Introduction of Products

Hydraulic Excavators PC210-10M0, PC500LC-10M0

Hiroyuki Mizuno

Tatsuo Wada

Kiichirou Kouno

Katsunaga Kashima

We have developed medium-sized hydraulic excavators PC210-10M0 and PC500LC-10M0 for strategic markets with Reliability, Productivity, and Expandability set as concepts and introduced them to the market. This paper explains their technologies and introduces the products.

Key Words: *Reliability, Productivity, Expandability, Robustness, High-capacity bucket*

1. Introduction

In recent years, there has been an increasing demand for high-capacity buckets in strategic markets as in traditional markets. In addition, in strategic markets, there is a stronger demand for low fuel consumption than in traditional markets; therefore, we have developed eco-friendly products centered on reliability and productivity, which are the basic skeletons of production goods (equivalent to EU STAGE III A).

Before the start, going back to the basics, Product Marketing Division, Production Division, and Service Division as well as Development Division participated in the grasping of the current situation. Then, after starting from the planning of the product concept, we developed the PC210-10M0 and PC500LC-10M0.

Recently, we succeeded in introducing these to the market for strategic markets, and we present the overview herein. (**Fig. 1**, **Fig. 2**)

Fig. 1 Appearance of PC210-10M0

Fig. 2 Appearance of PC500LC-10M0

2. Aims of development

The base of the development aim is Komatsu's "Quality and Reliability", which has been highly evaluated in the results of market research.

With "ensuring robustness" as the key term, we have conducted the development with something that has (i) the expandability such as mounting a high-capacity bucket that meets market needs (robustness of applied applications), (ii) the capability of ensuring productivity by improving production volume and reducing fuel consumption, and (iii) the reliability with an assumption of use in various environments (robustness of the working conditions). The outline and features are described below.

(1) Improved essential performance for a high-capacity bucket
- Increasing the maximum bucket capacity
  Increasing the capacity by max 25% compared to the existing model
- Increasing the strength of the main frame
- Improving the swing circle life

(2) Improved productivity
- Improving the fuel efficiency by 16% to 21% compared to the existing model
- Improving the fuel consumption
  - Fan clutch
  - Reducing the oil pressure loss
- Improving the production volume
  - Modifying the bucket shape
  - Changing the bucket digging force
  - Changing the engine output

3. Selling points

This section explains the PC210-10M0 and PC500LC-10M0 selling points.

3.1 Improved productivity

With the later described technology incorporated, the average work pattern comparison by KOMTRAX analysis showed that the PC210-10M0 and PC500LC-10M0 achieved reductions in fuel consumption of -20% and -11%, respectively (compared to the existing model).

3.1.1 Reduced fuel consumption by adopting a fan clutch system and high-capacity cooling

By controlling the fan speed with the built-in fluid clutch, the optimum fan speed can be achieved according to the operating conditions of the machine. We have succeeded in reducing the horsepower consumption of the fan without deteriorating the heat balance in combination with the adoption of high-capacity cooling.

3.1.2 Improvement of production volume by changing the bucket shape and increasing the applicable bucket capacity

We have optimized the bucket shape to improve the penetrability to earth and sand and reduce the digging resistance, thereby improving the digging performance (**Fig. 3**).

Table 1 compares the applicable buckets of the new and existing models. In addition, the basic design premised on the installation of a high-capacity bucket has achieved both an increase in production volume and ensuring durability.

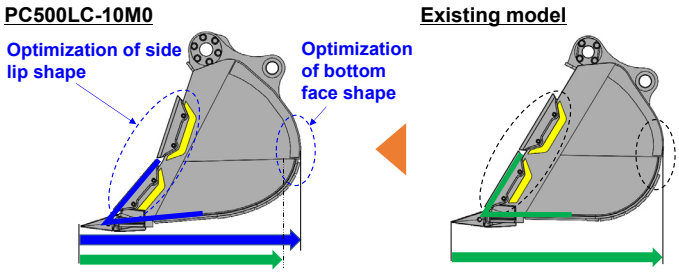

Fig. 3 Optimize the bucket shape
(example of PC500LC-10M0)

Table 1 Comparison of applicable buckets

Bucket capacity (m^3)	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7
PC210-10M0		High density ⇔ Small density									
Existing model		High density⇔ Small density									

Bucket capacity (m^3)	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2
PC500LC-10M0								High density ⇔ Small density							
Existing model		High density⇔ Small density													

3.1.3 Improvement of bucket digging force (PC500LC-10M0 only)

By reviewing and modifying the link motion around the bucket, the bucket digging force has been improved by 9% compared to the existing model. This has improved the balance with the arm digging force, resulting in the improvement of digging performance. (**Table 2**)

