

# Development of 2013 Model Year U.S. Accord

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## ABSTRACT

The Honda Accord sedan and coupe for the North American market, both best-selling mid-sized cars, have undergone a full model change with the 2013 models and are now in their ninth generation. The Accord has a 37-year history, and this model in particular has incorporated a large amount of new technology. An efficient packaging technology based on Honda's unique "man maximum, machine minimum" concept has achieved larger cabin space and greater cargo capacity than previous models, while total length of the sedan has been shortened by 70 mm and of the coupe by 40 mm. The line-up of available power trains includes the newly developed L4 2.4-liter direct-injection engine, the V6 3.5-liter variable cylinder management engine equipped with added VTEC mechanism, and the three transmission options of a continuously variable transmission, a six-speed manual transmission, and a six-speed automatic transmission. The combinations of engine and transmission achieve a high-level balance of driving performance and fuel efficiency performance. This model also achieves a high level of safety performance and was given the highest ranking of five stars in the United States New Car Assessment Program (US-NCAP). (Based on Honda in-house data.)

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## 1. Introduction

In the midst of a worldwide economic slump and increasing competition among automobile manufacturers, users have become more demanding in their selection of cars. There is an increasing tendency to purchase cars that have superior performance. In the middle-sized segment where the Accord is positioned, manufacturers have been placing one highly product-competitive new model after another on the market in recent years. Competition in this category has grown more intense than ever before, and car performance has been evolving conspicuously as a result.

When surveys of sedan users were conducted in the course of developing the 2013 model year U.S. Accord (new model Accord), it was found that the frequency of sedan use is increasing. Commuting to work is still the main use, but even on the weekend, for example, people are more likely than before to take their sedan rather than a minivan when they go out with their family. Sharply rising gasoline prices and growing awareness of environmental issues are among the background factors in this situation. The Honda team feels certain that consumers have high expectations for the Accord, which already has an established reputation for good fuel efficiency and spaciousness.

The team therefore decided to create a sedan that would address user expectations regarding both work and leisure

needs. This sedan would enable even more intelligent use and have styling that expresses a high-quality lifestyle. Development of this new model Accord began with the goal of a car possessing outstanding performance in every area.

## 2. Concept

The grand concept for the ninth-generation new Accord has been formulated as Excels in All Areas. This model further embodies intelligence, high quality, and advanced innovativeness (Fig. 1) through these three concepts: Its Intelligence follows the design sense and feeling of spaciousness of the previous model Accord, its High



Fig. 1 Exterior design (Sedan)

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Quality is based on the reliability and sense of security of the Honda sedan, and its Advances come from its position as the next-generation middle-sized sedan.

#### (1) Intelligence

The aim was to create an “Exhilarating and Efficient Package” in the form of a smart package with intelligence, high quality, and advanced innovation that is well thought-through down to the smallest detail.

#### (2) High Quality

The aim was to achieve advances in quick, sporty handling by means of the car’s high-rigidity body and newly developed suspension. These were also intended to achieve greater quietness and refined, dynamic performance.

#### (3) Advances

Advances were made in basic performance, including the achievement of environmental performance at the top of its class. Taking that as a basis, development was carried out with the aim of achieving a sedan that is superior in the area of safety.

The previous model of the coupe, on the other hand, achieved popularity, especially among personal users in their late 20s, for its styling as well as its spacious rear seats and roomy trunk. The new model Accord coupe incorporates these qualities while also introducing the evolutions in advanced basic performance achieved in the sedan. The aim with the coupe, therefore, was to achieve a car for adults that conveys a more dynamic, tighter sense of intelligence with the concept of Aggressive and Athletic (Fig. 2).



Fig. 2 Exterior design (Coupe)

### 3. Intelligence

#### 3.1. Package

“Exhilarating and Efficient Package” was adopted as the concept for the package layout. The aim was to achieve a balance between optimizing the body frame to support fuel consumption and other such environmental requirements together with safety performance, and carrying on the car’s comfortable interior space while creating new value as a sedan.

For the exterior, the aim was to build on the “man-maximum, machine-minimum” concept of Honda’s human-centered styling philosophy to assure outstanding visibility performance. On that basis, the Honda team wanted to express the essence generated by functionalities such as good fuel consumption and aerodynamic performance as well as spaciousness and comfort at levels one rank above its class. The exterior concept was formulated as “exhilarating” to express the comfortable space and “concentrated” to express the tightly contained dynamic feeling and excellent aerodynamic performance. An uncompromising approach was taken to the quality of the body surface, and this model was imbued with functional significance as it was formed. The overall form was made to express a powerful presence and high-quality appearance by envisioning a three-box design (with engine compartment, cabin, and trunk) for its sedan-like quality while adding horizontal design keynotes that emphasized an extended lengthwise appearance when viewed from the side. Viewed from above, the car body was narrowed at the front and rear while the center was slightly widened to make a barrel-like shape. The front and rear pillars were also drawn inward while the center pillars were pushed outward, and deeply curved glass was used throughout to enhance aerodynamic performance while making the exterior appearance convey the spaciousness and comfort of the interior.

