

Development of New Model LEGEND

Masahiro WATANABE*

Masafumi TAKITA**

Junichi FUKUDA*

Takefumi NAKAMURA**

Yasunori OKU**

Syoichi NEMOTO**

ABSTRACT

With the shrinking of the sedan market, the creation of new values for sedans is strongly demanded. Honda's luxury sedan, the LEGEND, is due for a full model change after an interval of nine years. The 2005 model year LEGEND has been developed with the aim of creating the ultimate luxury sedan brand of Honda and the attractive features expected of the luxury sedan class.

A good balance between excellent driving performance and fuel economy has been achieved with a lightweight and compact engine which has superb power performance, weight saving technologies, and SH-AWD to improve driving stability dramatically. The vehicle features the latest technologies such as iNVS and AFS, a driving support system to increase safety during night driving, and the latest safety equipment to reduce impact. The functional design of the spacious cabin, which appeals to the senses, and quietness in the cabin during driving present the driver and passengers with a relaxed and luxurious experience. These advanced technologies have been brought together in an ultimate sports sedan, the new LEGEND, which has new values and attractive features of "high quality as a luxury car" and "driving pleasure".

1. Introduction

Since the launch of its first generation as Honda's ultimate luxury sedan in 1985, the LEGEND has come to symbolize Honda's technological superiority. Recently, however, the Japanese sedan market has begun to shrink, and globally the production of flagship models in this class by major manufacturers has created an extremely competitive market situation. Nine years on from the launch of the third-generation model, the LEGEND therefore faced difficult prospects.

In designing a full model change for the fourth generation LEGEND, Honda therefore went back to basics in terms of what makes a driver's sedan. We have made an effort to

produce a vehicle which fulfills expectations of a Honda product and offers a superb level of driving pleasure, and succeeded in providing a sports sedan with highly advanced features and possessing a level of appeal unprecedented in the class.

The fourth generation LEGEND brings together Honda's most advanced technologies, in particular a lightweight and compact but powerful engine, weight-saving technology throughout and SH-AWD to dramatically improve driving performance. The technologies employed in the new LEGEND offer new values and attractive features, combining the high quality of a luxury vehicle and unparalleled driving pleasure.

* Wako R&D Center

** Tochigi R&D Center

2. Concept and Development Goals

The new LEGEND aimed to provide executives with a vehicle in which every moment they spent is a pleasurable experience, which allows them to make essential trips anywhere at any time in comfort and peace of mind without consideration of the hour or the weather, and which is in addition simply a pleasure to drive.

To achieve these goals, the latest driver support technologies were employed to achieve top-in-class dynamic performance. The design of the vehicle is such that its distinction and superb performance are recognizable at a glance. In addition, development aims of the new LEGEND included the integration of cutting-edge safety and environmental technologies and the achievement of a superb quality of fit and finish.

After in-depth study of the competition with the top-class European luxury sedans as the benchmark in this class, the following three specific targets for dynamic performance of the new LEGEND were set:

- (1) To achieve driving, cornering and stopping performance more advanced than that of European luxury sedans
- (2) To realize the world's top level of luxury and comfort
- (3) An original drive feeling for the LEGEND

3. Overview of the New LEGEND

In order to enable the realization of the goals, which are driving pleasure and a luxurious and comfortable cabin space as the concept of the new LEGEND, the specifications shown in Table 1 are adopted for the new LEGEND. In addition to the exterior styling of the vehicle shown in Fig. 1, the technologies and equipment discussed below have been employed to enable realization of these goals.



Fig. 1 Exterior styling of new LEGEND

Table 1 Comparison of vehicle specifications

	New Model	Previous Model
Overall length (mm)	4915	4995
Overall width (mm)	1845	1820
Overall height (mm)	1450	1435
Empty vehicle weight (kg)	1760	1690
Wheel base (mm)	2800	2910
Tire tread : front/rear (mm)	1575/1585	1550/1540
Tire size	235/50R17	215/60R16
Engine type	V6 SOHC VTEC	V6 SOHC
Engine displacement (l)	3.471	3.473
Power (kW/rpm)	221/6200	158/5200
Torque (N·m/rpm)	353/5000	312/2800
Transmission	5AT	4AT
Fuel capacity (l)	73	68
Minimum turning radius (m)	5.8	5.5
Riding capacity	5	5

