Motorcycles

Overall Trends

1 Introduction

Japanese motorcycle production in 2013 decreased by 5.4% to around 560,000 units. Motorcycle exports fell as Japanese manufacturers continued to shift production outside Japan to reduce costs and to lower logistic and currency risks.

Motorcycle shipments inside Japan in 2013 increased by 4.2% to around 420,000 units as a result of higher sales of class 2 motor-driven cycles, mini-sized motorcycles, and small-sized motorcycles.

2 Production and Demand

2. 1. Production

As shown in Fig. 1, Japanese motorcycle production in 2013 fell by 5.4% to 560,000 units. Exports also fell by approximately 10.1% to 430,000 units. In contrast, shipments inside Japan rose by 4.2% to 420,000 units.

2. 2. Demand in Japan

Figure 2 shows motorcycle demand in Japan based on engine displacement. Overall demand rose by 4.2% due to higher sales of class 2 motor-driven cycles, mini-sized motorcycles, and small-sized motorcycles. However, demand for class 1 motor-driven cycles) with a displacement of 50 cm^3 fell by 3.0%.

2. 2. 1. 50 cm^3 displacement motorcycles (class 1 motor-driven cycles)

In 2013, demand for this class fell by 3.0% to 239,000 units from the previous year. This was the second successive year-on-year decline since the increase in 2011 caused by the recovery in demand after the Great East Japan Earthquake.

2. 2. 2. 51 to 125 cm^3 displacement motorcycles (class 2 motor-driven cycles)

In 2013, demand for this class increased by 11.8% to 101,000 units, partly due to the launch of new models.

2. 2. 3. 126 to 250 cm^3 displacement motorcycles (mini-sized motorcycles)

In 2013, demand for this class increased greatly by 20.4% to 48,000 units. This was the third successive year-on-year sales increase since 2011, spurred by continuing strong sales of models produced outside Japan.

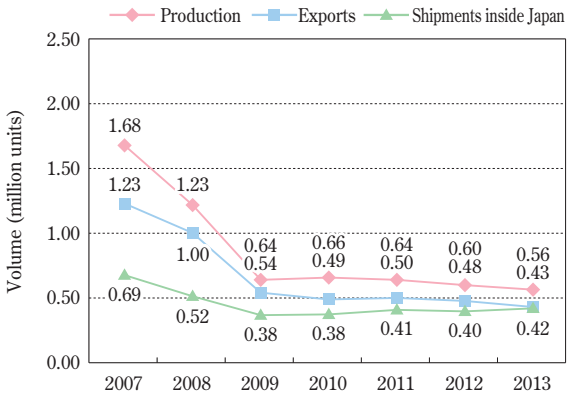

Fig. 1 Trends for production, exports, and shipments inside Japan.

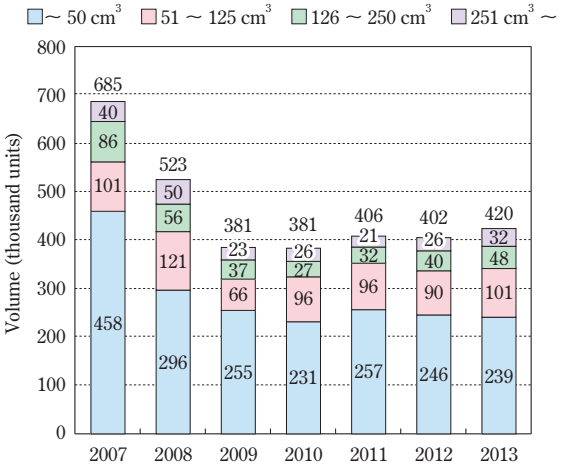

Fig. 2 Shipments inside Japan based on displacement.

2. 2. 4. 251 cm^3 or higher displacement motorcycles (small-sized motorcycles)

In 2013, demand for this class also increased greatly by 23.3% to 32,000 units. This was the second successive year-on-year increase, indicating that demand has recovered strongly.

2. 3. Exports

As shown in Fig. 3, motorcycle exports in 2013 fell for the second successive year by 10.0% to 431,000 units. Although exports were affected by lower sales in Europe, where economic recovery is lagging behind, the continuing shift by Japanese manufacturers to produce motorcycles outside Japan to reduce costs and to lower logistic and currency risks had a further major negative effect.

