

Introduction of Product

Introduction of D155AX-6 GALEO Series Large-Sized Crawler Dozer

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The in-depth surveys were conducted visiting distributors and job sites in North America and Europe, which are the main markets for large-sized crawler dozers. And then, closer inquiries led to the Dantotsu Features from the top two out of customers' demands. With the engine suited to EPA Tier 3 emission regulations, D155 crawler dozer has been superbly upgraded to D155AX-6 that is introduced in this report.

Key Words: *Bulldozer; GALEO Series, Tier 3 emissions Regulation, Dantotsu Feature, Sigmadozer, Electronically Controlled Lock-Up Automatic Transmission, Multi-Color Monitor, ROPS Integrated Cab, Electronically Controlled Implement Valve*

1. Introduction

Since it is marketed in 1999 as a new model, the D155AX-5 has enjoyed a high reputation for productivity and durability. In 2003, the D155AX-5 underwent a minor change to reduce fuel consumption and to improve comfortability. Nevertheless, recent model changes incorporated in competitor products have gradually eroded its product excellence. Furthermore, developing vehicles that meet the Tier 3 exhaust gas regulation of the EPA to be enforced beginning 2006 has become a pressing matter.

In North America, in Europe and in Japan, on the other hand, customers are demanding products that excel over competing products and meet the needs of the times.

Additionally, demands for protection of the global environment by adopting mechanisms such as exhaust gas regulations and calls for reducing noise and improving people's lifestyle and living environment have become stronger.

Against this backdrop, the D155AX-6 GALEO was launched after undergoing a full model change for the first time in seven years based on in-depth user surveys, incorporating state-of-the-art technologies. The D155AX-6 GALEO, which is overviewed below, features environmental friendliness and safety (**Photo 1**).



Photo 1 General view of D155AX-6 GALEO

2. Development Objectives

Development objectives as shown in **Fig. 1** were set at the start of developing a Dantotsu bulldozer, aiming at providing and maintaining a powerful competitive power as a next-generation bulldozer. The development effort for realization focused on new technologies as selling points based on the "IT, environment, safety and basic performance" as new brand concepts of Komatsu suiting the new century and providing solutions to the needs of users throughout the world.

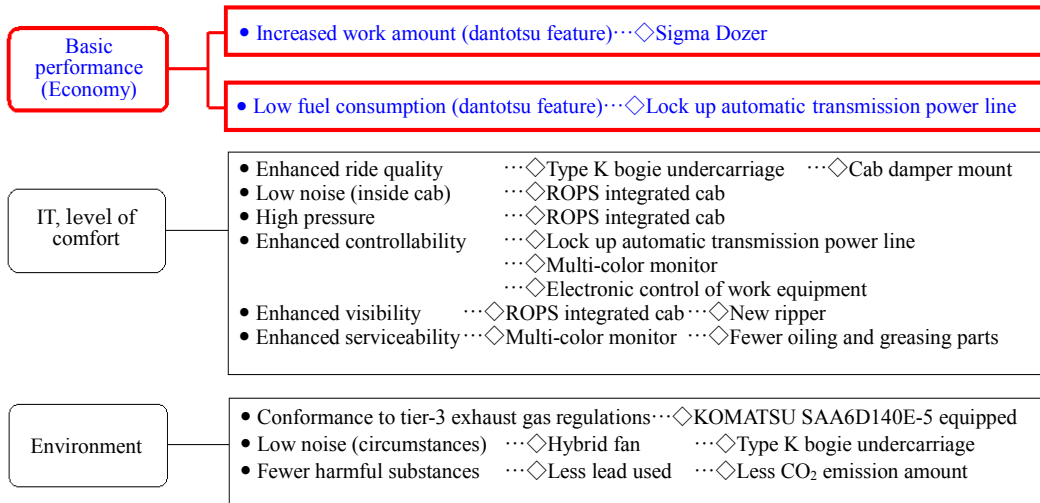


Fig. 1 Target of development

3. Dantotsu Features

The new technologies described in the following have increased the amount of work (m³/h) 15%, have reduced fuel consumption (ℓ/h) 10% and have improved the fuel consumption efficiency (m³/ℓ) by approximately 30% compared with conventional models (Fig. 2).

