Unit I

CAR BODY – Notes.

1.0.0. VEHICLE BODY ENGINEERING

Necessity of vehicle body engineering

For the **users,** the **vehicle body** is one of the **most important part** and the **requirements** of the **vehicle body** are:

(i) Vehicle body structure and **interior arrangement** provide **riding comfort** and **convenience** to the **driver** and **passengers.**

(ii) Vehicle body can give **protection** to the **users** from **weather** and **reasonable safety** in case of **accident.**

(iii) Vehicle body should be **free from distracting noises,** when the vehicle is in operation.

(iv) It should remain **free from body noises** and **squeaks** over the periods of its **life.**

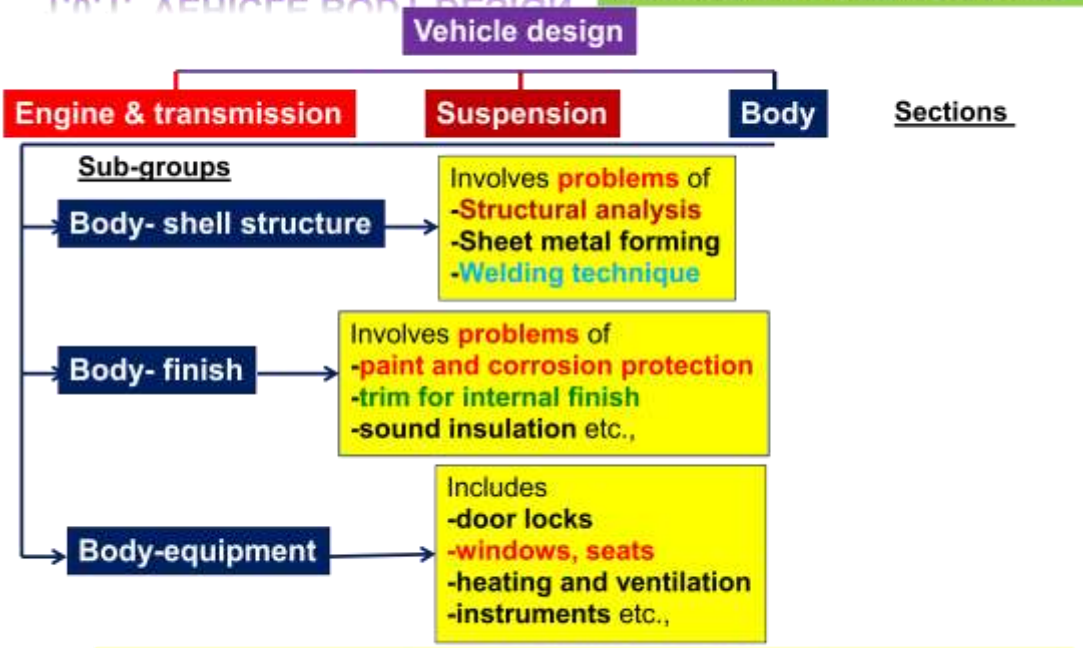
(v) It can give **good appearance** and a **certain degree** of **beauty.**

(vi) It will give **greater strength** with **light weight** in order to **reduce** the **inertia forces** and **make possible** rapid and **effective braking** and **acceleration.**

(vii) It should be **aerodynamically** designed with **good fuel economy.**

1.0.1. VEHICLE BODY DESIGN

Body design must always be guided by aesthetic considerations (or styling) -this must be true for all the sub-groups



involves a knowledge of several technologies from precision engineering for door locks to thermodynamics for the heating system. c.coomarasamy

1.0.1. VEHICLE BODY DESIGN

The importance of the body engineer

The body engineer - must be familiar with-

- all problems of vehicle design and involved at all stages of design.
- installing standard catalogue items such as transmission and suspension.
- legal requirements
- the ergonomics of seating and controls.
- account problems of field of vision.
- over-all aerodynamics.
- preparation of perspective drawings and sketches and co operate with the stylist.
- three dimensional geometry of curved surfaces, and be able to supervise the construction of suitable models and mock ups.
- preparation of initial design drawings and carry out the structural analysis on the body design.
- finally, comparison of the new design with the existing designs to ensure that some advances has been made.

1.0.2. PURPOSE OF BODY DESIGN

- The **purpose of body design** is to achieve the following:
- ***• Aesthetics:*** *to provide a pleasing overall appearance, surface quality and consistent* details.
- ***• Structural function:*** *to support the weight of the transported passengers and* load as well as the mechanical parts required for vehicle propulsion, control and other system functions, so withstanding mechanical stresses frommultiple sources.
- ***• Ergonomy and roominess:*** *to supply easy access and adequate room for the* driver, passengers and transported goods.
- **Safety:** to ensure integrity of passenger compartment in the event of a crash, while absorbing the impact energy as well as to reduce injuries to vulnerable road users (pedestrians, wheelers), in case of collision.
- ***• Aerodynamics:*** *to minimize drag due to air impact; to control air flow effects* on tyre-road contact and vehicle stability.

1.0.2. PURPOSE OF BODY DESIGN

- ***• Insulation:*** *to minimize noise, vibration and thermal transmission, generated* by body walls, by lack of sealing between compartment and movable parts and by thermal radiation from the surfaces of passengers compartment.
- ***• Visibility:*** *to provide the highest possible day and night visibility on the environment* and to host the lighting devices in the most effective way.

Moreover, the body **must satisfy** a **series of prerequisites:**
high reliability (to maintain design functions vehicle life along),
low cost (to minimize production investment, process and material cost),
high material recyclability (by rapid disassembling and straightforward division of heterogeneous materials).

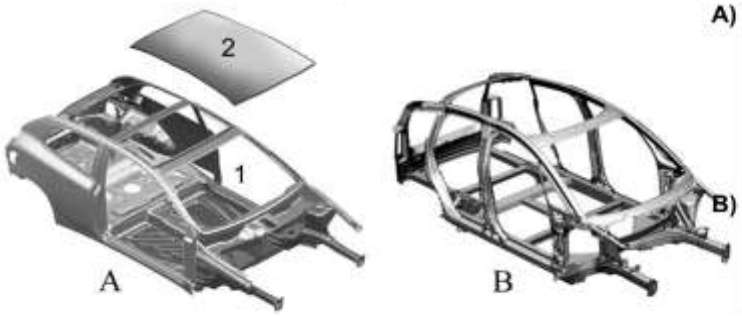
These functions ere **required** by the completely assembled body and are achieved through the individual contribution of body components and several body systems.

For some of the functions listed above, a number of different configurations of the underbody can be identified.

1.0.4. CAR BODY DETAILS - BODY IN WHITE

All vehicle manufacturers aim to build the perfect body in white (BIW). It is the basis of a premium quality, light-weight car.

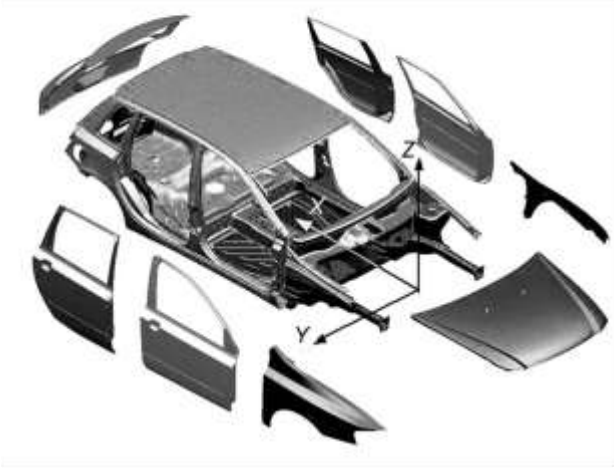
- In the usual configuration, a ***body in white*** *is an* ***assembly of a frame*** *and* ***panels***, made up of **homogeneous materials** (for instance, **steel** or **aluminum sheets** or **composites**).
- As an example, in Fig. a 3-door steel body and the frame of a 5-door aluminum body are shown.



A) Body in white steel sheets (1) and roof panel (2) of Fiat Stilo 3-doors, before their assembly.

B) Audi A2 aluminum body frame. (5-door)

1.0.4. CAR BODY DETAILS - BODY WORK



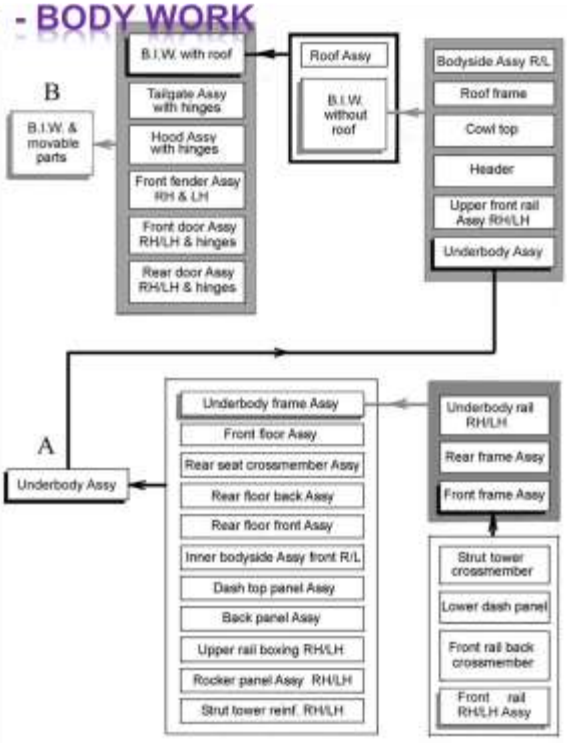
Body in white with movable parts and three dimensional reference system

Many detachable components are fitted to the body, such as the so-called

- ***movable parts*** *(eg. doors, deck lid, lift gate, hood, fuel filler flap and related locks and* hinges),
- **external components** (bumpers, windshield, windows, weather strips, grilles, spoilers, moldings, mirrors, lamps, windshield wipers, lamp wipers) and
- **interior trim** (instrument panel, seats, carpets, trim panels, safety belts, air bags), together constituting the **vehicle body.**

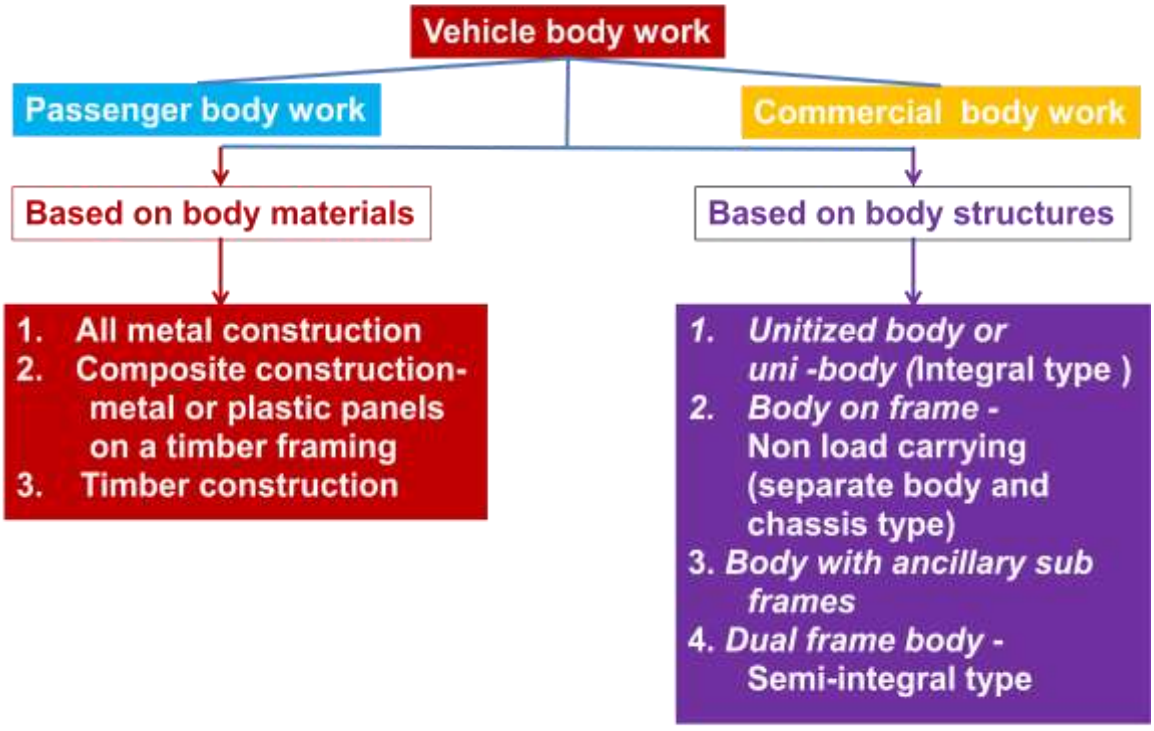
1.0.4. CAR BODY DETAILS - BODY WORK

Split set of bodywork sub-assemblies



A: underbody assembly ;
B: body assy.