2. 3. 1. North America

In 2013, exports to North America fell by 3.3% to 178,000 units, the first decrease after steady increases since 2011.

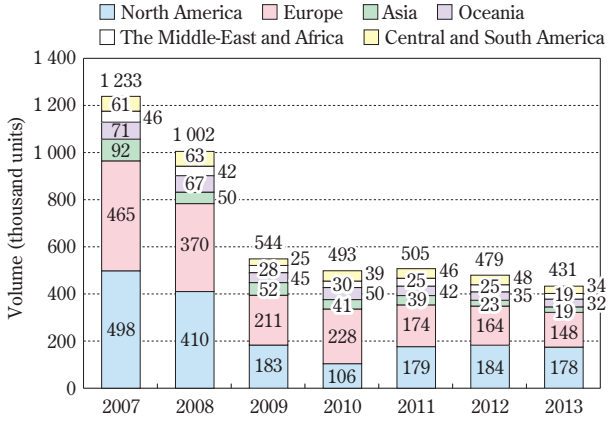

Fig. 3 Shipments per market.

2. 3. 2. Europe

In 2013, exports to Europe fell by 9.8% to 148,000 units.

2. 3. 3. Asia

In 2013, exports to Asia fell by 17.4% to 19,000 units.

2. 3. 4. Oceania

In 2013, exports to Oceania fell by 8.6% to 32,000 units.

2. 3. 5. The Middle-East and Africa

In 2013, exports to the Middle-East and Africa fell by 24.0% to 19,000 units.

2. 3. 6. Central and South America

In 2013, exports to Central and South America fell substantially by 29.2% to 34,000 units.

3 Design Trends

For large sporty models, Japanese manufacturers concentrated on strengths by promoting distinct designs reflecting brand image and new technologies. In particular, the adoption of LED headlamps has the potential to revolutionize motorcycle design and will be a key trend in the future.

For medium and lower displacement models, manufacturers are designing models more attuned to the tastes of emerging rather than developed markets. Design development is also reflecting the shift from localization to the global rollout of models.

In American-styled motorcycles, the latest designs are intended to appeal to new customers while making a unique impression.

4 Product and Technological Trends

4. 1. Product trends

Table 1 lists some representative models of motorcy-

Table 1 Details of main new motorcycles launched in 2013.

Month of launch	New	Modified	Manufacturer	Name of model	Characteristics
January		○	Honda	Giorno Special Edition	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Yamaha	YZF-R1	Water-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
		○	Suzuki	Skywave 400 Limited	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
	○		Suzuki	Skywave 650LX	Water-cooled/4 -stroke/2 -cylinder/DOHC/4 -valve/FI
February		○	Honda	VTR	Water-cooled/4 -stroke/V2/DOHC/4 -valve/FI
	○		Honda	VTR-F	Water-cooled/4 -stroke/V2/DOHC/4 -valve/FI
	○		Honda	Goldwing F6B	Water-cooled/4 -stroke/horizontally opposed 6 -cylinder/OHC/2 -valve/FI
		○	Yamaha	PW50	Air-cooled/2 -stroke/single-cylinder/crankcase reed valve
		○	Yamaha	SR400 35th Anniversary Edition	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Yamaha	XVS400 Dragstar	Water-cooled/4 -stroke/V2/SOHC/2 -valve/FI
		○	Yamaha	XVS250 Dragstar	Water-cooled/4 -stroke/V2/SOHC/2 -valve/FI
	○		Yamaha	Cygnus-X XC125/ Cygnus-X XC125SR	Water-cooled/4 -stroke/single-cylinder/SOHC/4 -valve/FI
		○	Yamaha	VOX XF50L	Water-cooled/4 -stroke/single-cylinder/SOHC/3 -valve/FI
		○	Yamaha	Jog CE50	Water-cooled/4 -stroke/single-cylinder/SOHC/3 -valve/FI
	○		Suzuki	GSR750ABS	Water-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
		○	Suzuki	Address V50	Forced air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
	○		Kawasaki	Ninja 250／Ninja 250 Special Edition／Ninja 250 ABS Special Edition	Water-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI

Table 1 Details of main new motorcycles launched in 2013 (continued).