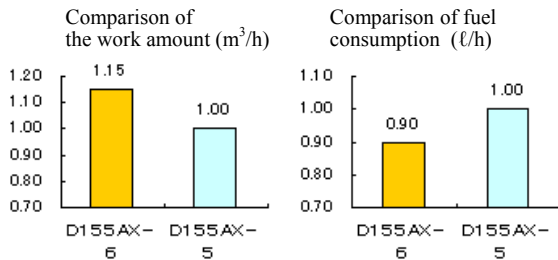


Fig. 2 Comparison of the work amount and fuel consumption

(1) Increased work rate by “Sigma Dozer”

To increase the work rate, the D155AX-6 is installed with a new shaped blade and the “Sigma Dozer” to ensure a higher digging efficiency (Fig. 3). The new blade concept is based on the unique shape of the front part of the blade by digging earth in the center of the blade. The new concept increases the amount of earth shoveled by the center part and reduces the amount of earth that spills over from both sides of the blade. The new blade increases the work rate by 15% with the same digging resistance as that of the conventional semi “U” blade (Fig. 4).

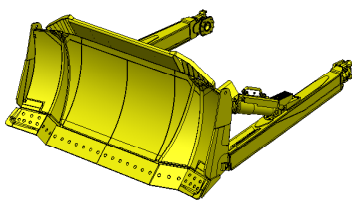


Fig. 3 Sigma Dozer

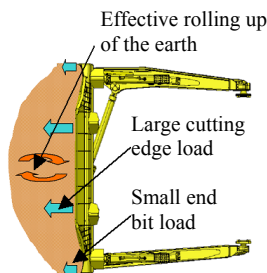


Fig. 4 Mechanism of digging

① Advance test

An advance test in two phases was conducted prior to the development. First, a bench test was conducted using a model to verify whether a large amount of earth could be dozed efficiently according to the theory. Next, a test was carried out using a real size blade to verify whether the calculated work rate could be achieved. Additionally, work other than dozing work that was required for the blade of a bulldozer (leveling, side cutting and boulder stone dozing) and performance due to differences in soil property were evaluated, to arrive at the optimum shape (Photo 2, Fig. 5).

② Application to new model D155AX-6

Incorporating the results of the advance test in the development work, the development target of increasing the work rate by 15% for the D155AX-6 could be accomplished.



Photo 2 Comparison of concentrating capacity (Side view)

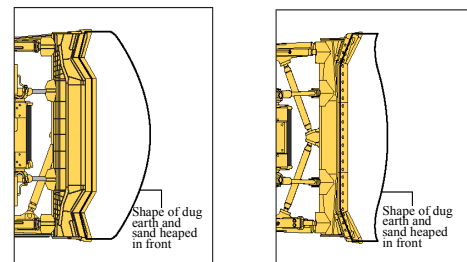


Fig. 5 Comparison of concentrating capacity (Overhead view)

(2) Low fuel consumption by lock up automatic transmission
 To efficiently transmit effective engine output to the work equipment, the D155AX-6 employs a lock up automatic transmission system. A total electronic control system that controls not only the power line and engine, but also work equipment, as well as a multi-gauge color display that is installed in Komatsu bulldozers for the first time, enhance the operability of the dozer simultaneously.

① System configuration

The control system configuration is shown in Fig. 6. Each ECU is connected by KOMNET (CAN), which transmits information and commands.

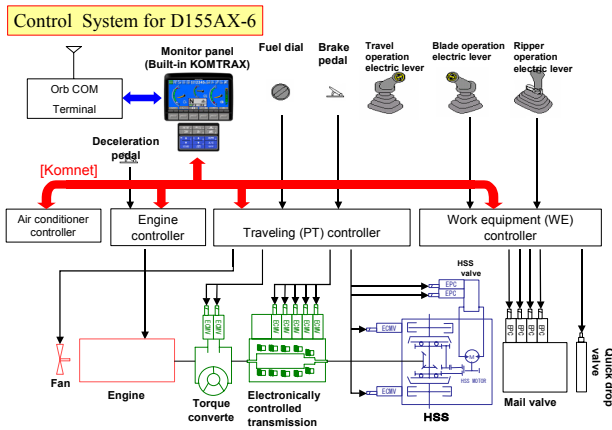


Fig. 6 Configuration of control system

② Engine control

In the automatic transmission mode, engine control is changed to mid range governor characteristics, thereby allowing fine engine output selection in accordance with mode selection, gearshift and L/U state to lower fuel consumption. In partial throttle or in deceleration, the mid range governor and HSI (Hi Speed Idle) are combined to achieve total area power control and limit of maximum speed of vehicle.

