Ninja 250/300 — A strategic global model beyond its class

Motorcycles with an engine displacement of 250 cm^3 represent a class that is increasingly popular as entry models in developed nations, and as high-end models in emerging countries. The first Ninja 250R model went on to achieve an outstanding sales record around the world after being introduced in this class in 2008. This paper will examine the distinct characteristics of the second generation model Ninja 250/300, and the engine and chassis technologies that underpin its exceptional product appeal.

Preface

Launched in 2008, the first generation Ninja 250R (Fig. 1) recorded favorable sales by being positioned as a high-end model in emerging countries such as Indonesia and Brazil, and as an entry model in developed nations including the U.S. and Japan. As such, it has established a position as Kawasaki's strategic global model. Not in the least content with the success of the predecessor model, we sought further improvements in the successor model Ninja 250/300 with the ambitious goal of developing a peerless model that transcends its class.

1 Product concept and design policy

(1) Product concept

The predecessor model achieved its success based on the product concepts of "supersport looks" and "ease of riding." In developing this model, we sought to create a definitive "Ninja Entry" that embodies the quintessential product appeal and marketability of the Ninja brand.

(2) Design policy

(i) Engine

To meet the needs of each market, we developed two types of engines with displacement of 249 cm^3 and

Fig. 1 First generation model Ninja 250R

Table 1 Main Specifications

		Ninja 250	Ninja 300
Engine	Displacement (cm^3)	249	296
	Bore × Stroke (mm)	62.0 × 41.2	62.0 × 49.0
	Maximum output (kW/rpm)	23.0/11,000	29.0/11,000
	Maximum torque (N･m/rpm)	21.0/8,500	27.0/10,000
	Compression ratio	11.3	10.6
Chassis	Length × Width × Height (mm)	2,020 × 715 × 1,110	2,015 × 715 × 1,110
	Wheelbase (mm)	1,410	1,405
	Frame type	Diamond	
	Seat height (mm)	785	
	Curb weight (kg)	172	
	Front tire	110/70-17M/C 54S	
	Rear tire	140/70-17M/C 66S	

296 cm^3. The Ninja 250, equipped with a 249 cm^3 engine, featured an improved intake and exhaust system to meet the engine performance requirements of each country. For the 296 cm^3 model Ninja 300, numerical targets including the following were established as compared with the predecessor model.

① Improve the maximum speed by 10 km/h.

② Reduce the acceleration time from 0-400 m by 0.7 seconds.

③ Ensure at least an equivalent driving force in the next higher gear.

(ii) Chassis

In order to further improve the ride comfort and a sense of high quality valued by the target customers, we achieved reduced vibration, improved shock absorption, and reduced hot air from the radiator felt by the rider, and adopted a digital speedometer. This also became the first Kawasaki motorcycle in its class to offer an ABS model.

(iii) Design

To make its Ninja heritage unmistakably clear, we adopted a styling based on the same design philosophy as the higher-end models of the Ninja series.

(3) Main specifications

The main specifications of the Ninja 250 and the Ninja 300 are shown in Table 1.

2 Engine related technology

(1) Assist & Slipper Clutch (Fig. 2)
— Featured on the Ninja 300

A clutch is a mechanical device to engage/disengage the power transmitted from the engine to the transmission. The transmission of power is achieved by pressing down the friction material with a spring.

