Numerical Simulation of Rollover Test on Complete Vehicle Considering the Effects of Welding Joints

何宏瑋、梁卓中

E-mail: 9707437@mail.dyu.edu.tw

ABSTRACT

Buses are the high loading capacity transportation on the road. When a major accident happened, the passengers would be serious injury. When a rollover accident of a bus happened, the damage often occurred in the weld zone. For passengers ’ safety, the design of superstructure of the bus should consider the weld zone which would affect the strength of a bus rollover accident. From the previous numerical analysis, the weld zone often idealistic assemble at an concurrent way. But those analysis did not account of the effects of welding. This paper adopted nonlinear software LS-DYNA to study the rollover strength of bus. At first, this paper added the failure criteria of both fillet welding and butt welding to the extrusion simulation analysis of a bus frame structure. Then compared the difference with the result of idealistic assemble at concurrent way. The result densely match with the previous experiment which considered welding. The elongation which the weld zone of roof structure failure is only 7.4% different from the previous experiment. The elongation which the weld zone of pillar structure failure is only 3.7% different from the previous experiment. The weld zone of bottom did not failure, so the result of numerical analysis is match with the previous experiment. Secondly, this paper based on the regulation, ECE R66(Economic Commission for Europe), to establish a computer simulation of bus rollover test, and used a certain type of Europe bus to study the effect of both the concur rant and the welding failure. Meanwhile, this paper tested whether the Europe bus is match the ECE R66. The result showed that the finite element model of the ideal concurrent way can absorbed energy due to the stiffer structure. When considering the finite element model of the welding effect, due to the failure criteria, the mechanical behavior is more closer to the actual situation. Also, the result showed that both the concurrent and the welding did not pass the regulation ECE R66. Finally, this paper adopted two common size of pipe, 40mm ×80mm×3mm and 60mm×40mm×3mm, to study The different impact on structure strength when using different size of ring cross-section. The result showed that the 40mm×80mm×3mm pipe of bus ’s ring could pass regulation ECE R66, and the pipe only increased 7.17% of the overall weight. This paper adopted computer simulation which used on equivalent approval method to do the rollover test on complete vehicle. Due to consider the welding failure, the result of this paper is close to the reality. This paper can provide a reference for the bus manufactory to do future manufacturing and design.

Keywords : Bus, Rollover, ECE R66, Fillet, Butt.

Table of Contents

REFERENCES

[1] 行政院交通部， http://www.motc.gov.tw/ [2] 內政部警政署， http://www.npa.gov.tw [3] FARS Web-Based Encyclopedia