3.1. Technologies for the Improvement of Dynamic Performance

- (1) Power plant technologies: To realize superb driving performance, the new LEGEND employed a new compact and high-power 3.5L V6 engine, and is also provided with a newly developed 5-speed automatic transmission (5AT).
- (2) Chassis technologies: The new LEGEND employed Super Handling All-Wheel Drive (SH-AWD). This new system enables independent control of the torque of all four wheels which increases both steering stability and the fidelity of the vehicle's cornering performance to the motion of the steering wheel, which dramatically improves driving performance. In addition, double wishbone suspension for the front wheels and multi-link suspension for the rear wheels have been adopted.
- (3) Materials: Ensuring weight savings is vital to the achievement of a balance between dynamic performance and fuel economy. Aluminum materials to be made by a newly developed production process have been employed in chassis components, including the suspension arms and the subframe. And magnesium has been employed for the engine head cover, the propeller shaft has been formed from carbon composite (CFRP), and aluminum and high-strength steel sheets have been used to achieve weight savings in the body.
- (4) Noise and vibration control technologies: To achieve a quiet and comfortable cabin, an anti-vibration rear subframe structure has been employed to improve vibration isolation and thus reduce the level of noise generated by vibration from the power plant and the road surface. New high-efficiency soundproofing materials have also been employed, and the use of active noise control to reduce the level of low-frequency noise has enabled the weight of the soundproofing to be reduced.

3.2. Environmental and Safety Technologies

- (1) Driver support technologies: A Collision Mitigation Brake System (CMS) and HiDS have been employed to increase the driving safety of the new LEGEND. The

safety of night driving has also been a consideration, and the vehicle is fitted with a night vision system and Adaptive Front Lighting System (AFS).

- (2) Collision safety technologies: The new LEGEND does not merely comply with the latest safety regulations, but employs Honda's proprietary crash compatible and pedestrian impact mitigation body technologies to achieve a top-in-class level of safety performance. The vehicle is fully equipped with advanced safety features, including side curtain airbags as standard.
- (3) Environmental technologies: The employment of a high-precision A/F control system, among other measures, has enabled the new LEGEND to comply with 2005 exhaust emission standards. The vehicle also employs a wide range of other environmentally friendly measures and technologies: acrylic urethane is now used instead of PVC in the undercoat, non-toxic trivalent chromium has replaced hexavalent chromium as the plating material for nuts and bolts, and the purification performance of the catalyzer has been improved and the odor of sulfur reduced.

The next section will discuss target performance and the methods used in its achievement, in addition to offering an overview of the technical details and the performance of the most important of the technologies mentioned above.

4. Vehicle Performance and Main Technologies

4.1. Design

4.1.1. Packaging

The design concept for the new vehicle stressed high-density packaging to balance a level of compactness able to maximize dynamic performance with the comfort and spaciousness demanded of a luxury sedan.

Through the adoption of measures including lowering the floor to change the driving position and modification of the trunk hinge to reduce the rear overhang, the overall length of the vehicle has been reduced and cabin space has been increased against those of the previous model (Fig. 2).

The design of the instrument panel offers the driver ample space around the knees and in combination with careful design of the upper section of the door linings, offers users a sense of enfoldment and luxury. As a result of these painstaking designs, the cabin offers users just the right sense of being safely enfolded during sporty driving while providing a deep and relaxing sense of comfort when the vehicle is cruising.

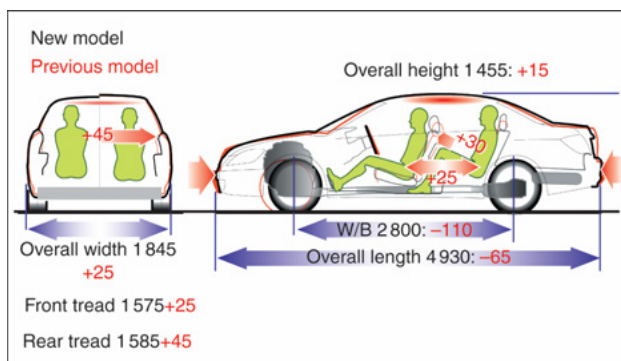


Fig. 2 Comparison of packaging design of new model and previous model

4.1.2. Exterior

"Emotional Ingot Design" was established as the concept for exterior design. This concept stressed a strong sense of integration that had at the same time a powerful emotional appeal (Fig. 3).

At the front of the vehicle, the sporty feel is expressed in the wide and low stance produced by the low hood and sharp grille.

