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Design and Material Optimization of Impact Analysis on a Car Door

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Abstract: ***Car door is used to protect the passengers from collisions. Presently Aluminium Alloy-2024 is used for car doors construction. The aim of the project is to analyse the car door with presently used material Aluminium Alloy-2024 and replacing with composite materials like AISI-1018, Carbon fibre reinforced polymer. In this project we will perform impact analysis on the car door by giving certain speed to it we will find out the stresses, displacements and compare it with different materials.***
By comparing the results, we will consider the best one for the car door design. Also we are going to decreases weight of the door by using composite materials replacing with aluminium alloy-2024. By decreases the weight of the car door, weight of the body reduces. so that the fuel consumption decreases. In this project, the car door is designed by using parametric modelling software Solidworks. Impact analysis will be done by COSMOS.
Keywords: Car door, Impact analysis, Solidworks.

I. INTRODUCTION

Car door is a type of door which is physically hinged but sometimes attached by other mechanisms. Door is used entering and exiting from a vehicle. Car door mainly provide security to the passengers from collisions. Door mainly consists of window glass, door latch, window regulator assembly and other components. Theses doors are opened manually or powered electronically. By the type of opening, Car doors are different types.

II. DIMENSIONS AND PROPERTIES

1) Analysis type- Impact analysis
2) Material- Carbon fibre reinforced polymer
3) Mass density-1400 Kg/m^3
4) Poisson's ratio-0.43
5) Elastic modulus-$1.02e^{+011} N/m^2$
6) Yield strength-$1.08e^{+009} N/m^2$
7) Length of door -1128mm
8) Width of door – 920mm

A. Properties of Materials

Properties	Aluminium alloy-2024	AISI-1018	CFRP
Mass density (Kg/m^3)	2800	7870	1400
Elastic modulus(N/m^2)	$7.3e^{+010}$	$2e^{+011}$	$1.02e^{+011}$
Yield strength(N/m^2)	$7.582e^{+007}$	$3.7e^{+008}$	$1.08e^{+009}$
Poisson's ratio	0.33	0.29	0.43

