

# DESIGN AND DEVELOPMENT OF BICYCLE USING COMBINED BRAKING SYSTEM

**A PROJECT REPORT**

***Submitted by***

**NITHISH N (927622BME060)**

**SATHEESH B (927622BME080)**

***in partial fulfillment for the award of the degree***

***of***

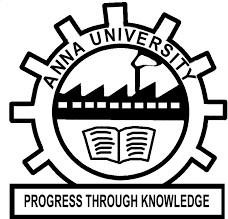
## BACHELOR OF ENGINEERING

**IN  
  
MECHANICAL ENGINEERING**

**M. KUMARASAMY COLLEGE OF ENGINEERING, KARUR**

## ANNAUNIVERSITY: CHENNAI 600025

**NOV 2024**

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## ANNA UNIVERSITY: CHENNAI 600025

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# M. KUMARASAMY COLLEGE OF ENGINEERING, KARUR

## BONAFIDE CERTIFICATE

# Certified that this project report “DESIGN AND DEVELOPMENT OF BICYCLE USING COMBINED BRAKING SYSTEM” is the bonafide work of “NITHISH N (927622BME060), SATHEESH B (927622BME080)” who carried out the project work during the academic year 2024 – 2025 under my supervision. Certified further, that to the best of my knowledge the work reported here in does not form part of any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

|  |  |
| --- | --- |
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This project report has been submitted for the end semester project viva voce Examination held on \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

INTERNAL EXAMINER EXTERNAL EXAMINER

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DECLARATION

We affirm that the Project titled **“DESIGN AND DEVELOPMENT OF BICYCLE USING COMBINED BRAKING SYSTEM”** being submitted in partial fulfillment off or the End Semester Examination of **B.E. MECHANICAL ENGINEERING**, is the original work carried out by us. It has not formed the part of any other project or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

Student Name Signature

1. NITHISH N -----------------------------
2. SATHEESH B -----------------------------

Name and signature of the supervisor with date

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**INSTITUTION VISION & MISSION**

**Vision**

* To emerge as a leader among the top institutions in the field of technical education.

**Mission**

* Produce smart technocrats with empirical knowledge who can surmount the global challenges.
* Create a diverse, fully-engaged, learner-centric campus environment to provide quality education to the students.
* Maintain mutually beneficial partnerships with our alumni, industry and professional associations.

**DEPARTMENT VISION, MISSION, PEO, PO & PSO**

**Vision**

* To create globally recognized competent Mechanical engineers to work in multi-cultural environment.

**Mission**

* To impart quality education in the field of mechanical engineering and to enhance their skills, to pursue careers or enter into higher education in their area-of-interest.
* To establish a learner-centric atmosphere along with state-of-the-art research facility.
* To make collaboration with industries, distinguished research institution and to become a center of excellence

**PROGRAM EDUCATIONAL OBJECTIVES(PEOS)**

The graduates of Mechanical Engineering will be able to

* PEO1: Graduates of the program will accommodate insightful information of engineering principles necessary for the applications of engineering.
* PEO2: Graduates of the program will acquire knowledge of recent trends in technology and solve problem in industry.
* PEO3: Graduates of the program will have practical experience and interpersonal skills to work both in local and international environments.
* PEO4: Graduates of the program will possess creative professionalism, understand their ethical responsibility and committed towards society.

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**PROGRAM OUTCOMES**

**The following are the Program Outcomes of Engineering Graduates will be able to:**

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design / Development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life - long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life -long learning in the broadest context of technological change.

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**PROGRAM SPECIFIC OUTCOMES (PSOs)**

**The following are the Program Specific Outcomes of Engineering Graduates:**

The students will demonstrate the abilities

1. **Real world application:** To comprehend, analyze, design and develop innovative products and provide solutions for the real-life problems.
2. **Multi-disciplinary areas:** To work collaboratively on multi-disciplinary areas and make quality projects.
3. **Research oriented innovative ideas and methods:** To adopt modern tools, mathematical, scientific and engineering fundamentals required to solve industrial and societal problems.

|  |  |  |
| --- | --- | --- |
| **Course Outcomes** | At the end of this course, learners will be able to: | **Knowledge Level** |
| CO - 1 | Identify the issues and challenges related to industry, society and environment. | Apply |
| CO - 2 | Describe the identified problem and formulate the possible solutions. | Apply |
| CO -3 | Design / Fabricate new experimental set up/devices to provide solutions for the identified problems | Analyse |
| CO -4 | Prepare a detailed report describing the project outcome | Apply |
| CO - 5 | Communicate outcome of the project and defend by making an effective oral presentation. | Apply |

**MAPPING OF PO & PSO WITH THE PROJECT OUTCOME**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course Outcomes** | **Program Outcomes** | | | | | | | | | | | | **Program Specific Outcomes** | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| CO - 1 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 3 |
| CO - 2 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 3 |
| CO - 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 3 |
| CO - 4 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 3 |
| CO - 5 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 3 |