③ Gearshift control

Automatic transmission of bulldozers is practically used in hydraulically driven power lines such as HMT and HST. However, the D155AX-6 is the first bulldozer with a torque converter to employ a gearshift presetting function. To allow the operator to smoothly accept this system, a drastic reduction in the gearshift shock and speed change was essential. New technologies were incorporated to accomplish this such as regulation of the lock up clutch pressure through the speed ratio of the power line input and output revolutions and a short synchronization time through engine torque control. This half lock up control prevents torque troubles, achieving speed change control that is unrivaled by conventional models.

(3) Advanced operator interfaces

The D155AX-6 employs new operator interfaces to freely operate lock up automatic transmission that is electronically controlled and to lower fuel consumption in collaboration.

The PCCS lever that has been accepted popularly with existing machines is continuously used as the travel lever.

The automatic transmission mode is set as default for ordinary uses such as dozing and leveling. In rocky terrain work such as in ripping and rough ground work, the manual transmission mode, which has the same functions as those of conventional models, can be selected (Fig. 7).

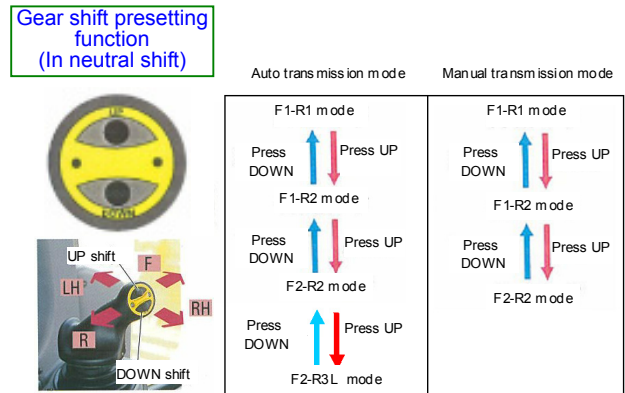


Fig. 7 Gear shift presetting

A large multi-gauge color display is used as a monitor. The gauges and graphs have the same designs that have been standardized for the Komatsu Dantotsu models. IT functions such as KOMTRAX information email and an external camera are provided as in other models. In addition to them, several functions have been added as functions that are dedicated to bulldozers (Fig. 8).

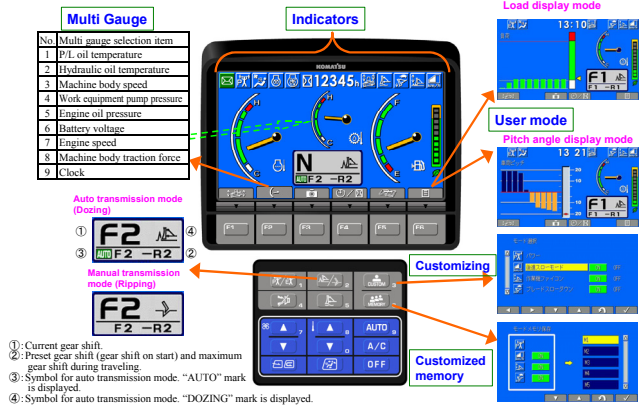


Fig. 8 Large multi-gauge color display

[Multi gauge] ... The multi-gauge display located in the center of the color display enables the operator to select and display a gauge that is needed to read in accordance with work conditions or vehicle conditions.

[User mode] ... The “load display mode” that scrolls as time passes by interlocking to the eco gauge visually displays the relationship between the work progress and vehicle load, thus contributing to energy saving operation. Similarly, the “pitch angle display mode” that scrolls as time passes displays the pitch angle in time series in response to high user demands, to enhance the work efficiency through comprehension of landform.

[User customize] ... The fine control characteristics of the

work equipment lever, quick drop valve operation, backward traveling slow mode setting and other items can be customized according to operator choice. The “customize memory” function allows of five settings to be memorized so that settings for several operators can be registered and settings for different work can be made. The new model controls work equipment by electronic control, thereby enhancing the blade controllability through quick drop work point control and other control. By combining it with the “user customize” function, it gives higher controllability tuned to work conditions and operator individuality (Fig. 9).

