

Introduction of Products

Motor Grader GD655 and 675-6

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The GD655/675-6 series is the first motor grader model which conforms to the Tier 4 Final/EU stage IV/Japan 2014 regulation (hereinafter “Tier 4 Final”), and has been launched to North American, European, and Japanese markets.

In particular, the Japan model is the revival of the grader since its discontinuation in 2013, 2 years ago. The technology of this machine is introduced here.

Key Words: *Motor grader, Exhaust Gas Regulation, Snow removal, Dual mode transmission, Low fuel consumption, Visibility, Safety, ICT*



Fig. 1 Earthmoving specifications for Japan



Fig. 2 Model for North America

1. Introduction

When the development of GD655/675-6 (hereinafter “Dash 6”) was started, the Komatsu Motor Graders sold in the emission controlled areas were GD655/675-5 (hereinafter “Dash 5”) introduced in 2009 for North America and Europe, and GD655-3 (hereinafter “Dash 3”), a model of one generation ago, for Japan.

Because the product service life of the grader is long, we skipped the development of a model which conforms to the transitional emission regulations of the Tier4Interim/EU Stage3B/Japan 2011, and developed the Dash 6 which conforms to the Tier 4 Final. By this model, the generations of the models for Japan, North America and Europe are leveled, and the capability to be a substitute of GD755/GH320 discontinued in 2013 in Japan is ensured.

This Dash 6 is a full model change including the installation of the after-treatment devices and the countermeasures for the safety regulations.

[Developed model] Unified to Dash 6	Japan	GD675-6
	North America	GD655-6
	Europe	GD675-6

←

[Former model] Dash 3 in Japan	Japan	GD655-3E0/Y0 Discontinued in 2013.
	North America	GD655-5
	Europe	GD675-5



Fig. 3 Model integration

2. Aims of development

To develop the Dash 6, based on Dash 5, and without changing the dimensions and major components, we converted the engine to the one conforming to the said emission control regulations, renewed the related engine auxiliaries and the control system, and introduced the changes

to conform to the relative safety standards.

In the case of model for Japan, as it is a full model change from Dash 3, the merchantability has been increased by the improved visibility with the hexagonal cab and by the increased output.

