Parala Maharaja Engineering College
A CONSTITUENT COLLEGE OF B.P.U.T GOVT. OF ODISHA

LABORATORY MANUAL

(RME5C202) VEHICLE BODY ENGINEERING LAB

DEPARTMENT OF

AUTOMOBILE ENGINEERING

Semester- VI

Laboratory Venue/Location: Workshop – 2, Room No- LB/04 of PMEC Campus

Parala Maharaja Engineering College, Berhampur
A Government Engineering College affiliated to
Biju Patnaik University of Technology, Odisha, Rourkela, India
ପାରଳା ମହାରାଜା ଯାନ୍ତ୍ରିକ ମହାବିଦ୍ୟାଳୟ, ବ୍ରହ୍ମପୁର
(ସରକାରୀ ଯାନ୍ତ୍ରିକ ମହାବିଦ୍ୟାଳୟ)

LIST OF EXPERIMENTS

01	Study of typical car body construction and propose new design sketches.	
02	Study of typical truck/bus body construction and detailed design.	
03	Study driver's seat position, passenger seat position, its requirement and construction and propose new design sketches.	
04	To prepare the analysis of the vehicle body weight and the weight distribution in different conditions and its effect on tractive performance.	
05	Measurement of drag, lift force of a scaled model in wind tunnel	
06	Study the anti-corrosion and body painting and repainting procedures.	
07	Study the construction of a special purpose vehicle.	
08	To prepare the analysis of the vehicle body weight and the weight distribution in different conditions and its effect on steering performance.	
09	To study commercial vehicle body details along with its construction.	

Experiment- 01

Study of typical car body construction and propose new design sketches

Aim of the experiment: To study car body construction in details and undergo new design sketches.

Theory:

1. **Car Body Structure:**
    - The **car body** is the external frame and structure that houses the vehicle's internal components (engine, transmission, passengers, etc.).
    - A **typical car body** consists of the following parts:
        - **Frame**: Provides structural integrity. It can be a unibody (integrated frame and body) or body-on-frame (separate).
        - **Panels**: Outer covering, including doors, roof, fenders, trunk, and side panels.
        - **Materials**: Usually made of metals like steel or aluminum, with some areas using plastics for bumpers, trim, and interior components.
    - **Aerodynamics**: Car body design greatly affects fuel efficiency. Streamlined shapes reduce air resistance (drag), improving mileage and handling.
2. **Materials Used in Car Body Construction:**
    - **Steel**: Strong, durable, and cost-effective, but heavier.
    - **Aluminum**: Lighter, improves fuel efficiency, but more expensive and less strong than steel.
    - **Plastics/Composites**: Lightweight and used in non-structural areas, like bumpers and interior parts.
3. **Types of Car Bodies:**
    - **Hatchback (Maruti Swift)**: A compact design with a rear door that opens upward.
    - **Sedan (Maruti Dzire)**: A traditional 4-door vehicle with a separate trunk space.
    - **SUV (Maruti Vitara Brezza)**: A vehicle designed for off-road driving with higher ground clearance and a rugged appearance.

Procedure:

1. **Study the Existing Maruti Car Body Designs**:
    - Examine the body designs of **Maruti Swift**, **Maruti Dzire**, and **Maruti Vitara Brezza** through images or scale models.
    - For each model, observe the following:
        - **Exterior design**: Shape, panel layout, surface contours.
        - **Frame construction**: Whether it's unibody or body-on-frame.
        - **Material usage**: Identify steel, aluminum, composites, and plastic components.

        - **Aerodynamics**: Study the vehicle's roofline, windshield angle, front grille, and rear design.
        - **Safety features**: Look for crumple zones, reinforcement bars, airbags, and safety-rated materials.
2. **Take Measurements**:
    - Measure the following dimensions using a measuring tape or ruler:
        - **Length**: From the front bumper to the rear bumper.
        - **Width**: Across the widest point of the body.
        - **Height**: From the ground to the highest point of the body.
        - **Wheelbase**: The distance between the front and rear axles.
        - **Ground Clearance**: Distance from the lowest part of the car to the ground.
3. **Analyze the Car Body Construction**:
    - **Frame Type**: Check if the car uses a **unibody** or **body-on-frame** construction. Unibody cars have the body and frame integrated into one piece, while body-on-frame cars have a separate chassis and body.
    - **Material Analysis**:
        - **Steel**: Used in frame and high-stress areas.
        - **Aluminum**: Used in lightweight parts like the roof or hood.
        - **Plastic/Composites**: Used in bumpers, panels, and interior components.
    - **Aerodynamics**: Examine how the body shape minimizes drag to improve fuel efficiency. This involves studying the **roofline**, **windshield angle**, **front grille** design, and **rear spoiler** (if any).
4. **Propose New Design Ideas**:
    - Using CAD software or hand sketching, propose redesigns for each of the three models:
        - **Maruti Swift (Hatchback)**:
            - **Aerodynamic Improvements**: A sleeker, more streamlined roofline for reduced drag.
            - **Functionality**: Increased boot space or rear seats that fold flat for added cargo room.
            - **Safety Features**: Reinforced side panels, additional crumple zones, and more robust bumpers.
        - **Maruti Dzire (Sedan)**:
            - **Aerodynamic Redesign**: Smoothed-out rear trunk lid, integrated spoilers for better airflow.
            - **Interior**: More spacious cabin design with better ergonomics, enhanced visibility from the rearview mirrors.
            - **Safety**: Add energy-absorbing foam in the front bumper and more integrated airbags.
        - **Maruti Vitara Brezza (SUV)**:
            - **Improved Ground Clearance**: Propose adjustments for better off-road performance while maintaining city usability.
            - **Aerodynamics**: Reduce air resistance by modifying the front grille and adding a more angular rear section.
            - **Strengthening the Frame**: Improve the underbody for better durability, especially for off-road driving.
5. **Presentation of Design Proposals**:

    - Use **CAD software** or **graph paper** to draw and annotate your redesigned sketches.
    - Include dimensions, material specifications, and the rationale for each design change.
    - Discuss how each proposed change benefits the car in terms of:
        - **Safety** (e.g., crumple zones, reinforcements)
        - **Functionality** (e.g., better space utilization, cargo capacity)
        - **Aesthetics** (e.g., modern design features, streamlined contours)
        - **Aerodynamics** (e.g., reducing drag, improving fuel efficiency)

Data/Values for Maruti Models:

1. **Maruti Suzuki Swift (Hatchback)**:
    - **Length**: 3.84 m
    - **Width**: 1.73 m
    - **Height**: 1.53 m
    - **Wheelbase**: 2.43 m
    - **Ground Clearance**: 170 mm
    - **Curb Weight**: 900-1000 kg
2. **Maruti Suzuki Dzire (Sedan)**:
    - **Length**: 3.99 m
    - **Width**: 1.73 m
    - **Height**: 1.53 m
    - **Wheelbase**: 2.43 m
    - **Ground Clearance**: 170 mm
    - **Curb Weight**: 900-1100 kg
3. **Maruti Suzuki Vitara Brezza (SUV)**:
    - **Length**: 3.99 m
    - **Width**: 1.79 m
    - **Height**: 1.64 m
    - **Wheelbase**: 2.5 m
    - **Ground Clearance**: 198 mm
    - **Curb Weight**: 1200-1300 kg

Materials Used:

- **Steel**: Yield Strength – 250 MPa, Tensile Strength – 400-600 MPa
- **Aluminum**: Yield Strength – 120 MPa, Tensile Strength – 160 MPa
- **Plastic/Composites**: Tensile Strength – 50-150 MPa

Observation:

- Record the existing design features and construction methods of the **Maruti Swift**, **Maruti Dzire**, and **Maruti Vitara Brezza**.
- Compare their materials and dimensions to identify areas for improvement.

- Evaluate the **safety features**, **aerodynamic performance**, and **functional aspects** such as interior space and cargo capacity.

Result/Conclusion:

- Present your **proposed design sketches** for the **Maruti Swift**, **Maruti Dzire**, and **Maruti Vitara Brezza**.
- Discuss how your design improvements will contribute to:
  - **Enhanced Safety**: Improved crumple zones, stronger side panels, better energy absorption.
  - **Better Aerodynamics**: Sleek rooflines, reduced drag, improved fuel efficiency.
  - **Increased Functionality**: More cargo space, improved ergonomics, better ground clearance for off-road performance.
- Address any **practical considerations** such as manufacturing costs, material choices, and market demand for these features.