Although the power to be transmitted increases with

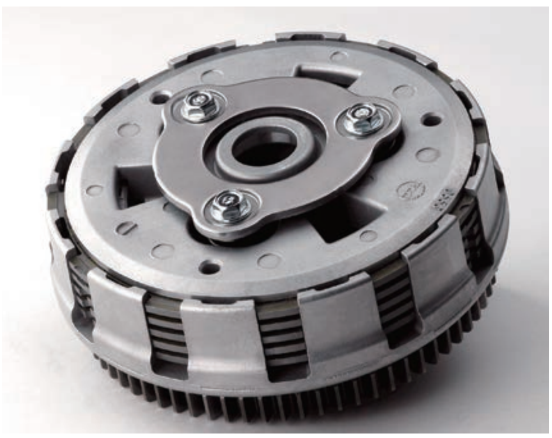


Fig. 2 Assist & Slipper Clutch

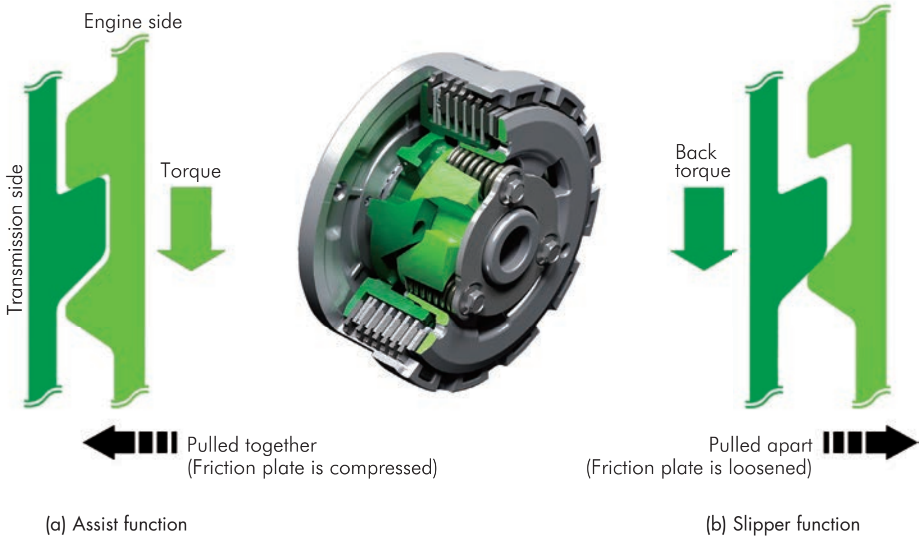


Fig. 3 Cam mechanism of the Assist & Slipper Clutch

the displacement, when the spring load is increased in response to this, the load of the clutch lever increases and makes it difficult for the rider to operate the clutch. To address this issue, an F.C.C. clutch equipped with an assist function for the clutch lever grip was adopted.

Under reduced clutch spring load, the friction material begins to slip when excessive power is transmitted. This problem was resolved by incorporating a cam mechanism. As soon as the parts begin to slip and move away from their relative positions, they are pulled together to produce an effect similar to being pressed by a spring, thereby controlling the slippage (Fig. 3 (a)). This resulted in a 20% increase in displacement, and a 25% reduction in the clutch lever load.

This cam mechanism is also equipped with a slipper function that operates in the direction that reduces the spring load, when a large back-torque is applied when braking (Fig. 3 (b)). This causes the clutch to slip, which helps prevent the hopping of the rear tire during deceleration and maintain stability when braking.

(2) Heat management

"Increased comfort against hot engine air" was highly demanded by riders in Southeast Asia. To ensure this strategic global model meets this need, we aimed to reduce the hot air from the radiator to a barely noticeable level. We particularly focused on finding a way to direct the hot air from the radiator fan away from the rider while idling. To this end, we developed a radiator fan cover as shown in Fig. 4.

This cover enables the hot air to be discharged away from the rider, as shown in Fig. 5. The temperature