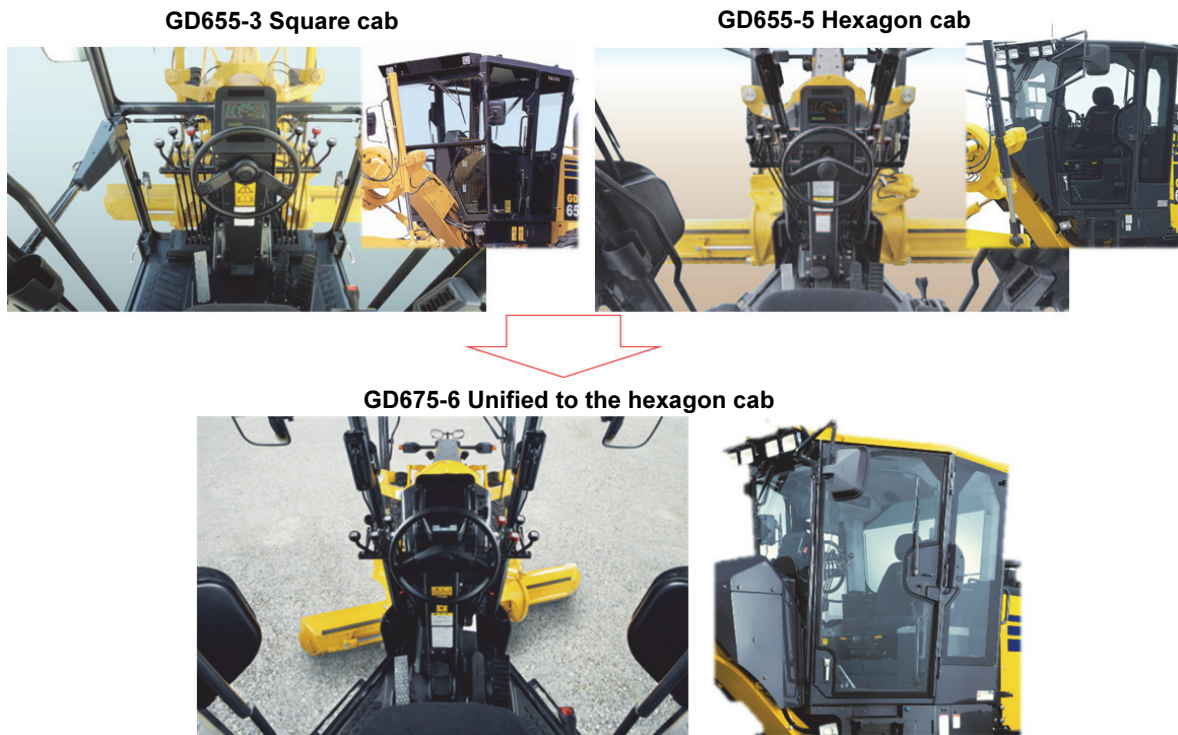


Fig. 4 Cab change

Currently, GD675 was used as the model name for Europe, and GD655 for North America and Japan. For Dash 6, GD675 will be used for Japan.

In the development of Dash 6, we unified the specifications in Japan, North America and Europe as much as possible, except for the parts related to the safety standards in Japan, so that the vehicles with almost the same specifications will be released in these three regions.

Examples of the unification of specification

- The work equipment lever lock, which was used only in EU models, has been extended to all regional models.
- The optional valve and lever have been installed as standard.
- The blade accumulator-less and the blade float-less models have been abolished.
- The Japan-specific work equipment lever arrangement and the draw-bar shift cylinder layout have been

unified with those for overseas models.

With regard to the work equipment lever arrangement described above, only the model for the Japanese market was different from the others in the past, so that two types of parts were needed for Japan and overseas models. The present hydraulic system that has adopted the closed center load sensing system (CLSS) does not need to consider the hydraulic interference during a simultaneous operation of two functions. Therefore, the lever arrangement (global pattern) for the overseas specifications, which enables a simultaneous operation of two levers to be operated together with one hand, is more advantageous. Because of this, the lever arrangement for Dash 6 has been unified to the global pattern.

For the work equipment controls, conventional mechanical type control in which a valve spool is directly operated with a lever via a link is used.

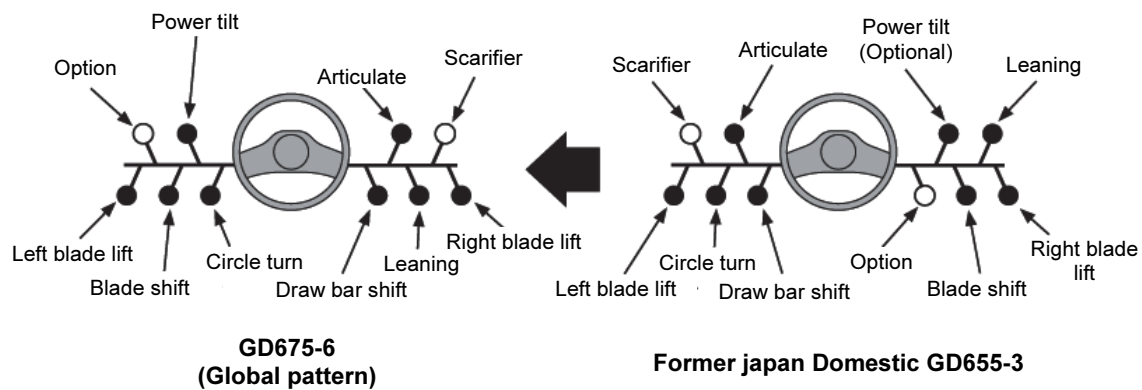


Fig. 5 Former work equipment lever arrangement

Unification is also considered on the engine hood design. The mounting holes for lights, which are different for Japan and overseas, are all provided.

Furthermore, unification of the specifications resulted in the improvement of the Japan model because the work equipment and comfortable equipment for Japan model were inferior to those for North America model.

Since the after-market information and communication technology (ICT) equipment has become popular for graders, in order to facilitate the installation of the 3DMC equipment manufactured by TOPCON CORPORATION, the “installable (Provision) specification” in which the mounting seat and the wiring hole are already provided, is prepared.

