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Statistical Analysis of Test Data of Child Restraint System Based on ECE R44 Front Sled Test

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Abstract: Child restraint system has beenincorporated into the China compulsory certification (3C), requiring children's safety seats that are not 3C certified and not marked with 3C certification should not be manufactured, sold, imported or used in other business actives sinceSeptember 2014.Child restraint systems were tested using the collision sled and P-series dummies required by the ECE R44 regulations. The protection ofthe child restraint system on child occupant was studied from two aspects: misuse of the child restraint system and the effect of fixation on group II and III tests.The results show that head displacement is the main factor of failure of child restraint system. Misuse of group I test seat tilt angle and 5-point harness restraint effect determine the dummy head displacement. For groupII and III which are tested by vehicle seatbelt restraint, the effect of ISOFIX on restraining displacementis not obvious, but the head displacement may be increased.According to the results of the study guide the structural design and use of child seat to improve the safety of children in our country is of great significance.

Keywords: Child restraint system, Dynamic test, Statistical analysis

1Introduction

Currently,the quality of child seats on the market is uneven.Consumers can only from the seat shape and fabric cover material intuitive judgments children's ride comfort. The protection for collision safety performance is required for dynamic tests by regulation. Dynamic test is an important index to evaluate the safety of child restraint system (CRS). The dynamic performance directly determines the performance of the whole CRS, which affects the safety of children's occupants[1]. The child seat test data from different manufacturers of child seat 3C certification test or child seat development test, as well as on the market child seat sampling test.

2 Child restraint system dynamic test equipment

To slow down sled as an example, CRS crash test required basic experimental device diagram shown in figure 1, including the sled system, camera system and control system of three parts. During the test, the sled was accelerated from rest to 48~50km/h by the ejection device, and then the olive head and the cushioning device PU tube were squeezed to achieve the buffer energy absorbing function, resulting in the required collision acceleration [2]. The collision buffer distance of sled is 600 to 700mm.

The test used P-series child dummy, which include P10, P6, P3, P1.5, P3/4 and P0. Except for P0 dummy, the rest of the dummies were equipped with 3-axis acceleration sensors to record the acceleration of the dummy's chest during the test [3]. At the same time, the movement of the dummy was recorded by the high speed camera. The maximum horizontal displacement and vertical displacement of the head were obtained during themovement. According to the chest acceleration and the head displacement damage evaluation in order to determine whether the child seat to meet regulatory requirements.

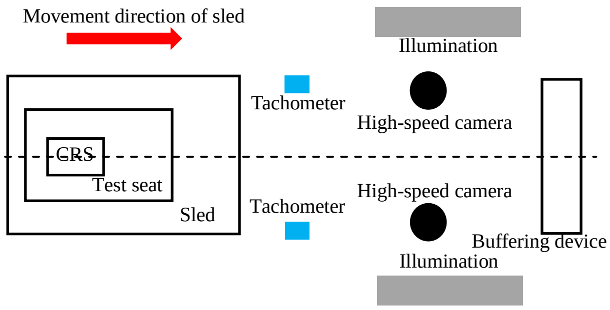


Fig. 1 Basic device required for the experiment

3 Child restraint system test data statistics

A total of 48 child restraint systems were counted and divided into six categories according to the number of available weight for the child, as shown in figure 2. Which applies to the body weight of less than 13kg of the child restraint system 3, less than 18kg of the child restraint system 7, weight less than 25kg of the child restraint system 3, weight in the range of 9~18kg child restraint system 4, weighing 15~36kg within the scope of the child restraint system 8, weight 9~36kg in the context of child restraint system 23 models. The physical development of children is a fast process, and a single group of child restraint system can be rapidly phased out, while increasing the user's cost of use, which makes cross-group products account for a considerable portion of the child restraint system.