Seen from the side, the vehicle's sporty framework gives it a powerful sense of integration, with the form flowing back in a single smooth motion from the low, sculpted hood to the cutaway rear deck. The side windows have also been made perfectly flush with the body to offer superb aerodynamic performance.

At the rear, the vehicle's wide stance, wide tires and flat twin silencers further express its sportiness. At the same time, production by aluminum blow molding gives the lid of the trunk a superb tautness, offering the elegance entirely appropriate to a luxury vehicle.

The integration, aerodynamics and wide stance of the new LEGEND's sporty framework and its details established in accordance with craftsmanship give the vehicle elegance which is suitable for a luxury vehicle. The superb integration of framework and detailing produces the embodiment of advanced luxury sedan design.



Fig. 3 Exterior design concept for new LEGEND

4.1.3. Interior

The interior design of the vehicle was based on the concept of "Sensuous Functionality," a functional design appealing to the senses, and aimed to bring together driving pleasure and a superbly comfortable, relaxing cabin space (Fig. 4).

The instrument panel is strongly slanted to produce an open form, and a new, organic surface treatment has been applied to the materials, resulting in a richly expressive design. Information systems, such as the navigation monitor, have been positioned to allow the driver to check the vehicle's status while driving with only minimal movement of the eyes. The superbly designed layout of the driving equipment, and the new technologies, including a multi-function controller, voice control system and paddle shifters, creates a space in which the driver can carry out all driving operations without changing his or her posture and can concentrate exclusively on driving.

The three large, independent, circular meters employed in the previous model have been further evolved for the new



Fig. 4 Interior design concept for new LEGEND

LEGEND, with a design that gives them a more three-dimensional feel and a sense of balance and sophistication.

The wood grain connecting the right and left and center panels respectively form an area of unified design. This new design sensibility offers not only structural power but also a condensed feel and a feel for the raw materials as a new value for sensuousness, and produced a superbly comfortable space.

The seats, increased in size and designed to hold their occupants more firmly, are soft and luxurious, thus contributing to the comfort and luxury of the overall cabin space.

4.2. Engine Performance

The concept for the new LEGEND power plant stressed driving performance and environmental performance in advance of its class. In order to realize this concept, the V6 SOHC-VTEC engine employed in the U.S. MDX was selected as the base engine for power train design, and the following basic performance targets were established:

- (1) Top-in-class power performance
- (2) Low emissions (75% less than stipulated in 2005 Japanese emissions standards)

4.2.1. Overview of engine and main specifications

Figure 5 shows a view of the engine. The power performance of the engine is shown in Fig. 6, and the main specifications in Table 2.

Both maximum power and maximum torque have been significantly increased against the engine of a previous model. This engine brought driving performance suitable for a luxury vehicle.



Fig. 5 View of V6 SOHC-VTEC engine

Table 2 Comparison of main engine specifications

	New Model	Previous Model
Engine type	60° V6 SOHC VTEC	90° V6 SOHC
Displacement	3471 (cc)	3473 (cc)
Compression ratio	11.0	9.6
Fuel	Premium	Premium
Max. power	221/6200 (kw/rpm)	158/5200 (kw/rpm)
Max. torque	353/5000 (N·m/rpm)	312/2800 (N·m/rpm)
Transmission	5AT	4AT
Fuel economy	8.6 (10-15mode)	8.7 (10-15mode)
Emission	J-SULEV ★★★★★	J-LEV ★★

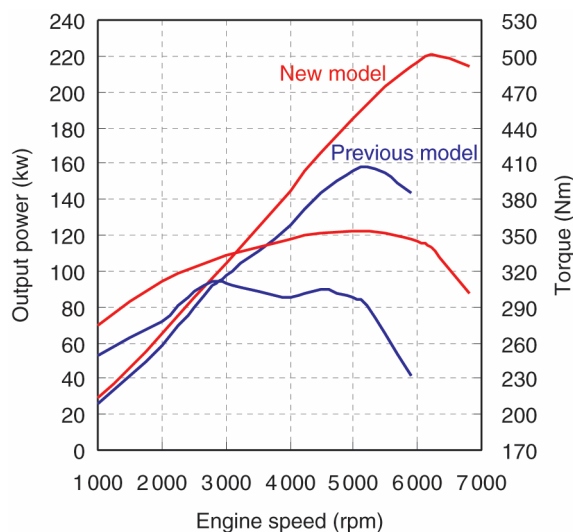


Fig. 6 Comparison of output performance of engine in new and previous models

4.2.2. Environmental performance

Figure 7 shows the configuration of the system employed to achieve the low emissions target. The engine is provided with an independent emission control system for each bank of cylinders. In addition, the employment of a high-precision A/F control system has resulted in the achievement of a 75% reduced emissions level, the 2005 Japanese standard, enabling the vehicle to take a four-star emissions rating in recognition of its superb environmental performance.