1.1.0. CLASSIFICATION OF MOTOR VEHICLE BODY



1.1.0. TYPES OF CAR BODIES

The passenger car is used for transportation of one to seven passengers.
It is also designed for comfort, economy and safety.
Common body and chassis configurations

A) *Unitized body or unibody,* in which the chassis parts cannot be physically removed from the upper body parts.

In this case, (all the unit)**suspensions** and **other mechanical parts** are **directly fitted (using brackets)** to **body frame** which is then directly attached to the **body.**

The **integral** or **frame less construction** in which the structure is designed in such a manner that combines function of **body** and **frame.**
In the more modern uni-body construction used in most cars today, the **integral floor pan** is the main structural element.

The **main advantage** of such solution is **relatively low weight,** while the **main disadvantage** is a **lower dimensional precision** of **suspension attachment**, due to **body tolerance** and the **lower filtering performance** of **suspension fittings**, **reducing** the **insulation** of **vibrations** due to **road-wheel excitation.**

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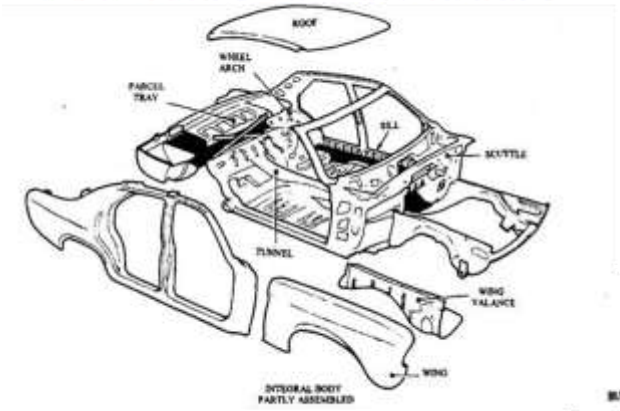
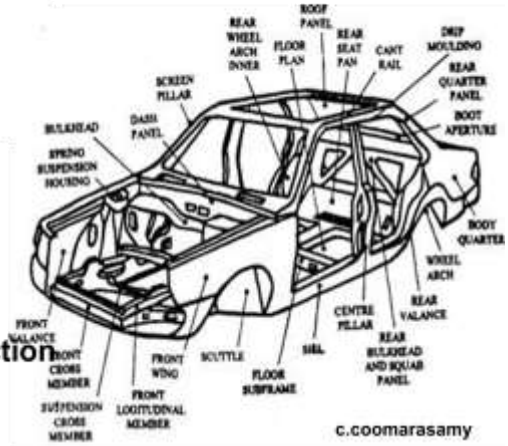
1.1.0. TYPES OF CAR BODIES





Integral body construction

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1.1.0. TYPES OF CAR BODIES

B) *Body on frame,* where the **chassis frame** is connected to **upper body frame** by **bolts**
with or **without** the **inter-position** of **rubber bushes.**

Body-on-frame construction means a vehicle body utilizes
a rigid steel frame **separate** from **the body.**
The ladder-style frame provides the vehicle's strength, and attachment points for the mechanical components.

- Such a solution offers the **main advantage** of allowing the **adoption** of **one chassis** for **different body shapes**, providing **benefits** in terms of **mechanical parts standardization** and **simplification** of the **assembly process** of a **mechanical chassis, before being matched** to **the upper body.**

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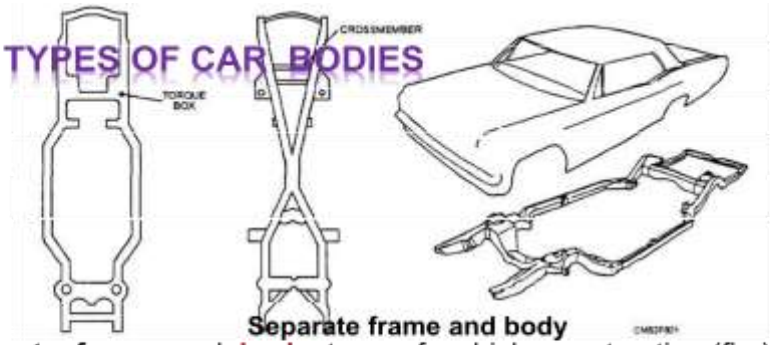
1.1.0. TYPES OF CAR BODIES



Separate frame and body

The **separate frame** and **body** type of vehicle construction (fig.) is the most common technique used when producing most **full-sized** and **cargo vehicles.**
The frame is designed to support the **weight** of the **body** and **absorb** all of the **loads** imposed by the **terrain, suspension system, engine, drive train,** and **steering system,** and the body merely contains and, in some cases, protects the cargo.
The body generally is bolted to the frame at a few points to allow for flexure of the frame and to distribute the loads to the intended load-carrying members.
This kind of solution is an older, less-sophisticated style, remains the foundation for pickup trucks, **cargo vehicles, off-road** and most true **SUVs.** The **main disadvantage** is the **increased weight** with respect to configuration A

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1.1.0. TYPES OF CAR BODIES

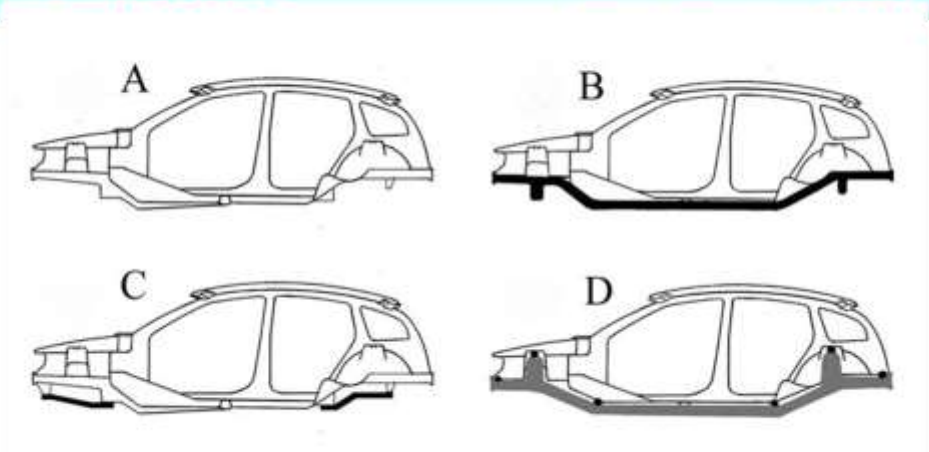
C) *Body with ancillary sub frames,* for **power train** and **suspension systems**; connections between the **sub frame** and the **body** can be either **rigid** or **through elastic bushes.**

- The **main advantages** are **modularity** and the **division** of the **assembly process** between **parallel lines**, enabling **components** to be mounted on the **sub-frames.**
- The **resulting sub-assemblies** can be **tested** before integration with **main body.**
- Moreover, the **relative ease** in which **elastic** and **damping devices** between **sub frame** and **body** can be inserted, provide an **improved insulation** from **noise** and **vibration.**
- Again, the **main disadvantage** is **increased weight,** but to **a lower extent** than configuration B.

1.1.0. TYPES OF CAR BODIES

D) *Dual frame body,* in which **body** and **chassis** are **separate** and connected through **elastic** and **damping bushes.**

- In this configuration, the **structural, safety, propulsion** and **driving functions** are **concentrated** and **optimized** in the **chassis,** with priority to **front** and **rear crash absorption, torsional stiffness** and **resistance to stress** induced through the **suspension** and **power train**

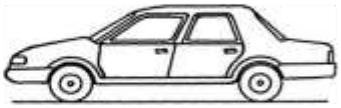


1.1.0. TYPES OF CAR BODY

Saloon car

Cars have now been identified by their **body styles** and **size.**
There are **different types of body styles** available in India

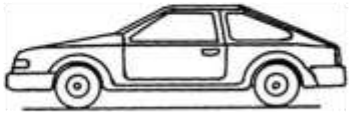
- 1. Saloon or Sedan
- i) Four door saloon
- ii) Two door saloon
- iii) Pillar less saloon
- iv) Hatch back
- v) Fast back
- vi) Notch back
- 2. Convertibles
- 3. Limousine
- 4. Estate car
- 5. Sports Coupe
- 6. Coupe
- 7. Multi-utility vehicle or Multi-purpose vehicle.



Four door saloon

Hatch back

Estate car



Coupe

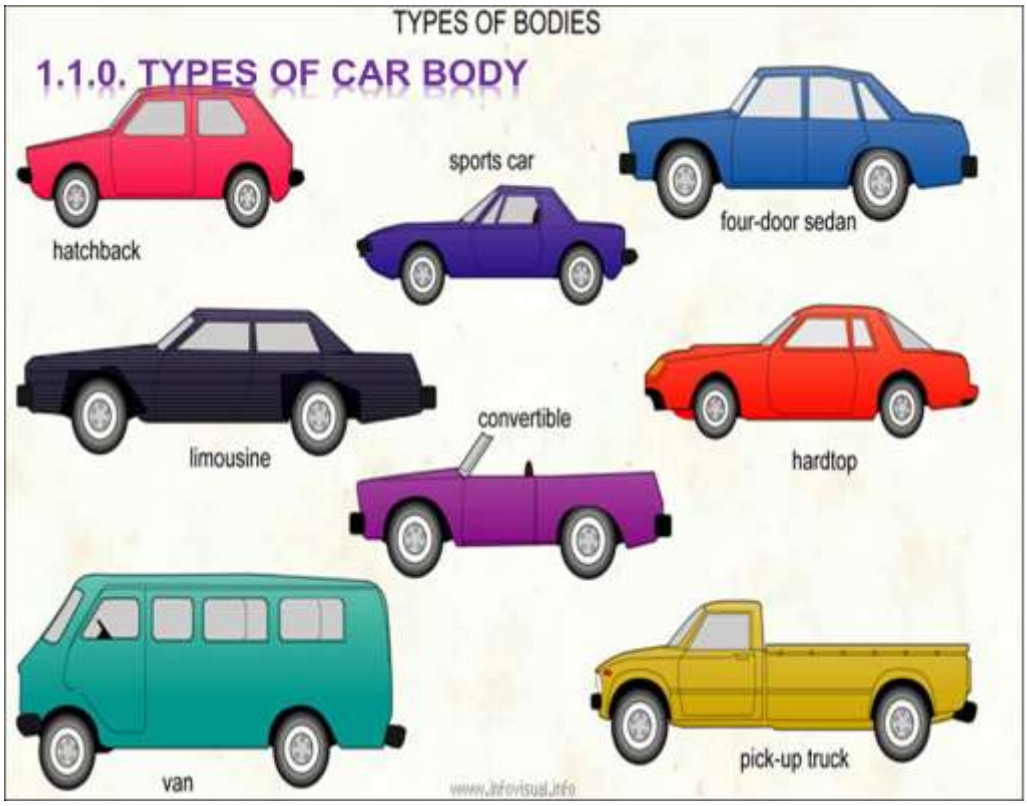
Limousine

1.1.0. TYPES OF CAR BODY

See figure:

Types of bodies: shell forming the exterior of a car.

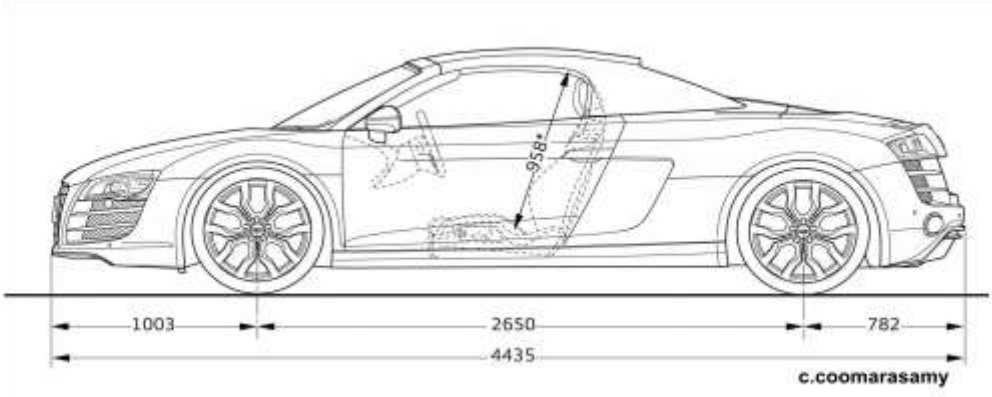
Hatchback: two-door passenger compartment with a door at the back.
Sports car: small, two-seated automobile.
Four-door sedan: passenger compartment with four doors and four side windows.
Limousine: large, six-seated passenger compartment.
Convertible: car with a removable roof.
Hardtop: two-door passenger compartment.
Van: small vehicle used to carry baggage; a small van.
Pick-up truck: a small truck.



