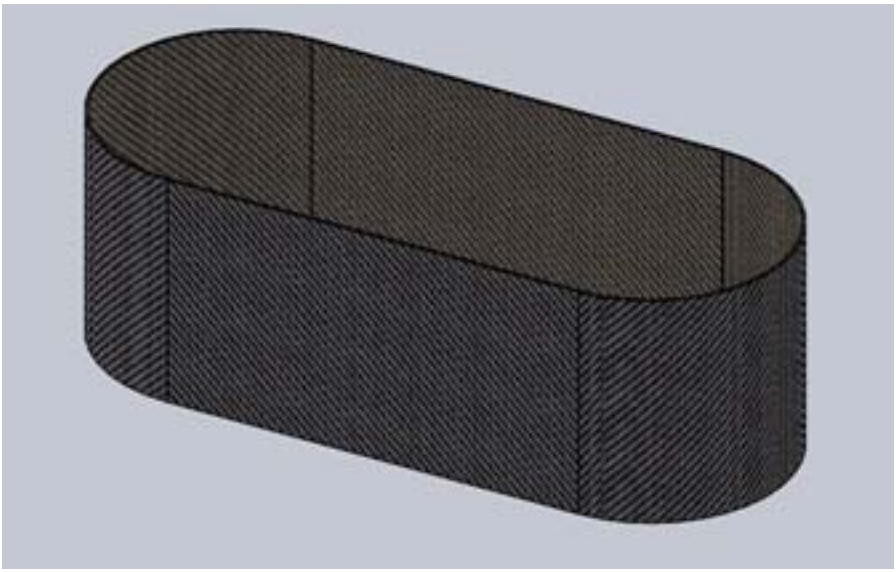


Figure 5.4

The cot

The material chosen for the cot is polyester and has the following characteristics:

- Material: 100% polyester
- Composition: 100% IRF polyester fireproof knitted fabric
- Feature: Flame retardant
- Weight: 210 g/m^2
- Characteristics: Fireproof, durable against norm washing, non-poisonous, smell freely, safe to human body, soft and comfortable

Since it is possible to observe this material is a fireproof material expiring with the regulation marked in reference to the materials used in the components of aircraft. In addition this material expires with the certifications in the United Kingdom as for example the standards BS5815-3, BS5852 or BS5866. These procedures refer to the employment of fireproof fabrics in public places and guarantee that the above mentioned fabrics are resistant to the fire since they must pass some normalized tests to guarantee their resistance.

5.2.2. Back loops

As it was said before the cot has several parts. One of them is the two back loops placed in it. The function of these ones is to hold the cot passing the belt of the adult across them.

Figure 5.5

Back loops

These loops are two straps of 17 centimetres of length and 5 centimetres of width done with the same material that the rest of the cradle, 100% polyester fireproof knitted fabric.

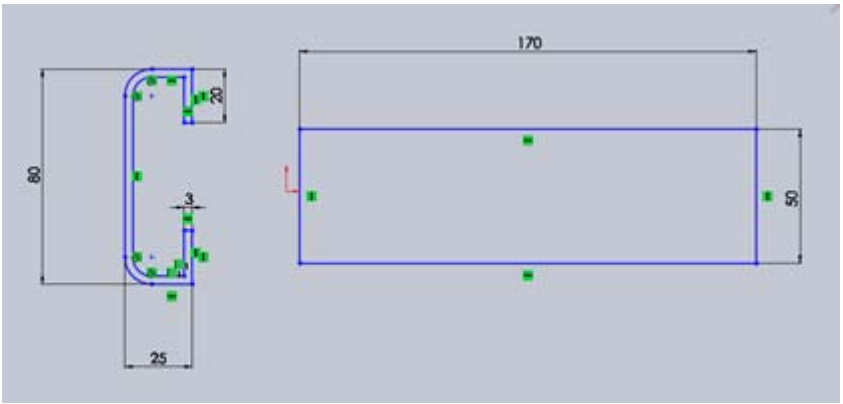


Figure 5.6

Layout of the loops

The loops are sewed in the back part of the cot and the final result is the one that it appreciates in the figure 5.5. By this form it is obtained a simple and effective fixation of the device to the belt of the adult.

5.2.3. Handles

Since it has been said before, the cot has a pair of handles to facilitate its transport in case of an emergency. As the back loops, the handles are also made of 100% polyester fireproof knitted fabric.

The handles also are sewed to the rest of the cradle and consist of a strip of 44 centimetres of length and 8 centimetres of width. After sewing them, the handles have the form of a sufficiently big semi circumference to be able to seize the cot without problems to carry it.

