PAB Deployment Simulation with Curved Retainer

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Abbreviations:

CS1 –	Constraint No. 1	
CS2 –	Constraint No. 2	
PAB –	Passenger Side Airbag	

Keywords: PAB, deployment, curved retainer

ABSTRACT

Some passenger side airbags (PAB) are mounted on the cylindrical inflator directly through retainer with similar curvature of the inflator. To accurately simulate the deployment of such a PAB, a fine-tuned model using additional constraints in LS-DYNA are employed in this paper to simulate the curved mounted PAB. The results from the fine-tuned model are compared with the simulation results from the PAB models with simply fixed bag mouth. It is found that by approximating the curved mounting with simply fixed airbag mouth introduces negligible error in airbag deployment simulation.

INTRODUCTION

To accurately simulate the airbag deployment process, the folded airbag instead of simple shrunken flat airbag should be employed. In most cases, the folded airbag needs to be scaled (shrunk) to fit into the airbag housing. Currently, the effective folding are all based on 2D airbags, where the mesh is layered on certain plane. The so-called 3D folding, such as scrunch folding [1-2], is still based on the flattened bag. The resultant folded airbag will generally have a flatten airbag mouth. For some PABs, they are mounted directly on the cylindrical inflator through a curved retainer. Due to the cylindrical shape of the PAB inflator, the airbag mouth is not in a plane anymore. To fold the PAB in the numerical simulation, the curved airbag mouth nodes must first be flattened. In most cases, the PAB mouth nodes will be either attached to rigid body or fixed using MPCs available in LS-DYNA during deployment process. This will not consider the effect of the curved mounting on the deployment process.

For airbag and its module suppliers, the accurate analysis of airbag deployment process is needed for fine-tuning the airbag module to meet the customer expectation and the federal regulations. Under such circumstance, the effect of the different airbag mounting methods on the deployment process should be evaluated to ensure accuracy of the analysis. Comparing to the result from the fine-tuned deployment analysis accounting for the curved mounting PAB, the feasibility of analysis using general constraints, such as fixed airbag mouth, for PAB with curved retainer is evaluated.

APPROACH

The PAB model used in the current study is shown in Figure 1. It includes PAB, airbag housing, inflator, protective cover, IP, and windshield. In order to fit the folded PAB into the housing, the folded PAB generally need to be shrunk. In the current paper, a relatively large shrunken ratio of 50% is employed. The higher shrunken ratio, the larger difference between the shrunken airbag mouth and the original airbag mouth. This also means more deviation of the model from the curved mounting of the PAB. The original PAB is mounted directly on the inflator through screwed metal retainer following the curvature of the inflator cylinder. The detailed model regarding the inflator cylinder, curved retainer, and shrunken PAB is shown in Figure 2.

Two different constraints and boundary conditions are employed in the current study. The first approach uses the *BOUNDARY_PRECRIBED_MOTION_NODE [3] in LS-DYNA to force the PAB mouth nodes to move to the curved retainer position within a very short time (10 ms in the current study). The time period selection is based on the consideration of the model stability and the deployment time. Both vector based or coordinate based movements are employed. The later can be easily incorporated into the occupant simulation. This approach is referred to as constraint No. 1 (CS1) in the current paper. The other approach, which is also called as constraint No. 2 (CS2) in this study, is simply to fix the PAB mouth nodes using *BOUNDARY_SPC_SET or *CONSTRAINED_EXTRA_NODES_SET [3], which is commonly used constraints employed in airbag deployment simulation and occupant simulation. Other conditions are kept the same for two different approaches. The Wang_Nefske multi-jetting airbag model [3] is employed to approximate the effect of buffer used in the PAB. The 2nd type of contact option is employed for the airbag single surface contact.