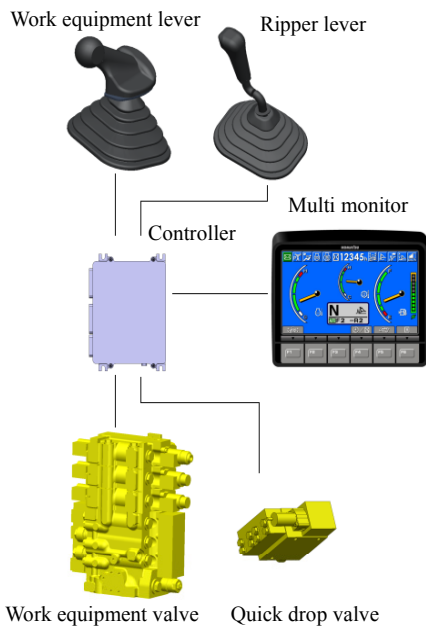


Fig. 9 Electronic control of work equipment

4. Selling Points

4.1 IT and comfortability

(1) Enhanced ride quality

The synergy effect of a cab damper mount that excels in shock absorption such as in conventional models and the K-bogie undercarriage system that is used in large machines such as D275 and larger models reduces vibration during travel and shocks while traveling on uneven ground (Table 1, Fig. 10).

Table 1 Enhanced ride quality

Item		D155AX-6	D155AX-5
Undercarriage type	—	K bogie	X bogie
Number of track rollers	Quantity	7	6
Cab mount type	—	Damper mount	Damper mount
Running-over shock *1	m/s ²	10.4	14.3

*1: 3-axis composite acceleration RMS value for the upper part of the operator’s seat (Running over a R2.70mm block)

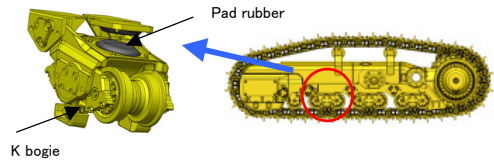


Fig. 10 Undercarriage of K bogie

(2) Reduced noise in cab

The sound shielding performance inside the cab has been greatly enhanced through the high-rigidity cab, which also incorporates the ROPS (roll-over protective structure) function and through high sealing performance by full electronic control, reducing noise by 2dB (A) compared with conventional models. The pressure level increased by approximately 5mmAg (Table 2).

Table 2 Noise at the operator’s station

Item		D155AX-6	D155AX-5
Noise at the operator’s station	dB(A)	75	77
Pressurized compartment	mmAg	14.7	9.5

(3) Improved visibility

Unlike the conventional structure, which has a cab and ROPS separately, the D155AX-6 uses a ROPS integrated cab that has a very high rigidity and is combined with the ROPS functions, thereby drastically improving the side visibility by removing ROPS pillars (Fig. 11).

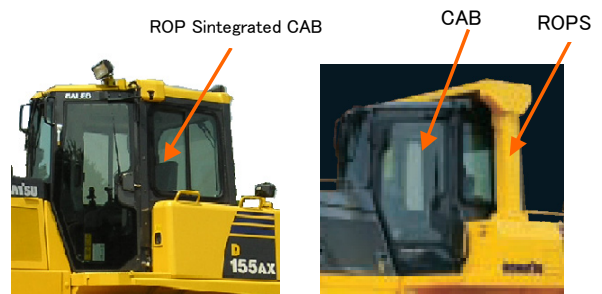


Fig. 11 ROPS integrated cab

A new link is used in the ripper, and the rearward visibility during ripping work has been greatly improved (Fig. 12).

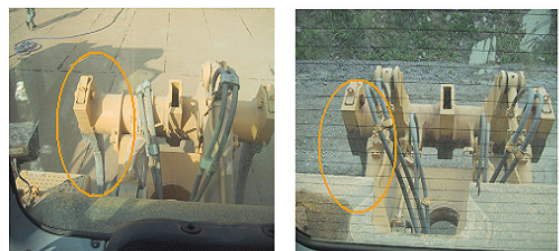


Fig. 12 Improved rear visibility through new link

(4) Improved serviceability

The caution display and trouble diagnosis functions of the multi-color monitor are enhanced and easier to see. The monitor quickly notifies the operator of any problems. The service mode functions are more user friendly (Table 3).