Month of launch	New	Modified	Manufacturer	Name of model	Characteristics
March		○	Honda	Integra Special Edition	Water-cooled/4 -stroke/2 -cylinder/OHC/4 -valve/FI
	○		Honda	CBR600RR／CBR600RR Special Edition	Water-cooled/4 -stroke/4 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	Vino XC50/ Vino XC50D	Water-cooled/4 -stroke/single-cylinder/SOHC/3 -valve/FI
		○	Suzuki	GSR400ABS	Water-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
		○	Suzuki	GSR250	Water-cooled/4 -stroke/2 -cylinder/SOHC/4 -valve/FI
		○	Suzuki	Skywave 250 Type S Basic	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Suzuki	Skywave 250 Type M	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Suzuki	Skywave SS	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Suzuki	Skywave 250 Limited	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
	○		Suzuki	Address V125 SS	Forced air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Suzuki	Let's 4 Pallet	Forced air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
April	○		Honda	CRF250M	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
	○		Honda	CBR400R	Water-cooled/4 -stroke/2 -cylinder/DOHC/4 -valve/FI
		○	Suzuki	Let's 4	Forced air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Suzuki	Address V50	Forced air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
	○		Kawasaki	Z250	Water-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI
May	○		Honda	CB400F	Water-cooled/4 -stroke/2 -cylinder/DOHC/4 -valve/FI
		○	Honda	Dio110	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Suzuki	Gladius 400 ABS	Water-cooled/4 -stroke/V2/DOHC/4 -valve/FI
	○		Suzuki	Let's 5	Forced air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
June	○		Honda	400X	Water-cooled/4 -stroke/2 -cylinder/DOHC/4 -valve/FI
	○		Honda	Grom	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
	○		Honda	Zoomer-X	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
	○		Honda	CBR125R	Water-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
	○		Honda	Cross Cub	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
	○		Yamaha	TMAX530／TMAX530 ABS／TMAX530 ABS BLACK MAX	Water-cooled/4 -stroke/inline 2 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	Jog CE50ZR Special Edition	Water-cooled/4 -stroke/single-cylinder/SOHC/3 -valve/FI
July	○		Honda	Lead 125	Water-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
	○		Honda	Forza Si	Water-cooled/4 -stroke/single-cylinder/SOHC/4 -valve/FI
	○		Honda	CTX700N	Water-cooled/4 -stroke/2 -cylinder/SOHC/4 -valve/FI
	○		Yamaha	YZ450F	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Yamaha	Vino XC50D Vacation Style	Water-cooled/4 -stroke/single-cylinder/SOHC/3 -valve/FI
		○	Suzuki	GSR250	Water-cooled/4 -stroke/2 -cylinder/SOHC/4 -valve/FI
		○	Suzuki	Address V125	Forced air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Kawasaki	D-TRACKER X	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Kawasaki	KLX250	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Kawasaki	KX450F	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Kawasaki	KX250F	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Kawasaki	KLX110L	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve
		○	Kawasaki	KX65	Water-cooled/2 -stroke/single-cylinder/piston reed valve
August	○		Honda	CTX700	Water-cooled/4 -stroke/2 -cylinder/SOHC/4 -valve/FI
		○	Honda	NC700X TypeLD Dual Clutch Transmission＜ABS＞	Water-cooled/4 -stroke/2 -cylinder/SOHC/4 -valve/FI
		○	Yamaha	WR250R／WR250X	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Yamaha	YZ250	Water-cooled/2 -stroke/single-cylinder/piston reed valve
		○	Yamaha	YZ125	Water-cooled/2 -stroke/single-cylinder/crankcase reed valve
		○	Yamaha	YZ85／YZ85LW	Water-cooled/2 -stroke/single-cylinder/crankcase reed valve
		○	Suzuki	Address V125 S	Forced air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Suzuki	Grasstracker	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Suzuki	Grasstracker BigBoy	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
	○		Suzuki	RM-Z450	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
	○		Suzuki	RM-Z250	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
	○		Kawasaki	KX85／KX85-II	Water-cooled/2 -stroke/single-cylinder/piston reed valve
September	○		Honda	CRF250R	Water-cooled/4 -stroke/single-cylinder/SOHC/4 -valve/FI
		○	Honda	CRF450R	Water-cooled/4 -stroke/single-cylinder/SOHC/4 -valve/FI
	○		Honda	Sh Mode	Water-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Honda	CRF150R／CRF150RII	Water-cooled/4 -stroke/single-cylinder/SOHC/4 -valve
		○	Honda	CRF250X	Water-cooled/4 -stroke/single-cylinder/SOHC/4 -valve
		○	Yamaha	PW50	Air-cooled/2 -stroke/single-cylinder/crankcase reed valve
		○	Yamaha	VMAX	Water-cooled/4 -stroke/V4 /DOHC/4 -valve/FI
		○	Kawasaki	W800／W800 Special Edition	Air-cooled/4 -stroke/parallel 2 -cylinder/SOHC/4 -valve/FI
		○	Kawasaki	Ninja 250／Ninja 250 Special Edition／Ninja 250 ABS Special Edition	Water-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI

Table 1 Details of main new motorcycles launched in 2013 (continued).

Month of launch	New	Modified	Manufacturer	Name of model	Characteristics
October	○		Honda	CRF125F	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve
		○	Honda	CRF50F	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve
	○		Yamaha	Majesty S XC155	Water-cooled/4-stroke/single-cylinder/SOHC/4-valve/FI
	○		Yamaha	YZ250F	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
		○	Suzuki	Address V125 S Limited	Forced air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Suzuki	Skywave 650 LX	Water-cooled/4-stroke/2-cylinder/DOHC/4-valve/FI
		○	Suzuki	Skywave 400 Limited ABS	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
		○	Kawasaki	VULCAN 900 Classic	Water-cooled/4-stroke/V2/SOHC/4-valve/FI
		○	Kawasaki	D-TRACKER 125	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Kawasaki	KLX125	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
November		○	Honda	Dio/Dio Cesta	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Honda	Little Cub 55th Anniversary Special	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Yamaha	MAXAM CP250	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
		○	Yamaha	XVS 400 Dragstar/XVS400C Dragstar Classic	Water-cooled/4-stroke/V2/SOHC/2-valve/FI
		○	Suzuki	Bandit 1250 F ABS	Water-cooled/4-stroke/inline 4-cylinder/DOHC/4-valve/FI
		○	Suzuki	Bandit 1250 S ABS	Water-cooled/4-stroke/inline 4-cylinder/DOHC/4-valve/FI
		○	Suzuki	V-Strom650ABS	Water-cooled/4-stroke/V2/DOHC/4-valve/FI
		○	Suzuki	Boulevard 400	Water-cooled/4-stroke/V2/SOHC/4-valve/FI
December		○	Honda	Monkey Limited	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Honda	Goldwing/ Goldwing F6B	Water-cooled/4-stroke/horizontally opposed 6-cylinder/OHC/2-valve/FI
	○		Yamaha	FJR1300AS／FJR1300A	Water-cooled/4-stroke/inline 4-cylinder/DOHC/4-valve/FI
	○		Yamaha	XVS950CU BOLT／XVS950CU BOLT-R	Water-cooled/4-stroke/V2/SOHC/2-valve/FI
		○	Suzuki	GSR250	Water-cooled/4-stroke/2-cylinder/SOHC/4-valve/FI
		○	Suzuki	Intruder Classic 400	Water-cooled/4-stroke/V2/SOHC/4-valve/FI
	○		Suzuki	GSR250S	Water-cooled/4-stroke/2-cylinder/SOHC/4-valve/FI
		○	Suzuki	Address V125 S	Forced air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Suzuki	Let's 4	Forced air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Kawasaki	ZRX1200 DAEG	Water-cooled/4-stroke/parallel 4-cylinder/DOHC/4-valve/FI
	○		Kawasaki	Ninja 400／Ninja 400 Special Edition／Ninja 400 ABS Special Edition	Water-cooled/4-stroke/parallel 2-cylinder/DOHC/4-valve/FI

cles launched in Japan in 2013. Compared to the previous year, there was a more noticeable trend for manufacturers to derive multiple models from common body and engine platforms. Examples include the Goldwing F6B, CBR400R/CB400F/400X, and CTX700N/CTX700 from Honda, the Suzuki GSR250/GSR250S, and the Kawasaki Z250. 2013 saw a comparatively higher number of class 2 motor-driven cycle launches.

