ACTUAL RATIO OF COW BONE, SNAIL SHELL AND EPOXY RESIN MATERIAL COMPOSITE FOR THE PRODUCTION OF AUTOMOBILE FRONT FENDER

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ABSTRACT

The study, actual ratio of cow bone, snail shell and epoxy resin material composite for the production of automobile front fender was successfully carried out. The cow bones and snail shells gathered, was cleaned, washed, sun dried and grounded to size to reduce impurity and moisture content. The grounded particles were sieved using standard sieve to achieve finer grains. Manual weighing balance was used to weigh materials into variable masses and was used to establish optimal levels using MATLAB software and 3D surface graphical interactions. Results showed that the best maximum real root of the polynomial model generated was 1.1903N/mm^2 and this represented the optimal impact strength for the material mixture. 3D surface interactions and optimization of the model for the three materials required for production of the automobile front fender part suggested that the optimal values for actual material mixture ratio is 12.5kg of cow bone, 24kg of snail shell and 36kg of Epoxy Resin. It was also observed that the use of cow bone, snail shell and epoxy resin as composite materials for the production of automobile front fender have several advantages such as light weight, high impact strength against accident collision, zero yielding. Researchers recommended based on the study; that the use of actual material ratio in fender production would improve performance or functional properties of the automobile front fender.

Keywords: *Actual ratio, Composite material, Automobile fender, Material mixture, Cow bone.*

1.0 INTRODUCTION

It has been the interest of researchers to achieve production cost cutting in automobile market that deals with the design, production, repair and modification of automobile vehicles. One of the ways through which this could be achieved is through the use of composite materials in the production of automobile parts. According to Gandla and Chandra (2018) as cited in Ibezim etal (2024) maintained that automobile front fender is a protective panel that is located above the front wheel of the vehicle and could be made of metal, plastic or alloys. The purpose of its design is to prevent water, debris, particulates and sands not to be thrown from the revolving tire to the body of vehicle. Furthermore, it supports vehicle styling and aerodynamic performances.

Mangesh and More (2020) investigated vibration and impact analysis of optimized automotive front bumper and consistently claimed that the use of composite materials in the design and production of automotive parts like bumpers could drastically reduced production costs when compared with the use of conventional materials. It is on this note, the researchers aimed to determine the actual ratio of cow bone, snail shell and epoxy resin material composite for the production of automobile front fender.

According to Ibezim et al (2024) stated that composite material is a heterogeneous combination of two or more materials with reinforcing element like fibers, fillers with binders such as resins or polymers. This paper aims to adopt cow bone, snail shell and epoxy resin as material composite and determine their optimal actual ratio for the production of automobile front fender. The skeletal structure that provides support to the animal cow is known as cow bone. The hard outer covering that protects and supports the snail is known as snail shell and epoxy resin is a thermosetting plastic that would function as binder for the reinforcement particles.

2.0 METHODOLOGY

Researchers gathered the cow bones and snail shells cleaned, washed, sun dried and grounded them to size to reduce impurity and its moisture content. The grounded particles were sieved using standard sieve to achieve finer grains. Manual weighing balance was used to weigh materials into variable masses and was used to establish or determine optimal levels using MATLAB software and 3D surface graphical interactions.

3.0 ACTUAL RATIO OF THE MATERIAL MIXTURE

The actual ratio of the material mixture was determined through optimization of the measured masses. Here, Y *is* a dependent variable or predicted response known as impact strength; *X1, X2 and X3* are independent variables; representing cow bone in kg, snail shell in kg and epoxy resin in kg respectively. The matrix for the three variables were chosen and varied at 3 levels (+2.5 0 – 3.5) for impact response prediction.

MATLAB (R2015a) was be used to generate regression model and 3D graphical analysis of surface interaction to establish the optimal values to be used for production.