Experiment-2

Study of typical truck/bus body construction and detailed design.

Aim of the experiment: To study bus body construction along with various sketches.

Bus body details

Types:

- Mini bus, single decker, double decker, two level, split level and articulated bus.
- Bus body lay out
  – floor height
  – engine location
  – entrance and exit location.
- Constructional details:
  --types of metal sections used
  – regulations
  – conventional and integral type construction.

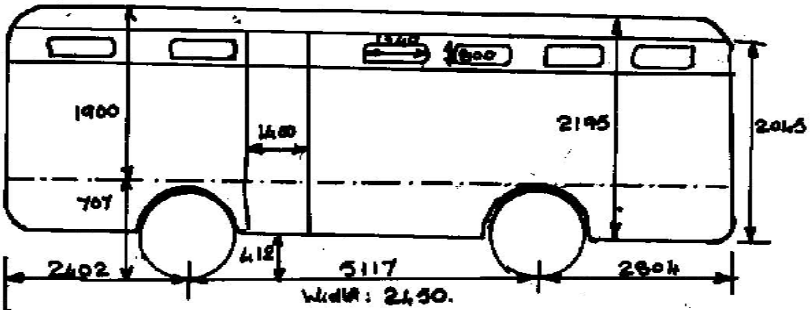
CLASSIFICATION OF BUSES
Passenger carrying buses are classifies based on:
1) Distance travelled by the vehicle
2) Capacity of the vehicle
3) Shape and Style of the vehicle

1. Distance travelled by the vehicle:
i. Mini bus, ii. Town bus, iii. Suburban bus, iv. Long Distance Coaches, v. Touring Coaches

2. **Based on the capacity of the vehicle**

Mini bus	8 to 15
Small coaches for long distance	16 to 30
Small buses for town	upto 40
Medium coach for long distance	31 to 45
Medium buses for town	41 to 60
Large coaches for long distance	46 to 60
Large buses for town	61 to 80
Very large buses for town	> 80

Bus body Regulations



CLASSIFICATION OF BUSES

Buses are categorized into four types. 1) Type I, 2) Type II, 3) Type III and 4) Type IV

Type I

Vehicles are the medium and high capacity vehicles designed and constructed for urban and sub urban / city transport with area for standing passengers.

Type II

Vehicles are those designed and constructed for inter-urban/inter-city transport without specified area for standing passengers

Type III

Vehicles are those designed and constructed for long distance passenger transport, exclusively designed for comfort of seated passengers and not intended for carrying standing passengers.

Type IV

Vehicles are those designed and constructed for special purpose use such as the following :-

(1) School Bus: means vehicles designed and constructed specially for schools, college, and other educational Institutions.
(2) Sleeper Coaches: means vehicles designed and constructed specially berth to accommodate sleeping passengers.
(3) Tourist Bus: means vehicles designed and constructed for the purpose of transportation of passengers as tourists and may be classified in any one Type of comfort levels.

• Non Deluxe Bus(NDX) means bus designed for basic minimum comfort level.
• Semi Deluxe Bus(SDX) means a bus designed for a slightly higher comfort level and with provision for ergonomically designed seats.
• Deluxe Bus(DLX) means a bus designed for a high comfort level and individual seats and adjustable seat backs, improved ventilation and pleasing interiors.
• A.C. Deluxe Bus(ACX) means a Deluxe Bus which is air conditioned.

Number of Service Doors

	NDX	SDX	DLX	ACX
Type I	2	2	1	1
Type II	1	1	1	1
Type III	N.A.	1	1	1

Minimum dimensions of Service Doors

Category		Height Min. (mm)	Width min. (mm) (As Applicable)**		
			Front	Rear	Middle#
Type I	NDX	1800	650 mm for single door and 1200 mm for double door	650 mm for single door and 1200 mm for double door	650 mm for single door and 1200 mm for double door
	SDX				
	DLX				
	ACX				
Type II	NDX	1650			-
	SDX				-
	DLX				-
	ACX				-
Type III	SDX				-
	DLX				-
	ACX				-

Windows

• The window panes shall be of sliding type for all buses except ACX buses.

• However, in ACX buses the provision for adequate ventilation in case of A.C. failure shall be made.

• The minimum width of the window aperture (clear vision zone) shall be 550 mm.

• The minimum height of the sliding part of the window aperture (clear vision zone) shall be 550mm

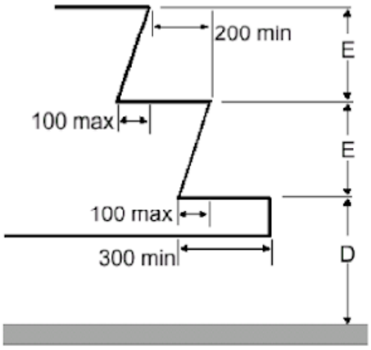
Emergency Exits:

• At least one emergency exit shall be situated on the opposite side of the service door.

• In case of more than one emergency exit, one of the emergency exit shall be situated in the front half of the vehicle, opposite to the service door and the second emergency exit shall be either on the rear half or at the rear side of the bus.

Category	Height (mm)	Width (mm)
Type I	1250	550
Type II	1250	550
Type III	1250	550

Steps:



Classes		I	II, III
First step from ground 'D'	Max. height (mm)	340	380
	Min. depth (mm)	300	
Other steps 'E'	Max. height (mm)	250	350
	Min. height (mm)	120	
	Min. depth (mm)	200	

CONSTRUCTIONAL DETAILS:

1.Frame construction

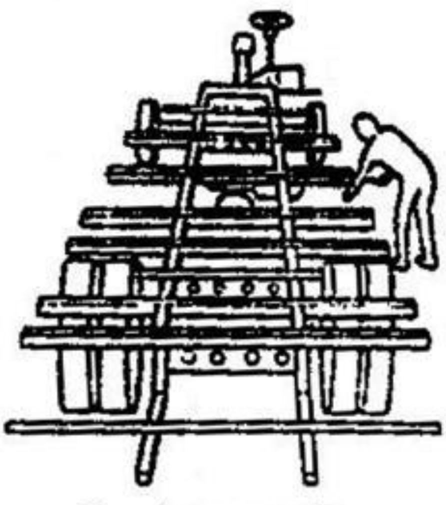
2.Double skin construction

1. FRAME CONSTRUCTION:

The design of bus body is based on the use of a light metal frame, braced by stressed metal panels. The main framing is of light members of thin gauge material formed by folding, pressing, stretch forming, rolling, extrusion and connected by gussets generally riveted to the structure framework which is applied to the inside face of the framing.

Chassis Preparation:

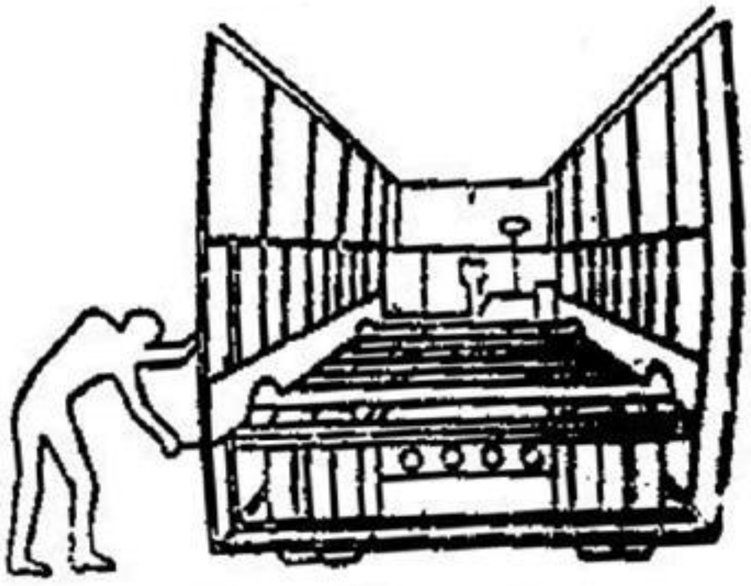
- The floor frame is placed in position, holding down and fixed with bolts or rivets and all parts of the chassis are painted.



