Unit 1: VEHICLE STRUCTURE AND ENGINES

Module 2: Layouts of an Automobile, Vehicle aerodynamics (various resistances and moments involved),

Description of an Automobile

- **Type:** Motor Cycle, Car, Bus, truck, etc.,
- **Capacity:** Tonnage and no. of seats
- **Make:** Manufacturer of the vehicle and Engine Capacity
- **Drive:** Left hand Drive or Right hand Drive, 2, 4, 6 wheel drive
- **Model:** Year of Manufacturing

Layouts of an Automobile

The different layouts of an automobile are as follows

- Front Engine Rear Wheel Drive
- Front Engine Front Wheel Drive
- Rear Engine Rear Wheel Drive
- Four Wheel Drive (All Wheel Drive)

1. Front Engine Rear Wheel Drive

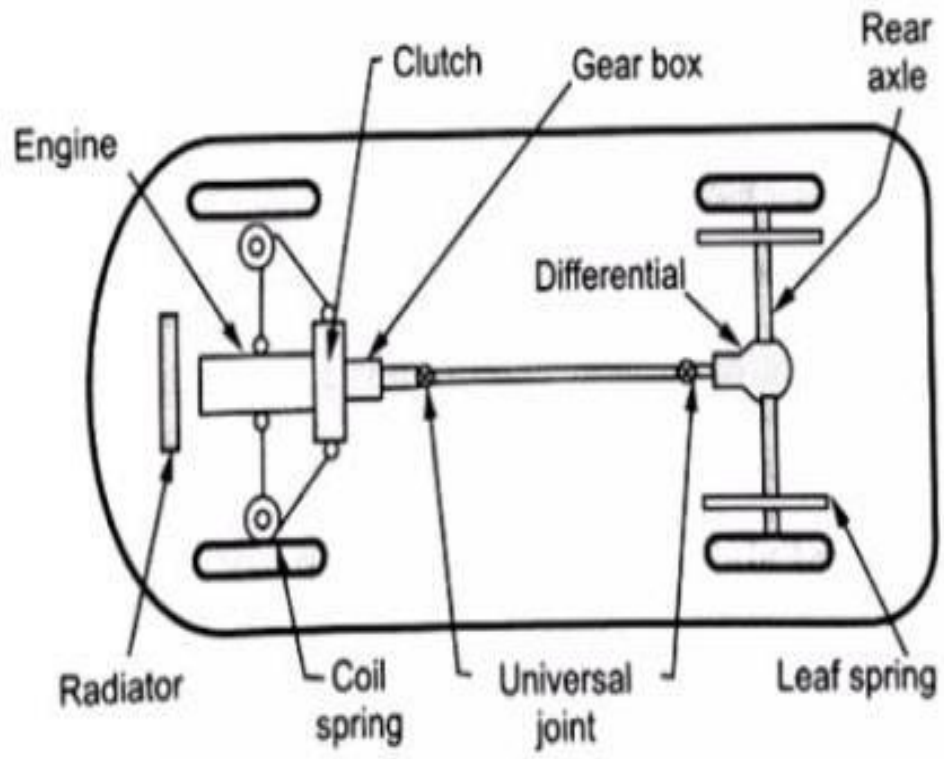

Fig.7 layout of Front engine rear wheel drive

In this chassis layout, the engine is fitted at the front.

•The engine, clutch and gear box are fitted at front while drive to the rear axle is given with the help of propeller shaft

•This chassis layout is one of the oldest and still remain popular for heavy commercial vehicle

Advantages

1. The weight distribution is reasonably balanced between the front and rear wheels, which gives good handling

characteristics.

2. Due to engine and radiator are at front , the forward facing radiator takes full benefit of the natural air stream , created by vehicle‘s movement .hence reduce the power losses for a large fan.
3. The weight of vehicle is shifted to rear driving wheels during acceleration and on steeps resulting in better road grip, hence, there are less chances of wheel slipping .
4. Since the front wheel are used only to steer the vehicle, hence steering mechanism become simple in design and easy to operate.
5. Accessibility to various components like engine , gear box and rear axle is better in comparison to outer layout
6. Large luggage space is available at back of vehicle which providing increased carrying capacity as well as space for easy body extension.