3. Main changes

3.1 Correspondence with Tier 4 Final

(1) Engine

The SAA6D107 engine used in Dash 5 has been adopted. To conform to the emission regulations, 134 kW, 149 kW and 163 kW are selected as the variations of the variable horsepower control (VHPC).

The fuel consumption of the engine unit is improved by about 5% as compared with the engine for Dash 5. In addition, the E-mode of the engine power mode switching function (which has been adopted since Dash 5) provides a feature which places emphasis on the fuel economy.

In the E-mode, the engine speed upper limit control is

applied in F1 to F6 speed gears (which are used during the work) to reduce the practical fuel consumption during the work.

Because the load of the grader work is small in most cases, if the work is performed with the accelerator pedal fully depressed, the maximum engine speed is constantly used and therefore the fuel consumption is deteriorated. If the engine speed upper limit control is applied to suppress the rise of the engine speed more than necessary even the accelerator pedal is fully depressed, the fuel consumption can be improved without requiring special attention to the operator.

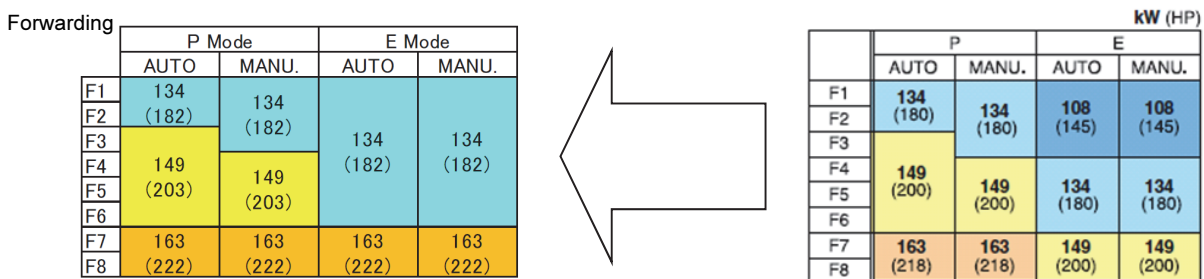


Fig. 6 Change of power setup - From Dash 5 to Dash 6

(2) Installation of the exhaust after-treatment device

In order to conform to the emission control regulations, installation of the exhaust after-treatment devices such as the Komatsu diesel particulate filter (KDPF) and the selective catalytic reduction (SCR) unit is required. In order to avoid a feeling of tightness and worsened visibility from the height of the engine hood when looking backward and to avoid the worsened engine serviceability, Dash 6 positioned the exhaust after-treatment device between the engine and the cooling unit, the authors aimed to keep the maximum height of the engine hood unchanged from that of the Dash 5 (conforming to Tier 3).

Although the length of the rear overhang was extended by the length of the exhaust after-treatment device because of this layout, the increased length has been effectively utilized by storing the AdBlue®* tank in the extended space, and a height of the front side of the engine hood has been kept unchanged from that of Dash 5. The rearward visibility has been improved with the rear-view monitor that has become a standard equipment from Dash 6.

(3) Transmission

The dual-mode transmission capable of switching the

automatic and manual operation has been adopted. The same as Dash 5, since the engine stall would not occur even in the manual mode thanks to the engine stall prevention function, the operator can concentrate on the work without worrying about the load.

In addition, in the first speed of the torque converter mode with low idling, the creep control maintains a constant speed of about 1 km/h, the speed adjustment for the finishing work is easy.



Fig. 7 Arrangement under the engine hood

(4) AdBlue®* tank

With regard to the position of the AdBlue®* tank, capability of supplying to the tank by the person on the ground was an essential condition considering the usability as a road machine. Because of this, the tank was installed at the rear end of the vehicle as described above and its filler port was arranged in the right side.

