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Design and Analysis of Restraining System for Frontal Impact Euro NCAP

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Abstract- In this project the crash analysis was carried out according to Euro NCAP regulation. In this paper i have to study the crash worthiness of the Occupant/Driver. The frontal crash of the integrated car system is successfully simulated in LS-DYNA. According to the basic principle of the dynamic non-linear finite element method, the basic crash describe equation and FE discretized equation are established. To save the occupant few minor tuning with respect to seats, seat belts, Knee bullstar, Airbags, Floor and other necessary anchkarage points are tuned. First the airbag static deployment is carried out and same as to be validated with the actual test. In this static deployment we mainly check the airbag dynamics, deployment pattern, area covered by the airbag, volume of the airbag, pressure of the airbag, determine the mass flow rate to capture the geometry and deployment time. After this the occupant injury need to be validated with the test.
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Index Terms- Frontal Crash, FEM.

1. INTRODUCTION

Frontal impact represents one of the most important crash modes in the field. In year 2001, 33.3% of fatalities and 28.6% of injuries of passenger car occupants were caused by Frontal impacts, 19.7% of fatalities and 25.7% of injuries of light truck occupants were due to Frontal impacts. Frontal airbag systems have been applied as a counter measure in many vehicles. After deployment, the airbag covers the frontal substrate of the vehicle like a steering, as the name indicates, to avoid the direct contact of the occupant's head to the substrate and out Frontal objects. It also helps retain the occupant from ejection in a rollover accident.

Compared with side airbag systems, Frontal airbag systems have some unique characteristics. First of all, unlike frontal crashes, Frontal crashes involve considerably less crush space between the point of impact on the striking vehicle and the occupant. This limited crush space increases the requirements to the airbag deployment sensing systems and inflator timing. Currently, Frontal impact sensing systems generally discriminate a crash condition within 15-25 milliseconds as compared to 6-13 milliseconds for frontal impact sensing systems. Airbag inflation time for Frontal impact airbags is 45 milliseconds for frontal airbags as compared to less and ranges between 20 and 30 milliseconds for side airbags. Secondly, Frontal airbags have to cover overall head, therefore they usually have a large coverage area. Inflator gas has to travel a long way to fill all the airbag chambers. The inflation process causes uneven distribution of the inflator gas and different filling time for the airbag chambers. To accelerate the inflation and optimize the gas distribution, it is a common practice to use a diffuser tube in the top portion of the airbag. The diffuser tube design is critical to the performance of the Frontal airbag systems.

Throughout the Frontal airbag design process, numerous tests are needed, including the airbag static deployment tests, free motion head form pole impact tests with linear impactor and system-level sled or barrier tests with real vehicle structure and dummy etc. Traditionally, hardware design engineers think out a concept, build hardware prototypes and conduct the tests, modify the design based on test results, then retest. Hardware tests are often expensive. Building prototypes can also be time consuming. To help shorten the design cycle and cut material costs, Computer Aided Engineering (CAE), especially mathematics-based simulation is proved to be a good alternative of the hardware tests.

The most commonly used airbag simulation model assumes uniform pressure and temperature everywhere in frontal the airbag. This is a close representative of the airbag after it is fully inflated and the gas flow in frontal the airbag stabilizes. For free motion head form impact simulations, the head form usually impacts the frontal airbag after its full inflation. The uniform pressure airbag models serve the simulation purpose adequately.

2. PROJECT METHODOLOGY

The procedure begins from a cushion outline draft then CAE is utilized widely to break down and enhance cushion plan. The investigation incorporates pad volume assessment, pad scope survey,

organization timing audit, crease shape and area survey.
In the event that a cushion configuration passes all these reenactment check points, models can be fabricated and tried. The tests are basically used to affirm the recreation results. The configuration advances in light of CAE recreations as opposed to on various tests.
After successful cushion static deployment, a Linear Impactor simulation is carried out. A few hardware tests may be needed to correlate the model unless strong confidence has been built from similar models. A parameter study of the linear impact model with different inflators and different impact locations is often conducted to help select inflators and further improve cushion design. Upon the completion of CAE analysis, some tests are necessary to confirm the simulation results. This concludes the component level design and analysis.
Before any physical airbag was sewn and tried, preparatory CAE investigation was performed to give directional direction to the airbag outline. Inflators with little and huge quantities of moles of gas were attempted to investigate the conceivable limits cushion thickness, volume, airbag weight, shrinkages and tie powers.

3. TEST PROCEDURE

3.1 Federal Motor Vehicle Safety Standard (FMVSS) No. 208

The objective of a crash test for Federal Motor Vehicle Safety Standard (FMVSS) No. 208 is to measure the crashworthiness of a passenger vehicle. The standard specifies performance requirements for the protection of vehicle occupants in crashes. Historically, this has encouraged improvements to the vehicle structure and restraint systems to enhance occupant crash protection. Structural design for crashworthiness seeks to mitigate two adverse effects of a crash – (1) degradation of the occupant compartment survival space and (2) the occupant compartment deceleration severity. Both effects have the potential to cause injuries – first, because of the increase in probability of occupant contact with intruding vehicle components, and, second, because of the potential for internal injuries to occupants.