The blade and ripper have a new link that reduces blade play amount and improves visibility improvement (mentioned above). The simplified link has greatly reduced the number of locations that require greasing (Fig. 13, Table 4).

Table 3 Mode display on multi color monitor

Mode	Function		
User mode	Maintenance mode	Time to change oil or a filter is displayed	
	Customize mode	Changing operability of the work equipment and other functions	
	Work status graph	Time series display of machine body inclination and traction force	
	Selection of gauge in a multi-gauge display	Gauges switching for the torque converter oil temperature, hydraulic oil temperature, etc.	
	Screen adjustment	Screen brightness and contrast adjustment	
	Language selection	Selection of 11 languages, including English and Japanese	
	Fan cleaning mode	Fan inverse operation mode while cleaning radiator	
	Service mode	Monitoring mode	Checking of sensor voltage and temperatures
		Failure history display	Codes of past failures are displayed
		Maintenance mode change	Maintenance mode settings can be changed
Adjustment mode		This mode enables various adjustments	
PM click mode		Monitoring of engine speed, water temperature and other parameters	
Deceleration mode		This mode is selected during engine failure diagnosis	

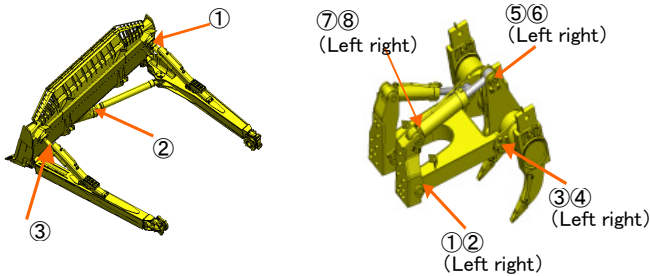


Fig. 13 Blade link and ripper link

Table 4 Oiling locations of blade and ripper

Item		D155AX-6	D155AX-5
Blade greasing location	Quantity	3	5
Ripper greasing location	Quantity	8	12

4.2 Environment

(1) Engine compliant to tier 3 exhaust gas regulation

The Komatsu SAA6D140E-5 engine embedding a cooled EGR system and an electronically controlled common rail injection system is equipped, accomplishing clean emission performance of the highest level of the world, good exhaust gas color and low fuel consumption (Table 5).

Table 5 Comparison of engines

		D155AX-6	D155AX-5
Engine	—	SAA6D140E-5	SA6D140E-3
Piston displacement	ℓ	15.24	←
Rated output	kW/rpm	239/1900	231/1900
Additional emission apparatus	—	EGR	None
After-cooler type	—	Air cooled	Water cooled

(2) Reduced exterior noise

The new K-bogie undercarriage not only enhances ride quality, but also reduces carriage noise when traveling. A hybrid fan has also reduced fan noise. Through these effects, exterior noise has been reduced to 2dB (A) in dynamic noise compared with the conventional model (Table 6).

Table 6 Comparison of exterior noise

		D155AX-6	D155AX-5
Dynamic noise	dB(A)	111	113
Stationary 15m exterior noise	dB(A)	76	77

(3) Reductions in CO₂ emission amount and harmful substance

The D155AX-6 has significantly reduced fuel consumption and, consequently, CO₂ emission amount is greatly reduced (Table 7).

The brass tube radiator that is made by lead soldering is replaced by an aluminum radiator and consumption of lead has been reduced drastically.

Table 7 CO₂ emission amount and mass of harmful substances

		D155AX-6	D155AX-5
CO ₂ emissions	kg/h	96	107
Harmful substance (Lead)	kg	0.9	21.3

5. Conclusion

The D155AX-6 will be marketed in North America on the Field Day in March 2006 and in Europe in April 2006 at the Intermat. The D155AX-6 incorporates many improvement items including the two Dantotsu selling points. It has been perfected through strict quality verification and is sure to achieve a high market evaluation.

Market entry of the D155AX-6 will be supported with minute care so that it will be accepted in the market without much delay.

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[A few words from the writer]

Planning and advance research of Dantotsu features were started in the second half of 2002. Mass production of the D155AX-6 began in January 2006 after mapping out and implementing a development plan in June 2003. The development and production departments are now making concerted efforts to deliver the Dantotsu bulldozer to industry throughout the world.

The writers intend to apply the Dantotsu technology gained in the development of the D155AX-6 to the higher and lower series.