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Short Report

Side Impact Testing with Big Rear-Facing Scandinavian Child Restraints

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Contents

Contents 1
1 Introduction 2
2 Methodology 2
3 Test Results 2
3.1 Head Acceleration 2
3.2 Neck Loads 3
3.3 Chest 4
3.4 Pelvis 5
3.5 Synthesis of Test Results 6
4 Analysis of the Test Results 6
5 Conclusion 6
6 Bibliography 7

1 Introduction

The current proposal for the ISO Side Impact Test Procedure for Child restraint Systems utilises a hinged door concept, where the intrusion is realised by a pivoted panel. Due to this concept the linear intrusion velocity is dependent on the distance of the dummy to the hinge line. Dummies positioned far from the hinge line experience higher linear intrusion velocities than dummies with a closer location.

Especially in Scandinavia rear-facing child restraints are used up to an age of six years. Up to three to four years of age almost all children in Scandinavian countries are transported in RF CRS. This restraint condition is mainly meant to improve safety in frontal impact conditions. However, recent accident analyses indicate also advantages for side impact accidents [Jakobsson, 2005; Crandal, 2005].

Experts of the Scandinavian countries feared that their big rear-facing child restraints could be discriminated by a hinged door test procedure because of the larger distance of the head to the panel hinge line compared to other FF and RF restraints.

To analyse the behaviour of these child restraints two different samples (ECE R44 group I and group I/II) have been tested and compared with forward facing group I seats.

2 Methodology

Three different forward facing and two different rear-facing child restraints were tested according to ISO WG1 document N741 [ISO, 2006] with a Q3 dummy. One of the RF samples was tested with and without lower tethers; the other one only with lower tethers.

All FF CRS selected for this comparison offer good side impact protection (e.g. good head containment).

3 Test Results

Especially head, neck and thorax are the body regions with considerable injury frequency in lateral impact accidents. The analysis of the test results comprises head, chest and pelvis acceleration as well as neck loads and chest compression.

3.1 Head Acceleration

Figure 1 shows considerably lower head acceleration for the tests with the rear-facing CRS.

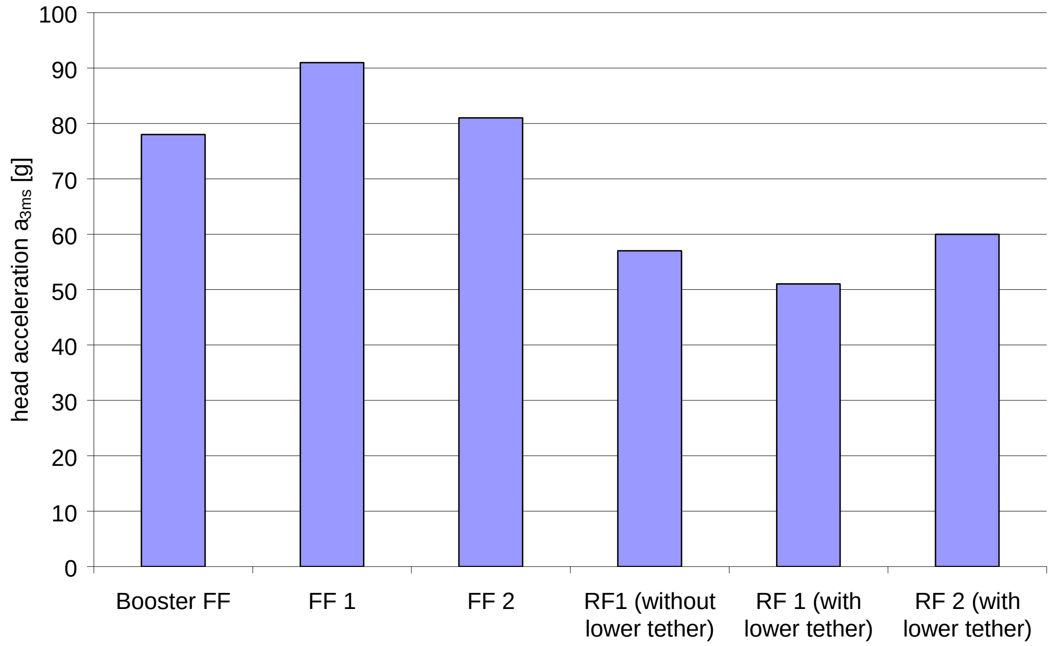


Figure 1: Head acceleration

3.2 Neck Loads

With respect to the neck loads the tension force FZ and the moment MX are felt to be adequate indicators for the injury risk.