Table 2 Comparison of bucket digging force
(for ISO 6015 one-touch up)

	PC500LC-10M0	Existing model
Maximum bucket digging force (7.1 m boom and 3.4 m arm specifications)	303	277

(kN)

3.1.4 Improved efficiency of engine and hydraulic component

Taking advantage of the strength of component in-house development, we improved the output and combustion efficiency of the engine while complying with regulations. In addition, we optimized the internal path of the main valve using CFD analysis and also optimized the shape of the hydraulic piping to reduce the oil pressure loss. (**Table 3**) (**Fig. 4**)

Table 3 Comparison of engine output
(ISO 9249/SAE J1349 NET)

PC210-10M0	Existing model
123	103

PC500LC-10M0	Existing model
269	257

(kW)

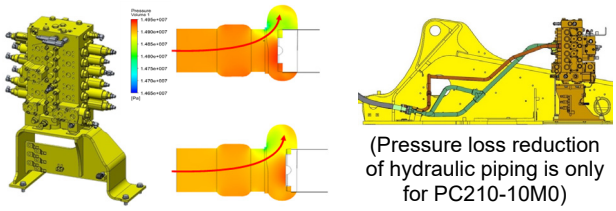

Fig. 4 Reduction of hydraulic component pressure loss

3.2 Improvement of durability

These models are to be introduced to strategic markets, and their working conditions are more diverse and harsher than those in Japan, the USA, or Europe. The following sections explain examples of items for which durability has been improved.

3.2.1 Strengthening work equipment

Prior to development, we collected information about defects reports in the existing model market around the world and analyzed them in detail.

From the results, we confirmed that the existing model meets the design target life; however, with the aim of further improving satisfaction, we chose to improve the target life in consideration of that the machine is used in a wide variety of working conditions in strategic markets and that the average operating time of the machine is longer than that in traditional markets.

Also, these models have improved engine power and bucket digging force as mentioned above; thus, we strengthened the work equipment in consideration of the increased load on the work equipment resulting from these improvements.

When strengthening it, we formulated the strengthening policy after clarifying the weak points of the work equipment based on the analysis result of the defect situation of the existing model.

Regarding the casting parts making up the work equipment, taking advantage of the strength of Komatsu as an in-house foundry company, the Himi Plant (casting) participated in the development project from its beginning, which allowed us to quickly make an optimum shape where both of the following were achieved together: (i) ensuring the strength required for the design and (ii) productivity peculiar to casting parts together.

In addition, we have achieved improved durability by making a significant shape change to remove compatibility with the existing model and by applying an advanced welding method using high-precision penetration control technology by the Manufacturing Engineering Development Center. (**Fig. 5**)

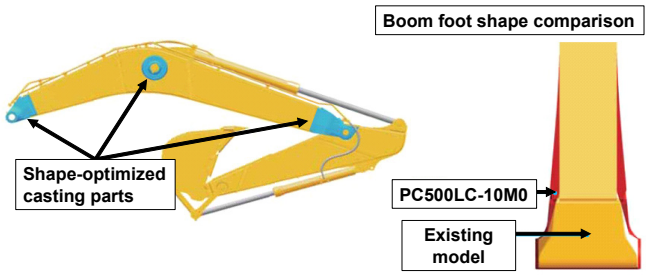

Fig. 5 Strengthening the work equipment
(example of PC500LC-10M0)

3.2.2 Strengthening the swing circle

The swing circle, a joint-like part that connects the upper structure and the undercarriage, is an important part that requires high durability.

In these models, we achieved improved durability by improving the ball sharing ratio by improving the manufacturing accuracy of the swing circle and its related parts. (**Fig. 6**)

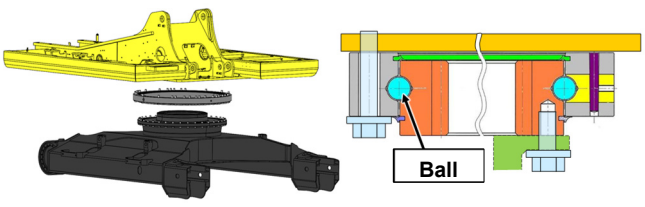

Fig. 6 Swing circle

3.2.3 Fuel system

As with the working conditions, strategic markets are not as well organized as traditional markets in terms of fuel circumstances for the reason of either the market or maintenance circumstances. To ensure reliability (ensure the robustness of working conditions), we adopted different fuel system depending on the market based on the research results. In addition, by designing them so that their specifications can easily be changed, we have made a design that allows quick response, for example, if the operating environment differs. (**Fig. 7**)