Chassis preparation

Side and front framing

- The body side framing and front end is assembled. Truss panels bolted into position, the body lined up with the waist rail and the lower bolts tightened

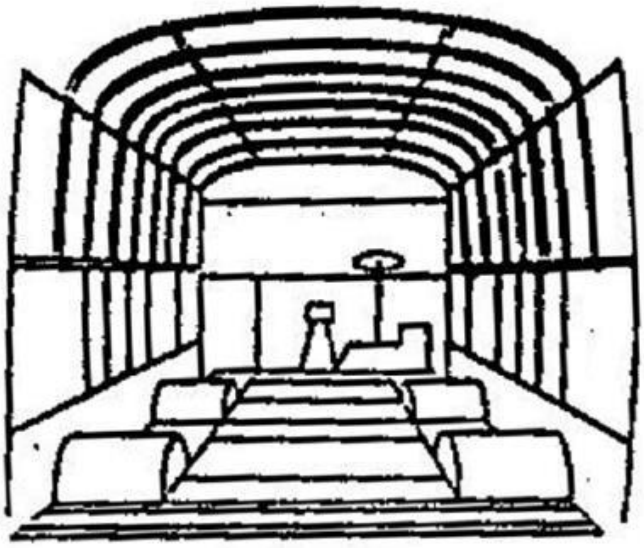


Side and front framing

Roof framing and rear end:

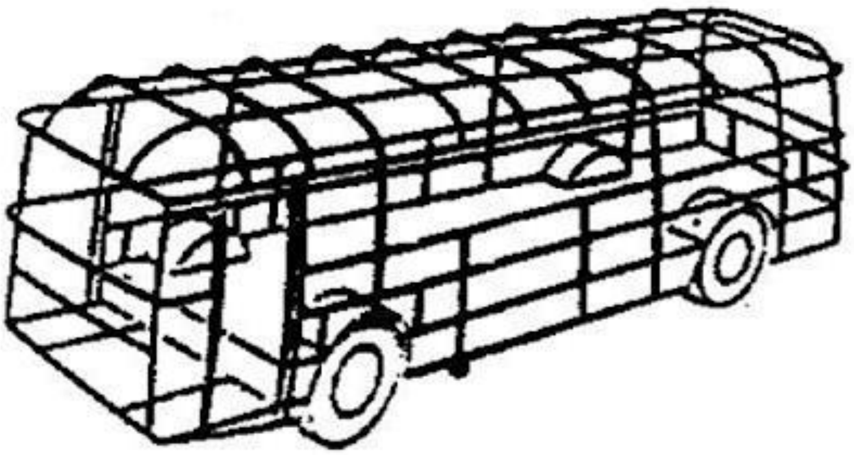
Roof framing and rear end

Truss panel riveted:



Truss panels rivited

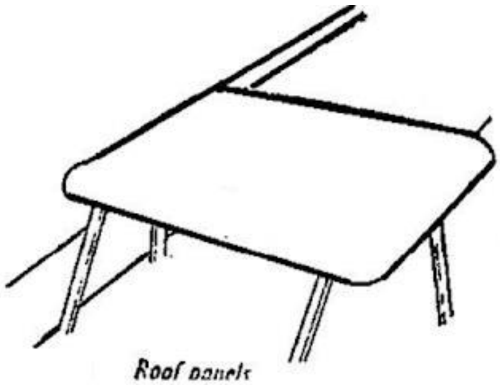
General inspection:



General inspection

Roof panels:

Roof panels are fixed and riveted

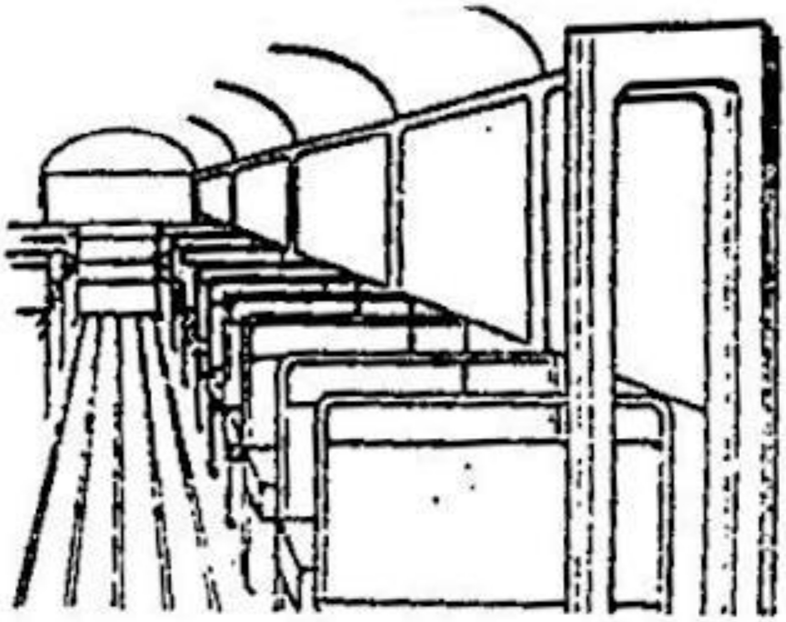


Roof panels

Panelling and moulding

Panelling and moulding

Final fittings and finishing:



Final finishing

EXPERIMENT 3

Study driver's seat position, passenger seat position, its requirement, construction and propose new design sketches

Aim of the experiment:

To study driver's seat position along with passenger seat position and its requirement and seat constructions of typical truck/bus body.

Introduction to driver's seat:

Driver seat is an inseparable part of any automobile. Its main function is not only to provide a seating space to driver but also support, protect and to provide comfortable seating posture to the occupants. Today driver seat design has been given very importance because poorly designed seat affect badly on human health as well as psychological condition of driver hence increases the chances of accidents. It is evolved after evolution of first car at the start of nineteenth century. Following table shows the evolution of driver seats with period and car where it is used.

Parts of driver seat:

Driver seat is very complicated, consists of large number of parts and mechanisms. Main parts of driver seat are frame, padding, seat pan, head restraints system, reclining mechanism with lever, trim (seat cover), and suspension system, air bags, seat belt, fore and aft adjustment, height adjustment etc.

Function of Major Components of Seat:

1. Seat Frame: It is most important part of any seat over which all other adjustment systems and components are mounted. It is made from HSLA (High Strength low alloy steel) tube

2. Anchorage: It is nothing but the space at which driver seat is mounted.

3. Seat Cushion/ Padding: It is that part of seat on which driver sit. It is soft and made from a resilient material such as PU foam of varying stiffness. Base and back cushions are used for seat.

4. Seat Back: It is that part of seat which is vertical or somewhat inclined and supports the driver lumbar, shoulder and head. At the top of seat back generally a head restraint system is mounted. Angle of seat back can be adjusted with the help of back reclining mechanism.

5. Seat Adjustments: It includes height, fore and aft as well as back reclining adjustment systems used to adjust height, fore and aft distance and angle of back respectively.

6. Head Restraint: It is mounted over the seat back at top, its main function is to support head also restrict the backward displacement and protect the cervical vertebrae. There are four types of head restraints namely integrated, detachable, separate and proactive head restraints. Proactive is advanced version of head restraint.

7. Suspension: Generally at two places suspension is used namely seat base and seat back. For suspension springs are used. Main purpose of suspension system is to attenuate the vibrations from road at driver seat and his body.

8. Trim: It is nothing but outermost covering of a driver seat, made from a cloth or leather of good quality. It has pleasant colour, appearance as well as styling.

Procedure:

1. **Study of Driver's and Passenger Seat Position in Tata Magna Bus:**
   - **Driver's Seat:**
     - Measure the height of the driver's seat from the floor.
     - Record the distance from the seat to the steering wheel and the pedals.
     - Measure the backrest angle and seat depth.
     - Evaluate the adjustability of the seat.
     - Observe the ergonomics of the driver's posture during normal operation.
   - **Passenger Seat:**
     - Measure the legroom from the back of the driver's seat to the front of the passenger seat.
     - Measure the seat-to-seat distance.
     - Measure seat depth and backrest angle.
     - Record features like armrests, lumbar support, and any adjustments for comfort.
2. **Study of the Construction of Tata Magna Bus Body:**
   - Examine the construction of the chassis, floor, and body of the bus.

- Measure the following components:
    - Chassis width and height.
    - Floor strength (how much weight it can support).
    - Cabin area for driver and passenger.
    - Dimensions of the windows and door locations.
    - Roof strength and safety features (reinforcement against rollovers).