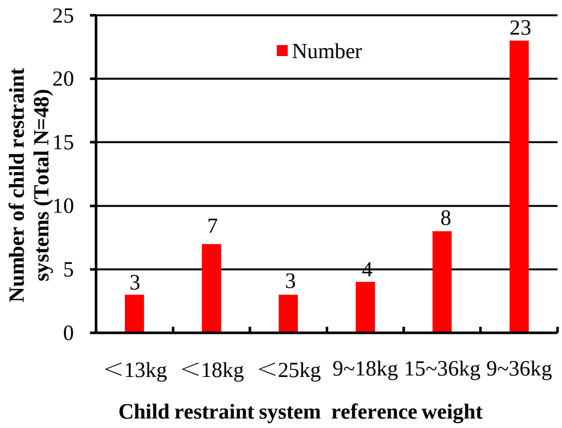
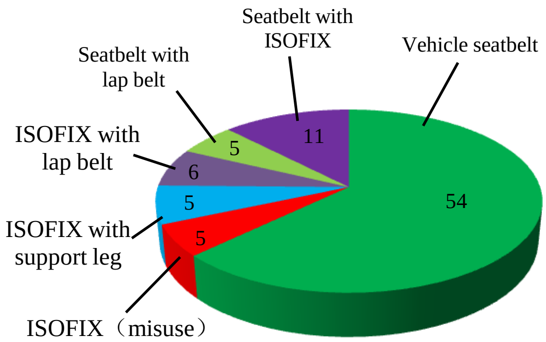


Fig. 2 Child restraint system scope

The weight of child restraint system varies with the age of the manufacture's design and materials used. The weight of child restraint system is mainly distributed in the range of 4~10kg, and the weight of child restraint system is less than 4kg for basket or height pad. The structure of child restraint system is relatively simple, and the material is mainly plastic. Most child restraint systemswhich mass exceeding 10 kg are equipped with ISOFIX devices. ISOFIX is rigidly attached to the vehicle when the child restraint system is installed and requires ISOFIX to have good resistance to bending deformation. ISOFIX bodies are mostly of high-strength metal parts and the regulations require that the weight of child restraint system with ISOFIX devices should not exceed 15 kg [4].

The current child restraint system fixation mainly for vehicle seatbelt fixed, ISOFIX interface with auxiliary devices (lap belt or support legs) fixed. Many manufacturers in order to make the child restraint system more secure, in the use of vehicle seatbelt fixed at the same time will add a lap belt or ISOFIX, so as to achieve the effect of reducing the displacement. Figure 3 shows the number of tests performed on the fixed system of child restraint system, which a fixed number of test vehicle seatbelt 54 times, according for more than half of the total number of tests. This is mainly because of group II and III test dummy restraint for vehicle seatbelt.



Number of child restraint systems tested (Total N=86)

Fig. 3 Child restraint system fixation

Among the 86 tests, the child restraint system failed in the form of head displacement beyond, seat damage and seat belts from the guide out of three types. The number of tests that did not meet the requirements of the regulations was 18 times, in which the child dummy head horizontal displacement exceeds quantity 14 times. The number of seats damaged after the test 3 times and the seatbelt was pulled out from the guide device once. Dummy head horizontal displacement beyond is the main factor of failure of the child restraint system. The reality will cause the child's head and the vehicle front seat collisions, thereby increasing the risk of child occupant injury. If the child restraint system is damaged after the test, the vehicle seatbelt remove from the guide device, even if the dummy injury index meets the test requirements, it is also unacceptable.

4 Child restraint system test data analysis

Table 1 for the five ISOFIX child restraint system misuse test, except forD child restraint system quality is 6.5 kg, the rest of the 4 child restraint system quality in more than 10 kg. Misuse test used is the largest group I dummy P3, dummy fixation is 5-point harness restraint and the seat fixed way for the ISOFIX interface with the test sled rigid connection.Except forB and E two kind of child restraint systems P3 dummy head displacement are less than regulatory requirements limit 550 mm, the rest do not satisfy regulatory requirements.D child restraint system appeared fly headrest fracture phenomena during the test. The regulations require that child restraint system can't appear any damage after the test.

