Autist mobile seat’s frame strength simulation used in a car

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Submission date: 21-Feb-2022 06:31PM (UTC+0700)
Submission ID: 1767504166
File name: Autist_mobile_seat_s_frame_strength.pdf (1.41M)
Word count: 1952
Character count: 9436

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Cite as: AIP Conference Proceedings **1725**, 020086 (2016); https://doi.org/10.1063/1.4945540
Published Online: 19 April 2016

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Autist Mobile Seat's Frame Strength Simulation Used in A Car

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Abstract. Going on a car with autistic children needs a special handling. Autistic children that tend to be hyperactive in the car may disturb driving. A tool is needed to keep them in a calm state when they are in the car. Autist Mobile Seat is an aid for the autistic children when going on a car. The aid is an additional seat paired with the main seat of the car. This aid consists of three main things: Main frame, body skin, and pneumatic system. Frame as the main component supporting the Autist Mobile Seat functions as a holder as well as a body skin retainer in order to be able to retain the body of the autistic children. The strength of the frame from this Autist Mobile Seat should be counted as an anticipation from the failure of the frame function when receiving load when used by the autistic children in the car. Consequently, a test on the frame of the Autist Mobile Seat towards the load received should be conducted by using a method of FEM (Finite Element Method) with the help of commercial software. The simulation produces the maximum strength, the frame towards the load received as well as the critical point on the frame when loading occurs.

INTRODUCTION

As an aid in driving for autistic children, Autist Mobile Seat plays an important role in keeping the children in a seating position in a vehicle. Children with behavioral challenges, such as autism spectrum disorder and attention deficit hyperactivity disorder (ADHD) may also require special needs restraints [1]. It could be strategy for improving road safety such as strategy for child seat, or more broadly child resistant systems (CRS) [2]. Children who cannot achieve good belt fit with vehicle belts alone should be seated in appropriately sized harness restraint or in a belt-positioning booster [3]. Belt-positioning booster seats are recommended for children who use vehicle seat belts as primary restraints but who are too small to obtain good belt fit [3]. In this case, the CRS type for older children is seat booster. Autist Mobile Seat could be categorized as a seat booster for children who could not use seat belt perfectly; thus, a cushion should be added to help children sit in a higher seating position, so that, the seat belt could be transverse from the shoulder to the child's abdomen perfectly. When children sit in a vehicle seat that is too large for their bodies, they will slide down, so that, they can bend their knees at the edge of the seat [4]. Booster seats are designed to provide specialized protection for older children who have outgrown their child restraint system (CRS) but are too small to fit into an adult seatbelt [5]. The installation of autist mobile seat uses a belt fastener vertically looped into the car seat (Figure 1).

The belt fastener mobile seat fastens three points on the frame of autist mobile seat, two points on the above; whereas, one point is in the middle. Those three points are connected by using a nylon belt equiped with a belt length adjuster and a belt fastener. That frame gives a cushion to the fabric skin consisting of anarm handle and a

The 3rd International Conference on Advanced Materials Science and Technology (ICAMST 2015)
AIP Conf. Proc. 1725, 020086-1–020086-6; doi: 10.1063/1.4945540
Published by AIP Publishing. 978-0-7354-1372-6/$30.00

foam pad. The frame consists of three main parts, an upper, middle, and bottom parts, in which each part is connected by hinges.

The use of autist mobile seat in a vehicle fastens the children by the arm handle on the upper body parts including shoulder to stomach, the middle body parts including upper legs, and the bottom body parts from knees down. When the vehicle is braking, the child's body could be held for not moving forward, his weight could be held by the arm handle which is forwarded to the frame via the frame of the belt fastener in Figure 2. Each of the frame parts consists of four belt fasteners made of nylon which is looped horizontally or vertically on the frame; the belt fastener is firmly installed to prevent the release of the fabric skin from the frame when the child pulls from the front.

Figure 1. The installation of autist mobil seat belt on a vehicle seat.

