# UNIT 1

# INTRODUCTION TO SAFETY SYSTEM

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# Introduction:

- Why is safety important?
- Automobile manufacturer give first preference to safety.
- Special departments and resources are used for improving safety.

**Automobile safety** is the study and practice of design, construction, equipment and regulation to minimize the occurrence and consequences of traffic collisions, road traffic safety more broadly includes roadway design.

When an automobile is designed, **the arrangement, choice, and type of components** depend on various factors.

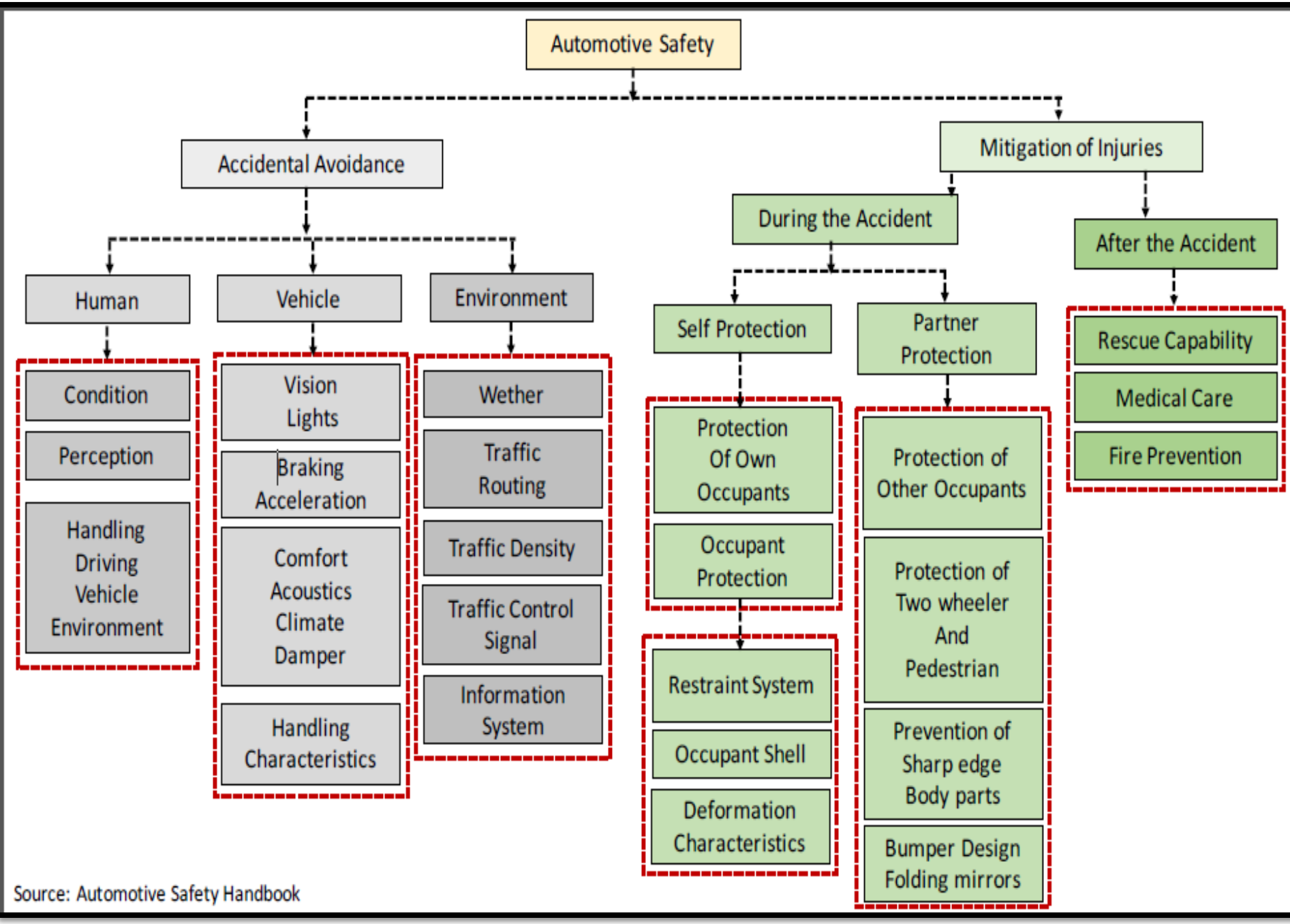
The **use of** the automobile is one factor.
Some cars are required only for **local driving**; these cars may be capable of achieving good fuel economy on short trips, but they may be less comfortable to drive at high speeds.

**A sports car**, built for speed, will have enhanced steering and handling abilities, but requires a stronger engine, more fuel, and a more sophisticated suspension system.

Other factors in the design of automobiles include
the requirements for **pollution-control components** that have been placed on the modern automobile.

**Safety features** are also a factor in the automobile's design, affecting everything from the braking and steering systems to the materials used to construct the body.

The design of the body must incorporate **standards of safety, size and weight, aerodynamics** or ways to reduce the friction of airflow.




