CHASSIS DESIGN AND STRUCTURAL OPTIMIZATION OF AGRICULTURE UTILITY VEHICLE

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Introduction:

The chassis serves as the foundational structure of any vehicle, providing support for components and determining its strength and stability. In agriculture utility vehicles, the choice of chassis is critical as it must withstand heavy loads, rough terrains, and varied operational demands and providing the necessary support to all components such as the engine, transmission system, wheels, suspension, steering system, and the tipping dumper mechanism. A well-designed and strong chassis ensures that the vehicle can endure harsh agricultural conditions, handle heavy loads, and operate efficiently over rough terrains. The choice of chassis type depends on the design objectives, weight distribution, operational efficiency, environmental conditions, and overall agricultural requirements and also the chassis of a vehicle is important part that gibes a rigidity to the vehicle body and also helps in the performance of vehicle. Ladder frame chassis is common choice due to its sturdy and simple design, comprising longitudinal beams connected by cross members. This type is well-suited for heavy loads and off-road usage, making it ideal for agricultural tasks. A 3-way dumper body is a highly versatile and efficient cargo body commonly used in agricultural utility vehicles, construction trucks, and other heavy-duty vehicles. Designed to allow material unloading in three different directions—rear, left, and right—it simplifies the transportation and distribution of materials, especially in uneven terrains or tight spaces.

Objectives:

1. Develop a robust and lightweight chassis capable of withstanding dynamic loads and ensuring vehicle stability on uneven terrains.
2. Design a versatile 3-way dumper body that enables efficient unloading in multiple directions, reducing operational time and improving task flexibility.
3. Ensure the chassis and dumper body are designed to handle varying agricultural loads without compromising structural integrity or performance.
4. Incorporate design elements that improve operational safety, such as load stability mechanisms and ergonomic dumping controls.

Methodology:

The project chassis design and structural optimization of agriculture utility vehicle under gone through

LITERATURE REVIEW

A literature survey of research papers related to drawbacks or limitations of present agriculture utility vehicles, & their chassis and dumper body.

DEFINING PROBLEM: -

1. Agricultural vehicles lack flexibility for diverse tasks, such as multi-directional dumping, leading to inefficiency.
2. Conventional designs struggle with terrain adaptability and durability under varying agricultural conditions.

SELECTION OF MATERIALS AND OTHER COMPONENTS (chassis, dumper): -

1. Chassis: High-strength steel or aluminum alloys for durability and weight reduction.
2. Dumper Body: Corrosion-resistant metals or composites for long-term reliability.
3. Suspension Components: Lightweight alloys for improved handling.

FABRICATION.

1. Design of chassis, dumper body.
2. Welding and assembling.
3. Inspection during fabrication.

FIELD TESTING AND ANALYSIS.

1. Performance in different terrains.
2. Vehicle balance.
3. Load testing of dumper body.
4. Testing efficiency.
5. Redesigning and re fabrication.

RESULTS AND DISCUSSION

The finished project has to be compared with the expected project outcome like whether the chassis and dumper body working properly with no structural weakness and can support the estimated load. It should achieve balance between efficiency and stability, fulfilling the project objective.

CONCLUSION

The chassis deign and structural optimization of AUV successfully meets the desired requirement and performance goal.

Result and Conclusion:

The goal of chassis design is to accommodate individuals without compromising the structural integrity of the vehicle which we achieved by cutting the entire upper part of the body and rebuilding it with custom steel tubes which not only provide great strength but also accommodate the passengers and the electrical equipment's like the battery, controller, converter etc.

1. Successfully developed a durable and rigid chassis using high strength steel.
2. The dumper body capacity for carrying sand with factor of safety is 549 kg.
3. 3 way dumping mechanism ensures versatility in unloading materials.
4. Provides sufficient space for the driver and co-driver with a focus on comfort and safety.
5. Total deformation observed by the chassis when applying 750kg load in ANSYS software is 0.14153mm
6. Maximum deformation observed by the chassis when applying 750kg load in ANSYS software is 0.0056968mm.
7. Factor safety is 1.5.
8. Stability maintained under uneven load condition due to the 1194mm track width.