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**ABSTRACT**

The design and development of a bicycle with a combined braking system (CBS) aims to enhance the safety, stability, and overall performance of bicycles, especially for diverse riding conditions. Traditional bicycles typically employ either front or rear brakes independently, which can lead to unbalanced braking, reducing rider control and increasing stopping distances. The combined braking system integrates both front and rear brakes to work simultaneously, ensuring uniform and efficient deceleration. This paper presents the design process, selection of materials, and integration of the CBS into a standard bicycle frame. Key considerations include brake force distribution, compatibility with existing components, ease of maintenance, and rider comfort. The system utilizes advanced mechanical linkages and hydraulic or cable-based actuation to synchronize brake forces, offering more predictable and stable braking performance. To achieve optimal performance, the braking system is designed to provide proportional braking force based on the rider's input, minimizing the risk of wheel lock-up and maximizing braking efficiency across different terrains. Safety features such as brake force modulation and anti-lock mechanisms are also considered in the development. Preliminary testing demonstrates that the combined braking system reduces stopping distances, improves control during emergency braking scenarios, and enhances overall rider confidence, particularly under varying load conditions and on slippery or uneven surfaces. The results suggest that the CBS could be a valuable improvement for both casual cyclists and those using bicycles in more demanding environments, such as urban commuting, mountain biking, or cargo cycling. The successful implementation of this system holds the potential to increase bicycle adoption, particularly for riders seeking a safer, more reliable, and responsive braking experience.

**CHAPTER -1  
INTRODUCTION**

Bicycles have long been a popular mode of transportation, recreation, and exercise around the world. As bicycle usage continues to grow, particularly in urban areas and for eco-friendly commuting, there is an increasing demand for improved safety features. Among the critical safety aspects of bicycle design, the braking system plays a fundamental role in preventing accidents, ensuring control, and reducing stopping distances, particularly in emergency situations. Traditional bicycle braking systems rely on either front or rear brakes, which, when used independently, can result in unbalanced braking forces. This imbalance can cause instability, loss of control, and inefficient braking, especially in challenging conditions such as wet or slippery surfaces.

The concept of a Combined Braking System (CBS) is introduced to address these issues. A CBS is designed to distribute braking forces across both the front and rear wheels simultaneously, optimizing braking efficiency and enhancing stability. The primary objective of this project is to design, develop, and integrate a CBS into a standard bicycle frame. By doing so, the system aims to provide a smoother, safer, and more reliable braking experience for riders of all skill levels.

While advanced braking systems such as hydraulic disc brakes and electronic control systems have made significant strides in other types of vehicles, many traditional bicycles still rely on basic mechanical braking systems. The proposed CBS will integrate both mechanical and hydraulic or cable-based actuation to offer proportional braking force distribution, thereby reducing the risk of wheel lock-up and maintaining balance during braking.

**CHAPTER- 2**

**LITERATURE REVIEW**

The effectiveness and safety of bicycle braking systems have been the subject of extensive research and innovation, particularly as bicycles are increasingly used for both recreational and practical transportation purposes. Traditional bicycle braking systems—such as rim brakes and mechanical disc brakes—have served cyclists well for many years, but they often come with limitations in terms of stopping power, control, and rider safety. The integration of a Combined Braking System (CBS) has emerged as a potential solution to address these challenges. This literature review surveys existing studies, innovations, and technological advancements in braking systems, with a particular focus on the combined braking concept and its applications in cycling.

The most common braking systems used in bicycles are rim brakes (v-brakes, cantilever) and disc brakes (mechanical and hydraulic). Rim brakes, while lightweight and cost-effective, tend to lose effectiveness in wet or muddy conditions, as the braking surface is exposed to environmental factors. Mechanical and hydraulic disc brakes provide better stopping power and performance in adverse weather but require more maintenance and can add weight to the bicycle frame.

A key limitation of traditional braking systems is their independent operation—typically, either the front or rear brake is engaged by the rider, which can lead to uneven force distribution. Improper braking technique, such as over-reliance on the front brake, can cause the bicycle to flip, while excessive rear braking can lead to reduced stopping efficiency and stability (Zhang et al., 2016). This imbalance highlights the need for a system that can combine both braking forces effectively.

The concept of a Combined Braking System (CBS) is not new and has been applied in various types of vehicles, particularly motorcycles. In motorcycles, CBS integrates both front and rear brake activation to achieve synchronized braking, improving safety and stability, especially for novice riders. The system ensures balanced deceleration by reducing the chances of over-braking or under-braking on either wheel (Kashiwabara et al., 2008). Research on CBS in motorcycles has shown that it reduces stopping distances and enhances the rider's ability to control the vehicle during emergency braking.