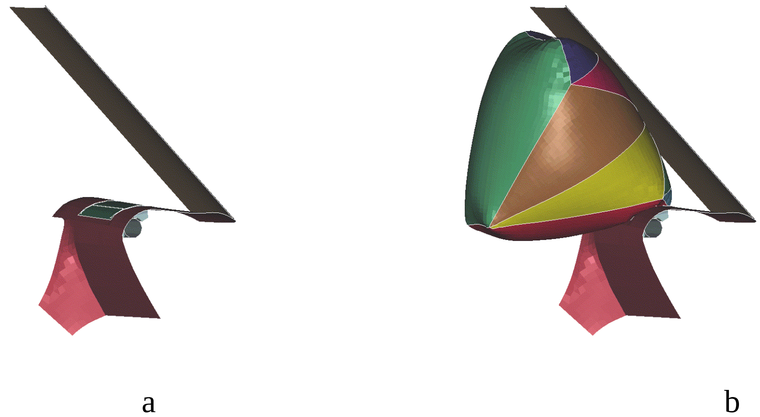

Figure 1. PAB model. (a). Static model (0 ms). (b). Fully deployed PAB model (50 ms).

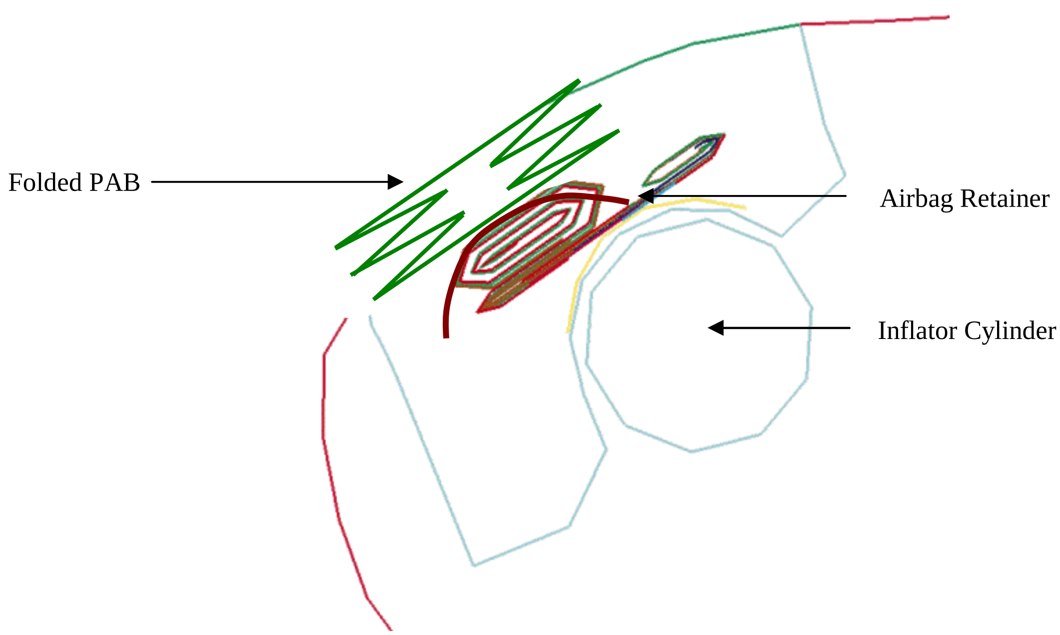

Figure 2. Detailed PAB model with curved retainer.

RESULTS AND DISCUSSION

The airbag pressure histories predicted from different types of constraints, CS1 and CS2, are shown in Figure 3. The experimental result is also shown in the figure for comparison. It is clear that the pressure histories predicted from both CS1 and CS2 are in good agreement with the tested result, and the difference between the results predicted by different constraints, CS1 and CS2, is very small.

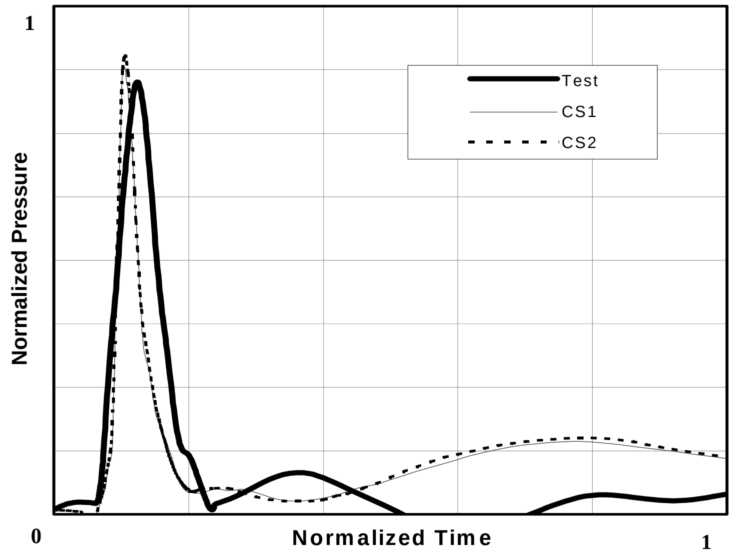

Figure 3. PAB pressures.