The interior expresses the concept of the luxurious modern interior with the themes of exhilarating, advanced, and high quality. Specifically, this involves the three aspects of generating a further sense of spaciousness in an ample interior space; realizing a next-generation interface that allows greater ease of operation; and conveying a sense of high quality that is one rank above its class. By achieving these three, a comfortable new sedan value was created.

#### 3.2. Triple-Gauge Cluster

As a conventional sedan, the emphasis was placed on visibility. A triple-gauge cluster was therefore adopted with a large-diameter speedometer in the middle. The metallic trim-rings were shaped to appear even more metallic and further heighten the sense of detailed precision. An information display was placed in the center of the speedometer, and an ambient light was positioned around the periphery to display fuel efficiency status by color (Fig. 3).



Fig. 3 Gauge cluster

## 4. High Quality

### 4.1. Body Rigidity

The rigidity of the body frame was reinforced throughout (Fig. 4) in order to achieve linear handling as well as greater ride comfort and quietness. Rigidity was increased in the rear chassis, in particular, which contributes significantly to running stability and ride comfort, and this yielded high performance. The development effort made good use of computer-aided engineering (CAE) and also employed the test course to put the car through an intensive run and optimize the structure. The structure was examined with care for human sensibility, with attention given even to slight deformation and vibration and corrective measures taken. Weight reduction measures were also taken, including the use of even stronger high-strength steel (high-tensile steel), to produce a body frame that is lighter in weight and greater in rigidity.

As a result, as shown in Fig. 5, static rigidity rose by 34% for bending rigidity and 42% for torsional rigidity. In terms of dynamic rigidity, a 16% increase was made in front left and right rigidity, which affects handling responsiveness, and a 39% increase in rear upper and lower rigidity, which affects rear tire contact feel and ride comfort. In addition, lateral rigidity at the rear ground contact points was raised 25% and rear damper torsional rigidity was raised by 40%, suppressing rear suspension geometry change during cornering. A high-level balance of handling and ride comfort was achieved by strengthening

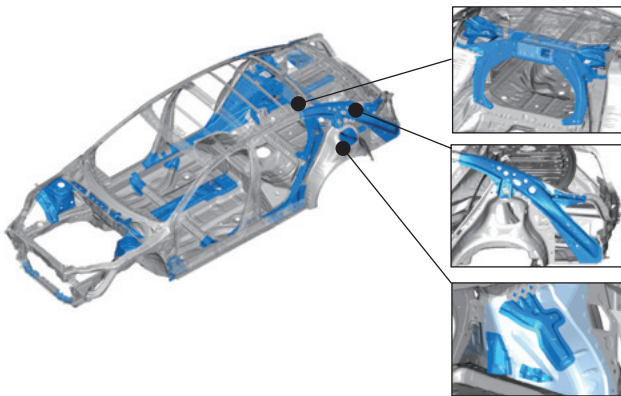


Fig. 4 Illustration of body strengthening

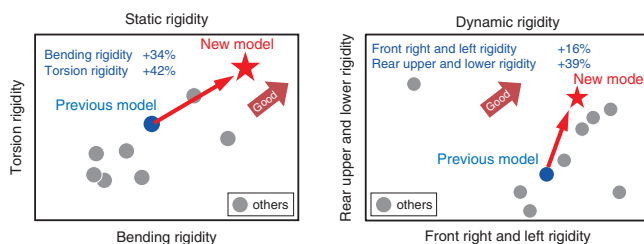


Fig. 5 Body rigidity comparison image

the front chassis while significantly increasing the rigidity of the rear chassis in this way.

### 4.2. Expanded Application of High-Tensile Steel

As shown in Fig. 6, higher strength high-tensile steel makes up 17.2% of the steel used. This includes the higher strength grade 1500 MPa steel achieved by hot stamping technology as well as grade 780 MPa and grade 980 MPa high-tensile steel. The result was an 8 kg reduction in the weight of the body frame.

### 4.3. Chassis

The chassis system was renovated with the aim of further evolving the quick, linear handling performance that was a strength of the previous model, as well as to achieve a balance between that and superior ride comfort.

A strut-type front suspension was adopted to enable a lighter weight and more efficient package. For the rear suspension, the basic structure of the previous model was retained and the suspension bushing was optimized to achieve a balance between dynamic performance at the top of its class and ride comfort with high-quality performance. The new model also included electric power steering (EPS), a lightweight, high-rigidity hybrid front subframe, and tires that provide outstanding grip performance while reducing rolling resistance. Thus, the developed chassis system could also contribute to reduction of fuel consumption.