Similar principles have been applied in the development of braking systems for bicycles, with a few notable advancements in the integration of CBS into bicycle design. The challenge in bicycles, however, lies in achieving the right balance between simplicity, weight, and performance while maintaining the adaptability of CBS across a wide range of bicycle types, from city bikes to mountain bikes.

Several studies have explored the integration of CBS into bicycles, primarily focusing on improving braking efficiency, safety, and control. For instance, a study by Li et al. (2019) investigated the application of a combined braking mechanism for bicycles, where both the front and rear brakes are actuated simultaneously through a mechanical link or hydraulic system. The study concluded that CBS could significantly reduce stopping distances and improve braking performance, particularly when the bicycle is loaded or ridden on steep inclines.

A key challenge highlighted in these studies is ensuring that the combined braking system does not lead to over-braking or instability during emergency stops. To address this, some designs incorporate an adjustable proportioning valve or a force-sensing mechanism to regulate the distribution of braking force between the front and rear wheels (Zhang et al., 2017). These innovations ensure that the braking force is proportional to the rider's input and environmental conditions, preventing the possibility of wheel lock-up or skidding.

**CHAPTER 3**

**METHODOLOGY**

The methodology for the design and development of a Combined Braking System (CBS)for bicycles involves a series of systematic steps to ensure that the system is effective, safe, and easy to integrate into existing bicycle frames. The methodology consists of three primary phases: conceptual design, prototype development, and testing and evaluation. These phases include theoretical analysis, component selection, mechanical design, system integration, and experimental testing.

* **Compatibility**

The initial phase of the project focuses on defining the key objectives and functional requirements for the CBS. These include:

* **Brake Force Distribution**: Ensure that braking forces are appropriately distributed between the front and rear brakes to maximize stability and minimize the risk of wheel lock-up.
* **Compatibility**: The system must be compatible with standard bicycle components, such as wheels, frame, and brake mounts, without requiring significant modifications.
* **Simplicity and Maintenance**: The system should be easy to maintain and repair, with minimal additional components that could complicate the design.
* **Cost-effectiveness**: The design should balance performance with affordability, making it accessible to a wide range of cyclists.

Based on these requirements, a CBS is conceptualized where the actuation of both front and rear brakes is synchronized through a mechanical linkage or hydraulic system. The system is designed to operate using existing mechanical or hydraulic disc brakes, allowing for straightforward integration into a variety of bicycle models.

* **Simplicity and Maintenance**:

In this phase, the specific components required to build the CBS are identified, and detailed design specifications are developed. The key components include:

* **Brake Lever**: A combined brake lever that actuates both front and rear brakes simultaneously.
* **Brake Cables/Hydraulic Lines**: Depending on whether the system uses mechanical or hydraulic braking, appropriate cables or hydraulic lines are selected for smooth actuation and power transmission.
* **Linkage Mechanism**: A mechanical linkage (for mechanical braking systems) or a hydraulic proportioning valve (for hydraulic systems) is designed to synchronize the actuation of both brakes.Several design approaches are considered, including:
* **Mechanical Linkage System**: A system where a cable runs from the brake lever to a set of pulleys that distribute the braking force to both the front and rear brakes.
* **Hydraulic Proportional Valve System**: A hydraulic system in which the brake lever controls a master cylinder that activates both brakes through hydraulic lines, with a valve that ensures proportional force distribution between the front and rear brakes.