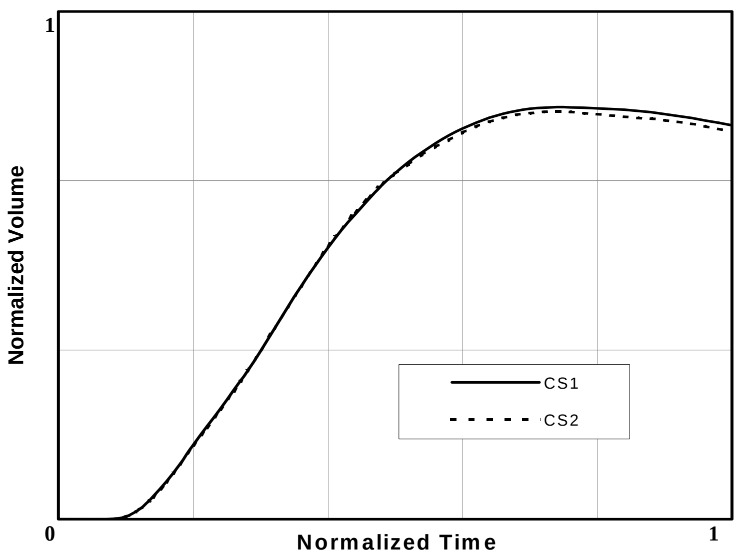

Figure 4. Predicted PAB volumes under different constraints.

The predicted volume and surface area histories for different constraints, CS1 and CS2, are shown in Figure 4 and 5 respectively. It is clear that both volume and surface area histories are very close for different constraints employed in the current study.

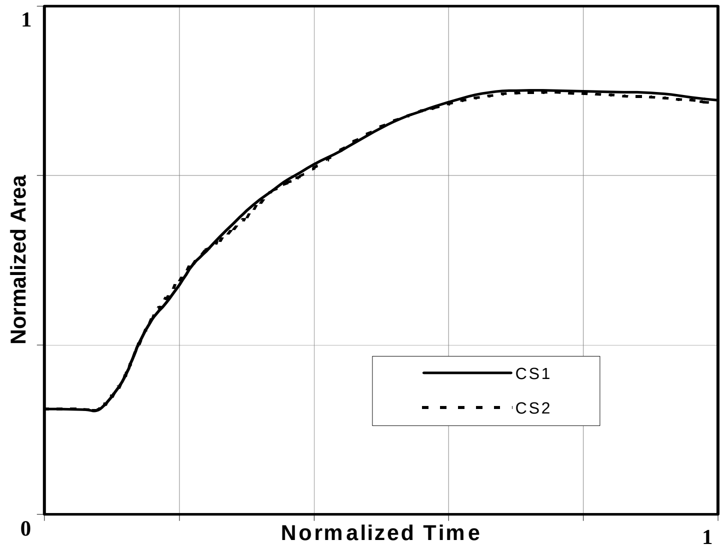

Figure 5. Predicted PAB surface areas under different constraints.

Figure 6 compares the PAB deployment shapes at different times for CS1 and CS2. The simulation deployment shapes are obtained from the section plane that passes through the center of the folded PAB along the line of the vehicle length. The experimental results are extracted from the static deployment photo slices taken by the high-speed digital camera located at the passage window. Similar to the results discussed above, the deployment shapes at different times from CS1 and CS2 are very close.