3. **Propose New Design:**
    - **Driver's Seat Design:**
        - Suggest any modifications in seat height, depth, or angle to improve comfort.
        - Propose better lumbar support or padding.
        - Recommend improved visibility adjustments for the driver's seat.
    - **Passenger Seat Design:**
        - Increase legroom where needed.
        - Suggest improved backrest design for better posture support.
        - Propose modifications to increase seat adjustability for passengers.
    - **Bus Body Design:**
        - Propose improvements in the layout for more space efficiency.
        - Suggest larger windows for better visibility and lighting.
        - Recommend safety features (e.g., reinforced sides, wider aisles for ease of movement).
4. **Design Sketches:**
    - Based on the study and findings, propose sketches illustrating the new design for both the seats and bus body.

Observations:

Parameter	Tata Magna Driver Seat Position	Tata Magna Passenger Seat Position
Seat Height (from floor)	18 - 22 inches	16 - 20 inches
Seat Back Angle	100° - 110°	100° - 110°
Distance from Seat to Steering Wheel	15 - 18 inches	N/A
Distance from Seat to Pedals	8 - 12 inches	N/A
Legroom (Driver)	24 - 28 inches	N/A
Legroom (Passenger)	N/A	24 - 30 inches
Seat to Seat Distance	N/A	24 - 30 inches
Lumbar Support	Adjustable	Fixed or adjustable

Calculation/Results (Optional):

- **Ergonomic Efficiency:**
    - Analyse how well the current seat positions support ergonomic principles. Example:
        - Calculate the optimal seat height based on body measurements (e.g., knee height for the driver, hip height for the passenger).
    - Use pressure-point measurements (if applicable) to evaluate comfort.

Design Sketches:

1. **New Driver Seat Design Sketch:**
    - Incorporate adjustable lumbar support and padding to reduce back strain.
    - Modify seat depth to ensure the driver can comfortably operate all controls.
    - Include adjustable headrests and armrests for better comfort.
    - Include a tilt-and-reach steering wheel for improved ergonomics.
2. **New Passenger Seat Design Sketch:**
    - Increase legroom to 28-30 inches for enhanced comfort.
    - Include reclining features for passenger seats on long journeys.
    - Introduce adjustable armrests and additional lumbar support for comfort.
3. **New Bus Body Design Sketch:**
    - **Cabin Layout:** Optimize the space for easier movement and better seating arrangement.
    - **Windows:** Larger windows to improve visibility and allow more natural light.
    - **Aisle Width:** Increase aisle width for better passenger movement, especially in emergency situations.
    - **Safety Features:** Reinforce the sides with stronger materials to increase passenger safety during rollovers or collisions.

Conclusion:

Based on the measurements and observations, suggest ergonomic modifications to the driver's and passenger seats to improve comfort and reduce fatigue during long journeys. Propose design changes to the bus body to optimize space utilization, safety, and aesthetics. The proposed sketches should illustrate a well-balanced layout that prioritizes user comfort and safety.

Suggested Values for Tata Magna Bus:

For real-world experiments, here are typical dimensions for the Tata Magna bus seats:

- **Driver Seat Height:** 18 inches
- **Passenger Seat Height:** 16 inches
- **Seat Back Angle:** 105° (ideal for long hours of driving)
- **Distance between Driver Seat and Pedals:** 10 inches
- **Seat Depth:** 15 inches
- **Legroom (Driver):** 26 inches
- **Legroom (Passenger):** 28 inches
- **Distance between Seats:** 24 inches

EXPERIMENT- 04

To prepare the analysis of the vehicle body weight and the weight distribution in different conditions and its effect on tractive performance.

Objective:

- To measure the total body weight of a vehicle.
- To determine the weight distribution between the front and rear axles of the vehicle.
- To analyse how changes in weight distribution affect tractive performance (i.e., traction, handling, and stability).

Theory:

1. **Vehicle Body Weight:** The total body weight of a vehicle is the sum of all components, including the chassis, engine, passengers, cargo, and fluids.

$$W_{total} = W_{vehicle} + W_{passengers} + W_{cargo} + W_{fluids}$$

2. **Weight Distribution:** Weight distribution refers to how the total weight is distributed between the front and rear axles. Ideal weight distribution helps in achieving better handling, stability, and tractive performance.

   Front-to-rear axle weight ratio is given by:

$$\text{Front weight ratio} = \frac{W_{front}}{W_{total}} \times 100$$

$$\text{Rear weight ratio} = \frac{W_{rear}}{W_{total}} \times 100$$

3. **Tractive Performance:** Tractive performance refers to the ability of a vehicle to convert its weight and power into usable force to move the vehicle forward, maintaining control over various road conditions.

   The vehicle's traction is influenced by the **normal force** on each tire, which is affected by the weight distribution. The formula for traction is:

$$F_{traction} = \mu \times N$$

   Where:

   - $F_{traction}$ is the tractive force.
   - μ is the coefficient of friction (depends on road surface and tire).
   - N is the normal force (weight supported by the tire).

   Changes in weight distribution affect the normal force on each tire and therefore influence tractive performance.

Changes in weight distribution affect the normal force on each tire and therefore influence tractive performance.

Apparatus:

- Vehicle with front and rear axles.
- Weighing scales (preferably with high precision).
- Load cell or pressure sensors (for measuring weight distribution on each axle).
- Tachometer (for measuring wheel speed).
- Accelerometer (for measuring vehicle acceleration).
- Brake force tester (optional, for measuring braking performance).
- GPS or data acquisition system for real-time data collection.

Procedure:

Step 1: Vehicle Preparation

- Ensure the vehicle is empty of any passengers or cargo to obtain baseline weight measurements.
- Record the total body weight of the vehicle using a large industrial scale or a set of calibrated wheel scales.

2. **Step 2: Measure the Total Vehicle Weight**
    - Drive the vehicle onto the scales and record the total weight. This is the sum of the vehicle's body, passengers, and cargo.

    Example:
    $W_{total} = 1500\,\text{kg}$

3. **Step 3: Measure Weight Distribution**
    - Use load cells or individual wheel scales to measure the weight supported by the front and rear axles.

    Example:

    - Weight on front axle, $W_{front} = 900\,\text{kg}$
    - Weight on rear axle, $W_{rear} = 600\,\text{kg}$

    Calculate the front and rear weight ratios:

$$\text{Front weight ratio} = \frac{900}{1500} \times 100 = 60\%$$

$$\text{Rear weight ratio} = \frac{600}{1500} \times 100 = 40\%$$

4. **Step 4: Vehicle Loading Conditions**
   - Add weight incrementally to the rear or front of the vehicle (such as cargo or passengers) to observe how the weight distribution changes.
   - Record the new weight on each axle and calculate the updated ratios.

   Example with additional cargo:
   - New total weight: $W_{total} = 1600\,\text{kg}$
   - Weight on front axle: $W_{front} = 950\,\text{kg}$
   - Weight on rear axle: $W_{rear} = 650\,\text{kg}$

   Updated ratios:

$$\text{Front weight ratio} = \frac{950}{1600} \times 100 = 59.375\%$$

$$\text{Rear weight ratio} = \frac{650}{1600} \times 100 = 40.625\%$$

5. **Step 5: Testing Tractive Performance**
   - Perform a series of controlled driving tests, measuring wheel speed, acceleration, and traction at different weight distributions.
   - Use a tachometer to measure wheel speed, and an accelerometer to measure the vehicle's acceleration.
   - Record the tractive force using the equation $F_{traction} = \mu \times N$, where N is the normal force on each tire.

   Example Test:
   - Coefficient of friction $\mu = 0.8$ (on dry asphalt).
   - Normal force on front tire $N_{front} = 450\,\text{kg} \times 9.81 = 4414.5\,\text{N}$
   - Normal force on rear tire $N_{rear} = 300\,\text{kg} \times 9.81 = 2943\,\text{N}$

   Calculate tractive forces:

$$F_{traction,front} = 0.8 \times 4414.5 = 3531.6\,\text{N}$$

$$F_{traction,rear} = 0.8 \times 2943 = 2354.4\,\text{N}$$

6. **Step 6: Data Analysis**
   - Analyze how different weight distributions (e.g., more weight on the front vs. rear) affect the normal force on each tire and, consequently, the tractive performance (acceleration and traction).
   - Discuss the impact of front-heavy vs. rear-heavy weight distributions on handling, stability, and traction performance.

