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Study on the Behavior and Damage of Pedestrian at Car Body Impact

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차체 충돌에 있어서의 보행자의 거동 및 손상에 관한 연구

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Abstract

The study for traffic safety improvement is so necessary to minimize the wound of pedestrian at car impact as to prevent pedestrian from this accident. This study aims at analyzing the behavior affected by impact on which car body hits pedestrian. Load and damage of pedestrian are also investigated. This model is the small car body as frame structure. The pedestrian is modeled with dummy by CATIA as Korean standard body style. The car impacts the side of pedestrian with the speed from 30 to 90km/h. Behavior and damage of pedestrian at impact are analyzed by ANSYS. In case of 30km/h, The maximum pressure of dummy becomes the maximum value of 100MPa after the elapsed time of 0.1second and then seems to remain at 105MPa constantly. In case of 60km/h, its pressure becomes the maximum value of 110MPa at the elapsed time of 0.05second and decreases at 90MPa until the elapsed time of 0.1second. This value fluctuates after the elapsed time of 0.1second. In case of 90km/h, its maximum pressure becomes the maximum value of 155MPa at the elapsed time of 0.07second and fluctuates after the elapsed time of 0.07second until 0.3second. This value seems to remain at 100MPa constantly after 0.3second until 0.5second. But this pressure increases suddenly just after 0.5second. Maximum deformations of dummy increase linearly according to elapsed time at hitting velocities of 30, 60 and 90km/h.

Key Words : Pedestrian(보행자), Car impact(자동차 충돌), Translational velocity(병진 속도), Dummy(더미), Behavior(거동), Damage(손상), Pressure(압력), Deformation(변형)

1. Introduction

According to the press of National Police Agency, about 65% of the death accidents is happened when pedestrian crosses the crosswalk or the road where is near the crosswalks or overhead bridges in 2008. Not only the engineering countermeasure of traffic and road but also the study for traffic safety improvement is so necessary to minimize the

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wound of pedestrian at car impact as to prevent pedestrian from this accident[1~3]. Many progressive studies focus on driver's safety when car crashes, but the pedestrian's safety becomes more important than driver's[4~7]. This study aims at analyzing the behavior, load and damage of pedestrian affected by impact on which car body crashes pedestrian. This model is the body of small car as frame structure. The pedestrian is modeled with dummy by CATIA as Korean standard body style. The car impacts the side of pedestrian with the velocity from 30 to 90km/h. Behavior and damage of pedestrian at impact are analyzed by ANSYS AUTODYN[8].

2. MODEL and ANALYSIS

Fig. 1 and 2 are shown by the model of car body and pedestrian respectively. Pedestrian is described by dummy. Fig. 3 is mechanic model defined by mesh. Table. 1 expresses the character of model and the data of material properties.

The following constraint conditions are given to show the dummy's behavior and hitting value when car hits dummy. Contact condition is no friction with 'Frictionless' as shown in Fig. 4. And car model is given with the translational velocity of 30 to 90km/h as shown in Fig. 5.

Fig. 6(a), 6(b) and 6(c) are respectively shown with dummy behaviors after elapsed time of 0.5 second when car body