The neck tension forces are also lower than those of the FF CRS, see Figure 2.

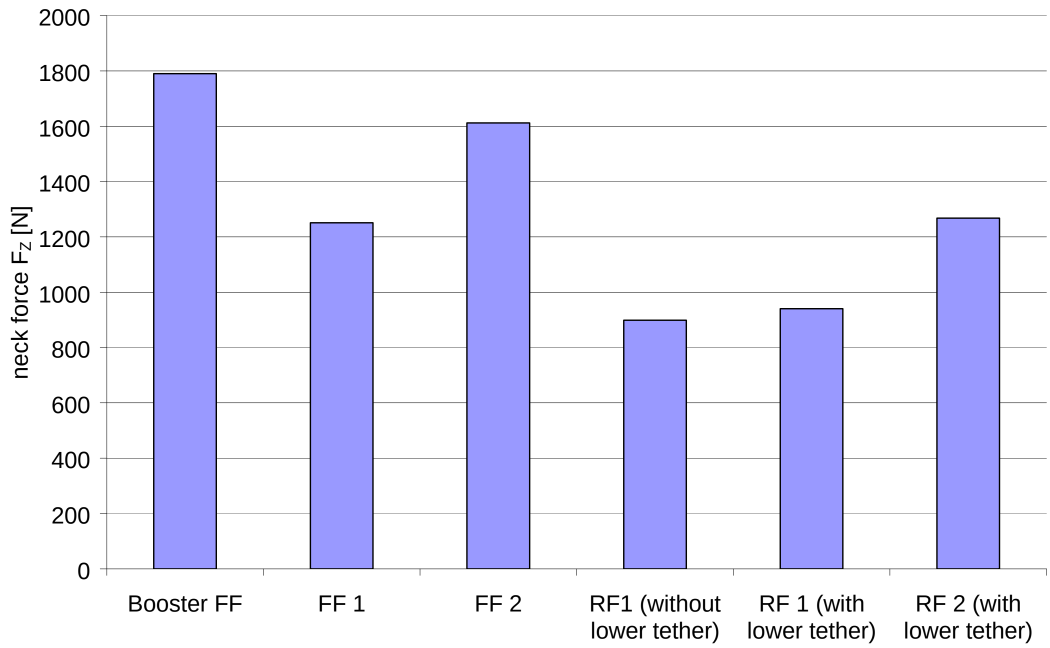


Figure 2: Neck tension forces

Looking at the neck moments no significant difference between RF and FF CRS can be observed, Figure 3.