#### 4.3.1. Suspension

A MacPherson strut-type front suspension was adopted for dynamic performance exceeding that of the previous model. This new model suspension achieves a reduction in weight of 15 kg while also contributing to a higher-efficiency package by enabling a shortened front nose. In order to provide a further evolution in its top-class dynamic performance while achieving greater ride

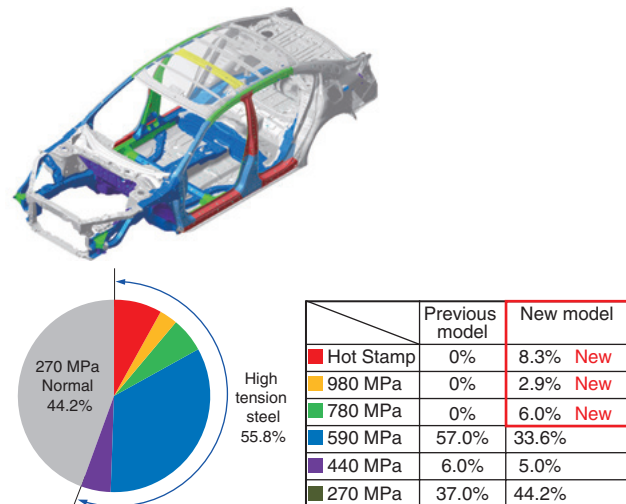


Fig. 6 High-tension steel utilization

comfort, suspension dampers with a new structure were adopted together with hydro-compliance bushings arranged coaxially with movable lower arms (Fig. 7, Fig. 8). High-frequency road noise was also reduced.

Newly adopted rebound springs in the front dampers act on the extension side and reduce vehicle roll by suppressing the lift of the inside wheels during cornering. As a result, this measure assures high turn stability while lowering the spring rate of the main damper springs and increasing ride comfort. Steps were also taken in the interior structure of the dampers, where Teflon rings were added to the oil seal in order to reduce upward movement on the springs and enhance responsiveness to the start of rolling movements during fine steering operations. In addition, a new valve structure matched to a newly developed oil was adopted in order to optimize the attenuation characteristics, achieving a flat ride. The system can change characteristics for lower spring rate in response to input from suspension stroke, and higher spring rate in response to input from cornering force, achieving a balance of handling and ride comfort. The adoption of a hydro-compliance bushing reduced steering vibration at high speeds (Fig. 9).

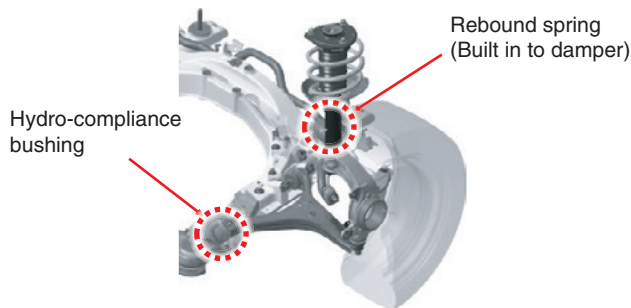


Fig. 7 MacPherson front suspension

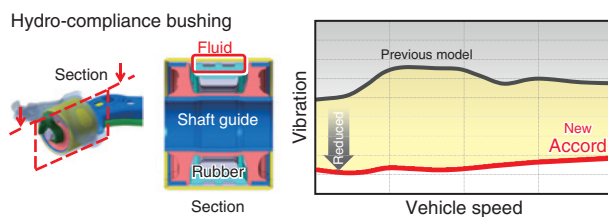


Fig. 8 Hydro-compliance bushing

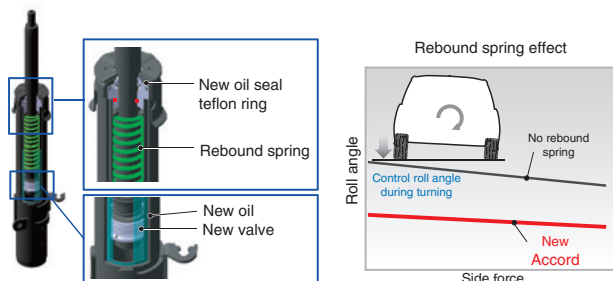


Fig. 9 Rebound spring

The multi-link double-wishbone rear suspension was continued, with the suspension bushings and dampers tuned to achieve superior running stability and greater ride comfort.

#### 4.3.2. Steering system

EPS with superior fuel efficiency performance was adopted as the steering system. The adoption of a non-contact type as the new torque sensor equipped to the EPS increased sensor detection accuracy at the start of steering operation and achieved a more linear steering feel (Fig. 10). The quick, light handling performance that was a strength of the previous model was evolved by the adoption of a quicker steering ratio. Moreover, the use of a highly rigid steering column reduced the amount of vibration transmitted to the steering wheel and enhanced the rigid feel when steering.