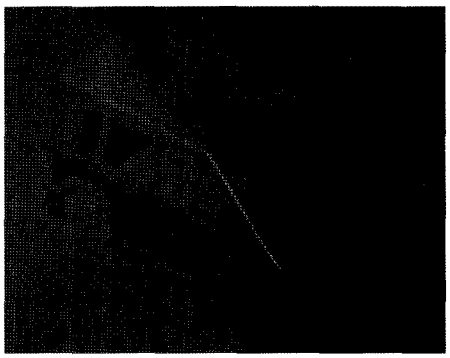


Fig. 1 Model of automotive body

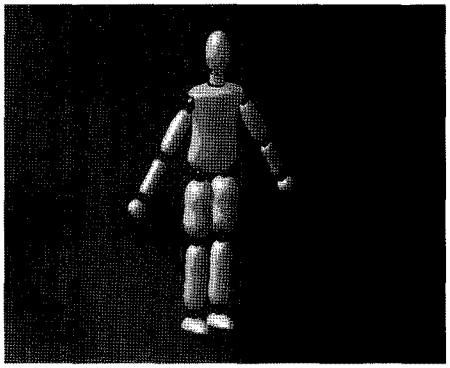


Fig. 2 Model of dummy

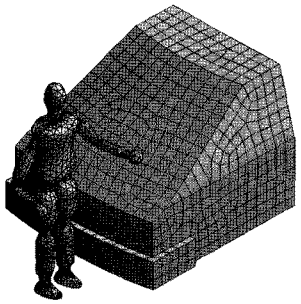


Fig. 3 Mesh of model

Table 1 Material property

	Automotive Body	Dummy
Young's Modulus	2×10^{10}Pa	4900
Poisson's Ratio	0.3	0.42
Tensile Yield Strength	250Pa	57.09Pa
Compressive Yield Strength	250Pa	0Pa
Tensile Ultimate Strength	460Pa	60.4Pa
Compressive Ultimate Strength	0Pa	0Pa
Density	1300Kg/m^3	900Kg/m^3
Shear Modulus	8.18E$\times10^{10}$Pa	1×10^{10}Pa

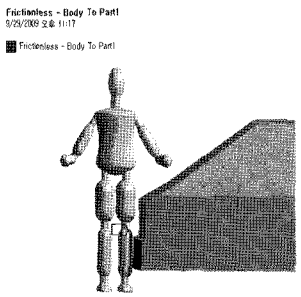


Fig. 4 Contact condition

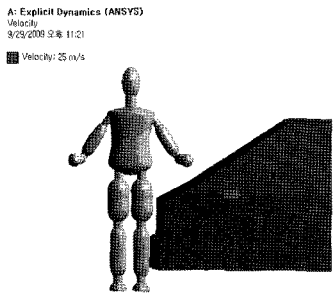


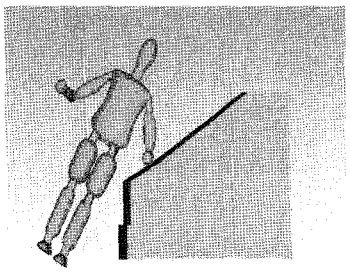
Fig. 5 Translational velocity of car

hits the dummy with 30, 60 and 90km/h.

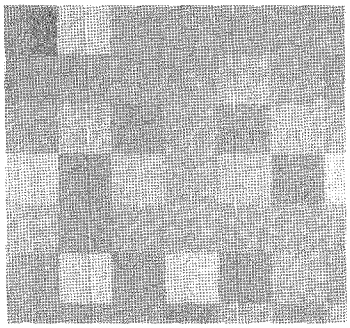
Fig. 7(a), 7(b) and 7(c) are shown with maximum pressures of dummy according to elapsed time at hitting velocities of 30, 60 and 90km/h. Fig. 8(a), 8(b) and 8(c) are also shown with maximum deformations of dummy according to elapsed time at these velocities.

In case of 30km/h, The maximum pressure of dummy becomes the maximum value of 100MPa after the elapsed time of 0.1second and then seems to remain at 105MPa constantly.

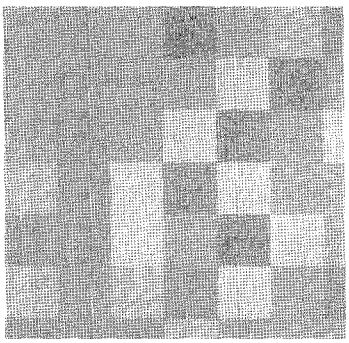
In case of 60km/h, its pressure becomes the maximum value of 110MPa at the elapsed time of 0.05second and decreases at 90MPa until the elapsed time of 0.1second. This value fluctuates after the elapsed time of 0.1second.



