Design of Seat to Prevent Neck Injury in Rear Impact

陳宥霖、鄧作樑

E-mail: 9806429@mail.dyu.edu.tw

ABSTRACT

Rear impact accidents can cause serious injuries to the neck because of that the vehicle seat cannot provide needed support when occupant move backward and may result in whiplash injury. It causes the neck contusion due to the movement of cervical vertebrae. Seat is a main part of vehicle to contact with occupant in rear impact and chiefly concern with the severity of neck injuries. Therefore, improvement in seat design can effectively reduce the neck injuries of occupant. To enhance the occupant safety, this paper designs a seat to prevent neck injuries in a rear impact. The sled test is used to assess the effectiveness and safety of improvement in seat design. The sled test is implemented by computer simulation for taking into consideration required cost and time. First of all, the numerical model of sled test is developed by using MADYMO software. In order to confirm the accuracy of numerical model, results of dummy injury are compared with experimental tests from the literature. For designing an effective vehicle seat to protect occupant, this study discusses the relevance between the seat parameters and occupant ’s neck based on the validated numerical model. The seat parameters include the stiffness of automobile seat recliner, seat friction and angle of head restraint. Finally, improvement in seat design is implemented based on the factors influencing neck injuries of occupant. Owing to the back of the seat and head restraint move backward together, a larger velocity and acceleration variance of the head and neck is induced during the collision process. Therefore, this study proposes a concluding of seat design which is a concept of separate head restraint from seat back. In addition, the neck injuries of dummy are calculated using with sled test simulation to confirm the safety of seat design. The sled test numerical model which is developed and validated in this study can be assisted to evaluate the effectiveness of other passive safety devices. The discussion of influencing factors of seat and design of separate type seat also can be referred by research institution and industry to enhance the occupant safety in rear impact accidents.

Keywords : Rear Impact、Neck Injury、Separate Type Seat

Table of Contents

REFERENCES

[1]行政院內政部警政署: http://nweb.npa.gov.tw[2]NHTSA,“ Traffic Safety Facts ”, 2005.
[3]NHTSA,“ Final Regulatory Impact Analysis,FMVSS No.202 Head Restraint for Passenger Vehicles ”, Docket 1987-1, 2004.
[4]NHTSA,“ Head Reatraints-Identification of Issue Relevant to Regulation, Design, and Effectiveness ”, U.S. Department of Transportation Docket 96-22, 1996.
[5]IIHS,“ Specical issue:neck injures in rear-end crashes ”, Status Report 34（5）, 1999.
[6]Crowe, H.E.,“ Injuries of the Cervical Spine ”, Western Orthopaedic Association, 1928.
[7]Severy, D.M., Brink, H.M. and Baird, J.D.,“ Backrest and head restraint design for rear-end collision protection ”, SAE Paper No.680079, 1968.
[8]Charles, E.S. and Michael, B.J.,“ Evaluation of Seat Back Strength and Seat Belt Effectiveness in Rear End Impacts ”, SAE Paper No.872214, 1987.
[9]Mats, Y.S., Per, L., Yngve, H. and Stefan, L.,“ The Influence of Seat-Back and Head-Restraint Properties on the Head-Neck Motion During Rear-Impact ”, Accident; Analysis and Prevention, Vol.28, NO.2, pp.221-227, 1996.
[10]Lundell, B., Jakobsson, L. and Alfredsson, B.,“ The WHIPS Seat - A Car Seat for Improved Protection Against Neck Injuries ”, Proc. 16th ESV Conference, Paper No.98-S7-O-08, 1998.
[11]Roy, M., Murray, P.A., Pitcher, M. and Galasko, C.S.B.,“ Lower Back and Neck Strain Injuries: The Relative Roles of Seat Adjustment and Vehicle Seat Design ”, Transport Research Laboratory, Paper No.98-S6-W-29, 1998.
[12]Makoto, S.,“ Seat Designs for Whiplash Injury Lessening ”, SAE Paper No.98-S7-O-06, 1998.
[13]Kleinberger, M., Sun, E., Saunders, J., Zhou, Z.,“ Effects of Head Restraint Position on Neck Injury in Rear Impact ” Traffic Safety and Auto Engineering Stream of the Whiplash-Associated Disorders World Congress, pp.7-11, 1999.
[14]Bhavin, V.M., Prasad, P. and Pobert, W.II,“ Importance of Seat and Head Restraint Positions in Reducing Head-Neck Injuries ”, SAE paper No.2001-01-2659, 2001.
[15]Lawrence, M., Siegmund, P.,“ Seat back and head restraint response during low-speed rear-end automobile collisions ”, Accident Analysis and Prevention 32., pp.219-232, 2000.
[16]Cappon, H., Philippens, M., Ratingen, M. van, Wismans, J.,“ Development and Evalution of a new Rear-Impact Crash Dummy:the RID2 ”, Stapp Car Crash Journal, Vol. 45, 2001.
[17]Kim, A., Anderson, K.F., Berliner, J., Bryzik, C., Hassan, J., Jensen, J., Kendall, M., Mertz, H.J., Morrow, T., Rao, A. and Wozniak, J.A.,“ A Comparison of the Hybrid III and BioRID II Dummies in Low-Severity, Rear-Impact Sled Tests ”, Stapp Car Crash Journal, Vol. 45, 2001.

