Design of a sliding seat for transfer of person from Wheel Chair into car

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Abstract - *There are many challenges faced by physically challenged and elderly people.One such problem is getting in and out of the car. Even though there are many equipment and transfer aids are available in the market still people find difficulty in getting in and out.This paper provides an idea for transferring the people in the form of a sliding seat. The normal seat is acting as seat for both the Wheel chair and Car seat.*

***Keywords*:Physicallychallenged, Transfer,Sliding,Seat,Wheel Chair, Car seat.**

1.INTRODUCTION (Car Seats and Wheel Chair)

Car seat is analyzed based on ergonomic comfort they provide and are designed to accommodate 95 percent of the people. At the same time they should be able to give comfort and ease the passenger from travel strain. They should also provide safety features for the passenger and protect them. They must last long and take up the loads from various component and should not transfer it to passenger.
Wheel Chair serves as legs for the Physically Challenged or Elderly people. They carry them to their destination. There are different types of wheel chairs suiting different people and their needs.

2.DIFFERENT TYPES OF SEATS

2.1 BENCH SEATS

This type of seat was more predominant in the olden day cars. It will resemble a normal park bench. The seat will run for the entire width of the car and can accommodate three people. Now a days they have been used only for the rear seats and the front seats are replaced by the bucket type of seats.

2.2 BUCKET SEATS

Bucket seat are designed to hold one person. At first they are used in race cars to keep the drivers and co-drivers intact when they are making sharp and quick turns. Slowly they entered the commercial automotive segment and started occupying the front rows replacing the bench seats of the cars.

2.3 CHILD SEATS

Child Seat are also known as Infant seat. They are designed specifically for children to protect them from injury in case of an accident. Other type of seat is known as Booster Seat which is also specifically for children until they are able to use the regular adult Passenger seat in car.

2.4 POWER SEATS

Power Seat are the normal seats in which the movement of seats such moving the seat forward and backward, adjusting the seat recline are controlled with the help of Electronic controls. The movements are achieved using small motors and Control units.

3. DIFFERENT TYPES OF WHEEL CHAIRS

3.1 SELF PROPELLED

They are the most basic type of Wheel Chair in the market. These Wheel Chair have two smaller Caster Wheels at front and a two larger wheel at rear. Sometimes they have separable cushion which provides comfort to the person. The push rims on the rear wheel helps in moving the Wheel Chair. The person applies Force thus pushing the rims forward which in turn rotates the wheel and makes the Wheel Chair to move forward. The manual lever when pulled acts as a brake to stop the Wheel Chair. The rear wheel will be mostly having a diameter of 24 or 26 inches.
There are two types in self-propelled
1. Folding -can be folded and made compact
2. Rigid -cannot be folded; occupies large space

3.2 POWER WHEEL CHAIR

These are the upgraded versions of the normal Wheel Chairs. They don't require human effort for their movement. They have Electric motor which propels the Wheel Chair. Batteries are the source of energy for the motors. Controller which looks like a video game joystick or a sip and puff will be operated by the user for moving the Wheel Chair in the required direction. The seats are normal seats with cushions on it .The back rest also can be tilted to an extent in some Wheel Chairs which provides comfort for the user. Some Companies offer Customized seats for the comfort of the user. The main limitation it face is the size and weight of the Wheel Chair which limits its movement in the surrounding environment. Since they can't be folded they occupy higher amount of space compared to the normal folding type Wheel Chair. Many re-design and alteration are incorporated in overcoming the limitation of this type of Motorized or Powered Wheel Chair.

4.CURRENT ASSISTANTS

4.1 CAR EASE SLIDE

Slick surface and makes the person to get in and out easily. It is a thin sheet like fabric which allows rotation too.

4.2 BEASYTRANS TRANSFER BOARD

The transfer board is S-shaped. It's long length can comfortably accommodate the person and easily transfer them into the car. Provides a way for safe transfer in a dignified way. Lifting sometimes may lead to injury. But this avoids the risk of lifting and twisting of the torso as well as back injury. Friction less slide and best in state of sliding transfer. It also allows rotation so that the patient can comfortably move in.

