車架結構之碰撞強度分析

劉俊宏、梁卓中

E-mail: 9126611@mail.dyu.edu.tw

摘 要

近年來世界各國政府與車廠積極研究車輛之安全設計，以期降低事故發生率與減少乘客傷亡。車輛安 全之研究領域，一般分成主動安全(ACTIVE SAFETY)與被動安全(PASSIVE SAFETY)兩種，而車架結構為被 動安全領域中車體結構中極其重要的部分，根據德國戴姆勒事故研究機構統計，一般事故中前撞發生率 最高約佔58%。因此本論文以前方正面碰撞為研究對象，並採用有限元素分析軟體MSC/DYTRAN 來進行車架 撞擊分析，首先以一空心圓管之軸向撞擊實驗以及PARVIS 之S形縱樑車架之撞擊研究，來評估軟體MSC /DYTRAN 之撞擊分析能力，其次進行階梯式車架、周邊式車架、桁架型車架之前方正面撞擊分析，以電腦 輔助分析軟體MSC/PATRAN 來建構車架有限元素模型， 再以MSC/DYTRAN 來研究車架之前方正面撞擊之變形 、能量吸收、速度、加速度之動態反應，期間並針對數值模擬所遭遇的困難點，加以探討。經由車架之撞 擊分析結果顯示某牌階梯式車架與某牌周邊式車架於碰撞後皆產生摺疊崩潰機構，並藉著折疊處吸收撞擊 能量及延長碰撞時間，某牌桁架型車架於碰撞後車架前段並無顯著變形，中間段有較嚴重之摺疊情形，影響 車中乘客之安全，以上分析結果期能做為未來車架設計之參考。

關鍵詞 : 前撞，階梯式車架，周邊式車架，桁架型車架，變形，能量吸收

目錄

參考文獻

[1] HTTP://WWW.NHTSA.GOV/ [2] RESELE, "SAFETY AND CRASH BEHAVIOR", DA-YEH INSTITUTE OF TECHNOLOGY, AE&ICE SERIES, VOL. 21.

[3] 王之政, 楊成宗, " 汽車碰撞原理與設計" , 全華科技圖書股份有限公司 [4] HTTP://WWW.GEOCITIES.COM/ [5] HTTP://WWW.MERCEDES-BENZ.COM.TW/ [6] HTTP://WWW.OSA.GO.JP/ [7] JAMES A. AUGUSTITUS, MOUNIR M. KAMAL, AND LARRY J. HOWELL,"DESIGN THROUGH ANALYSIS OF AN EXPERIMENTAL AUTOMOBILE STRUCTURE, " SAE PAPER NO. 770597, PP.2186-2198, (1977) [8] H. A. BROWNFIELD AND D. O. ROGERS, "ANALYSIS OF 30 MPH FRONTAL BARRIER UTILIZING HALF -SCALE METAL MODELS, " SAE PAPER NO. 780366, PP. 1738-1739, (1978) [9] W. A. ELLIOTT, D. E. MALEN, AND D. R. WHITTAKER, "MODELING LARGE DEFORMATIONS USING P -OLYCARBONATE SCALE MODEL, " SAE PAPER NO. 790701, PP. 2455-2464, (1979) [10] ABDULLATIF K. ZAOUK, NABIH E. BEDEWI, CING-DAO KAN, AND DHAFER MARZOUGUI, "VALIDATION OF A NON-LINEAR FINITE ELEMENT VEHICLE MODEL USING MULTIPLE IMPACT DATA", NCAC PAPER, (1996) [11] HANSJORG SCHRETZENMAYR, "TECHNICAL REPORT: THE ALUMINIUM BODY OF THE AUDI A8,"INTERNA -TIONAL JOURNAL OF VEHICLE DESIGN, VOL. 21, NOS. 2/3, PP.303-312, (1999) [12] JAMES A. NEPTUNE, "A COMPARISON OF

