

## Introduction of GALEO MR-2 Series 3- to 5-Ton Compact Hydraulic Excavators

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*In 1998, KOMATSU put on the market the MR-1 series of 3- to 5-ton compact hydraulic excavators with tight tail swing radius. Recently, for the first time in five years, the company carried out a model changeover of the MR-1 series and came up with the GALEO MR-2 series as the first of its overwhelmingly good products. The new series has been developed with "higher degree of safety", "larger cab space", and "better maintainability" as the watchwords. This paper describes the salient features of the GALEO MR-2 series.*

**Key Words:** *Compact Hydraulic Excavator with Tight Tail Swing Radius, MR-2, Two-pole ROPS Canopy, ROPS Cab, Floor Tilt-up Mechanism, ERS System, X-shaped Cast Steel Track Frame*

### 1. Introduction

The MR-1 series of compact hydraulic excavators (PC30 – PC45) had been very well received by many users for its high stability and good maneuverability. However, as the competition put on the market new models with tight tail swing radius one after another, KOMATSU was feeling the need to add to the appeal of its existing series. On the other hand, the general public is attaching greater importance to protecting the global environment and respecting humanity.

Under those conditions, the company has developed and put on the market the GALEO MR-2 series of compact hydraulic excavators (PC30 – PC50) that has a number of superb selling points which cannot easily be emulated by the competition. More important, the new series is very friendly to the user and the environment (**Photo 1**, **Table 1**).



**Photo 1** GALEO MR-2 series

**Table 1** Principal specifications

Item	Unit	PC35MR-2 <canopy>	PC50MR-2 <canopy>
Machine weight	kg	3580 <3740>	4790
Rated output	kW/rpm	21.7/2400	29.4/2350
Standard bucket capacity (JIS)	m <sup>3</sup>	0.11	0.16
Trave speed	Hi	km/h	4.6
	Lo	km/h	2.8
Maximum digging depth	mm	3170	3800
Maximum digging radius	mm	5360	6220

## 2. Aims of development

While the demand for construction equipment has been rather weak in Japan in recent years, it has been growing appreciably in the United States and Europe. Therefore, it was necessary for us to introduce to the market a new product which fully meets the needs of overseas users, as well as those of domestic users. Prior to starting the present development, we carried out a comprehensive study of products of the competition and an in-depth analysis of overseas markets. On the basis of the results of the study and analysis, we decided to develop a new product which has unparalleled international competitiveness, with “higher degree of safety”, “larger cab space”, and “better maintainability” as the watchwords (Table 2). Thus,

- ① Higher degree of safety – Meeting the world’s most stringent safety regulations
- ② Larger cab space – Offering a cab space sufficient even for an operator of very large build
- ③ Better maintainability – Reducing the cost of machine repair and maintenance in view of the rental market.

**Table 2** Aims of development

Major selling points (development concept)	
Item	Content
Higher degree of safety	Two-post ROPS canopy
	ROPS cab
	Conformance to the extremely stringent noise regulations of the Ministry of Land, Infrastructure and Transport and the new noise regulations of the EU
	Conformance to the Tier 2 emission regulations
	Safety lever for locking all actuators
	Retractable seatbelt
	Fail-safe engine starter
Larger cab space	Widened operator’s seat
	Increased space around seat
	Easier boarding and alighting
	Thin-type, vertical-mounted air conditioner
Better maintainability	Floor tilt-up mechanism
	Fully-opening engine hood and side cover
	500-hour maintenance interval
	Easy-to-remove mud from track frame
	Sheet-metal exterior
	Built-in work equipment piping
	Increased boom swing pin diameter