[18]Zellmer, H., Stamm, M., Seidenschwang, A.,“ Enhancement of Seat Performance in Low-Speed Rear Impact ”, Winterthur Insurance Corp., Dep. of Accident Research, Winterthur, Switzerland Document No.231, 2001.
[19]楊秉文，車禍事故中人體頭頸部之損傷分析，碩士論文，國防大學中正理工學院兵器系統工程研究所，桃園，2002。
[20]Schmitt, K.U., Muser, M., Heggendorn, M., Niederer, P. and Walz, F.,“ Seat Component to Prevent Whiplash Injury ”, ETH Paper No. 224, 2003.
[21]Viano, D.C.,“ Seat Influences on Female Neck Responses in Rear Crashes:A Reason Why Women Have Higher Whiplash Rate ”, Traffic Injury Prevention 4, pp.228-239, 2003.
[22]Voo, L., Merkle, A., Wright, J. and Kleinberger, M.,“ Effect of Head-Restraint Rigidity on Whiplash Injury Risk ”, SAE paper No.2004-01-0332, 2004.
[23]Kaneko, N., Wakamatsu, M., Fukushima, M. and Ogawa, S.,“ Study of BioRID II Sled Testing and MADYMO Simulation to Seek the Optimized Seat Characteristics to Reduce Whiplash Injury ”, SAE paper No.2004-01-0336, 2004.
[24]Zou, R., Grzebieta, R., Richardson, S.,“ Rear Seated Occupant in Frontal Impacts ”, Proc. 19th ESV Conference, Paper No.05-0230-O, 2005.
[25]Wang, P., Zhang, L. and Xu, L.,“ Study on Effect of Crura Constraint to Whiplash in Rear End Collision ”, Proceedings of the 4th MADYMO China Users’ Meeting, Paper No.2008-16, 2008.
[26]安全專有名詞字典: http://www.iosh.gov.tw/data/f18/safedic_a.htm[27]Bostrom, O., Svensson, M., Aldman, H., Hansson, H., Haland, Y., Lovsund, P., Seeman, T., Suneson, A., Saljo, A., Ortengren, T.,“ A New Neck Injury Criterion Candidate-Base on Injury Findings in the Cervical Spinal Ganglia after Experimental Neck Extension Trauma ”, International IRCOBI Conference on the Biomechanics of Impact, pp.123-136, 1996.
[28]Croft, A.C., Herring, P., Freeman, M.D., Haneline, M.T.,“ The Neck Injury Criterion:Future Considerations ”, Accident Analysis and Prevention 34, pp.247-255, 2002.
[29]MESSRING: http://www.messring.de/[30]NHTSA: http://www.nhtsa.dot.gov/[31]SeattleSafety: http://www.seattlesafety.com/newsletter/index.php[32] RCAR, IIWPG,“ RCAR-IIWPG Seat/Head Restraint Evalution Protocal, Version 2.5 ”, September 2006.
[33]IIWPG,“ IIWPG Protocol for the Dynamic Testing of Motor Vehicle Seats for Neck Injury Prevention ”, January 14, 2004.
[34]RCAR,“ A Procedure for Evaluating Motor Vehicle Head Restraints (Issue 3) ”, March 2008.
[35]Denton ATD, Inc: http://www.dentonatd.com/[36]Crash-Network: http://crash-network.com/Basic_Knowledge/BioRIDPaper.pdf[37]Bostrom, O., Haland, Y., Fredriksson, R., Svensson, M. and Mellander, H.,“ A Sled Test Procedure Proposal to Evaluate the Risk of Neck Injury in Low Speed Rear Impacts using a New Neck Injury Criterion (NIC) ”, 16th Conference on the Enhanced Safety of Vehicles, pp.1579-1585, 1998.
[38]MADYMO Theory Manual.
[39]許哲綱，正撞氣囊數值分析技術之建立，碩士?文，大葉大學機械工程研究所，2008。
[40]楊書銘，正撞衝擊測試?值模型之建?與分析，碩士?文，大?大學機械工程研究所，2004。
[41]MADYMO Model Manual.
[42]全原創專業汽車導購: http://www.che168.com/article/html/200903/20090302/20090302_235987_6.html[43]CAJ現代汽車: http://www.2456.com/trad/epub/details.asp?epubiid=1&id=6227[44]汽車制動網: http://www.chebrake.com/tech/othertech/2008/2/16/0821618582935361765.asp