4.3 SWIVEL SEAT CUSHION

This is similar to a normal cushion but it allows 360 degree rotation. Light and weight and is also easily one can carry. It won't bind since it has bearing beneath the cushion and friction is avoided.

4.4 CAR CADDIE BY STANDERS

It is made of nylon which can be fitted to the car window frame. Can be adjusted for different heights for different car windows. The cushion provides grip to hand and comfort when getting in and out of car. Just wrap around the window when needed ,use and remove it.

4.5 CAR HANDY BAR

This is a normal handle which provides support tot user during entry and exit. The grip will be securely held by the door lock hook. Compact and is corrosion resistant.

4.6 CUSTOMIZED CAR

Hand operated controls are being fitted to the cars to help Physically Challenged people. Pedals are hand operated using external accessories or the controls are given near the hand reach.

5. SLIDING SEAT DESIGN CONSIDERATION

5.1 BIO MECHANICAL ASPECTS OF CAR SEAT

5.1.1 LOAD IN L5/S1 REGION

- The load in this region should be less since the spine region will be stressed at this portion.
- This region will experience more amount of stress in the sitting posture due to compression.
- So to avoid this natural shape of the spinal column should maintained by providing some lumbar support.

5.1.2 SEAT BACK ANGLE

- The load will be high in case of seated posture when compared to standing.
- This load can be reduced with the provision of the seat back angle adjustment.
- More than 90 degree back angle will reduce the stress developed in the lower region of spine.

5.1.3 AVOID LONGER CUSHIONS

- The longer cushion length should be avoided since it causes stress in the lower body.
- The seat cushion length is decided in such a way that length will be shorter compared to the buttock to popliteal length as this allows the support of weight of upper body on seat back.
- The most preferred design is designing for the fifth percentile female's buttock to popliteal length.

5.2 OTHER PARAMETERS

- **HIP POINT:** Point which simulates Pivot center of Human upper body and thigh region and it provides guidelines for the passenger sitting position.

- **BACK ANGLE:** Angle between the torso line and the vertical axis through the Hip Point.

- **HIP ANGLE:** Angle between the torso line and the thigh axis.

- **KNEE ANGLE:** Angle between the thigh axis and lower leg axis.

- **FOOT ANGLE:** Angle between the lower leg axis and paddle plane.

- **THIGH ANGLE:** Angle between thigh axis and horizontal axis.

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6. PROPOSED IDEA

Currently existing car seat dimension is taken as reference for the CAD model. Car considered is Hyundai i10.

Table 1-Specs from car

Area	Dimensions(in cm)
Width of seat	44(max);without side bolster(40)
Length of seat	50
Height of backrest	55
Ground Clearance	37
Distance between rails centers	40
Length of the rails	60
Opening from top to bottom	100
Opening in side ways(Without dash)	80
Opening in side ways(With dash)	65
Distance between mount to cushion	28
Gap between seat ,side sill and console	2 (each side)

