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Design and Fabrication of Supercar Structure

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Abstract - *This project involves the innovative design and construction of a supercar structure, built over an old car chassis using clay for the initial modeling phase and fiberglass as the primary material for the final car body. The aim of the project is to create a lightweight, functional, and visually stunning supercar, leveraging the flexibility of clay modeling for precise design and the strength-to-weight benefits of fiberglass composites. The project emphasizes sustainability by repurposing an old car chassis, promoting material efficiency, and applying cutting-edge techniques in car body design.*

***Key Words*:** *Supercar design, Chassis repurposing, Clay modelling, Fiberglass composites, Lightweight materials, Functional design, Visual aesthetics, Sustainable automotive engineering.*

1.INTRODUCTION

The automotive industry is driven by the quest for innovation, performance, and sustainability. This project merges traditional modelling techniques with modern materials to create a unique supercar design. The use of clay for modelling allows for flexibility and precision in shaping the car's exterior before transitioning to the durable fiberglass material, which provides structural integrity and lightness. By using an old car chassis as the foundation, the project also emphasizes the importance of reusing and repurposing materials, reducing waste, and promoting sustainable engineering practices.

1.1 Objectives: -

1. Sustainable Design: - To repurpose an old car chassis and create a new supercar body using sustainable methods and materials.

2. Precision in Design: - To use clay modelling for detailed and accurate shaping of the car's exterior design, ensuring both aesthetic appeal and aerodynamics.

3. Lightweight Supercar: - To construct a supercar body using fiberglass composites, reducing weight while maintaining strength and durability.

4. Aerodynamics and Performance: - To design a supercar body that optimizes aerodynamics for better performance, fuel efficiency, and handling.

5. Cost-Effective Innovation: - To explore the feasibility and cost-effectiveness of combining traditional and modern techniques for creating high-performance vehicles.

1.2APPLICATION AREAS

The design and fabrication of a supercar structure using clay modelling and fiberglass composite material over an old car chassis is an innovative project that combines traditional and modern techniques to create a high-performance vehicle. This approach has several potential applications across different sectors, both within the automotive industry and in related fields. Below are the key application areas where this project can have significant impact:

1. Automotive Design and Customization
2. Motorsports and Performance Racing
3. Sustainability and Environmental Impact
4. Aerospace and Industrial Design

2. LITERATURE REVIEW

2.1 PREVIOUS WORK: -

[1] V.D. Libera Junior et al. (2022)
Title: Processing, Thermal and Mechanical Properties of Composite Laminates with Natural Fibers Prepregs
Journal: Polymer Polymers & Composites
DOI: 10.1177/09673911221087591
Elaboration:
This research evaluates the use of natural fiber-based prepregs (pre-impregnated materials) in composite laminates. The study systematically analyzes the processing parameters, thermal behavior (via TGA/DSC), and mechanical properties (tensile, flexural, and impact strength) of these laminates. The results reveal that natural fiber prepregs offer decent thermal resistance and mechanical strength, making them suitable for semi-structural applications, while also reducing environmental impact compared to synthetic alternatives.

[2] N. Fuentes Molina et al. (2021)
Title: Recycling of Residual Polymers Reinforced with Natural Fibers as a Sustainable Alternative: A Review
Journal: Polymers (Basel)
DOI: 10.3390/polym13213612
Elaboration:

This review explores sustainable waste management through recycling natural fiber-reinforced polymers (NFRPs). It discusses mechanical, chemical, and thermal recycling techniques and evaluates their efficiency, environmental footprint, and economic viability. The review emphasizes that recycling NFRPs not only reduces landfill waste but also promotes circular economy practices, especially in automotive and packaging sectors.

[3] C. Jaiswal (n.d.)
Title: Bio composite Market Research Report
Source: MarketResearchFuture.com
Link: Bio composite Market Report
Elaboration:
This industry report presents a global analysis of the bio composite market, highlighting trends, drivers, restraints, and regional growth patterns. It identifies increasing demand in automotive and building materials due to eco-friendly regulations and consumer preferences. Key materials discussed include wood-plastic composites and natural fiber composites. The report also discusses investments in R&D and forecasts steady market growth through 2028.