4. 2. Technological trends

In addition to the growing number of launches of models produced outside Japan, another noticeable trend was the reduction of costs by adopting 2-cylinder engines across wide model categories in the 400 to 700 cm^3 displacement class, including sporty models. Furthermore the Worldwide Harmonized Motorcycle Emissions Certification Procedure (WMTC) was introduced from October 2012. As a result, new models in 2013 were labelled with the WMTC fuel economy performance, which should encourage even greater interest in fuel economy by customers in the future.

Engines

1 Technological Trends in Japan

1. 1. Overview

Table 1 shows the new engines launched by each manufacturer in Japan in 2013. Although various motorcycles were launched in 2013 from each company, manufacturers concentrated on refining the engines to enhance sporty performance and riding enjoyment in everyday use on urban streets, rather than simply increasing engine speed and power. In addition, further evolution of electronic controls has helped to enhance multi-functionality and environmental performance while emphasizing comfort and handling.

1. 2. Trends of each manufacturer

1. 2. 1. Honda Motor Co., Ltd.

(i) CBR400R: This motorcycle is installed with a 399 cm^3, water-cooled, 4-stroke, DOHC, 4-valve, parallel 2-cylinder engine. The bore×stroke dimensions are 67.0×56.6 mm and its compression ratio is 11.0. The valve sizes and port shapes were optimized to achieve strong

Table 1 Specifications of new engines in 2013.

Manufacturer	Name of model	Engine type	Displacement (cm^3)	Bore (mm)	Stroke (mm)	Maximum power (kW/rpm)	Maximum torque (Nm/rpm)
Honda	CBR400R	Water-cooled/4-stroke/2-cylinder/DOHC/4-valve/FI	399	67.0	56.6	34/9 500	37/7 500
	CRF450R (racing model)	Water-cooled/4-stroke/single-cylinder/SOHC/4-valve/FI	449.7	96.0	62.1	N.A.	N.A.
	CRF250R (racing model)	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI	249.4	76.8	53.8	N.A.	N.A.
Yamaha	MT-09 (model for outside Japan)	Water-cooled/4-stroke/inline 3-cylinder/DOHC/4-valve/FI	847	78.0	59.1	84.6/10 000	87.5/8 500
	YZ450F (racing model)	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI	449	97.0	60.8	N.A.	N.A.
	YZ250F (racing model)	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI	249	77.0	53.6	N.A.	N.A.
Suzuki	GSR750 ABS	Water-cooled/4-stroke/parallel 4-cylinder/DOHC/4-valve/FI	749	72.0	46.0	78/10 000	80/9 000
	Skywave 650LX	Water-cooled/4-stroke/parallel 2-cylinder/DOHC/4-valve/FI	638	75.5	71.3	37/7 000	60/5 000
	RM-Z450 (racing model)	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI	449	96.0	62.1	N.A.	N.A.
	RM-Z250 (racing model)	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI	249	77.0	53.6	N.A.	N.A.
Kawasaki	Ninja 250	Water-cooled/4-stroke/parallel 2-cylinder/DOHC/4-valve/FI	248	62.0	41.2	23/11 000	21/8 500
	Z1000 (model for outside Japan)	Water-cooled/4-stroke/parallel 4-cylinder/DOHC/4-valve/FI	1 043	77.0	56.0	104.5/10 000	111/7 300
	Ninja 1000 (model for outside Japan)	Water-cooled/4-stroke/parallel 4-cylinder/DOHC/4-valve/FI	1 043	77.0	56.0	104.5/10 000	111/7 300
	KX450F (racing model)	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI	449	96.0	62.1	N.A.	N.A.
	KX250F (racing model)	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI	249	77.0	53.6	N.A.	N.A.

Fig. 1 External appearance of CBR400R.

torque characteristics at everyday low and medium engine speeds, while achieving unconstrained performance at high speeds with maximum power generated at 9,500 rpm. A roller rocker arm, which is an effective means of helping to reduce friction, and a silent chain were adopted in the valve train. The balance between piston stiffness, strength, and lightness was enhanced by computer analysis. In addition, the CBR600RR features various technologies adopted from higher grade models, such as friction-reducing surface treatment technology for the piston pins and connecting rods. Low vibration and compact size were achieved by adopting a 180°-phase crankshaft and laying out the balancer at the rear surface. This engine achieves both excellent fuel economy and environmental performance. Figure 1 shows the external appearance of the CBR400R.