## 3. Salient features

### 3-1 High degree of safety – Safety concept taking into consideration future stringent regulations

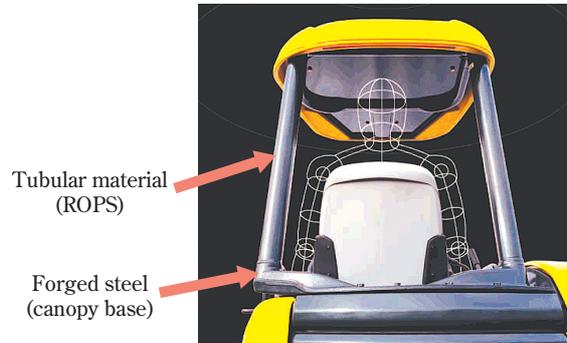
#### (1) Two-post ROPS canopy

The former series was equipped with either of two types of canopies – the TOPS (Tip-Over Protective Structure) canopy and the two-post soft canopy. In terms of “ease of boarding/alighting” and “visibility” the TOPS canopy that had four posts was inferior to the two-post soft canopy. Therefore, the TOPS canopy did not become widespread in areas where there were no safety regulations. As the standard canopy for the new series, we developed the world’s first two-post ROPS (Roll-Over Protective Structure) canopy that meets the requirements of easy boarding/alighting and good visibility, with the aim of:

- ① Protecting the operator from a machine rollover and fallen object regardless of whether there are safety regulations.

- ② Eliminating the customer’s need to spend money on extra safety even if the existing safety regulations are made more stringent in the future.
- ③ Eliminating the need to make any special modification to the machine even after it is resold overseas.

By employing a forged steel canopy base and low-temperature steel tube (diameter: 76.3 mm), we secured the strength required of a ROPS canopy without sacrificing the aesthetic appeal and productivity of the canopy (Photo 2).

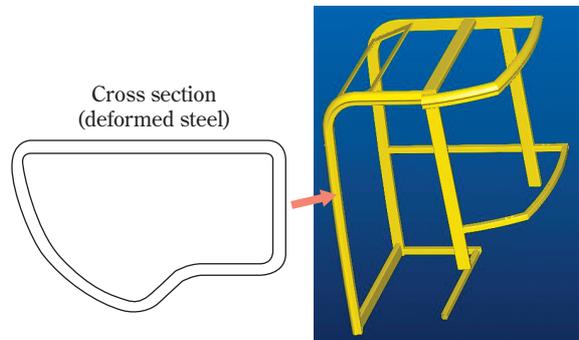


**Photo 2** ROPS canopy

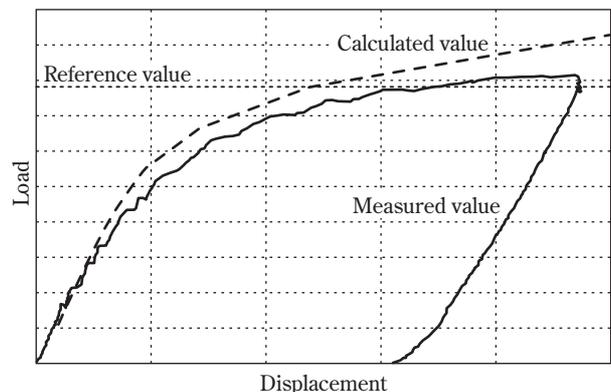
#### (2) ROPS cab

In view of the fact that compact hydraulic excavators equipped with a cab are increasing in number, we developed a ROPS cab for the new series. On the basis of FEM analysis results, we decided an optimum pillar arrangement of the cab so that the new ROPS cab offers a wider field of vision than the former cab. The cost of fabricating the new cab has been reduced by adopting a deformed steel construction.

In order to facilitate the operator to get on and off the machine even in a confined place, the ROPS cab is provided with a slide door for the first time in the world (Fig. 1, Fig. 2).



**Fig. 1** Pillar arrangement of cab



**Fig. 2** Calculated and measured values of displacement under lateral load

(3) Conformance to the extremely stringent noise regulations of the Ministry of Land, Infrastructure and Transport

Since many of compact hydraulic excavators are often used in urban areas, there is strong demand for reduction of their noise. In view of this, we made the level of noise of the new series meet the extremely stringent noise regulations of the Ministry. (The former series met the less stringent noise regulations of the Ministry.)

The most difficult technical problem involved in reducing the level of noise (to 93 dB) is the balance between noise and heat. This problem was solved by taking the following measures (Photo 3).