Source: Automotive Safety Handbook

# Body &
# Safety Considerations

## Introduction

- Designer should ensure maximum safety of the driver, passenger, and other road users
- Vehicle should be designed to reduce the effects of collision and ensure minimum injury
- Stylists should avoid sharp ornaments, edges and projected elements. Careful attention to door handles, mirrors, hooks, control knobs, etc. reduces injury to pedestrians and also affects in reduction of aerodynamic drag & noise.

Safety Features Of Vehicles can be grouped as :

- **Vehicle Body Structure, its Systems & Parts**
- Additional Safety Features & Systems
- General & other safety recommendations

Safety Features Of Vehicles :

- Vehicle Body Structure, its Systems & Parts
  - ➔ Basis of body design for safety
  - ➔ Safety features of Door system
  - ➔ Window Glasses & Windscreen
  - ➔ Bumpers
  - ➔ Seat  back & head restraints
  - ➔ Rear view mirrors
  - ➔ Ventilation

Vehicle Body Structure, its Systems & Parts

- Basis of body design for safety

  - The design of vehicle body for optimum characteristics should be based on basic energy relationship

  - The kinetic energy of a vehicle destroyed during a collision is absorbed by the workdone on materials by elastic deformation

The kinetic energy of a vehicle destroyed during a collision can be expressed as

$$\mathbf{K.E = ( m - \nabla m ) V^2 / 2}$$

where ;

m = total mass of vehicle

$\nabla$m = moveable mass(passenger or load)

V = Velocity

Workdone on materials by elastic deformation is

$$\int \mathbf{Pds} = (\sigma^2 / 2E)\ \mathbf{A\ L}$$

where; P = force generated during collusion on vehicle structure

S = distance traveled during the collision

E = Young's modulus, Stress/Strain

A = cross sectional area of the structure

$\sigma$ = local stress in the material

L = deformation in cm

## Vehicle Body Structure, its Systems & Parts

- Safety Features of Door System

  - Photo - electric beam door closes automatically at pre - determined time

  - Gear shift lock prevent selection of gear until all exit doors are closed

  - Electrically sensitive edge on exist door causes automatic opening if obstruction is encountered

  - Pneumatic - sensitive - edges give audible and visual warning to the driver of door obstruction

Vehicle Body Structure, its Systems & Parts

- Transmission interlock prevent opening of doors whilst vehicle is in motion

Window Glasses

- Shatter proof glass should be used. When hit against any object the whole glass falls out and there will be no sharp edged pieces
- In bullet proof glass when hit there will be no normal angle of incident (inclination). The bullet is thrown out as there will always be some angle of incident.

Vehicle Body Structure, its Systems & Parts

- Reliability / Safety Requirements Windscreen

  - Freedom from faults which interfere with vision

  - High transparency & freedom from visual distortion

  - External durability to reduce surface degradation & scoring from wipers, ice scrapers, road grit, etc.

  - Vision not affected by normal road stone impacts

Vehicle Body Structure, its Systems & Parts

- Bumper

  - Shock absorbers behind the bumpers may be used. In some designs semi - circular shape is adapted. This avoids direct collision and tilt of the vehicle.

  - Bumper design & height should be such that in case of accident it hits passenger below the knee. In this case the passenger will fall on to the vehicle otherwise on road which would be more dangerous.

Vehicle Body Structure, its Systems & Parts

- Seat - Back & Head Restraints

  - Seat-backs should be in an upright position to get maximum protection from the seat belts

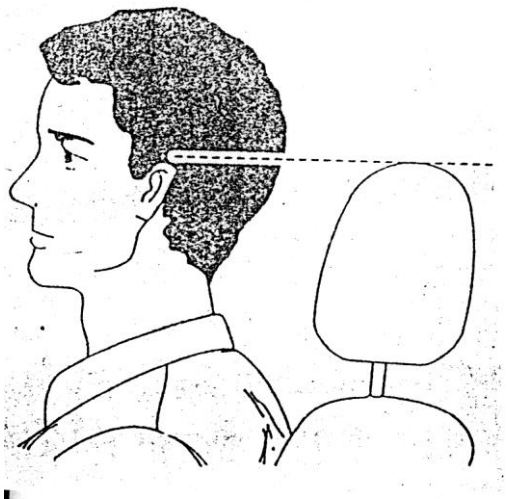
  - In reclined seat-back position the risk of sliding under the seat belt increases in a severe crash.

  - The front head restraints help from whiplash and other injures.

Vehicle Body Structure, its Systems & Parts

- Seat - Back & Head Restraints

  - For most effectiveness, the Head Restraint should be adjusted such that the top of the restraint is even with the top of the ears as shown



Vehicle Body Structure, its Systems & Parts

- Ventilation

  - Proper air vents directed towards the windscreen, side windows, passenger compartment, front and rear passenger foot walls should be provided.

- Rear View Mirror

  - Inside rear view mirror can be adjusted up, down or sideways to obtain the best view. Always adjust the mirror set to day positions

Vehicle Body Structure, its Systems & Parts

- Rear View Mirror

  - Outside rear view mirror can be folded flat against the side of the vehicle and can be inclined at an angle to position it properly. The size or distance of a vehicle or object seen in an outside convex mirror look smaller and appear farther away as compared to a flat mirror.