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III. CAR DOOR MODEL

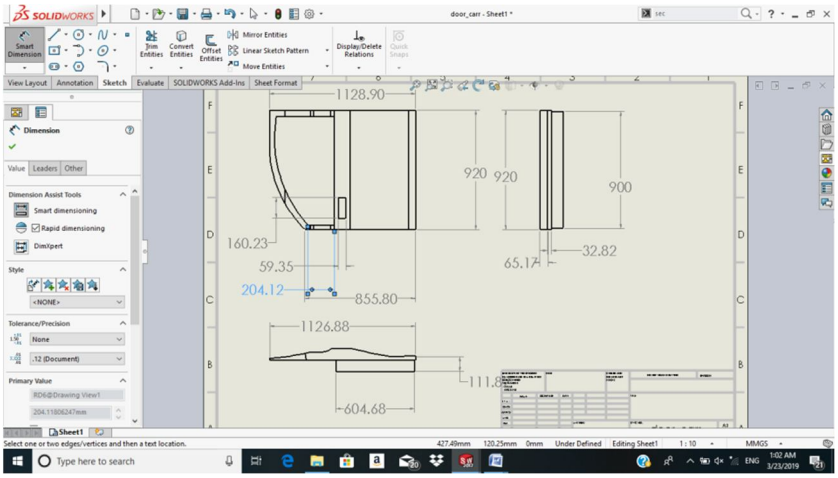


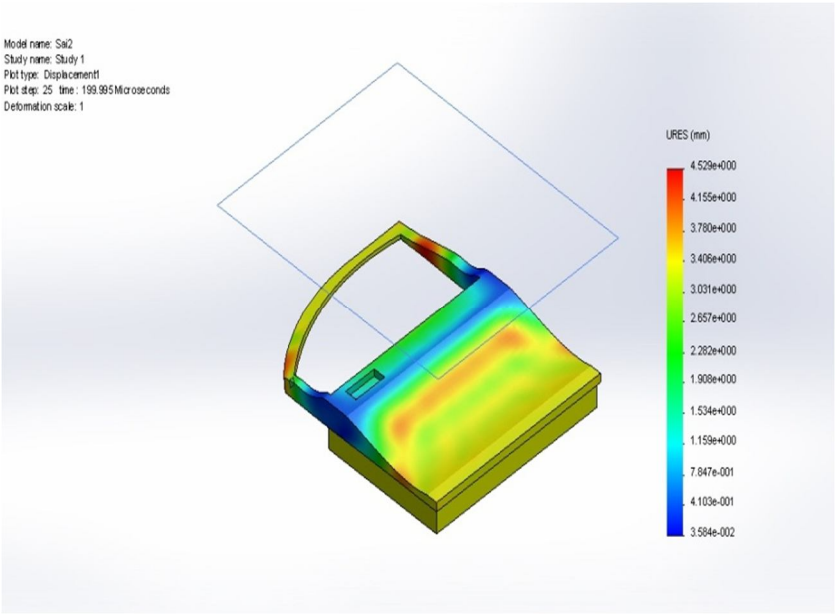
Fig: 2 D drafting of car door

IV. ANALYSIS

A. *Aluminium Alloy 2024*

1) At 60km/hr Speed

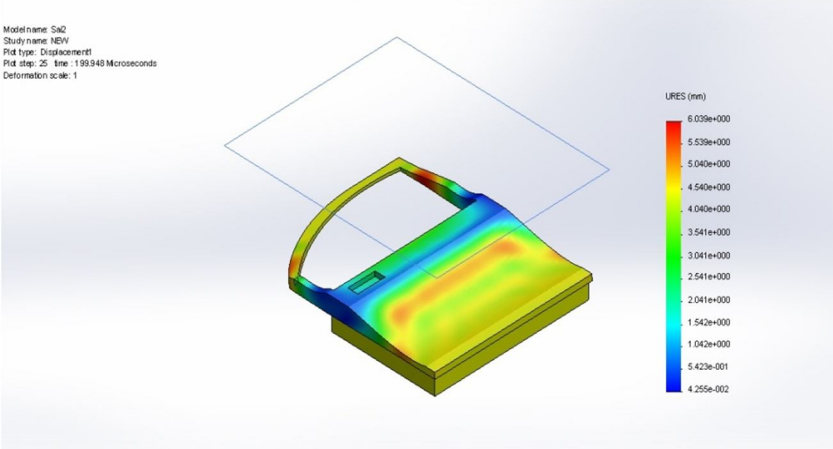
Results	Min	Max
Stress(N/mm^2)	1.22229e-015	422.232
Displacement(mm)	0.0358435	4.52904
Strain	3.20508e-019	0.0050324



2) At 80 km/hr Speed

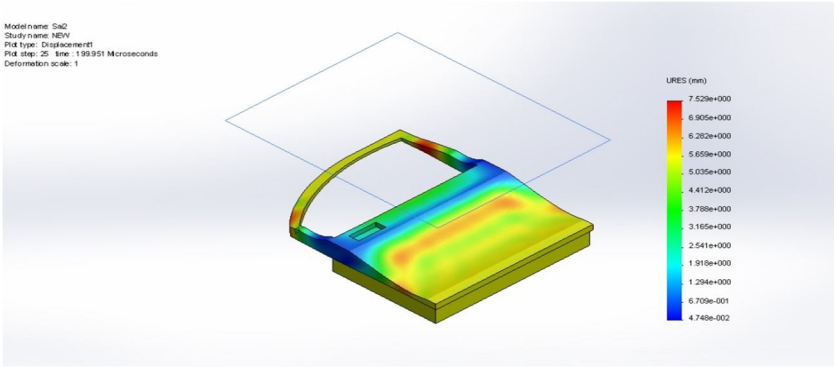
Results	Min	Max
Stress(N/mm^2)	2.57751e-014	738.606
Displacement(mm)	0.0425525	6.03905
Strain	3.08657e-019	0.00669916

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3) At 100 km/hr speed

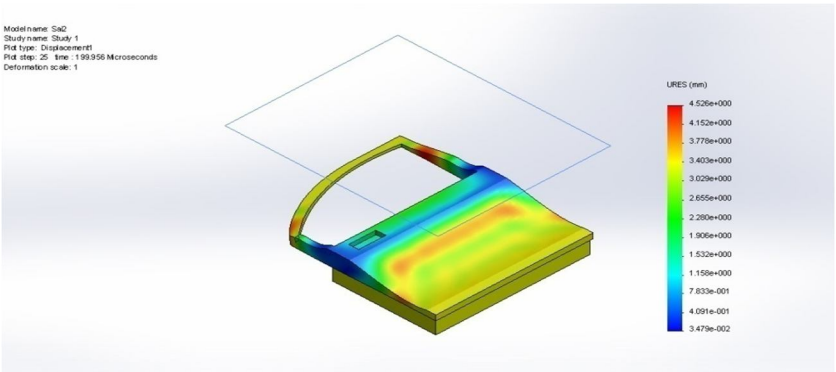
Results	Min	Max
Stress(N/mm^2)	1.82554e-014	919.856
Displacement(mm)	0.0474818	7.52896
Strain	2.66484e-019	0.00833616