#### 4.3.3. Front subframe

For the front subframe, Honda has developed a proprietary manufacturing method of joining steel and aluminum that is a world first. The resulting hybrid steel and aluminum structure enabled a 25% reduction in weight and an 20% increase in rigidity relative to the previous model, in which this structure was made entirely of steel<sup>(1)</sup>. Newly developed Friction Stir Welding (FSW) was used for the dissimilar-metal welding of steel and aluminum. As this joining technology involves the application from above of a rotating tool under high pressure against an aluminum piece lapped over a steel piece, it results in the creation of an

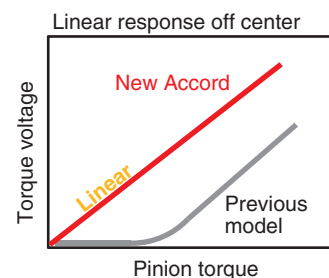
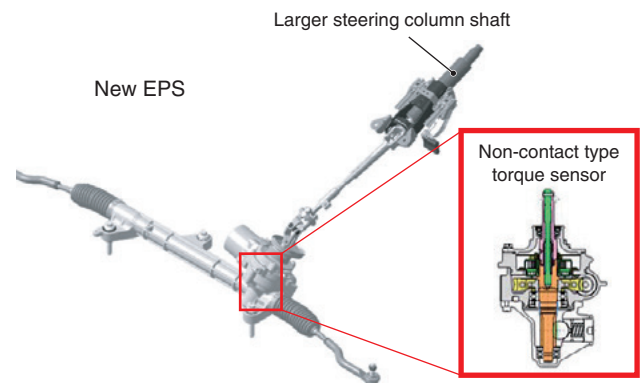


Fig. 10 EPS system

intermetallic compound of steel and aluminum as the tool advances (Fig. 11).

#### 4.4. Noise and Vibration (NV) Performance

In order to realize high-quality driving, detailed measures were taken to suppress unpleasant noise and vibration under a variety of driving and road conditions.

First, active noise control (ANC) was adopted in both the 2.4-L and 3.5-L vehicles. Active sound control (ASC) was newly adopted in addition to ANC in order to add generated sounds to the engine sound during acceleration and produce a pleasant acoustic quality. This reduces booming noise when the car starts moving and also realizes a linear engine sound synchronized with acceleration, producing a sporty feel (Fig. 12).

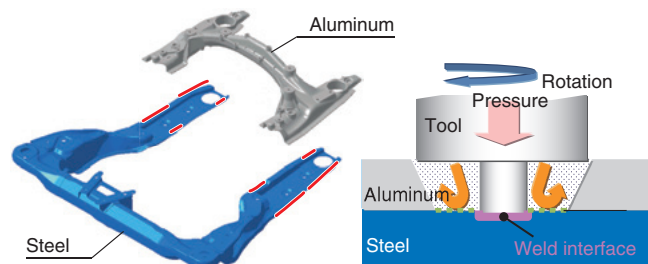


Fig. 11 FSW technology

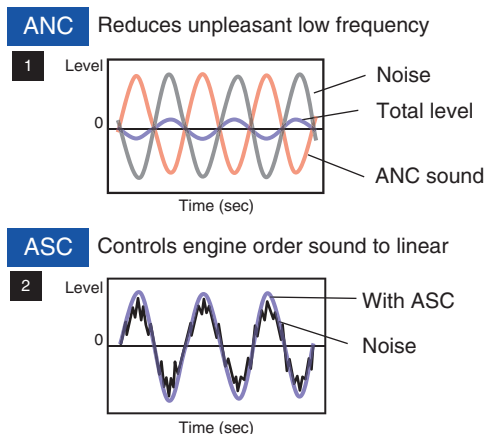
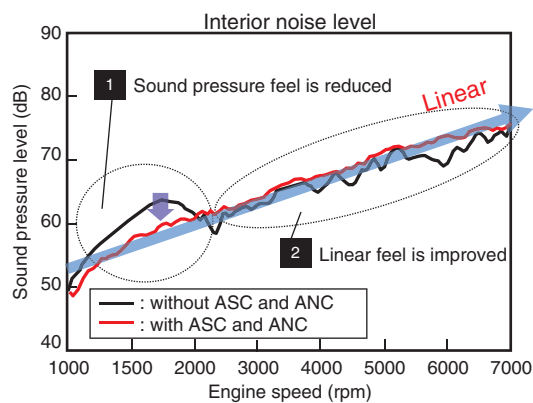


Fig. 12 Active noise control and active sound control

A specially designed muffler is used in the 3.5-L coupe in order to tune the exhaust sound. The ASC was also set to produce a sportier acoustic quality and volume, achieving a balance between impact during acceleration and refined quality when cruising.

In order to support the new model V6 engine that has higher mid-to-low-speed torque, the actuators of the active control engine mount (ACM) adopted for use on 3.5-L vehicles have been upgraded from 12V to 28V specifications for greater power (Fig. 13). Superior NV performance enables cylinder resting over a greater range and contributes to enhanced fuel efficiency performance.