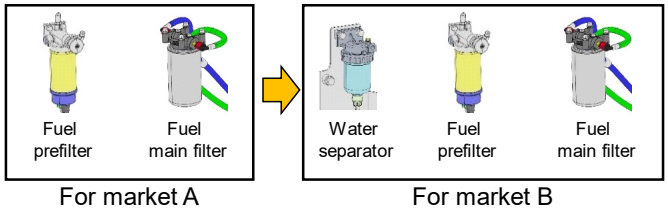

Fig. 7 Differences in fuel system by market (example of PC210-10M0)

3.3 Comfort, serviceability, and expandability

Prior to development, we conducted market research from the perspective of each specialized field in cooperation with the team of the product planning, development, and production departments to understand the current situation of the machine introducing markets.

The research results show that in the target markets of this introduction project, smartphones are fairly widespread and are well used but our products (hydraulic excavators in this project) are not.

Therefore, as the product concept of this development, in addition to economic efficiency (work efficiency), robustness, and expandability, we added the viewpoint of "user-friendliness" to develop the product.

3.3.1 Comfort

We incorporated 12 V charging sockets into the standard equipment in consideration of the high penetration rate of smartphones found in market research and the compatibility of these models with smartphones. We also added an AUX jack for indoor use of smartphone music to the standard equipment. If the application is limited only to smartphones, a USB port is fine, however, we also considered expandability by installing a 12 V socket instead of a USB port so that products widely available in the world can be used. (**Fig. 8**)

Fig. 8 12 V socket and AUX jack placed in the operator's cab

In addition, in strategic markets, since various operators and service personnel handle machines, we have taken consideration to ensure that 15 languages are available in consideration of the introduction country and that the information displayed on the machine monitor can be properly communicated to the operator and service personnel.

In addition, although there is a great deal of information that can be displayed on the monitor, the information fitting in one screen page on the monitor is limited, thus the monitor display is designed hierarchically. Therefore, in these models, we have taken consideration to ensure that pieces of information with high operating frequency can be displayed at a shallow hierarchical level, and aiming for an operation feeling like a smartphone, we have designed the operation screen that enables the operator to use it without reading the operation and maintenance manual. (**Fig. 9**)

Fig. 9 Easier adjustment of the work mode

3.3.2 Serviceability and expandability

To realize the robustness, which is a concept of this development, we have improved the robustness for each of the devices, in addition, introduced a mechanism that facilitates the failure diagnosis (i.e. earlier response) and enables preventive maintenance of failures by installing various sensors so that the occurrence or sign of abnormality can be known.

We hope that using the mechanism of KOMTRAX, which has been installed in the past, we will construct a mechanism that allows the owner (administrator), dealer, and Komatsu to share information, leading to stable machine operation (= suppressing sudden machine shutdown and ensuring the robustness of operation). In particular, understanding the status of filters and working media (hydraulic oil and engine oil) has been difficult to monitor in the past, and it was, therefore, only positioned as a factor for estimating the cause when a failure occurred. In this development, by attaching a clogging sensor to the filter, we have made it possible to detect clogging, which can prevent the machine from continuing to be used with it clogged. As for the working media, we have installed a sampling port to enable easy sampling, which has enabled continuous diagnosis of the machine conditions. (**Fig. 10**)

This has resulted in the introduction of a mechanism like a periodic health checkup that can catch the symptom before a major abnormality occurs.

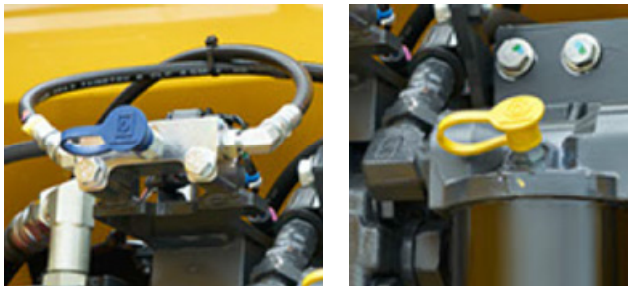

Fig. 10 Oil sampling ports
(Left: for hydraulic oil; right: for engine oil)

In strategic markets, the applications of the introduced machine are not as limited as in traditional markets, and they are often used for various purposes. Therefore, we have taken consideration to ensure the quality of machine modification as easily as possible during a change of its application. In strategic markets, since proper maintenance is often unfinished also in terms of services, in particular, problems such as overheating may easily occur; thus, we designed the cooling cores (e.g. radiator, oil cooler, air conditioner capacitor) to be easier to clean. (**Fig. 11**) (**Fig. 12**)