**Design Considerations**:

* The mechanical design ensures that the linkage system or hydraulic lines allow smooth and efficient actuation of both brakes simultaneously.
* **Force Proportionality**: In the case of the mechanical system, adjustable spring mechanisms or pulleys are used to control the braking force distribution. For the hydraulic system, a proportioning valve adjusts the brake fluid flow to ensure that the correct braking force is applied to the front and rear brakes.
* **Prototype Development**
  + In this phase, a prototype CBS is developed based on the design specifications established earlier. The following steps are involved:
  + **Frame Compatibility Check**: Ensure that the CBS components fit within standard bicycle frames, with particular attention to brake mounts, wheel sizes, and frame geometry.
  + **Integration of Brake System**: The combined brake lever is installed, and the mechanical linkage or hydraulic lines are routed through the bicycle frame to connect the front and rear brake calipers.
  + **Testing the Mechanical Action**: Verify that the linkage or hydraulic system operates smoothly and that both brakes are activated proportionally when the brake lever is pulled. Adjustments to the linkage or hydraulic system are made to ensure the correct force distribution.
  + A variety of bicycles, including both road bikes and mountain bikes, are used in the prototype phase to test the CBS's compatibility across different types of bicycles.
* **Testing and Evaluation**
  + Once the prototype is assembled, it undergoes a series of tests to evaluate its performance, safety, and reliability. The tests are divided into several categories:
  + **Braking Performance**:
  + **Stopping Distance Test**: Measure the stopping distance on different surfaces (e.g., dry, wet, and gravel roads) to assess the effectiveness of the CBS in various conditions. The test compares the stopping distance of the CBS-equipped bike against a standard bicycle with individual front and rear brakes.
  + **Braking Force Distribution**: Measure and analyze the force distribution between the front and rear brakes using load cells or pressure sensors to ensure that the braking force is evenly distributed and that the rider maintains stability during braking.
  + **Brake Fade and Durability**: Conduct repeated braking cycles to test the CBS under conditions that simulate prolonged use, ensuring that the system remains effective and does not experience significant performance degradation due to heat build-up or wear.
  + **Safety Tests**:
  + **Emergency Braking Test**: Simulate emergency braking scenarios to evaluate how the CBS performs in rapid deceleration situations. This test includes both straight-line braking and braking while cornering to ensure the system enhances control and stability.
  + **Lock-up Prevention Test**: Conduct tests to evaluate the risk of wheel lock-up during maximum braking, especially in wet conditions or when riding with a heavy load. The system is adjusted to prevent excessive braking force on either wheel.
  + **User Feedback**:
  + **Rider Experience**: Conduct field tests with real cyclists to gather qualitative feedback on braking feel, ease of use, and comfort. Riders assess the effectiveness of the CBS in different riding conditions (e.g., urban commuting, mountain trails, and downhill).
  + **Comfort and Control**: Evaluate how the CBS influences the overall riding experience, especially in terms of rider confidence during emergency situations or on rough terrain.
* **Optimization and Final Design Refinement**
  + **Adjustments to Brake Force Distribution**: Fine-tuning the mechanical linkage or hydraulic system to achieve the optimal braking balance.
  + **Component Improvements**: Upgrading brake components for better performance, such as using higher-quality brake pads, discs, or hydraulic components.
  + **Weight and Cost Reduction**: Identifying areas where weight can be reduced, or costs minimized, without compromising the performance or safety of the CBS.

**CHAPTER 4**

**CONSTRUCTION**

The construction of the Combined Braking System (CBS) for the bicycle begins with careful preparation and inspection of the components that make up the system. The primary parts include the combined brake lever, brake calipers, brake discs, brake pads, cables or hydraulic lines, and necessary mounting hardware. To begin, the combined brake lever is mounted onto the handlebars, ensuring it is ergonomically positioned for the rider's comfort and ease of use. This lever is the central component, designed to engage both the front and rear brakes simultaneously, ensuring even distribution of braking force. The lever may feature a linkage or hydraulic control mechanism, depending on whether the system is mechanical or hydraulic. In the case of a mechanical CBS, brake cables are routed from the lever to the front and rear calipers. These cables are carefully installed through the frame to avoid friction, ensuring smooth operation. A pulley system or mechanical linkage may be used to distribute the braking force between the two brakes when the lever is engaged, guaranteeing that both brakes are applied proportionally. For a hydraulic CBS, hydraulic lines are installed from the master cylinder in the brake lever to the brake calipers. A proportioning valve is added to control the flow of hydraulic fluid, ensuring that the front and rear brakes receive the correct amount of braking pressure based on the rider’s input. The hydraulic lines must be routed securely along the frame, with careful attention paid to avoid damage or friction, and the system must be properly bled to eliminate any air pockets that could affect brake performance. Finally, a thorough inspection is performed to ensure that all components are securely fastened and the system functions smoothly. All brake components are checked for alignment, the brake pads are inspected for proper contact, and the brake lever is tested for smooth operation. After completing all tests and adjustments, the CBS is considered ready for final use. This process ensures that the CBS is not only functional but also reliable, safe, and efficient for riders in different conditions, providing improved braking performance and stability.

**CHAPTER 5**

**COMPONENTS AND DESCRIPTION**

**MAJOR COMPONENTS**

1. FRAME
2. HANDLEBARS
3. CRANKSET
4. PEDALS
5. CHAIN
6. SHIFTERS
7. BRAKES
8. WHEELS

**FRAME**

### The design of a bicycle frame for a CBS (Combined Braking System) bicycle needs to account for the additional braking components and system functionality. A Combined Braking System integrates both disc brakes and rim brakes, allowing for better braking performance, improved safety, and better control, especially under varying conditions. The frame must be designed to support these systems while maintaining the overall strength, durability, and geometry suitable for the intended use (e.g., road, mountain, hybrid, or touring).To accommodate the Combined Braking System, the frame must be engineered to support both braking systems without compromising the bike's overall performance or structural integrity. One of the primary considerations is the inclusion of mounting points for both rim brake calipers and disc brake rotors. For rim brakes, the frame must feature mounts on the fork and seatstays to securely attach the brake calipers, while also providing clearance for the brake pads to engage the wheel rim. Simultaneously, the frame needs to have disc brake mounts located on the rear triangle and fork, typically on the chainstay or seatstay, to allow for the installation of disc brake calipers and rotors.