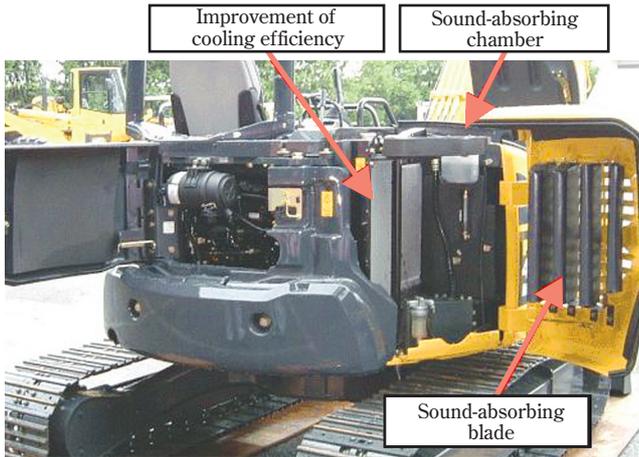


Photo 3 Measures taken to reduce noise

- ① Arranging the radiator and the oil cooler on the same plane (side by side) to improve the cooling efficiency, and lowering the fan speed.
- ② Employing a sound-absorbing blade to widen the opening for admitting cooling air.

In addition, a sound-absorbing chamber was adopted to reduce the engine air suction sound, and a large muffler having an increased number of internal partitions was adopted to reduce the exhaust sound.

(4) Conformance to Tier 2 emission regulations

We adopted a new-type engine with high fuel-injection pressure and improved injection timing to meet the Tier 2 emission regulations of North America, Europe, and Japan.

(5) Safety lever for locking all actuators

We applied PPC control to all actuators (hydraulic cylinder, hydraulic motor) and adopted a mechanism which permits locking all the actuators by a safety lever.

(6) Retractable seatbelt

As the ROPS canopy and ROPS cab were adopted, a seatbelt is provided as standard. This seatbelt is a retractable type which is convenient to the operator.

(7) Engine neutral start system

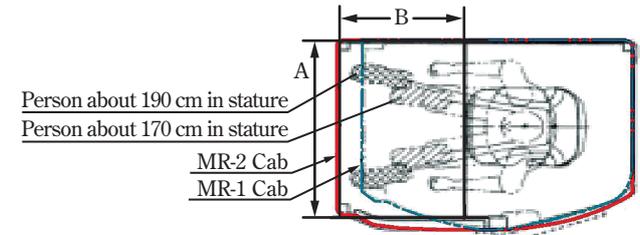
In order to prevent the work equipment from moving suddenly due to incorrect operation at the start of the engine, we adopted a mechanism which permits starting the engine only when the lock lever described in (5) is in the LOCK position.

**3-2 Larger cab space – Cab space of machine one class higher**

(1) Largest cab space for this class of machine

Many of conventional compact hydraulic excavators have a cab space insufficient for the operators, especially those who exceed 170 cm in stature.

According to the U.S. and European market surveys carried out prior to the present development, widening the cab space was the strongest demand from users. In particular, increasing the legroom and widening the opening for boarding and alighting were strongly called for. We took the following measures to meet those demands (Fig. 3, Photo 4).



		PC30-50MR-2	PC30-35MR-1	PC40/50MR-1	PC78US-6
A	mm	960	840	925	940
B	mm	600	490	485	600
A × B	cm <sup>2</sup>	5760	4116	4486	5640

Fig. 3 Comparison of legroom



Photo 4 Comparison of opening for boarding/alighting

- ① Adopting the ERS (Ecology/economy Reservoir System – system for separating air-bubbles from oil) to reduce the amount of hydraulic oil and make the hydraulic tank compact (Fig. 4).
- ② Arranging the air-conditioning equipment at the right side of the machine to increase the legroom.
- ③ Adopting an automatic transmission system and abolishing the 2-speed changeover pedal.
- ④ Rearranging the consoles and reducing the lock lever stroke to widen the opening for boarding and alighting.