B. AISI 1018

1) At 60 km/hr speed

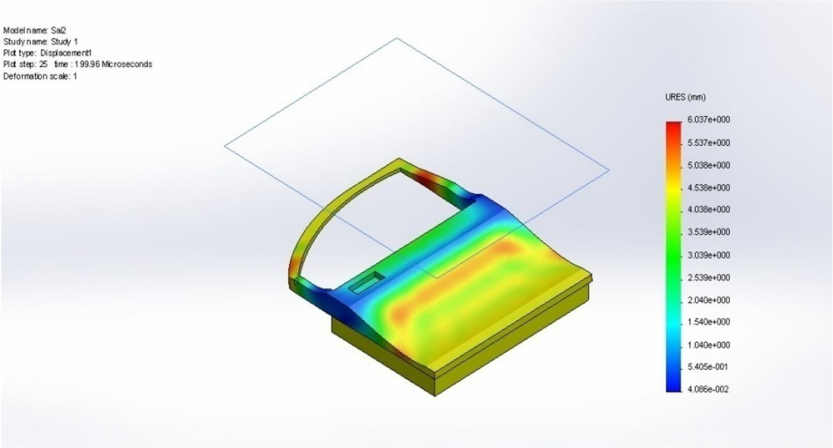
Results	Min	Max
Stress(N/mm^2)	1.87126e-015	1218.76
Displacement(mm)	0.0347883	4.52615
Strain	2.92663e-019	0.00503705



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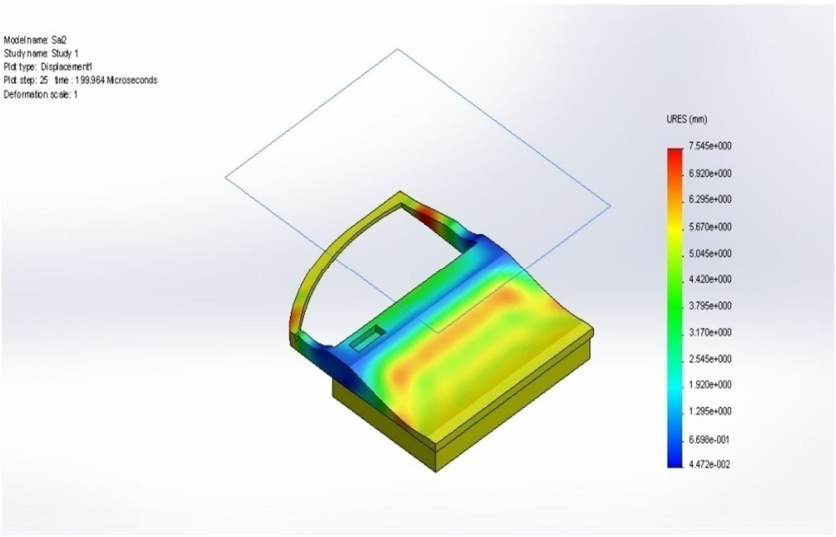
2) At 80 km/hr speed

Results	Min	Max
Stress(N/mm^2)	1.51711e-015	1626.6
Displacement(mm)	0.0408572	6.03697
Strain	1.74574e-019	0.00670635



3) At 100 km/hr Speed

Results	Min	Max
Stress(N/mm^2)	5.02873e-015	2034.23
Displacement(mm)	0.0447191	7.54523
Strain	2.8085e-019	0.00836776