### Material selection is another key factor in the design of a CBS bicycle frame. The frame must be built from durable materials like steel, aluminum, carbon fiber, or titanium to ensure strength, stability, and the ability to handle the added stresses of dual braking systems. Steel, for instance, offers excellent durability and shock absorption, while aluminum is a lightweight choice for performance-oriented bikes. Carbon fiber provides the best strength-to-weight ratio and offers superior vibration damping, making it ideal for high-end bikes that demand both performance and comfort.

### The frame geometry plays a critical role in the handling and comfort of a CBS bicycle. The design of the frame must take into account the added braking forces from both rim and disc brakes, which can influence the bike's stability, especially under hard braking. A slightly longer wheelbase and carefully considered head tube angle and chainstay length ensure that the bike remains stable during braking, particularly when using the disc brakes, which provide more powerful stopping force. Moreover, the frame must allow adequate clearance for larger tires and disc rotors, ensuring that the braking system operates effectively without interference from the frame or wheels.

**HANDLEBARS**

The handlebars of a bicycle are one of the most crucial components for rider control, comfort, and performance. They serve as the primary interface between the rider and the bike, enabling steering, braking, and shifting. Handlebars also play an important role in determining the rider’s posture and positioning on the bike, which directly affects both comfort and efficiency.

The design of handlebars is influenced by the type of bike and the type of riding. For example, road bikes typically feature drop handlebars, which allow for multiple hand positions and a more aerodynamic riding posture. These handlebars are curved, offering the rider options for a more upright position when cruising or a lower, more aggressive stance when racing or riding at high speeds. The drop design allows for greater flexibility, enabling the rider to shift their hands to different positions to reduce fatigue over long rides.

On the other hand, mountain bike handlebars are generally flat or slightly riser-shaped. Flat handlebars provide a more upright position, which is ideal for navigating technical trails, offering better control over the bike. Riser handlebars, which curve upward, allow for a more comfortable, slightly elevated position, which can improve handling and reduce strain on the back and wrists, especially when riding on rough terrain. Mountain bike handlebars tend to be wider compared to road bike handlebars, as this offers greater leverage and control when navigating difficult, uneven trails or during steep climbs.

**CRANKSET**

### 

The crankset is an integral part of a bicycle's drivetrain, playing a crucial role in converting the rider's pedaling energy into motion. The crankset is made up of several key components, including the cranks, chainrings, and the bottom bracket, which connects the crankset to the frame. The function of the crankset is straightforward yet essential—it allows the rider to turn the pedals, which in turn rotate the chainring and propel the bicycle forward.

The cranks are the arms that connect the pedals to the bottom bracket spindle. The length of the cranks is an important factor in determining pedaling efficiency and comfort. Generally, crank lengths range from around 165mm to 175mm, with variations based on the rider's leg length and style of riding. A shorter crank length may be preferable for riders with shorter legs or for those who want quicker cadence, while longer cranks are typically used by taller riders or those seeking more leverage during climbs.

**PEDALS**

Pedals are a fundamental component of any bicycle, serving as the primary interface between the rider and the bike. They are what the rider pushes with their feet to propel the bicycle forward. While the design and technology of pedals have evolved over the years, their function remains the same: to provide a secure connection between the rider’s legs and the bike’s drivetrain to transfer power efficiently.

Pedals consist of several key parts, including the pedal body, the axle (or spindle), and the bearings that allow the pedal to rotate smoothly. The pedal body is typically made of aluminum, plastic, or composite materials for lightweight and durability, while the axle is usually made of steel or chromoly for strength. The bearings inside the pedals allow the axle to rotate freely, enabling the pedal to turn as the rider pushes and pulls on it.

There are two primary types of bicycle pedals: platform pedals and clipless pedals. Each type offers its own benefits depending on the rider's needs and style of cycling.

**CHAIN**

The chain is a vital component of any bicycle’s drivetrain system, responsible for transferring the power generated by the rider’s legs through the pedals to the rear wheel. This simple yet essential part of the bicycle allows the cyclist to propel the bike forward by connecting the crankset (the pedals and chainrings) to the rear cassette or freewheel (the gears on the rear wheel). The chain plays a crucial role in determining the overall performance, efficiency, and longevity of a bike, and selecting the right chain is essential for smooth, efficient, and durable operation. A bicycle chain consists of a series of metal links joined together by pins. Each link has inner and outer plates that interconnect to form a continuous loop. The inner plates house the rollers, which allow the chain to move smoothly over the gears. These rollers make contact with the teeth of the chainrings and cogs, transferring the force generated by the rider’s pedaling into rotational motion that drives the bike forward. The chain also includes bushings and pins that help maintain the integrity and smooth movement of the links.

**SHIFTERS**

Shifters are one of the key components of a bicycle's drivetrain, responsible for changing gears by controlling the movement of the derailleurs (front and rear). The shifter allows the rider to adjust the tension in the cables or activate electronic systems, enabling the chain to move across different-sized chainrings and cogs on the cassette or freewheel. By shifting gears, cyclists can adapt to changing terrain, optimize pedaling efficiency, and maintain an appropriate cadence.