Observations:

Condition/Load	Total Weight (kg)	Front Axle Weight (kg)	Rear Axle Weight (kg)	Front-to-Rear Ratio (%)	Traction Front (N)	Traction Rear (N)	Acceleration (m/s^2)
Empty Vehicle	1500	900	600	60/40	3531.6	2354.4	5.2
Loaded Vehicle	1600	950	650	59.375/40.625	3796.8	2605.2	4.9
Rear Heavy	1700	800	900	47.05/52.95	3187.2	2943	4.5

Conclusion:

- The experiment allows for the analysis of how body weight and weight distribution affect tractive performance. As seen from the results, the weight distribution affects the normal force and traction on each tire, which in turn influences acceleration and vehicle handling. A more balanced distribution of weight between the front and rear axles typically leads to more efficient traction and better overall performance.

Precautions:

1. Ensure that the vehicle is stationary and on a level surface before measuring weight.
2. When adding weight, do so gradually and measure at each stage.
3. Make sure that the measuring equipment (scales, sensors) is calibrated correctly for accurate readings.
4. Perform the tests in safe, controlled conditions, preferably on a test track or closed circuit.

EXPERIMENT-05

Measurement of Drag and Lift Forces of a Scaled Model in a Wind Tunnel

Objective:

To measure the drag and lift forces acting on a scaled model placed in a wind tunnel and analyse the results based on the aerodynamic principles.

Introduction:

- **Drag** is the resistance a body experiences when moving through a fluid (air, in this case). It is parallel to the direction of the fluid flow.
- **Lift** is the force perpendicular to the flow direction, typically created by the difference in pressure on different surfaces of an object (e.g., an air foil).

The experiment involves placing a scaled model (e.g., an airfoil or car body) inside a wind tunnel and measuring the drag and lift forces acting on the model at different wind speeds using force sensors or balances.

Apparatus:

- Wind Tunnel (Subsonic or Low-speed type)
- Scaled Model (e.g., airfoil, car body)
- Strain Gauge or Load Cells for Drag and Lift force measurement
- Manometer or Pitot tube for velocity measurement
- Digital Display Unit or Data Acquisition System (DAQ)
- Power Supply for the wind tunnel fan

(A working model of wind tunnel located in Vehicle Body Engineering Lab)

Theory:

1. Drag Force (F_d): The drag force is calculated using the drag coefficient C_d as:

$$F_d = \frac{1}{2}\rho v^2 A C_d$$

where:

- F_d = Drag Force (N)
- ρ = Air density (kg/m³)
- v = Velocity of air (m/s)
- A = Reference area of the object (m²)
- C_d = Drag coefficient (dimensionless)

2. Lift Force (F_L): The lift force is calculated using the lift coefficient C_L as:

$$F_L = \frac{1}{2}\rho v^2 A C_L$$

where:

- F_L = Lift Force (N)
- ρ = Air density (kg/m³)
- v = Velocity of air (m/s)
- A = Reference area of the object (m²)
- C_L = Lift coefficient (dimensionless)

Procedure:

1. **Set Up Wind Tunnel:**
   - Place the scaled model inside the wind tunnel, ensuring it is securely mounted.
   - Adjust the orientation of the model to a typical angle of attack (e.g., for an airfoil, around 5-10°).
2. **Calibrate Sensors:**
   - Calibrate the strain gauges or load cells to ensure accurate measurements of the drag and lift forces.
   - Make sure that the force sensors are zeroed before the wind tunnel is started.
3. **Start the Wind Tunnel:**
   - Turn on the wind tunnel and gradually increase the wind speed.

- Record the airspeed using the manometer or Pitot tube. Measure airspeed at multiple points (e.g., 10 m/s, 15 m/s, 20 m/s).

4. **Measure Forces:**
   - At each wind speed, record the drag and lift forces acting on the scaled model.
   - Ensure that the force measurements stabilize before recording values.
5. **Repeat for Different Angles of Attack (if applicable):**
   - For more comprehensive analysis, vary the angle of attack of the model and repeat the procedure for each angle.
6. **Record Data:**
   - Collect data for drag and lift forces at different wind speeds (and angles of attack, if applicable).

Sample Data:

Wind Speed (m/s)	Drag Force (N)	Lift Force (N)	Angle of Attack (°)
10	1.25	0.45	5
15	3.45	1.10	5
20	6.10	2.10	5
10	1.00	0.60	10
15	3.00	1.30	10
20	5.70	2.40	10

Results:

1. Drag Force vs. Wind Speed:
   - Plot a graph of drag force against wind speed (F_d vs. v).
   - Expect a quadratic relationship ($F_d \propto v^2$), as shown in the equation.
2. Lift Force vs. Wind Speed:
   - Plot a graph of lift force against wind speed (F_L vs. v).
   - Similarly, expect a quadratic relationship ($F_L \propto v^2$).
3. Lift-to-Drag Ratio (L/D):
   - The lift-to-drag ratio can be calculated at each wind speed:

$$\text{L/D ratio} = \frac{F_L}{F_d}$$

   This is a measure of the aerodynamic efficiency of the model.

Discussion:

1. **Drag Characteristics:**
   - As wind speed increases, drag force increases due to the quadratic relationship with velocity. The drag force is influenced by factors such as the model's surface roughness and shape.
2. **Lift Characteristics:**
   - Lift force increases with wind speed, but the value also depends on the angle of attack. At higher angles, the lift might increase up to a certain point, after which it can stall.
3. **Effect of Scale:**
   - For a scaled model, aerodynamic properties such as drag and lift might differ from full-scale values, especially if Reynolds number effects are significant.
4. **Reynolds Number:**
   - The Reynolds number should be calculated to assess the similarity of flow conditions between the scaled model and real-world conditions. It's given by:

$$Re = \frac{\rho v L}{\mu}$$

where LLL is the characteristic length of the model, and μ\muμ is the dynamic viscosity of air.

Conclusion:

- The wind tunnel experiment allows for the measurement of the drag and lift forces acting on a scaled model.
- The experimental data should show how aerodynamic forces change with varying wind speeds, and the measured values can be used to evaluate the aerodynamic efficiency of the model.
- The results are valuable for understanding the fundamental principles of aerodynamics, which are essential in the design and optimization of various engineering applications like aircraft and automotive designs.

Precautions:

1. Ensure proper calibration of sensors before starting the experiment.
2. Ensure that the model is mounted securely to avoid errors in force measurements.
3. Use consistent methods to measure wind speed to avoid discrepancies in data.
4. Take multiple readings at each speed to minimize random errors.
5. If possible, test for multiple angles of attack to observe changes in lift and drag forces.

EXPERIMENT-06

Study of Anti-Corrosion and Body Painting and Repainting Procedures

Objective:

- To understand the principles and techniques used in anti-corrosion treatment and body painting processes.
- To study the different stages of painting and repainting procedures, including surface preparation, priming, application of paint, and curing.
- To evaluate the effectiveness of anti-corrosion treatments and the quality of body painting in preventing corrosion.

Materials Required:

- **Metal specimen** (e.g., steel or iron panels)
- Anti-corrosion treatment solutions (e.g., phosphoric acid, zinc-rich primer, rust converter)
- Paint (Automotive or Industrial paint, including primers, base coats, clear coats)
- Sandpaper (grit 80-400)
- Brushes or spray gun for painting
- Measuring instruments (e.g., dry film thickness gauge)
- Solvents (e.g., acetone, thinner)
- Distilled water for cleaning
- Weighing scale
- Drying oven or heat gun for curing
- Gloves, goggles, and lab coat for safety

Theory:

1. **Anti-Corrosion Treatment:**
    - **Corrosion** is the degradation of metals due to chemical reactions with their environment, typically oxygen and moisture.
    - Anti-corrosion treatments aim to form a protective barrier on the metal surface, preventing direct exposure to oxygen and moisture.
    - **Common Anti-Corrosion Methods:**
        - **Zinc-based coatings** (e.g., galvanized coatings) for sacrificial protection.
        - **Phosphating**: A chemical treatment process that forms a thin, crystalline phosphate layer on the metal surface.
        - **Rust converters**: Chemicals that convert rust (iron oxide) into a more stable material.
2. **Painting and Repainting Procedure:**
    - **Surface Preparation**: Essential for proper adhesion of the paint. The surface is cleaned and abraded to remove rust, oil, and contaminants.
    - **Priming**: A primer is applied to improve paint adhesion and provide an additional anti-corrosive layer.