3.2 Frontal Impact

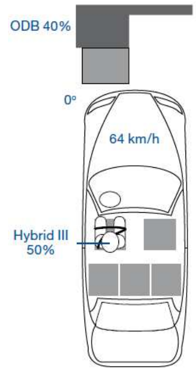

Fig.1 Euro NCAP protocol

The test is conducting according to Euro NCAP protocol.

Here we are 64km/h Regulations using and negative points are awarded if following conditions are occurred.

3.3 Modifier:

Head	
4 points	HIC_{36} < 650; a_{3ms} < 72 g
0 points	HIC_{36} > 1000; a_{3ms} > 88 g
Modifier	unstable airbag contact (-1 point), Steering column displacement (-1 point)

Neck		
4 points	$M_{y,extension}$	< 42 Nm
	$F_{z,tension}$	< 2.7 kN @ 0 ms < 2.3 kN @ 35 ms < 1.1 kN @ 60 ms
	$F_{x,shear}$	< 1.9 kN @ 0 ms < 1.2 kN @ 25 – 35 ms < 1.1 kN @ 45 ms
0 points	$M_{y,extension}$	> 57 Nm
	$F_{z,tension}$	> 3.3 kN @ 0 ms > 2.9 kN @ 35 ms > 1.1 kN @ 60 ms
	$F_{x,shear}$	> 3.1 kN @ 0 ms > 1.5 kN @ 25 – 35 ms > 1.1 kN @ 45 ms

Chest	
4 points	Deflection < 22 mm; VC < 0.5 m/s
0 points	Deflection > 50 mm; VC > 1.0 m/s
Modifier	Deformation A-Pillar (-2 points) Compartment deformed (-1 point) Contact with steering wheel (-1 point)

Femur	
4 points	Axial Force$_{Compression}$ < 3.8 kN
0 points	Axial Force$_{Compression}$ > 9.07 kN @ 10 ms > 7.56 kN

Knee	
4 points	Displacement < 6 mm
0 points	Displacement > 15 mm
Modifier	Variable contact (-1 point) Concentrated Loading (-1 point)

Tibia	
4 points	TI < 0.4; Axial Force$_{Compression}$ < 2 kN
0 points	TI > 1.3; Axial Force$_{Compression}$ > 8 kN
Modifier	z–displacement of worst pedal (-1 point)

Foot	
4 points	x–displacement braking pedal < 100 mm
0 points	x–displacement braking pedal > 200 mm
Modifier	footwell intrusion (-1 point) blocked pedal (-1 point)

- 4.00 points
- 2.67 – 3.99 points
- 1.33 – 2.66 points
- 0.01 – 1.32 points
- 0.00 points

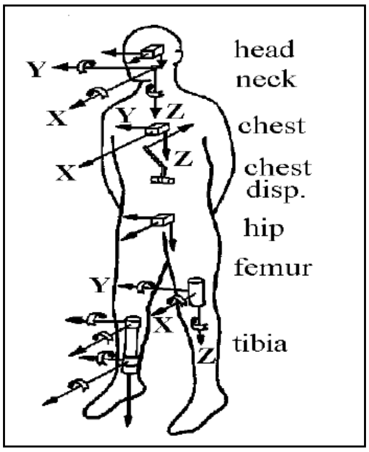

Fig.2 Body coordinate system

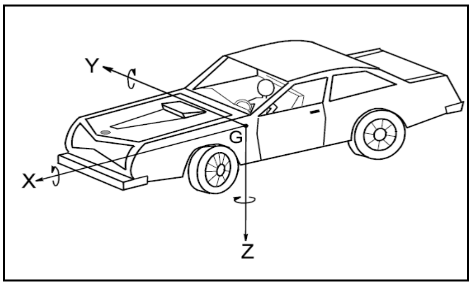

Fig.3 Component coordinate system

3.3.1 Driver

The score generated from driver dummy data may be modified where the protection for different sized occupants or occupants in different seating positions, or accidents of slightly different severity, can be expected to be worse than that indicated by the dummy readings or deformation data alone There is no limit to the number of modifiers that can be applied.

3.3.1.1 Head

Unstable Contact on the Airbag-If during the forward movement of the head its centre of gravity moves further than the outside edge of the airbag, head contact is deemed to be unstable. The score is reduced by one point. If for any other reason head protection by the airbag is compromised, such as by detachment of the steering wheel from the column, or bottoming-out of the airbag by the dummy head, the modifier is also applied.

Note: Head bottoming-out is defined as follows: There is a definite rapid increase in the slope of one or more of the head acceleration traces, at a time when the dummy head is deep within the airbag. The acceleration spike associated with the bottoming out should last for more than 7ms.The acceleration spike associated with the bottoming out should generate a peak value more than 5 g above the likely level to have been reached if the spike had not occurred. This level will be established by smooth extrapolation of the curve between the start and end of the bottoming out spike.

3.3.1.2 Chest

Displacement of the A Pillar-The score is reduced for excessive rearward displacement of the driver's front door pillar, at a height of 100mm below the lowest level of the side window aperture. Up to 100mm displacement there is no penalty. Above 200mm there is a penalty of two points. Between these limits, the penalty is generated by linear interpolation.