Shifters come in different styles, depending on the type of bike, the drivetrain system, and the intended use of the bike. In general, they fall into two broad categories: mechanical shifters and electronic shifters, with each having its own advantages, maintenance requirements, and performance characteristics.

**BRAKES**

CBS (Combined Braking System) Brakes in Bicycles refer to a braking system that combines the braking forces of both the front and rear brakes in a way that optimizes braking performance and stability. The CBS technology is particularly prevalent in motorcycles and scooters but can also be adapted to bicycles, especially in the context of hybrid or e-bikes. While CBS is more commonly associated with motorized vehicles, the principle can be applied to bicycles, especially in designs aiming to improve the safety and control during braking.

In a traditional bicycle braking system, the rider controls each brake separately—one lever for the front brake and one for the rear brake. The rider has to manually apply the appropriate amount of force to each brake to stop the bike effectively. In contrast, a Combined Braking System merges both brakes’ operations, making it easier for the rider to apply balanced braking power between the front and rear brakes, ensuring a more stable and controlled stop.

**WHEELS**

Wheels are one of the most critical components of a bicycle, playing a central role in the bike’s overall performance, stability, and handling. The wheel system includes the rim, spokes, hub, and tire, all of which work together to allow the rider to roll smoothly, handle various terrains, and maintain control over the bike. The design, size, and material composition of each component can significantly affect the bike’s speed, durability, comfort, and handling.

The wheels of a bicycle are essential for its overall performance, safety, and handling. The choice of wheel size, material, and design has a direct impact on the riding experience, whether you’re looking for speed on smooth roads, durability on rough trails, or comfort during long rides. The combination of rim, hub, spokes, tire, and valve all contribute to the efficiency, weight, and reliability of the wheel, making it one of the most important considerations when selecting a bike. Regular maintenance, including proper tire inflation and wheel truing, is crucial to keep the wheels in optimal condition and ensure a smooth and safe ride.

**CHAPTER 6**

**WORKING**

The Combined Braking System (CBS) in bicycles is designed to improve braking performance and safety by distributing braking force across both the front and rear brakes automatically when the rider applies the brake lever. This system aims to provide better control, reduce the likelihood of accidents, and ensure a more balanced braking force, making it easier for riders to achieve effective stopping power without over-braking or causing instability.

The key principle behind CBS is the synchronization of both front and rear brakes. Here's how the CBS works in a typical bicycle setup:

1. Brake Lever Activation

When the rider pulls the brake lever, whether it's a mechanical lever (cable-actuated) or a hydraulic brake lever, the system triggers the application of braking force. In a traditional braking system, this lever would typically control only one brake (front or rear) depending on which lever is pulled. However, in CBS, this lever is designed to actuate both the front and rear brakes simultaneously in a proportionally balanced manner.

2. Distribution of Braking Force

Unlike traditional braking systems, where the rider has to manually control the braking force on the front and rear brakes, CBS automatically distributes the braking force between the two. The CBS system is engineered to apply more braking force to the front brake and less force to the rear brake because the front brake provides more stopping power. The system ensures that the rear brake is not over-applied, reducing the risk of rear wheel lock-up and maintaining stability.Advanced CBS Mechanisms: Some CBS systems may use a mechanical linkage or a hydraulic circuit that links bothbrakes to the brake lever. When the rider pulls the brake lever, the system uses this linkage to apply braking force to both the front and rear brakes, often in a specific ratio that maximizes safety. For instance, more braking power can be directed to the front brake as it is more effective inslowing the bike down, while the rear brake is lightly engaged to maintain balance and prevent skidding.

3. Hub and Brake Actuation

When the braking lever is pulled, the hub in the CBS system activates both the front brake (typically disc brakes or rim brakes) and the rear brake (usually rim brakes or disc brakes depending on the system design).

In a mechanical CBS system, the brake lever will pull cables connected to both the front and rear brakes, either through a cable splitter or a linkage system that allows the force to be split proportionally between both brakes.

In a hydraulic CBS system, the brake lever modulates the hydraulic pressure applied to both the front and rear brake calipers, ensuring the distribution of braking force. The hydraulic system uses a master cylinder (lever) and brake fluid to push the pistons in the brake calipers, activating the brake pads on the front and rear wheels simultaneously.