**Engine location**

**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 and in addition the cornering ability of a vehicle is normally better if the weight is concentrated at the front.

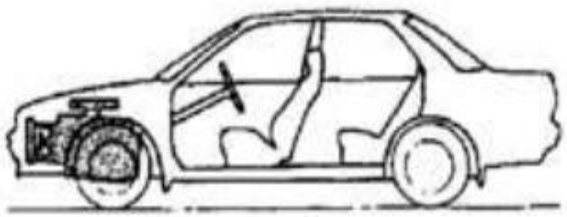
**Rear engine:**

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.

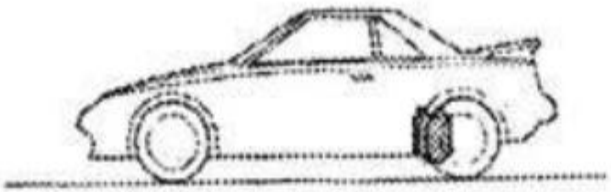
**Central and mid-engine:**

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

**Crumple zone:**

Also known as a **crush zone**,
crumple zones are areas of a vehicle that are designed to deform and crumple in a collision. This absorbs some of the energy of the impact, preventing it from being transmitted to the occupants.

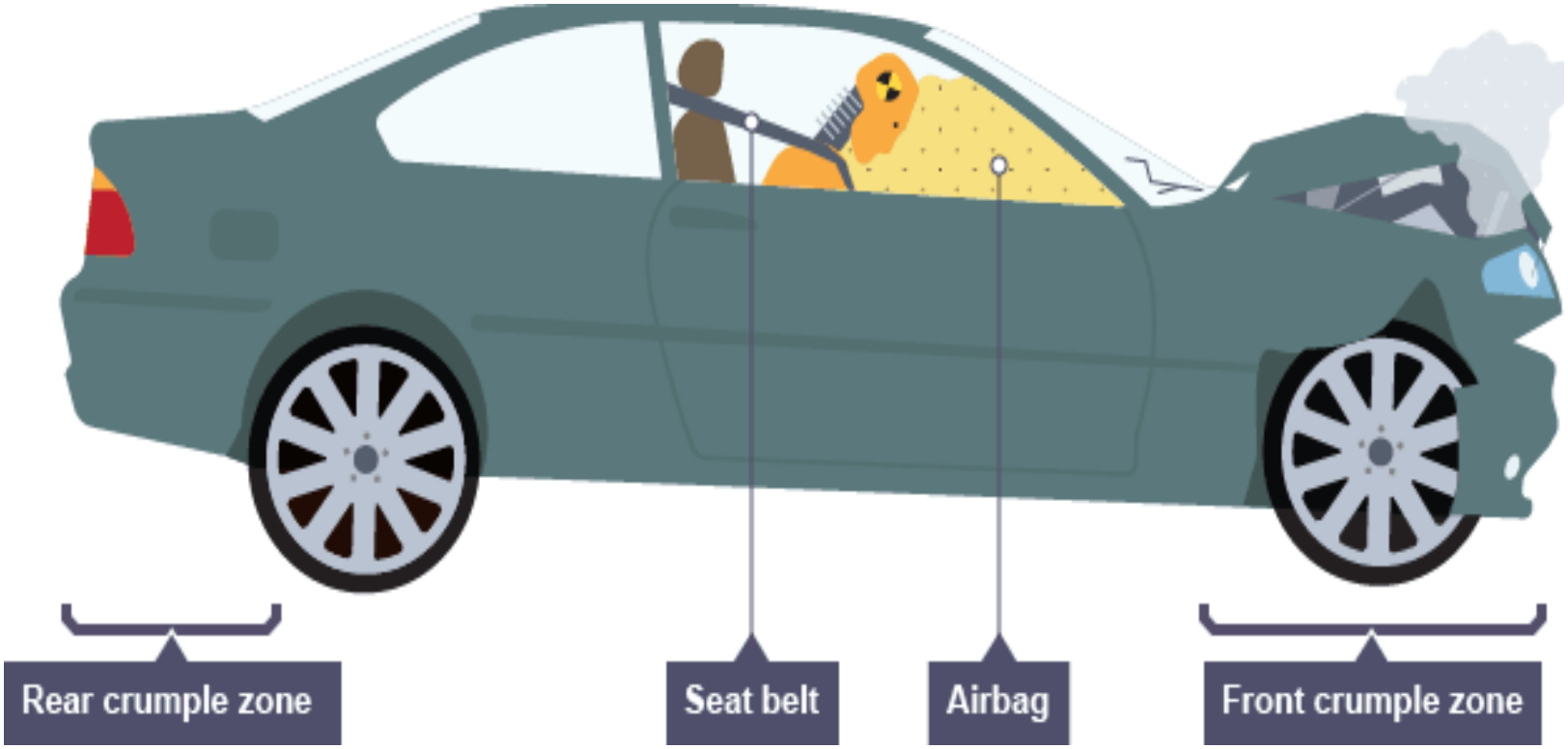
Whenever a car is involved in a crash, intense kinetic forces are at work. A given amount of force is present during any crash. The actual numbers vary based on the speed and mass of the car and the speed and mass of whatever it hits. Physicists measure this force as **acceleration -** even when moving from a high speed to a lower speed, any change in speed over time is scientifically referred to as acceleration. To avoid confusion, we will refer to crash acceleration as **deceleration**.