4.0 RESULTS

Optimal values of cow bone, snail shell and epoxy resin is modeled as shown below.

```
>> % Y = dependent impact response variable in kg;
>> % X1 = independent variable, amount of cow bone in kg;
>> % X2 = independent variable, amount of snail shell in kg;
>> % X3 = independent variable, amount of epoxy resin in kg;
>> Y = [2.5 0 -3.5];
>> X1 = [25 0 50];
>> X2 = [0 50 25];
>> X3 = [50 25 0];
>> % the expected relationship for the variables is below;
>> Y = X1 + X2 + X3;
>> Y = A; X1 = B; X2 = C; X3 = D;
Undefined function or variable 'A'.

>> A = [2.5 0 -3.5];
>> B = [25 0 50];
>> C = [0 50 25];
>> D = [50 25 0];
>> mdl = fitlm(B, A)

mdl =


Linear regression model:
    y ~ 1 + x1

Estimated Coefficients:
                   Estimate      SE        tStat     pValue
                   ________    _______    _______    _______

    (Intercept)     1.4167      3.1678    0.44721    0.73228
    x1               -0.07     0.09815    -0.7132     0.6056
```

```
Number of observations: 3, Error degrees of freedom: 1
Root Mean Squared Error: 3.47
R-squared: 0.337,  Adjusted R-Squared -0.326
F-statistic vs. constant model: 0.509, p-value = 0.606
>> tbl = anova(mdl)

tbl =

          SumSq    DF    MeanSq     F       pValue
          ______   __    ______   _______   ______

   x1      6.125    1     6.125   0.50865   0.6056
   Error  12.042    1    12.042

>> mdl = fitlm(C, A)

mdl =


Linear regression model:
   y ~ 1 + x1

Estimated Coefficients:
                   Estimate     SE       tStat     pValue
                   ________   ______   _______   _______

   (Intercept)     0.91667    3.5404   0.25891   0.83871
   x1                -0.05    0.1097   -0.4558   0.72774

Number of observations: 3, Error degrees of freedom: 1
Root Mean Squared Error: 3.88
R-squared: 0.172,  Adjusted R-Squared -0.656
F-statistic vs. constant model: 0.208, p-value = 0.728
>> tbl = anova(mdl)

tbl =

          SumSq    DF    MeanSq     F       pValue
          ______   __    ______   _______   _______

   x1      3.125    1     3.125   0.20776   0.72774
   Error  15.042    1    15.042

>> mdl = fitlm(D, A)

mdl =


Linear regression model:
   y ~ 1 + x1

Estimated Coefficients:
                   Estimate      SE       tStat     pValue
                   ________   ________   _______   ________
```

(Intercept)	-3.3333	0.37268	-8.9443	0.070882
x1	0.12	0.011547	10.392	0.061071

Number of observations: 3, Error degrees of freedom: 1
Root Mean Squared Error: 0.408
R-squared: 0.991, Adjusted R-Squared 0.982
F-statistic vs. constant model: 108, p-value = 0.0611
>> tbl = anova(mdl)

tbl =

	SumSq	DF	MeanSq	F	pValue
x1	18	1	18	108	0.061071
Error	0.16667	1	0.16667		

The response linear regression model for the three materials required for production is shown below.

$$\boldsymbol{Y = 1.4167 - 0.07X_1 - 0.05X_2 + 0.91667 + 0.12X_3 - 3.3333\ N/mm^2} \ldots\ldots (4.0)$$

>> % TO OBTAIN THE ROOT OF THE POLYNOMIAL;
>> E = [1.4167 -0.07 0.91667 -0.05 0.12 -3.3333];
>> sqrt(E)

ans =

Columns 1 through 4

1.1903 + 0.0000i   0.0000 + 0.2646i   0.9574 + 0.0000i   0.0000 + 0.2236i

Columns 5 through 6

0.3464 + 0.0000i   0.0000 + 1.8257i

The best maximum real root of the polynomial is 1.1903N/mm^2 and this represents the optimal impact strength for the material mixture.