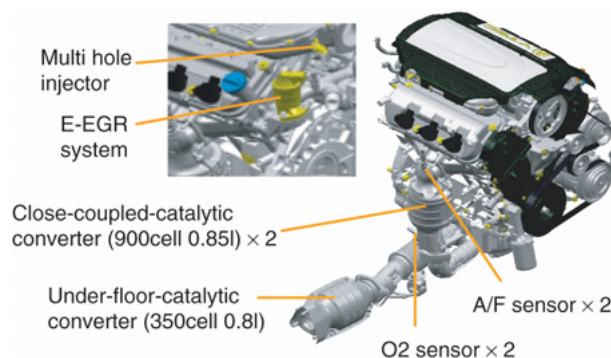


Fig. 7 Emission control system

4.3. Vehicle Performance

4.3.1. Collision safety performance

In terms of collision safety performance, the aim for the new LEGEND was to achieve the top level in collision safety evaluations carried out by the J-NCAP, the US-NCAP and the IIHS, as befits Honda's flagship model. To achieve this, a polygonal framework has been employed and its cross-section increased in size, the bending mode during collision has been controlled and the efficiency of restraint devices has been increased, reducing the deformation of the vehicle and improving occupant restraint performance and resulting in the achievement of a top-in-class level of collision safety performance.

The carbon fiber reinforced plastic (CFRP) propeller shaft was developed and employed for the new LEGEND. The CFRP tubes and the joints of the stabilizer shafts employed have been designed to collapse with the rearward motion of the engine in a collision, enabling collision energy to be absorbed.

The new LEGEND features Dual-Stage Front Airbags (SRS), front-side airbags with a passenger-side Occupant Position Detection System (OPDS), and a side curtain airbag system as standard safety equipment. Large side airbags have been employed to further increase the level of passenger protection.

The new LEGEND employs an Advanced Compatibility Engineering (ACE) body structure which represents a further advancement of Honda's proprietary G-force Control (G-CON) collision safety technology. The body effectively disperses and absorbs collision energy, and not only improves the self-protection of small vehicles, but also improves partner protection in large vehicles⁽¹⁾.

4.3.2. Overview of body

High-tensile strength steel was used in 50% of the steel sheets of the new LEGEND body, and part of the framework employs higher-strength 780 MPa class steel sheets which have been subjected to induction hardening. The employment of high-tensile steel sheets, in combination with high-efficiency joining of each section of the framework, has not only resulted in higher collision safety performance, but has also increased driving stability, improved NVH performance and reduced the weight of the vehicle. To achieve further weight savings, the external sheet of the hood⁽²⁾, the front fender and the trunk have been formed from aluminum, as shown in Fig. 8. High-speed blow molding is used to produce the front fender and the trunk, enabling the achievement of a smooth sculptural form unattainable with the former press stamping. Aluminum is also employed in the front to rear bumper beam.

The efficient placement of high-tensile strength sheets

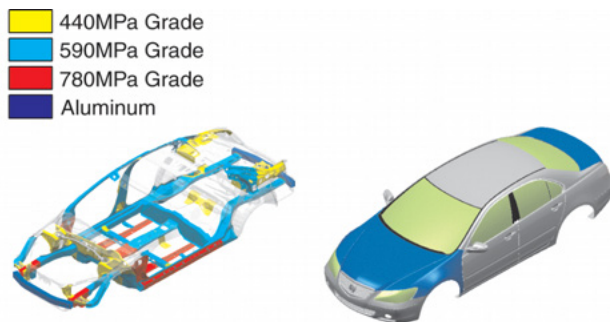


Fig. 8 Application of high-strength steel and aluminum in body construction

new model against the former model to only around 4%. It has also enabled weight reduction of components which are distant from the vehicle's center of gravity, thus reducing the inertial moment of the roll axis by approximately 5% despite the increase in the weight of the vehicle.

4.4. Advanced Technologies

In order to achieve the highest safety performance, in addition to improving visibility performance, the latest and most advanced technologies have been employed in the new LEGEND.