Next, renovation of the front suspension, addition of dynamic dampers to the rear subframe, increased body rigidity for the suspension attachment structures, and other such measures have suppressed the transmission of vibrations that cause road noise. Then, the use of sound-absorbent material and acoustic insulation was expanded and various structural measures were devised. This involved providing the dashboard insulator with acoustic insulation functionality in addition to sound absorption by means of a triple-layer construction with a rubber layer sandwiched between felt layers. The number of places where urethane foam is inserted in the pillars was increased from six to 10, and thicker glass was used for the side windows as measures to reduce airborne road noise.

In addition, the wind noise suppression in the previous model, which was already at the top level for its class, was further increased. Superior body geometry was adopted for aerodynamic performance, the resting position for the front windshield wipers was lowered, and the flow of air from the engine hood over the front window glass was made smoother. The change in level between the front pillars and the front window glass was reduced by 20% or more, suppressing the turbulence in the air flow to the sides.

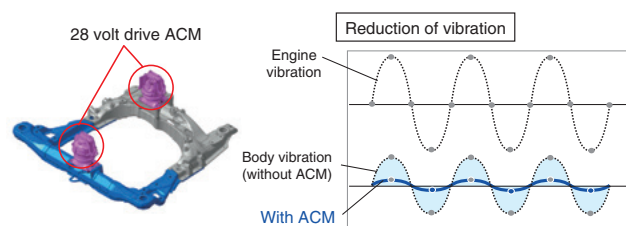


Fig. 13 Image of active engine mount control

## 5. Advances

### 5.1. Engine

The new model Accord engine applies EARTH DREAMS TECHNOLOGY, which is based on outstanding environmental performance and which pursues the joy

of driving found only with Honda. Specifically, it offers an L4 2.4-L DOHC i-VTEC engine that uses a direct injection system and is newly developed from the block up, or a newly developed V6 3.5-L i-VTEC engine that switches between low-speed and high-speed valve timing in addition to providing a cylinder cutoff system for increased power and torque relative to the previous model. Transmission options include a newly adopted Continuously Variable Transmission (CVT) (L4) and a six-speed automatic transmission (6AT) (V6), which together have also enhanced fuel efficiency performance (Fig. 14). These configurations (the CVT and 6AT for California) have also acquired designation as Super Ultra-Low Emission Vehicle (SULEV) and Partial Zero-Emissions Vehicle (PZEV), recognized for their clean performance under the California Air Resources Board (CARB) emissions regulations.

The L4 engine has Honda's proprietary VTEC and Variable Timing Control (VTC) systems, and in addition has a direct injection system (Fig. 15). By narrowing the valve inclination angle, the surface area of the combustion chamber was reduced to lower thermal loss. Steps were also taken to optimize the geometry of the intake ports and combustion chamber. These measures produced a powerful tumble flow within the cylinders, which promoted homogeneity of the air-fuel mixture and enhanced combustion stability. Detailed measures were also taken to reduce friction and lower weight, including the adoption of offset cylinders and a double-arm tensioner to reduce tensioner load from the timing chain.

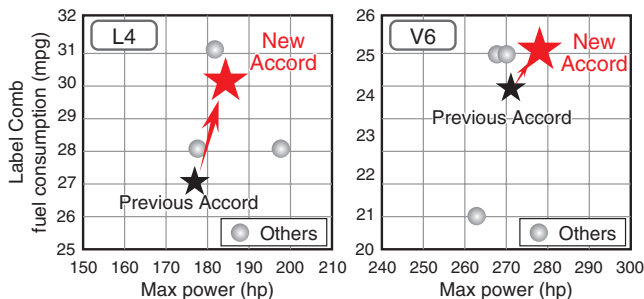


Fig. 14 Label FE-Power

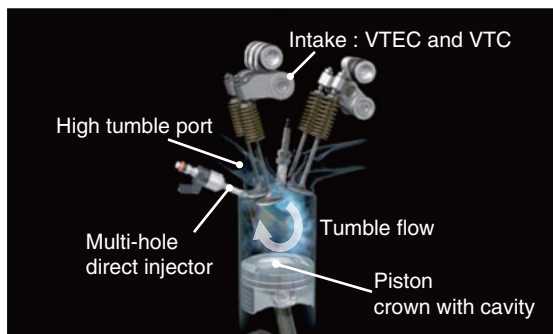


Fig. 15 Direct injection system

The V6 engine has a VTEC system that switches between low-speed and high-speed cams on the intake side of the front bank of cylinders, and a three-stage VTEC system that switches between a low-speed cam, a high-speed cam, and a cutoff cam on the intake side of the rear bank (Fig. 16). The low-speed cam has increased torque during three-cylinder combustion and expands the cylinder cutoff range. The high-speed cam has also increased power in the high-speed range.

## 5.2. Transmission

A high-precision CVT (Fig. 17) was newly developed for the L4 engine. The highly efficient CVT is capable of supporting the high torque of direct injection engines and making effective use of the range of greater engine efficiency, as well as advantageous use of its characteristic enhanced fuel efficiency. In addition, the G-Design Shift transmission control system, which provides immediate response to accelerator operation, gives drivers a feeling of linear acceleration (Fig. 18).