Integrity of the Passenger Compartment:-

Where the structural integrity of the passenger compartment is deemed to have been compromised, a penalty of one point is applied. The loss of structural integrity may be indicated by characteristics such as:

• Door latch or hinge failure, unless the door is adequately retained by the door frame.

• Buckling or other failure of the door resulting in severe loss of fore/aft compressive strength.

• Separation or near separation of the cross facia rail to A pillar joint.

3.3.1.3 Knee, Femur & Pelvis

The position of the dummy's knees is specified by the test protocol. Consequently, their point of contact on the facia is pre-determined. This is not the case with

human drivers, who may have their knees in a variety of positions prior to impact. Different sized occupant and those seated in different positions may also have different knee contact locations on the facia and their knees may penetrate into the facia to a greater extent. In order to take some account of this, a larger area of potential knee contact is considered. If contact at other points, within this greater area, would be more aggressive penalties are applied.
The area considered extends vertically 50mm above and below the maximum height of the actual knee impact location. Vertically upwards, consideration is given to the region up to 50mm above the maximum height of knee contact in the test. If the steering column has risen during the test it may be repositioned to its lowest setting if possible. Horizontally, for the outboard leg, it extends from the centre of the steering column to the end of the facia. For the inboard leg, it extends from the centre of the steering column the same distance inboard, unless knee contact would be prevented by some structure such as a centre console. Over the whole area, an additional penetration depth of 20mm is considered, beyond that identified as the maximum knee penetration in the test. The region considered for each knee is generated independently. Where, over these areas and this depth, femur loads greater that 7.8kN and/or knee slider displacements greater than 6mm would be expected, a one point penalty is applied to the relevant leg.

3.3.1.4 Lower Leg
Upward Displacement of the Worst Performing Pedal
The score is reduced for excessive upward static displacement of the pedals. Up to 90 percent of the limit considered by EEVC, there is no penalty. Beyond 110 percent of the limit, there is a penalty of one point. Between these limits, the penalty is generated by linear interpolation. The limit agreed by EEVC was 80mm.

3.3.1.5 Foot & Ankle
Foot well Rupture
The score is reduced if there is significant rupture of the foot well area. This is usually due to
separation of spot welded seams. A one point penalty is applied for foot well rupture. The foot well rupture may either pose a direct threat to the driver's feet, or be sufficiently extensive to threaten the stability of foot well response. When this modifier is applied, knee mapping data will not be accepted.
Pedal Blocking

3.4.1 Door Opening during the Impact
When a door opens in the test, a minus one-point modifier will be applied to the score for that test. The modifier will be applied to the frontal impact assessment for every door (including tailgates and moveable roofs) that opens. The number of door opening modifiers that can be applied to the vehicle score is not limited.

3.4.2 Door Opening Forces after the Impact
The force required to unlatch and open each side door to an angle of 45 degrees is measured after the impact. A record is also made of any doors which unlatch or open in the impact. Currently, this information is not used in the assessment but it may be referred to in the text of the published reports.
Door opening forces are categorized as follows:
Opens normally Normal hand force is sufficient
Limited force £ 100N
Moderate force > 100N to < 500N
Extreme hand force ³ 500N
Tools had to be used Tools necessary

3.5 Seat Belt reminders (SBR)
Latin NCAP will assess SBR in the front seating positions according to Euro NCAP Assessment Protocol – SA Version 5.6 or later (Chapter 7). SBRs will give 0.5 point for the driver seating position and 0.5/N point for each front passenger position that meets the requirements (N is the number of available front passenger positions). Hence the maximum number of SBR points achievable is 1. A car is eligible for scoring SBR points if the following conditions are met:

3.6 Scoring & Visualization
The protection provided for adults for each body region are presented visually, using coloured segments within body outlines. The colour used is based on the points awarded for that body region (rounded to three decimal places), as follows:
Green 4.000 points
Yellow 2.670 - 7.999 points
Orange 1.770 - 2.669 points
Brown 0.001 - 1.729 points
Red 0.000 points
For frontal impact, the body regions are grouped together, with the score for the grouped body region being that of the worst performing region or limb. Results are shown separately for driver and passenger. The grouped regions are:
• Head and Neck,
• Chest,
• Knee, Femur, Pelvis (i.e. left and right femur and knee slider)
• Leg and Foot (i.e. left and right lower leg and foot and ankle).
The contribution of the frontal impact test to the Adult Occupant Protection Score is calculated by summing the body scores for the relevant body regions, taking the lower of the driver and passenger scores. The total achievable score is 17.00 points and the overall scores are then used to generate star ratings as follows:
Frontal Impact:

14.00 – 16.00 points + 1 point SBR + 4ch ABS + ECE95* ……...5 stars
11.00–17.99 points ....…………………….. 4 stars
8.00–10.99points ....………………………....7 stars
5.00–7.99 points ..…………………………......2 stars
2.00–4.99 points ......……………………….......1 star
0.00–1.99 points …………………………….......0 stars
*To be eligible for 5 stars the car must score over 14 points in the ODB test (after application of modifiers). In addition, it must have the full point on SBR, 4 Channel ABS and offer some side impact performance protection. To demonstrate the latter, a MDB test must be sponsored by the manufacturer on an actual Latin NCAP market car of the identical specification as the frontal crash car according to the test specification of ECE R95. The MDB test would need to be performed even in cases where under the regulatory requirements the vehicle would be exempted due to various reasons, for example seating position. In order to qualify for 5 stars, the performance criteria of ECE95 should be met. The test results may be published by Latin NCAP. Where the car is equipped with a side protection airbag (curtain or thorax side airbag) the airbags should be standard fitted.