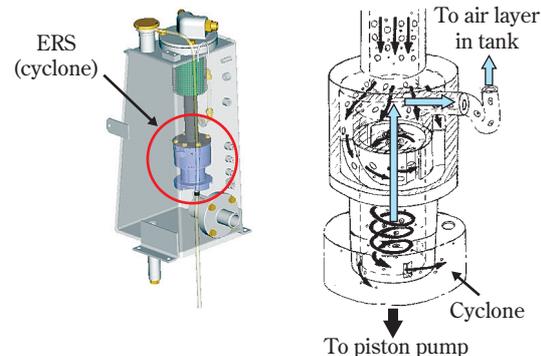
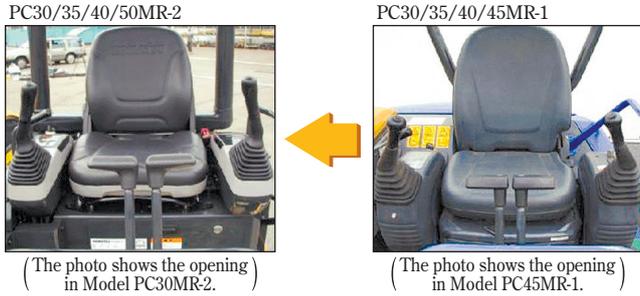


Fig. 4 ERS cyclone system

(2) Wider space around seat

In addition to the legroom, the amount of seat slide and the space at each side of the seat (the inside width between the consoles) were increased to widen the space around the operator's seat (Photo 5).



	PC30 - 50MR-2	PC30 - 45MR-1
Inside width between consoles	515	460
Amount of seat slide	140	100

Photo 5 Comparison of space around operator's seat

(3) Newly-developed air conditioner

In the present development, installing an air conditioner was one of the essential requirements. Therefore, we prepared a thin-type, vertical-mounted air conditioner exclusive for the new series. In developing the air conditioner, we confirmed the following items for the first time with a compact hydraulic excavator and imparted the following qualities to the air conditioner (Fig. 5 and Photo 6).

Cooling capacity : 3500 kcal/h ← 3000 kcal/h  
 Air flow rate : 479 m<sup>3</sup> ← 359 m<sup>3</sup>

- ① Implementing CFD analysis of the air flow in duct to optimize the duct size.
- ② Confirming cooling/heating performance with the machine placed in a high-temperature room.

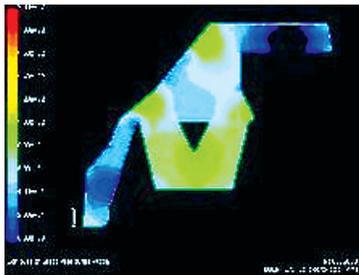


Fig. 5 CFD in duct

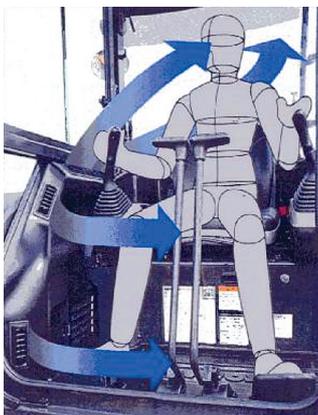


Photo 6 Air conditioner installed in machine

3-3 Better maintainability - Machine design taking rental market into consideration

- (1) Significant improvement in accessibility to internal components by adoption of floor tilt-up construction and full-opening engine hood and side cover

Because of their comparatively small compartment, the internal components of conventional compact hydraulic excavators are hardly accessible during inspection or repair. In the rental business that is an important part of the construction equipment market, compact hydraulic excavators are inspected and repaired on a routine basis. Therefore, improving the accessibility to their internal components helps reduce the burden on users significantly.

- ① Adopting floor tilt-up construction which permits easy access to internal components during inspection before starting or in case of some trouble

In order to facilitate maintenance and parts replacement in the field and reduce the man-hours and cost of maintenance, we adopted a floor tilt-up construction for the new series (Photo 7).



Photo 7 Machine with its floor tilted up

This new construction has facilitated the overhaul and replacement of the engine swing machinery, swivel joint, etc. which are difficult with conventional compact hydraulic excavators. In addition, it has improved the machine reliability since permits visual inspection of the piping and wiring.