1.1.2. CONVERTIBLES

- **Convertibles** have either **two** or **four doors,** come with **flexible operating roof.**
- If the **top is made of strong** or **rigid material as steel,** it is called **retractable hardtop**.
- With the press of a button it can be converted into **coupe** or **convertible.**
- The **collapsible roof section** is usually made from **flexible canvas** or **vinyl** or **an articulated folding frame.**
- Now most of the modern vehicles come with an **electrical retraction mechanism.**
- When the **top is erected** it is secured to the **windshield frame header** with **automatic** or **manual latches**.
- e.g., BMW Z4, Audi R8 Spyder, Porsche Boxster

[Read more: http://www.motortrend.in/autonews.htm#ixzz2Y5AZawOA]



1.1.2. CONVERTIBLES

- **Porsche Boxster** comes in last for visibility, but improves when roof is opened

Roadster :
Roadster is 2-seater lightweight cars **without a permanent top** usually are **sporty convertibles**.
Roadster can also have **more than two seats** with **transferable roof.**

Read more: http://www.motortrend.in/autonews.htm#ixzz2Y5AsDgRW

1.1.3. LIMOUSINE

- The **term now** refers to a
- luxury sedan or saloon car, especially one with a lengthened wheelbase or driven by a chauffeur.
- The chassis of a limousine may have been extended by the manufacturer or by an independent coachbuilder.
- These are called "stretch" limousines and are traditionally black or white.
- Limousines are usually liveried vehicles, driven by professional chauffeurs.
- As the most expensive form of automobile ground transportation, limousines are culturally associated with extreme wealth or power and are commonly cited as examples of conspicuous consumption.
- Among the less wealthy, limousines are often hired during special events (most commonly weddings, proms, and bachelor parties).

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A **limousine** (or **limo**) was **originally** an **"enclosed automobile** with **open driver's seat,"** and was named from the **French *limousine*** (in the Occitan language) that was originally an adjective referring to a **region in central France.**

The **automobile meaning** evolving from a type of **cloak** and **hood** that was worn by the **inhabitants of the Limousine region** that later resembled the **covering** of a **carriage** and much later used to describe an **automobile body** with **a permanent top** that extended over the **open driver's compartment.**

- It is a **luxurious car.**
- A **high roof line** to allow **better head room** for **seating five persons comfortable** behind **the driver.**
- A **high quality equipment** and **finish** and **luxurious interiors,**
- **Cushioned seats,**
- **Air-conditioning system,**
- **Cooling classes, etc.,**
- Also it can provide **partition** between the **driver** and the **rear passengers.**

1.1.3. LIMOUSINE

1.1.4. ESTATE CAR / VAN

- An **estate car** (or **station wagon,** as it is known in America) is very popular with **families who have pets (often dogs).**
- In essence, they are **very similar to a saloon car,** because they have a **large amount of passenger space.**
- However, while a **saloon car** will **have little** or **no cargo space,** an estate car will have a **large boot space** – that can, in most estate cars, be extended into **seats** for **more passengers.**
- The **boot space** on an **estate car** can be accessed by **a fifth door.**
- This door, depending on the model of the car, can either be accessed by **a vertical-lifting door,** or a **simple car door at the rear.**

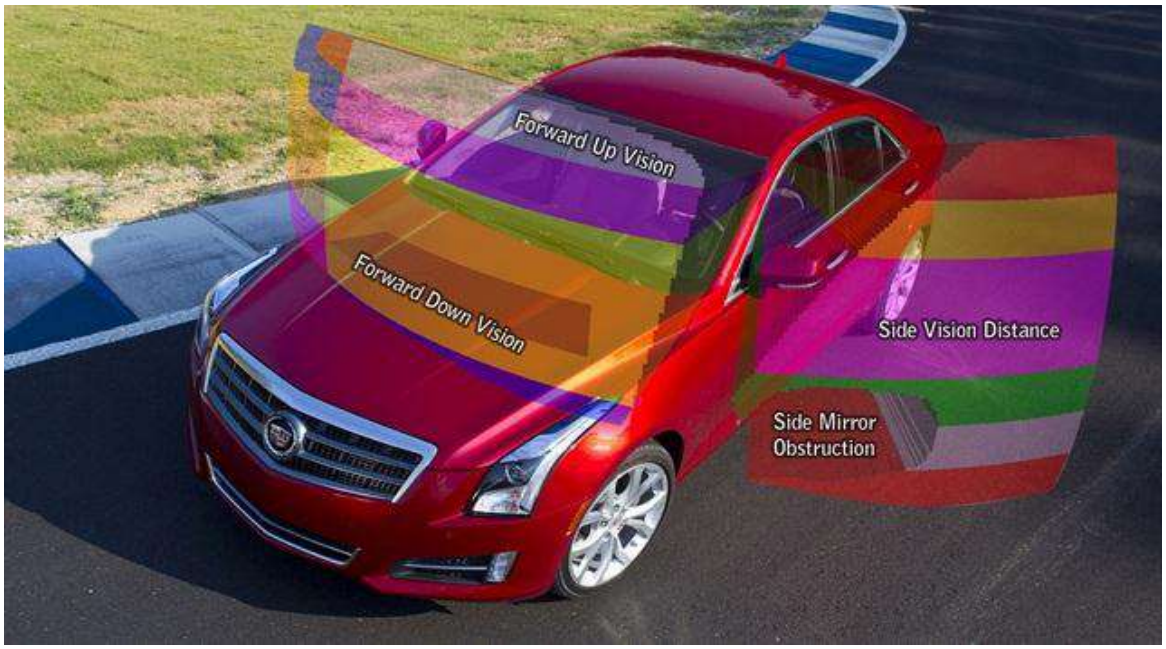
1.1.4. ESTATE CAR / VAN

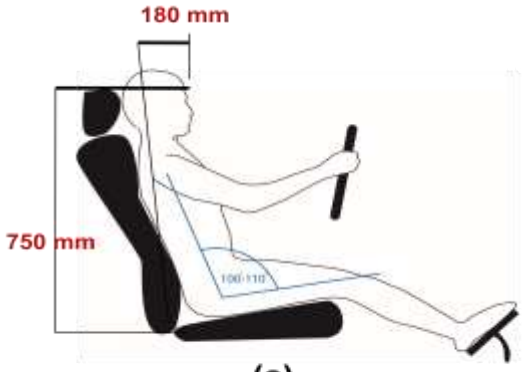
- A **station wagon** (also known as an **estate** or **estate car**) is an automobile with a body style variant of a sedan/saloon with its roof extended rearward over a shared passenger/cargo volume with access at the back via a third or fifth door (the liftgate or tailgate), instead of a trunk lid.
- The **body style** transforms **a standard three-box design** into a **two-box design—**to include an A, B, and C-pillar, as well as a D-pillar.
- Station wagons can **flexibly reconfigure** their **interior volume** via **fold-down rear seats** to **prioritize either passenger or cargo volume.**
- Various other names are **Kombi, camping brake,** etc.,

Examples of estates/station wagons:
Hyundai i40 Tourer
Jaguar XF Sportbrake
Mercedes-Benz CLS Shooting Brake

1.2.0.VISIBILITY

- In **transport, driver visibility** is the **maximum distance** at which the driver of a **vehicle can see** and **identify prominent objects** around the vehicle.
- **Visibility** is primarily determined by **weather conditions** and by a **vehicle's design**.
- The **parts** of a **vehicle** that **influence visibility** include the **windshield,** the **dashboard** and the **pillars.**
- **Good driver visibility** is essential to **safe road traffic.**
- **Good all round visibility** is now **one** of the **main requirements** of the **body design.**
- This clearly depends on the **window opening** and **their position relative to their occupants**.
- Fig. shows the drivers' eye position.



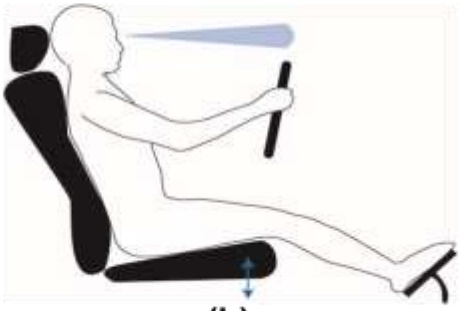


(a)

Eye position of average driver

While most people do actually **adjust** the **angle** of the **seat back** when in the **driver's seat, not many do it properly.** It is **easy** to become to **laid back** or **uptight** in the **driver's seat. Recline** the **back** between **100^0 -110^0.** This angle **supports your upper body** while maintaining and **upright** and **attentive posture** . (Fig. a)

Raise the **seat** so that you have a **good view** out the **windshield, but not so high** that your **legs** will **interfere** with the **steering wheel.** You may need to **re-adjust** **<u>your leg room</u>**. (Fig. b)



(b) c.coomarasamy

1.2.1.VISIBILITY REGULATIONS

Key human factor issues

- **spatial arrangement** of driver's/ passenger's seats,
- **reachability of the occupants** towards various controls (gear, accelerator, clutch, break , various knobs and switches etc.)
- **force requirement** for operating controls
- **comfort/ discomfort during driving** or for sitting for long duration
- **visualization of displays/dials** or controls inside vehicle
- **visibility towards road ahead** or **vision through rear view mirrors**
- **various clearance dimensions** (leg room, head room, lateral clearance etc.)
- **environmental conditions** (noise level, temperature, humidity etc.) and so on.

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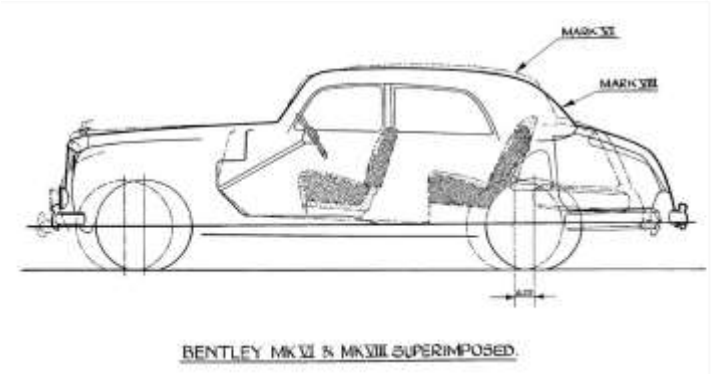
1.2.1. VISIBILITY REGULATIONS

- Presently, vehicle manufacturers follow various standard recommended dimensions for their design.
- **Standards provided by Society of Automotive Engineers (SAE Standards) are widely followed.**
- In the present module, one case study of ergonomic evaluation of a vehicle workstation with an individual on driver seat has been depicted to provide an idea how vehicle workstation can be evaluated for various human factor issues.



BENTLEY MK VI & MK VIII SUPERIMPOSED.