A new six-speed manual transmission was also developed to support the high torque of the direct injection engine and enhance both the driving experience and fuel

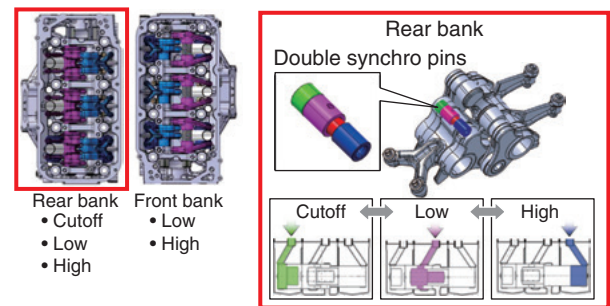


Fig. 16 VTEC structure

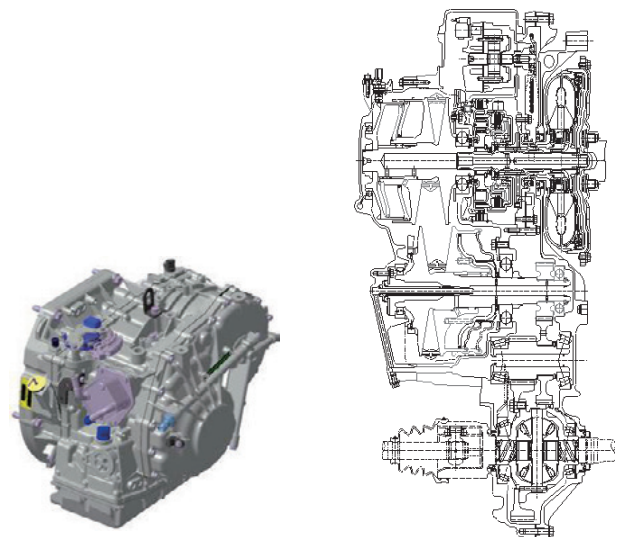


Fig. 17 CVT structure

efficiency. Inventive engineering of the structure and placement of every component achieved increases in strength and transmission efficiency while also realizing light weight and compactness on a par with previous five-speed manual transmissions.

A six-speed automatic transmission was newly adopted for the V6 engine in order to maximize the engine characteristics that enhance mid-to-low-speed torque and power. Expanding the gear ratio by multi-staging and expanding the lock-up range by means of a multi-plate lock-up clutch enhanced fuel consumption performance while also achieving driving with a solid, direct feel.

### 5.3. LED Headlights

LED headlights for the new Accord were developed to provide approximately twice the amount of illumination as halogen headlights for one-half or less of the power consumption (Fig. 19). The use of two projector headlights

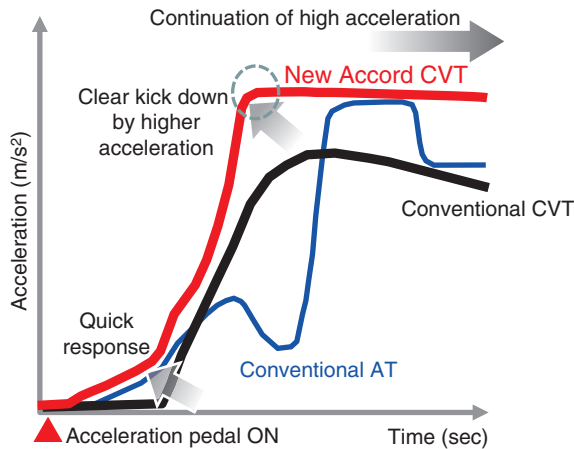


Fig. 18 Kick down characteristics



Fig. 19 LED headlight

employing five LEDs each achieved outstanding light distribution characteristics, increasing the driver's sense of security when driving at night by providing illumination over a wider area and greater distance (Fig. 20).

### 5.4. LaneWatch

The new model Accord was the first in the world to adopt the LaneWatch system (Fig. 21). This system has a camera built into the bottom part of the door mirror on the front passenger side that captures imagery across a range that cannot be covered with the door mirror and displays the imagery on an eight-inch high-resolution Wide-Video Graphics Array (WVGA) display. Compared to the approximately 20° angle of visibility with the door mirror, LaneWatch displays a range of approximately

