Underbody System

**Construction**
Ladder construction with longitudinal rails, cross-members and floor pan spot welded together

**Connections**
Spot welded to body sides on either side, to the dash panel, inner fender of the front end and rear sill. Sub-frames are bolted to the rails

**Frame/Rail**
Main structural member responsible for transferring suspension and engine loads. Responsible for absorbing energy during frontal crash. It also supports front & rear bumpers

**Cross-members**
Support transmission, front and rear seats and spare tire
**Body-Side System**

**Construction**

1 piece body-side stamping is welded to inner sheet metal parts to form sections. This provides stiffness to the structure.

**Connections**

Spot welded to shotgun on the front end, to the cowl, the headers on the roof and the floor.

**Pillars**

Main structural members responsible for protecting against roof crush. Also required to hang and latch doors. A-pillar angle is important for vision.

**Roof Rail and Rocker**

Main structural members needed to complete framing and provide stiffness to the floor and the roof.
### Front End System

**Construction**
Consists of radiator support, shotgun welded together. Inner fender connects shotgun to the frame

**Connections**
Shotgun forms a welded joint with the cowl structure and Hinge pillar. Shock tower is welded to the shotgun. Lower radiator support is welded to the frame

**Shotgun**
Main structural member absorbs part of crash energy, supports battery and other parts, transfers shock loads from shock tower to the body

**Radiator Support**
Supports radiator.
Dash & Cowl System

Construction Consists of dash panel and cowl welded together.

Connections Dash panel is welded to the floor pan on one side and to the cowl on the other. Cowl is welded to Hinge Pillar/shotgun joint. It also has a braced connection to cross-car beam which supports the steering column.

Dash Panel Supports accelerator, brake and clutch pedals

Cowl Supports windshield wipers and motor. It also provides stiffness to the body
**Construction**

- Consists of roof panel, headers and bows

**Connections**

- Roof panel is welded to headers and the roof rails. Headers are welded into a joint with roof rail and A or C (D) pillar. Roof bows are attached to the roof by mastic

**Roof Panel**

- Sometimes carries luggage rack

**Headers and bows**

- Provide stiffness to the roof and the body structure
# Door System

<table>
<thead>
<tr>
<th>Construction</th>
<th>Consists of door inner and outer panels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connections</td>
<td>Panels are attached at both ends using hem flanges. Connected to Hinge pillar with hinges and to the B-pillar with latch. Door inner is separated from body-side with door seal or weather strip</td>
</tr>
<tr>
<td>Door Inner Panel</td>
<td>One piece stamped construction supports window mechanism and regulator, speakers, latch mechanism etc. Intrusion beam for side impact, is welded to door inner</td>
</tr>
<tr>
<td>Door outer</td>
<td>One piece styled stamped surface</td>
</tr>
</tbody>
</table>

![Diagram of Door System](image)
Liftgate System

<table>
<thead>
<tr>
<th>Construction</th>
<th>Consists of inner and outer panels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connections</td>
<td>Panels are attached at the both ends using hem flanges. Connected to rear header with hinges and to the rear sill with latch. Door inner is separated from body with seal or weather strip</td>
</tr>
<tr>
<td>Door Inner Panel</td>
<td>One piece stamped construction</td>
</tr>
<tr>
<td>Door outer</td>
<td>One piece styled stamped surface</td>
</tr>
</tbody>
</table>

Hinges

Fixed Glass

Inner Panel

Bumper

Latch

Balancers
## Hood System

**Construction**
- Consists of inner and outer panels

**Connections**
- Panels are attached at both ends using hem flanges as well as gum drops. Connected to cowl with hinges and to the radiator support with latch.