4.4.1. Intelligent Night Vision System

70% of pedestrian fatalities occur at night, and most of them are accidents involving pedestrians who are crossing the road or walking at the side of the road⁽³⁾ when the vehicle is traveling on straight roads.

An Intelligent Night Vision System (iNVS) has been employed in the new LEGEND to reduce these accidents. This system processes stereo infrared images to enable it to detect the movements of pedestrians and judge the distance between the pedestrians and the vehicle. Together with a warning buzzer, a highlighted image of the pedestrian is shown on a head-up display (HUD) (Fig. 9). This system supports the driver in recognizing the presence of pedestrians approaching the road on which the vehicle is traveling at night⁽⁴⁾.



Fig. 9 Example of HUD image

4.4.2. Adaptive Front Lighting System

The new LEGEND employs an Adaptive Front Lighting System (AFS) to further improve the driver's ability to locate pedestrians and to make it easier to judge the road situation at night. When the vehicle is cornering or traveling on a curve, the headlights on the inner wheel side turn in response to the steering angle and vehicle behavior. This illumination of AFS gives the driver better visibility during driving than the conventional front illumination (Fig. 10).

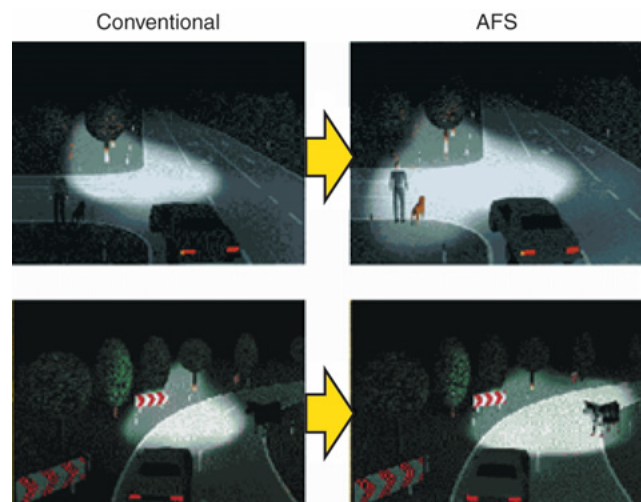


Fig. 10 Comparison of lighting performance

4.4.3. Collision Mitigation Brake System

The new LEGEND has been equipped with Honda's Collision Mitigation Brake System (CMS), already employed in the INSPIRE and other vehicles to help prevent rear-end collisions and mitigate injuries when collisions do occur.

4.4.4. HiDS

In the LEGEND equipped with HiDS, a newly developed pinion assist-type electronically controlled power steering system (EPS) was used. This EPS system employs a brushless motor to provide high-efficiency and high-power control. It has resulted in a reduction of steering wheel inertia relative to standard EPS vehicles and the achievement of a luxurious steering feel.

4.5. Steering Stability and Riding Comfort

The LEGEND aims to balance the achievement of luxurious driving at the top of the vehicle's class with high-performance driving, that is, running, cornering and stopping, using application of handling improvement technology based on the newly developed SH-AWD system⁽⁵⁾.

4.5.1. Suspension/subframe

Aluminum materials have been used throughout the suspension and the subframe, at both front and rear, to reduce weight at the same time as achieving high rigidity⁽⁶⁾. A double wishbone suspension system has been employed at the front of the vehicle, while an in-wheel multi-link system is used at the rear (Fig. 11).

The improvement of steering feel, roll feel and the responsiveness of the vehicle were important design aims. The front-rear roll axle has been designed to slope downwards from the rear to the front of the vehicle⁽⁷⁾, which has improved responsiveness. With the theory of a three-link virtual arm⁽⁸⁾, the length of the virtual arm and the positioning