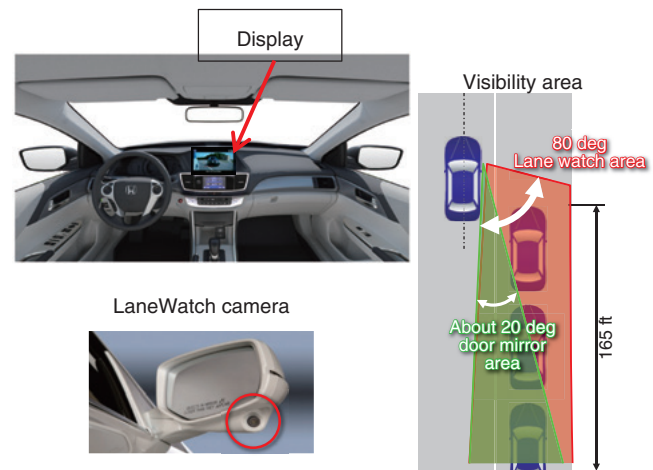


Fig. 21 LaneWatch system

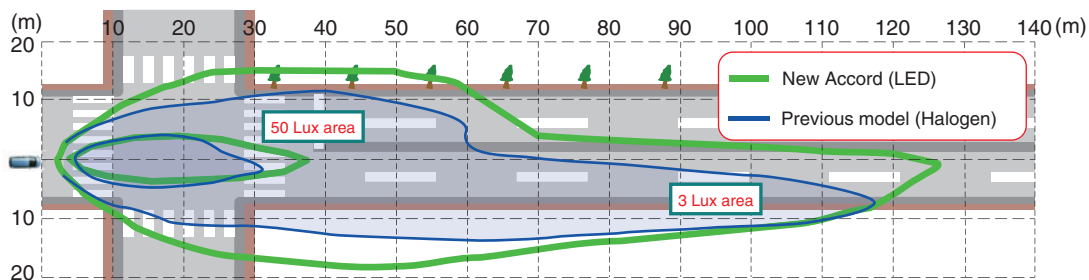


Fig. 20 Distributed headlight comparison

80°, enabling support in checking for vehicles to the rear side. Furthermore, the display is placed at a readily visible location on the upper instrument panel so that drivers can check without having to significantly divert their attention from the road. The display of guidelines also makes it easier to judge distances. Pressing the switch at the tip of the turn signal lever or turning on the right turn signal will bring up the camera imagery. Usability on vehicles equipped with navigation systems has been enhanced by enabling dual display of LaneWatch and the navigation system.

### 5.5. Forward Collision Warning System

The new model Accord has forward collision warning (FCW), which is a support technology for preventing collisions. In this system, a millimeter-wave radar placed in an opening in the front bumper or a monocular camera mounted inside the front windshield can detect vehicles ahead. When the car nears a detected vehicle and the system determines that there is a risk of collision, it warns the driver by blinking a dedicated heads-up warning (HUW) projected on the windshield, causing an FCW indicator in the gauge cluster to start blinking, and sounding a warning tone. The system allows for customization to enhance usability, so that system operation can be set to Normal, Short, or Long timing, and it can also be turned OFF.

### 5.6. Lane Departure Warning System

The new model Accord has lane departure warning (LDW), which is a support technology for preventing a car from inadvertently moving out of its current traffic lane. This system shares use of the FCW camera to detect lane markers on the left and right of the car's lane. If the system determines from the car's lateral velocity that it is about to depart from a detected lane, it causes an LDW indicator to blink in the gauge cluster and sounds a warning tone that is different from the FCW warning. In order to enhance usability, the system has a switch that allows it to be turned OFF or ON (Fig. 22).

### 5.7. Audio with Touch Screen

An audio system with touch screen (Fig. 23) was developed for the new model Accord. It has a 5.8-inch touch-sensitive color LCD panel in an easy-to-reach location. Only the necessary buttons and icons are displayed in large sizes on the touch screen so that users can select the desired operation quickly and easily. The system was also made capable of connecting with a variety of different sources such as Pandora, Aha (an Internet radio service), short message service (SMS), e-mail, portable audio players, and mobile telephones (by Bluetooth and USB connections).

### 5.8. Honda Link

The Honda Link used in the new model Accord supports Aha Radio, through which it can provide a variety of Internet services. When users connect their smartphone

(iPhone or Android) to it, Aha Radio can access web content such as Facebook, Twitter, Podcasts, Slacker Radio, traffic information, and restaurant information, and it also allows people to enjoy using software applications in the car.

### 5.9. Safety Performance

The highly evolved Advanced Compatibility Engineering (ACE™) body is one instance of the high standard of passive safety realized by the enhancements in this model. It represents a further advance in safety performance over the previous model, which had acquired five stars in the United States New Car Assessment Program (US-NCAP) and was named a Top Safety Pick by the Insurance Institute for Highway Safety (IIHS). The highly efficient body frame construction, the adoption of high-tensile steel with even greater strength, and other such measures have upgraded the impact absorption performance. This model has also been early in supporting the new small overlap collision rating introduced by IIHS, and the Federal Motor Vehicle Safety Standard (FMVSS) for rollover testing, which will be introduced in stages from September 2013.

#### 5.9.1. Small overlap support

The small overlap test is for a mode that envisions collision with standing trees and other such barriers. The car is run into a pole-shaped barrier with a 25% overlap at 64 km/h (40 mph).