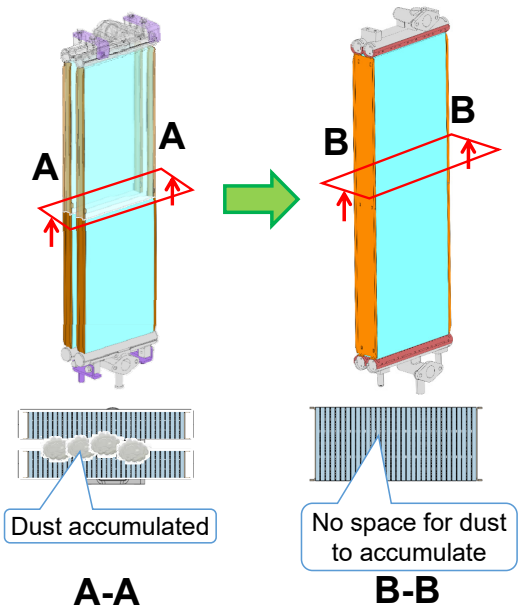

Fig. 11 Modification of oil cooler structure

Fig. 12 Swing type air conditioner condenser
(PC210-10M0 only)

3.4 Market introduction

In this development, we conducted the following:

(i) reconstructed the sales menu to take measures for selling support, and

(ii) participated in new product education and provided face-to-face education in order to support smooth market introduction.

3.4.1 Reconstruction of sales menu

In conventional development, the development department performed development according to various specifications required by the product planning department, and the production department produces them based on sales orders, and then products are shipped and delivered; however, trying to meet the needs of customers has increased the number of types of sales specifications. Because we had too many candidates for selection, the sales department could not respond to customers' requests in detail, and the production department could not accelerate the delivery date. Therefore, in this project, by changing the product specification proposal style to the customer in a cross-departmental manner among the sales, product planning, development, and production departments, we have constructed a new mechanism that can propose, in a short lead time, those optimum specifications optimized for the customer that were present in the initial goal.

To achieve this, we begun with the reanalysis of the current situation and encountered many problems such as the specifications consolidation and abolition in the development and production departments, and the establishment of the production organization, but after solving the problems while cooperating among the departments, we are in the situation where we can deal with them in order, beginning with these models. We have received favorable results; for example, the sale and production departments, which have already experienced the effects, can now flexibly respond to specification changes involved with business negotiations, resulting in shorter delivery lead times, and by making effective use of cross sourcing, the plants have been able to respond flexibly fluctuations in demand.

3.4.2 New product education

We participated in new product education conducted at Asia Training and Demonstration Center (ATDC) and Dubai Training and Demonstration Center (DTDC) under the coordination of Construction Equipment Marketing Division, and explained the product concepts and features and the new technologies incorporated in these models, to the salesmen and technicians of overseas subsidiaries and local dealers.

It was a good opportunity for us to realize that it is our mission as development designers to convey the product appeal of a designed product toward the front lines of sales. Through these activities, we have contributed to smooth market introduction. (**Fig. 13**) (**Fig. 14**)

Fig. 13 A scene of new product education (at ATDC)

Fig. 14 A scene of new product education (at DTDC)

4. Conclusion

The PC210-10M0 and PC500LC-10M0 are the first series of main models in the strategic market. With "Quality and Reliability" as the base, we succeeded to incorporate elements to improve the product appeal everywhere because they are models developed as products deployed to strategic markets, rather than those products for traditional markets that are deployed to strategic markets. We hope that they will be highly evaluated in the market.

Introduction of the authors

Hiroyuki Mizuno
Joined Komatsu Ltd. in 1994.
Digital Innovation Development Center,
Development Division

Tatsuo Wada
Joined Komatsu Ltd. in 2001.
Vehicle Development Center 2,
Development Division

Kiichirou Kouno
Joined Komatsu Ltd. in 2004.
Vehicle Development Center 2,
Development Division

Katsunaga Kashima
Joined Komatsu Ltd. in 2004.
Bangkok Komatsu Co., Ltd.

[A comment from the authors]

We have received a great deal of cooperation from related departments such as Product Marketing Division, Production Division, and Service Division, from the market research stage of product planning to trial production, quality verification, and mass production. Also in Development Division, we received the cooperation of a large number of people for the development of both models, including their transfer, and they were developed by bringing together all human and technological efforts. We feel that the development was rewarding although we encountered some tough phases during the development. We will continue to cooperate with related departments in product development from the customer's perspective.