3.7 Head injury criterion (hic)

An Injury criterion can be defined as a biomechanical index of the passenger vehicle crashes. As a result, many countries a head injury during a car crash as a measure for estimating the degree of HIC (Head Injury Criterion), and using its result value is regulated. HIC header hit by injuries to the head injury, the most widely used to estimate the value equation (1) is expressed as.

$$HIC = \left[\frac{1}{(t_2-t_1)}\int_{t_1}^{t_2} a\ dt\right]^{2.5} \circ (t_2 - t_1)$$

For the calculation part we are considering HIC_{36}

	4	3	2	1	0
HIC36	<650	720	790	880	>1000
a_{avg}	72	75.2	78.4	81.6	88
CD	22	29	36	43	70
Tibia	<2KN	3.2	4.4	5.6	>8KN
Femur	<3.8KN	4.854	5.908	6.962	>9.07KN
Knee	<6mm	7.8	9.6	11.4	>15mm
Chest	<0.5m/s	0.1	0.2	0.3	>1m/s
Neck $F_{x,Tension}$	<1.9ms	0.24	1.44	2.64	>3.1ms(shear)
Neck $F_{z,Tension}$	<2.7ms	2.78	2.86	2.94	>3.1ms
Neck $M_{y,extension}$	<42Nm	45	48	51	>57Nm

Table.1: Calculation for HIC_{36}

4. RESULT AND DISCUSSION

4.1 Body zone 1:

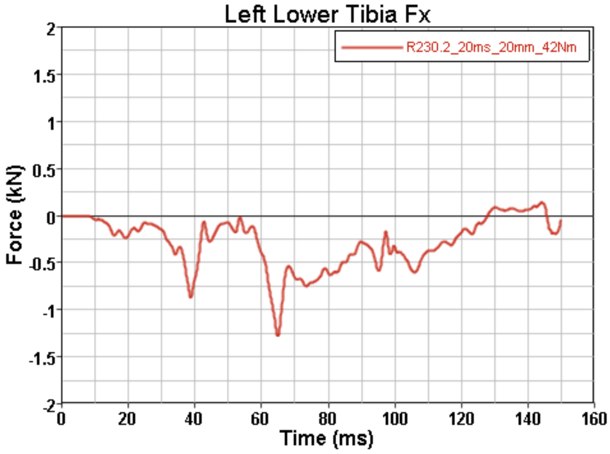

Fig.4 Graph of Left Lower Tibia F_x V/S Force

The Graph represents Lower left Tibia F_x force. According to dummy co-ordinate system Tibia +X represents Tensile i.e. Tibia moving outward and Tibia -X co-ordinate represents Compression i.e. Tibia moving inward.
In this curve there are 2 peaks ,the first peak is because of the tibia coming contact with the instrumental panel ,the point of contact is at 39ms,the second peak is because of the tibia coming in contact with the floor and the point of contact is at 65ms at this duration floor intrusion starts.
From the injury criteria to get 4 points, the maximum force should be less than 2KN in our case 2.2KN i,e the injury point for tibia is 3.8.

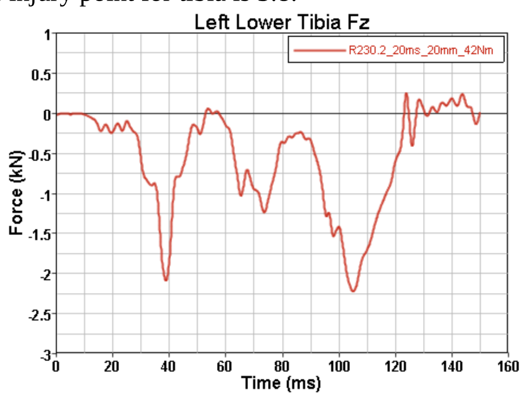

Fig.5 Graph of Left Lower Tibia F_z V/S Force

The Graph represents Lower left Tibia F_Z force. According to dummy co-ordinate system Tibia +X represents Tensile i.e. Tibia moving outward and

Tibia -X co-ordinate represents Compression i.e. Tibia moving inward.

In this curve there are 3 peaks ,the first peak is because of the tibia coming contact with the instrumental panel ,the point of contact is at 39ms,the second peak is because of the tibia coming in contact with the floor and the point of contact is at 65ms at this duration floor intrusion starts and the 3rd peak the point of contact will be 100ms and the car will becomes lift.

From the injury criteria to get 4 points, the maximum force should be less than 2KN in our case 2.2KN i.e. the injury point for tibia is 3.8.

