Effective Vehicle Side Impact Simulation in a Sled Test Environment at YanFeng-Key

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Abstract： With the introduction of Chinese legislation GB20071 and CNCAP ratings, occupant side impact protection is becoming more relevant to local and overseas OEMS wishing to sell vehicles in china today. The sled test methodology has proven very effective in a frontal application in producing advanced safety restraint systems. However a side impact application of the sled test is completely new in China. This document demonstrates implementation of side impact sled test facility at YFK technical centre. This side impact sled facility accurately simulates various types of side impact barrier tests and is an effective tool in developing advanced side impact restraint systems

Introduction

Recent developments in Chinese occupant protection legislation and the introduction of the Chinese new car assessment program have increased the relative importance of side impact compared to frontal impact protection. Frontal impact protection, particularly in China is becoming a more established science compared to side impact protection, which remains relatively new. Sled testing methodology in a frontal application has also become an established and useful tool in optimizing the restraint system performance. However, applying effective sled testing methodology as an effective tool to optimize side impact restraint systems remains in a state of flux particularly in mainland China. Fundamental differences in the injury mechanisms between front and side impact are responsible for the different sled testing approach.

In a frontal impact the occupant is decelerated by safety restraints (seat belt, airbag) with relatively little influence of vehicle deformation. Subsequently occupant injuries observed are of the inertial type, caused by the rapid deceleration of the vehicle during the crash, producing what's known as the crash pulse. This crash pulse can be inputted into a sled environment, thereby accurately simulating occupant injuries without the deformation of the vehicle cabin.

However, with a side impact the occupant is accelerated by the deforming structure of the vehicle. Injuries are generally determined by the severity of vehicle deformation. Therefore side sled test methodology must go someway toward simulating this side impact intrusion seen during the crash. Simulating this lateral vehicle intrusion accurately remains the main challenge for effective side impact sled simulation.

Simulating Side Impact Vehicle Intrusion

Chinese legislation 20071 and CNCAP dictates that a minimum level of occupant protection must be provided to a 50%ile dummy while occupying a motionless target vehicle when struck by a moveable deformable barrier at 50km/h (see fig.1)

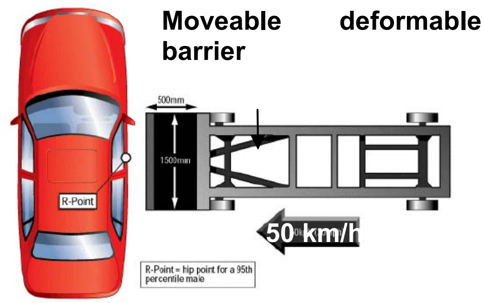

Figure 1 Target Vehicle, struck by Moveable Deformable Barrier.

The moveable deformable barrier strikes the vehicle, causing large deformations, which in turn causes occupant injuries. The YFK side sled system simulates this intrusion by allowing the seated occupant, the side structure and door to move relative to the sled buck. The relative motion is permitted by mounting the seat and door structure on rails, which in turn are mounted on the sled buck (see fig. 2).