(a) In case of 30km/h



(b) In case of 60km/h

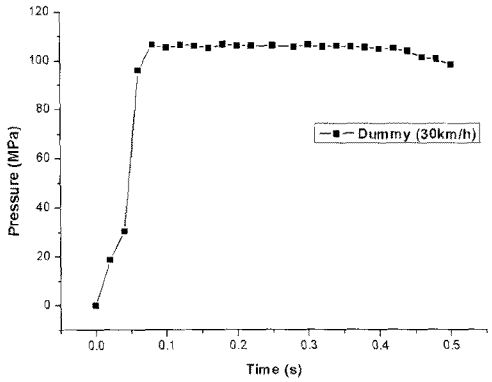


(c) In case of 90km/h

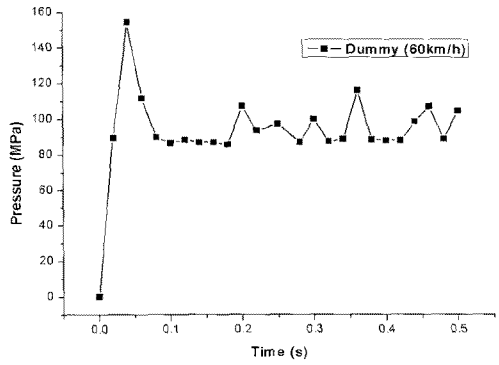
Fig. 6 Behaviors of dummy after elapsed time of 0.5 second at hitting velocities of 30, 60 and 90 km/h

In case of 90km/h, its maximum pressure becomes the maximum value of 155MPa at the elapsed time of 0.07 second and fluctuates after the elapsed time of 0.07 second until 0.3second. This value seems to remain at 100 MPa constantly after 0.3second until 0.5second. But this pressure increases suddenly just after 0.5 second.

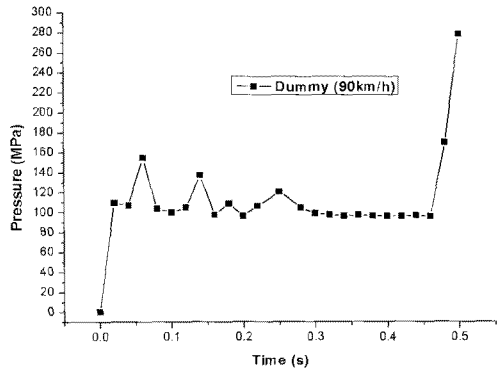
Maximum deformations of dummy increase linearly according to elapsed time at hitting velocities of 30, 60 and