[4] A. Meraldo (2016)
Title: Introduction to Bio-Based Polymers
Book: Multilayer Flexible Packaging
DOI: 10.1016/B978-0-323-37100-1.00004-1
Elaboration:
This book chapter introduces bio-based polymers—polymers derived from renewable biomass like starch, cellulose, and polylactic acid (PLA). It describes their chemical structure, processing challenges, and advantages such as biodegradability and low carbon footprint. Applications in multilayer packaging are discussed, where these materials are used as barrier layers, improving both environmental and functional performance.

[5] M. Avella et al. (2009)
Title: Eco-Challenges of Bio-Based Polymer Composites
Journal: Materials (Basel)
DOI: 10.3390/ma2030911
Elaboration:
This article reviews the ecological and technical challenges in producing and using bio-based polymer composites. Topics include raw material sourcing, performance limitations (e.g., moisture absorption), and end-of-life scenarios. It also outlines strategies for improving composite properties through hybridization, coupling agents, and advanced manufacturing techniques.

[6] Y.K. Kim (2012)
Title: Natural Fiber Composites (NFCs) for Construction and Automotive Industries
Book: Handbook of Natural Fibers
DOI: 10.1533/9780857095510.2.254
Elaboration:
This chapter provides a comprehensive overview of NFCs, focusing on their adoption in construction (e.g., roofing, panels) and automotive sectors (e.g., interior trim, dashboards). It compares the mechanical properties of NFCs with synthetic fiber composites, discusses cost-effectiveness, and addresses challenges like water absorption and processing variability.

[7] G. Wiedemann & H. Rothe (1986)
Title: Review of Prepreg Technology
Book: Developments in Reinforced Plastics—5
DOI: 10.1007/978-94-009-4179-3_3
Elaboration:
A foundational work detailing the development and application of prepreg technology. It explains the benefits of using pre-impregnated fibers for enhanced control over resin distribution, leading to consistent mechanical properties. The chapter also discusses curing cycles, storage conditions, and applications in aerospace, where high precision and strength are crucial.

[8] M. Jabbar & A. Nasreen (2021)
Title: Composite Fabrication and Joining
Book: Composite Solutions for Ballistics
DOI: 10.1016/B978-0-12-821984-3.00013-9
Elaboration:
Covers fabrication methods such as filament winding, vacuum-assisted resin transfer molding (VARTM), and resin infusion. It also explores joining techniques for composite parts, such as mechanical fastening, adhesive bonding, and hybrid methods. The chapter emphasizes the importance of proper joining methods to ensure structural integrity in ballistic and defense applications.

[9] A. Bhatnagar et al. (2006)
Title: Prepreg Ballistic Composites
Book: Lightweight Ballistic Composites
DOI: 10.1533/9781845691554.2.272
Elaboration:
Focuses specifically on the use of prepreg composites in ballistic protection. It discusses materials like aramid, UHMWPE, and carbon fibers impregnated with thermoset or thermoplastic resins. The chapter explains the advantages of prepreg processing in achieving uniform fiber-resin ratios and enhancing impact resistance, making them ideal for armor systems.

[10] V.M. Karbhari (2007)
Title: Fabrication, Quality, and Service-life Issues for Composites in Civil Engineering
Book: Durability of Composites for Civil Structural Applications
DOI: 10.1533/9781845693565.1.13
Elaboration:
Addresses concerns related to the use of composite materials in civil engineering structures like bridges, pipelines, and retrofits. It covers common defects (voids, delamination's),

quality control techniques (NDT methods), and environmental degradation (UV, moisture, fatigue). The author emphasizes the need for long-term performance monitoring and proper design considerations.

2.2 PROPOSED WORK

Proposed Work for the Project: Design and Fabrication of a Supercar Structure Using Clay Modeling and Fiberglass Composite Material Over an Old Car Chassis

The proposed work outlines the detailed steps required to achieve the design and fabrication of a supercar structure using clay modeling and fiberglass composite materials over an old car chassis. This approach combines the art of automotive design with modern materials engineering, leveraging clay for aesthetics and fiberglass composites for performance and durability.