The outline of the tilt-up mechanism and its operation is as follows (Fig. 6).

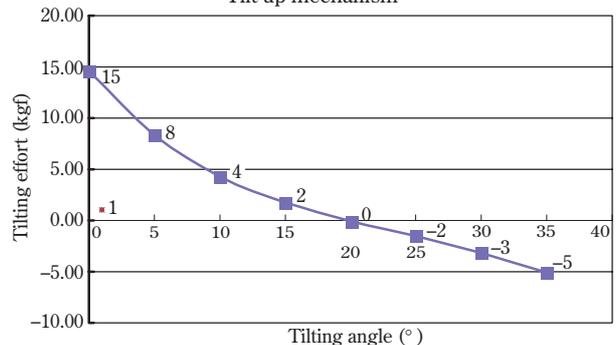
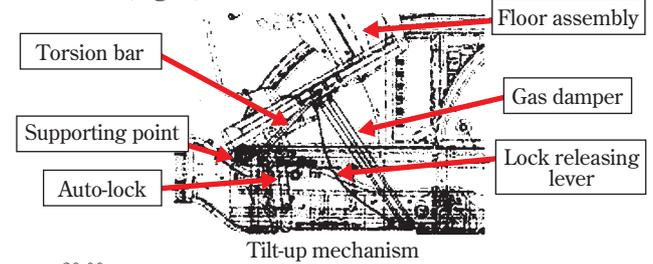
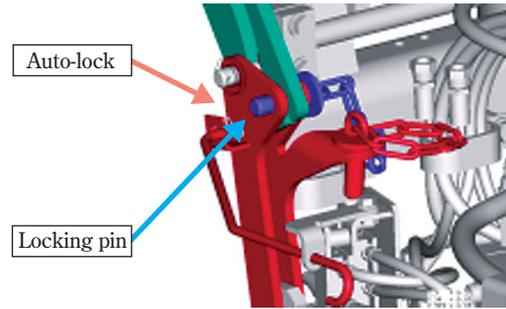


Fig. 6 Floor tilt-up mechanism

- The supporting point for tilting is positioned at the front of the floor. (A rubber bushing is installed to reduce the floor vibration.)
- To tilt up the floor, remove the fixing bolts at the rear of the floor and lift the floor while manipulating the lock releasing lever provided at the inspection window of the left-hand side cover.
- A gas damper and a torsion bar are used in combination to ensure that the floor is tilted up by uniform effort. The tilt-up mechanism is provided with the following two types of locks to ensure the safety of the serviceperson (**Fig. 7**).



**Fig. 7** Locking devices for tilt-up mechanism

- Automatic locking mechanism
  - Locking by insertion of locking pin
- ② Adopting full-opening engine hood and side cover to facilitate routine inspection



**Photo 8** Points of routine inspection

For routine inspection, the following three parts of the machine can be fully opened without using any tools.

The inspection items are as follows (**Photo 8**).

- Side hood  
Amounts of fuel and hydraulic oil/amount of window washer fluid/level of battery solution
- Engine hood  
Engine oil (inspection)/air cleaner (cleaning)
- Right-hand side cover  
Amount of hydraulic oil/amount of radiator water/radiator and oil cooler (cleaning)/fuel tank (drain of water)/water separator (drain of water)



**Photo 9** Easy cleaning of radiator and oil cooler

In addition to the full-opening right-hand side cover, the side-by-side cleaning system has significantly facilitated cleaning the radiator and oil cooler (**Photo 9**).