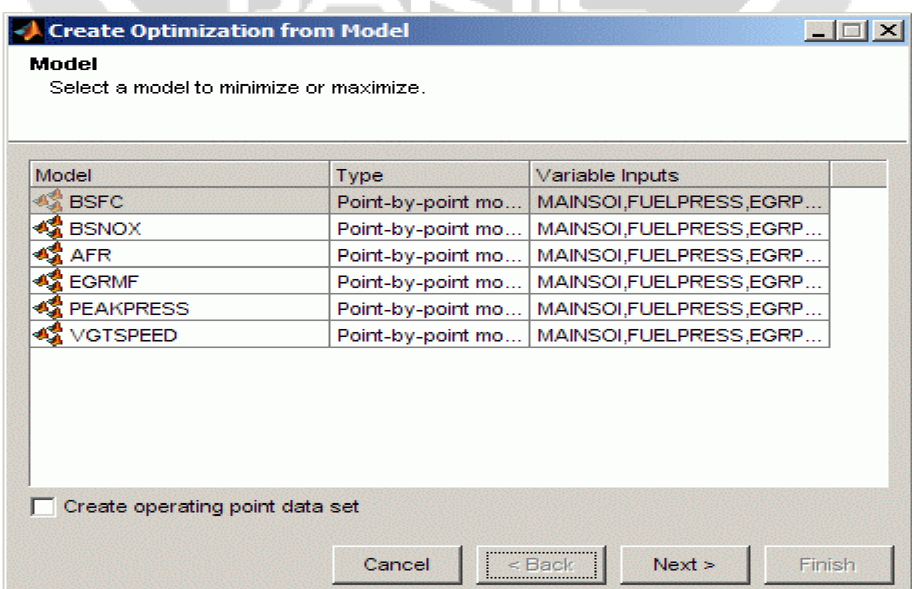

Fig 1.0: Optimization box for polynomial model

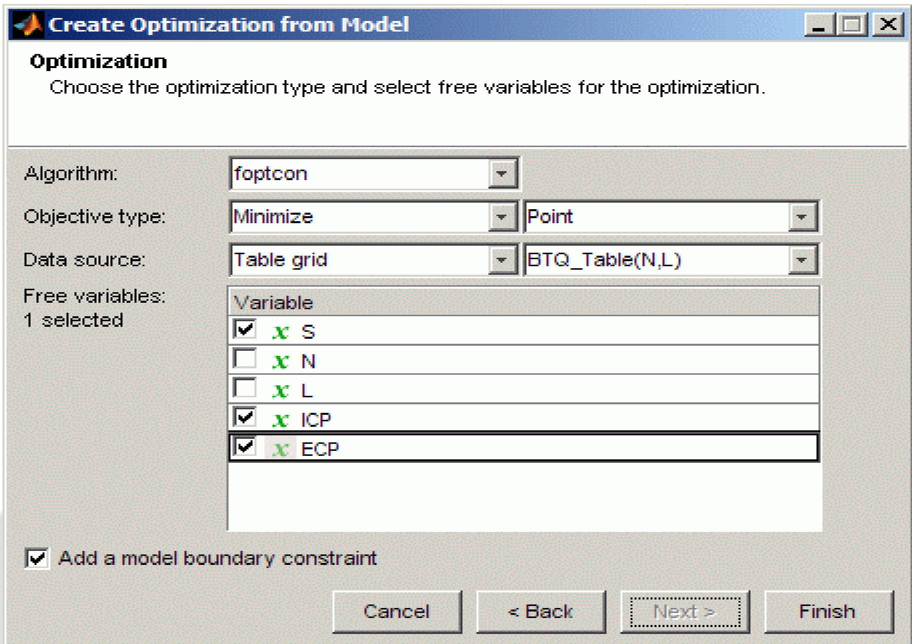

Fig 2.0: Optimization box for polynomial model

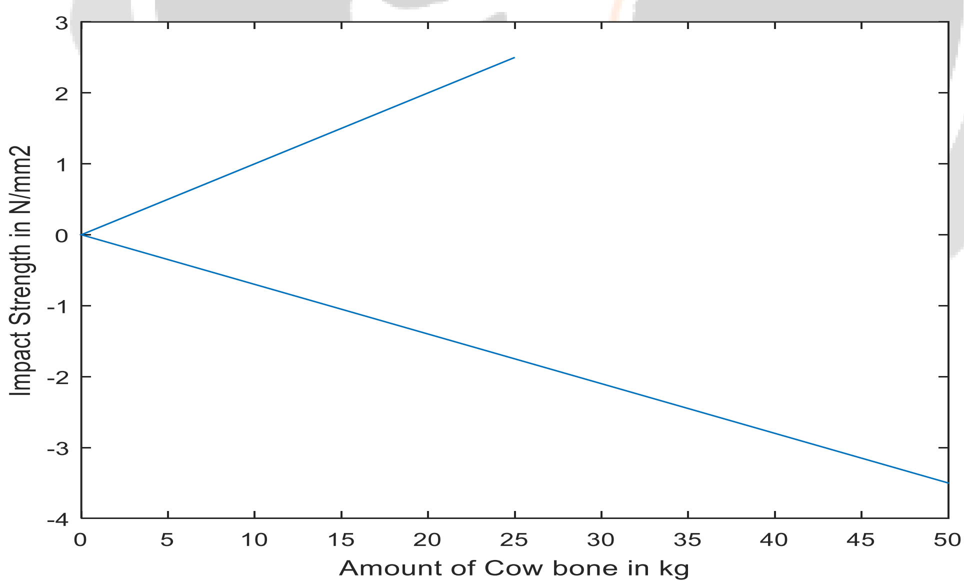

Fig 3.0: Graph of Impact Strength against Cow bone

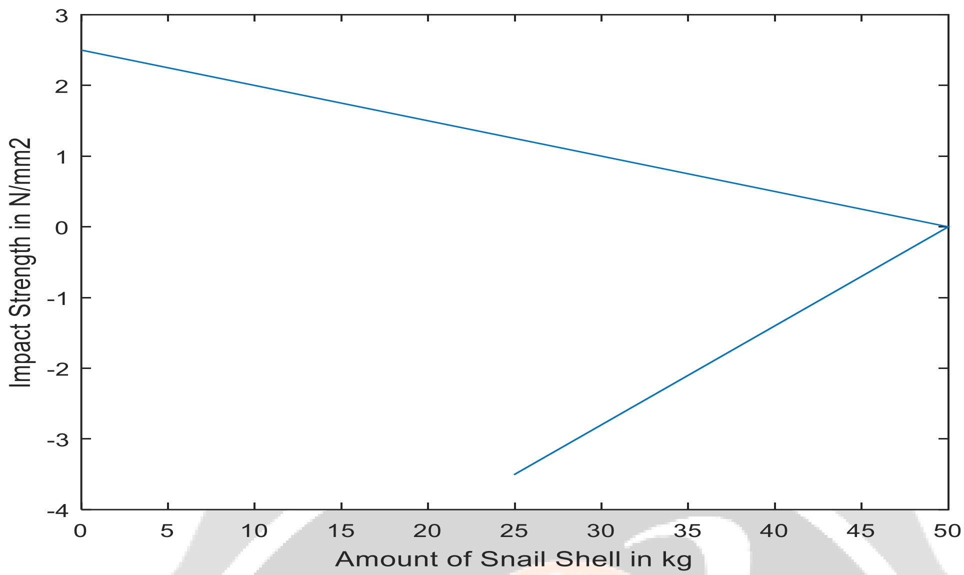

Fig 4.0: Graph of Impact Strength against Snail Shell

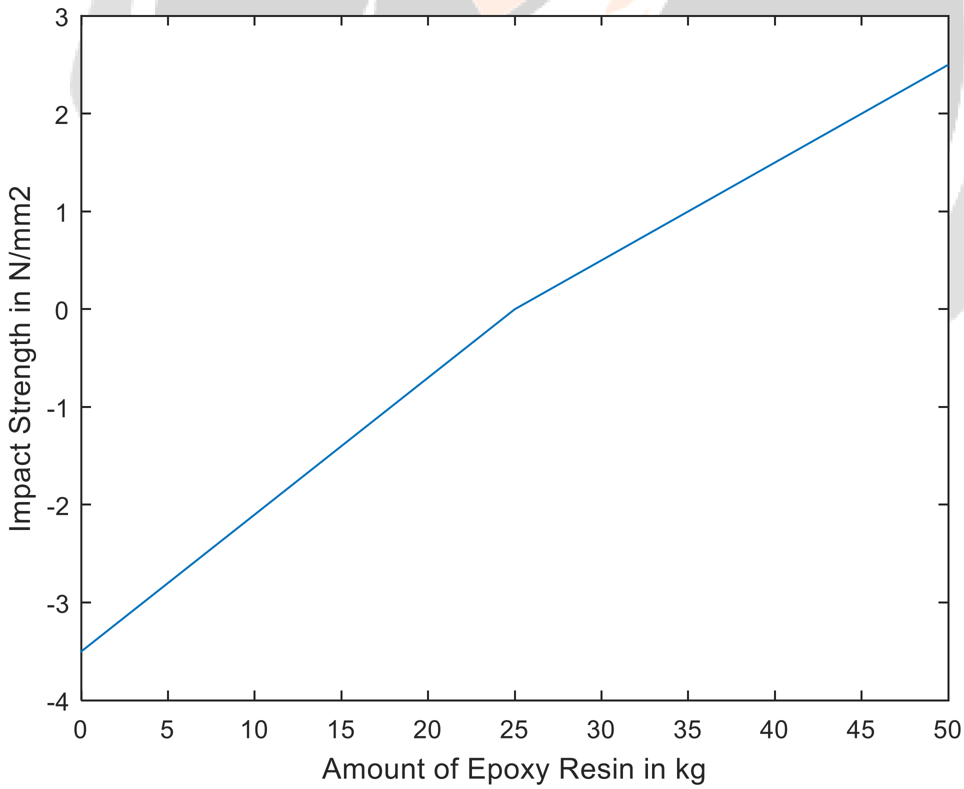

Fig 5.0: Graph of Impact Strength against Epoxy Resin

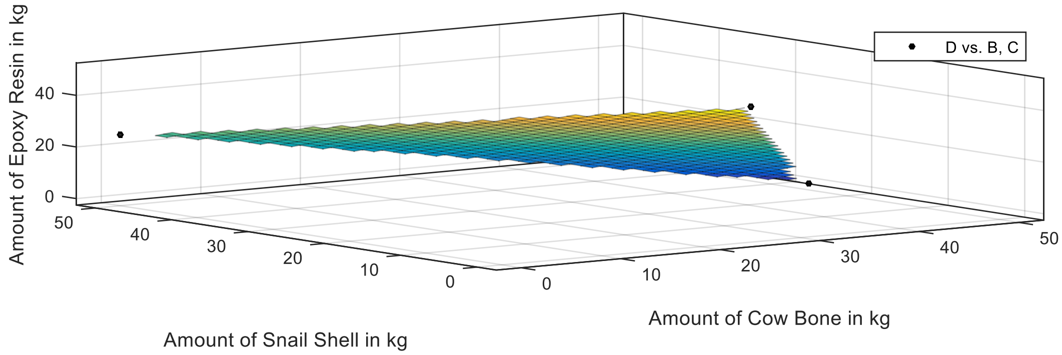

Fig 6.0: 3D Surface Interaction of Materials

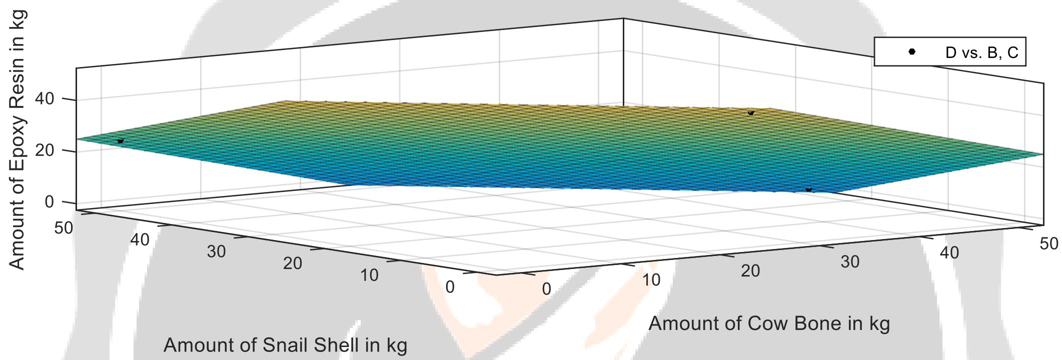

Fig 7.0: 3D Surface Interaction of Materials

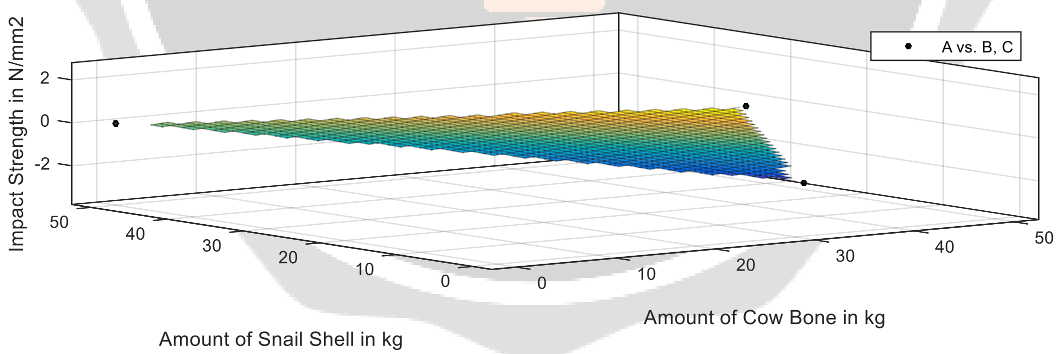

Fig 8.0: 3D Surface Interaction of Materials and Impact Strength

