restrained with Anchorage Belt System at variable speeds. These studies are conducted for Forward Facing Upright configuration (FFU). The standard child seat is redesigned and occupant kinematics is studied for CRS restrained with Rigid Latch Belt System positioned in FFU configuration at variable speeds. Parametric studies are then conducted that used the redesigned CRS model to investigate the effect of rigid latch belt system in order to improve the chances of survivability of the occupant in the event of crash at variable speeds.

The study shows that at higher speeds the standard CRS tends to move forward resulting in severe injuries to the child occupant. At higher speeds when the modified CRS is restrained using the new LATCH system, the level of injury severity is low and the injury parameter values are within limits. This investigation is extended to the aircraft environment and the standard CRS is restrained using the new LATCH system on a standard aircraft seat. Occupant simulations were studied for CRS restrained on a standard aircraft seat. These studies were conducted for forward facing upright configuration. The standard CRS seat was redesigned and is restrained using the new LATCH system on an aircraft seat.

Parametric studies were conducted so as to improve the chances of survivability of the occupant in the event of a crash. The study shows that in the event of crash in aircraft environments the standard CRS tends to move forward resulting in severe injuries to the child occupant. When the modified CRS is restrained using the new LATCH system, the level of injury severity is low and the injury parameter values are within the standard limits for both automobile and aircraft environments.