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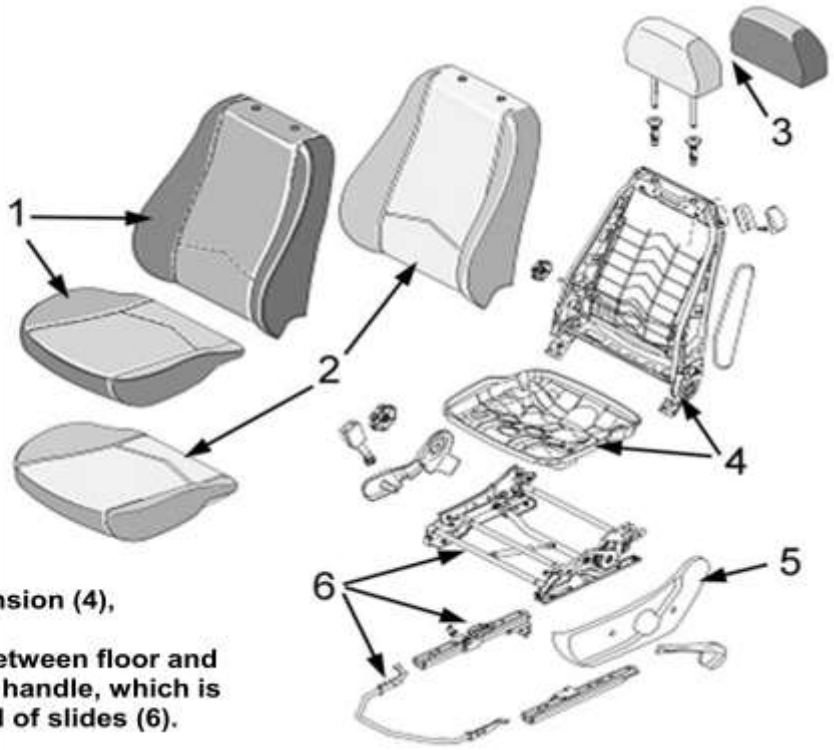
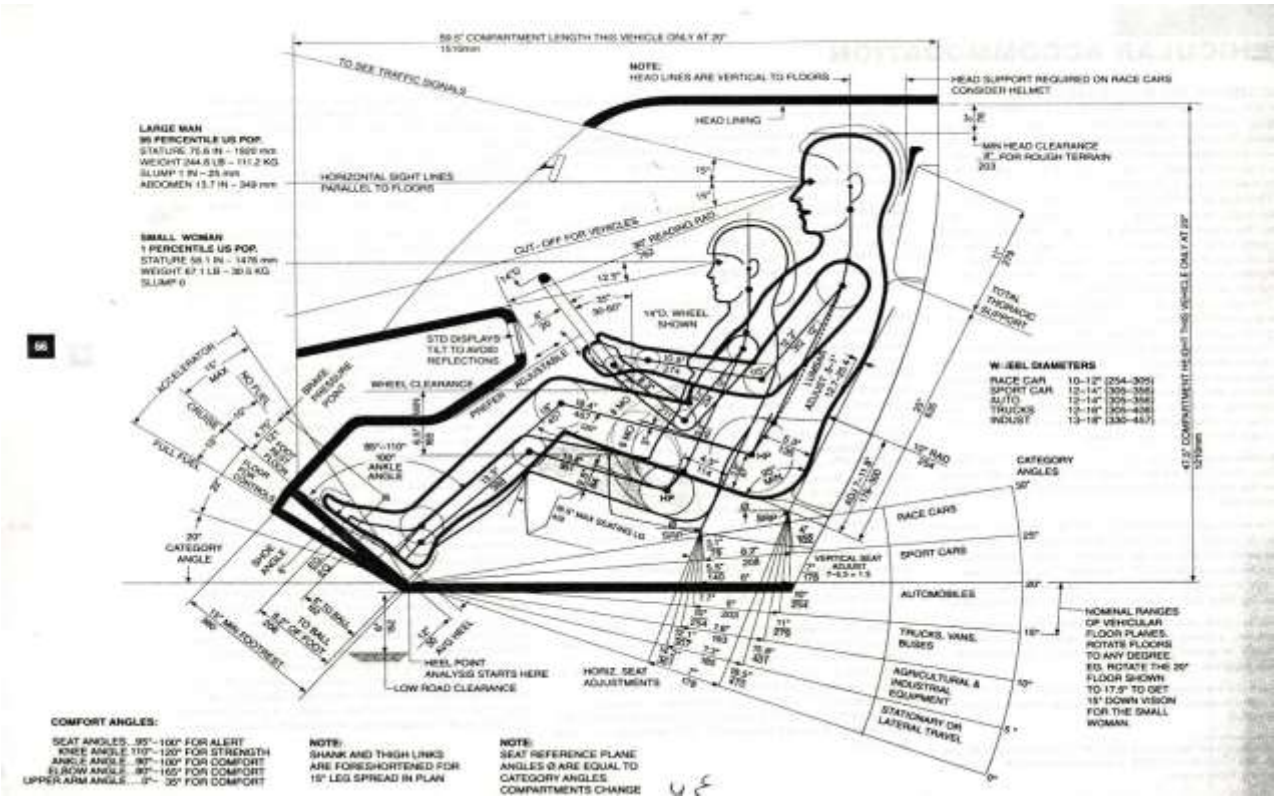
SEAT



Seat Components
covers (1),
foams (2),
headrest (3),
structure and suspension (4),
plastic trim (5),
interface structure between floor and mechanisms, slides, handle, which is the activation control of slides (6).

- A correct driving position is important in the vehicle layout, and the seating position in relation to the steering wheel, foot controls and other secondary controls is of fundamental importance in body design.
- Seating position has an influence not only on the driver's comfort but also on the road safety.
- At the design stage a celluloid model is most often used.
- The driver's seat should be adjustable- 45 mm horizontally and 30 mm vertically.

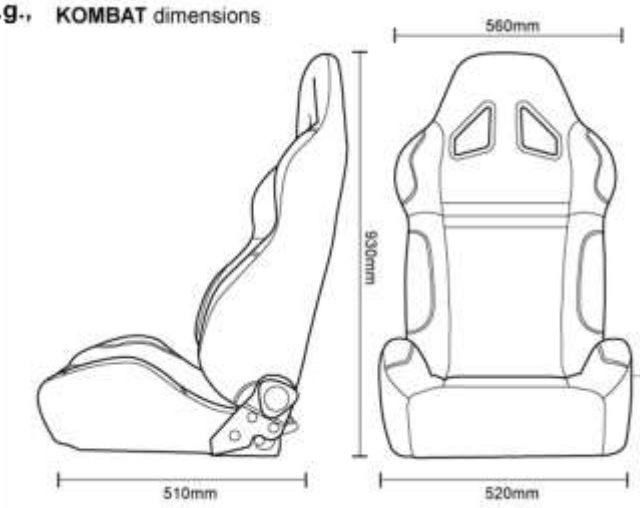
1. Sit upright and well back in the seat.
2. Adjust the position of the seat forward or backward to ensure the pedals can be reached and easily depressed to the extent required.
3. Adjust the seatback so that the controls are easily operable.
4. Adjust the tilt and telescopic positions of the steering wheel downward so the airbag is facing your chest.
5. Lock the head restraint in place with the center of the head restraint closest to the top of your ears.
6. Wear the seat belt correctly.



Geometrical relations of driver's seat

Class of vehicle	Cushion height above floor	Angle of cushion inclination	Angle of backrest inclination	Max. force on the pedals
	h (mm)	o	o	(kg)
Saloon	300-340	12	100	66
Light commercial	340-380	10	98	70
Normal control truck	400-470	9	96	74
Forward control truck	430-500	7	92	82

e.g., **KOMBAT** dimensions



All SAAS seats have been tested to meet ADR 3/02 - Seats and Seat Anchorages 2005

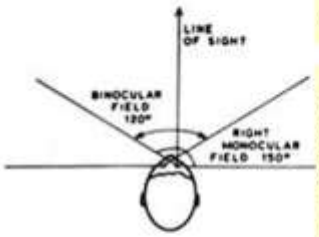
1. ADR 3/02 5.5.1.1 & 5.5.2 Seat and Seat Anchorages Longitudinal 20 "g" Test
2. ADR 3/02 5.5.3 Seat Rearward Backrest Test
3. ADR 3/02 6.4 Seat Energy Dissipation Test
4. ADR 22/00 Head Restraints Test

*A.D.R certificate is available upon request.

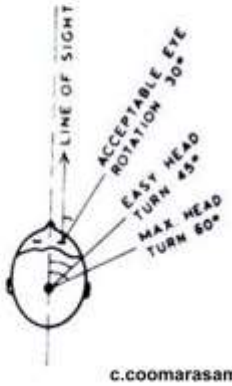
1.2.2. DRIVER'S VISIBILITY

- **Limits of Visual Field:**
  Driver **can turn both eyes** and **head** to gain **a wider field** of **view,** and moreover can make use of **peripheral vision to see objects** or **movements** even **without turning eyes.**
  In the **horizontal plane,** the **binocular field of view extends some 120 degrees,** as in figure given below .

Vision is **sharp only** over **a fairly small area directly ahead**. So, eyes need to be turned to focus on objects outside the foveal (central vision) area.



According to SAE J985 eyes generally **only turn** by **about 30 degrees before** the **head** is **turned**, which can comfortably give a **further 45 degrees view** to **either side.**



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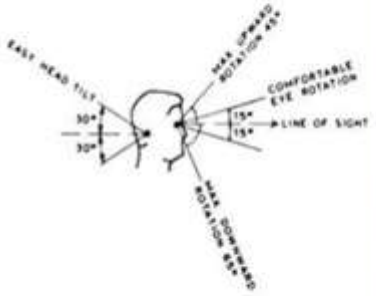
1.2.2. DRIVER'S VISIBILITY

- In the **vertical plane eye movement** (fig.) is comfortable **within 15 degrees above** or **below the horizontal,** although the eye **can see up to 45 degrees upward** or **65 degrees downward** if necessary.



On the other hand, head can **easily incline 30 degrees upward** or **downward.**
Thus, **by movement** of **head** and **eye,** the **driver** can have **extended direct field view.**
The driver has to concentrate **on direct view**, that is **on road.**
So **glancing away** from the **road** for a **short period** is **possible.**
Mirror and **other instruments** should be **close** to the **driver,**
so that **driver does not require** a much **head** and **eye turn** to have a look.

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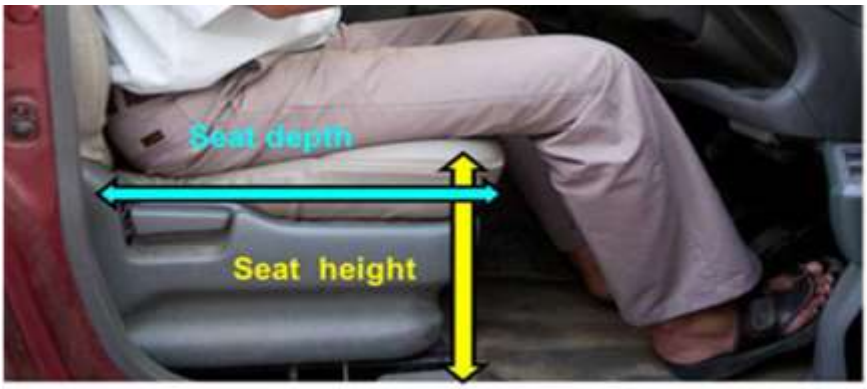


Sitting Accommodation:

All the seat dimensions (seat cushion depth, width and height, backrest with and height; head rest dimensions) should be acceptable.

More over due to various adjustable features of the seat one can adjust backrest angle/position of headrest, position of seat etc. as per his/ her requirement

VISIBILITY REGULATIONS

Sitting and Driving Comfort:

Adopted driving posture by the individual should show that angles at various body joints are in comfort range as defined by Porter and Gyi (1998).

Clearance Dimensions:

• Headroom:

The headroom for the vehicle should be sufficient for uses to avoid head striking with roof during jolts/ jerks.

VISIBILITY REGULATIONS

• Leg room:
The legroom for the vehicle should be sufficient for users for normal pedal operation.

There is no collision between:
• Seat front edge with popliteal area (behind knee) of lower leg,
• Thigh/knee with steering wheel/dashboard

VISIBILITY REGULATIONS

Lateral Clearance:
Observation:
Left side and right side lateral clearance for the driver seat should be sufficient.

SAE specifies that if the optical center of the headlamp, or optical center height (OCH), is less than 90 cm (36 inches) above the roadway surface, then the reference point should be at the same height as the optical center. If the optical center is more than 90 cm (36 inches) above the roadway surface, the reference point should be 5 cm (2 inches) below the headlamp optical center. These reference points were adjusted for the greater alignment distance.[10] Figure 6 shows a comparison between the 7.6-m (25-ft) and 10.7-m (35-ft) alignment distances. The units, a mix of English and the International System of Units, are prescribed by the SAE guidelines.

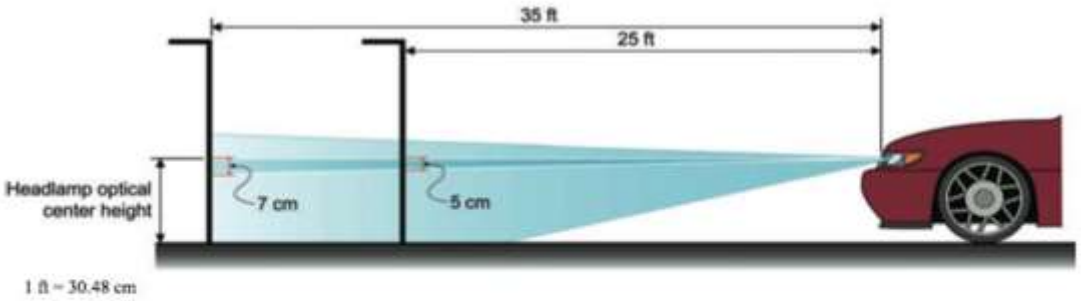
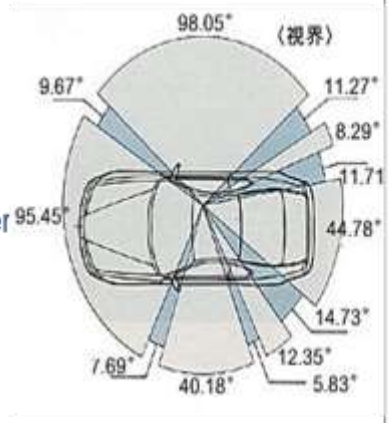


Figure 6. Diagram. Comparison of vertical reference point for 25-ft and 35-ft headlamp alignment distances.

