Replacement of Child Seats After A Collision

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Abstract

Child Restraint Systems (CRS) have been shown to significantly reduce the potential for injuries to child occupants in motor vehicle accidents. Provincial and Federal regulations in Canada govern both the use and the performance requirements for new CRS.

In recent years, Manufacturers have included notices in owner's manuals which recommend the CRS be replaced in the event the vehicle in which it was installed is involved in a collision. These recommendations make no reference to any minimum severity threshold that would warrant replacement. Caregivers and other persons who are responsible for the decision to replace a CRS following a minor or moderate impact are often not satisfied with the lack of information or minimum threshold replacement guidelines, and are unable to make an informed decision. Many are unwilling to incur the replacement expenditure following low speed impacts in which they do not believe the CRS was damaged. Lack of accurate threshold data can lead to either unnecessary expenditure, or to non-replacement of CRS that should be taken out of service.

This paper outlines the results of a series of low speed CRS sled tests, and the durability of the seats in these tests.

Résumé

Il a été démontré que les systèmes de retenue réduisent considérablement le risque de blessures aux enfants dans les accidents de la route. L'utilisation des systèmes de retenue ainsi que les critères de fonctionnement de nouveaux systèmes de retenue sont gouvernés par les règlements provinciaux et fédéraux du Canada.

Ces dernières années, les fabricants de systèmes de retenue ont inclus dans les manuels d'instructions des avis qui recommandent le remplacement de systèmes de retenue impliqués dans une collision de voitures. Ces recommandations ne font aucune référence au seuil de sévérité minimum qui en justifierait le remplacement. Les personnes qui ont la charge d'enfants et qui sont responsables pour la décision de remplacer un système de retenue après une collision mineure ou moyenne sont souvent insatisfaites du manque de critères de remplacement selon un seuil minimum et de là, sont incapables de prendre une décision informée. Plusieurs personnes ne sont pas prêtes à encourir les frais de remplacement après les collisions à basse vitesse.

Ce document décrit les résultats d'essais contre une barrière à basse vitesse et la résistance des systèmes de retenue durant ces essais.

Figure 1. CRS sled testing

Introduction

When CRS first came into popular use in the early 1980's there were no guidelines for replacement following a collision. As a general rule, seats that showed physical damage would be replaced, but if no visible damage was evident, no replacement was undertaken. In the past few years however, CRS Manufacturers have included statements to the effect that "*If this car seat is in an accident, it must be replaced. Do not use it again! An accident can cause unseen damage and using it again could cause serious injury or death*" [1].

Such disclaimers do not include any information or specifications to define the term "an accident", but the general understanding of caregivers is that this must include a collision exceeding a certain minimum threshold. No CRS Manufacturer has indicated what this minimum threshold might be, or even if one exists.

On the other hand, caregivers are often not convinced that their CRS is unsafe to continue to use after a very minor low speed impact, and are unwilling to incur the cost of replacement in such circumstances. Similarly, many Insurance Companies cover the cost of CRS replacement under the automobile collision policy, but such policies often specify replacement of *damaged* items only. Coverage for replacement of undamaged seats following low speed impacts is unclear. To date, there has been no research published to support or refute the need to replace CRS under such circumstances. This can lead to incorrect, costly, or potentially unsafe replacement decisions.

In order to provide useful information to these groups, the author has conducted tests of CRS in simulated low speed impacts. These tests consisted of two separate series of crash tests;

- Four preliminary full-scale vehicle crash tests were conducted at speeds of 48 km/hr and 64 km/hr into a 40% offset barrier. Three different CRS were mounted in a series of 1989 and 1990 Ford Tempo vehicles and repeatedly crashed to determine what failure modes could be observed. This information was used to determine a visual inspection protocol for use in later low speed crash testing.
- Nine different CRS representing various styles, manufacturers, and ages were mounted on a test sled and impacted fifty times each. The impact speed was 15 Km/hr with a deceleration of approximately 10 g. The seats were then subjected to a number of post-crash tests to determine if they had sustained any damage. Post-crash tests included visual inspections, pre and post crash x-ray examinations, and dynamic compliance tests in accordance with Canadian Motor Vehicle Safety Standard 213.

The results of these tests have been detailed in a videotape, copies of which can been made available to caregivers, and other persons involved to provide them with information to assist in determining the need for replacement of CRS.