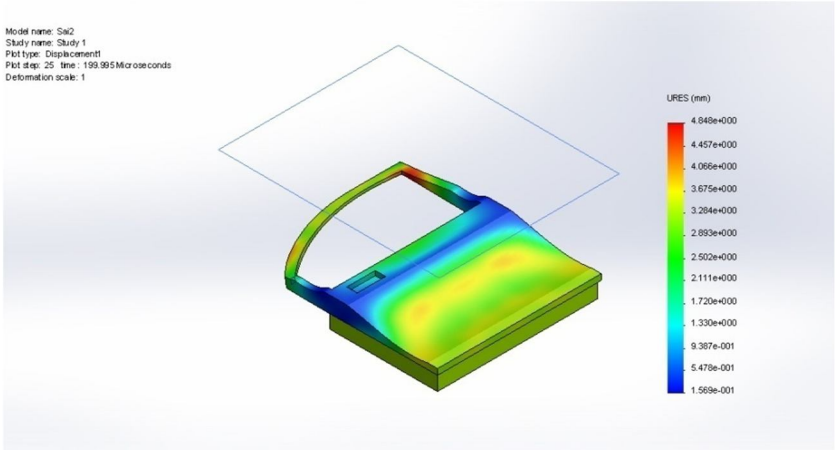


C. CFRP

1) At 60 Km/hr speed

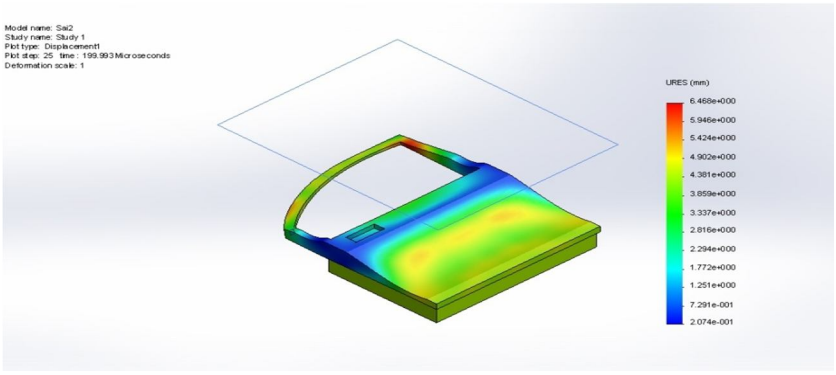
Results	Min	Max
Stress(N/mm^2)	3.04767e-015	338.376
Displacement(mm)	0.156872	4.84772
Strain	5.2041e-019	0.0052094

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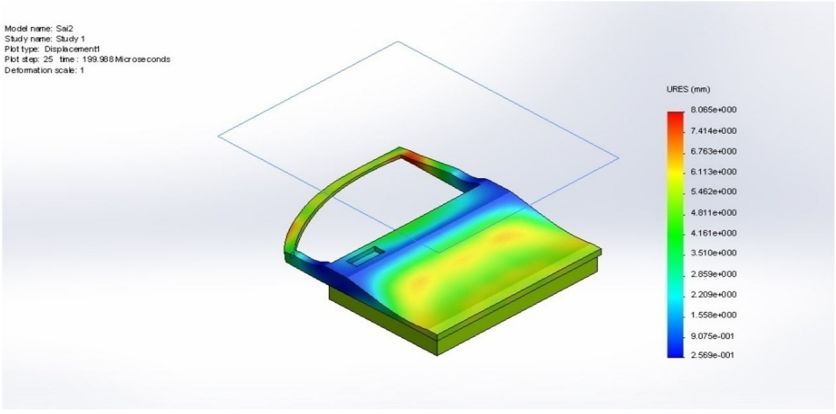
2) At 80 km/hr Speed

Results	Min	Max
Stress(N/mm^2)	1.81922e-015	451.129
Displacement(mm)	0.207416	6.46751
Strain	5.39016e-019	0.00692768



3) At 100 km/hr Speed

Results	Min	Max
Stress(N/mm^2)	1.72168e-015	562.004
Displacement(mm)	0.256853	8.06463
Strain	2.85844e-019	0.00860724



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STRESS (N/mm^2) TABLE

Speed (km/hr)	Al 2024	AISI 1018	CFRP
60	422.232	1218.76	338.376
80	738.606	1626.6	451.129
100	919.856	2034.23	562.004

DISPLACEMENT (mm)

Speed (km/hr)	Al 2024	AISI 1018	CFRP
60	4.529	4.526	4.847
80	6.039	6.036	6.467
100	7.528	7.545	8.064

STRAIN

Speed (km/hr)	Al 2024	AISI 1018	CFRP
60	0.005	0.005	0.0052
80	0.0066	0.0067	0.0069
100	0.0083	0.0083	0.0086

V. CONCLUSION

By comparing the results from above results tables, we did impact analysis on car door at four different speeds that are 60,80,100 Km/hr. From above results we can see car door with CFRP has less stresses than other two materials(Al 2024 & AISI 1018).