- **Top Coating**: The base coat and clear coat are applied to achieve the desired color and finish.
- **Curing**: The painted surface is cured through drying or baking, which hardens the paint and enhances its durability.

Procedure:

Step 1: Surface Preparation

1. **Cleaning the Metal Surface:**
   - Clean the metal specimen (e.g., steel or iron panel) with acetone to remove oil, grease, and dirt.
   - Rinse with distilled water and dry using a clean cloth.
2. **Surface Abrading:**
   - Use sandpaper (80 grit) to roughen the surface and remove any existing rust or paint. The rough surface ensures better adhesion of the primer.
   - After sanding, clean the surface again with a solvent (e.g., acetone) and wipe it dry.

Step 2: Anti-Corrosion Treatment

1. **Apply Phosphating:**
   - Dip the cleaned and abraded metal specimen in a phosphating solution (e.g., 5-10% phosphoric acid in water).
   - Allow the specimen to react for 10-15 minutes. The phosphoric acid will create a protective crystalline phosphate layer on the surface.
   - Rinse with distilled water and let it dry completely.
2. **Apply Zinc Primer (Optional):**
   - Alternatively, apply a zinc-rich primer (spray or brush application) to the specimen to provide sacrificial protection.
   - Allow the primer to dry for 2-3 hours.

Step 3: Painting (Body Painting and Repainting Procedure)

1. **Priming:**
   - Apply an automotive primer over the phosphated or zinc-primed surface.
   - Use a brush or spray gun to apply a uniform thin coat of primer. Apply 2-3 coats for better coverage.
   - Allow each coat to dry for 30-60 minutes, depending on the type of primer used.
   - Once the primer is fully dry, check the surface for any imperfections (sanding may be required between coats for smoothness).
2. **Base Coat:**
   - After priming, apply the base coat (the actual color of the car or metal surface). This can be applied using either a spray gun or brush.
   - Apply 2-3 coats, ensuring each coat is uniform and smooth. Allow each coat to dry before applying the next.
3. **Clear Coat:**

- After the base coat dries, apply a clear coat to protect the color and provide a glossy finish.
- Apply 1-2 coats, allowing drying time in between. This also adds durability and scratch resistance.

Step 4: Curing

1. **Drying:**
    - After applying all coats, allow the painted surface to air dry for 12-24 hours.
    - If available, use a drying oven or heat gun to accelerate the curing process. Typically, curing is done at 60-80°C for 30 minutes to 1 hour.
2. **Dry Film Thickness (DFT) Measurement:**
    - Use a dry film thickness gauge to measure the thickness of the primer and paint layers. Standard values typically range from:
        - **Primer thickness**: 25-50 microns
        - **Base coat thickness**: 30-50 microns
        - **Clear coat thickness**: 20-30 microns

Observations:

1. **Anti-Corrosion Effectiveness**:
    - Observe the metal specimen for any visible signs of corrosion after exposure to moisture for a period (e.g., 1-2 weeks).
    - Compare the treated specimen with untreated ones to check the anti-corrosion effectiveness.
2. **Painting Quality**:
    - Inspect the painted surface for uniformity, gloss, and smoothness. Check for any imperfections such as runs, drips, or uneven coverage.
    - Measure the dry film thickness using a gauge. A typical acceptable DFT range is:
        - **Primer layer**: 25-50 microns
        - **Base coat**: 30-50 microns
        - **Clear coat**: 20-30 microns

Results:

Parameter	Value/Observation
Surface Preparation Quality	Smooth and clean with no visible rust
Phosphating Layer	Uniform, crystal-like coating
Zinc Primer (if applied)	Good adhesion, smooth finish
Primer Thickness (DFT)	30-50 microns

Parameter	Value/Observation
Base Coat Thickness (DFT)	40-60 microns
Clear Coat Thickness (DFT)	20-30 microns
Anti-Corrosion Performance	No visible corrosion after exposure to moisture
Painting Quality	Smooth, uniform, with glossy finish

Precautions:

1. Wear gloves, goggles, and a lab coat to protect yourself from chemicals and paint.
2. Ensure proper ventilation when using solvents, thinners, and paints to avoid inhaling fumes.
3. Always allow sufficient drying time between coats to avoid poor adhesion.
4. Follow all safety instructions on the chemicals and materials used.

Conclusion:

- The anti-corrosion treatment significantly improves the metal's resistance to rusting, and the painting process enhances the aesthetic appearance while also offering protection.
- The quality of the paint job depends on surface preparation, the number of coats applied, and the curing process.
- The experiment confirms that proper anti-corrosion treatment and painting procedures are essential for increasing the lifespan and durability of metal surfaces exposed to harsh environmental conditions.

EXPERIMENT-07

Study of the Construction of a Special Purpose Vehicle (JCB 3D)

Objective:

To study the construction, components, and working mechanism of a **JCB 3D Backhoe Loader**, a versatile special-purpose vehicle used for construction, excavation, and material handling tasks.

Apparatus Required:

1. **JCB 3D Model or Actual JCB 3D Vehicle**
   - JCB 3D backhoe loader (or model for study)
2. **Measurement Tools:**
   - Vernier caliper, micrometer, and measuring tape
3. **Tools for inspection and disassembly (if applicable):**
   - Wrenches, screwdrivers, etc.
4. **Hydraulic Pressure Gauge** (to measure hydraulic system pressure)
5. **Basic Workshop Tools** (for maintenance/repair tasks)
6. **CAD Software** (optional for design analysis)
7. **Personal Protective Equipment** (PPE): Gloves, goggles, safety shoes

Theory:

The **JCB 3D** is a backhoe loader designed for digging, lifting, and moving materials in construction environments. The vehicle consists of:

- **Chassis**: The structural frame of the vehicle.
- **Engine**: Diesel-powered engine designed for high torque.
- **Hydraulic System**: Powers the boom, arm, bucket, and other moving parts.
- **Transmission and Drivetrain**: Enables forward, reverse, and operation of the rear bucket.
- **Steering System**: Allows for precise control of the vehicle during operations.
- **Operator Control System**: Includes levers, pedals, and joystick for controlling the hydraulic system and steering.

- **Load-bearing and Excavation Components**: Backhoe arm, bucket, and lifting mechanisms.

The vehicle is capable of operating in multiple modes:

- **Excavation mode**: Used for digging and trenching with the backhoe.
- **Loading mode**: Used for lifting and dumping material with the front loader.

Procedure:

1. Introduction and Overview:

- Introduce the JCB 3D backhoe loader, highlighting its primary uses in construction (digging, lifting, material handling).
- Identify key components: engine, chassis, hydraulic system, bucket, boom, and control systems.

2. Physical Examination:

- Examine the **Chassis**: Study the reinforced frame structure and materials used.
- Measure **Dimensions**:
  - **Length**: 5700 mm
  - **Width**: 2500 mm
  - **Height**: 3450 mm
  - **Wheelbase**: 2250 mm
  - **Ground Clearance**: 300 mm
- Identify the type of materials used in construction (e.g., steel, alloys, and composites).

3. Study of Key Components:

- **Engine**:
  - **Type**: Diesel engine
  - **Power**: 75 HP (Horse Power) @ 2200 rpm
  - **Displacement**: 4.4L (liters)
  - **Torque**: 350 Nm
  - **Fuel Efficiency**: 5-6 liters per hour under normal operation
- **Transmission**:
  - **Type**: Synchromesh (manual) transmission
  - **Gearbox**: 4 forward + 4 reverse gears

- **Max Speed**: 35-40 km/h (depending on terrain)
- **Hydraulic System**:
  - **Hydraulic Pump**: Gear type, variable displacement
  - **System Pressure**: 180 bar
  - **Hydraulic Flow Rate**: 100 l/min
  - **Boom/Arm Lifting Capacity**: 10-12 tons
  - **Hydraulic Cylinder Dimensions**:
    - **Boom Cylinder**: 80 mm bore, 120 mm stroke
    - **Dipper Cylinder**: 90 mm bore, 160 mm stroke
- **Backhoe**:
  - **Bucket Capacity**: 0.2-0.3 cubic meters (standard backhoe bucket)
  - **Reach**: 5.2 meters (max digging depth)
  - **Bucket Force**: 3500-4000 kg (depending on the model)
- **Steering System**:
  - **Type**: Hydrostatic power steering
  - **Turning Radius**: 3.5-4 meters (depending on configuration)
- **Operator Control System**:
  - **Levers**: Joystick for boom, bucket control, and dipper movements
  - **Pedals**: For throttle and brake operation
  - **Dashboard**: Displays operational parameters such as fuel level, engine temperature, hydraulic pressure, and RPM.