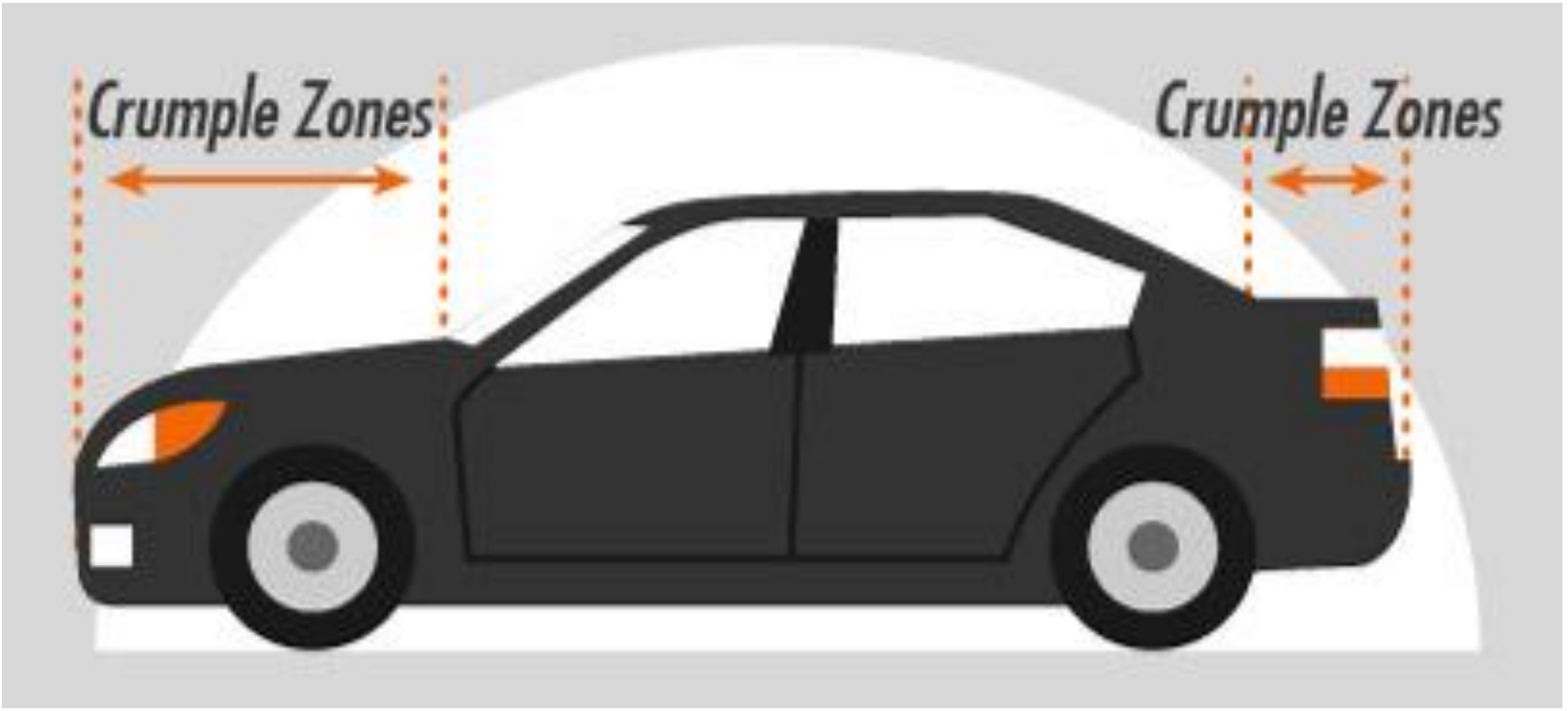
Crumple zones accomplish two safety goals.

- They reduce the initial force of the crash,

and

- they re-distribute the force before it reaches the vehicle's occupants.




Crumple Zones
Crumple Zones

# Safety Sandwich Construction

Sandwich panel constructions using **metallic and polymeric honeycombs and foams** have been used for many years in the competition and high performance sectors of the automotive industry, and there is considerable knowledge and confidence in their **static, dynamic and crashworthiness properties**.