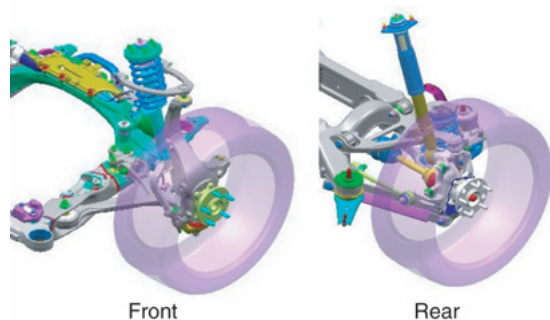


Fig. 11 View of suspension of new LEGEND

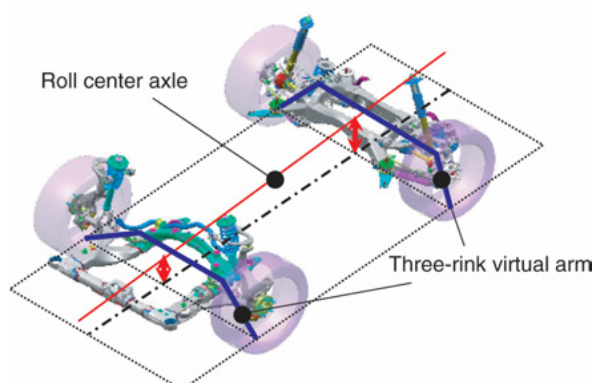


Fig. 12 Concept of suspension system

of the roll axis were decided with consideration of the reduction of jacking phenomenon (Fig. 12).

Correction of the locus inclination angle of the wheel centers⁽⁹⁾ and increasing the size of the compliance bushing and the subframe mount bushing have reduced harshness, leading to increased riding comfort. In addition, low and wide positioning of the subframe mount has both increased steering stability and improved NVH performance.

4.5.2. Steering

Electronically controlled speed-responsive hydraulic power steering was employed. A motor torque assist control valve unit controlled by the ECU enables the system to apply the correct amount of assist in response to the speed of the vehicle, ensuring steerability from low to high speeds (Fig. 13).

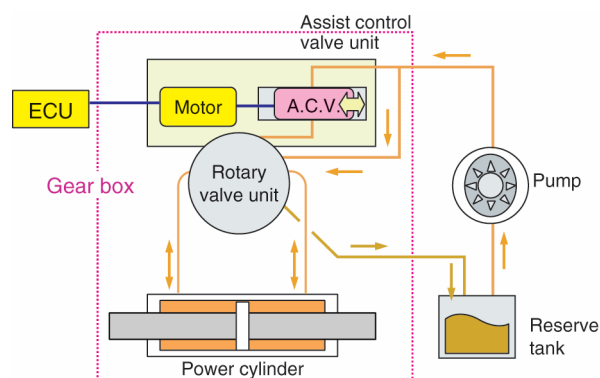


Fig. 13 System of ECPS system (Electronically controlled power steering)

4.5.3. Brakes

To achieve high levels of performance from the brakes while ensuring that they are lightweight and high-rigidity, high-diameter ventilated disks have been used in the front and rear brake system, aluminum opposed 4-pot calipers have been used in the front and aluminum body collet calipers in the rear (Fig. 14). In addition, ECU tuning (including provision with dedicated logic) has been carried out to match the performance of Vehicle Stability Assist (VSA) with that of SH-AWD.

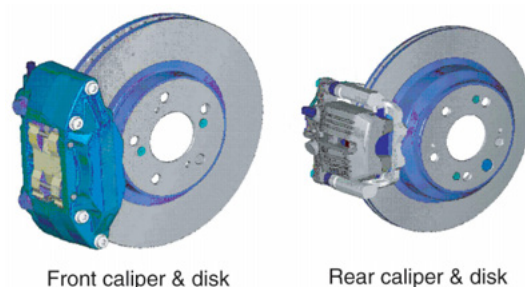


Fig. 14 Front & rear brakes

4.5.4. Aerodynamic performance

The new LEGEND demanded improvement of stability at high speeds, as expected of a luxury sporty vehicle, and for the front and rear lift balance to be fitted for the high stabilizing potential of SH-AWD. In order to satisfy these requirements, aerodynamic drag has been reduced through the technology of optimization of the body shape, such as flush surface side windows, and of the airflow around the

underfloor section by employment of large underfloor covers and rear defusers (Fig. 15).

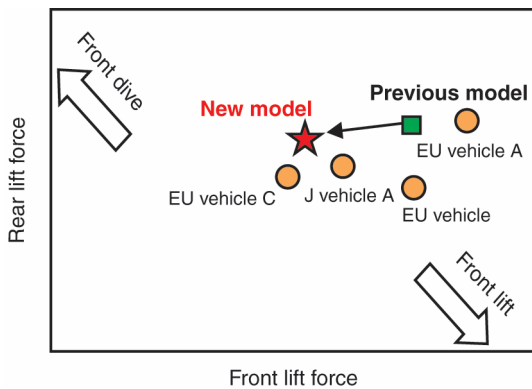


Fig. 15 Map of front & rear lift balance

4.6. Noise and Vibration

The employment of a high-power 221 kW engine, the SH-AWD system and large-diameter wide tires are detrimental to NVH performance. Against this background, the new LEGEND required the ambitious target of a level of engine noise and road noise suitable for a luxury vehicle. The following technologies gave the LEGEND the top level of cabin quietness, which equals and surpasses that of European competitors in this class.