Figure 5.7

Handles of the cot

5.2.4. Filling material

Between the walls and in the base of the cot there is a filling of polyester, the same type of material that is used for refilling the pillows for example, to make the cot more comfortable to the infant.

By means of a cap of landfill of 4 centimetres approximately it is achieved that the cot is more comfortable for the baby and simultaneously it is provided certain protection since with the filling material it is absorbed the small movements or blows that could exist during the flight as for example in the landing.

5.2.5. Reinforcement material

In the back part of the cot there is a reinforcement material in its interior since it is a zone that must resist the efforts transmitted across the loops when turbulence or an emergency landing happens.

This material could be plastic if it is enough resistant to support most of the efforts that are suffered in emergencies. With this material it is prevented from perforate the fabric of the cot and damage both the adult and the baby.

5.2.6. Elastic wire

As the walls of the cot do not have the sufficient consistency to support the form of the base it is necessary to add an elastic wire in the top edge. This wire is placed inside the exterior cap of the cot and subject by means of a double in the fabric towards the interior as it is shown in the next picture.

Figure 5.8

Elastic wire

The length of the wire is 185 centimetres, the same as the perimeter of the base of the cot.

5.2.7. Lateral straps

In the wings of the cot there are two straps. The material used in these straps is a synthetic fiber as in the current safety belts used in all the cars. This material has some characteristics: Its minimal width must be 50 millimetres and the resistance to the traction of the straps must be equal or superior to 1500 kilograms.

In this case the measures of the straps are 5 centimetres width and 35 centimetres long and they are sewed to the wings of the cot.

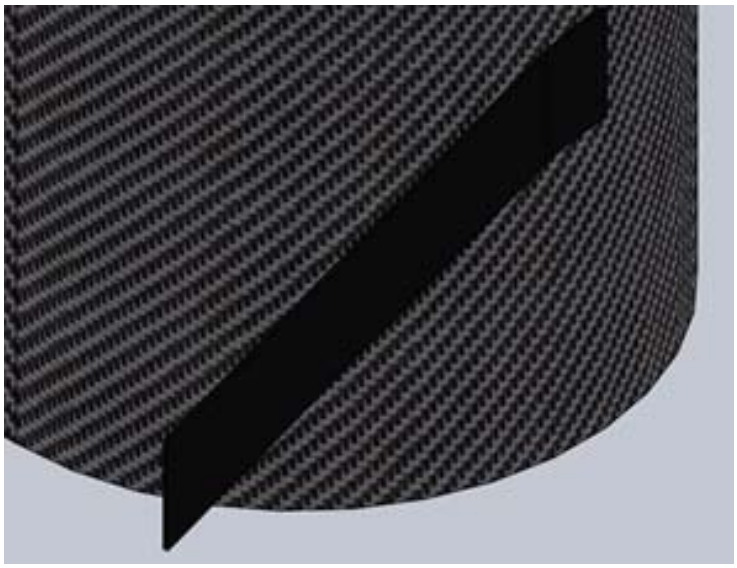
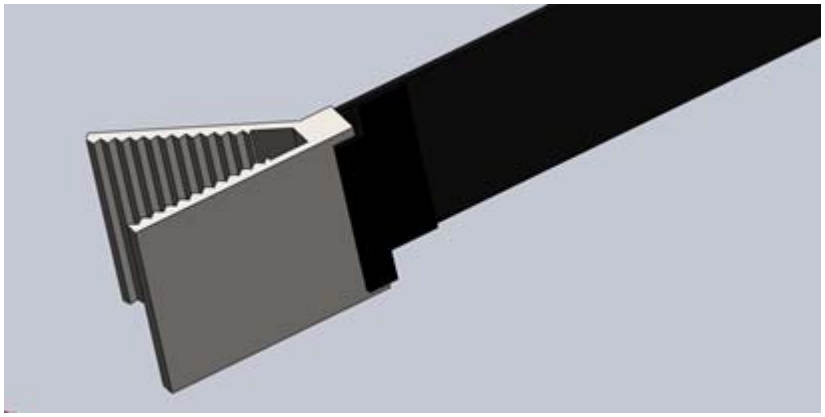


Figure 5.9

Straps

5.2.8. Metallic hookings

In the end of the straps there are two steel hookings to fix the cot to the belt of the adult. These metallic hookings are jagged in their interior to provide an ideal grasp of the device to the adult's belt since by means of the teeth of the interior it is impossible that the device can move.



