Mechanical Design of Two Wheeler EV

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Abstract: The mechanical design of an electric two-wheeler encompasses a vehicle that is multidisciplinary in nature to balance performance, efficiency, safety and cost. This paper presents the important points on the design of such vehicles which includes chassis, frame, and suspension; motor, drivetrain; battery; braking system; controls and instrumentation; safety features; ergonomics; materials and manufacturing processes. The aim here is to have engineers from different fields working together in order to come up with a light yet study chassis, a frame optimized for aerodynamics, a reliable suspension system, an efficient electrical engine as well as power transmission mechanism consisting of battery pack suitable for range or durability purposes, regenerative braking capability capable of supporting user-friendly control panel plus gauges along with numerous save ergonomic criterion under a comprehensive material selection and production requirements. Through these considerations the idea is to develop an EV designed for two-wheelers that addresses issues related to sustainable urban mobility.

Keywords: Performance, Efficiency, Braking system, Cost Effectiveness, Chassis, Frame, Suspension

I.INTRODUCTION

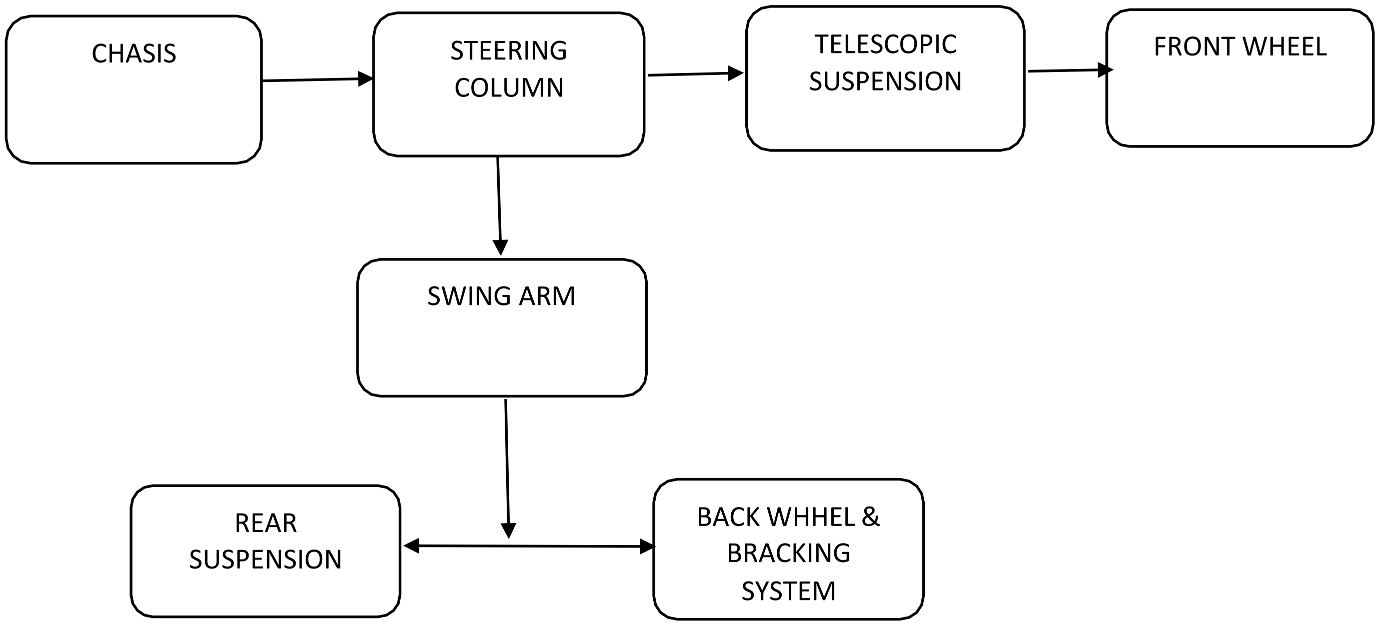
Problems such as the increasing discharge of greenhouse gasses into the atmosphere, air pollution and reliance on energy imports from abroad have made it clear that there will be a shift towards sustainable road mobile transport systems based on alternative fuels and power trains. Urbanization has mostly taken place in cities and therefore transportation is more important. The urbanized environment is one of the major sources of noise, local air pollution, etc., but these problems could be minimized by means of electric vehicles having zero emission. Equally as per estimates, 25 % of global cars will use electricity by 2025. Another type of vehicle known as an alternate fuel vehicle is any vehicle that runs on some other kind of non-fossil petroleum like propane or diesel; it also refers to any technology used to power an engine which don't take only petrol e.g Electric Vehicle, hybrid electric vehicles, solar powered and hydrogen fuel cells. However with drivers like environmental concerns high oil prices among others combined this would lead to cleaner alternative fuels development and advanced power systems for vehicles due to a number factors including but not limited to rising public awareness about the impact of environmental degradation caused by burning fossil fuels and depletion of our water.