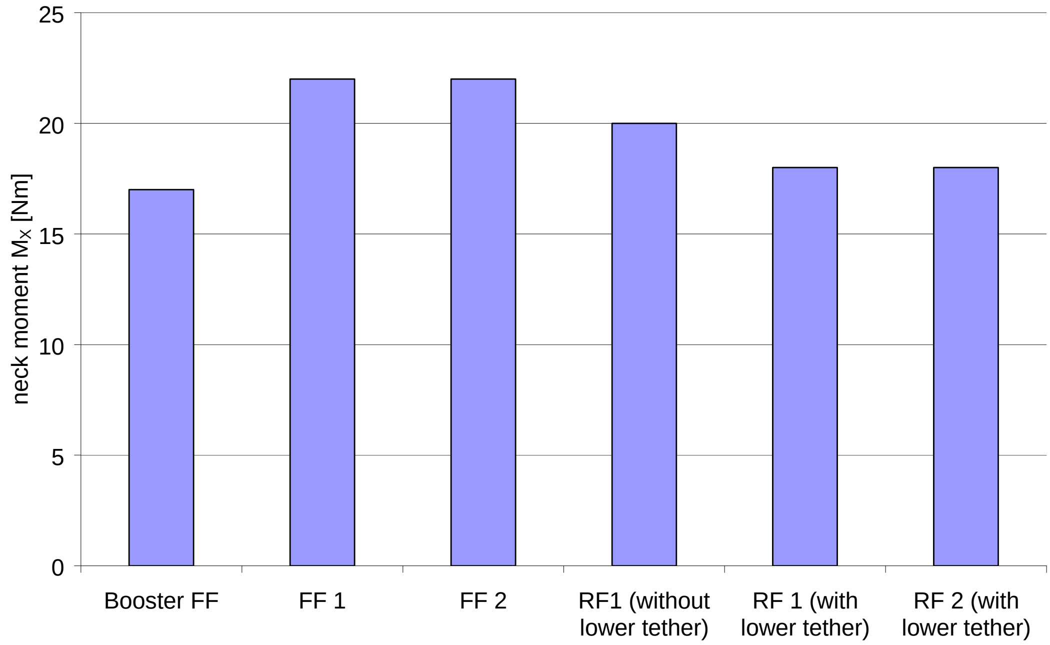


Figure 3: Neck moment M_X

3.3 Chest

To assess the chest loading both chest acceleration and chest compression can be analysed.

The chest acceleration is considerably lower for the tested RF seats compared with the FF ones, see Figure 4.

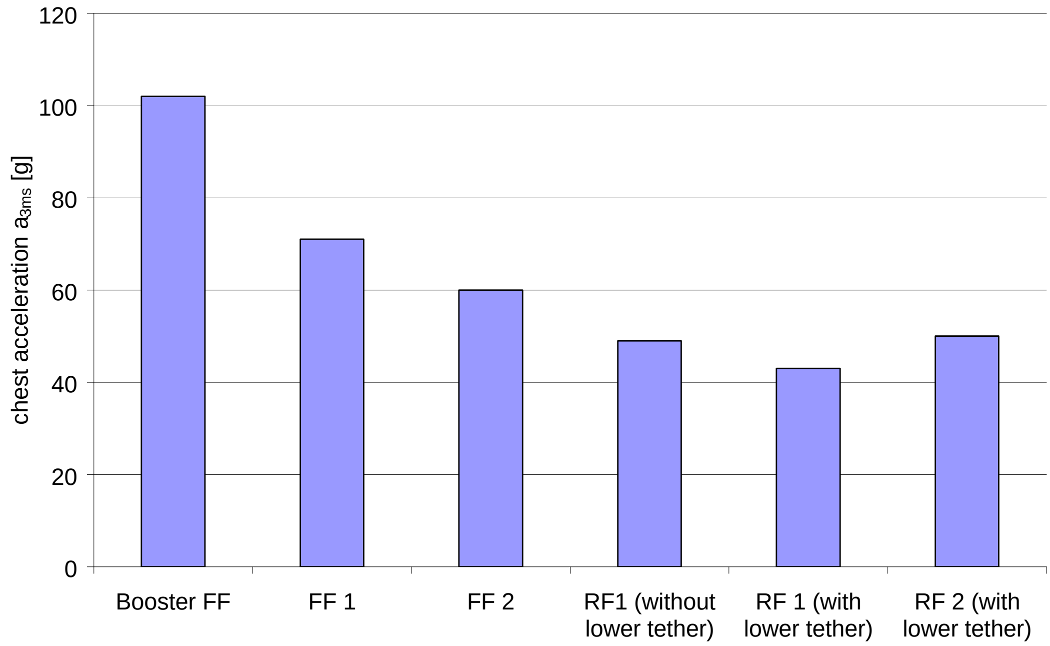


Figure 4: Chest acceleration

Regarding the chest deflection there is no significant difference between RF and FF seats, see Figure 5.