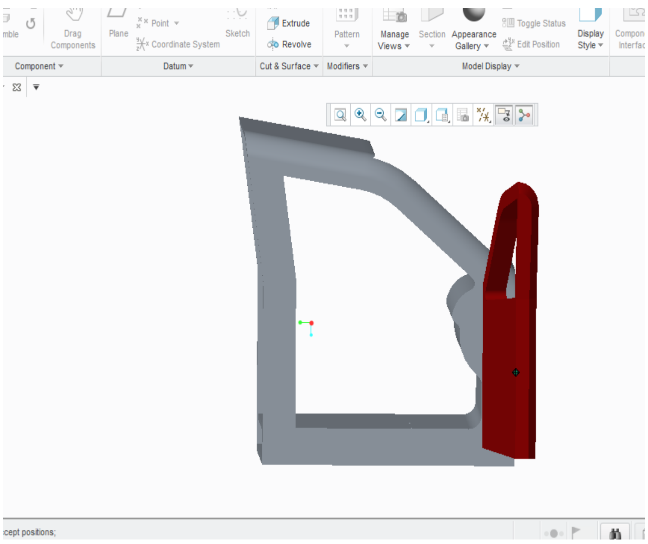

Figure 1-Entry in car

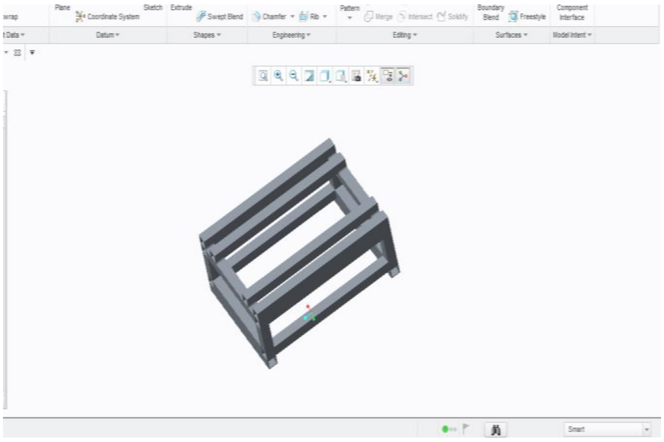

Figure 2-Inner Frame which holds seat

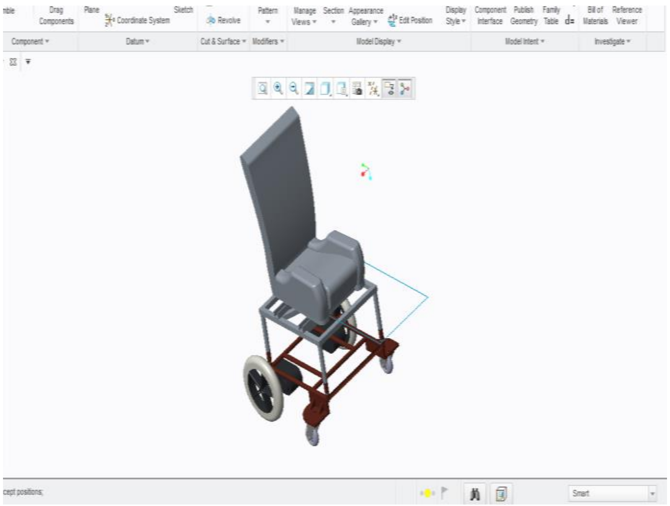

Figure 3-Modified Wheel Chair

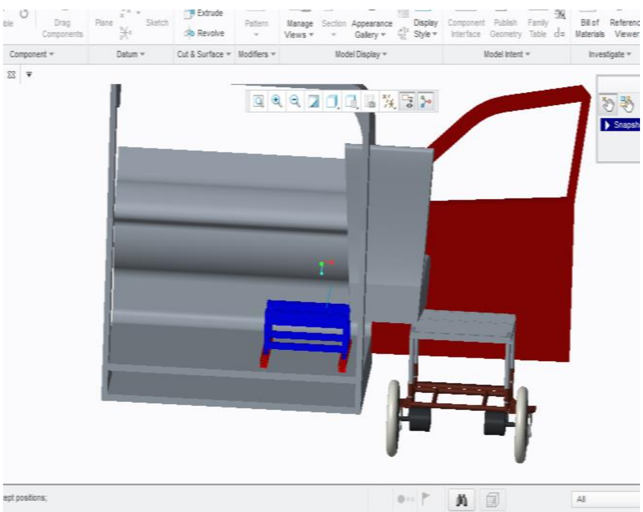

Figure 4-Sliding Transfer

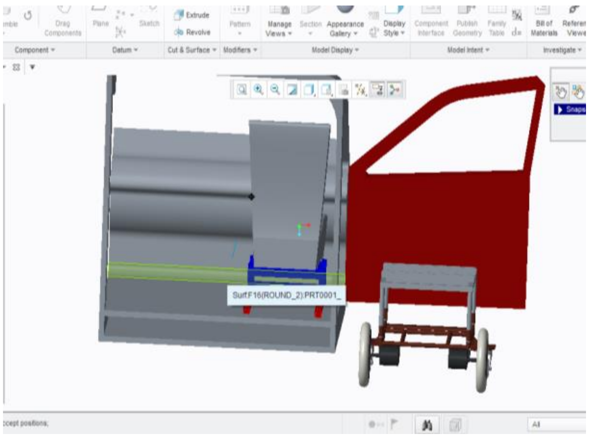

Figure 5-Transfer Complete

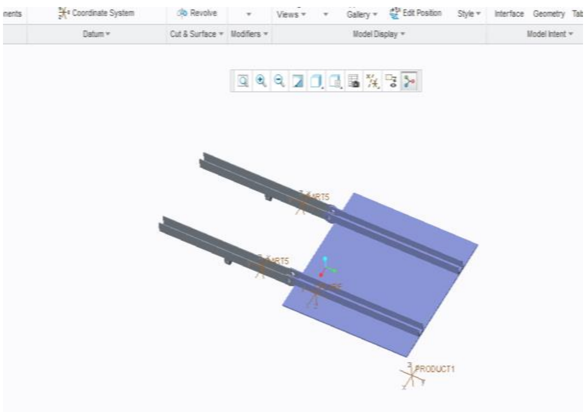

Figure 6-Top of Wheel Chair

7. ANALYSIS

Every seat has to withstand the braking and accelerating load along with the load from the passenger and it should not move from the locked position. In this model the inner frame has to bear all these loads as it is the structure which is fixed

Table 2-Load specs

Details	Weight in kilograms
Weight of seat	20
Weight of person	80
Total Weight coming from seat	100
Weight of the car	961
Weight considered for load calculation	450

7.1 VELOCITY DETAILS

Initial Velocity =60 KmPH
Final Velocity = 0 KmPH
Time taken =10 Seconds

7.2 FORMULA USED

$$Force = Mass \times Acceleration$$

The mass will be the total mass acting and deceleration will be calculated using the velocity details. These will be in turn multiplied by a factor of "2",since sudden or impact load is being taken into consideration.
Mass=mass of seat+mass of person+mass of car during transfer
=>**Mass**=20+80+450=**550 kilograms**

$$Deceleration = u - v / t$$

Where
u-initial velocity; v-final velocity; t=time taken
Deceleration=(60-0)/10=6 KmPH
=>**Deceleration**=6*(5/18)=**1.667 m/s**
Note: The factor (5/18) is multiplied to convert and get the final result in "m/s".
Force=1.67 X 550=918.5 N
Total Force = 2 X Force = 2 X 918.5
Total Force =1837 N
But Analysis is carried with extreme load of 5000 N acting for 1 Second and the result obtained is extremely good and each and every individual part is given a load of 2000 N to ensure whether they are capable of withstanding the load.
Every Point where the locks are present are given as fixed support. Surface where the Forces /Loads will act is determined and accordingly at those surfaces or point the load is applied.
After analysis total deformation is determined and the Factor of safety is checked whether it is in permissible range.
Aluminum Alloy is taken as material for the analysis.