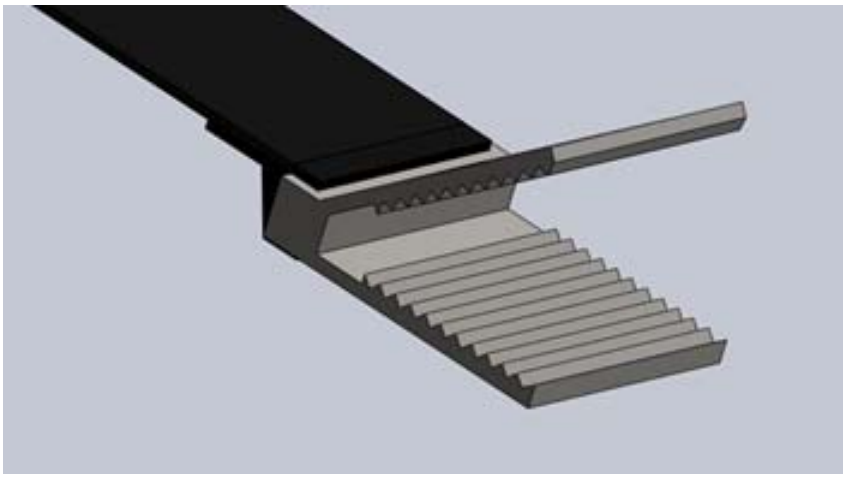


Figure 5.10

Details of the metallic hookings

These hookings are made of steel. The characteristics of this metal are not very important in what to resistance is referred for so that any type of steel can be used for their manufacture.

5.2.9. Interior hooking

The last part of the device is an interior hooking in order that the infant travels inside the cot holded without the risk of going out of the cot.

This hooking would have on the one hand a female part and on the other a male part for the anchorage and it is sewed to the base of the cot. It would be made of steel and the female would be covered with plastic with a button to give up the anchorage. This device is exactly the same as the one used in the helmets of motorbikes for example.

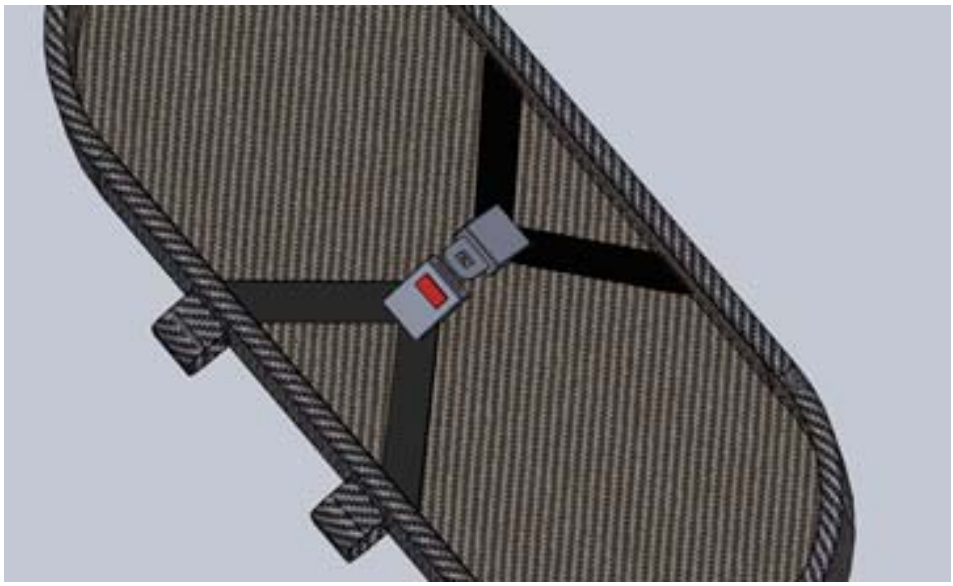


Figure 5.11

Interior hooking

The straps of the hooking are made of synthetic fiber as the lateral straps of the cot. It is possible to modify the length of the above mentioned straps for what it is possible to adapt the interior hooking to any size. This is very important because by this way it is guaranteed the safety of all the infants who travel in the new restraint device.

5.3. ANALYSIS

To verify the efficiency of the restraint device some standard tests are realized according to the specific regulation as it has been explained in the section 3.6 of this report. A frontal and a side impact test are done to check if the safety device is good enough to provide the suitable levels of safety. The first one is realized at a speed of 64 km/h and consists of striking a car against a deformable barrier that simulates another vehicle and the second one the vehicle is beaten by a deformable aluminum block at a speed of 50km/h.

Obviously I have not got the sufficient means to realize this analysis to the device. Instead of that it has been simulated an emergency stop with a car to prove the efficiency of the restraint device designed.