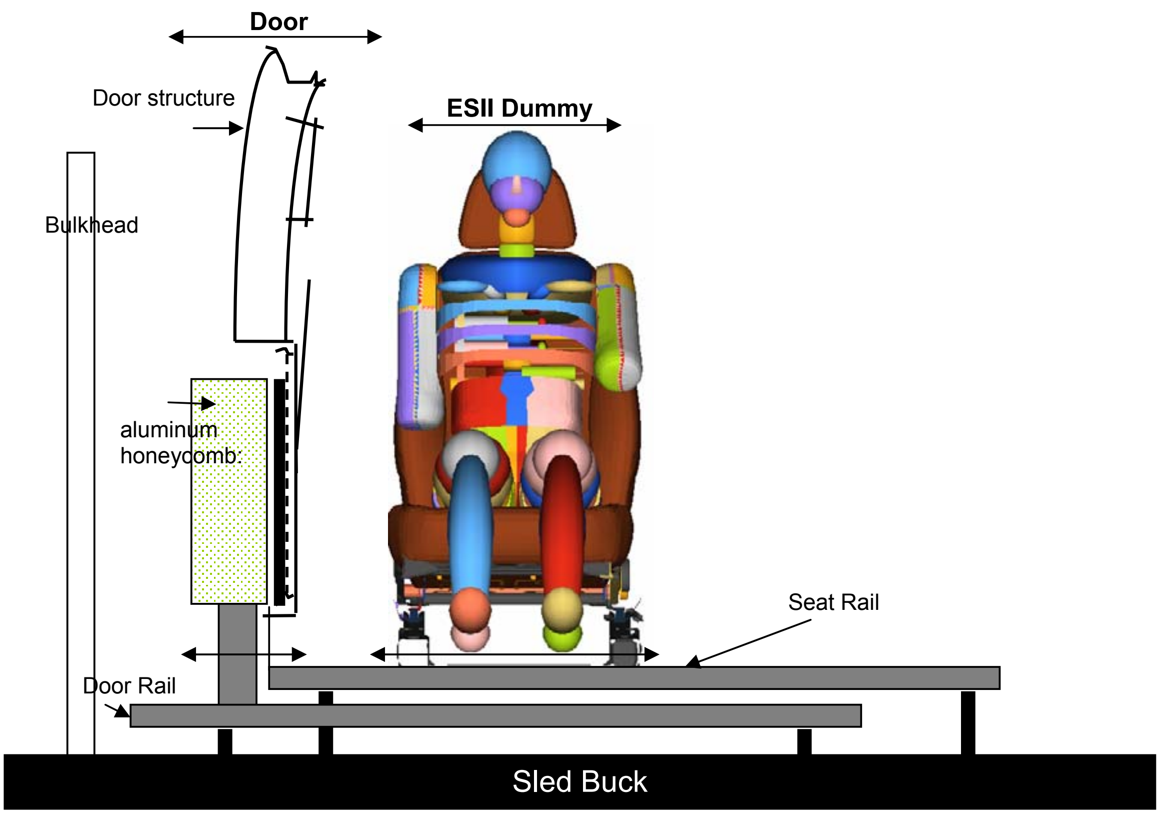

Figure 2 Sled set up

This figure shows that on acceleration of the sled buck, the door and seat can move relative to each other, thereby simulating the vehicle intrusion during the crash. The door structure movement is restricted by a bulkhead mounted on the sled buck, Careful adjustment of this relative motion is necessary for good correlation. This process is described in a later section.

Sled Test Acceleration Input

For a frontal application, the position of accelerometer for sled pulse input is well established; a position close to the base of the B-pillar is generally accepted to give the best sled to barrier correlation. However with a side impact application, selection of the pulse for correlation becomes more critical. Figure 3 shows typical locations for accelerometer positions in a side impact barrier test. Each of these locations will give a very different reading due to the large variation in deformation throughout the vehicle during the crash.