4.6.1. Rear differential mount system

A sub-frame supported with rubber mountings can isolate the high frequency vibrations from differential gear box to body, however, there are vibration modes in which the sub-frame and the differential resonate at low frequencies. In such cases, these vibrations increase in amplitude and are transmitted to the body. A methodology to prevent resonance caused by vibration between differential and sub-frame is necessary. A sub-frame supported with rubber mountings is employed to reduce road noise; in addition, the new LEGEND employs the rear three-mount system shown in Fig. 16, with two mounting points at the front left and right and one mounting point at the rear left. This supporting system of the rear differential can control the pitching mode of the sub-frame, and thereby reduce the amplitude of vibration of the sub-frame.

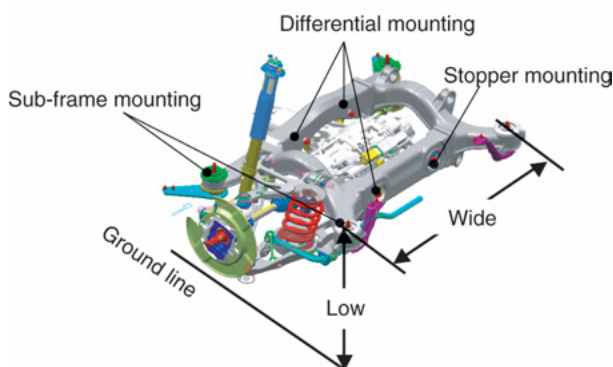


Fig. 16 Rear differential mounting system

4.6.2. Lightweight soundproofing package

The highly sound-absorbent but lightweight materials employed in the new LEGEND's soundproofing system have significantly reduced high-frequency noise, increasing the

level of quietness of the vehicle.

Soundproofing has been employed throughout the interior, and includes a dash insulator, floor carpet, roof lining and trunk lining. The new soundproofing has increased the quietness of the vehicle while enabling the weight of the soundproofing system to be significantly reduced relative to that employed in the previous model (Fig. 17).

In order to design for acoustic sensitivity in the cabin, statistical energy analysis (SEA)⁽¹⁰⁾, the latest method to study the configuration of soundproofing packages, was employed to enable the amount of sound insulation materials required as a result of the increased weight of the vehicle to be minimized.

As a result, an excellent balance has been achieved between weight savings and quietness, and the quietness of the new LEGEND excels that of the previous model despite the fact that its soundproofing package weighs only approximately 30% as much.

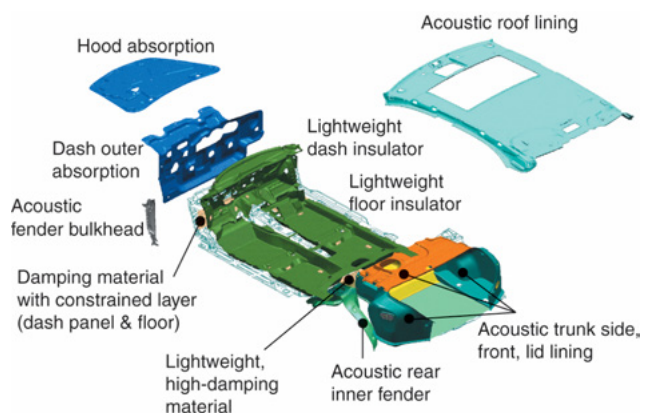


Fig. 17 Lightweight soundproofing materials

4.6.3. Exhaust system

The exhaust silencer (muffler) has been provided with variable exhaust valves to balance high flow with a high level of quietness. This enables engine power targets to be achieved while controlling exhaust noise and increasing cabin quietness at medium engine speeds using the minimum capacity of the exhaust silencer.

4.6.4. Active noise control

Active noise control (ANC) system has been employed in the new LEGEND to balance the level of quietness expected of a luxury vehicle with the achievement of the sportiness established as a goal for the new vehicle (Fig. 18). This has significantly reduced the large power level of low-frequency booming noise produced by resonance in the exhaust system, resulting in the achievement of both the target level of quietness and a linear sporty sound in the cabin.