Table 1 child restraint system misuse test

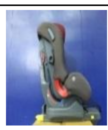
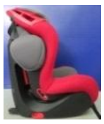
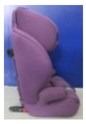
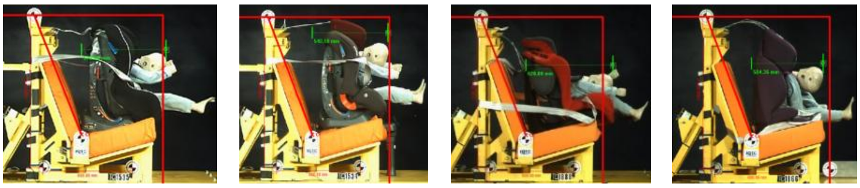
Picture					
Name	A CRS	B CRS	C CRS	D CRS	E CRS
Weight	10.2kg	14kg	12.9kg	6.5kg	11.4kg
Head horizontal maximum displacement	570mm	542mm	620mm	Headrest fracture	504mm

Figure 4 shows the corresponding maximumhorizontal displacement of the momenton four child restraint systems except the D child restraint system. From the figure we can see that, since the base ISOFIX interface is rigidly connected with the test vehicle, the dummy will move forward along with the child restraint system around the ISOFIX during the early movement period, and then the dummy will continue to move under the action of the 5-point harness. The smaller flip angle of the child restraint system, the smaller head displacement will be.C child restraint system in the course of the test process although the seat flip angle is very small, but the 5-point harness can’t effectively limit the dummy’s body so that dummy continue to move forward, the head displacement of dummy reached 620 mm at 120 ms.



A CRS 104ms B CRS 108ms C CRS120ms ECRS 104ms

Fig. 4 Child restraint system misuse of head maximum displacement corresponding moment

The F and G child restraint systems shown in figure 5 were tested about group II and III, whichrespective usedvehicle seatbelt and vehicle seatbelt with ISOFIX. The statistics of F CRS were P3, P6 and P10 test, G CRS for P6 and P10 test.

Both child restraint systems in vehicle seatbelt and vehicle seatbelt with ISOFIX the head horizontal displacement of the dummy is shown in figure 6. From the figure can be found, G child restraint system for the P6, P10 dummy test whether the vehicle seatbelt fixed or vehicle seatbelt with ISOFIX fixed way, the dummy head horizontal displacement than F child restraint system was significantly higher. For P3, P6 lighter weight dummies, ISOFIX can effectively limit the amount of child restraint system slippage, so that the vehicle seatbelt with ISOFX fixed dummy head horizontal displacement is less than vehicle seatbelt fixation. For P10 larger weight dummy, ISOFIX limit seat displacement of the poor results, on the contrary will increase the dummy head displacement.

F CRS G CRS

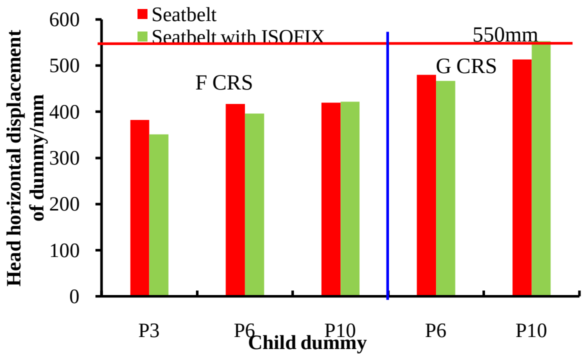


Fig. 5 Child restraint system **Fig. 6 Head displacement of dummy in two fixed**

5 Conclusions

(1) In child restraint system test statistics found that cross-group products accounted for half of the total, the seat weight is mainly distributed in the 4~10 kg and the head displacement is beyond the main form of child restraint system failure.

(2) In the fixed mode of group II and III test analysis of known that for P3, P6 lighter weight dummy, ISOFX can effectively reduce the dummy head displacement, and for the larger P10 dummy, ISOFIX effect is not obvious, but may increase the head displacement. At the same time, the vehicle seatbelt restraint system dummy head displacement are in the statutory requirements of the limit of 550 mm range, the proposed group II、III test using vehicle seatbelt restraint can be.

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