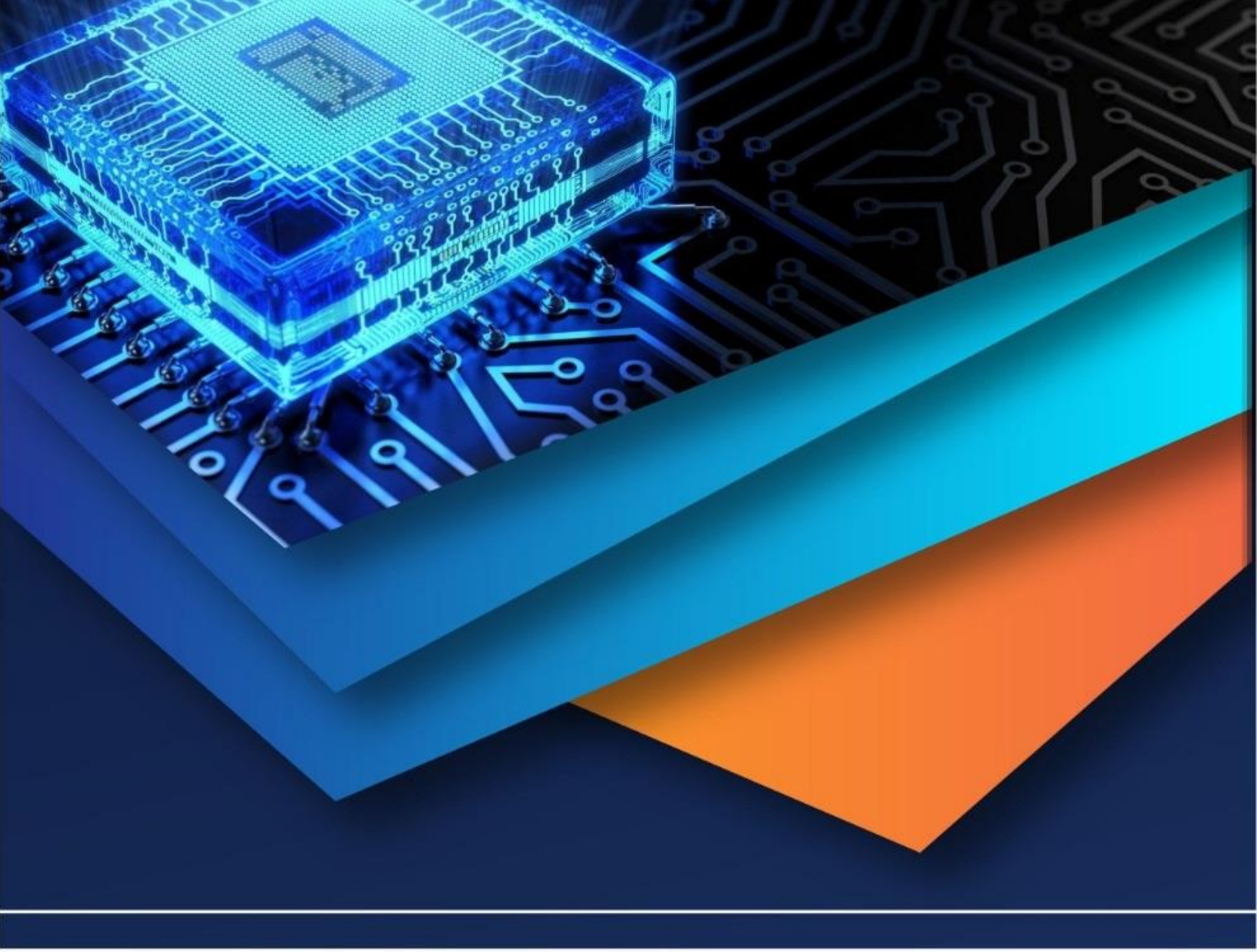
By exerting its unique properties in which CFRP has very less density comparatively to other two materials. Its weight was also very less which helps in reducing, the overall weight of vehical and helps in fuel efficiency.

Hence we can conclude that car door using CFRP material is very safe during impacts & posses very high strengths and also helps in fuel efficiency for its low weight.

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