- The potential advantages of polymer composites for automotive parts (high specific strength and stiffness, corrosion resistance) Further benefits are available from the use of sandwich construction, in which a
  - relatively stiff,
  - strong skin is bonded either side of a much thicker,
  - lightweight core.
- Sandwich panels have been widely used for structural applications in the **marine, aerospace and performance automotive industries** for several decades

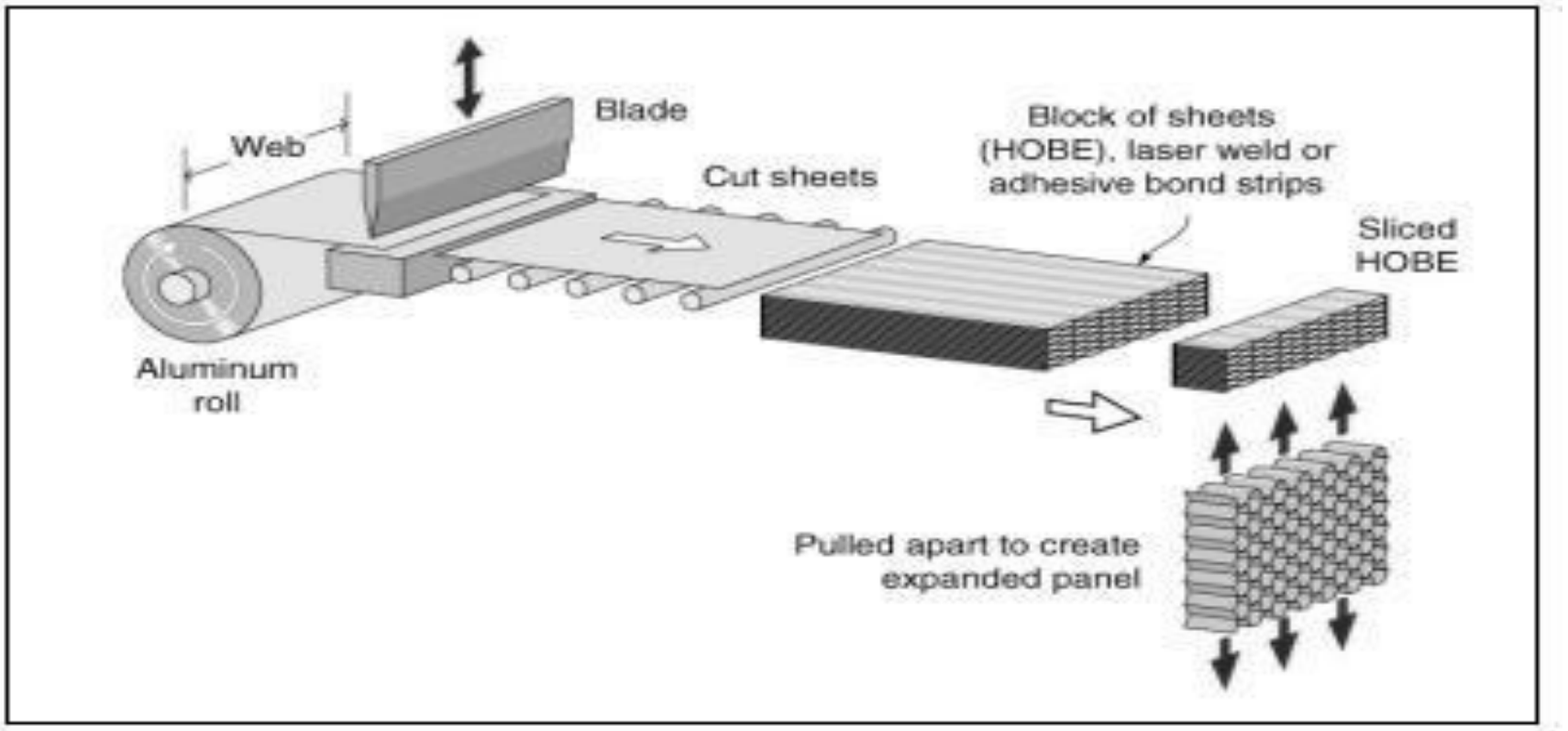
- Lightweight core materials have included **balsa, polymer foams and metallic**, paper or polymer honeycombs.
- These have been used in various combinations with skins of **carbon, glass and/or aramid fiber-reinforced polymer, as well as aluminum**.
- The principle of sandwich construction is that **bending loads are carried by the skins**, while the **core transmits shear load**.
- They enable large gains in **structural efficiency**, since the thickness of panels can be increased without significant weight penalty.