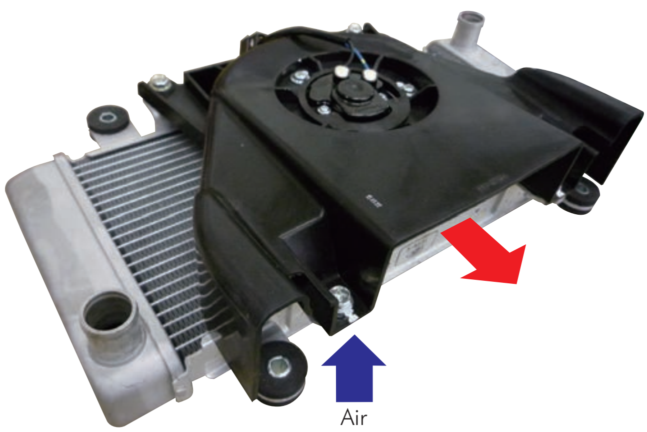
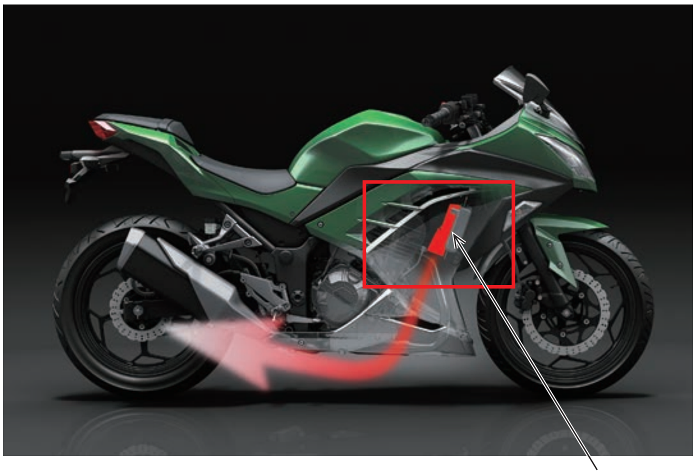
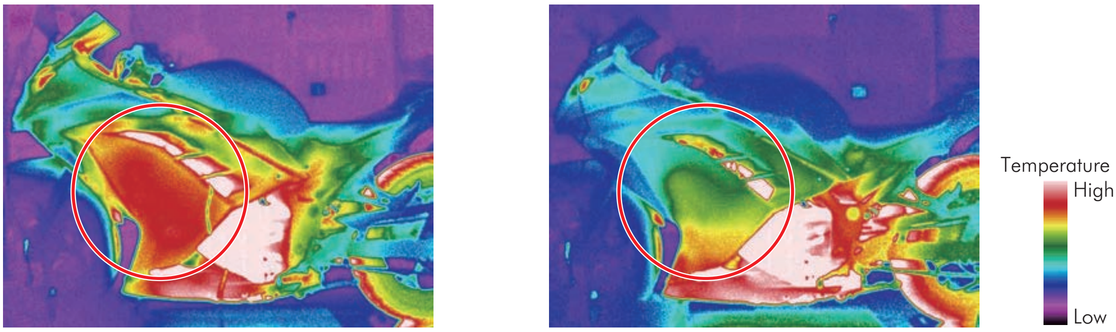


Fig. 4 Radiator fan cover



Radiator fan cover

Fig. 5 Flow of hot air with radiator fan cover attached



(a) Without fan cover

(b) With fan cover

Fig. 6 Effect of the radiator fan cover on temperature distribution

distribution with and without the fan cover attached is shown in Fig. 6. It is clear that the cowl surface temperature remains low with the cover attached, and the heat is dissipated instead of being accumulated inside the cowl.

This cover was also effective in reducing the temperature of the electrical components located above the engine.

(3) Complex cross-section short muffler

In order to conform to noise regulations, generally it is necessary to increase the muffler volume as the displacement is increased. However, in order to design a sportier motorcycle, the muffler needs to appear as small as possible. Therefore, in the predecessor model, the catalyst arranged inside the muffler was housed inside an upstream joint pipe, to increase the effective capacity of the muffler and maintain an equivalent volume. Furthermore, the cross-section was changed to a complex trapezoidal shape from a round shape (Fig. 7), which

Fig. 7 Short muffler with complex cross-section

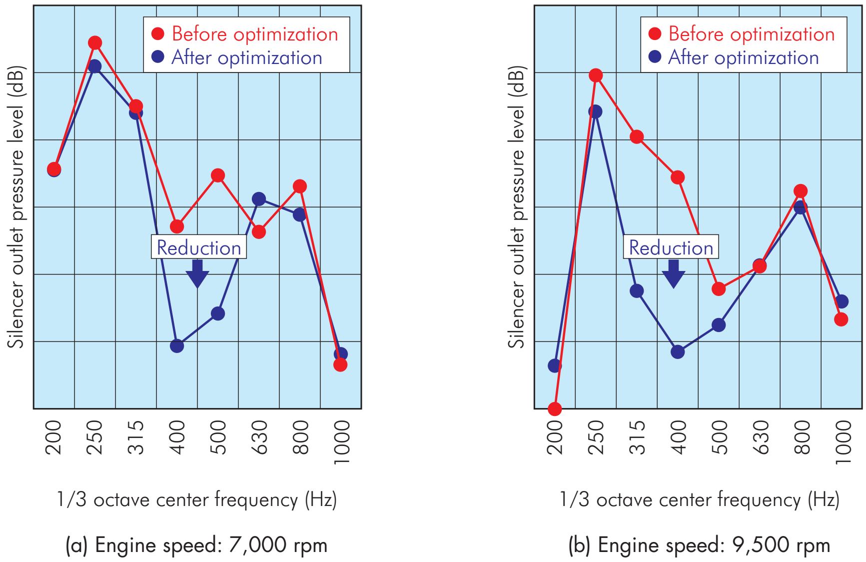


Fig. 8 CFD analysis of noise reduction effect

increased the cross-sectional area and allowed the overall length to be shortened.