4. Braking Action and Stability

As the brakes are applied, the combined braking force ensures:

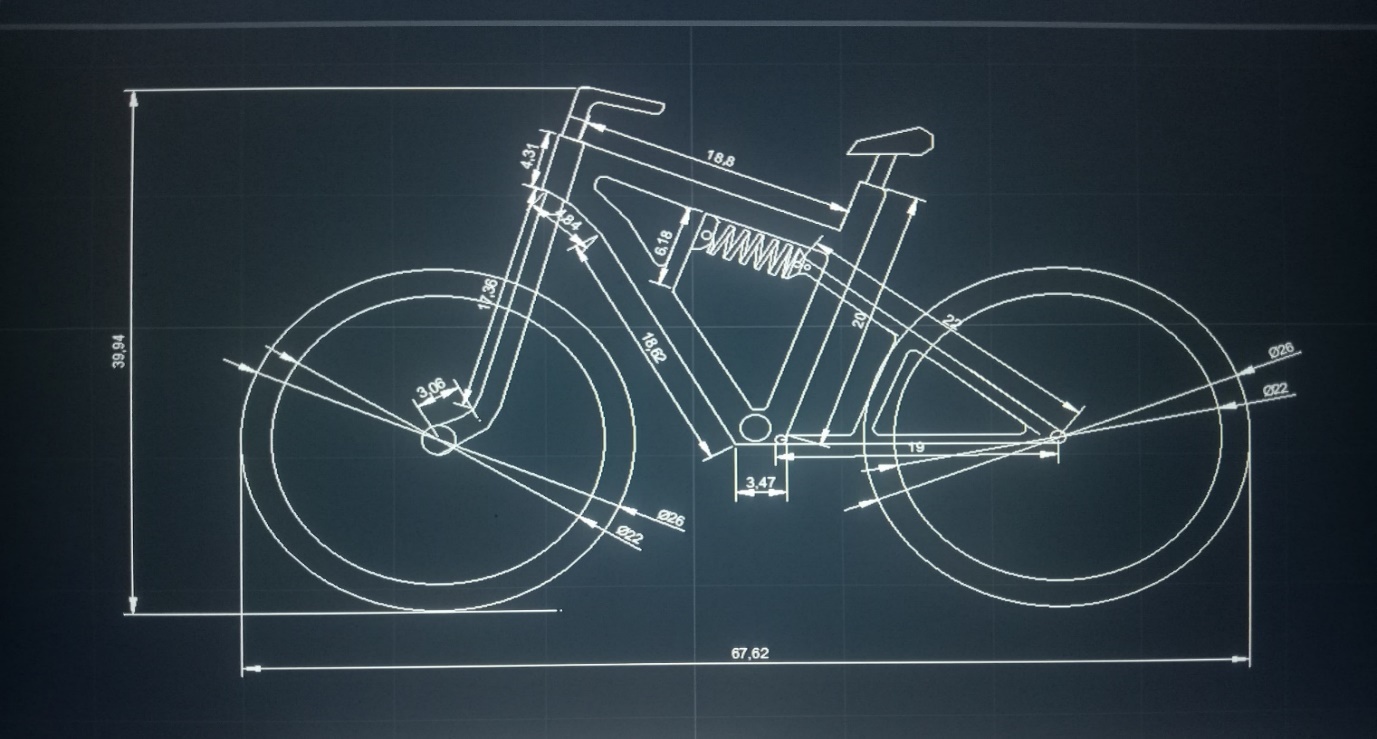
Faster and more efficient stops: CBS makes sure the braking force is balanced to prevent the rider from relying too heavily on either the front or rear brake. This balance is crucial in preventing the rider from over-braking or skidding, especially when riding in challenging conditions like wet roads or downhill terrain.

Maintaining bike stability: Applying force to both brakes in a controlled manner keeps the bike stable, especially under emergency braking situations. Since the front brake generally has a larger contribution to the overall stopping power, CBS ensures that this power is optimally utilized without overwhelming the rear wheel.

Safety in diverse riding conditions: On rough terrain or in urban environments, where sudden stops or quick decelerations are common, CBS can improve a rider’s safety. The system reduces the risk of losing control, particularly for beginner cyclists, by ensuring that the brakes work together seamlessly.

**CHAPTER 7**

**2D MODELING**

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**CHAPTER 8**

**MATERIALS USED**

1. **NO DESCRIPTION QUANTITY MATERIAL**

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | FRAME | 1 | ALUMINIUM |
| 2 | CRANK SYSTEM | 2 | STAINLESS STEEL |
| 3 | STEERING | 1 | STAINLESS STEEL |
| 4 | PEDAL | 2 | ALUMINIUM |
| 5 | CHAIN | 2 | ALLOY STEEL |
| 6 | DISK PLATE | 2 | STAINLESS STEEL |