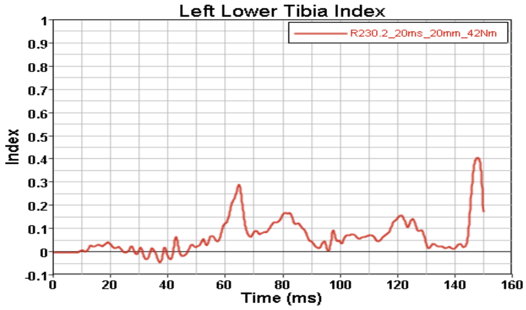

Fig.6 Graph of Left Lower Tibia Index V/S Time

Tibia Index is calculated depending upon the forces and moments on the tibia.

As we can see from the above graph the peak left lower tibia index is around 0.4,so that depending upon this point obtained is 4.

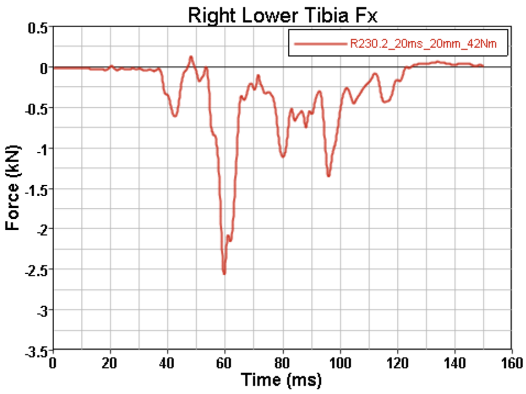

Fig.7 Graph of Right Lower Tibia F_x V/S Force

Here lot of peak is observed because the right leg is placed on the acceleration, from the graph we observed that from 0 to 30ms,there is no force acting on the right lower tibia because pedal movement when it reaches maximum movement, the force transfer to the tibia.

From the injury criteria to get 4 points, the maximum force should be less than 2KN in our case 2.2KN i,e the injury point for tibia is 3.8.

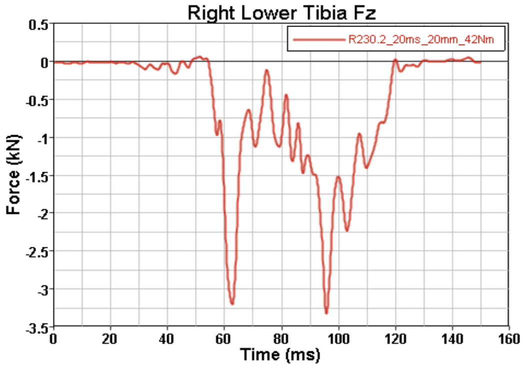

Fig.8 Graph of Right Lower Tibia F_z V/S Force

Here lot of peak is observed because the right leg is placed on the acceleration, from the graph we observed that from 0 to 30ms,there is no force acting on the right lower tibia because pedal movement when it reaches maximum movement, the force transfer to the tibia.

From the injury criteria to get 4 points, the maximum force should be less than 2KN in our case 2.2KN i,e the injury point for tibia is 3.3.

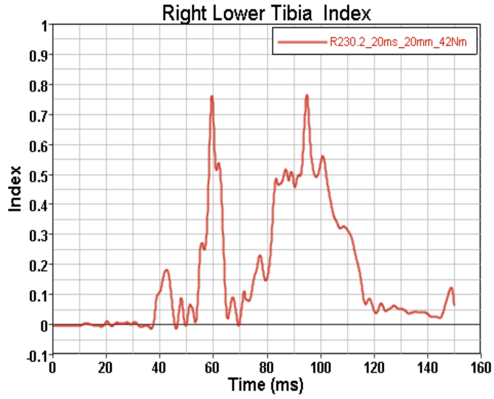

Fig.9 Graph of Right Lower Tibia Index V/S Time

Tibia Index is calculated depending upon the forces and moments on the tibia.

As we can see from the above graph the peak lift right tibia index is around 0.75,so that depending upon this point obtained is 2.9.

Left F_x	3.8	2.9
Left F_z	3.8	
Index Left	4	
Right F_x	3.3	
Right F_z	3.3	
Index Right	2.9	

Table.2 Body Zone 1

From the above table the lowest point is assigned to the body zone, in this case 2.9 is the worst point which is assigned to the lower body zone.

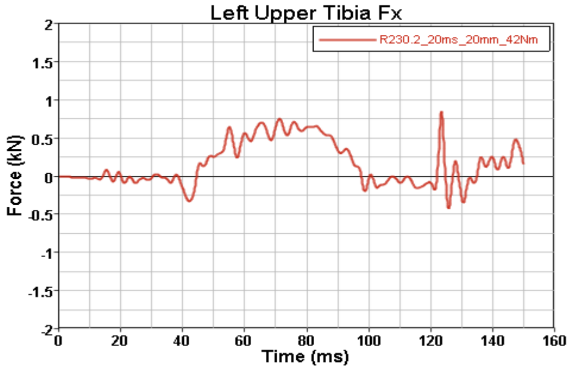

Fig.10 Graph of Left Upper Tibia F_x V/S Force

From the injury criteria to get 4 points, the maximum force should be less than 2KN in our case 2.2KN i,e the injury point for tibia is 0.8.
The left upper tibia affects 4points as it is not crossing 2KN force