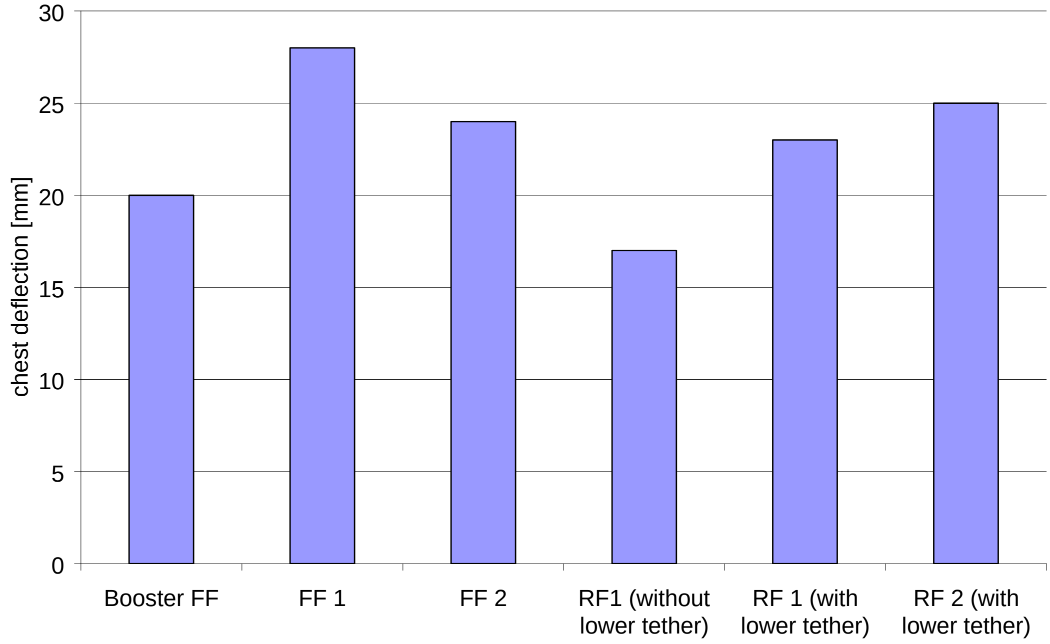


Figure 5: Chest deflection

3.4 Pelvis

The pelvis acceleration represents the pelvic loads. Although a considerably low number of pelvic injuries can be observed in the field, it seems to be important to observe this value.

The pelvis acceleration measured in the test series shows minor advantages for the RF CRS, see Figure 6.