1.2.2. DRIVER'S VISIBILITY

- During **automobile design,** **care** should be **taken** to **provide maximum view all around** either through **direct vision** or with **the help of devices** like **mirror** or **camera.**
- It is also **important** to **ensure minimum visual obstruction** either by **vehicle components** or by **driver's own body parts.**
- This is **particularly important** for **allowing unobstructed view** of the **displays** on the **dash board.**

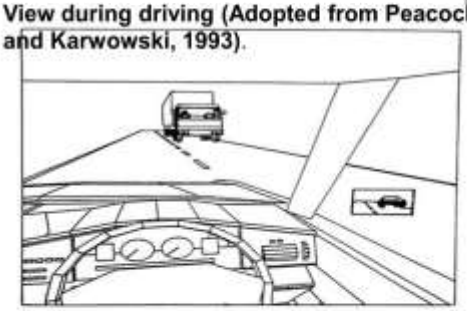
Visibility diagram for a 1991-era Honda Prelude:



VISIBILITY

- On the **road**
  driver need much longer view
  to **anticipate** and **prepare** for **avoiding actions**.
- **Views close** to the **vehicle** is **equally important**
  when turning left or right and
  maintain proper distance to **avoid accidents.**
- Fig. shows the **view inside the vehicle**,
  forward and
  side views through glasses and
  rear view through mirror.

View during driving (Adopted from Peacock and Karwowski, 1993).



Design Course on
Basic Ergonomics in Automotive design
The Fundamentals of Human-System Interactions

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VISIBILITY

- • **Indirect View:**
  The **views to the rear of the vehicle** mainly obtained through the **mirrors** .
- **This view provides information on passing vehicle**,
  vehicle close to the rear when
  the driver proposing to change the lane.
- **The reflected view of mirror** can be represented in the same way as in **direct view with the viewing angles.**
- The **view of image is bounded by the frame of mirror.**
- The **image boundaries can be determined by the mirror dimensions, locations of the mirror with respect to driver's eye and optical characteristic of mirror.**
- By **adjusting the mirror the field of view of rear can be adjusted**.

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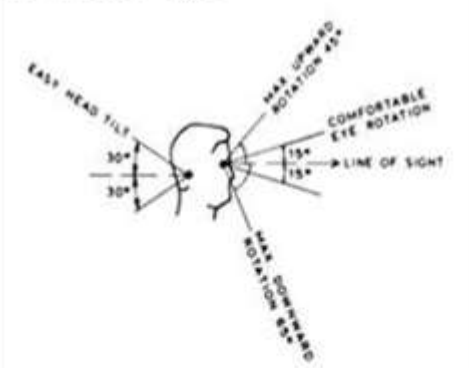
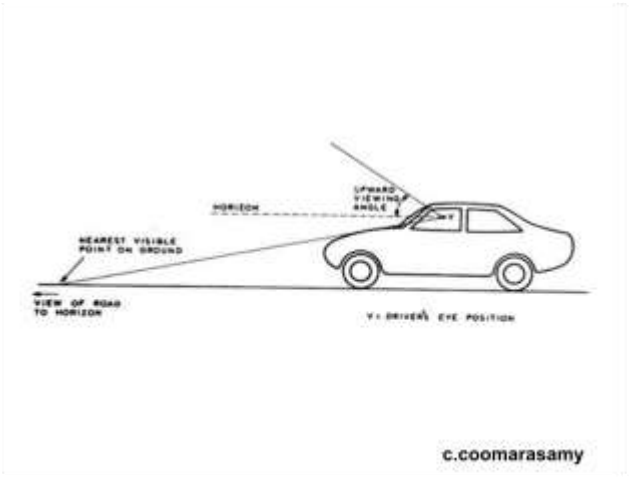
The downwards view can be considered for road. Height of the dashboard and curvature of the bonnet are the two determining factor for downward view through front windshield.

Upper edge of the dashboard should be **at least 15 degree below** that **horizontal eye line of driver** with smallest (5th percentile) sitting eye height.

The far distance view is based on the horizon, the sightline passing through the driver's eye.





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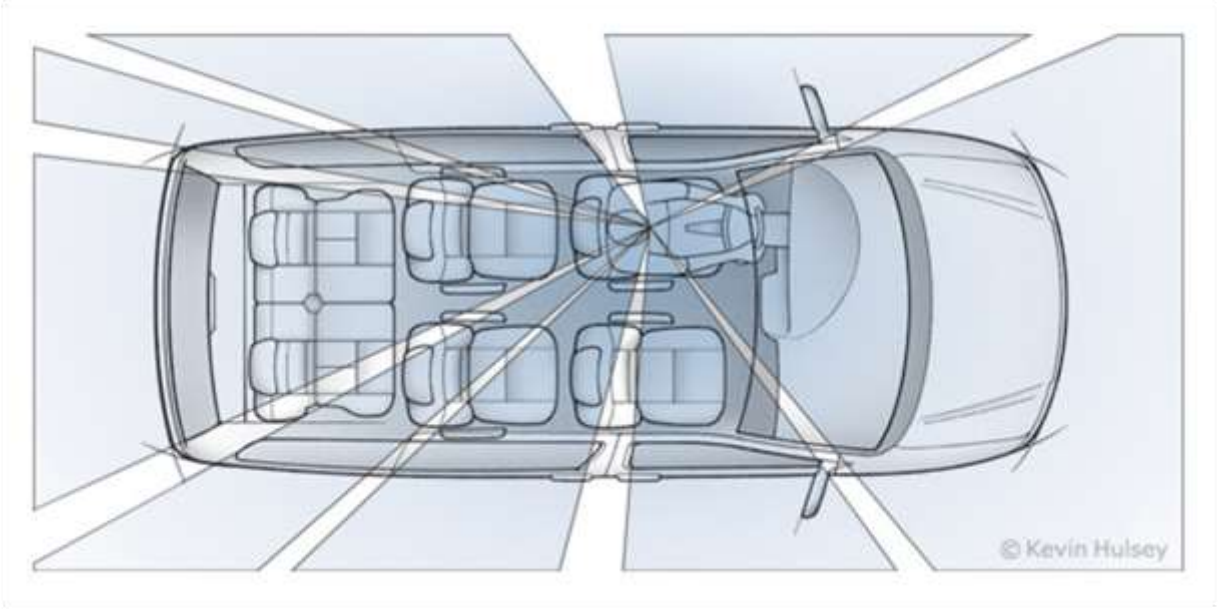
VISIBILITY

- This diagram shows a minivan's full range of driver visibility and door pillar blind spots in a 360 degree radius.



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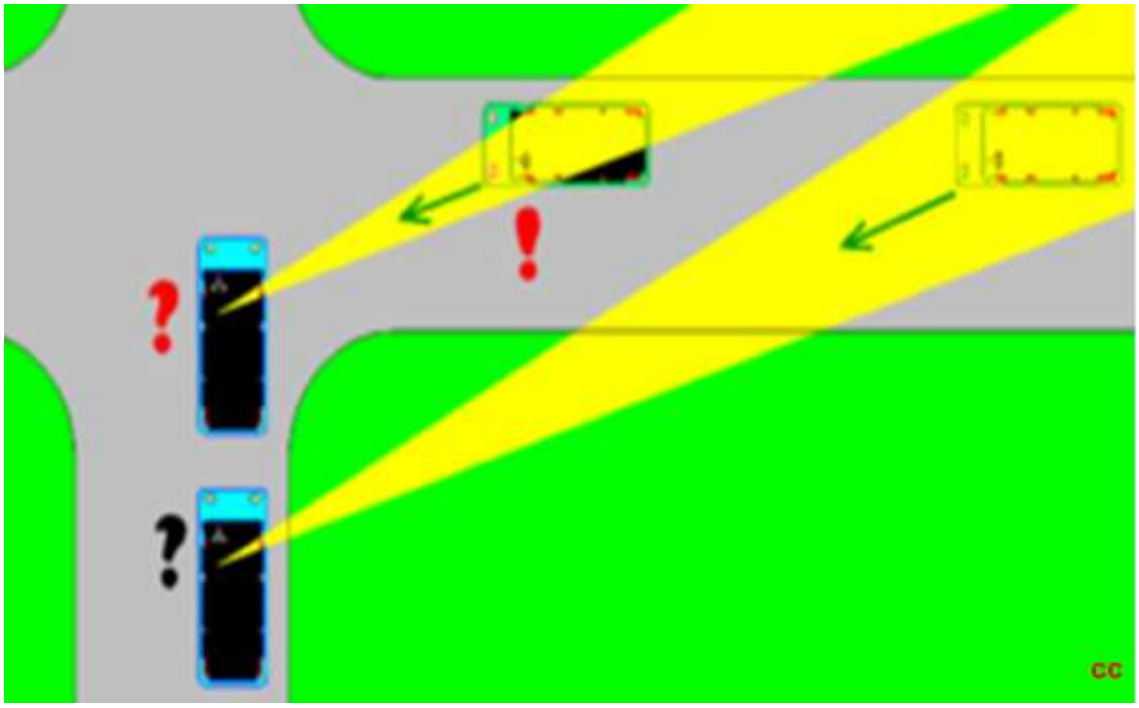
FORWARD VISIBILITY

- This diagram shows the **blocked view in a horizontal-plane in front of the driver.**
- **The front-end blind spots** caused by this can **create problems** in traffic situations, such as in **roundabouts**, **intersections**, and **road crossings**.
- **Front-end blind spots** are **influenced by the following design criteria:**
- **Distance between** the **driver** and the **pillar**
- **Thickness** of the **pillar**
- **The angle** of the **pillar** in a **vertical plane side view**
- **The angle** of the **pillar** in a **vertical plane front view**
- the **form** of the **pillar straight** or **arc-form**
- **Angle** of the **windshield**
- **Height** of the **driver** in relation to the **dashboard**
- **Speed** of the **opposite car**

cc



As cars get safer and stronger, our view of the road seems to be getting worse.
Vehicle blind spots account for around 1% of all road accidents, and around 25 deaths a year.
So does being well-protected in a crash have to come at the expense of being able to see cyclists, pedestrians and other road users properly?

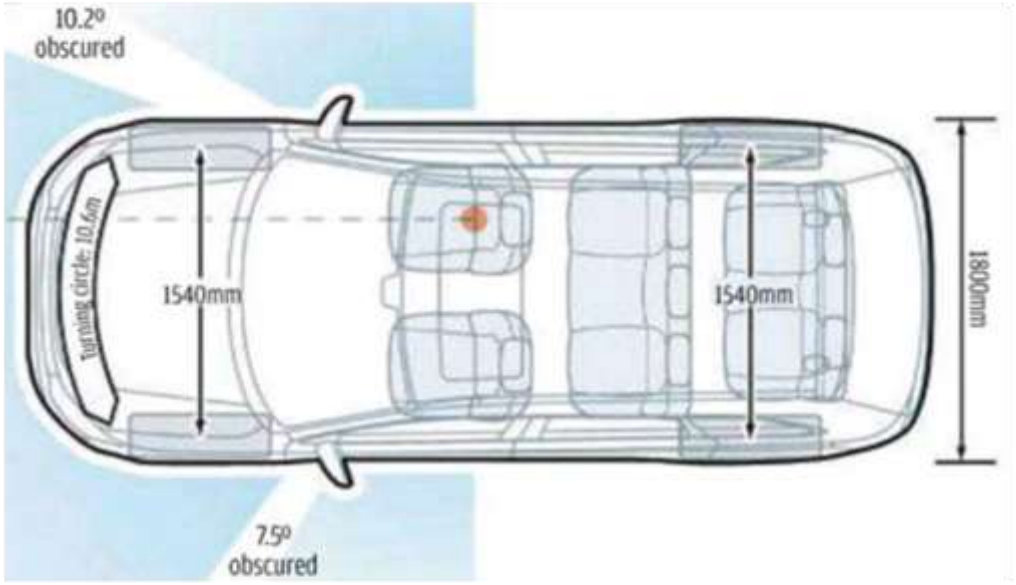
Small windows and a wide C pillar create a large blind spot in the 2009 Astra

- View from the driver's seat
- Today's cars are a lot safer in a crash than they were 20 years ago, but a common complaint with modern cars is that visibility has suffered as a result.
- Windscreen and door pillars have become far bigger, while today's car stylists also seem to favour designs that restrict visibility.
- It's not only the view forward that's suffering.
- All-round visibility is generally worse.
- This makes manoeuvring difficult, and it's also detrimental to your rear three-quarter view, which is crucial for changing lanes, pulling away from a standstill and emerging from acute junctions. cc
-

Visibility test
Which cars allow you a perfect view? and which are a pain to park?
visibility testing of every vehicle is done from the driver's seat using hi-tech equipment.
Every car that passes test Lab is assessed in a specially designed visibility rig, using lasers, digital cameras and sophisticated computer software to rate visibility from the driver's eye position.