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Door Inner Panel</td>
<td>One piece stamped construction</td>
</tr>
<tr>
<td>Door outer</td>
<td>One piece styled stamped surface</td>
</tr>
</tbody>
</table>

![Diagram of Hood System with labeled parts: Latch, Inner Panel, Styled Outer Panel, Gum Drops, Hood Hinges.](image)
Sub-frame

Supports Suspension Arms

Bolted to body

Supports engine
Punching Process

Desired Shape

Puncher

Clamp
Flanging Process

Trimmed Part

Flange for Welding

Flanged Part
Spot Welding Process

- Power Supply
- Electrodes
- Flanged Part
## Body Assembly Process

<table>
<thead>
<tr>
<th>Assembly</th>
<th>Sub-System</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>Underbody</td>
<td>Cross-members are welded to the rails. Floor pan is welded to the grid. Rocker inner is welded to the floor.</td>
</tr>
<tr>
<td>Step 2</td>
<td>Front End</td>
<td>Radiator support, inner fender, shotgun, shock tower, cowl side and inner hinge pillar are welded together.</td>
</tr>
<tr>
<td>Step 3</td>
<td>Front End, Underbody, cross-car beam and cowl</td>
<td>Front end is welded to the underbody, cowl and cross-car beam. Cross-car beam is used for alignment</td>
</tr>
<tr>
<td>Step 4</td>
<td>Dash Panel and Strainer</td>
<td>Dash panel and strainer is welded to the floor and the cowl</td>
</tr>
<tr>
<td>Step 5</td>
<td>Body Side</td>
<td>Body sides are welded on each side</td>
</tr>
<tr>
<td>Step 6</td>
<td>Pillars</td>
<td>A, B, C, and D pillar inners are welded</td>
</tr>
<tr>
<td>Step 7</td>
<td>Roof</td>
<td>Roof rail inners, headers and bows are assembled. Roof panel is attached.</td>
</tr>
<tr>
<td>Step 8</td>
<td>Paint, Trim and Closures</td>
<td>Body, closures, fenders are painted. Trim is assembled and then closures/fenders are hung.</td>
</tr>
</tbody>
</table>
Vehicle Assembly Process

1. **Body In White Assembly**
   - Body
   - Body Paint Shop
     - Closures Assembly
       - Closures
         - Vehicle Assembly
           - Chassis Assembly
           - Power-train Assembly
           - Climate Control Assembly
           - Electrical Assembly
           - Body Trim
Body System Functional Requirements

- Provide seating comfort to the required number of passengers
- Provide easy ingress and egress
- Provide safe driving environment
- Provide easy access to driver controls
- Provide means to attach other major systems and components
- Provide the driver with required vision
- Prevent water from entering passenger/engine/luggage compartment
Body System Safety Requirements

- Protect passenger from frontal crash
- Protect passenger from rear crash
- Protect passenger from side impact
- Protect passenger from a roll-over accident
- Protect passenger from head injury
- Protect pedestrian from an accident
- Prevent seat from detaching from the floor
Body System NVH Requirements

- Control tactile responses
- Control noise levels in the passenger compartment
- Control wind noise
- Control mirror vibrations
- Isolate vibrations due to engine
Body System Durability Requirements

- Make sure the structure will endure loads throughout its life
- Make sure all attachment brackets will endure loads
- Make sure body will not rust during required life
Body System Performance Requirements

- Floor is capable of supporting passengers
- Load floor is capable of supporting luggage
- Roof is capable of supporting luggage rack
- Body is sufficiently stiff
- Prevent extensive damage during minor accidents
- Able to tow a trailer or able to be towed
Door System Performance Requirements

- Door opens and closes properly lasting required years
- Door will not allow intrusion during side collision
- Door closing effort is satisfactory to the customer
- Door is sufficiently stiff
- Door prevents wind noise
- Door locks open/close required number of times
- Door window goes up/down required number of times
- Door is not damaged by slamming
Hood System Performance Requirements

• Hood opens and closes properly lasting required years
• Hood is sufficiently stiff
• Hood does not flutter
• Hood is not damaged by slamming
Lift-gate System Performance Requirements

- Lift-gate opens and closes properly lasting required years
- Lift-gate is sufficiently stiff
- Lift-gate prevents wind noise
- Lift-gate is not damaged by slamming