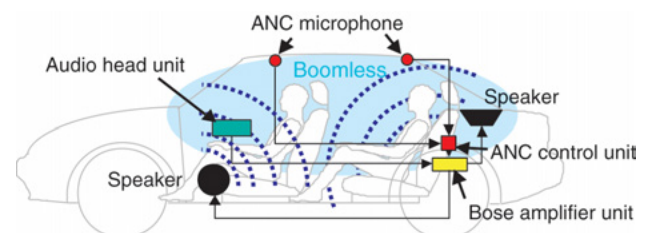


Fig. 18 Active noise control system

5. Conclusion

After an interval of nine years, the LEGEND has undergone a full model change with the new 2005 model. There are some of the world's finest vehicles in this luxury car class. In this class, the new LEGEND was required to create new value as an ultimate luxury vehicle, which other luxury vehicles do not have, and to create new attractive features as the LEGEND brand.

Among its many features, the new LEGEND is provided with an engine with superb dynamic performance, SH-AWD to dramatically improve driving stability, a range of weight saving technologies, advanced driver support technologies to increase safety, and ample safety equipment and body technologies that have enabled the vehicle to achieve the top results in the latest collision safety performance evaluations.

The new LEGEND is Honda's ultimate sports sedan, a vehicle possessing new values and attractive features and combining the quality of a luxury vehicle with driving pleasure. The 2005 LEGEND is worthy of taking its place as a part of Honda's ultimate luxury sedan brand.

This project succeeded with the generous assistance of many individuals from Honda and other companies. The authors wish to take this opportunity to thank all those who offered their assistance in the project.

References

- (1) Yoshimoto, T., Taguchi, Y.: Innovative Body Structure for Compatibility, 2004 JSAE Annual Congress Proceedings, No. 45-04, p. 11-14 (2004)
- (2) Hayashi, N., Ando, K., Kashiwagi, M.: Development of Aluminum Hood for 2005 Model Year LEGEND, Honda R&D Technical Review, Vol. 16, No. 2, p. 17-22
- (3) Asanuma, N., Kawai, M., Takahashi, A., Tsuji, T.: Introduction of HONDA ASV-2 (Passenger cars), HONDA R&D Technical Review, Vol. 12, No. 2, p. 1-8
- (4) Tsuji, T., Hattori, H., Watanabe, M., Nagaoka, N.: Development of Night Vision System (Collision avoidance system to the pedestrian), Honda R&D Technical Review, Vol. 13, No. 1, p. 151-158
- (5) Kunii, R., Iwazaki, A., Atsumi, Y., Mori, A.: Development of SH-AWD (Super Handling-All Wheel Drive) System, Honda R&D Technical Review, Vol. 16, No. 2, p. 9-16
- (6) Fukuchi, F., Yabane, T., Akiyama, H., Ogawa, T., Iwasaki, H., Hori, I.: Development of Aluminum Subframe Using Hot Bulging and Vacuum Die Casting, Honda R&D Technical Review, Vol. 16, No. 2, p. 23-30
- (7) Higuchi, M., Taneda, K., Shibahata, Y., Minagawa, M.: A Theoretical Study of Influence of Roll on Vehicle Dynamics (First Report), Transactions of Society of Automotive Engineers of Japan, Vol. 33, No. 4, p. 121-126
- (8) Teruo, M., Uemura, H.: On Development of Vehicle Dynamics by Means of a Digital Computer, SAE paper690233, p. 987-999 (1969)
- (9) Ninomiya, J., Ninagawa, M., Orimoto, Y., Nakahara, J.: Measurement Technique of Force Transmitted from Road Surface to Tire during Actual Driving and

Application, HONDA R&D Technical Review, Vol. 9, p. 148-155

- (10) Misaji, K., Tada, H., Yamashita, T., Kokabu, S., Tanaka, H., Koshigoe, S.: Hybrid SEA Modeling Scheme for Analysis of High-Frequency Noise in Passenger Car, 2004 JSAE Annual Congress Proceedings, No. 72-04, p. 13-18 (2004)

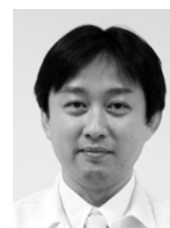
■ Authors ■



Masahiro WATANABE



Masafumi TAKITA



Junichi FUKUDA



Takefumi NAKAMURA



Yasunori OKU



Syoichi NEMOTO