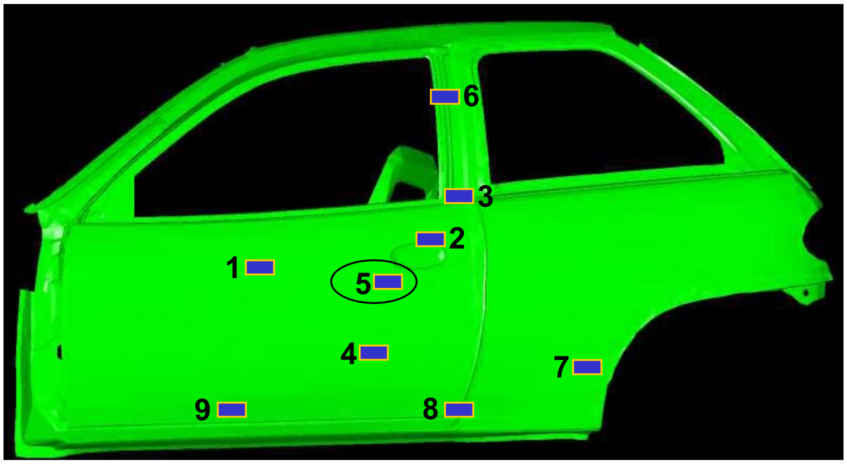

Figure 3 Accelerometer Locations

Typically an accelerometer position close to location 5 is chosen for pulse correlation to the actual barrier test (for Chinese legislation and CNCAP). This location is chosen as it represents the area of intrusion closest to the chest and ribs of the EuroSID2 dummy. The rib deflection is typically the area that incurs most injury during an impact, consequently it is the area of most importance. By correlating the sled pulse at position 5, we would expect highest degree of correlation at the rib area of the dummy. Figure 4 shows a typical pulse measured at this location on the vehicle during side impact crash.

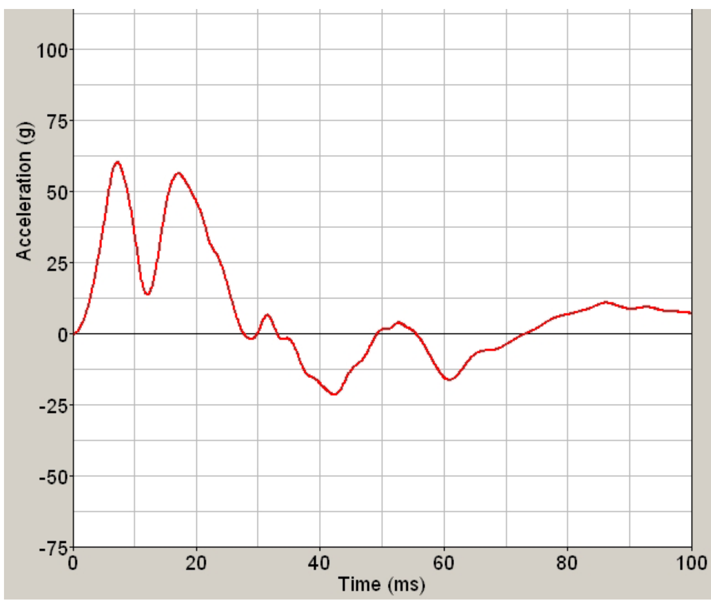

Figure 4 Typical Pulse at location 5

Side Structure Preparation

The side structure is prepared by cutting one side of the body in white. The door inner is welded or bolted to this side structure so it can be reused. Figure 5 shows the car structure. Hexcel, similar to the material representing the deformable part of the moveable barrier, is mounted to the side structure at the appropriate height. This hexcel provides the correct stiffness when the door structure strikes the dummy. Seat belt, door trim, B-pillar and other trims are also fitted. The large wooden bulkhead is also shown.