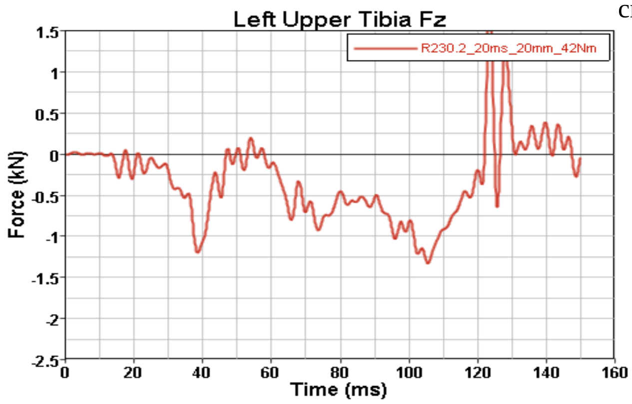

Fig.11 Graph of Left Upper Tibia F_z V/S Force

From the injury criteria to get 4 points, the maximum force should be less than 2KN in our case 2.2KN i,e the injury point for tibia is 1.5.The left upper tibia affects 4points as it is not crossing 2KN force.

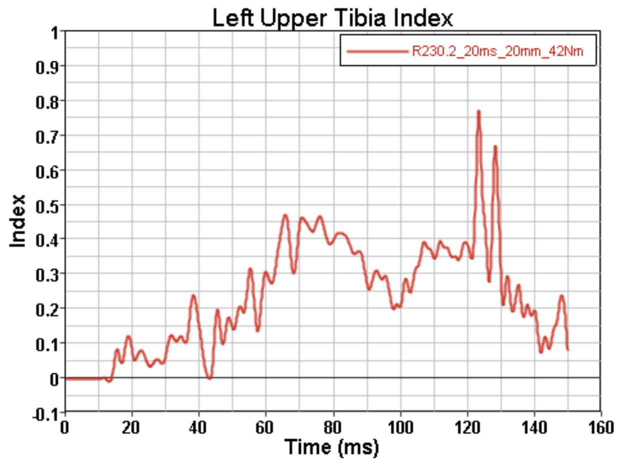

Fig.12 Graph of Left Upper Tibia Index V/S Time

As we can see from the above graph the peak lift right tibia index is around 0.75,so that depending upon this point obtained is 2.9.

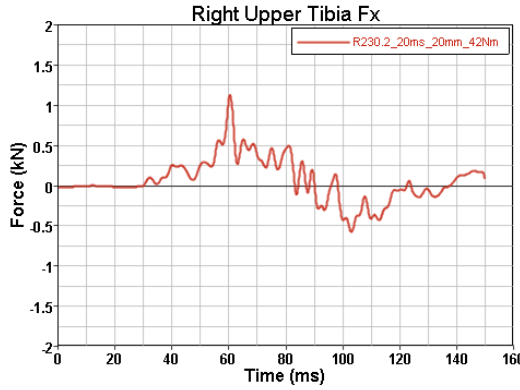

Fig.13 Graph of Right Upper Tibia F_x V/S Force

From the injury criteria to get 4 points, the maximum force should be less than 2KN in our case 2.2KN i,e the injury point for tibia is 1.
The right upper tibia affects 4points as it is not crossing 2KN force.

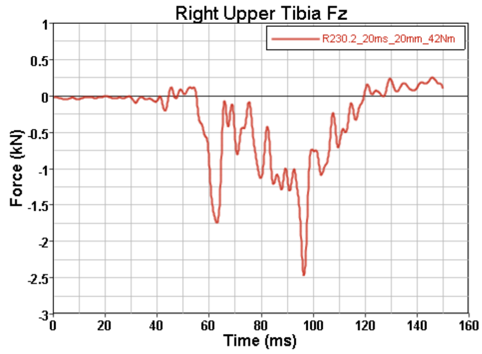

Fig.14 Graph of Right Upper Tibia F_z V/S Force

From the injury criteria to get 4 points, the maximum force should be less than 2KN in our case -2.5KN i.e. the injury point for tibia is 3.8
The right upper tibia affects 3.8points as it is not crossing 2KN force.

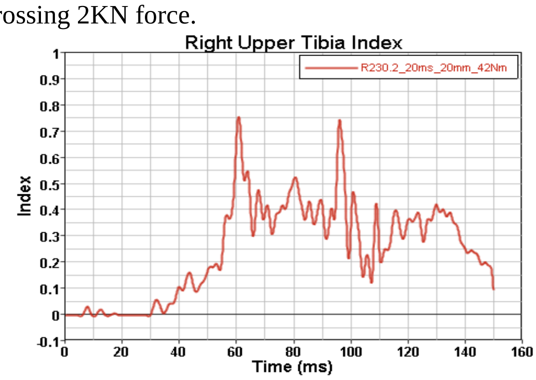

Fig.15 Graph of Right Upper Tibia Index V/S Time

As we can see from the above graph the peak right upper tibia index is around 0.7,so that depending upon this point obtained is 3.

Left upper F_x	4	2.9
Left upper F_z	4	
Upper Index Left	2.9	
Right upper F_x	4	

Right upper F_z	3.8	
Upper Index Right	3	

Table.3 Body Zone 1

4.2 Body zone 2:

This is the second body zone.