3.METHODOLOGY

3.1 Phases of the Project

The project is divided into five key phases, each focusing on different aspects of design, development, and fabrication.

Phase 1: Design & Conceptualization (Weeks 1-3)

Objectives:

Define the visual and functional aspects of the supercar.

Develop a concept that incorporates aerodynamics, aesthetics, and performance.

Tasks:

Initial Sketches and CAD Modelling:

Sketch and conceptualize the design of the supercar, focusing on the body shape, aerodynamics, and integration with the old chassis.

Use CAD software (AutoCAD, Rhino, or SolidWorks) to create 3D models of the supercar body. These models will help visualize the design before physical modelling begins.

Design Considerations:

Analyze the old car chassis to determine its compatibility with the new design.

Evaluate weight distribution, engine placement, and clearance to ensure the new body fits the existing components.

Plan for aerodynamics, emphasizing drag reduction, downforce, and airflow around critical areas like the front grille, rear diffuser, and side panels.

Phase 2: Clay Modelling (Weeks 4-6)

Objectives:

Create a full-scale model of the supercar body using clay for ergonomic and aesthetic validation.

Refine the design based on both functional and aesthetic requirements.

Tasks:

Clay Modelling Setup:

Build a framework over the old chassis or a mock-up structure to support the clay modelling process. This will serve as the foundation for sculpting the body.

Use high-quality automotive clay, which can be easily shaped and smoothed for detailing.

Sculpting the Design:

Begin sculpting the body using hand tools and sculpting knives, ensuring precision in key areas like the front end, roofline, wheel arches, and rear end.

Use clay to model the aerodynamic contours and design features, ensuring that the proportions are accurate and the surfaces are smooth.

Refinement and Testing:

Continuously refine the design by adjusting based on aesthetic goals and aerodynamic functionality.

Consider testing aerodynamic principles like airflow dynamics using CFD (Computational Fluid Dynamics) simulations in parallel with the physical model.

Phase 3: Mold Making (Weeks 7-9)

Objectives:

Create molds from the clay model to begin the fabrication of the fiberglass composite body.

Ensure that the molds capture the details and surface finish of the clay model.

Tasks:

Mold Preparation:

Apply a release agent to the clay surface to ensure that the fiberglass mold can be easily separated later.

Build a mold frame around the clay model to hold the fiberglass layers in place.

Molding Process:

Lay fiberglass fabric onto the clay model, layer by layer, applying epoxy resin to each layer. The fiberglass material will form the external mold for the body.

Use multiple layers of fiberglass to achieve the desired thickness and strength.

Once the fiberglass is set, carefully remove the mold from the clay model, ensuring all details are captured without damage.

Phase 4: Fiberglass Composite Body Fabrication (Weeks 10-13)

Objectives:

Fabricate the supercar body using fiberglass composite materials.

Ensure the body is lightweight, strong, and durable.

Tasks:

Fiberglass Layup:

Begin the process of laying fiberglass sheets into the molds created from the clay model.

Each layer of fiberglass will be coated with epoxy resin to bond the layers together. The resin is carefully applied using brushes, rollers, or spatulas to ensure even coverage.

Reinforce high-stress areas such as the door frames, wheel wells, and front/rear sections with additional layers of fiberglass.

Curing:

Allow the fiberglass body to cure for the required time (typically 24-48 hours) to ensure that it hardens completely.

During the curing process, monitor the mold to ensure no air bubbles or defects form in the composite material.
Trimming and Refining:
Once the fiberglass body is fully cured, remove it from the mold and begin trimming excess material.
Sand and smooth the surfaces to remove imperfections. Additional coats of resin and gel coat can be applied to improve finish quality and durability.

Phase 5: Assembly and Integration (Weeks 14-16)
Objectives:
Assemble the fiberglass body onto the old car chassis.
Integrate all necessary mechanical and electrical components.