9. Gradeability is 28 degrees.
10. Dumper rear tilt angle 78 degrees.
11. Dumper side tilt angle 32 degrees.

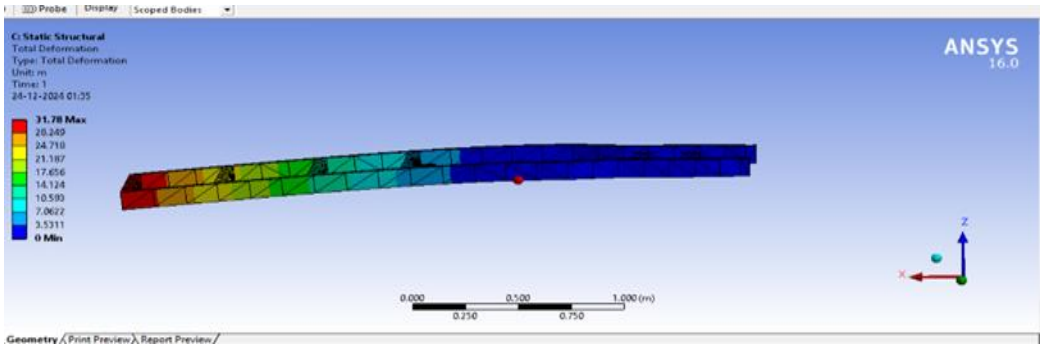

Figure 1: Total deformation test of designed chassis in ANSYS.

Figure 1:- Result of carrying 500kg load after chassis and dumper body fabrication.

Figure 3: - Result of side dumping of dumper body.

Figure 4: - Result of road test before fixing the dumper body.

Figure 5: - Result of rear side dumping of dumper body.

In Conclusion The chassis for the Agricultural Utility Vehicle (AUV) has been engineered to serve as a durable and reliable foundation, tailored specifically to the demands of agricultural tasks. Designed using mild steel square tubing, the chassis ensures a balance of strength, resilience, and economic feasibility. With dimensions optimized for a compact yet robust structure, the chassis is capable of supporting substantial loads while maintaining stability and maneuverability across rough terrains.

Project Outcomes & Industry Relevance

1. Useful Farm Vehicle: -A strong and reliable vehicle made specially for farming work.
2. Less Fuel Use: -The hybrid engine saves fuel and is better for the environment.
3. 3-Way Dumper: -The dumper can unload in three directions, which saves time and effort.
4. Strong Chassis: -The vehicle frame is strong and light, so it can carry heavy loads easily.
5. Affordable and Helpful: -The vehicle is low-cost and useful for farmers, helping them work faster and easier.

This project is useful for the agricultural and farming machinery industry. It offers a smart and fuel-saving solution by using a hybrid engine, which is becoming more important as fuel costs rise. The 3-way dumper makes work faster and easier, which is very helpful on farms and construction sites. The strong but lightweight chassis design can be used by vehicle makers to improve other utility vehicles too. Overall, this project matches the growing need for efficient, eco-friendly, and multi-purpose farming machines in today's market.

Working model

The project is a working model which is done by designing and fabrication of chassis and 3 side dumping dumper body.

Project outcomes and Learnings

1. Useful Farm Vehicle.
2. Less Fuel Use.
3. 3-Way Dumper.

4. Strong Chassis.
5. Affordable and Helpful.

Learnings

1. Gained hands-on experience in mechanical design, material selection, and fabrication techniques.
2. Learned how to integrate mechanical systems and fabrication of chassis.
3. Understood the importance of testing, simulation (like ANSYS), and iteration in improving the design.
4. Improved teamwork, project planning, and problem-solving skills during real-time challenges.

Future Scope:

The future scope of this project includes:

1. Camera can be installed on the agriculture utility vehicle to see the progress of work in agriculture field or in remote places. Then footage can be accessed through mobile phone.
2. Sensor based mobile app, which can be used to control all the operation of the dumper and its accessories.
3. Collapsable ladder can be installed on the dumper which can be used to harvest coconut, aeronaut etc.
4. Collapsable gun spray can be installed for the spraying of pesticides for the crops.