- By fixing a camera at a typical driver's head height, using a fixture in the front seat, we can pan a full 360 degrees around the car's interior, logging how much of the view is clear window and how much is obstructive – including the pillars, roof and headrests.
- a 'line of sight' test is also carried out to work out whether you can see any low bollards, pets or other hazards while parking – this is affectionately known as the 'sausage dog' test.
- Aspects such as the view in the mirrors, the size of the swept area of the windscreen, headlight beam pattern, reversing sensors and windscreen reflections all go towards our overall visibility score. cc

VISIBILITY TEST- MITSUBISHI'S *OUTLANDER*



Front: **Driver's pillar** is the main issue because **the cabin is tighter than the class norm.** Otherwise**, visibility is good.**
Headlights: Lateral spread of light is good on standard xenons, which also self-level when towing.

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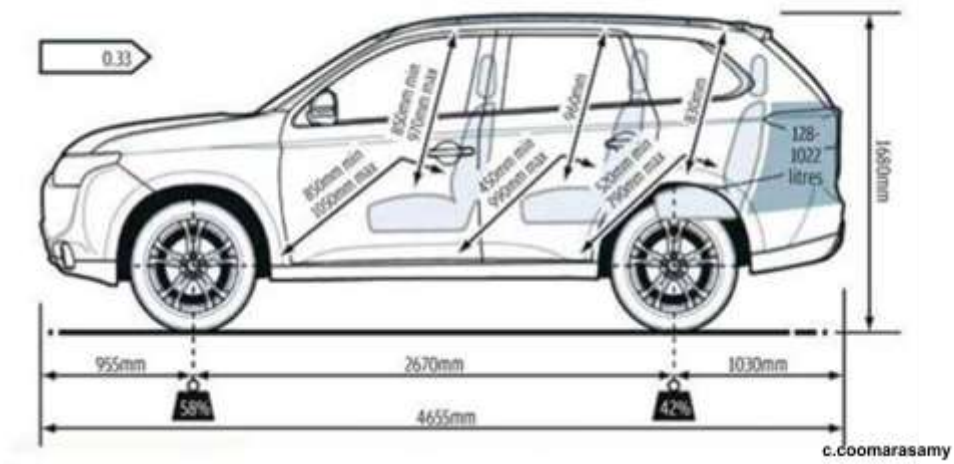
VISIBILITY-BLIND SPOTS

- A **blind spot** in a **vehicle** is **an area around** the **vehicle** that **cannot be directly observed** by the **driver** while at the controls, under existing circumstances.
- **Blind spots** exist in a wide range of vehicles: cars, trucks, motorboats and aircraft.



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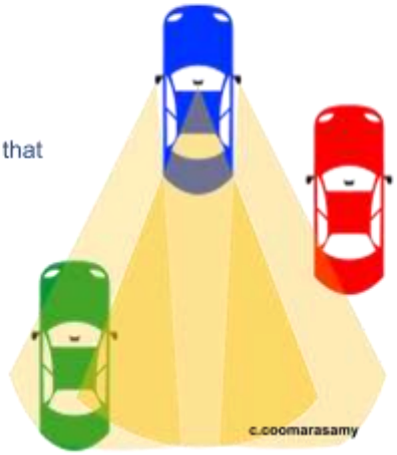
VISIBILITY-BLIND SPOTS

- **Blind spots** may occur in the **front of the driver** when the **A-pillar** (also called the windshield pillar), **side-view mirror**, and **interior rear-view mirror** block a driver's view of the road.
- Behind the driver, there are **additional pillars**, **headrests**, **passengers**, and **cargo**, that **may reduce visibility.**
- **Motor vehicles**
- The **blue car's** driver sees the **green car** through his mirrors **but cannot see** the **red car** without turning to check his **blind spot**.



SAFETY

- **Active and passive safety**
- The terms **"active"** and **"passive"** are simple but important terms in the world of automotive safety.
- **"Active safety"** is used to refer to technology assisting in the prevention of a crash and **"passive safety"** to components of the vehicle (primarily airbags, seatbelts and the physical structure of the vehicle) that **help to protect occupants** during **a crash.**

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ACTIVE SYSTEMS

- **Active safety systems are operating all the time i.e. they are not waiting for an accident to occur.**
- **Antilock brakes –** Electronically controlled system to prevent the wheels from locking and skidding when the brakes are applied. This helps the driver maintain control when braking.
- **Aerodynamic stability –** A stable car is less likely to go out of control
- **Dual circuit brakes –** Standard on all modern cars, if one brake pipe bursts, the brakes will still work on at least two wheels.
- **Comfortable driving position –** The driver is more likely to be able to react to potential trouble.
- **Safety glass –** Toughened glass shatters on impact into small road granules which do not cause cuts, but vision is impaired. Modern laminated glass resists heavy impacts without shattering and vision remains good
- **Good ventilation –** Helps to keep the driver awake and alert.
- **Efficient bad weather equipment –** Good lights and good windscreen wipers, to name just two parts, ensure the driver can see and be seen.

PASSIVE SAFETY SYSTEMS

- **Passive safety systems start operating in the event of an accident.**
- **Air Bags –** In the event of an accident these bags 'explode' onto position to cushion the driver and passenger.
- Antiburst door locks – These door locks prevent the doors from flying open.
- Collapsible steering column – used to try prevent chest injuries to the driver, the steering column collapses and is pulled down away from the driver in the event of a front end collision.
- **Crumple zones –** When an impact occurs, the movement energy has to be dispersed. If this is passed through to the passengers, then serious injury will result. Crumple zones absorb as much of the energy as possible, reducing the risk to the occupants.
- **Padded steering wheel –** helps to reduce injury to the drivers chest.
- **Rollover cage –** In the event of the vehicle rolling over, a cage prevents the cabin from collapsing.
- **Seat belt tensioners –** Pull the seat belt tighter at the instant of impact.
- **Side impact bars –** Bars in the door which strengthen the side of the vehicle

SAFETY

- **Crash avoidance**
- **Crash avoidance systems** and **devices help the driver** — and, **increasingly, help the vehicle itself** — **to avoid a collision.**

This category includes:

- The vehicle's **headlamps**, **reflectors**, and other **lights and signals**
- The vehicle's **mirrors**
- The vehicle's **brakes**, **steering**, and **suspension** systems

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SAFETY

- **Safety equipments for cars:**
- **Bumper design:** The bumper should be designed to absorb more energy.
- **Ignition switch** should be connected with door lock that ignition can be switched ,only when all four doors are perfectly locked.
- **Airbag** and **Safety bags** have to be used.
- **Heelomatic flash or Horn.**
- **Collapsible steering.**
- **Heat toughened glass.**

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DRIVER ASSISTANCE

- A subset of crash avoidance is **driver assistance systems**, which help the driver to detect obstacles and to control the vehicle.

Driver assistance systems include:

- **Automatic Braking** systems to prevent or reduce the severity of collision.
- **Infrared night vision** systems to increase seeing distance beyond headlamp range
- **Adaptive headlamps** control the direction and range of the headlight beams to light the driver's way through curves and maximize seeing distance without partially blinding other drivers
- **Reverse backup sensors**, which alert drivers to difficult-to-see objects in their path when reversing
- **Backup camera**

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- **Adaptive cruise control** which maintains a safe distance from the vehicle in front
- **Lane departure warning systems** to alert the driver of an unintended departure from the intended lane of travel
- **Tire pressure monitoring** systems or **Deflation Detection Systems**
- **Traction control systems** which restore traction if driven wheels begin to spin
- **Electronic Stability Control**, which intervenes to avert an impending loss of control
- **Anti-lock braking systems**
- **Electronic brakeforce distribution** systems
- **Emergency brake assist systems**
- **Cornering Brake Control** systems
- **Precrash system**
- **Automated parking** system

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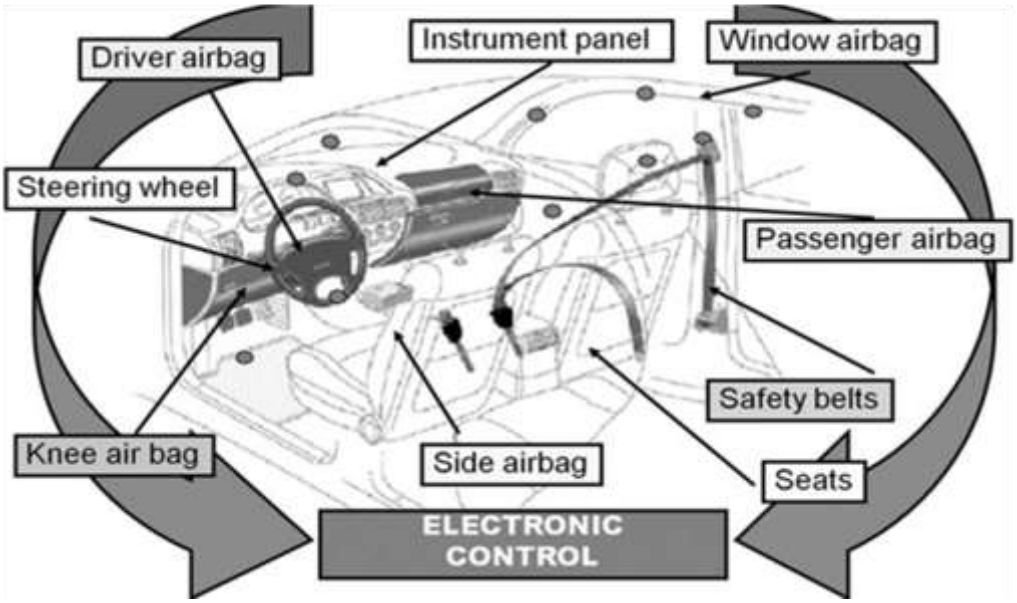
CAR PASSIVE SYSTEM



CRASHWORTHINESS

- **Crashworthy systems** and **devices** **prevent or reduce** the **severity of injuries** when **a crash is imminent** or **actually happening.**
  Much research is carried out using **anthropomorphic crash test dummies.**

- **Seatbelts** limit the **forward motion of an occupant, stretch to absorb energy, to lengthen the time of the occupant's deceleration in a crash, reducing the loading on the occupants body.**

They **prevent occupants being ejected from the vehicle** and **ensure that they are in the correct position** for the **operation of the airbags.**

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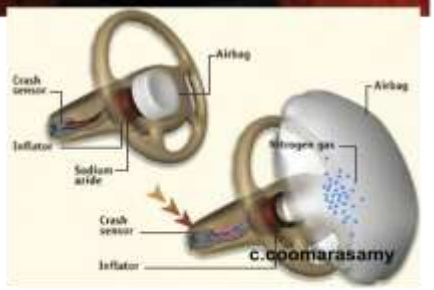
CRASHWORTHINESS

Airbags inflate to cushion the impact of a vehicle occupant with various parts of the vehicle's interior.
The most important being **the prevention of direct impact** of the driver's head with **the steering wheel and door pillar.**


Ferrari F430 steering wheel with airbag


Drivers Side Air Bag



Air Bag in Steering Column

Exploded view of a driver air-bag

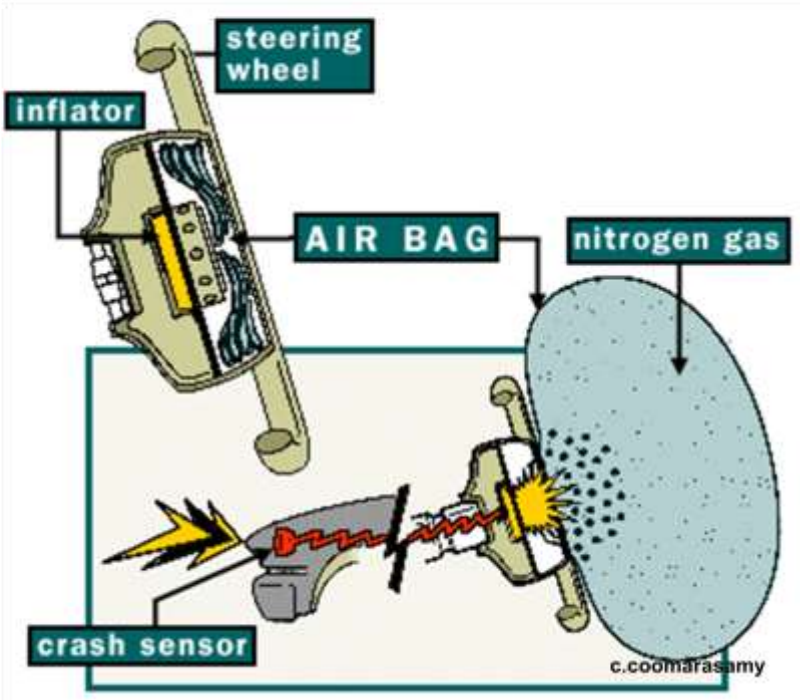
CRASHWORTHINESS

Airbags

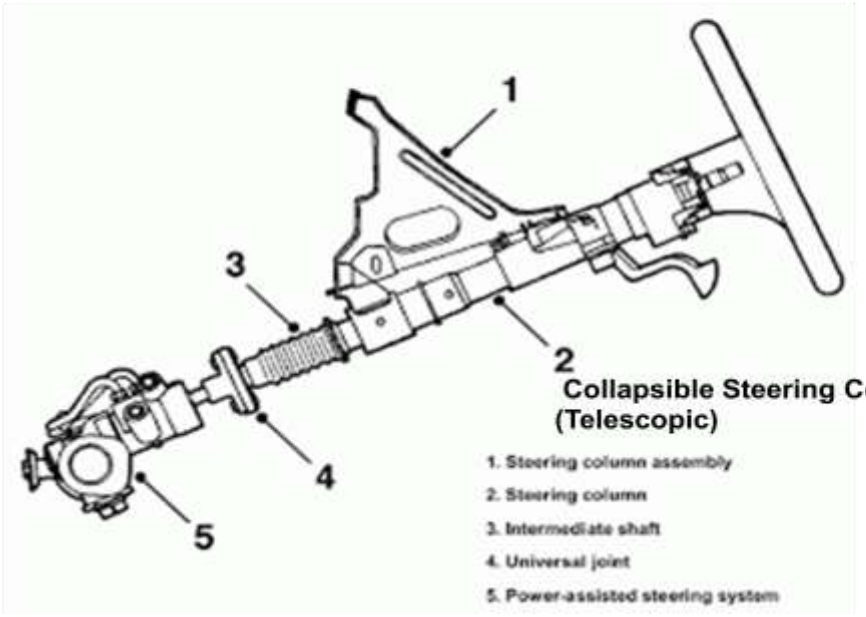
An **airbag** is a vehicle safety device.