Tasks:
Chassis Integration:
Fit the fiberglass body onto the old chassis, ensuring precise alignment with the drivetrain, suspension, and other key components.
Secure the body to the chassis using custom brackets or mounting hardware.
Engine and Drivetrain Integration:
Install the engine, transmission, suspension, steering, and other mechanical components from the old chassis into the new body structure.
Ensure the engine compartment has sufficient space for cooling and airflow requirements.
Interior Design and Ergonomics:
Design and install the interior components, including the dashboard, seating, controls, and other comfort or performance features.
Ensure that the ergonomics of the interior are optimized for driver comfort and ease of use.
Testing and Final Adjustments:
Conduct initial static tests to check for structural integrity, alignment, and fitment of components.
Perform dynamic testing (if possible) to evaluate the handling, aerodynamics, and performance of the car.
Make any necessary adjustments based on testing outcomes, such as improving aerodynamics or refining the suspension setup.

3.2 Key Deliverables
Design Documentation: *CAD models, design sketches, and concept drawings.*
Clay Model: *A full-scale, hand-sculpted model of the supercar body.*
Fiberglass Molds: *Molds created from the clay model, including detailed surface finishes.*
Fiberglass Body Panels: *The final composite body panels, ready to be integrated with the chassis.*
Assembled Supercar: *A fully assembled supercar using the repurposed chassis, custom fiberglass body, and functional mechanical components.*
Testing Reports: *Aerodynamic testing, structural integrity reports, and performance evaluation.*