It involves a meticulous process that merges mechanical engineering principles with cutting-edge technology to create a safe, efficient, and agile mode of transportation. In this chapter the final design of the chassis is shown and explained. The main idea is to have clear every single component that is going to form the body of the bike. The frame, the sub- chassis and the swing arm constituted basic parts of the chassis and have been developed for this project; however, other important parts of the chassis assembly such as suspensions, wheels or braking systems are spare parts or components from other companies and have been incorporated n this final design. It's remarkable the fact that the design of body works is out of the scope of this project, and components such as the false fuel tank, the fairing that covers the power train box and the sub-chassis, the seat... have not been introduced nor considered, including the possible appendixes to hold them.

II. FUNCTIONAL OVERVIEW

In the design of a two-wheeler EV, a double cradle chassis is chosen for its exceptional structural integrity and safety. Made from high-strength steel or aluminum alloys, this chassis enhances impact absorption and protects critical components like the battery and motor. It also improves rider comfort by distributing stress and strain more effectively, reducing vibrations. Additionally, the double chassis ensures even load distribution, contributing to a lower center of gravity and improved handling. Complementing this design, the front suspension features telescopic shock absorbers.

These consist of two tubes sliding into each other with an internal spring and damping mechanism, absorbing road shocks and maintaining front-wheel contact for a smoother ride. High-end models offer adjustable damping and preload settings, allowing riders to tailor the suspension to their preferences and riding conditions, thereby optimizing performance.



Block Daigram of Mechanical Design of Two Wheeler EV

III. DESIGN

	Types of chasis used	**stress**	**strain**	**Weight balance**	**Weight of the chasis**
OLA MOBILITY	Single cradle chasis	high	moderate	balanced	12
ECORIDE	Double cradle chasis	moderate	low	balanced	15
URBANSCOOT	Perimeter chasis	low	low	imbalance	10
GREENWHEELS TECHNOLOGIES	Backbone chasis	high	high	imbalance	18
ELECTRIC CITY COMMUTERS	Double cradle chasis	moderate	moderate	balanced	15

Table - 1

In our vehicle we have used Double cradle chasis because of its Efficient ,Durable, Improves ride quality, Easy maintenance and Cost-effective and it is also a light weighted where it can balance all the load of human weight and also components in it.so it is more efficient.

BrakingSystem	**Braking Efficieny (%)**	**Braking Rate %**	**Cost**	**Braking Area (cm²)**	**Maintenance Requirements**	**Applications**
Disc Brakes	90-95	80-85	High	80-100	Regular inspection and pad/rotor replacement	Urban commuting, last-mile delivery, campus transportation, recreational use
Drum Brakes	80-85	70-75	Moderate	60-80	Periodic adjustment and shoe replacement	Last-mile delivery, campus transportation, rental services, recreational use
Rim Brakes	70-75	60-65	Low	40-60	Regular adjustment and pad replacement	Tourist attractions, rental services, recreational use, campus transportation
Regenerative Braking	85-90	75-80	Moderate	N/A (Integrated)	Minimal maintenance required	Urban commuting, last-mile delivery, campus transportation, commercial fleetoperations
Electronic Brake Systems(EBS)	90-95	80-85	High	N/A (Integrated)	Periodic inspection and calibration	Campus Transport on, last mile delivery, commercial fleet operations, specifications.

Table -2

In our vehicle we have used disc and drum braking system because of its Efficient ,Durable, Improves ride quality, Easy maintenance and Cost-effective and it is has a capability for absorbing the vibrations and also handling the bike in the speed breakers and muddy areas so this is efficient.