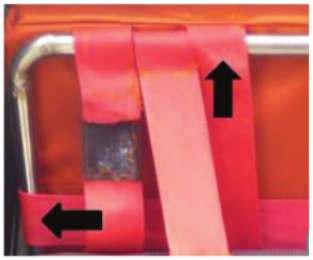

Figure 2. A frame belt fastener.

METHODS

On the frame (Figure 3) is the main component building autism mobile seat, as a connector from fabric skin to the vehicle seat via the belt fastener. Then, in the present study, the frame is simulated by using finite element method; the software used is Solid Work. Finite element models can accurately predict deformations [6]. The frame from autist mobile seat would be designed according to the original dimension of the frame. The model must always contain all component with a strong influence on the resulting values [7]. However, the components from the frame are simulated only for the upper parts which experience a pull from the child's body as well as being directly connected to the vehicle seat (Figure 4).

A proposal process conducted is by using the ECE 44 method; this standard is a standard test for child booster seat which applies in Europe, Middle East, and most of Asian countries. This test employs a crash test dummies which is placed on the booster seat tested; then, placed on the vehicle seat tested. Furthermore, the vehicle dummy is to have a frontal crash in the speed of 50 km/ hour. In the present study, a simulation of crash test would be conducted by employing the FEM method. There are some materials chosen on the software such as ASTM 3161 SS sheet. Further, the yield strength is given to the frame as much as 20-28 G. The pulse is the same as in ECE 44 (child

restraints): with a peak deceleration of 20 Gto 28G [8]. Nevertheles, if the frame does not meet the standards from ECE 44, the force which is below the yield strength from the frame of autist mobile seat would be given. According to the observation on the frame of autist mobile seat, there are 8 points of yield strength as well as three holders or constraints on the form of the belt fastener to the vehicle seat. Those points would be interpreted in the software of solid work as the points of yield strength and constraints (Figure 5).

Figure 3. The frame of the autist mobile seat.

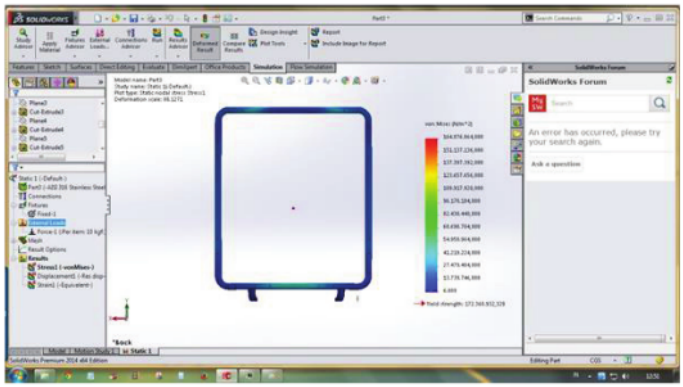

Figure 4. The autist mobile seat modelling.

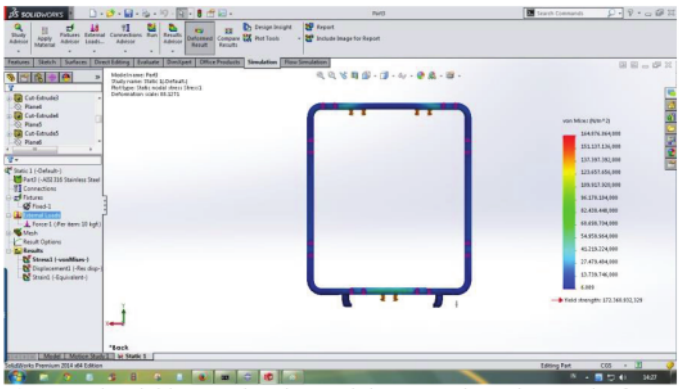

Figure5.The yield strength points and the constraint points on the frame.