Some representative properties of sandwich panels are given in Table

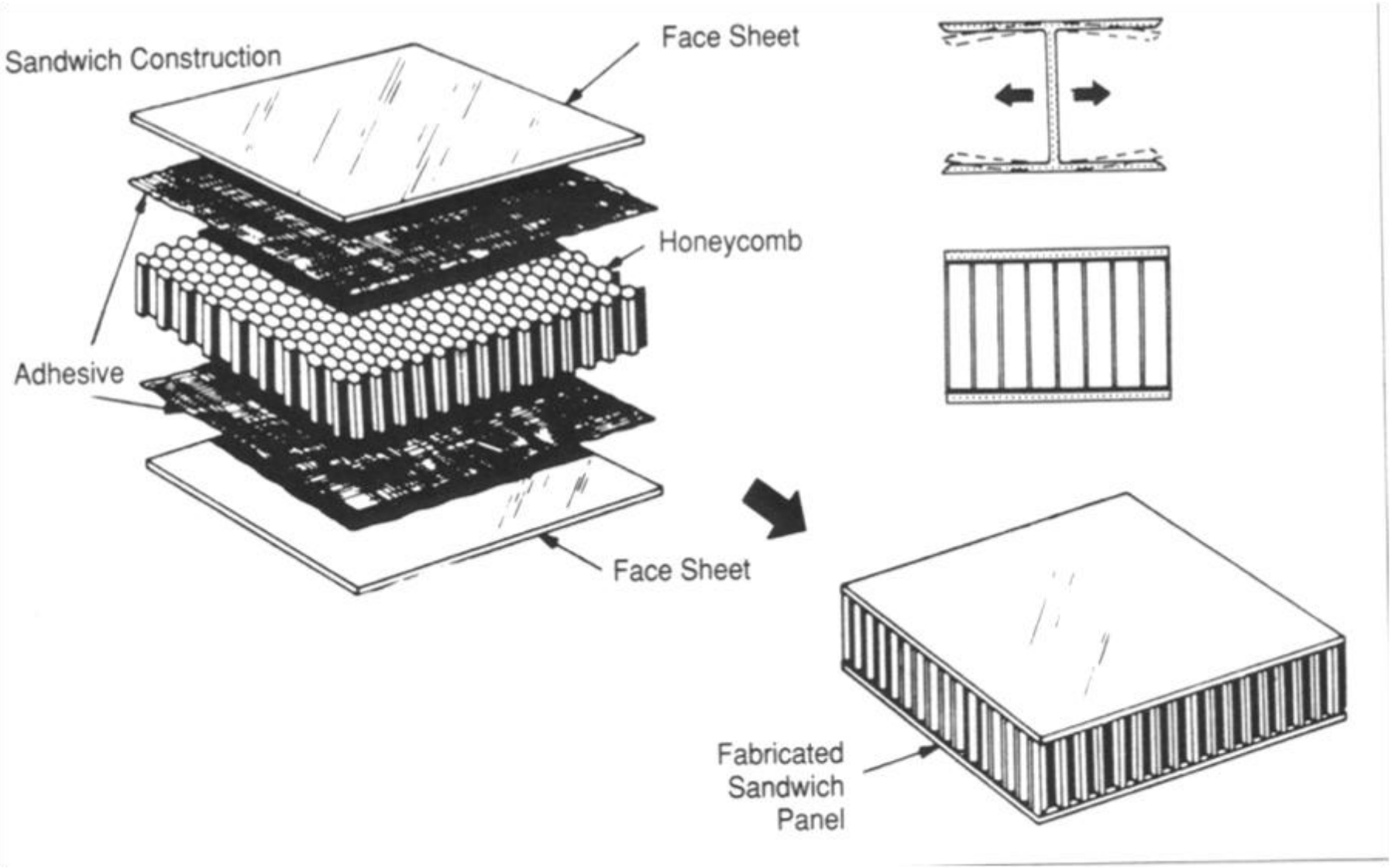
| | Thickness (mm) | Bending stiffness per unit width ($Nm_2/m$) | Weight per unit area of sandwich beam ($kg/m_2$) | Weight per unit area of monolithic Al. with same bending stiffness ($kg/m_2$) |
|---|---|---|---|---|
| F-board | 13.7 | 1,100 | 3.08 | 15 |
| | 26.4 | 4,500 | 4.21 | 25 |
| | 52.3 | 20,500 | 7.54 | 41 |
| M-board | 13.9 | 3,500 | 4.67 | 23 |
| | 26.6 | 13,500 | 5.73 | 36 |
| | 52.0 | 52,500 | 7.84 | 56 |

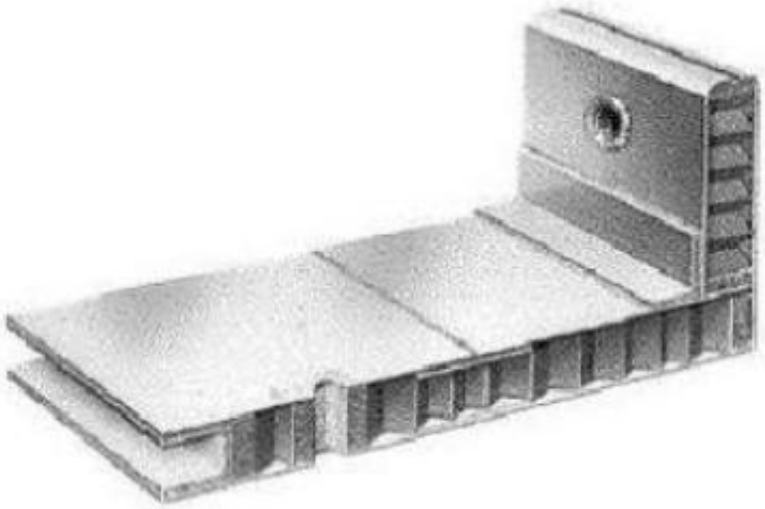
➢sandwich panels are also available as flat sheet, stock material.