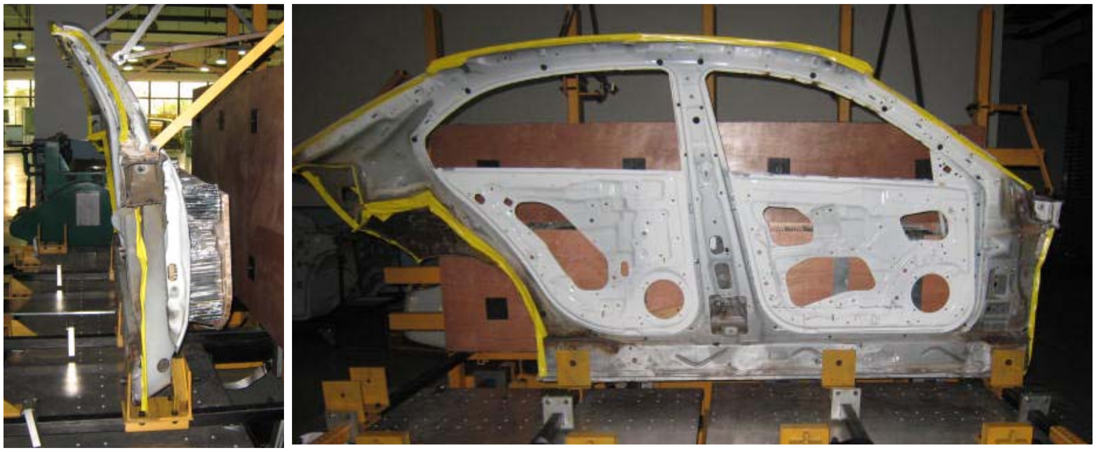

Figure 5 Side Structure

Sled Test Set Up

Figure 6 shows the actual sled test set up at YFK. The side structure, cut from the BIW, can be seen mounted to buck on 2 rails. Actual vehicle seat is mounted on two rails at the correct height and distance relative to the door. Euro SID 2 dummy is set up according to the legislative protocol with respect to H-point location, dummy angle etc. A series of metal blockers guidelines and attachments prevent rebound once the dummy and seat have moved into the door and fully loaded the structure. The sled pulse is shot, matching the acceleration time history at location 5. The inertia of the dummy and seat causes the dummy to strike the door, simulating the intrusion seen in an actual barrier test.

Figure 6 Sled Test Set Up

Correlation Process

In addition to correlating the acceleration pulse on the sled structure to barrier pulse, dummy injury values should also be correlated to actual dummy injury values seen in the barrier test. Direct comparisons of time history dummy injury readings between sled test and barrier test are made to correlate and validate sled test process. Several set-up parameters can be tuned to improve dummy injury correlation. These are; Hyge set pressure, this can alter the onset or aggressiveness of the pulse. Initial distance between the bulk head and the door, this effects this initial peak value of the pulse. The initial angle of the door, which simulates the deformation pattern; this effects the contact area of dummy and door. Depth and stiffness of hexcel; this effects the contact stiffness between dummy and door.

Fine tuning these parameters leads to a baseline correlation, accurately predicting the injury values of the EuroSID2 dummy. As previously mentioned, certain injury areas should be focused upon. These injury values would receive the greatest effect from any airbag countermeasure implementation. An example shown in figure 7 is baseline correlation of sled to barrier, focusing on the rib deflection.

