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# DESIGN AND ANALYSIS OF STEERING SYSTEM FOR LOW SPEED ELECTRIC VEHICLE (EV)

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**Abstract:**

Electric vehicles are gaining significant importance as a sustainable and eco-friendly transportation solution, particularly for low-speed applications such as campuses, hospitals, industrial areas, airports, and tourist locations. Among the various subsystems of a vehicle, the steering system plays a crucial role in ensuring safe maneuverability, directional control, and driver comfort. This project focuses on the design and analysis of a steering system for a low-speed electric vehicle. The design is based on Ackermann steering geometry, which ensures proper angular relationship between the inner and outer wheels during turning, thereby minimizing tyre slip and improving vehicle stability. Important vehicle parameters such as wheelbase, track width, and turning radius are considered in the design process. Analytical calculations are carried out to determine steering angles, steering arm length, and tie rod length for efficient steering operation. The proposed design aims to reduce steering effort, enhance maneuverability, and improve overall steering performance. The results demonstrate that the designed steering system is reliable, cost-effective, and suitable for implementation in low-speed electric vehicles used in various practical applications.

***Keywords*** — Electric Vehicle, Steering System, Ackermann Steering Geometry, Vehicle Design, Maneuverability

## I. INTRODUCTION

Electric vehicles (EVs) are becoming increasingly popular due to their environmental benefits and energy efficiency. Low-speed electric vehicles are commonly used in controlled environments such as campuses, hospitals, airports, and industrial areas. These vehicles require efficient steering systems to ensure smooth operation, safety, and ease of control.

The steering system is one of the most critical components of a vehicle, as it directly influences vehicle handling and stability. In low-speed applications, achieving a smaller turning radius and reducing steering effort are key design requirements. Conventional steering systems may not always meet these requirements effectively.

This work focuses on the design and analysis of a steering system for a low-speed electric vehicle using Ackermann steering geometry. The main objective is to develop a steering mechanism that ensures proper wheel alignment, reduces tyre wear, and improves maneuverability.

## II. METHODOLOGY AND DESIGN

### A. Vehicle Parameters

The following parameters are considered:

- Wheelbase, L = 1680 mm
- Track width, W = 1000 mm
- Minimum turning radius, R = 2800 mm

These parameters are used to design the steering geometry.

### B. Steering Mechanism

A rack and pinion steering system is selected due to its simplicity, compact design, and suitability for low-speed electric vehicles.

**Ackermann Steering Geometry**

Ackermann geometry ensures that:

- Inner wheel turns at a greater angle than the outer wheel
- All wheels rotate about a common instantaneous center

This reduces tyre slip and improves turning efficiency.

### C. Design Calculations

The steering angles are calculated as:

- Inner wheel angle, $\theta_i = 36.2°$
- Outer wheel angle, $\theta_o = 27°$

Other important dimensions:

- Steering arm length = 866 mm
- Tie rod length = 950 mm

These values ensure proper steering linkage and geometry.

### D. Ackermann Condition

$$\cot(\theta_o) - \cot(\theta_i) = \frac{}{L}$$

The above equation represents the Ackermann steering condition, where $\theta_i$ and $\theta_o$ are the inner and outer steering angles, W is the track width, and L is the wheelbase. This condition ensures that all wheels rotate about a common instantaneous center, reducing tyre slip and improving steering efficiency.

## III. ANALYSIS

The steering system is analyzed based on steering geometry and turning performance.

The calculated inner wheel angle (36.2°) is greater than the outer wheel angle (27°), which satisfies the fundamental requirement of Ackermann steering geometry. This ensures that both wheels follow concentric circular paths during turning.

The turning radius of the vehicle is found to be 2800 mm, which is suitable for low-speed applications requiring high maneuverability. The steering arm length and tie rod length are designed to maintain proper linkage geometry and reduce steering effort.

The Ackermann condition is verified and found to be satisfied, confirming that the steering system minimizes tyre slip and provides smooth turning performance.

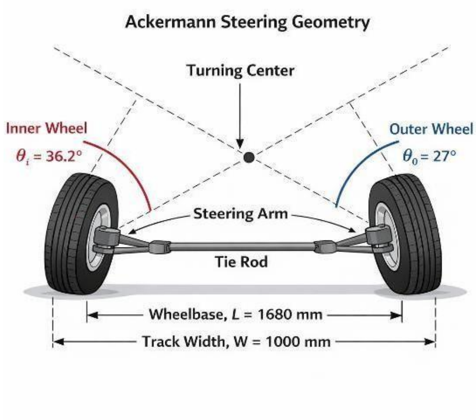


Fig. 1 Ackermann Steering Geometry

The above figure illustrates the Ackermann steering geometry used in the designed steering system. The inner wheel is turned at an angle of 36.2°, while the outer wheel is turned at 27°, ensuring that both wheels follow concentric circular paths with a common turning center. This arrangement minimizes tyre slip and improves steering efficiency**.**

## III. RESULTS AND DISCUSSION

The designed steering system demonstrates efficient performance under turning conditions. The inner wheel angle (36.2°) is greater than the outer wheel angle (27°), satisfying the Ackermann condition. This ensures proper alignment of wheels during turning.

The turning radius of 2800 mm is suitable for low-speed applications requiring high maneuverability. The optimized steering geometry significantly reduces tyre wear and improves vehicle stability. Additionally, the system requires minimal steering effort, enhancing driver comfort and control.

## IV. CONCLUSION

The steering system for the low-speed electric vehicle has been successfully designed and analyzed. The application of Ackermann steering geometry ensures proper wheel alignment during turning, minimizing tyre slip and improving efficiency. The system provides enhanced maneuverability, reduced steering effort, and improved stability. The proposed design is simple, cost-effective, and suitable for practical implementation in low-speed electric vehicles.

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