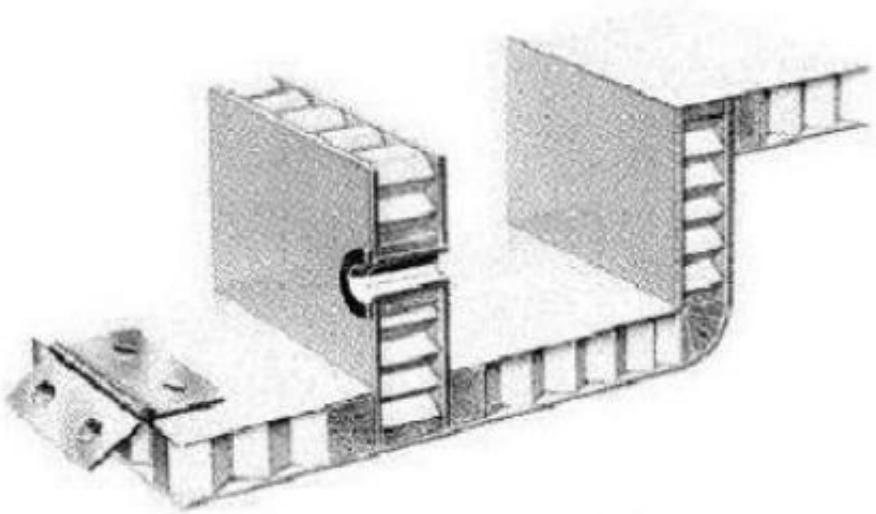
➢Hexcel Composites, for example, supply arrange of honeycomb cored sheets of varying specifications which is widely used for building cladding, aircraft flooring, luggage bins and bulkheads.