(ii) CRF250R (racing model): This motorcycle is installed with a 249.4 cm^3, water-cooled, 4-stroke, OHC, 4-valve, single-cylinder engine that features higher torque at lower and medium speeds while maintaining power at high speeds. Compared to the 2012 model, the updated CRF250R features a higher compression ratio, and modifications to the combustion chamber shape, intake and exhaust port shapes, and injector spray angle. The design of the intake and exhaust system, transmission, and other parts was also revised. A new piston top shape helps to boost power by increasing the compression ratio from 13.2 to 13.5. In addition, molybdenum shot-peening was applied to the piston skirt to reduce friction. The piston profile was changed to reduce the clearance between the cylinder and piston, thereby increasing the combustion gas sealing performance and enabling further increases in power. The fuel injection setting was re-designed to optimize the ignition timing and fuel injection quantity in accordance with the advances in the power unit. Furthermore, the injection control was partly changed to achieve a strong power sensation at low and medium speeds and fast throttle response. Called Dual Stage Fuel Injection, the control performs two injections per combustion cycle. This control helps to reduce the sensation that the engine is losing power on high-load road surfaces and achieves a more linear power response with respect to the rider's throttle operation. In accordance with the power boost, the face width of the gears in the transmission was increased by a maximum of 13%. This ensures greater durability while enabling a compact layout within the frame of the motorcycle, without affecting the upright stability of the rider. Figure 2 shows the external appearance of the CRF250R.

1. 2. 2. Yamaha Motor Co., Ltd.

(i) MT-09 (model for outside Japan): This motorcycle is installed with a newly designed 847 cm^3, water-cooled, 4-stroke, DOHC, 4-valve, parallel 3-cylinder engine. The

Fig. 2 External appearance of CRF250R.

Fig. 3 External appearance of MT-09.

bore×stroke dimensions are 78.0×59.1 mm and its compression ratio is 11.5. This is a fuel-injection engine with a downdraft layout intake system. A narrow valve included angle of 26.5° (intake: 13°, exhaust: 13.5°) enables rapid combustion and a compact combustion chamber shape. Cast aluminum pistons, plated cylinders, and fracture splitting connection rods were adopted from the standpoints of reducing weight as well as improved heat dissipation and production accuracy. Vibration was reduced by adding a balancer. The intake system uses an unequal-length funnel to boost torque characteristics and an offset-cylinder design to reduce sliding resistance. A 3-into-1 exhaust system, which integrates the exhaust pipe with a muffler containing three internal expansion chambers, helps to centralize the mass while improving exhaust efficiency. The synergistic effect of these innovations helps to improve both dynamic performance and fuel economy. Furthermore, the D-MODE system allows the rider to choose between three throttle control mapping settings in accordance with preference and the riding situation. The three settings are designed to achieve easy handling and sharper response in everyday riding on urban streets and other environments. Figure 3 shows the external appearance of the MT-09.

(ii) YZ250F (racing model): This motorcycle is installed with a newly designed 249 cm^3, water-cooled, 4-stroke, DOHC, 4-valve, single-cylinder engine. The bore×stroke dimensions are 77.0×53.6 mm and its compression ratio is 13.5. The carburetor used by the 2012 model has been replaced by fuel injection. The number of intake valves was reduced from five to four and titanium was adopted for both the intake and exhaust valves. The valve diameter was set to 31 mm on the intake side and 25 mm on the exhaust side. A narrow valve included angle of 23.75° was set to create a compact combustion chamber. Double-ring cast aluminum pistons were adopted to reduce power loss through lower weight and sliding resistance. Optimizing the intake and exhaust ports and the cam profile boosted power and improved power characteristics at medium and high speeds. The dry-sump lubrication system of the 2012 model was replaced by a wet-sump, thereby reducing the weight of the engine by approximately 1 kg. The engine layout includes a straight front intake with the exhaust to the rear. This allows the cylinder to be angled toward the rear of the body with respect to the crankcase and helps to centralize the mass. The intake path that connects directly from the air cleaner at the front of the body to the combustion chamber through a wide-port throttle body with a diameter of 44 mm was designed to improve intake efficiency. Viewed from above the cylinder, the exhaust pipe has a distinct layout that wraps around clockwise from the exhaust port of the cylinder head. This ensures sufficient length for the exhaust pipe and enhances the power characteristics of the engine through the pulsation effect. Figure 4 shows the external appearance of the YZ250F.