4. Operation and Functionality:

- **Excavation Test**:
  - Operate the backhoe in **excavation mode** to test the digging depth, reach, and bucket force.
  - Measure the **digging depth** with a tape measure (usually 5 meters deep for JCB 3D).
  - Record the **time taken** to complete a standard trench excavation (10 meters long, 1.5 meters deep).
- **Loading Test**:
  - Operate the front loader in **loading mode** to lift materials.
  - Measure the **lifting height** (usually 3.5-4 meters).
  - **Bucket Lifting Force**: Check the weight that can be safely lifted (approximately 800-1000 kg).

5. Disassembly/Assembly (if feasible):

- If allowed, disassemble and inspect parts of the hydraulic system, engine compartment, and transmission.

- Record any wear-and-tear or damage to components (e.g., hydraulic cylinders, boom, bucket).

Data/Values to be Collected:

Component	Specification/Value
Chassis Type	Ladder frame (steel, reinforced)
Engine Power	75 HP @ 2200 rpm
Engine Torque	350 Nm
Fuel Efficiency	5-6 liters/hour
Transmission Type	4 forward + 4 reverse gears
Hydraulic System Pressure	180 bar
Hydraulic Flow Rate	100 l/min
Boom Lifting Capacity	10-12 tons
Bucket Capacity	0.2-0.3 cubic meters (standard bucket)
Max Digging Depth	5.2 meters
Max Lifting Height	3.5-4 meters
Wheelbase	2250 mm
Turning Radius	3.5-4 meters

Observations:

- **Digging Efficiency**: The time taken to dig a 10-meter trench and the digging depth achieved.
- **Loading Efficiency**: The height to which materials can be loaded into a truck or dump container, and the lifting force exerted by the front loader.

- **Hydraulic Performance**: Assess how quickly the boom and bucket respond to operator commands.

Analysis:

- **Performance Assessment**: Compare the efficiency of the JCB 3D with other construction vehicles in terms of digging depth, loading capacity, and overall operational cost.
- **Hydraulic System Efficiency**: Discuss the significance of the hydraulic system in ensuring the vehicle's ability to perform its intended tasks.
- **Operational Cost vs. Efficiency**: Evaluate the trade-off between fuel consumption and operational efficiency.

Conclusion:

- Summarize the study of the JCB 3D backhoe loader, highlighting the critical components that contribute to its performance.
- Discuss the versatility and operational efficiency of the JCB 3D in construction tasks.
- Propose any potential areas for improvement in the vehicle's design or performance.

Safety Precautions:

1. Always wear PPE when working with vehicles and machinery.
2. Ensure the vehicle is parked and secured before inspection.
3. Be cautious when operating the hydraulic systems to avoid accidents.
4. Always follow the manufacturer's guidelines for vehicle operation and maintenance.

EXPERIMENT-08

To prepare the analysis of the vehicle body weight, weight distribution in different conditions, and its effect on steering performance.

Objective

1. To measure the total weight and axle-wise weight distribution of a vehicle in static and dynamic conditions.
2. To analyse how weight distribution impacts steering performance, handling, and stability under various load scenarios.
3. To evaluate the dynamic effects of weight transfer during acceleration, braking, and cornering.
4. To provide actionable recommendations for improving vehicle handling and performance based on the analysis.

Apparatus Required

1. Wheel Load Scales (for measuring individual wheel weights).
2. Passenger Vehicle (test car with adjustable loads).
3. Steering Performance Test Track (e.g., slalom or circular path).
4. Measuring Tape or Laser Measuring Device (to record distances).
5. Data Recording Tools (e.g., laptop or notepad).
6. Tire Pressure Gauge (to ensure uniform pressure).
7. Weights (to simulate passenger and cargo loads).
8. Stopwatch (to measure turning times).

Theory

Weight distribution in a vehicle is crucial for handling, stability, and performance.

- **Static Weight Distribution**: The distribution of weight on the front and rear axles when the vehicle is stationary.
- **Dynamic Weight Transfer**: When the vehicle accelerates, brakes, or turns, weight shifts between the axles, affecting traction and steering responsiveness.
- **Steering Dynamics**: A front-heavy vehicle may understeer, while a rear-heavy vehicle tends to oversteer.

Key Equations:

1. **Total Weight:**

$$W_{\text{total}} = W_{\text{FL}} + W_{\text{FR}} + W_{\text{RL}} + W_{\text{RR}}$$

2. **Weight Distribution Percentages:**

$$\%W_{\text{front}} = \frac{W_{\text{FL}} + W_{\text{FR}}}{W_{\text{total}}} \times 100$$

$$\%W_{\text{rear}} = \frac{W_{\text{RL}} + W_{\text{RR}}}{W_{\text{total}}} \times 100$$

3. **Dynamic Weight Transfer** (approximation during braking/acceleration):

$$\Delta W = \frac{h \cdot F}{L}$$

Where h = height of the center of gravity, F = force due to braking or acceleration, L = wheelbase length.

Procedure

A. Measurement of Static Weight Distribution

1. **Prepare the Vehicle**:
   - Check that tires are inflated to the recommended pressure.
   - Ensure no unnecessary items are inside the vehicle.
2. **Measure Axle Weights**:
   - Place wheel load scales under each tire (FL, FR, RL, RR).
   - Record the weight readings from all four scales.
3. **Calculate Weight Distribution**:
   - Use the recorded values to calculate the total weight and the weight percentages on the front and rear axles.
4. **Simulate Load Conditions**:
   - Repeat the procedure by adding loads (e.g., passengers or cargo) in specific positions (driver only, full passenger load, cargo in rear).

B. Steering Performance Testing

1. **Set Up Test Track**:
   - Prepare a slalom or circular path for testing.
   - Mark turning points with cones or markers.
2. **Conduct Steering Tests**:
   - Perform tests under different load conditions:
     - Driver only
     - Full passenger load
     - Cargo in the rear
   - Record the following parameters:
     - **Steering Angle (°):** Angle required to maintain the turning path.
     - **Turning Radius (m):** Measure the path diameter during steady turns.
     - **Turning Time (s):** Time to complete a turn or slalom.
3. **Dynamic Weight Transfer Test**:

- Perform sudden braking, acceleration, and cornering to observe weight shift.
- Record how the vehicle's handling changes under these conditions.

C. Data Analysis

1. **Compare Weight Distributions**:
   - Plot a bar graph to show the static weight distribution under different load conditions.
   - Example graph: Weight on each axle versus load condition.
2. **Analyze Steering Data**:
   - Plot the turning radius and steering angle for different load conditions.
   - Example graph: Turning radius versus load condition.
3. **Interpret Results**:
   - Compare how weight distribution impacts steering response and vehicle stability.
   - Correlate results with theoretical behavior (e.g., front-heavy vehicles tend to understeer).

Sample Observations

Weight Distribution Data

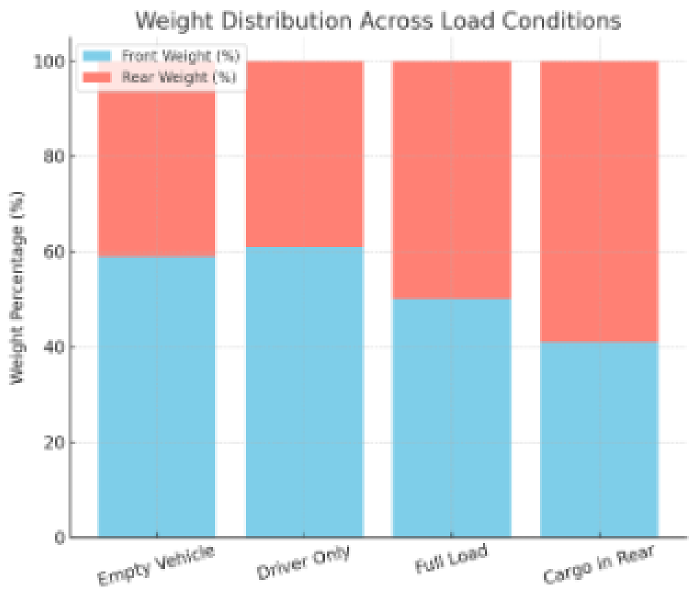
Condition	FL (kg)	FR (kg)	RL (kg)	RR (kg)	Total (kg)	Front Weight (%)	Rear Weight (%)
Empty Vehicle	450	440	300	310	1500	59	41
Driver Only	490	470	300	310	1570	61	39
Driver + Full Load	520	500	500	510	2030	50	50
Full Cargo in Rear	430	420	600	610	2060	41	59