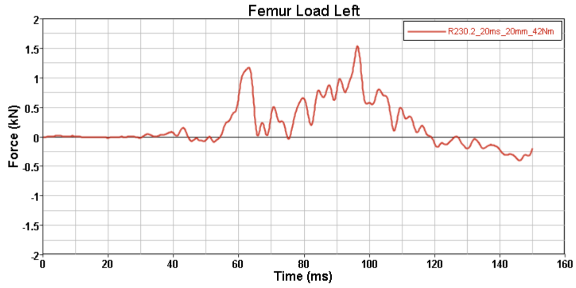

Fig.16 Graph of Femur load left V/S Force

From the above graph the femur load is not crossing 3.8KN,from the injury criteria we can say that complete 4 points are awarded.

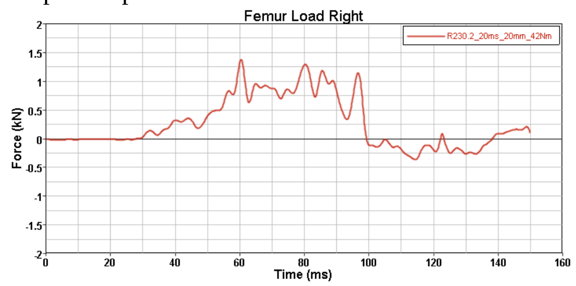

Fig.17 Graph of Femur load Right V/S Force

From the above graph the femur load is not crossing 3.8KN,from the injury criteria we can say that complete 4 points are awarded.

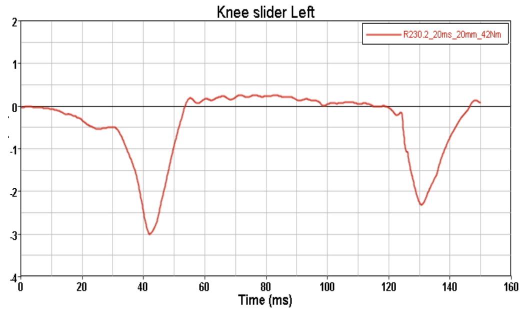

Fig.18 Graph of Knee Slider Left V/S Force

Fig.19 Graph of Knee Slider Right V/S Force

As the displacement of knee joint is less than 6mm from injury criteria 4 points is awarded.

Femur Left	4	4
Femur right	4	
Knee Slider Left	4	
Knee Slider Right	4	

Table.4 Body Zone 2

From the above table we can say that least point obtained is 4,so the body zone awarded with 4 points.

4.3 Body zone 3:

4.3.1Chest Displacement

This is a most critical injury parameter, from the above figure the maximum chest displacement or deflection is 38mm,so the point obtained is 3.3 points from the injury criteria.

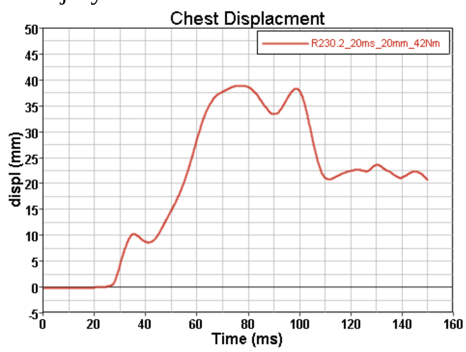

Fig.20 Graph of Chest Displacement V/S Time

4.3.2Chest Resultant

From the chest acceleration we will calculate the viscous criteria of the chest which is around 0.4m/s, from the injury criteria table point obtain is 4 points for the chest viscous criteria.

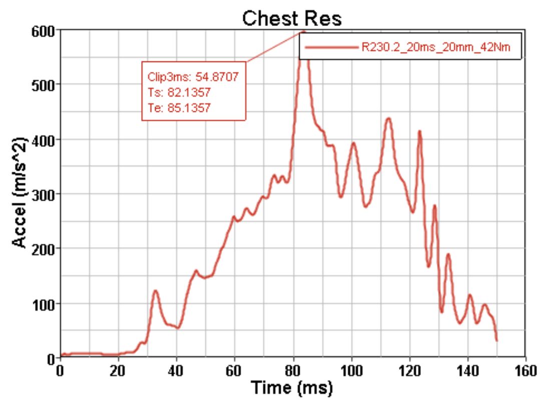

Fig.21 Graph of Chest Resultant V/S Acceleration

Chest Displacement	3.3	3.3
Viscous Criteria	4	

Table.5 Body Zone 3

4.4 Body zone 4:

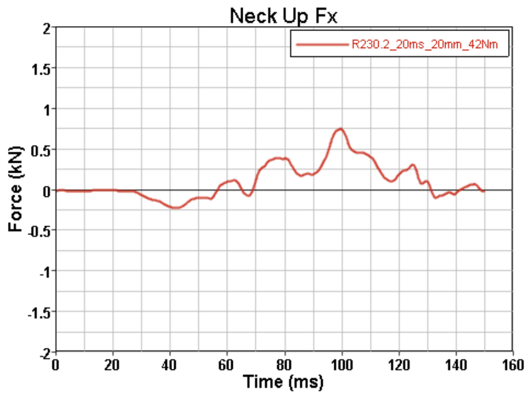

Fig.22 Graph of Neck Up F_x V/S Force

From the above graph we can say that the force on the neck is less than 2.7KN from the injury criteria 4 points are awarded for the neck F_x.

