Whiplash Injury Parameter Study for 2nd Row Occupants

Kunil Park, Taeyeop Lee, Joogyub Shin, Changsup Ahn

I. INTRODUCTION

The purpose of this study was to confirm the performance status of the newly developed vehicles and make a guide line for 2nd row seat design. A design guide including requirements has been produced to secure robust performance by using Computer Aided Engineering(CAE) simulation with various parameters, stiffness of seat foam, head rest layout, dimensions for each component and so on.

II. METHODS

A physical sled test was performed in order to validate current performance. The static dimension between the occupant and the head-rest was measured. It is one of the major deciding factors in occupant injury level. The static assessment was estimated considering the nominal and worst case position, followed by the dynamic test for the nominal and worst case position.

Static Measurements for 2nd Row Seat

The 2nd row seat of the newly developed vehicles has three types of head-rest (integrated, "L" and "Wing" type). The integrated type shows a poor result in the static measurement and dynamic tests. The integrated seat has been excluded from this study. The others show acceptable performance in static measurement. Those static measurement results have been statically assessed in accordance with the Euro NCAP whiplash assessment protocol [1]. The calculated score of those static assessments are listed in Table I.

TABLE I
EURO NCAP ASSESSMENT SCORE OF 2ND ROW SEATS

Type		RH seat	LH seat
"L" type		'Good' (0.875)	'Good' (0.875)
"Wing" Type		'Good' (0.875)	'Good' (0.875)

Dynamic Test for 2nd Row Seats

The dynamic tests have been performed in accordance with the Korea NCAP whiplash test protocol [2]. Tests have been done in two test conditions, the nominal and worst case position of the head-rest. The occupant injuries are similar to 1st row seat injuries with regards to the nominal case position. However, there are excessive neck injuries in the worst case position. Table II shows the dynamic test results.

Kunil Park is a Principal Engineer at the Renault Techno-center in Korea (kunil.park@renaultsamsungM.com), Taeyeop Lee is an engineer at the Renault Techno-center in Korea (taeyeop.lee@renaultsamsungM.com), Joongyub Shin is a Principal Engineer at the Renault Techno-center in Korea (joongyub.shin@renaultsamsungM.com), Changsub Ahn is a Principal Engineer at the Renault Techno-center in Korea (changsup.ahn@renaultsamsungM.com) .

TABLE II

NECK INJURIES OF 2ND ROW SEAT

Injuries	Test	Worst
Nkm	1.94	4.22
NIC	1.05	1.34
*Score**	0.89	0.46

Unit of injuries in Table 2, 3, 4, 5: unit-less (ratio of each value to internal requirement)

Score in Table 2, 3, 4, 5 is calculated total score based on the assessment of the Korea NCAP 1st row whiplash test*

CORRELATION OF CAE SIMULATION

A finite element model has been built in order to simulate the dynamic test result. Table III shows that the simulation model correlate well with the physical dynamic test. Subsequent case studies therefore used this simulation result.

TABLE III

CORRELATION OF CAE SIMULATION MODEL WITH PHYSICAL DYNAMIC TEST

Injuries	Physical dynamic test	Simulation model
Nkm	1.94	1.06
NIC	1.05	1.09
*Score**	0.89	0.95

III. PARAMETER STUDY FOR DESIGN GUIDE AND REQUIREMENT

After developing the base simulation model, a parametric study was done to find major factors influencing excessive neck injuries.

Seat geometry layout

Selected parameters which are relative to seat geometry inflict an injury on the human body. Table IIII shows change of *Score** according to the variation of parameters. Each variation of parameters represents a tendency and it can be used as a guide for geometry seat design which has significantly superior performance potential than present seat design.

TABLE IIII

PARAMETRIC STUDY REGARDING GEOMETRIC DIFFERENCE

Parameters	-D2	-D1	Base Model	+D1	+D2	+D3
Headrest Position Z	0.82	0.92	0.95	0.91	0.74	-
Headrest Position X	0.90	0.94	0.95	0.84	0.83	-
Seatback angle Y	-	-	0.95	0.92	0.91	0.90

Stiffness of seat-back foam

Stiffness of seatback foam determines the overall movement of the occupant. Thus, it is crucial to restrain the occupant.

TABLE IV

PARAMETRIC STUDY REGARDING SEATBACK STIFFNESS

Parameters	-D1	Base Model	+D1	+D2	+D3
Stiffness of seat back frame	0.89	0.95	0.92	0.89	0.86

IV. DISCUSSION

This study was conducted to check the current performance and find some key parameters in order to secure the robustness of 2nd row seats. As a result of the parametric study, the base model shows the most superior safety performance. On the basis of this study, results can suggest a guide of geometry and stiffness of seatback frame to achieve excellent safety performance of 2nd row seats. Since this study was conducted with a mid-size sedan, vehicles of different size and type are necessary for further study.

V. REFERENCES

[1] ENCAP/Euro NCAP Assessment Protocol-AOP v7.0.3, ENCAP site (www.euroncap.com), 2016

[2] MOLIT(국토교통부)/자동차안전도평가시험 등에 관한 규정, 국가법령정보센터 (www.law.go.kr), 2013