This test consisted on stopping the car from 50 km/h to 0 km/h and calculates the G forces that the infant would suffer. To calculate the G force it is necessary to know the variation of the speed and the time of stopped as the deceleration is defined by the next equation:

$$a = \frac{\Delta v}{t}$$

Equation 5.1

Were Δv corresponds to the variation of the speed in m/s and t to the time of stopped in seconds.

In this case the values are 13.88 m/s and 1.35 seconds respectively. Then the deceleration can be calculated:

$$a = \frac{\Delta v}{t} = \frac{13.88}{1.35} = 10.28 \text{ m/s}^2$$

Now to calculate the value of the G force it is necessary to divide this value between the value of the gravitational force, which is 9.81 m/s^2. The value of the G force that is suffered by the infant in this test is **1.05 G**.

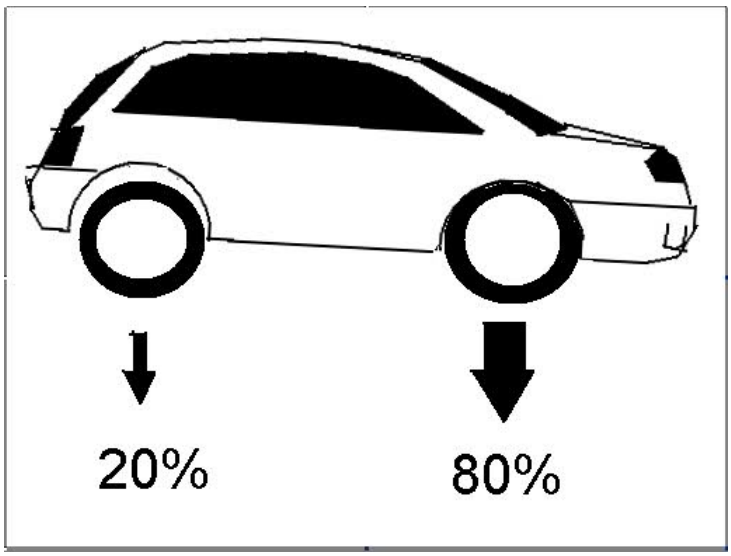


Figure 5.12

Distribution of forces during a stopped

We note that the value of this force is much smaller than the force that can be suffered in an air emergency that is between 7 and 9G forces.

During the accomplishment of this test two videos were recorded to be able to compare visually the different behavior of the infant with the two-point security belt used nowadays by the airlines and the new restraint device. It was clearly observed that there was risk of injury in the first cases since the force of stopped stimulated the body and the head of the baby ahead existing risks of injuries both in the neck and in the abdomen or vertebral column and how it was reduced with the new device since the infant travels inside the cot hooked with the interior hooking with less range of motion.

It should be remembered that these tests had been realized with forces of 1.05G so in an air emergency in which there can manage to be suffered forces of 7 or 9G the consequences for the infant can be fatal.

5.4. MANUFACTURING OF THE RESTRAINT DEVICE

For the accomplishment of the test and to have a better idea of the restraint device this one was manufactured making the fabrics and other parts of the design using a sewing machine yielded by Glyndwr University. In this section it is going to be explained the stages realized to make this device.

Figure 5.13

Restraint device

The first step to manufacture the device is to create the base of the cot. For it two caps of fabric are needed with the shape of ellipse of 80 centimetres of length and 34 centimetres of width. The ends of these pieces of fabric are rounded according to a semi circumference of 17 centimetres of radio. By this form the base remains oversized in order that sufficient fabric stays to sew the seam with facility having 2 centimetres extra around the whole base as it is shown in the picture.

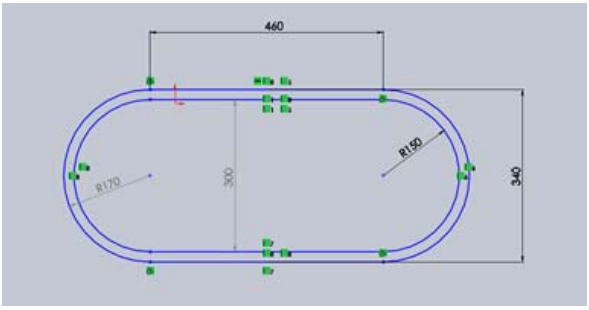


Figure 5.14

Dimensions of the base

Before sewing the whole perimeter of the base of the cot it is necessary to introduce the filling material between both caps to make the base quilted and comfortable for the infant. Then finish sewing the rest of the perimeter of the base. Finally the interior hooking can be sewed to the base of the cot.