It is an occupant restraint consisting of a flexible envelope designed to inflate rapidly in an automobile collision,

to **prevent vehicle occupants** from **striking interior objects** such as the **steering wheel** or **window.**



SAFETY



Collapsible Steering Column (Telescopic)

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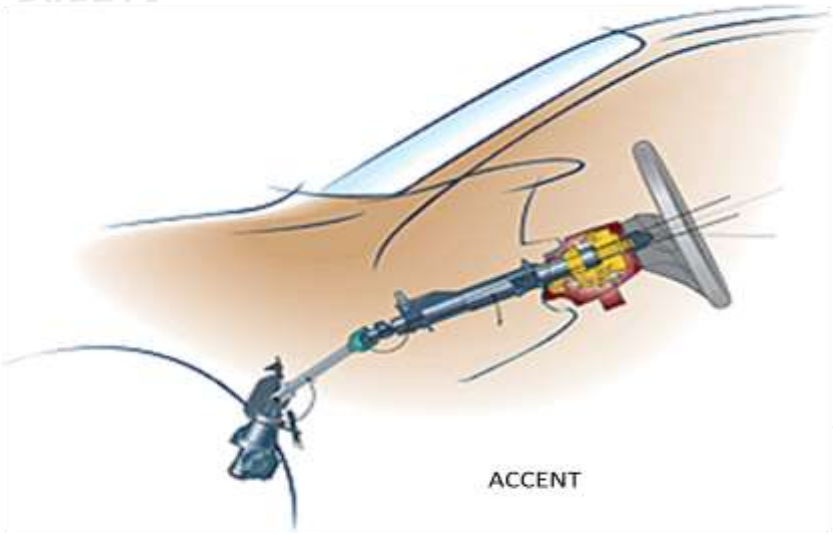
SAFETY



The steering column is fully collapsible and minimizes risk of chest injuries in the event of a frontal impact .

Safety
Collapsible Steering Column

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Laminated windshields remain in one piece when impacted, preventing penetration of unbelted occupants' heads and maintaining a minimal but adequate transparency for control of the car immediately following a collision. It is also a bonded structural part of the safety cell.

Tempered glass side and rear windows break into granules with minimally sharp edges, rather than splintering into jagged fragments as ordinary glass does.

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- Crumple zones absorb and dissipate the force of a collision, displacing and diverting it away from the passenger compartment and reducing the deceleration impact force on the vehicle occupants.
- Vehicles will include a front, rear and maybe side crumple zones (like Volvo SIPS) too.
- Safety Cell - the passenger compartment is reinforced with high strength materials, at places subject high loads in a crash, in order to maintain a survival space for the vehicle occupants.
- Side impact protection beams, also called anti-intrusion bars.
- Collapsible universally jointed steering columns, along with steering wheel airbag.
- The steering system is mounted behind the front axle - behind and protected by, the front crumple zone. This reduces the risk and severity of driver impact or even impalement on the column in a frontal crash.

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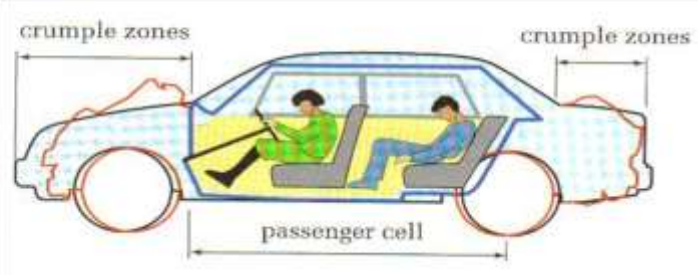
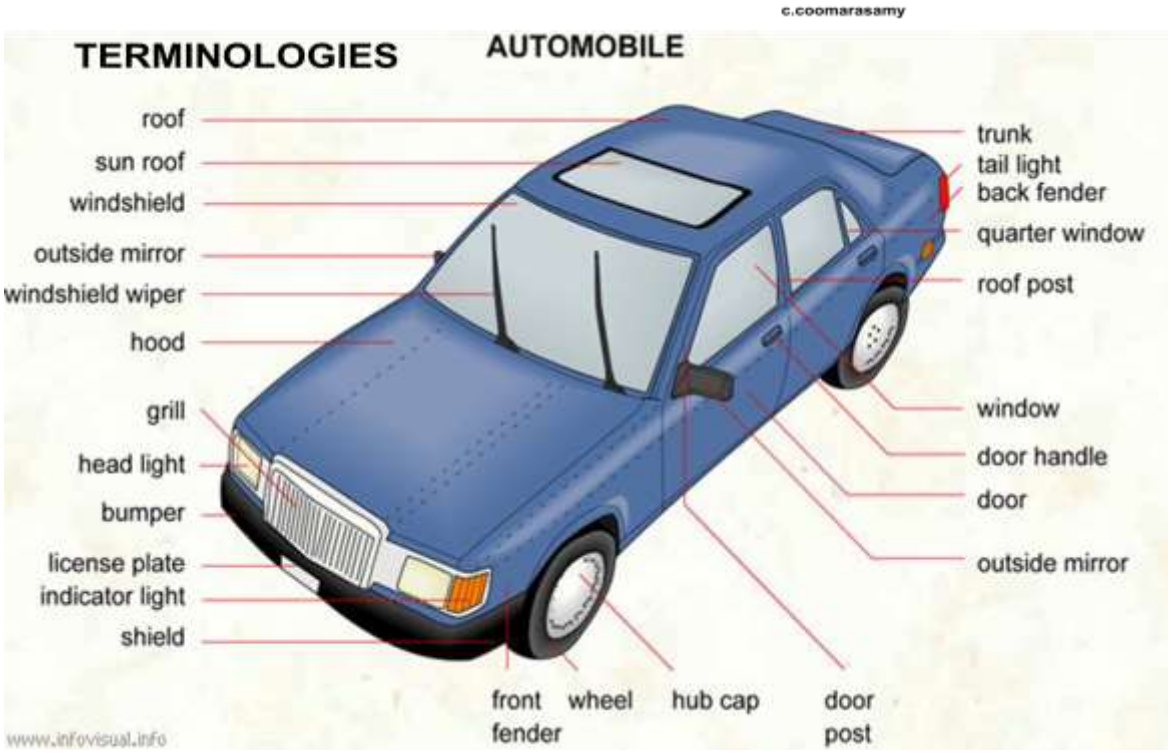


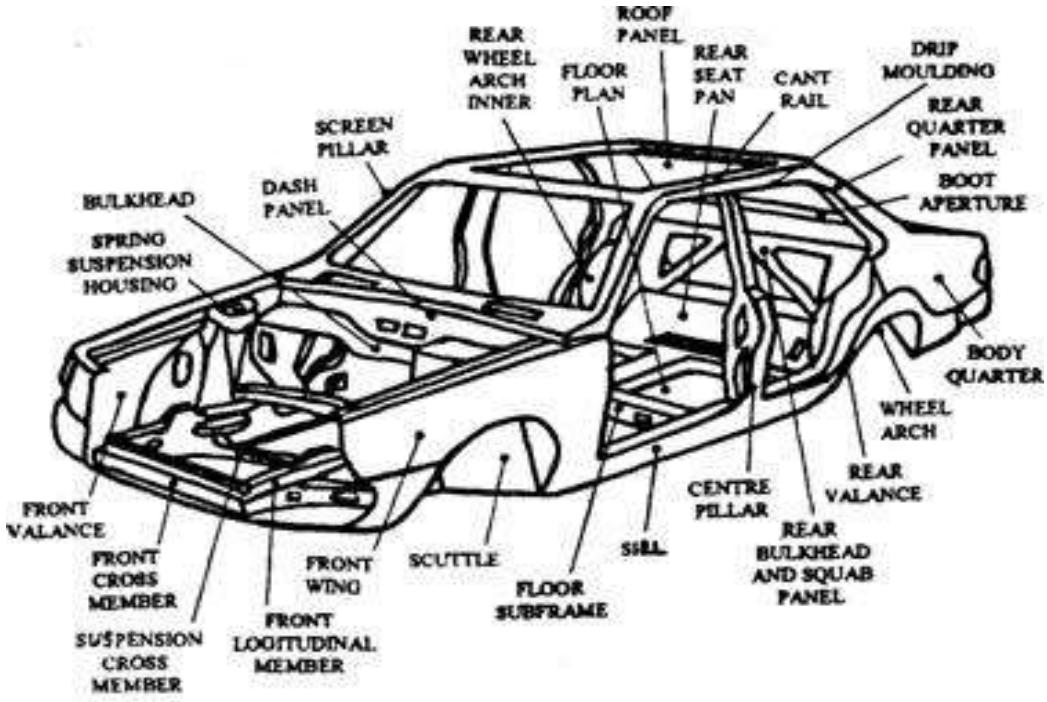
- Pedestrian protection systems.
- Padding of the instrument panel and other interior parts, on the vehicle in areas likely to be struck by the occupants during a crash, and the careful placement of mounting brackets away from those areas.
- Cargo barriers are sometimes fitted to provide a physical barrier between passenger and cargo compartments in vehicles such as SUVs, station wagons and vans.
- These help prevent injuries caused by occupants being struck by unsecured cargo.
- They can also help prevent collapse of the roof in the event of a vehicle rollover.

TERMINOLOGY

- **Chassis** – The basic frame for a motor vehicle
- **A Post** - The post on which the front door hinges are fixed.
- **Body mounting** – Fittings for mounting the body to the chassis for older type cars or heavier vehicles.
- **Composite construction** - The chassis and body of the vehicle are built as two separate units,
- **Integral construction** – Most modern light vehicles use this method, also called mono or unity construction. The body and chassis are combined.
- **Car derived van** – A van which is based on a similar car.
- **Body panels** – Wings, bonnet and door for example.
- **BC Post** – The centre post, the 'B' post has the front door striker plate and the 'C' has the hinges for the rear doors. Only appropriate to four/five door vehicles.
- **D Post** – The rear post on which the rear door striker is fitted. Front door striker if a two/three door vehicle.



All vehicles are made up of separate systems and components, they have their own purpose and operation, however, all of these systems are brought together to give us the modern motor vehicle.

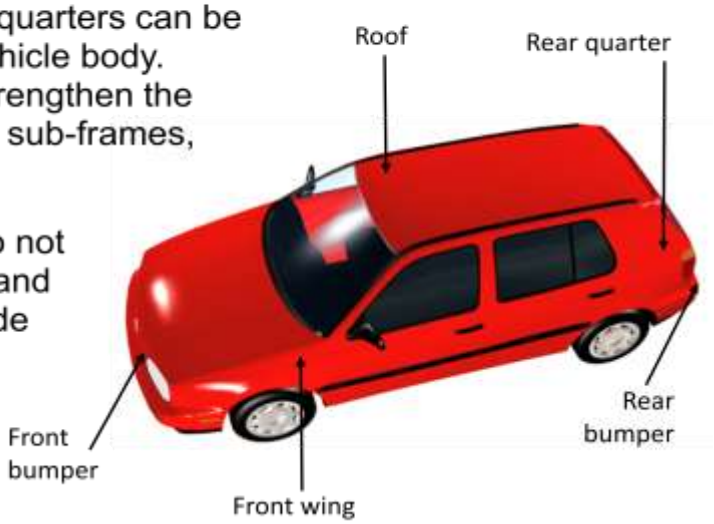


All vehicle component locations are identified by sitting in the driving seat. These are front, rear, left and right. In the diagram below, the left front wing can easily be identified.