High Speed Crash Tests

Four high-speed crash tests were conducted at PMG Technologies in Blainville, Quebec. The tests were in conducted as a joint endeavor with the Insurance Corporation of British Columbia (ICBC), and Manitoba Public Insurance (MPI).

MPI was also testing adhesive bonding repair techniques on the same vehicles.

Two CRS were mounted in the two rear outboard seating positions of each test vehicle, and appropriate sized child ATD's were installed in each seat. Test seats used included a front facing T-shield design, a front facing 5-point harness design, and a rear facing design with a detachable base mounted in the car. All front-facing seats had tether straps attached. Each seat was subjected to multiple impacts – two to four impacts – to determine failure modes in multiple high-speed crashes.

The vehicles were front-impacted into an offset barrier. High-speed cameras monitored the motions of the CRS and the child ADT's during each impact.

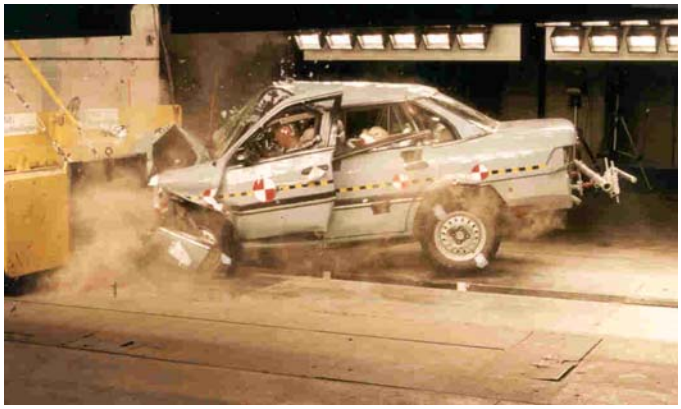

Figure 2. 64 km/hr crash test

Following each barrier impact, the CRS were removed from the vehicles and visually inspected. If a defect was observed in the visual inspection, the defect was noted, and the CRS re-tested to determine the performance effects of that defect. If no defect was observed, the CRS was subjected to additional impacts to determine its durability in multiple consecutive high-speed impacts.

Some of the CRS exhibited deterioration in their first test, although non failed to restrain the ATD. Seats always performed as well in subsequent tests as they did in the first test.

The latch plate on the T-shield seat was bent foreword approximately 2 cm in the first impact.. No further deterioration of the latch plate was evident in subsequent impacts.

The 5-point harness seat performed well in all tests, although researchers did introduce a tether strap failure by misapplication of the tether on the first impact of this seat. This did not affect the performance in subsequent impacts (after correction of the misapplication).

The rear-facing seat performed well in four consecutive tests. Researchers were unable to note or introduce any failure in this seat. Following these tests, a visual inspection protocol was developed for post crash inspection of CRS.[2]

Similar tests have been since conducted by the Insurance Institute For Highway Safety (IIHS). In a series of 48km/hr car to car crash tests, using twelve different CRS, the IIHS observed some minor damage to several of the seats. However, upon re-testing the same seats in subsequent 48km/hr impacts, they concluded that the seats still succeeded in restraining the test dummies through the second impact.[3]

It is unlikely that caregivers would be comfortable nor would they be well advised to continue with use of a CRS after a major impact such as the ones included in either of these test series. These tests did illustrate, however, that CRS are very durable devices. Researchers were thus led to believe that it would be appropriate to conduct a series of lower speed tests to determine the effects of moderate speed impacts. Consequently, the testing moved on to phase two: low speed impacts.

Low Speed Crash Tests

Nine CRS were selected for a series of low speed crash tests on a test sled. The seats were chosen to include a cross section of CRS representing most popular manufacturers and configurations. In order to represent in-service conditions, seat ages ranged from new to ten years old, and installation on the test sled incorporated typical amounts of belt slack.

The seats were mounted on a test sled, which was propelled into a fixed barrier. These facilities were located at B.C. Research Inc. on the campus of the University of British Columbia. B.C. Research staff conducted the testing. Seats were tested in groupings of three.

A crash pulse for the sled was developed to duplicate the results of full vehicle crash tests conducted for insurance rating purposes by members of the Research Council For Automobile Repairs (RCAR). [4]

The RCAR test is a 15km/hr impact into a 40% offset barrier. It normally generates a deceleration rate of approximately 10g when measured at the base of the vehicle's C pillar on the impacted side. The crash pulse was tuned to replicate this 10 g pulse by control of the sled approach speed (15 km/hr), and placement of energy absorbing foam on the barrier face.