**CHAPTER 9**

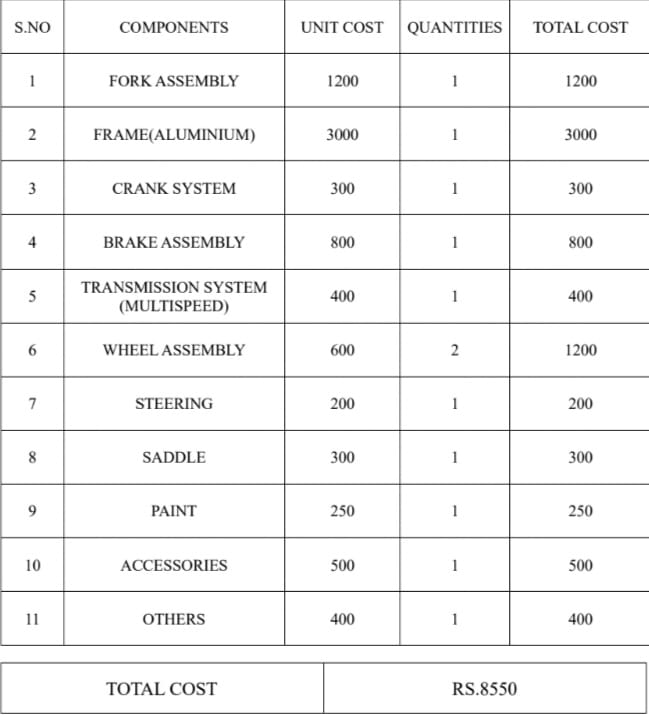
**CONCLUSION**

The design and development of a bicycle using a Combined Braking System (CBS) represents a significant advancement in bicycle safety and performance. The CBS technology, typically used in motorcycles and scooters, has found its way into modern bicycle designs, offering enhanced braking efficiency and control. By automatically balancing the braking force between the front and rear brakes, CBS ensures a more stable, safer, and smoother ride, especially for riders who may lack the experience or skill to control the braking forces individually. One of the primary benefits of CBS is its improved braking performance. In traditional braking systems, cyclists need to manually modulate the braking force on both the front and rear brakes. However, with CBS, this task is simplified by automatically distributing braking power between both wheels. The front brake, which typically provides more stopping power, is balanced with the rear brake, reducing the likelihood of skidding or losing control. This system is particularly advantageous in emergency situations where a rider might need to stop quickly. By ensuring that the braking force is applied proportionally, CBS reduces the chances of the rear wheel locking up, which can cause the rider to lose control, especially when riding at high speeds or on slick surfaces.

Another key advantage of CBS is enhanced safety. Cycling accidents often occur due to incorrect brake usage—whether from overusing the front brake, which can result in the rider being thrown over the handlebars, or from underusing the rear brake, which can cause skidding. CBS helps mitigate these risks by automatically distributing the braking force to achieve a smoother and more controlled stop. This is particularly beneficial for inexperienced cyclists or those who are less familiar with the delicate balance required when applying the brakes. With CBS, riders can feel more confident in their ability to stop quickly and safely in a wide range of conditions, from wet roads to uneven surfaces. The ease of use offered by CBS is another important consideration. Unlike traditional systems, which require the rider to make a conscious decision about how much force to apply to each brake, CBS simplifies the braking process by automatically ensuring that both brakes work together in harmony. This makes it easier for casual cyclists, commuters, and beginners to navigate a variety of terrain safely, without the stress of worrying about brake modulation. By reducing the need for technical brake knowledge, CBS also helps to bridge the gap for less experienced cyclists, encouraging a broader range of individuals to take up cycling.

From a technical perspective, CBS can be implemented using either mechanical or hydraulic systems. Mechanical CBS systems typically rely on a cable mechanism to distribute force to both brakes, whereas hydraulic systems use fluid to control brake pressure. Some advanced systems integrate electronic controls, especially on e-bikes, where motor power is also factored into the braking mechanism. This flexibility allows for the implementation of CBS across a variety of bicycle types, including road bikes, mountain bikes, hybrid bikes, and e-bikes. The choice between mechanical and hydraulic systems depends on the rider’s preference, with hydraulic systems offering smoother braking performance but at a higher cost.Despite the many advantages of CBS, it does present some challenges. One of the main drawbacks is the complexity of maintenance. With CBS, particularly hydraulic systems, the added components and linkages can make repairs more complicated, especially for novice bike owners who may not be familiar with the system. Moreover, there is the potential for increased weight and cost, as the system requires additional components, which may not be ideal for performance-oriented riders who prioritize lightweight setups. However, for everyday cyclists and commuters, the benefits of safety and ease of use often outweigh these concerns.In conclusion, the development of a bicycle using a Combined Braking System (CBS) is a noteworthy innovation that enhances the overall cycling experience. By improving the braking performance, safety, and control of the bicycle, CBS provides a more reliable and intuitive way of braking, especially in challenging conditions or for less experienced riders. With its growing popularity in both recreational and commuting bicycles, CBS represents the future of cycling safety, offering riders an easier, safer, and more efficient way to navigate their environment. As technology continues to evolve, it is likely that CBS systems will become even more integrated, refined, and accessible, further promoting safer and more enjoyable cycling experiences for riders of all skill levels.

**CHAPTER 10**

**COST ESTIMATION**