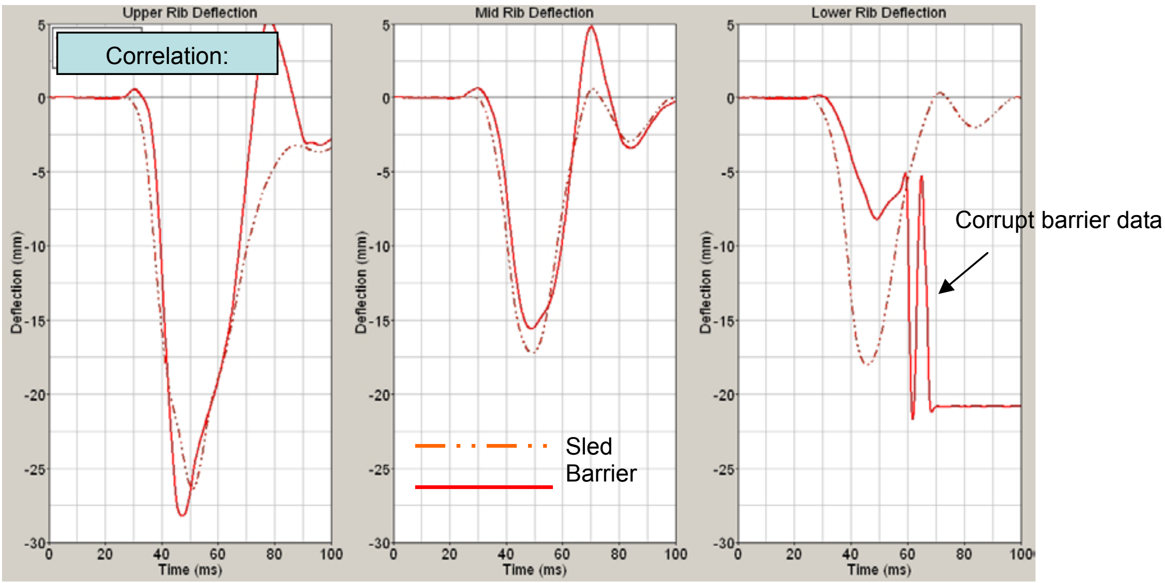

Figure 7 Example of rib deflection correlation

Figure 8 below shows the animation sequence of the sled test scenario. The effect of the seat and door moving relative to the sled buck can be clearly seen.

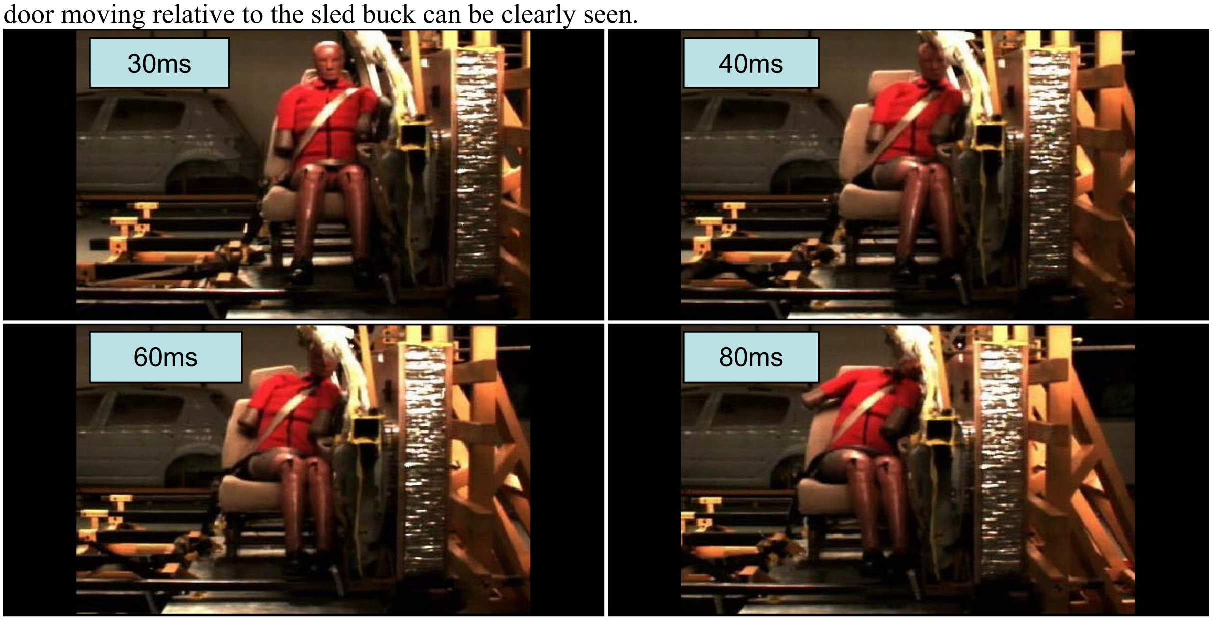

Figure 8 Typical animation sequence

Conclusion

YFK are able to simulate side impact barrier tests in a 12” Hyge sled test environment. The example set up shown in this paper is equivalent to GB20071 and ECE R95 scenario. Other crash type set ups, such as pole tests and FMVSS 214 can also be implemented.

Difficulties in correlating the complete dummy injury profile maybe encountered, consequently focusing on the injury of greater significance is recommended.

References

[1] GB20071 – 2006: The Protection of Occupants in the event of lateral collision

[2] ECE R95 - 1998: The Provisions Concerning the Approval of Vehicles with Regard to the Protection of the Occupants in the Event of a Lateral Collision.