Figure 5.15

Detail of the interior hooking

Once the base of the cot is ready the next step is the walls. For that it is important to distinguish between the interior and the exterior walls. For the exterior walls it is needed two pieces of fabric of measures 97 centimetres of length and 32 centimetres of width whereas for the exteriors the measures are 100 centimetres of length and 40 centimetres of width. The fact that there are needed two pieces of every

type of wall it is because each of them includes the half of the perimeter of the base. As in case of the base these measures are oversized.

In the top face of the base, on which the baby travels, there are sewed both pieces of the interior walls and once sewed both, join them by sewing at a height of the exterior edge of the base. In the other face the exterior walls are sewed by the same way. Once they are sewed they are turning around so that the seams remain hidden obtaining a better ended of the design.

Sewing the handles and the back loops to the exterior wall is advisable to facilitate the later work. To manufacture the handles it is necessary two strips of fabric of 44 centimetres of length and 8 centimetres of width. Then they are doubled for the half so that we have a strip of 4 centimetres of width and are sewed leaving 5 centimetres free in each side. Once this step is finished the handles are turning around in order that the seams remain hidden.

Figure 5.16

Back loops and handles of the cot

As soon as the walls are sewed, they are filled equally as the base. At the moment to sew the top part of the same ones, the exterior wall is doubled inside of the cot in order that a free space stays in the top edge. This one is the space where it will be put the elastic wire.

Finally the elastic wire is inserted in that space to provide the form to the contour of the cot. This elastic wire is inserted in the wing of the cot as it exists a hole in the union of the two parts of the walls. This is shown in the next picture.

Figure 5.17

Elastic wire on the top edge of the cot

As soon as the cot is finished, the lateral straps are added to the same one. These are sewed on the seam of union of both pieces of the exterior walls to guarantee that it could not break. Finally the metallic hookings are added in the end of the straps.

Figure 5.18

Lateral straps and metallic hooking

6. CONCLUSIONS

It exists studies which affirm that the current safety belt used onboard commercial transport aircraft, a two-point security belt, does not turn out to be sufficiently safe. And not only that but also it has been demonstrated that this type of belt can cause serious injuries of column or abdomen to adults. In case of infants these injuries can be major, managing to cause even the death. For these reasons, the aim of this project was to develop a new device to increase the security of infants.

The design of the device had to bear in mind the fulfillment of the air regulation referred to safety. This regulation is developed by the different aviation agencies, such as the European Aviation Safety Agency (EASA) in Europe, the Federal Aviation Agency (FAA) which belongs to USA, the Civil Aviation Authority (CAA) in UK, and must be followed by all the airlines.

Apart from that it was important to know all the emergency protocols that exist about evacuation of the plane in case of emergency to design the device adequately.

As far as the materials and components of the restraint device are concerned, it must be adapted to the regulations in terms of fireproof materials. As all the rest of materials that compose the cockpit of aircraft, they must be fireproof materials and expire with the necessary certifications of each country or aviation agency.

Besides adapting to the regulation, the new device must support all the efforts caused by turbulence, moderated or severe ones, and of other emergencies that can happen onboard aircraft as for example an emergency landing.

It exists some tests to prove the efficiency and the safety level that offer the different types of restraint devices. During an accident or emergency the passengers of the plane can manage to suffer forces of between 7 and 9G. To verify the efficiency of the new device it was realized a test that was consisting of one stopped of emergency from a speed of 50 km/h up to 0 km/h in which the infant was suffering forces of 1.05G.

This test was realized with the current system of safety used by the airlines, the two-point security belt, and with the new restraint device and in it it was possible to observe that the risk of suffering injuries of column, abdomen or neck of the infant were reduced drastically.

To summarize it is possible to say that with this new design of restraint device the safety of infants traveling by plane is increased as it has been demonstrated in the tests so that the initial aims of this project have been fulfilled.

To conclude, I want to say that as far as the improvements in the security of infants developed with this idea are concerned, I, Carlos Eder, save the intellectual property of the design of this restraint device in order to avoid plagiarisms in future designs.

7. RECOMMENDATIONS

Manufacture of the device:

- “Las costuras básicas” retrieved via Internet Explorer http://www.madauri.com/puntos.htm

- “Conceptos básicos de costura” retrieved via Internet Explorer http://www.perso.wanadoo.es/baya_de_oro/conceptos_costura.htm

- “Costuras” retrieved via Internet Explorer http://www.taringa.net/posts/apuntes-y-monografías/3727384/tipos-de-costuras.html