International Journal of Research in Engineering, IT and Social Sciences, ISSN 2250-0588, Impact Factor: 6.565, Volume 09 Issue 03, June 2022, Page 4-12

In our vehicle we have used Telescopic shock absorbers because of its Efficient, Durable, Improves ride quality,

	ATHER 450X	OLA S1 PRO	TVS iQUBE S	RIVER INDIE	BAJAJ CHETAK
Front Shock Absorber	Telescopic Fork	Single Fork	Telescopic Fork	Telescopic Fork	Leading Link
Rear Shock absorber	Mono shock	Mono shock	Mono shock	Twin Shock absorbers	Mono shock
Spring Type	Progressive coil springs	Progressive coil spring	Progressive coil springs	Progressive coil spring	Coil spring with hydraulic damping
Vibration Absorption (Front)	Moderate to high-frequency vibrations	Moderate to high-frequency vibrations	Moderate to high-frequency vibrations	Moderate to high-frequency vibrations	Low to moderate frequency vibrations
Vibration Absorption (Rear)	Wide range of frequencies low and high amplitude	Wide range of frequencies,low and high amplitude	Wide range of frequencies, low and high amplitude	Wide range of frequencies, low and high amplitude	Wide range of frequencies, low and high amplitude

Table – 3

In our vehicle we have used Telescopic shock absorbers because of its Efficient, Durable, Improves ride quality, Easy maintenance and Cost-effective.

Aspects	Suspensions1	Suspensions 2
Type telescopic shock	Mono shock rear	Dual shock rear
Performance	Excellent shock absorption, smooth ride	Good shock absorption, decent ride comfort
Adjustability	Preload adjustment	Preload and damping adjustment
Durability	High quality material	Study construction, reliable
Reliable weight	Lightweight design	Moderately lightweight
Cost	Moderate price	Higher price point
User feedback	Positive reviews	Mixed reviews, some complaints about stiffness

Table -4

From the whole discussion in suspension system, it is observed that suspension system provides the energy to a vehicle to protect itself from damaging, increasing life of the vehicle, handing and comfort of passengers and many more. So, if the suspension system is removed, then ride in an Audi or Mercedes will feel like a bull-cart ride.

Feature	River indie	Ola S1 Pro	Ather 450 X	TVS iqube	Bajaj Chetak
Wheel Size	14-inch alloy wheels	12-inch wheels	12-inch alloy wheels	12-inch wheels	12-inch alloy wheels
Tire Type	Tubeless	Tubeless	Tubeless	Tubeless	Tubeless
Front Tire Size	90/90-14	110/70-R12	90/90-12	90/90-12	90/90-12
Rear Tire Size	90/90-14	110/70-R12	90/90-12	90/90-12	90/90-12
Front Brakes	Disk Brake	Disk Brake	Disk Brake	Disk Brake	Disk Brake
Rear Brakes	Drum Brake	Disk Brake	Disk Brake	Drum Brake	Drum Brake
Front suspension	Telescopic ic fork	Single fork	Telescopic fork	Telescopic fork	Leading link Suspension
Rear suspension	Dual shock absorbers	Mono-Shock	Mono-shock	Dual shock absorber	Mono shock

Table - 5

The over all performance of all the components in the mechanical design of two wheeler ev from this we have designed that the in the chasis we selected double cradle chasis and in shock absorber we selected telescopic absorber and in braking system we selected the disc and drum braking system. We selected the above because of the over all efficiency is more compared to others parts.

IV. WORKING

The following calculations are made considering that 2g force acts,

Approximated weight = 220 kg (the weight of the bike + driver)

Impact load = 2*9.81*220= 4316.4 N

Also, Impact time=(Mass*Velocity)/Impact load Assuming the maximum speed = 58 km/h, i.e. velocity=16.11m/s

Impact time= (220*16.11)/4316.4

=0.82s

Yield stress=460 MP

The above calculations shows about the efficiency and the capability of the component that we used in the Ev and also the components can handle the weight of 400kg-500kg .the above is the calculation of the double cradle chasis.