(a) In case of 30km/h

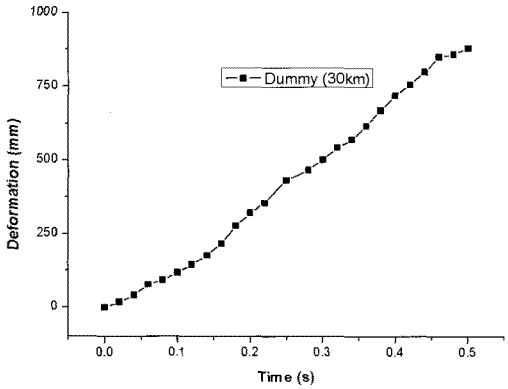


(b) In case of 60km/h

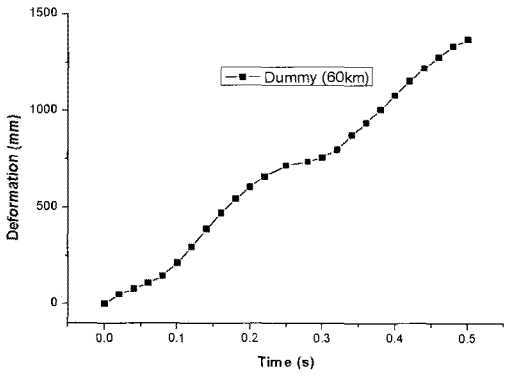


(c) In case of 90km/h

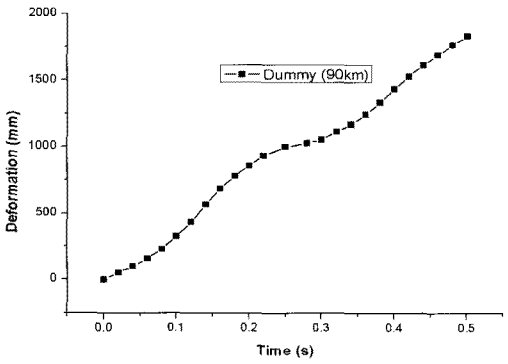
Fig. 7 Maximum pressure of dummy according to elapsed time at hitting velocities of 30, 60 and 90km/h



(a) In case of 30km/h



(b) In case of 60km/h



(c) In case of 90km/h

Fig. 8 Maximum deformations of dummy according to elapsed time at hitting velocities of 30, 60 and 90 km/h

90km/h. Theses values become 800, 1200 and 1800 mm respectively after 0.5sec in case of 30, 60 and 90 km/h.

3. Conclusion

In this study, dummy behavior and hitting value when car with 1500kg hits the dummy with 70kg are analyzed. The conclusions are as follows.

(1) At the hitting velocity of 30km/h, dummy moves with the motion wound on the car. The maximum pressure of dummy becomes the maximum value of 100MPa after the elapsed time of 0.1second and then seems to remain at 105MPa constantly.

(2) At the hitting velocity of 60km/h, dummy moves with the motion flung by the car pushing. Its pressure becomes the maximum value of 110MPa at the elapsed time of 0.05second and decreases at 90MPa until the elapsed time of 0.1second. This value fluctuates after the elapsed time of 0.1second.

(3) At the hitting velocity of 90km/h, dummy moves with the motion tumbled to the roof of the car. Its maximum pressure becomes the maximum value of 155MPa at the elapsed time of 0.07second and fluctuates after the elapsed time of 0.07second until 0.3second. This value seems to remain at 100MPa constantly after 0.3second until 0.5second. But this pressure increases suddenly just after 0.5second.

Acknowledgement

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References

(1) Bae, J. W., Lee, Y. H., Beom, H. K., and Kim, D. S., 2004, "Pedestrian Analysis with Test and Case Study Considered with Initial Condition," 2004 *Symposium of KSAE*, pp. 77~82.

(2) Yoo, J. S., Park, G. J., and Chang, M. S., 2005, "Pedestrians Trajectory Characteristic for Vehicle Configuration and Pedestrian Postures," *Transactions of KSAE*, Vol. 13, No. 4, pp. 8~18.

(3) Oh, C., Kang, Y. S., Kim, W. K., and Kim, B. M., 2005, "Method for Estimating Target Population by Introducing Pedestrian-Vehicle Collision Regulation on Pedestrian Protection," *2005 Spring Conference Proceeding of KSAE*, pp. 697~705.

(4) Kim, M. H., Cho, S. S., and Ha, S. K., 1999, "Design and Structural Analysis of Aluminum Bumper for Automobile," *Trans. of KSAE*, Vol. 7, No. 4, pp. 217~227.

(5) Shin, D. H., Kim, K. H., and Son, K., 2007, "Analysis of car-pedestrian collisions using scaled Korean dummy

models," Journal of the Korean Soiety for Precision Engineering, Vol. 24, No. 5, pp. 110~117.

(6) Ahn, S. M., and Kang, D. M., 2008, "Analytical Model in Pedestrian Accident by Van Type Vehicle," *Journal of the Korean Society of Manufacturing Process Engineers*, Vol. 7, No. 4, pp. 115~120.

(7) Cho, J. U., Han, M. S., and Min, B. S., 2009, "Analysis on the Behavior of Pedestrian at Car Impact," *KSAE 2009 Annual Conference Proceedings*, p.185.

(8) Swanson, J., 2009, *AUTODYN 12.0*, ANSYS Inc., U.S.A.