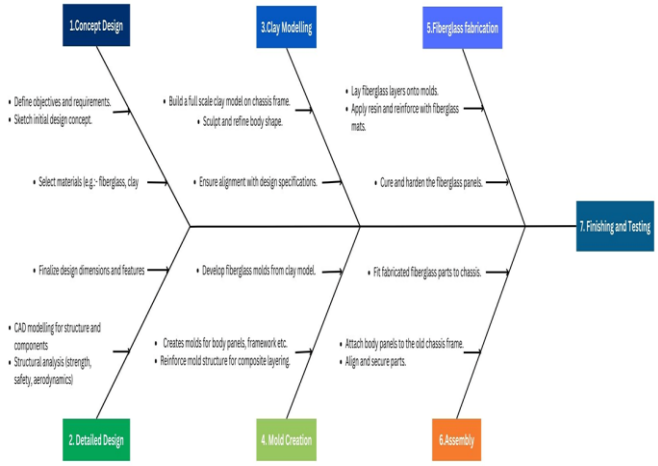


Fig -1: Flowchart for Work Process

3.3BLOCK DIAGRAM FOR PROPOSED WORK MODEL

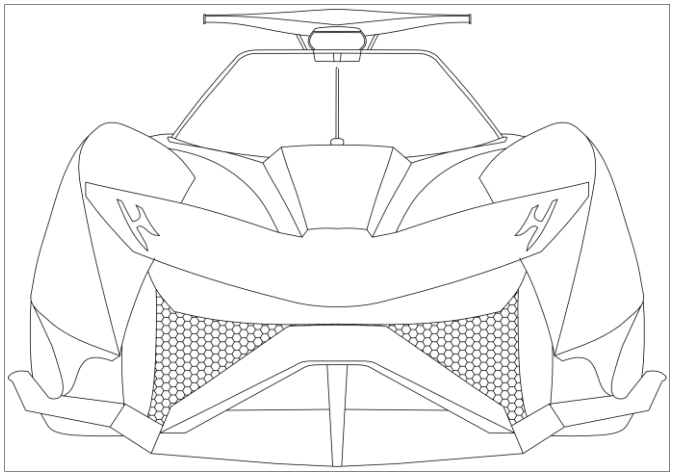


Fig -2: Front View of Model

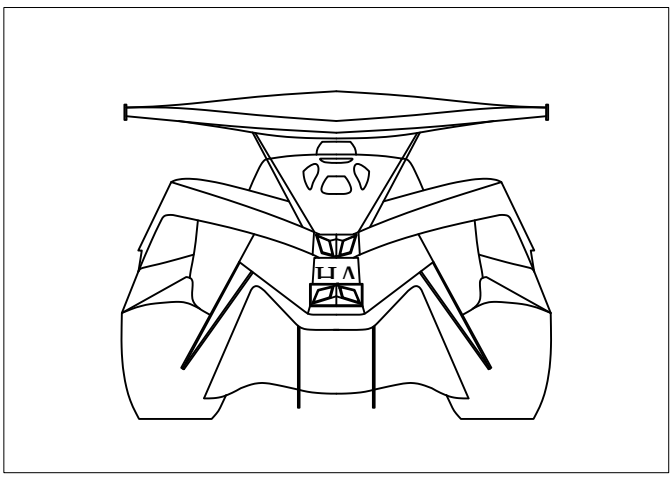


Fig -3: Back View of Model

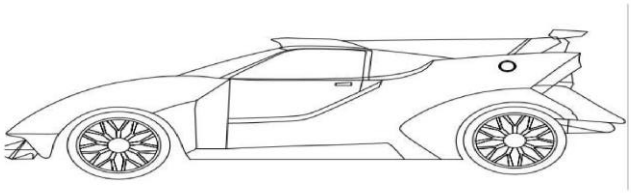


Fig -4: Side View of Model

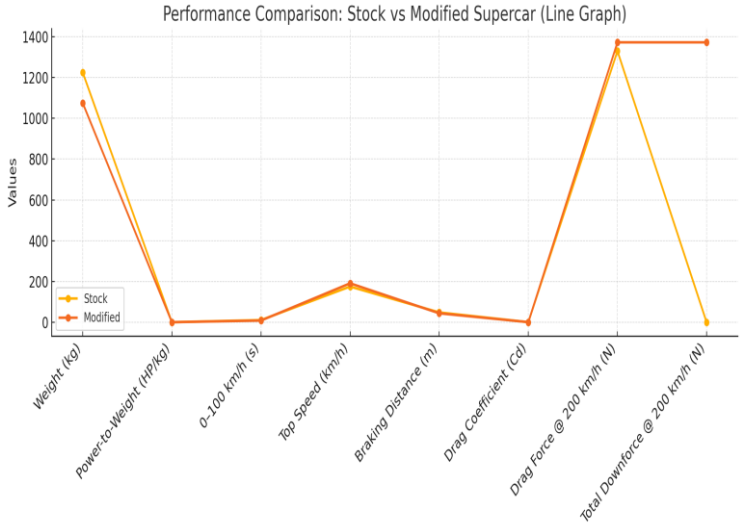
4.Calculation and Result

4.1 Improvement Table (Stock v/s Modified Car)

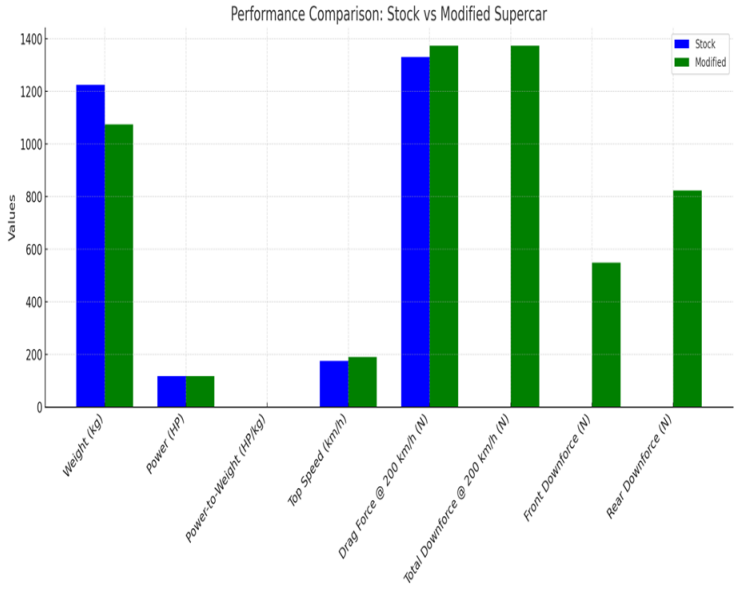
Metric	Stock Honda City (2008)	Modified Supercar (Fiberglass Body)	Difference / Impact
Weight	~1225 kg	1075 kg	150 kg lighter
Power (HP)	118 HP	118 HP	No change
Power-to-Weight Ratio (HP/kg)	~0.096	0.11	+15% improvement
Acceleration (0–100 km/h)	~10.5 sec	~8.15 sec	~2.35sec faster
Top Speed	~175 km/h	~191 km/h	+16km/h increase
Braking Distance (100–0 km/h)	~48–50 m	~43.7 m	~6 m shorter
Drag Coefficient (Cd)	~0.31	0.32 (optimized with downforce)	Slightly higher due to downforce
Drag Force @ 200 km/h	~1330 N (estimated)	1373 N	Small increase due to added width
Total Downforce @ 200 km/h	Minimal	1373 N	Significantly increased, improves grip
Front/Rear Downforce Split	-	549 N / 824 N	Balanced 40/60 split for stability