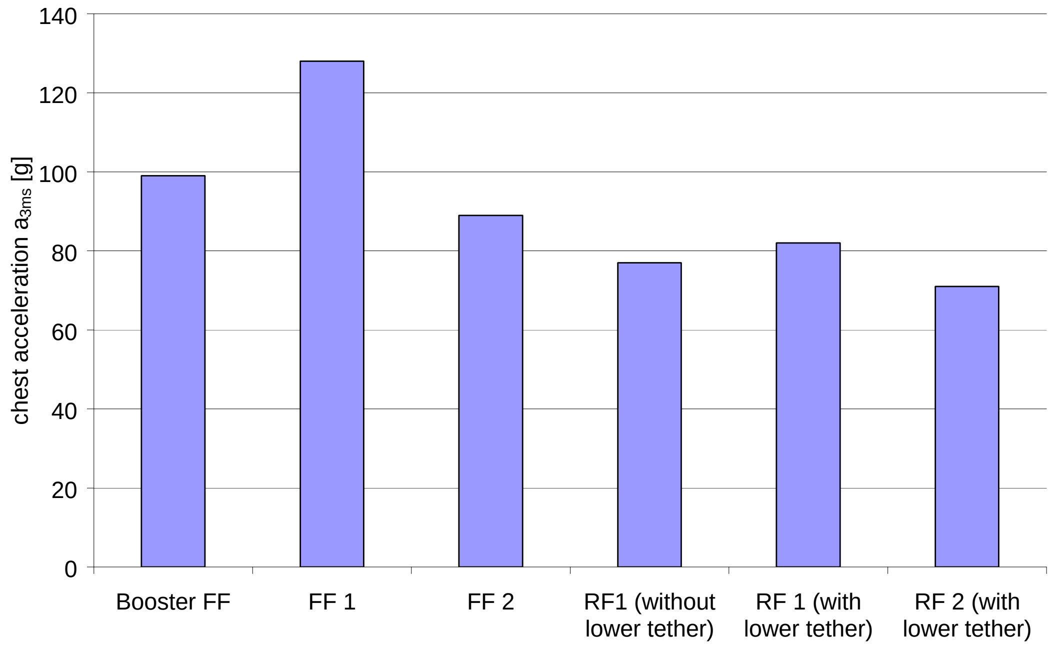


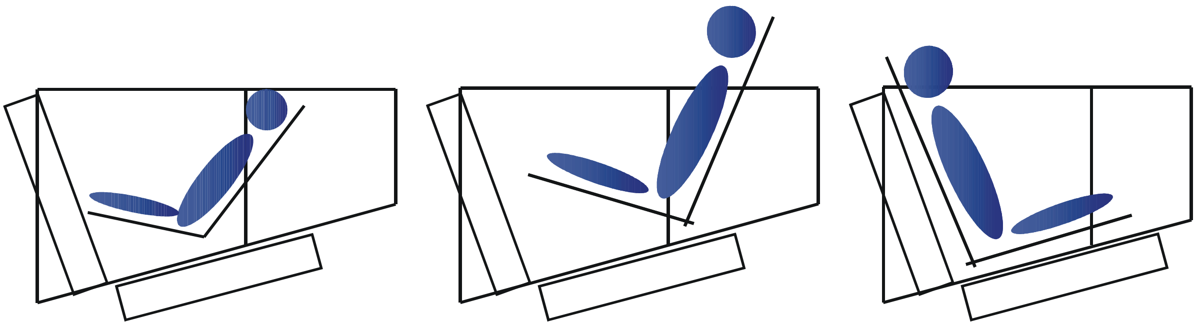
Figure 6: Pelvis acceleration

3.5 Synthesis of Test Results

All measured dummy readings show either advantages for the tested rear-facing child restraints (head acceleration, neck tension forces, chest acceleration, pelvis acceleration) or no clear difference between big RF and FF group seats (neck bending moments and chest deflection).

4 Analysis of the Test Results

There are two “competing” parameters to influence the dummy response. On the one hand the horizontal distance between hinge line and dummy head (larger distances result in higher dummy readings), on the other hand the vertical distance between upper panel edge and dummy head (larger distance results in lower dummy readings as only parts of the dummy are loaded directly by the panel). In addition the test procedure defines a lower angular velocity for RF CRS compared to FF CRS, which also leads to lower dummy readings. Figure 7 shows the theoretical differences between the different CRS types. The differences in head position are clearly visible.



baby shell big RF FF

not to scale

Figure 7: Principle sketch showing CRS and dummy position depending on CRS type

For these reasons no discrimination of Scandinavian RF CRS can be expected.

5 Conclusion

Scandinavian experts on child restraint testing expressed their worries; their big RF seats could be discriminated due to the hinged door concept proposed for the ISO Side Impact Test Procedure according to ISO WG1 document N741.

A test series with RF and good performing FF seats tested with a Q3 indicate lower dummy readings for the RF child restraints.

The main reason for the lower readings is the higher position of the CRS with respect to the upper panel edge.

6 Bibliography

Crandall, J.; Sherwood, C.: Factors Influencing the Performance of Rear Facing Restraints in Frontal Vehicle Crashes, 3rd International Conference – Protection of Children in Cars, Munich, 2005

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Jakobsson, L.; Isaksson-Hellmann, I.; Lundell, B.: Safety for the Growing Child – Experience from Swedish Accident Data. 19th ESV Conference, Washington DC, June 2005.