Dis Advantages

1. During the breaking ,weight of vehicle is fitted to front wheels and weight on rear wheels decreased , results in decreased breaking effort developed
2. It required long propeller shaft and differential at rear, therefore height of floor area is increased .Also, due to long propeller shaft transmission problems and weight are increased.
3. Due to less weight on driving rear wheels, there is less adhesion on road and result in less holding capacity .therefore there is less chance of skidding on slippery surface.

2. Front Engine Front Wheel Drive

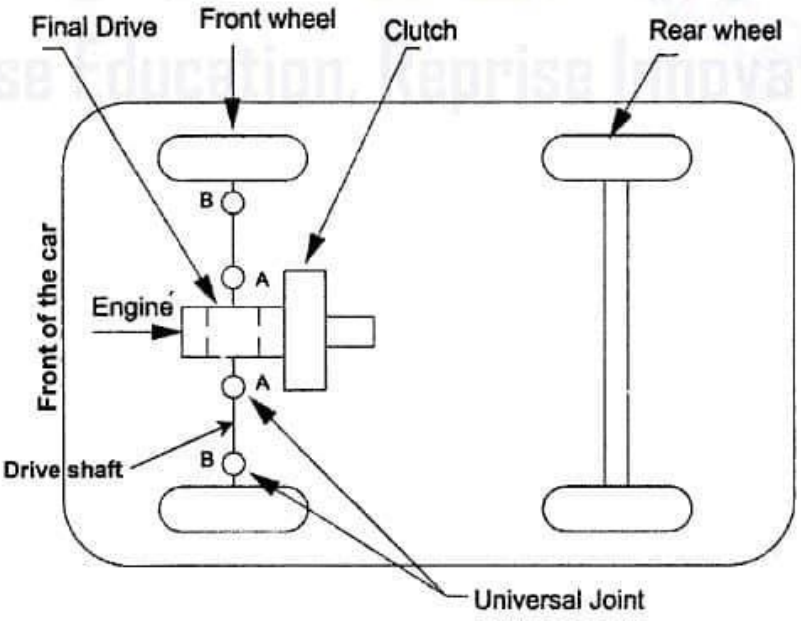

Fig.8 layout of Front engine Front wheel drive

1. In this type of chassis layout the engine is fitted at front and drive is also given to the front wheel .No propeller shaft is used in this layout and differential are included in the same assembly.
2. This layout provides optimum body luggage space and flat floor line. However , due to all assemblies at front ,it make very difficult to accommodate the steering mechanism.

Advantages

1. Due to more weight placed on driving front wheel, the vehicle has more adhesion on road. Hence good road holding capacity even on the curves and slippery roads.
2. This layout provides low floor, since no propeller shaft and the differential placed at front instead of rear.
3. The clutch, gearbox, and final drive usually made as one unit thereby coast of vehicle are reducing.
4. The wheel does not take to sharply turn into the curve due to tendency of understeering. The understeer

conditions generally preferred by many drivers are promoted by this type of chassis.

5. Either a transverse or longitudinal engine position can be used. In case of transverse mounted engine, as the engine crankshaft and wheels already rotate in the parallel planes, therefore, they do not require their drive to be turned through 90^{O} as in case of conventional longitudinally mounted engines.

Dis Advantages

1. The weight on the driving front wheels is reduced during acceleration and climbing of steep gradient due to weight of the vehicle shifting to the rear wheels. Hence, result in decreased tractive effort which makes slippery gradient.
2. The steering mechanism become more complicated due to accommodation of engine, clutch, gearbox & final drive all at front of vehicle.