http://www-fars.nhtsa.dot.gov/ [4] UNECE， http://www.unece.org/ [5] NHTSA， http://www.nhtsa.dot.gov [6] T. Roca, J. Arbiol and S. Ruiz,“ Development of rollover – resistance bus structures ”, Society of Automotive Engineers, 970581 (1997).
[7] M. Matolcsy,“ Development Possibilities in Relation to ECE Regulation 66 (Bus Rollover Protection) ”, The 16th International Technical Conference on the Enhanced Safety of Vehicles (ESV), Paper Number:98-S4-O-04 (1998).
[8] S. Vincze,“ European Test Methods for Superstructures of Buses and Coaches Related to ECE R66(The Applied Hungarian Calculation Method) ”, The 16th International Technical Conference on the Enhanced Safety of Vehicles (ESV), Paper Number:98-S4-P-18 (1998).
[9] James C. Anderson,“ Rollover Crashworthiness of a New Coach Structure ” Society of Automotive Engineers, 2000-01-3520 (2000).
[10] Luis Castejon, Jesus Cuartero, Antonio Miravete and Marco Carrera Carrera“ Simulation and Testing of Composite Buses Roll over ” SAE 2004-01-0741 (2004).
[11] Wolfgang Schwartz,“ Simulations with LS-DYNA for Registration Approval of a Coach according to ECE R66 Regulation ” International Congress on FEM Technology with ANSYS CFX & ICEM CFD Conference(2004).
[12] 吳昌明，“ 大客車車身結構之翻覆強度分析 ”，大葉大學車輛工程研究所碩士班畢業論文，2004。
[13] 梁卓中，林育正，吳昌明，“ 歐規ECE R66大客車車身段翻覆試驗之數值模擬 ”，第二十一屆全國學術研會論文集，pp.3269-3274，2004。
[14] 梁卓中，黃朝琴，吳昌明，張瑞宏，“ 歐規ECE R66大客車車身段擺錘碰撞試驗之數值模擬 ”，第二十一屆全國學術研會論文集，pp.3275-3280，2004。
[15] 梁卓中，粘鴻祺，蔡易修，“ 美規FMVSS 220校車車頂擠壓試驗之數值模擬 ”，第二十一屆全國學術研會論文集，pp.3281-3285，2004。
[16] 梁卓中，蔡易修，粘鴻祺，“ 大客車門窗開口對強度之影響及設計建議 ”，車輛研究資訊雙月刊，pp.2-7，2005-03。
[17] 張瑞宏，“ 提升大客車車體結構強度之研究 ”，大葉大學車輛工程研究所碩士班畢業論文，2005。
[18] Su-Jin Par, Yuen-Ju Kwon, Hyun-Woo Kimand Wan-Suk Yoo“ OMPARISON OF BEAM MODEL AND SHELL MODEL FOR ROLLOVER SIMULATION OF BUS WITH THE LS-DYNA PROGRAM ” Proceedings of ACMD06(2006) Paper Number:A00654.
[19] 范志銘，“ 國內傾斜穩定度法規檢測制度建立研究 ”，經濟部八十八年度科技研究發展專案計畫技術報告，1999。
[20] Yu-Cheng Lin and Hong-CHi Nian,“ Structural Design Optimization of the Body Section Using the Finite Element Method ” Society of Automotive Engineers, 2006-01-0954 (2006).
[21] 邱筱婷，“ 大客車骨架結構補強型式之設計與評估 ”，大葉大學機械工程研究所碩士班畢業論文，2006。
[22] Savaidis ”Hot-Spot Stress Evaluation of Fatigue in Welded Structural Connections Supported By Finite Element Analysis ” International Journal of Fatigue 22. 85-91 (2000).
[23] Zhang“ Optimization of Spot-Welded Structures ” Finite Element in Analysis and Design 37. 1013-1022(2001).
[24] P. Dong“ A structural stress definition and numerical implementation for fatigue analysis of welded joints ” International Journal of Fatigue 23. 865 – 876 (2001).
[25] S. Xu, X. Deng“ An evaluation of simplified finite element models for spot-weld joints ” Finite Element in Analysis and Design 40. 1175-1194 (2004).
[26] 周荻翔，蔡顯榮，蔡宗亮，毛慶平，“ 建立大客車骨架結構焊接規範 ”，第11屆車輛工程學術研討會，2006。
[27] Cem Topkaya“ Block shear failure of gusset plates with welded connections ”Engineering Structures 29. 11 – 20 (2007).
[28] Dean Deng , Wei Liang , Hidekazu Murakawa“ Determination of welding deformation in fillet-welded joint by means of numerical simulation and comparison with experimental measurements ” Journal of Materials Processing Technology 183. 219 – 225 (2007).
[29] 財團法人車輛研究測試中心，大客車設計應用技術研討會，2004， http://www.artc.org.tw/。
[30] LS-DYNA THEORETICAL MANUAL,1998.
[31] LS-DYNA KEYWORD USE ’ S MANUAL,V970,2003.
[32] 周長彬，蔡丕椿，郭央諶“ 焊接學 ”全華科技圖書股份有限公司，1993。
[33] 胡惠文，陳永昌，王?村，楊忠霖，“ 大客車車體結構焊接之模擬與分 ”，第11屆車輛工程學術研討會，2006。