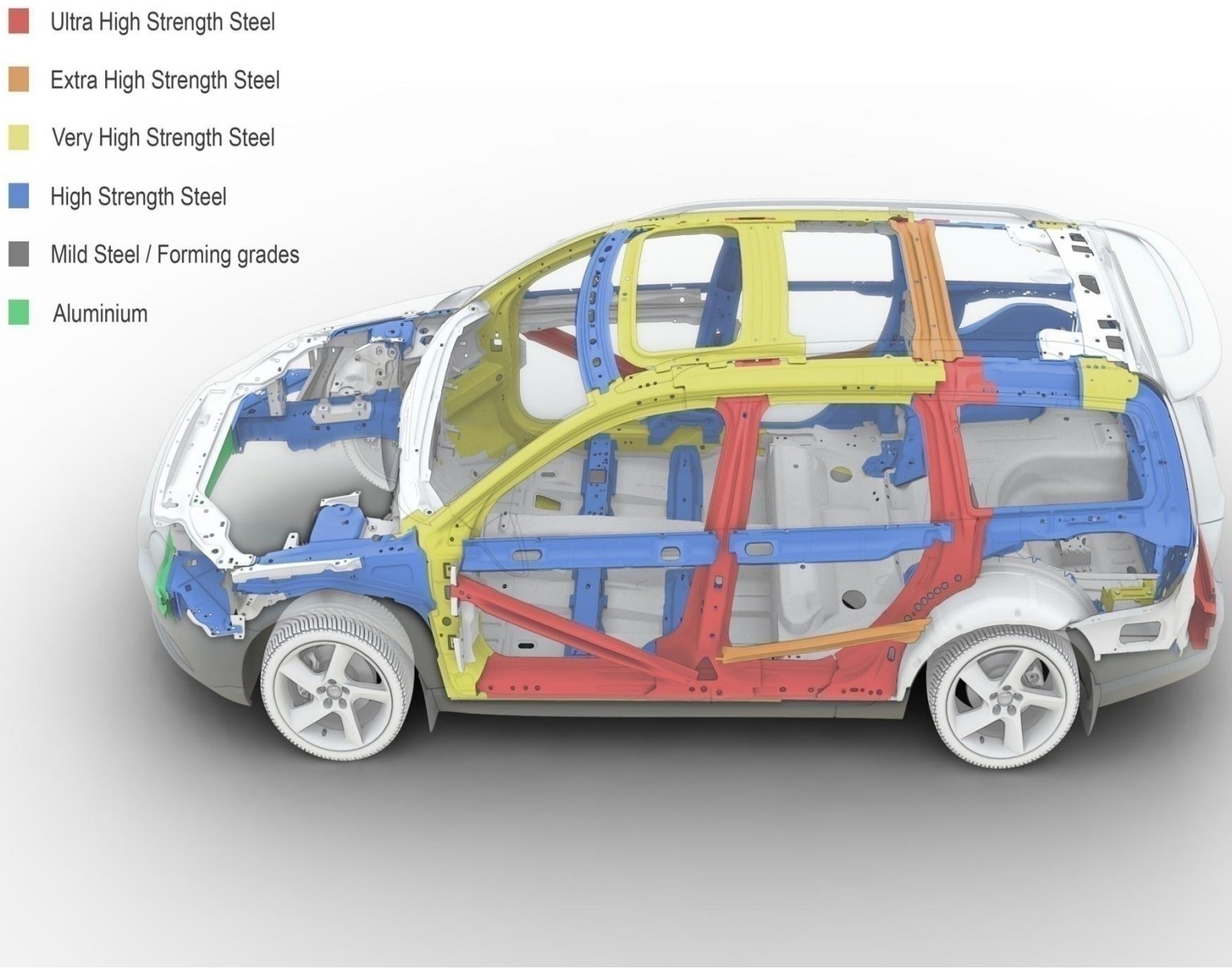


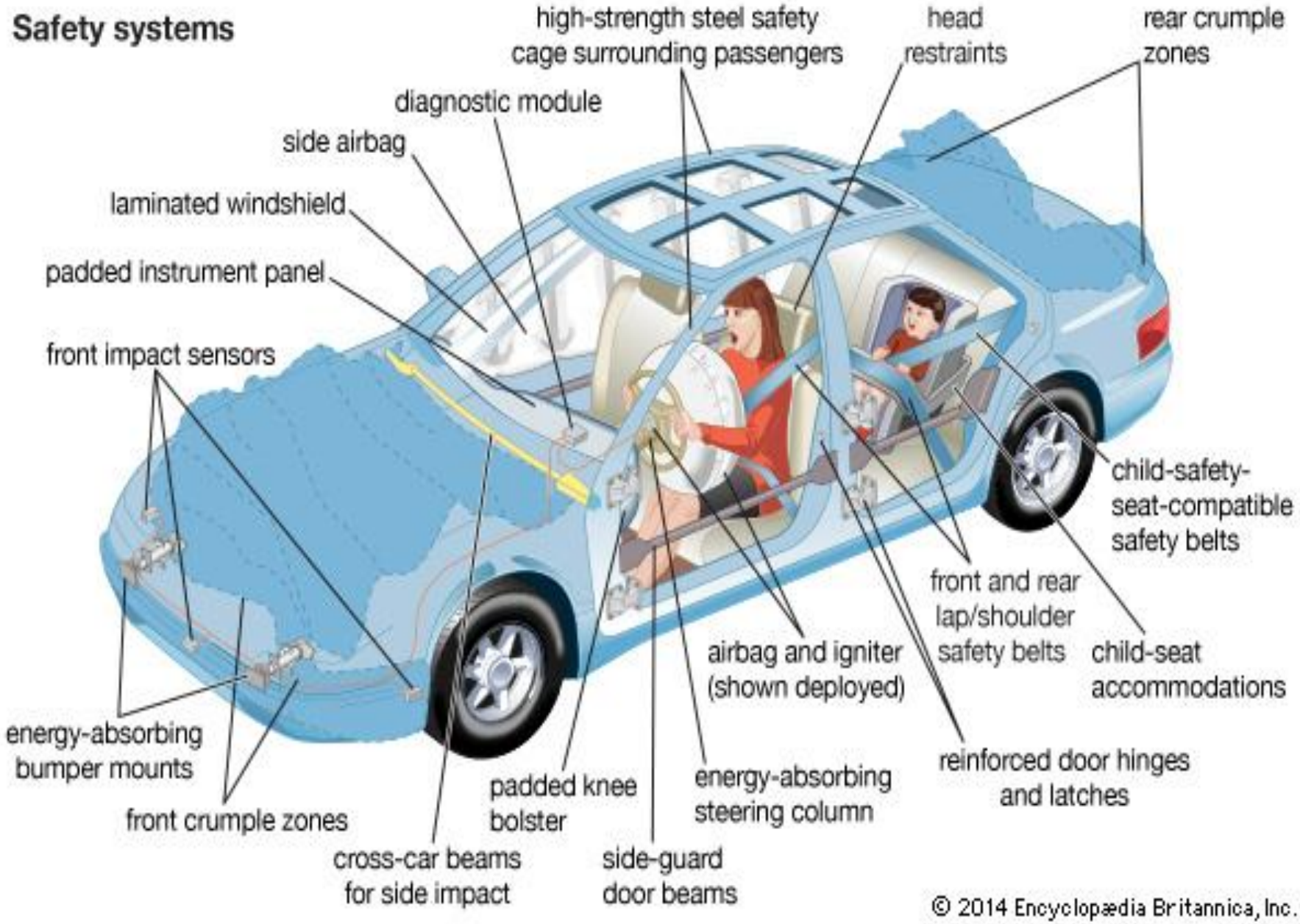

Expansion Honeycomb Manufacturing Method Hexcel Composites


Sandwich Construction
Face Sheet
Honeycomb
Adhesive
Face Sheet
Fabricated
Sandwich
Panel






Ultra High Strength Steel
Extra High Strength Steel
Very High Strength Steel
High Strength Steel
Mild Steel / Forming grades
Aluminium


Safety systems
high-strength steel safety cage surrounding passengers
head restraints
rear crumple zones
diagnostic module
side airbag
laminated windshield
padded instrument panel
front impact sensors
child-safety-seat-compatible safety belts
front and rear lap/shoulder safety belts
child-seat accommodations
airbag and igniter (shown deployed)
energy-absorbing bumper mounts
front crumple zones
padded knee bolster
energy-absorbing steering column
reinforced door hinges and latches
cross-car beams for side impact
side-guard door beams
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# Unit - 1 End