3. Rear Engine Rear Wheel Drive

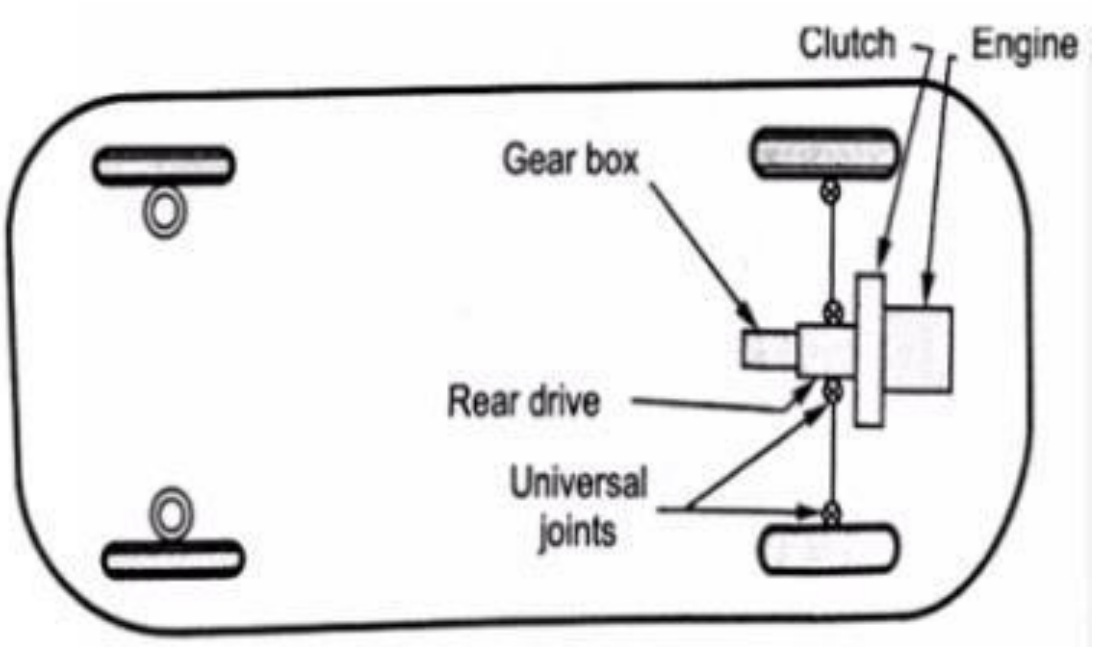

Fig.9 layout of Reart engine rear wheel drive

In this chassis layout engine is fitted at the back and drive is also given to rear wheel

•This arrangement eliminates the necessity for a propeller shaft because engine is mounted near the driven wheel.

•The passenger are kept away from inconveniences like noise, heat and fumes because engine at back of vehicle

Advantages

1. Because of high weight on driving axle, it provides excellent traction and grip on steep hills
2. The rear floor can be made flat because of absence of propeller shaft.
3. The clutch, gearbox, and final drive usually made as one unit thereby coast of vehicle are reducing.
4. The driver cabin is well isolated from noise
5. The front body can be designed with steam lining and stylish.

Dis Advantages

1. Natural air cooling of the engine is not possible, hence it requires powerful radiator fan at rear.
2. The clutch and gear system mechanism is long and complex
3. Because of high weight concentration at rear, the vehicle has a tendency to over steer while taking harp turns