Also, the volume ratio of the three expansion chambers was optimized by a CFD analysis, which enabled the noise value to be reduced while maintaining the engine performance (Fig. 8).

3 Chassis related technology

In order to achieve a high-quality ride feel, we worked on reducing engine vibration.

Among the three positions (upper front, upper rear, and lower rear) where the engine is mounted onto the frame, we changed the upper front mount from a rigid mount to a rubber mount. The configuration before and after the change is shown in Fig. 9.

As a result of a preliminary validation of the vibration reduction effect by analysis, it was confirmed that the portions in red representing high vibration areas seen in Fig. 10 (a) were eliminated in (b). The effect of this change was also measured using a test vehicle, which showed sufficient vibration reduction across the entire range of the engine speed (Fig. 11).

Since this change prevented the engine from being used to support the rigidity of the frame, we also improved the rigidity and strength of the frame itself.

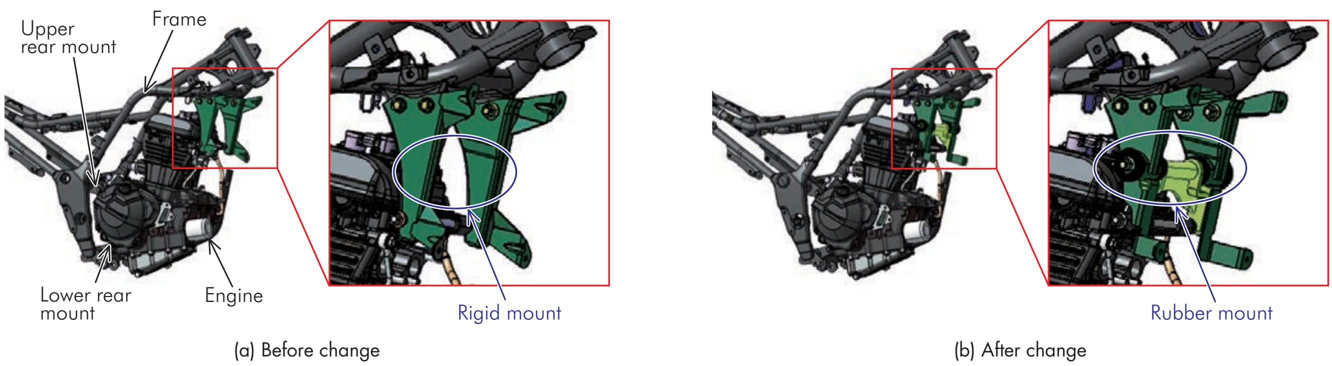


Fig. 9 Rubber engine mounts

Concluding remarks

In Indonesia, orders started flooding in right after launch, and people had to wait several months to receive their motorcycles. After one and a half years, supply is finally catching up with the demand. The Ninja 250/300 have won great popularity in every country including Japan, where orders from dealers reached the annual production schedule in just three days. We will not content ourselves with this success, and will continue to make ceaseless efforts to improve the product appeal and marketability of this model, so that the people who purchased this motorcycle will become a true fan who believes the Ninja is the best brand.

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(a) Before change (b) After change

Fig. 10 Results of vibration analysis

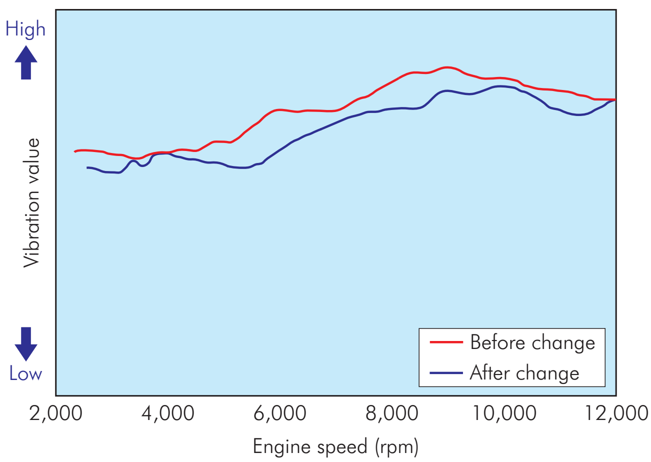

Fig.11 Vibration reduction effects of rubber engine mounts