The roof, front wings and rear quarters can be used to help strengthen the vehicle body. Other parts can also help to strengthen the vehicle body e.g. glass, doors, sub-frames, chassis and floor-pan.

On convertible vehicles that do not have a rigid roof the floor pan and centre tunnel are normally made stronger and stiffer.

The front and rear bumpers offer some protection in low speed front or rear impacts.

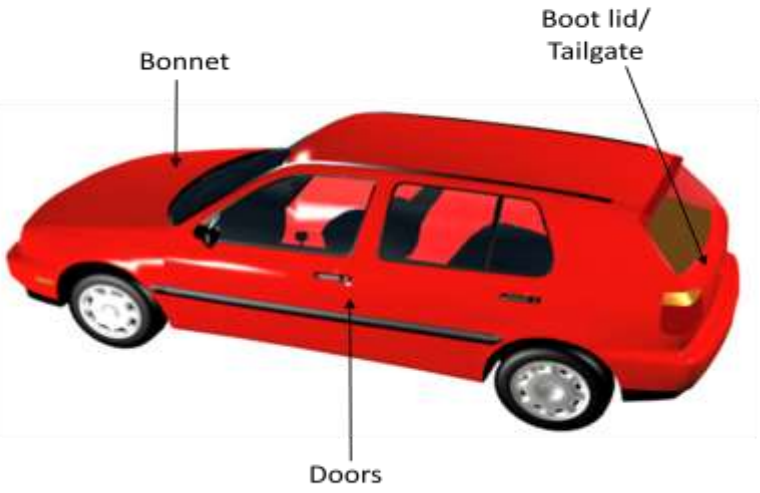


- Body Panels & Lighting include:
- Auxiliary Lights/Parts – Spotlight/Parts
- Door Mirrors
- Lights – Rearlight, Indicator, License Plate Light, Rear Fog Light, Reverse Light, Stop Lights
- Vehicle Rear – Bonnet, Bumper, Panelling, Wing
- **Body Panels** – Front Fairing, Mudguard, Rear-End Cowling, Wing
- Headlight & Bulbs
- Passenger Cabin – Auxiliary Stop Light, Doors, Mirrors
- Vehicle Front – Bonnet, Bumper, Fog Light, Headlight

The bonnet is a hinged cover for the engine compartment. It can be hinged to open toward the windscreen toward the front of the vehicle, or in some cases toward either wing.

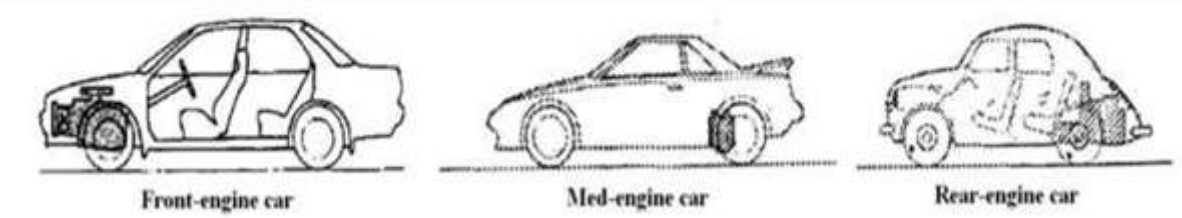
The **boot lid** is a hinged cover over the boot. The boot is used as an area to store luggage or other items.

The doors are used as a means for the vehicle passengers to enter and leave the vehicle. When closed, the doors help to strengthen the vehicle.



- Engine position:
- Front engine
- The large mass of an engine at the front of the car gives the driver protection in the event of a head on collision.
- Engine cooling is simpler to arrange.
- In addition the cornering ability of a vehicle is normally better if the weight is concentrated at the front.
- Rear engine
- It increases the load on the rear driving wheels, giving them better grip of the road.
- Most rear-engine layouts have been confined to comparatively small cars, because the heavy engine at the rear has an adverse effect on the 'handling' of the car by making it 'tail-heavy'.
- Also it takes up good deal of space that would be used on a front-engine car for carrying luggage.
- Most of the space vacated by the engine at the front end can be used for luggage, but this space is usually less than that available at the rear.

- Central and mid-engine
- These engine situations generally apply to sports cars because the engine sitting gives a load distribution that achieves both good handling and maximum traction from the driving wheels.
- These advantages, whilst of great importance for special cars, are outweighed in the case of everyday cars by the fact that the engine takes up space that would normally be occupied by passengers.
- The mid-engine layout shown combines the engine and transmission components in one unit.
- The term mid-engine is used because the engine is mounted in front of rear axle line.



Front-engine car | Med-engine car | Rear-engine car

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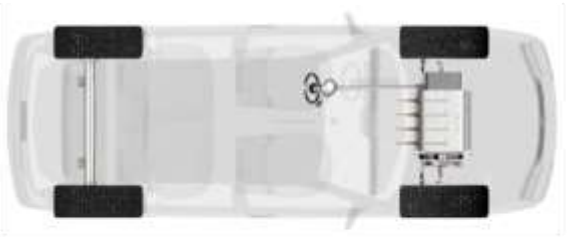
Typical Engine Configurations

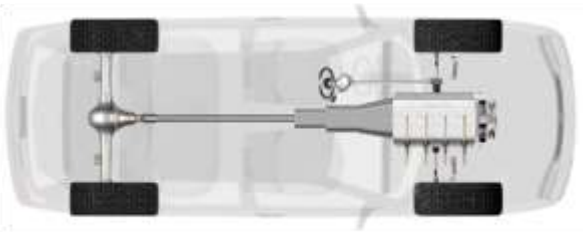
The engine may be placed in different positions within the vehicle, each having its own advantages. There are four main engine configurations.

Front engine, front wheel drive can help with the drive-ability of the vehicle.
The engine weight over the driven wheels gives greater traction.
This can be particularly useful in adverse weather conditions.



Front engine, front wheel drive

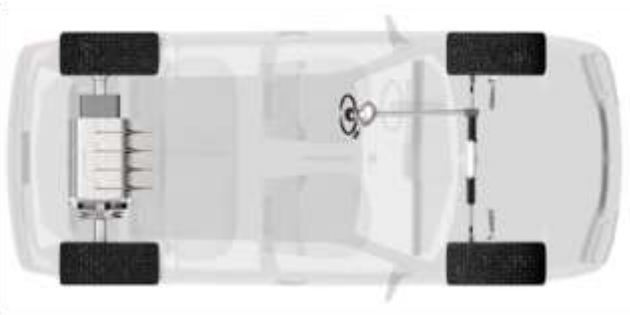
The front engine, rear wheel drive configuration has the advantage of better weight distribution.
However, some traction can be lost because the bulk of the weight is not over the driving wheels.



Front engine, rear wheel drive

Rear engine, rear wheel drive provides a larger load to the rear driving wheels.

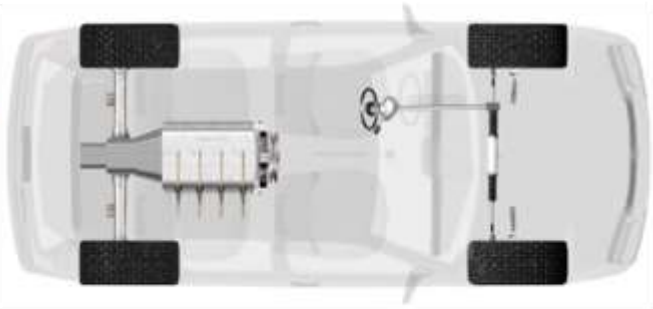
However, it can become 'tail heavy' which affects handling of the vehicle. It also reduces luggage space (which is now in the front), as the passenger seats need to be moved forward in order to accommodate the engine.



Rear engine, rear wheel drive

Mid-engine, rear wheel drive engines provide good vehicle handling and good traction at the rear wheels.

They are normally found on two-seat sports cars where these factors are important.



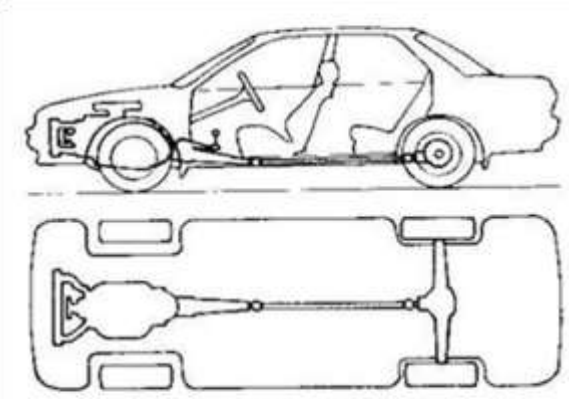
Mid-engine, rear wheel drive

Drive arrangements:

Front engine and rear-wheel drive

Advantages:

- *Better axle load distribution
- *Better road grip
- *Comfort riding
- *Better cooling
- *Less noise (long exhaust pipe)
- *Use a long engine



Rear-wheel drive (RWD)

Disadvantages:

- *Heavy (more weight)
- *The passenger compartment has the propeller shaft tunnel.

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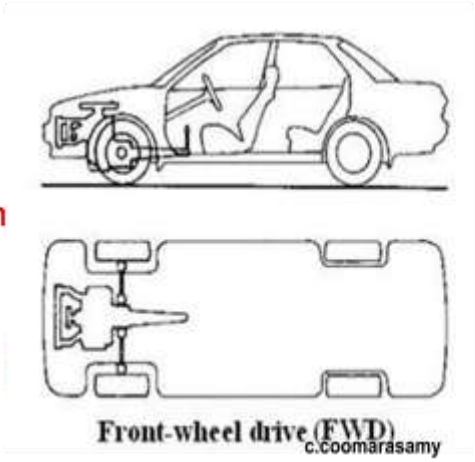
Front engine and front-wheel drive

Advantages:

- * More space in passenger compartment.
- * Easy to place the fuel tank (bigger)
- * More safe in the event of head on collision. (engine mass)
- * Shorter car length and better passenger compartment
- * Better cooling
- * No problem in steering the car in a slippery road.

Disadvantages:

- * The need to a power steering
- * More tire wear in the front axle
- * Less brake efficiency, 75% front an 25% rear.
- * Less climbing ability
- * Less accessibility for engine parts (maintenance)



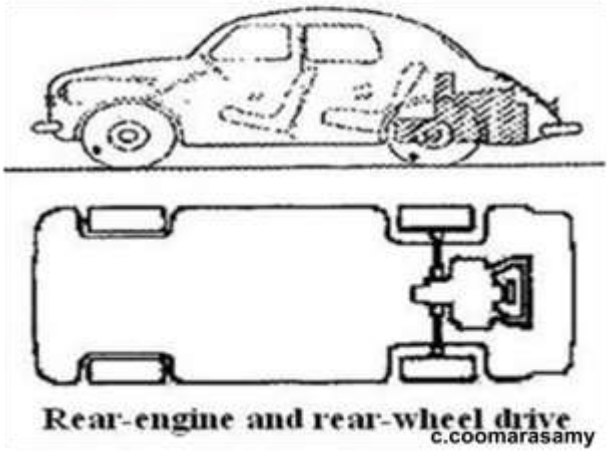
Rear engine and rear wheel drive

Advantages:

- * Good brake distribution on the axles
- * Better climbing ability and acceleration
- * Less steering effort

Disadvantages:

- * More rear wheel tire wear.
- * Bad cooling
- * Less space for luggage
- * Sensitive to the wind.
- * Less safety (front fuel tank)



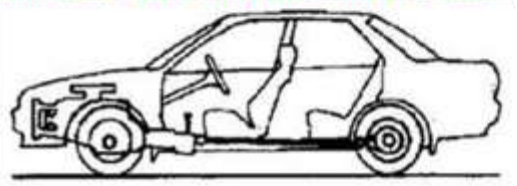
Four-wheel drive

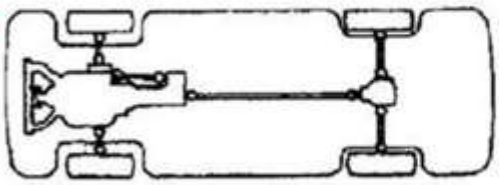
Advantages:

- * Better traction
- * Less risk of wheel spin
- * Minimizes the possibility of wheel lock-up when braking the car.
- * More gradient ability

Disadvantages:

- * Heavier
- * Increase the fuel consumption
- * Tires wear if driven on a paved road.





Four-wheel drive

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