The Design and Evaluation of Reinforcement Structures for Bus Frame

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ABSTRACT

A rollover event is one of the most crucial hazards for the safety of passengers and bus drivers. In past years it was observed that the deforming body structure seriously threatened passengers ’ lives. During the recent years the increasing number of fatal bus accidents with tragic consequences for passengers showed the importance of passive safety in addition to the driver ’s competence and active safety. In the European countries the certification of sufficient deformation strength when overturning is compulsory fo the approval of a bus according to the ECE R66 （Economic Commission for Europe， ECE） regulation. The certification is granted often positive results from crash tests or computer simulation with partial or full bus structure. The ECE R66 regulation defines a residual space for the passengers which must remain intact often the accident. The test specifies either the overturning of the vehicle structure from a tilting platform or it would correspond to the crash of the structure when falling onto the ground. Since such tests with real vehicle structures are costly and computer efficiency, on the other hand, is becoming increasingly better and cheaper, crash simulation will play a more important role for the approval in the future. In order to increase stiffness and decrease the stress concertration of bus frame. This study divided the bus superstructure into three parts: top roof, side pilla, bottom frame and built the database by searching the reinforcements of aircraft, ship and vehicle. At first, the verification of the calculation procedure following regulation ECE R66 was performed. Three separate specimens were prepared for experimental investigation at ARTC (Automotive research & Testing Center). These parts were subjected to specific boundary conditions and quasi-static loads at ARTC testing facility. The same test scenarios were simulated by using LS-DYNA. Force-deflection curves both for the experimental and simulations were compared, and it was observed that these were good correlation between experiment and simulation. The verification by calculation is a compulsory requirement of the regulation, as it is the technical service ’s responsibility to verify the assumption used in the numerical analysis. After that, ARTC test method of reinforcement of bus was applied to analyze and evaluate the efficiency of reinforcements. At last, the suitable reinforcement for three parts of bus superstructure were applied to the body section and complete bus structure for the computer simulation of bus rollover test. Thereforce, the non-linear LS-DYNA 3D was used to simulate the body section and complete bus rollover test according ti the Europen regulation ECE R66. These suitable reinforcements were applied to the body section and complete bus finite element model. The results show that using the filling reinforcement of top roof will improve the collapse due to the rollover; by using the patching reinforcement of side pillar will be against the bending force during the rollover; on the other hand using the filling reinforcement of bottom frame will decrease the stress concentration and rise the plastic hinge zone so that improve the situation of intruding into the residual space during the test.These calculations shall serve as a preparation for future calculations to obtain the necessary certification. This research can provide useful guidelines for researchers and bus manufacturers to study or design bus structure, raise the bus safety, and reduce occupant injuries and fatalities.

Keywords : bus, rollover, ECE R66, reinforcement, filling, patching.

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