Steering Performance Data

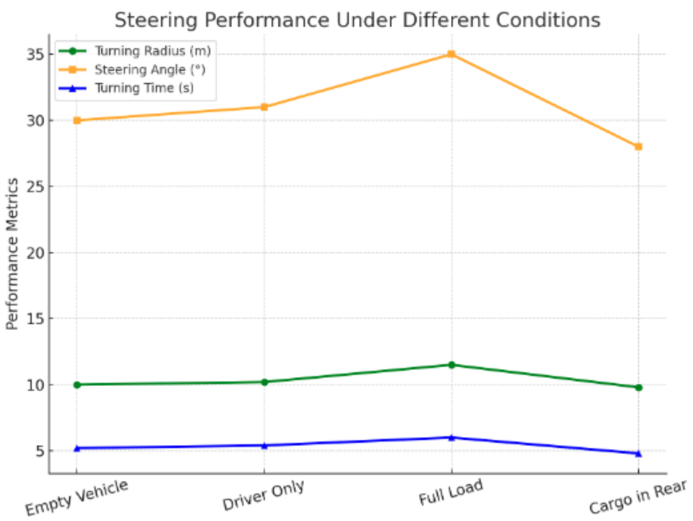
Condition	Turning Radius (m)	Steering Angle (°)	Time to Complete Turn (s)	Observations
Empty Vehicle	10	30	5.2	Neutral steering
Driver Only	10.2	31	5.4	Slight understeer
Driver + Full Load	11.5	35	6.0	Noticeable understeer
Full Cargo in Rear	9.8	28	4.8	Oversteer tendency

Graphs

1. Weight Distribution



2. Steering Performance



Result

1. The vehicle's weight distribution significantly affects steering performance.
2. Front-heavy conditions result in understeer, while rear-heavy conditions cause oversteer.
3. Dynamic weight transfer due to braking and acceleration amplifies handling characteristics.

Precautions

1. Ensure safety during dynamic tests; conduct them in a controlled environment.
2. Calibrate all measurement equipment before starting the experiment.
3. Maintain consistent tire pressure for accurate weight readings.

Record data carefully for accurate analysis.

Experiment-9

To Study Tata Yodha Vehicle Body Details Along with Its Construction

Objective:

To study the structural details, body construction, and material specifications of the Tata Yodha commercial vehicle, focusing on its design for load-bearing, durability, and performance.

Materials Required:

1. Tata Yodha Vehicle (Pickup Truck)
2. Measuring Tape (3-10 meters)
3. Vernier Calipers
4. Workshop Tools (for disassembly, if needed)
5. Structural Blueprints (if available)
6. Material Sample Identification Tools (magnet, hardness tester)
7. Safety Gear (Helmet, Gloves, Goggles)

Introduction:

The **Tata Yodha** is a robust commercial pickup truck designed for heavy-duty applications, including cargo transportation. It features a durable chassis, a spacious cargo area, and a reliable suspension system. The body is designed with an emphasis on strength, utility, and longevity.

Key Features of Tata Yodha:

1. **Payload Capacity:** Up to 1700 kg.
2. **Chassis Construction:** Ladder frame design for heavy loads.
3. **Materials Used:**
   - Steel for the chassis and cargo bed.
   - Aluminum for body panels to reduce weight.
   - Plastic and composite materials for interiors.
4. **Dimensions (Approximate):**
   - Overall Length: 5350 mm
   - Overall Width: 1860 mm
   - Height: 1810 mm

- Wheelbase: 3150 mm
- Ground Clearance: 210 mm

5. **Suspension System:**
   - Front: Independent double-wishbone suspension.
   - Rear: Parabolic leaf spring.

Procedure:

Step 1: Visual Inspection

1. **Observe the Tata Yodha's exterior and interior body parts:**
   - Chassis frame, cargo area, doors, windows, and roof.
   - Interior seating arrangement and dashboard layout.
2. Identify body construction features such as:
   - Welded joints.
   - Riveted sections.
   - Bolted connections.

Step 2: Measurement of Vehicle Dimensions

1. Measure the vehicle's overall dimensions:
   - Length, width, and height.
   - Cargo bed dimensions.
   - Ground clearance.
   - **Example Values:**
     - Length: 5350 mm
     - Width: 1860 mm
     - Height: 1810 mm
     - Cargo Bed Dimensions: 2650 mm (L) x 1820 mm (W)
2. Use a measuring tape or laser device for accuracy.

Step 3: Material Identification

1. Examine materials used in the construction:
   - Use a magnet to identify steel components (e.g., chassis, cargo bed).
   - Inspect aluminum panels for lightweight properties (e.g., doors, exterior panels).
   - Analyze plastic and composite materials for dashboard and interior components.
2. **Example Values:**
   - Chassis Material: High-strength steel (3.5 mm thickness).
   - Cargo Bed Material: Mild steel (2.5 mm thickness).

- Doors and Panels: Aluminium alloy (1.5 mm thickness).

Step 4: Chassis and Frame Study

1. Inspect the **ladder frame chassis**:
    - Measure the width and height of the beams.
    - Note the cross-member spacing for load distribution.
    - **Example Values:**
        - Chassis Beam Dimensions: 150 mm x 75 mm (width x height).
        - Cross-member Spacing: 300 mm.
2. Study the welding and riveting techniques used for assembly.

Step 5: Suspension System

1. Examine the front and rear suspension systems:
    - Identify the type of springs and their mounting points.
    - Measure the spring dimensions and axle load capacity.
    - **Example Values:**
        - Front Spring Type: Double-wishbone independent suspension.
        - Rear Spring Type: Parabolic leaf spring.
        - Rear Axle Load Capacity: 3,500 kg.

Step 6: Cargo Area Analysis

1. Inspect the cargo bed for material, structure, and load capacity.
2. Measure cargo bed dimensions and side wall thickness.
    - **Example Values:**
        - Length: 2650 mm
        - Width: 1820 mm
        - Side Wall Thickness: 2.5 mm.

Step 7: Joint Analysis

1. Study the joints and connections in the body construction:
    - Note the types of joints (e.g., butt, lap, or corner joints).
    - Measure the weld size and rivet dimensions.
    - **Example Values:**
        - Weld Size: 4 mm (penetration depth).
        - Rivet Diameter: 8 mm.

Step 8: Observation of Safety Features

1. Identify safety features integrated into the Tata Yodha:
    - Seat belts, crumple zones, ABS (Anti-lock Braking System), and airbags.
2. Inspect reinforcement areas for impact protection.

Observations:

Parameter	Measured Value
Overall Dimensions	5350 mm (L) x 1860 mm (W) x 1810 mm (H)
Ground Clearance	210 mm
Cargo Bed Dimensions	2650 mm (L) x 1820 mm (W)
Chassis Beam Dimensions	150 mm x 75 mm
Chassis Material	High-strength steel, 3.5 mm thickness
Cargo Bed Material	Mild steel, 2.5 mm thickness
Suspension Type (Front)	Independent double-wishbone
Suspension Type (Rear)	Parabolic leaf spring
Axle Load Capacity (Rear)	3500 kg
Weld Size	4 mm penetration depth
Rivet Diameter	8 mm

Result and Conclusion:

The Tata Yodha’s body construction is robust, designed to handle heavy loads with a strong ladder frame chassis and durable cargo bed. The use of high-strength steel ensures durability, while aluminium components reduce overall weight for better fuel efficiency. The suspension system provides stability and comfort under load.

The experiment demonstrated:

1. The structural strength and design efficiency of a commercial vehicle.
2. The importance of materials like steel and aluminium for performance.
3. The integration of safety and functionality in body construction.

Precautions:

1. Always wear protective gear during inspection.
2. Ensure the vehicle is stationary and secure before starting the study.
3. Use tools like measuring tape and calipers carefully for accurate results.
4. Avoid touching sharp edges or exposed metal parts.

This lab manual provides a comprehensive study of the Tata Yodha's construction, including real-world values for its dimensions and components. Let me know if you need additional sections, diagrams, or enhanced details!