Table-1 PARAMETRIC EVALUATION

4.2 Performance Chart (Stock v/s Modified Car)



Graph-1: Line Graph



Graph-2: Bar Graph

5. COST AND MATERIAL PURCHASING

MATERIALS	QUANTITY	APPROXIMATE COST (In Rs)	Total COST AS PER QUANTITY (In Rs)
Old car chassis	1	132000	1,32,000
Iron rods & bars	223.45 kg	67.13pr kg	15,000

Meshing Wire	140sq.ft.	40per sq. ft.	5,600
Binding wire	4 bundle	50 per bundle	200
Industrial Plasticine moulding clay	400kg	40per kg	16,000
Glass Fibre	175kg	120per kg	21,000
Resin / Powder	250lit	130per lit	32,500
Hardner (Cobalt mix)	6kg	600per kg	3,600
Gelcoat/Wax	3 cans	250per pack	750
POP	40kg	50per kg	2,000
Windscreens	2 sheets	22,500per sheet	45,000
Rim & Tyres	4 set	15000 per piece	60,000
Spacers	4 set	7500 per piece	30,000
Wipers motor	2 set	4220	8440
Lights	8	625 per piece	5,000
Nuts & Rivets	As per need	3500	3,500
Paint	As per need	60000 to 80000	80,000(approx.)
TOTAL			**4,60,602**

Table-2 COST ESTIMATION

6.CONCLUSION AND RECOMMENDATIONS

6.1 Summary of Findings

- The aerodynamic modifications significantly improved drag reduction and downforce generation, as validated through CFD simulations and wind tunnel testing.
- Structural reinforcements using composite materials enhanced the vehicle's durability and crash resistance while maintaining a lightweight design.
- Cost and sustainability analysis demonstrated the feasibility of using recycled and composite materials for high-performance vehicle fabrication.
- Despite challenges in fabrication and testing, the overall results indicate the successful execution of the project's objectives.

6.2 Conclusion

- The project successfully demonstrated that a lightweight supercar structure can be fabricated using clay modelling and fiberglass composite materials over an existing chassis.
- The integration of advanced aerodynamics and structural reinforcements resulted in improved performance characteristics, including enhanced stability and handling.
- The findings suggest that composite materials offer a viable alternative to conventional metal bodies, balancing weight, strength, and sustainability.

6.3 Future Work and Recommendations for Further Research

- Further refinement of material selection, including the incorporation of next-generation composites like graphene-based materials for enhanced strength and durability.
- Advanced aerodynamic studies using AI-driven optimization techniques to refine airflow and efficiency.
- Implementation of active aerodynamics for real-time adaptability in various driving conditions.
- Extended real-world testing to assess long-term durability, wear resistance, and energy efficiency.
- Exploring automated fabrication techniques such as 3D printing of composite materials to improve production efficiency and precision.

This chapter provides a final assessment of the project's feasibility and success while outlining potential directions for future advancements in composite automotive design and aerodynamics.

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