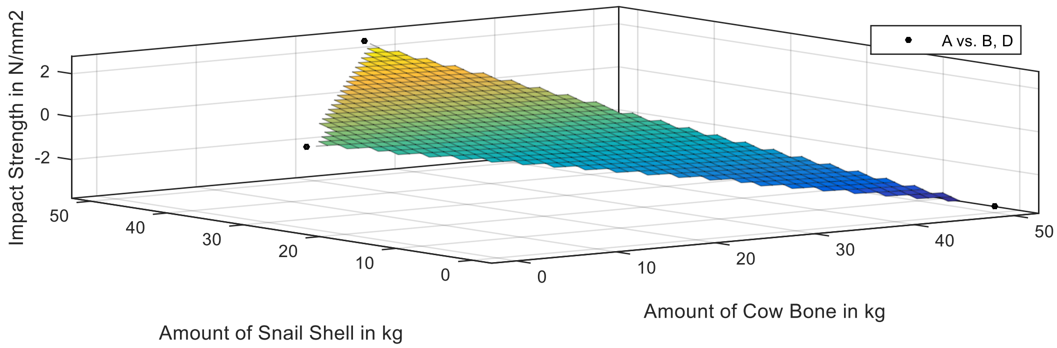

Fig 9.0: 3D Surface Interaction of Materials and Impact Strength

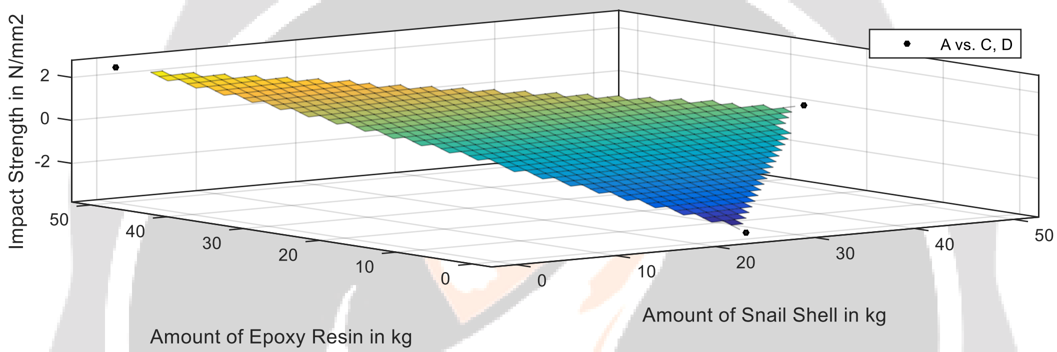

Fig 10.0: 3D Surface Interaction of Materials and Impact Strength

The best maximum real root of the polynomial is 1.1903N/mm^2 and this represents the optimal impact strength for the material mixture. MATLAB (R2015a) was used to generate regression model and 3D graphical analysis of surface interaction to establish the optimal values of material mixture before production as shown in **fig 3.0 to fig 10.0**. The 3D surface interactions and optimization of the model for the three materials required for production of the automobile front fender part suggested that the optimal values for material mix is 12.5kg of cow bone, 24kg of snail shell and 36kg of Epoxy Resin. This yielded optimal impact strength of 1.1903N/mm^2, as suggested by the best root of the polynomial model.

5.0 CONCLUSION

The findings of the study showed that the use of composite material, cow bone, snail shell and epoxy resin for automobile front fender production would require actual materials mixture ratio of 12.5kg: 24kg: 36kg for cow bone, snail shell and epoxy resin as material composite respectively with optimal impact strength of 1.1903N/mm^2. It was also observed that the use of cow bone, snail shell and epoxy resin as composite materials for the production of automobile front fender have several advantages such as light weight, high impact strength against accident collision, zero yielding, etc. Hence, cow bone, snail shell and epoxy resin as composite material should be used in automotive fender design and manufacturing to cut cost and improve performance. The following recommendations are suggested based on the study; actual material ratio should be used in fender production to improve performance or functional properties of the automobile front fender. Composite materials must have high impact strength rather than tensile strength, since failure due to compressive stress is predominant, this research could also be done in future using different actual ratio of composite materials and other advanced software for generalization.

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