1. 2. 3. Suzuki Motor Corporation

(i) GSR750ABS: This motorcycle is installed with a 749 cm^3, water-cooled, 4-stroke, DOHC, 4-valve, parallel 4-cylinder engine based on the engine used by the sporty GSX-R750 model. The new engine features a revised cam profile and a re-designed intake and exhaust system compared to the base engine specifications. The modifications enable strong and linear torque output from low speeds while ensuring a rapid increase in engine speed. The basic design of the engine reflects its sporty origins through the compact combustion chambers and cast pistons. The bore×stroke dimensions are 72.0×46.0 mm and its compression ratio is 12.3. Revised fuel injection settings help to ensure fast response at low and medium speeds, acceleration performance, better fuel economy, and lower emissions. Although this model was part of Suzuki's lineup sold outside Japan until 2012, it has been launched on the Japanese market for 2013. It retains the

Fig. 4 External appearance of YZ250F.

Fig. 5 External appearance of GSR750ABS.

Fig. 6 External appearance of Skywave 650LX.

Fig. 7 External appearance of Ninja 250.

same power characteristics as the model for outside Japan while ensuring easy handling for urban streets and powerful acceleration. Figure 5 shows the external appearance of the GSR750ABS.

(ii) Skywave 650LX: This motorcycle is installed with a refined 638 cm^3, water-cooled, 4-stroke, DOHC, 4-valve, parallel 2-cylinder engine. The bore×stroke dimensions are 75.5×71.3 mm and its compression ratio is 11.2. A 360°-phase crankshaft configuration achieves flat torque and powerful-feeling dynamic performance. Two counter balancer shafts were adopted to reduce engine vibration. The fuel injection settings were designed to maintain optimum combustion. Emissions were reduced by electronic combustion controls, such as providing a secondary air supply device in the exhaust ports, a catalyzer inside the muffler, and a fuel injection O_2 feedback system. The electronically controlled CVT uses an actuator motor to vary the reduction ratio and the optimum gear ratio is selected automatically by computer control. In addition to two fully automatic modes (drive mode and power mode, which is particularly convenient for climbing hills), a manual mode is also provided that allows the rider to select from six preset gear ratios using an up/down switch on the left grip. This mode simulates the operation feeling of a manual transmission. Figure 6 shows the external appearance of the Skywave 650LX.

1. 2. 4. Kawasaki Motors Corporation

(i) Ninja 250: This motorcycle is installed with a 248 cm^3, water-cooled, 4-stroke, DOHC, 4-valve, parallel 2-cylinder engine. The bore×stroke dimensions are 62.0×41.2 mm and its compression ratio is 11.3. Lightweight pistons using an aluminum die-cast sleeveless plated cylinder and a hard alumite coating ensure high durability. The fuel injection system adopts injectors that atomize the spray to a droplet diameter of 60 μm, thereby helping to improve combustion efficiency. Dual throttle valves that control the intake air precisely and efficiently ensure linear and natural response at all speeds. The intake air volume was increased by setting a sub-throttle valve diameter of 40.2 mm. As a result of these innovations, this motorcycle is easy to handle while touring and also has an exciting sensation of power for enjoyable sporty riding. Figure 7 shows the external appearance of the Ninja 250.

(ii) Z1000 (model for outside Japan): This motorcycle is installed with a 1,043 cm^3, water-cooled, 4-stroke, DOHC, 4-valve, parallel 4-cylinder engine. The bore×stroke dimensions (77.0×56.0 mm) and compression ratio (11.8) are carried over from the 2012 model. However, engine power was increased from the previous model by changing the intake funnel length and cam profile, adding communicating pores for the cylinders, changing the diameter of the connecting pipe in the exhaust system, and modifying the internal muffler structure. In addition, the fuel injection settings were refined to obtain a more direct throttle response. In combination with the opti-