Calculations to determine the dimensions of the spring: Wire diameter: d = √(4 * P/ (π * G * S))
Mean coil diameter: D =d*S

Free length: Lf=(P*S^2)/(G*d^4
Calculations for Helical springs for Shock absorbers Modulus of Rigidity (Steel),
G=78600 N/mm2

Mean diameter of coil, D=33.3mm
Diameter of wire, d=6.7mm
Total number of coils, N1=17
Factory of Safety

Front impact	Side impact
The total working stress for Front impact=220.37MPa FOS = 460/220.37 =2.09	The total working stress for Side impact = 262.62 MPa FOS = 460/262.62 =1.75
Rear impact	Torsion test
The total working stress for Rear impact =244.71MPa FOS = 460/244.71 =1.88	The total working stress for Torsion impact=180.92MPa FOS = 460/180.92 =2.54

Height, h=210mm
Outer diameter of spring coil, Do=D+d=40mm
Number of active turns, N=15
Weight of bike=131Kg

Let the weight of one person=75Kg

Weight of two person=2×75=150Kg

Total Weight of Bike and Persons=263Kg

Rear Suspension=65% of weight=171Kg

Considering Dynamic loads, it weight will be double, w=342Kg=3355N
For single shock absorber weight, W=w/2=1677N
Compression of spring, δ=WD3.n/G. d4
Structural Steel, δ=49.61
Beryllium Copper, δ=73 Spring Index, C=D/d=5
Solid Length, Ls=N1×d=17×6.7=113.9mm

Free length of the spring, Lf =Solid length+Maximum

Compression + between adjustable coil=113.9+46.91+ (46.91×0.15)=167.8mm
Spring Rate, K=W/δ=35.74

Pitch of coil, P= (Lf-Ls Clearance)/N1+d=10mm.

The above is the working calculation of the shock absorber in the vehicle where the above calculation shows about the vibration that a spring absorbs and the spring which gives the smoothness in the vehicle in muddy roads ant the comfortable of the user.

The above shows the working and calculation of the mechanical design of the two wheeler Ev.

V. RESULT

The rapid development of electric vehicles (EVs) has revolutionized the automotive industry. This report focuses on the mechanical design aspects of a two-wheeler EV, with particular emphasis on the chassis, shock absorbers, braking system, and wheels and tires. The chassis, as the backbone of the two-wheeler EV, provides structural integrity and support for all other components. Common materials used include steel for its strength and durability, aluminum for its lightweight and corrosion resistance, and composite materials for their high strength-to-weight ratio. Key design considerations involve load distribution to prevent stress concentrations, aerodynamics to minimize air resistance and enhance efficiency, and battery integration without compromising structural integrity.

Fig 1-chasis

In our vehicle we have used Double cradle chasis because of its Efficient, Durable, Improves ride quality, Easy maintenance and Cost-effective.

Shock absorbers are critical for maintaining vehicle stability and comfort, with hydraulic and gas-filled types being commonly used. These components must be optimized to absorb road irregularities while providing a smooth ride and must accommodate the expected range of motion during various driving conditions. Strategic placement of shock absorbers ensures effective suspension, balancing front and rear placements for even load distribution and stability. Design considerations include balanced brake force distribution to prevent skidding and effective heat dissipation to prevent brake fade, with safety features like anti-lock braking systems (ABS) to maintain control during emergency braking.

Fig 2 -Shock absorber(back tyre)

Fig 3 - Shock absorber(front tyre)

In our vehicle we have used telescopic shock absorber because of its Efficient, Durable, Improves ride quality, Easy maintenance and Cost-effective.

The design of wheels and tires involves selecting materials like aluminum or steel for wheels and optimizing size and width for balance between stability, efficiency, and ride comfort. Tire selection focuses on tread patterns designed for optimal grip and performance in various conditions, and material composition using high-quality rubber compounds for durability and efficiency by focusing on the chassis, shock absorbers, braking system, and wheels and tires, this report highlights the critical aspects that ensure performance, safety, and efficiency in a two-wheeler electric vehicle.

OUR OVERALL ELECTRICAL VEHICLE

VI. CONCLUSION

In conclusion, the mechanical design of the two-wheeler EV project has been a comprehensive exploration into the complexities of creating an efficient and sustainable electric vehicle. Our focus on optimizing structural integrity while reducing weight has resulted in a robust yet lightweight frame, enhancing the vehicle's agility and energy efficiency. Additionally, the attention to comfort design and user experience has ensured comfort and convenience for riders, enhancing the overall appeal of our two-wheeler EV. Moving forward, continual refinement and innovation in the realms of material sciences, aerodynamics, and energy storage will further elevate the performance and sustainability of electric two-wheelers. This project has laid a strong foundation for future advancements in the field, contributing to the ongoing evolution of electric mob.

VII. REFERENCES

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