RESULTSAND DISSCUSION

After the simulation towards the strength of autist mobile seat is conducted, yield strength is obtained from the materials of ASTM 316l SS sheet as much as172 Mpa. The data from the yield strength would be compared with the stress found on the frame of autist mobile seat on the form of von mises data. Figure 6 is an image from the result of modelling the autist mobile seat's frame strength in which on the front side of the image, shape changes could not be seen; nonetheless, seen from the left and right sides of the image, its shape changes due to loads. On the first test with the stress of 20 G, frame receives a maximal stress as much as 329 Mpa (Figure 7). On the test with the stress of 28 G, von mises stress obtained is 461 Mpa (Figure 8).

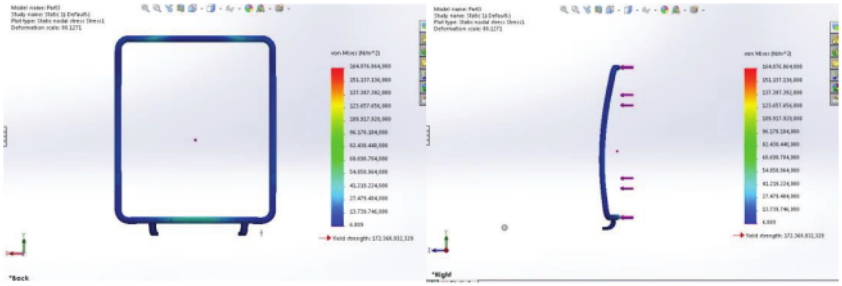

Figure 6. The simulation of the autist mobile seat frame.

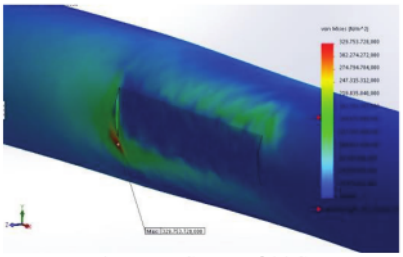

Figure 7. Stress of 20G.

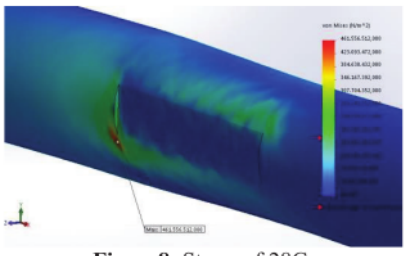

Figure8. Stress of 28G.

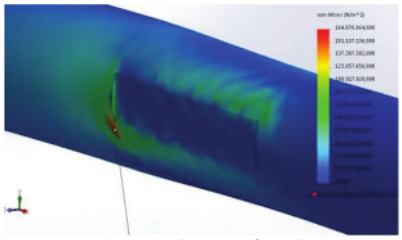

Figure9. Stress of 10 G.

Table 1. A stress test on the frame.

Stress G force (G)	Yield strength frame (Mpa)	Max Von mises (Mpa)	Pass
10	172	164	yes
20	172	329	no
28	172	461	no

From the tests above, we attempt to discover the safe limits of the stress given to the frame, so that, when force is given, the frame could still survive. From the test conducted, we discover that the greatest stress of 10 G is still below the yield strength points from the frame Table 1. Consequently, the magnitude of the stress is the safe limit towards the stress which could be accepted by the frame.

CONCLUSION

From the tests conducted, we discover that the frame of autist mobile seat could hold the stress of 10 G with the von mises stress of 164 Mpa. It is below the yield strength stress owned by the materials building the frame of autist mobile seat of 172 Mpa. When the same stress is given on the tests with dummie test on the standard test ECE 44 as much as 20 G – 28 G, the magnitude of von mises that occurred to the frame is as much as 329 – 461 Mpa. The values revealed is above the yield strength value of the autist mobile seat materials. Consequently, when the real tests by employing the standard test ECE 44 are conducted on the autist mobile seat, the greatest possibility obtained is the frame would undergo a malfunction.

The increase of the strength of the autist mobile seat could be achieved by changing the types of materials that have higher yield strength values. It could also be conducted by changing the frame design rigidly as well as adding the number of belt fasteners that connected the fabric skin to the frame, and the frame to the vehicle seat.

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