Comparing the PAB deployment shapes at different times in Figure 6, it is clear that one of the main differences between the results from CS1 and CS1 is at the vicinity of the retainer. Because the airbag mouth nodes move to their corresponding mounting positions in the beginning of the deployment process with CS1, the PAB is deployed from a relative wider and curved opening. On the other hand, the deployed PAB shapes with a fixed airbag mouth using CS2 has relative narrower opening. In general, the PAB shapes under CS2 trends to extend a little further than the corresponding shapes under CS1, but the difference in negligible. Therefore, the simplified constraints generally used in airbag or occupant simulations are accurate enough for the curved mounted airbags. This approach can be extended to other mounting positions of the airbag to access the feasibilities of the simplified constraints employed during the simulation.

CONCLUSION

The deployment of a PAB with curved mounting retainer is modeled in the current study. It is found that the characteristics of the PAB deployment are similar to those from the model where the airbag mouth is simply fixed during deployment process as generally employed in airbag deployment simulation.

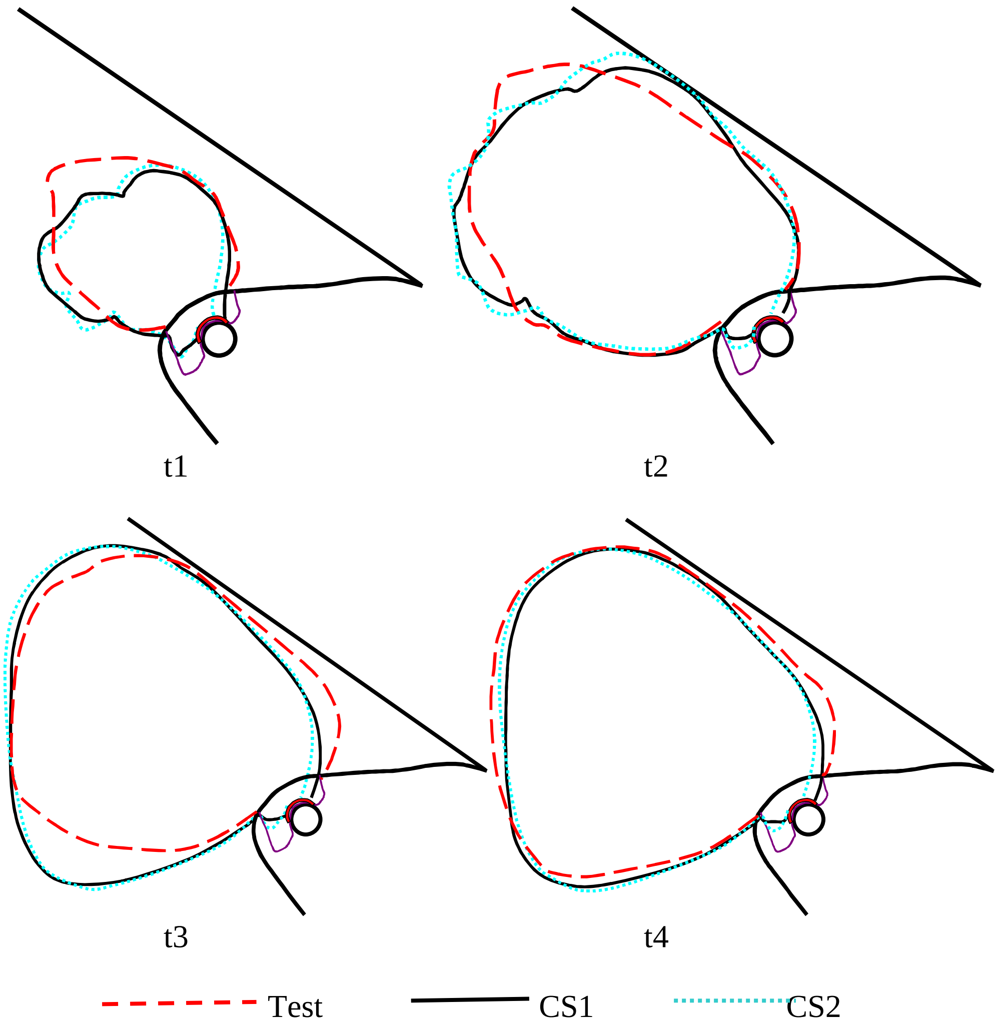

Figure 6. PAB deployment shapes at different time.

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