4. Four Wheel Drive (All wheel Drive)

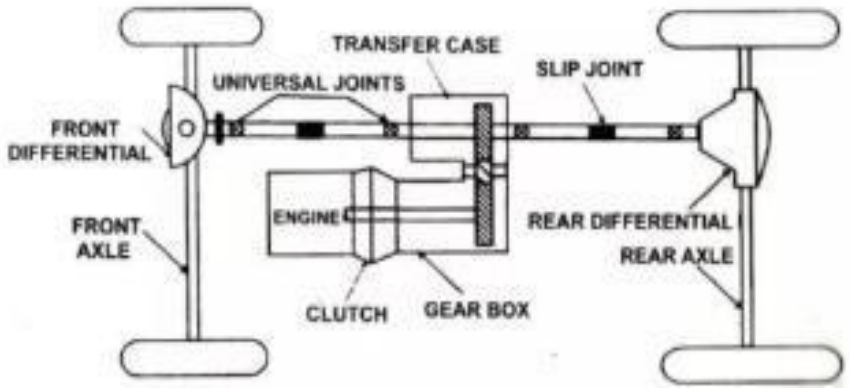

Fig.10 layout of All wheel drive

- 4X2 = 4 Wheel vehicle and 2 Wheels can receive torque.
- 4X4 = 4 Wheel vehicle and all 4 Wheels can receive torque.
- E.g. are Jeeps, SUVs (Sports Utility Vehicle), etc.
- Games derived its name from 4WD only.
- Used mostly in defense services or where graveled or slick roads are present.
- To get enough “TRACTION” between wheels and road surfaces.
- To move vehicle on slick surfaces, dirt, slippery roads, sand roads and snowy,muddy roads etc.

Advantages

- Increased Traction is obtained in slippery surfaces.
- More balanced axle load distribution.
- Even tire wear

Dis Advantages

- Weight of vehicle is increased.
- Cost of the vehicle is increased.
- Maximum speed of vehicle is reduced.
- Less fuel economy than 2WD

Vehicle Aero Dynamics

The term ―Aero‖ means air, ―Dynamic‖ means motion. Therefore, aerodynamic is the study of effects of the wind on the vehicle in motion.

When the vehicle is moving the air flow is dependent on the two factors.

- Vehicle speed.
- Ambient wind.

Advantages of Aerodynamics

- More Fuel Efficiency
- Higher Speeds
- Good Aesthetic and Stylish Appearance
- More Stability of car at high Speed
- Reduce Noise Level

Resistance of an Automobile

- ✓ A moving vehicle is opposed by various forces, known as resistance
- ✓ For moving the vehicle, the driving force (F) should be equal to the sum of all resistance forces applied on it. $F= R_a+R_r+Rg$
- ✓ When _F‘ exceeds the sum of all resistance forces, vechile accelarate
- ✓ When _F‘ less than the sum of all resistance forces, vechile deaccelarate

Air Resistance (R_a): This is the resistance offered by air to the movement of a vehicle. The air resistance has an influence on the performance, ride and stability of the vehicle and depends upon the size and shape of the body of the vehicle, its speed and the wind velocity. The last term should be taken into account when indicated, otherwise it can be neglected. Hence in general, air resistance,

- It *increases as the square of the vehicle speed* owing to which much importance is given to streamlining and frontal area of modern automobiles. In calculating air resistance, air velocity is usually neglected.

Air resistance, $R_a = k_a A V^2$

where, k_a = Coefficient of air resistance,

A = Projected frontal area, m^2, and

V = Vehicle speed, km/h.

Rolling Resistance (R_r): The magnitude of rolling resistance depends mainly on

- the nature of road surface,
- the types of tyre viz. pneumatic or solid rubber type,
- the weight of the vehicle, and
- the speed of the vehicle

- It is measured in kg or N and is expressed as kg/tonne or N/tonne of vehicle weight or as a *percentage of the vehicle weight*. Rolling resistance on average type of road surface is between **1 to 2% of vehicle weight.**

Rolling resistance, $R_r = k_r W$

where, k_r = Constant of rolling resistance, and

W = Total weight of vehicle.

Gradient Resistance (R_g): The resistance due to steepness of the road gradient. It depends upon the weight of the vehicleand road gradient. It does not depend upon vehicle speed.

- Gradient resistance, $R_g = \frac{W}{G}$, or, $W \sin \theta$

(if gradient is expressed in angular dimensions)

where, W = Total weight of vehicle,

G = Gradient, and

θ = Inclination. (For small values, $\tan \theta = \sin \theta$)

MOMENTS DUE TO FORCES: Moments created by forces acting on the vehicle

Rolling Moment – Created by cross wind about x-axis

Pitching moment – Created by drag or lift force about y-axis and reduces the traction in the wheelsYawing moment- Created by cross wind about z-axis