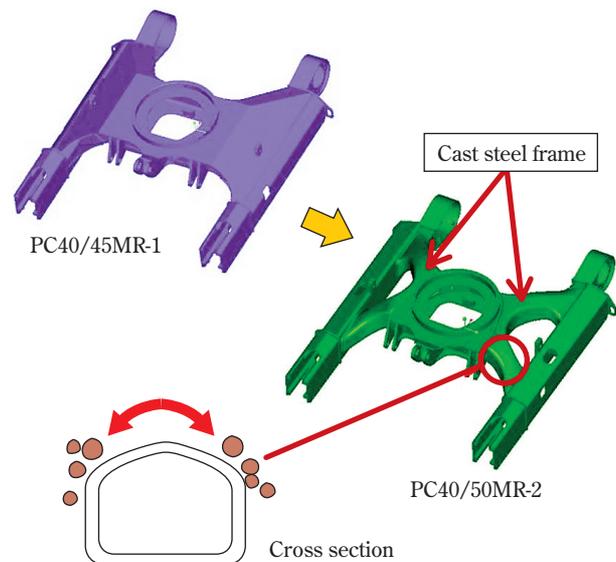
(2) 500-hour maintenance interval

The maintenance interval has been prolonged to 500 hours to reduce the cost of machine maintenance incurred by the customer.

- ① The bucket is provided with an oil-impregnated bushing. For the other parts, a high-strength brass bushing is used. As a result, the lubrication interval has been prolonged from 100 hours to 500 hours.
- ② The use of an eco-white filter has prolonged the hydraulic filter replacement interval from 250 hours to 1,000 hours.
- ③ The replacement intervals for engine oil, oil filter, and fuel filter have been prolonged to 500 hours.
- ④ The lubrication interval for the swing circle pinion has been prolonged to 500 hours.

(3) Improvement in removability of mud from track frame  
In the rental business, there is strong need for reduction of the man-hours required for washing machines and the cost involved in treating the muddy water produced by the washing process.

The newly-developed, X-shaped track frame of cast steel has a curved cross-section shape which minimizes the flat portion to prevent the build-up of muddy soil (**Fig. 8**).



**Fig. 8** X-shaped track frame

(4) Sheet metal exterior

A sheet metal exterior is partly employed for conventional compact hydraulic excavators to facilitate repairing damaged parts. For the new series, sheet metal is used for all the

external components, except for the right-hand side hood, to improve their reparability significantly.

(4) Built-in work equipment piping

Even conventional models have a built-in joint between the arm and the boom. In addition to the joint, the new series incorporates the boom foot piping to improve the reliability of the work equipment piping.

(5) Increased diameter of boom swing pin

The boom swing pin that tends to become loose most under a large load has been increased in diameter (Table 3, Photo 10).

Table 3 Comparison of boom swing pin diameter

Boom swing	PC30MR		PC35MR		PC40/50MR	
	MR-2	MR-1	MR-2	MR-1	MR-2	MR-1
Pin diameter	95	90	100	120	120	110

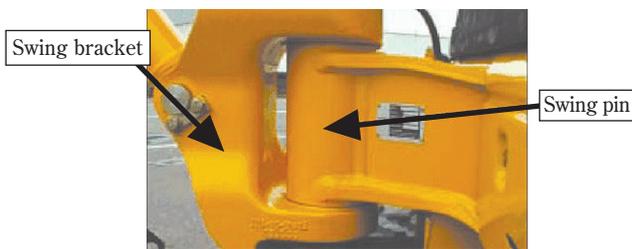


Photo 10 Boom swing

4. Conclusion

Since introduction in July 2003, the MR-2 series has been very well received by many users for its advanced development concept and self-evident selling points.

It is a great pleasure to all the persons who were involved in the development of the MR-2 series. In the future, we intend to improve the degree of perfection of the new series by carefully following up the market needs.

Introduction of the writers



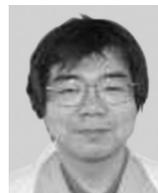
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[A few words from the writers]

Since it was put on the market in July 2003, the MR-2 series that features a higher degree of safety, a larger cab space, and better maintainability than the MR-1 series has been very well received by many users for its self-evident selling points and advanced development concept. In the present development, we became well aware that “being easy to understand” is an important factor in materializing selling points.

The MR-2 series was a project which was attracting companywide attention as it was nominated as the first of the overwhelmingly good products of the Komatsu Group. We could introduce the new series smoothly to the market by solving a number of difficult technical problems in the present project with the aid of System Development Center, Production Technology Development Center, etc. and through close cooperation with Production/Quality Verification Department and Marketing Department.