Since the barrier impacts with the outside of the side frame, the issue is how the collision energy is to be

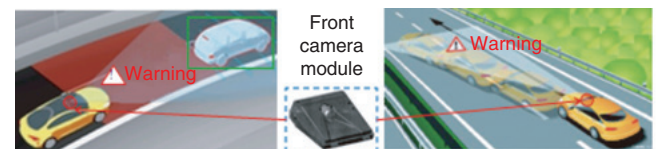


Fig. 22 FCW (Camera) and LDW image



Fig. 23 Audio with touch screen and 8-inch display

absorbed within the engine compartment. The new model Accord supports this by means of the Next Generation ACE™ body, which is an evolution of the ACE™ body adopted from the current model. The efficiency of the joint between the side frame and lower member has been increased and the lower members have been made higher-strength. Thus, collision energy can be absorbed effectively within the engine compartment by also using the side frame. Deformation of the cabin has also been limited by the use of high-tensile steel to reinforce the pillars, side sills, and roof rails (Fig. 24). These measures have achieved support of the small overlap impact with a lighter and more efficient body frame than vehicles without an ACE™ body.

### 5.9.2. Rollover support

Rollover support was provided by strengthening the cabin for small overlap support, increasing the roof strength to bear a greater load, and installing a rollover sensor. In the event of a roll, this helps increase occupant survivability while the rollover sensor provides optimized timing for deployment of the side-curtain airbags. In order to protect occupants' heads, the side-curtain airbags are constructed to enable them to remain in the deployed state (Fig. 25).

### 5.9.3. New side airbag construction

For the new side airbags (SmartVent™), two-layer construction was adopted to provide a high-pressure portion that deploys promptly and a low-pressure portion

that comes in contact with the occupant. This achieves a balance between mitigation of occupant injury during high-speed collisions and reduction of potential hazards to children and other occupants of the front passenger seat. As a result, there is no longer any need for the Occupant Position Detection System (OPDS) at the front passenger seat (Fig. 26).

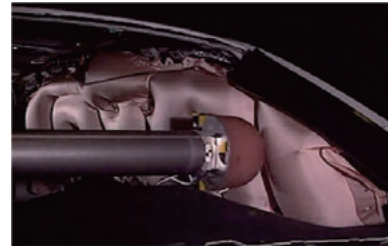


Fig. 25 Side curtain airbag

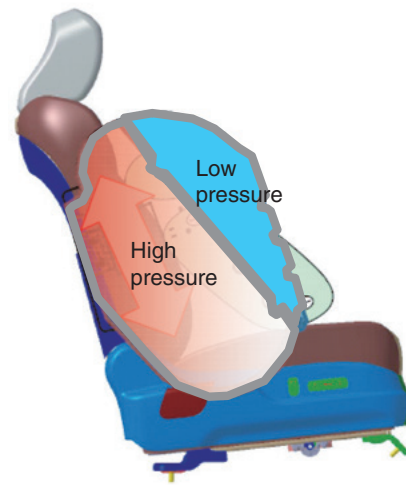


Fig. 26 Smart vent

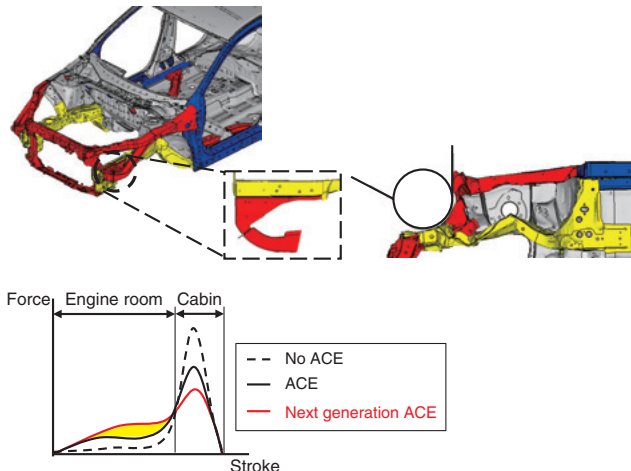
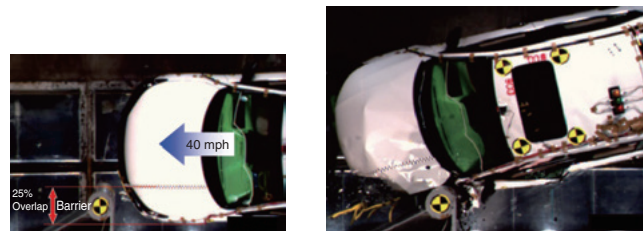


Fig. 24 Small overlap collision

## 6. Conclusion

The new 2013 model Accord for the North American market has a newly developed engine and platform and incorporates numerous new technologies. The above describes how the Honda team took on the challenge of building the world's most balanced sedan that would be chosen by users around the world. The vehicle that was produced as a result is an optimal family sedan that is matched to the needs of the future. Moreover, the coupe was given high-quality styling of dynamism and refinement within which the technology of the sedan is contained to ensure the achievement of a more aggressive vehicle.

The Honda team feels certain that customers will enjoy driving the new model Accord, and that it will enable them to experience the joy of driving and the joy of mobility in safety and comfort.

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