CRUSH STIFFNESS CHARACTERISTICS FROM PARTIAL-OVERL -AP FRONTAL CRASH TESTS," SAE PAPER 1999-01-0105, PP. 383-391, (1999) [13] K. YAMAZAKI, J. HAN, " MAXIMIZATION OF THE CRUSH ENERGY ABSORPTION OF CYLINDRICAL SHE -LLS", ADVANCES IN ENGINEERING SOFTWARE, VOL. 31, PP. 425-434, (2000) [14] 李銘孝, 鄭志偉, 鄭先志, 廖景雲, 程重光, 姚志明, 李俊宏, " 汽車前撞分析及模型處理",MSC. SOFTWARE 台灣研討會, (2000) [15] DAVID C. CHANG, "A DESIGN-ANALYSIS METHOD FOR THE FRONTAL-CRUSH STRENGTH OF BODY STRU -CTURE", SAE PAPER NO.770593, PP. 2177-2185, (1977) [16] GARY E. TOWNLEY AND JOSEPH W. KLAHS, "DYNAMIC SIMULATION OF AN AUTOMOBILE BODY UTILIZ -ING FINITE ELEMENT AND MODEL SYNTHESIS TECHNIQUES", SAE PAPER NO.780364,PP.1718-1725, (1978) [17] J. A. BENNETT AND M. E. BOTKIN, "AUTOMATED DESIGN FOR AUTOMOTIVE STRUCTURES," JOURNAL OF MECHANICAL DESIGN, VOL. 104, PP.799-805, (1982) [18] PARVIZ E. NIKRAVESH AND IN SOO CHUNG, " STRUCTURAL COLLAPSE AND VEHICULAR CRASH SIMUL ATION USING A PLASTIC HINGE TECHNIQUE", JOURNAL OF STRUCTURAL MECHANICS, 12(3),PP.371 -400, (1984) [19] SHINJI NISHIO AND MASARU IGARASHI, "INVESTIGATION OF CAR BODY STRUCTURAL OPTIMIZATION METHOD", INTERNATIONAL JOURNAL OF VEHICLE DESIGN, VOL. 11, NO. 1, PP.79-86, (1990) [20] E. NALEPA, "CRASHWORTHINESS SIMULATION OF THE OPEL VECTRA USING THE EXPLICIT FINITE E -LEMENT METHOD," INTERNATIONAL JOURNAL OF VEHICLE DESIGN, VOL. 11, NO. 2, PP.160-165, (1990) [21] I. HAGIWARA, Y. SATOH AND M. TSUDA, "STUDY OF AN ANALYTICAL TECHNIQUE AND SYSTEM FOR CONDUCTING VEHICLE CRASH SIMULATIONS", INTERNATIONAL JOURNAL OF VEHICLE DESIGN, VOL. 11, NO. 6, PP. 564-577, (1990) [22] RAVINDRAN GOPALAKRISHNAN, HARI N. AGRAWAL, "DURABILITY ANALYSIS OF FULL AUTOMOTIVE BO -DY STRUCTURES", SAE PAPER NO.930568, PP. 775-791, (1993) [23] A. K. PICKETT, L. T. KISIELEWICZ, E. HAUG, G. MILCENT, AND F. X. WIJNANT, K. H. PARK, S. H. SHIN, AND H. S. CHO, "OPTIMIZATION OF THE CRASHWORTHINESS OF A PASSANGER CAR US -ING ITERATIVE SIMULATIONS", SAE PAPER NO. 931977, PP. 2172-2179, 1993 [24] BRIAN WALKER AND NICHOLAS MARTINDALE, JOHN GREEN AND NEIL RIDLEY, "THE CRASH ANALYSIS OF A PASSENGER VEHICLE UNDER DIFFERING FRONTAL CRASH CONDITIONS",SAE PAPER NO. 932910 PP. 2388-2400, (1993) [25] J. P. DIAS AND M. S. PEREARA, "DESIGN FOR VEHICLE CRASHWORTHINESS USING MULTIBODY DYN -AMICS", INTERNATIONAL JOURNAL OF VEHICLE DESIGN, VOL. 15, NO. 6, PP.563-577, (1994) [26] DHAFER MARZOUGUI, CING-DAO KAN, AND NABIH E. BEDWI, "DEVELOPMENT AND VALIDATION OF AN NCAP SIMULATION USING LS-DYNA3D", NCAC PAPER, (1996) [27] 賈宏波, 黃金陵, 谷安濤, 李掌宇, " MSC/DTRAN 在轎車車身碰撞性能研究應用" , (1997) [28] R. G. WHIRLEY AND B. E. ENGELMANN, "ELECTRIC AND HYBRID VEHICLE CRASHWORTHINESS