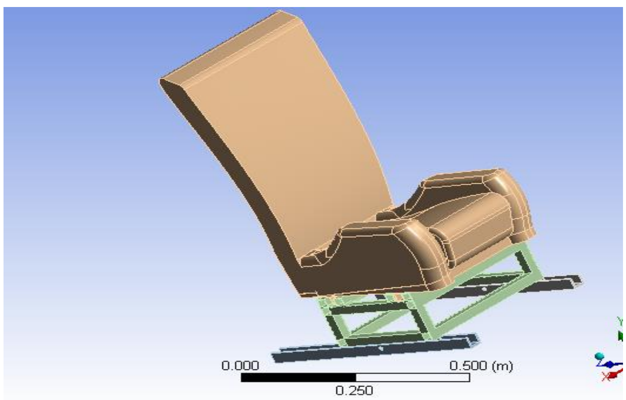

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Figure 7-Assembled Seat

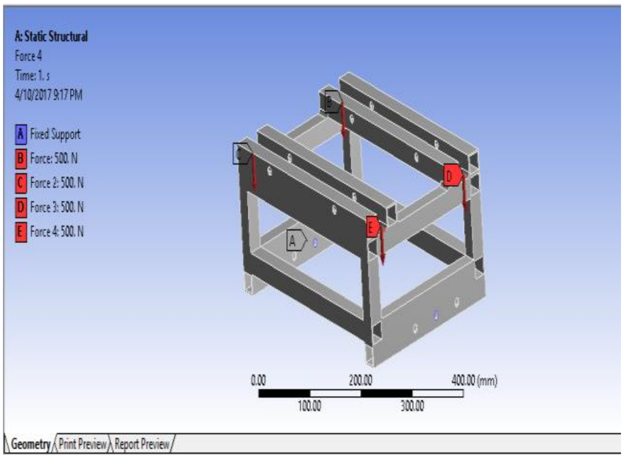

Figure 8-Loads on Inner Frame

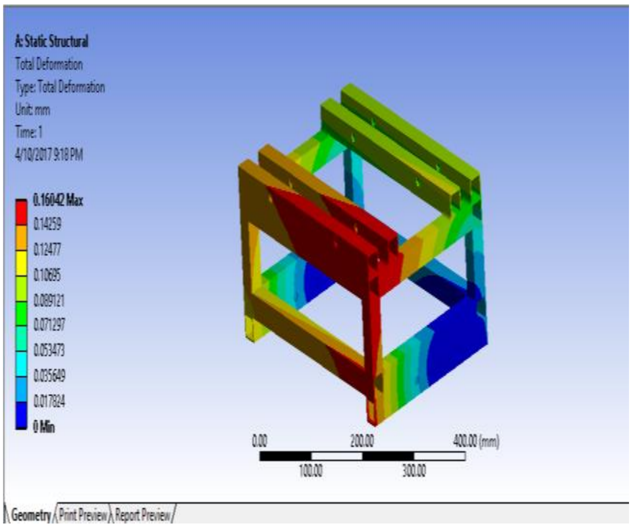

Figure 9-Total Deformation of Inner Frame

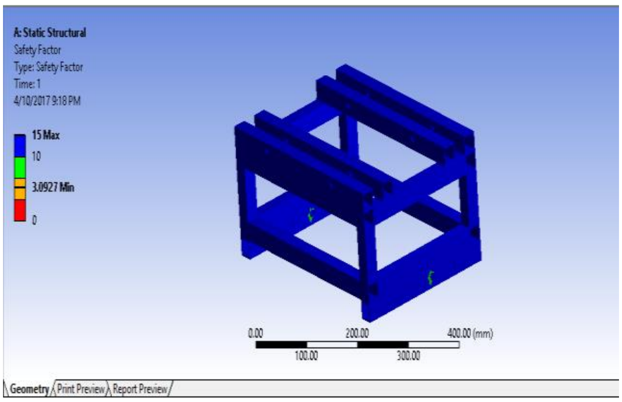

Figure 10-Factor Of Safety of Inner frame

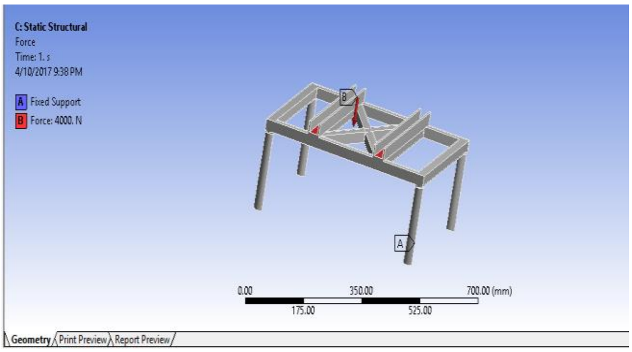

Figure 11-Load on Top of Wheel Chair

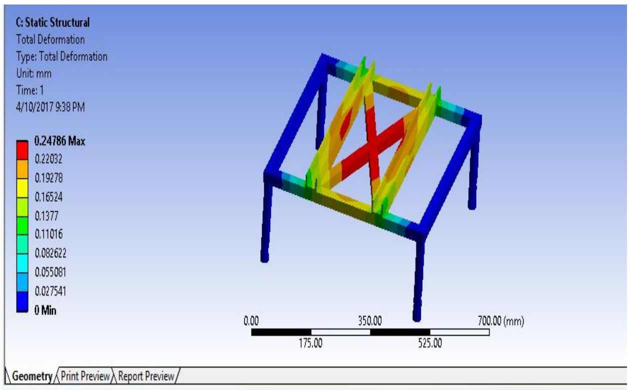

Figure 12-Total Deformation of Top of Wheel Chair

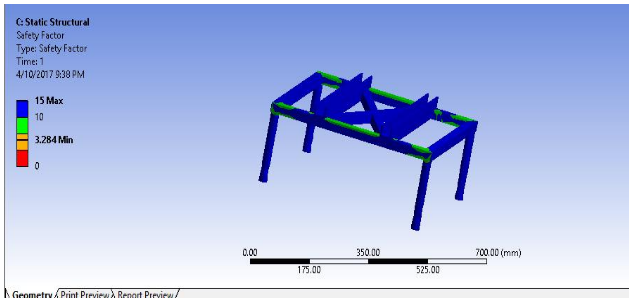

Figure 13-Factor Of Safety of Top of Wheel Chair

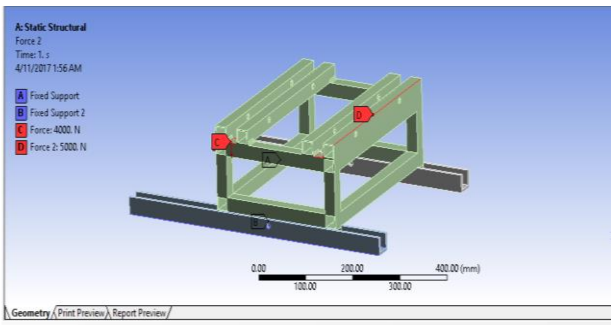

Figure 14-Brake Force Analysis

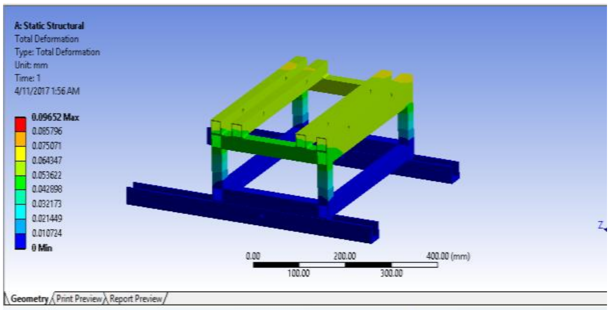

Figure 15-Total deformation during Braking

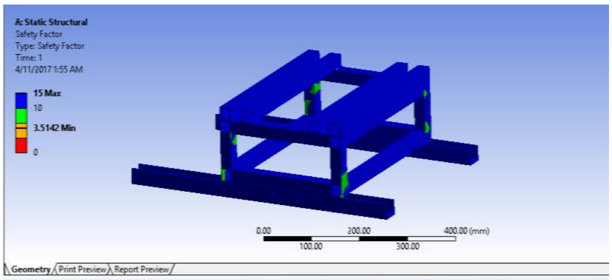

Figure 16-Factor of Safety during Braking

8. CONCLUSIONS

From the analysis the design is found to be success and the model can withstand sudden Braking force/Accelerating force. The max deformation occurred is 0.9mm(approx) in the rails of the seating arrangement.The Factor Of Safety is always above "1.5" for all parts which is Safe.The sliding of the seat was also able to achieve manually with less effort

REFERENCES

For Seat:
[1].https://en.wikipedia.org/wiki/Bucket_seat
[2].https://en.wikipedia.org/wiki/Bench_seat
[3].https://en.wikipedia.org/wiki/Car_seat
[4].https://en.wikipedia.org/wiki/Child_safety_seat
[5].https://en.wikipedia.org/wiki/Power_seat

For Wheel Chair:

[6].https://en.wikipedia.org/wiki/Wheelchair
[7].https://www.karmanhealthcare.com/blog/2014/02/26/transfer-wheelchair-car/
[8].http://www.mobility-aids.com

Materials Related:

[9].http://www.casualplay.com/en/tips/what-materials-are-used-manufacture-casualplay-car-seats
[10].http://www.autopartswarehouse.com/seat_frame~pop.html
[11].http://mitchellfauxleathers.com/Default/ViewPoint/Read/faux-leather-viewpoint/2014/04/07/what-is-faux-leather
[12].https://www.karmanhealthcare.com/blog/2013/07/30/durable-wheelchairs-best-material/

Books:

[13].Ergonomics in the automotive design process by **Vivek D. Bhise.**
[14].A textbook of Machine Design by **R.S Khurmi and J K Gupta.**

Others:

[15].Video on transfer technique from YouTube.