Neck Up F_z

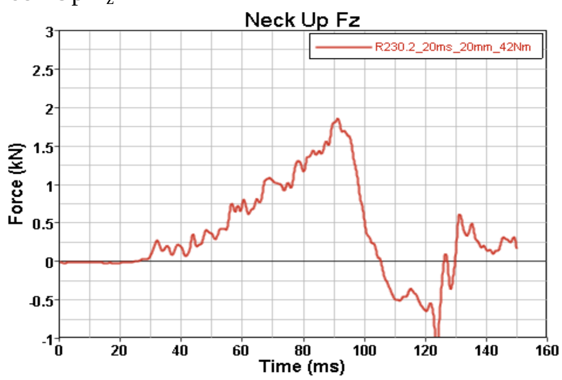

Fig.23 Graph of Neck Up F_z V/S Force

From the above graph we can say that the force on the neck is less than 2.7KN from the injury criteria 4 points are awarded for the neck F_z.

Neck Up M_y

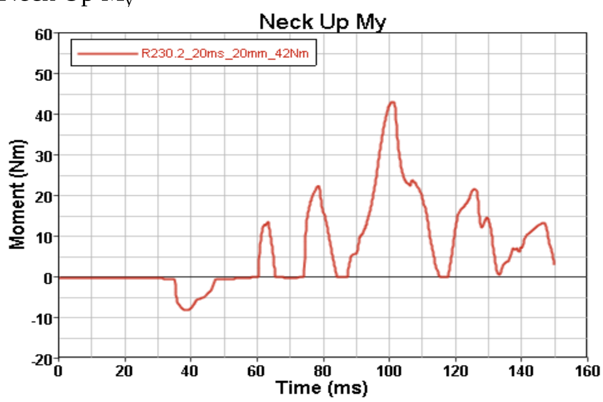

Fig.24 Graph of Neck Up M_y V/S Force

From the above graph the neck moment Y is 44Nm.From the injury criteria 3.8 points are awarded.

Head Resultant Acceleration

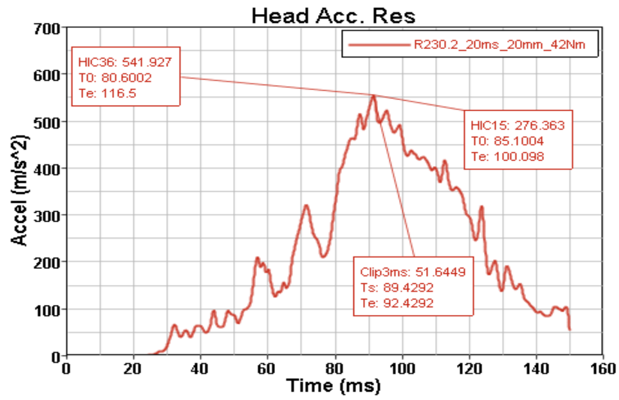

Fig.25 Graph of Head Acceleration V/S Time

From the above graph 3 important injuries are extracted HIC_{36},HIC_{15},H3.depending upon the dummies which HIC need to consider. According to the regulation male 50 percentile dummy considered. Therefore HIC_{36} need to be calculated.

In this HIC_{36} 514 which is less than 650 units, from the injury criteria 4 points are awarded and h3 is around 51.5gravity which is less than 72g.therefore from the injury criteria 4 points are awarded.

HIC_{36}	4	3.8
H3	4	
Neck F_x	4	
Neck F_y	4	
Neck M_y	3.8	

Table.6 Body Zone 4

From the above body zone 4, the least point is 3.8 from the neck movement.

Body Zone 1	2.9	14
Body Zone 2	4	
Body Zone 3	3.3	
Body Zone 4	3.8	

Table.7 Overall Body Zone

5. CONCLUSION AND SCOPE FOR THE FUTURE WORK

1.The main objective of this project is to evaluate frontal impact of driver side according to EURO NCAP regulation.

2. The human body dynamics is measured with respect to forces, moments, displacement and gravity which will represents bone fracture, internal bleeding, external bleeding etc.

3. When we start the correlation we starts with foot to head as the foot will be the first contact in human body with respect to vehicle.

4. If the tibia, femur, abdomen correlated properly automatically chest, neck, head get will correlate with the test.

5. We observed some injury (Internal bleeding, External Bleeding, Bone fracture) in body zone 1 i.e.

lower and upper tibia much tuning is to be done with respect to occupant safety.
6. In body zone 2 we observed no injuries (i.e. Internal bleeding, External Injuries, Bone fracture etc) which shows here no need to improve in tibia.
7. In body zone 3 we observed no injuries (i.e. Internal bleeding, External Injuries, Bone fracture etc) which shows which shows lower and upper tibia much tuning is to be done with respect to occupant safety.
8. In body zone 4 we observed slide improvement (i.e. Internal bleeding, External Injuries, Bone fracture etc) which shows lower and upper tibia slide tuning is to be done with respect to occupant safety.
9. According to EURO NCAP regulation, this structure vehicle get four star ratings which is good for safety.

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