SIMUL -ATION", INTERNATIONAL JOURNAL OF VEHICLE DESIGN, VOL. 18, NO. 5, PP.413-432, (1997) [29] P. FREI, R. KAESER, R. HAFNER, M. SCHMID, A. DRAGAN, L.WINGEIER, M. H. MUSER, P. F. N -IEDERER AND F. H. WALZ, "CRASHWORTHINESS AND COMPATIBILITY OF LOW MASS VEHICLE IN CO -LLISIONS", SAE PAPER NO. 970122, PP. 190-198, (1997) [30] AZIM ESKANDARIAN, DHAFER MARZOUGUI AND NABIH E. BEDEWI, "FINITE ELEMENT MODEL AND VAL -IDATION OF A SURROGATE CRASH TEST VEHICLE FOR IMPACTS WITH ROADSIDE OBJECTS",NCAC PA -PER,(1997) [31] 谷安濤, 王中校, 賈宏波, " 奧奇牌轎車的CAE 應用" ,(1998) [32] J. G. THACKER, S. W. REAGAN, J.A. PELLETTIERE, W. D. PILKEY, J. R.CRANDALL, E. M.SIEV -EKA, " EXPERIENCES DURING DEVELOPMENT OF A DYNAMIC CRASH RESPONSE AUTOMOBILE MODEL", FINITE ELEMENT IN ANALYSIS AND DESIGN, VOL. 30, PP. 279-295, (1998) [33] LONNY L. THOMPSON, PIPASU H. SONI, SRIKANTH RAJU AND E. HARRY LAW, "THE EFFECTS OF CH -ASSIS FLEXIBILITY ON ROLL STIFFNESS OF A WINSTON CUP RACE CAR", SAE PAPER NO. 983051 PP. 2558-2570, (1998) [34] LONNY L. THOMPSON, SRIKANTH RAJU AND E. HARRY LAW, " DESIGN OF A WINSTON CUP CHASSIS FOR TORSIONAL STIFFNESS",SAE PAPER NO. 983053, PP. 2571-2584, (1998) [35] 谷安濤, 王中校, 李掌宇, 賈宏波, " 碰撞模擬技術在轎車車身碰撞性能研究之應用" , (1999) [36] H. S. KIM AND H. HUH, " VEHICLE STRUCTURAL COLLAPSE ANALYSIS USING A FINITE ELEMENT L -IMIT METHOD", INTERNATIONAL JOURNAL OF VEHICLE DESIGN, VOL. 21, NOS. 4/5, PP.436-449 ,(1999) [37] ALLEN R. YORK AND TERRY D. DAY, " THE DYMESH METHOD FOR THREE-DIMENSIONAL MULTI-VEHIC -LE COLLISION SIMULATION", SAE PAPER 1999-01-0104, PP. 365-381, (1999) [38] S. W. KIRKPATRICK, " DEVELOPMENT AND VALIDATION OF HIGH FIDELITY VEHICLE CRASH SIMULAT -ION MODELS", SAE PAPER 2000-01-0627, PP. 872-881, (2000) [39] 江國寧, 徐柏林, " 電腦模擬全車碰撞國家高速電腦中心" ,(2000) [40] Z. Q. CHENG, J. G. THACKER, W. D. PILKEY, W. T. HOLLOWELL, S. W. REAGAN, E. M. SIEVEK -A, " EXPERIENCES IN REVERSE-ENGINEERING OF A FINITE ELEMENT AUTOMOBILE CRASH MODEL", FINITE ELEMENTS IN ANALYSIS AND DESIGN, VOL. 37, PP. 843-860, (2001) [41] 張洪欣, " 汽車設計" , 科技圖書股份有限公司, (1991) [42] 林百福, " 汽車設計" , 全華科技圖書股份有限公司, (1999) [43] MSC/DYTRAN VERSION 4.7 使用手冊 [44] 吳炳文, " 防護結構抗貫穿能力之研究", 國防大學中正理工學院國防科學研究所博士論文,(2002) [45] MSC/DYTRAN SEMINAR NOTES [46] 劉登基, " 歐日各型汽車車身結構規格圖解資料全書", 現代輪業出版社, (1990) [47] HTTP://WWW.TNCAR.COM.TW/PRICEPOST/NEWCAR/SAAB9-5/95-2/ [48] 世本健次, " 世界名車鑑賞SAAB" , 閱世界出版股份有限公司, (2000) [49] 世本健次, "世界名車鑑賞BENZ" , 閱世界出版股份有限公司, (2000) [50] 世本健次, " 世界名車鑑賞VOLVO" , 閱世界出版股份有限公司, (2000) [51] HTTP://WWW.HONDA-MOTOR.COM.TW/ [52] HTTP://WWW.HONDA-MOTOR.COM.TW/GCON520.HTM [53] HTTP://WWW.TOYOTAVN.COM.VN/ [54] HTTP://WWW.SAABUSA.COM/ [55] 美國FMVSS 208 法規 [56] 歐洲96/79/EC 法規 [57] 日本TRIAS 47 法規