Figure 3. Test sled with three CRS mounted

Each seat was then impacted into the barrier a total of fifty times. Results were monitored through recording of the pre-impact speed of the sled, deceleration of the sled, and through high speed video (1000 frames/sec).
Following fifty impacts, the CRS were removed for inspection, and replaced with the next series of test seats.

The tested CRS were then divided into three groups for follow up inspections. The first group was given a visual inspection according to the protocol developed in the previous high speed crash testing. This followed normal CRS inspection criteria including checks for deformation or stress cracks in the plastic shell, checks for stretching or fraying of the belt webbing, and checks of latch integrity and operation. No signs of deterioration were found in any of the seats in these inspections.

The second set of three seats had been send to Canspec Group Consultant Engineers in Richmond B.C. before the sled testing for preliminary x-ray inspection. They were then returned to Canspec for follow up x-ray inspection to determine if any internal, non-visible deterioration had taken place. The result of the follow up inspection was negative. No damage was found on any of the seats.

The third group of three seats was sent to the Defence and Civil Institute of Environmental Medicine (DCIEM) in North York Ontario, for testing in accordance with Canadian Motor Vehicle Safety Standard 213 (Dynamic Testing of Child Restraint Systems). This consists of a simulated 48km/hr impact with specified limits to head excursion and chest deceleration. All three seats were still in compliance with standards for new CRS in these tests.

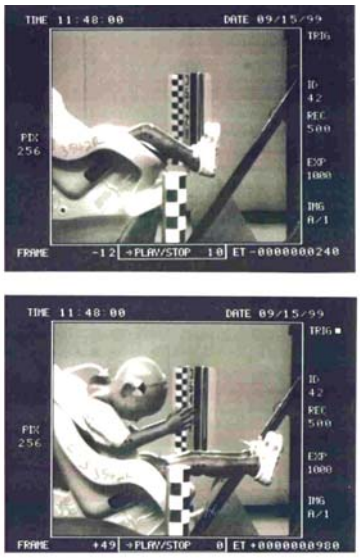

Figure 4. CMVSS 213 Testing of subject seats

Crash Pulse

The impact speed of 15-km/hr and attendant crash pulse was selected for the low speed tests for a number of reasons;

- It is a crash pulse that replicates typical damage from a moderate speed impact. Occupant protection standards Compliance tests for occupant protection and bumper standards are not within this typical crash range.
- It is used by Insurers worldwide for damagability rating, and there is significant documentation to illustrate the physical appearance of a typical vehicle after such an impact. This documentation can be helpful in determining if a particular subject vehicle has been in a crash of similar magnitude. (See figure 4)
- Based on Insurance Loss Cost Statistics, close to 70% of motor vehicle crashes would appear to

involve impact speeds that are equal to or lesser than the one replicated in this test. While the results of this research indicate that a no-damage threshold for CRS is probably higher than the 15-km/hr RCAR test, this will still give usefully information related to a majority of vehicle crashes.

Figure 4. Typical vehicle damage in RCAR test.

The crash pulse used in these tests was developed to replicate an actual crash pulse from a typical RCAR test, and was supplied by Thatcham Research in the United Kingdom. Like many RCAR members, Thatcham Research continually conducts these tests for Insurers and Auto Manufacturers.

Discussion

Low to moderate impacts used in these sled tests caused no damage to the CRS, even after fifty impacts on each seat. All CRS involved in these tests passed all subsequent inspections and tests to which they were subjected.

There may be non-technical considerations that could lead to replacement of CRS following such impacts, including social, psychological, or business reasons. However, these low speed tests showed no physical deterioration in the seats that would warrant their replacement.

A videotape of this research has been prepared, and can be used to provide caregivers with useful information in making a replacement decision following a minor front-end impact.

Further research may be in order to investigate the effect of minor side impacts on CRS replacement requirements.

References

[1] Smart Fit Series Instruction Manual, PM 1070AA. Century Products, 9600 Valley View Road, Macedonia, Ohio. P2

[2] Gane, J; Replacement of Child Seats After a Collision. Research Council For Automobile Repairs, Madrid Spain 1999

[3] Tough Strong Durable; Insurance Institute For Highway Safety Status Report, April 2000. P 1-6

[4] Research Council for Automobile Repairs; The Procedure For Conducting a Low speed 15 km/hr Offset Insurance Crash Test. RCAR 1999 (www.RCAR.org)