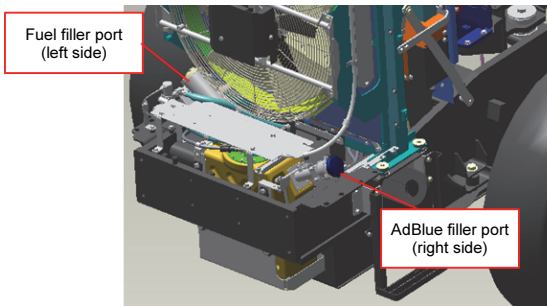


Fig. 8 Arrangement of the AdBlue®* tank

* AdBlue® is a registered trademark of the German Association of the Automobile Industry (VDA)

3.2 Development of the monitor panel

In order to correspond with the increased display items in accordance with the Tier 4 Final and the display switching function, the 7-inch color liquid crystal display (LCD) has been adopted for the monitor panel instead of the conventional monochrome LCD.

The monitor panel of the grader is required to mount in the compact steering post so as not to interfere with the visibility at work. The authors have been developed a monitor panel optimum for the grader, which displays the the engine speed and the vehicle speed on the LCD, and combined with the separate indicator LED unit fit for the steering post.

In the center of the standard screen of the LCD monitor, the articulate angle indicator that is unique to the grader is arranged. The screen incorporates the design that is common to the wheeled construction machines of Komatsu, while considering the usability for a grader.

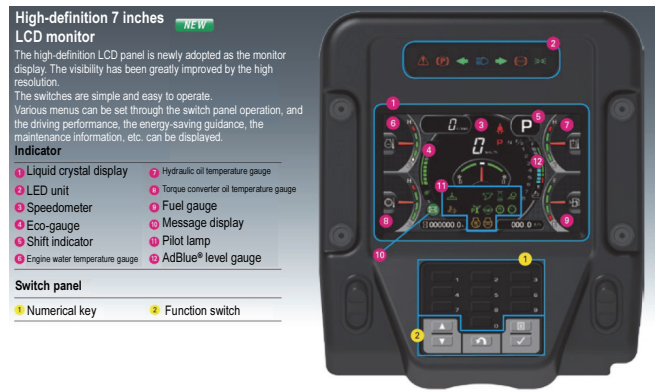


Fig. 9 High-definition 7-inch liquid crystal monitor

3.3 Resin work equipment wear plate

Between a draw bar that holds the work equipment and the rotatable section underneath it (called as circle), a sliding material (called as wear plate) that was formerly made of metal is inserted. In Dash 6, resin wear plate has been adopted to improve the wear life and to reduce the sliding resistance when the circle is rotated.

By adopting composite resin that is strengthened by adding fibers into the self-lubricating resin, it can be used without supplying grease to the sliding surface, and the component wear has been reduced because of the self-lubricating feature. As a result, the maintenance interval for the clearance adjustment of the work equipment can be extended, and the weight per one plate has been reduced to 1/6 of the weight in the past due to the material change to resin from metal, and the handling has become easier.

We believe that the expanded application of the resin components like this can facilitate many kinds of maintenances.

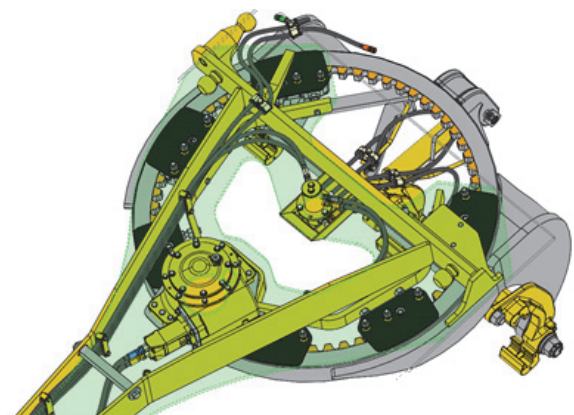


Fig. 10 Work equipment and wear plate

4. Snow-removal grader

4.1 Snow-removal work specification

As described above, with regard to the graders for the snow removal for the market in Japan, in addition to the 3.7 m class with the standard specifications blade of 3.7 m, this model should substitute the larger 4.0 m class and the 4.3 m class. For this purpose, the 4.3 m blade that was dedicated for the overseas in the past has been set up for the specifications for Japan. This model can conform to the snow removal

grader standards of the 3.7 m, 4.0 m, and 4.3 m classes by selecting one of the three types of blades.

As the snow-removal work specification, the snow-proof device which prevents sucking snow into the engine and heated side mirrors as well as the heater glass defroster for the front window, winter wiper blade, flash warning lights are provided for the snow-removal work in the cold area.

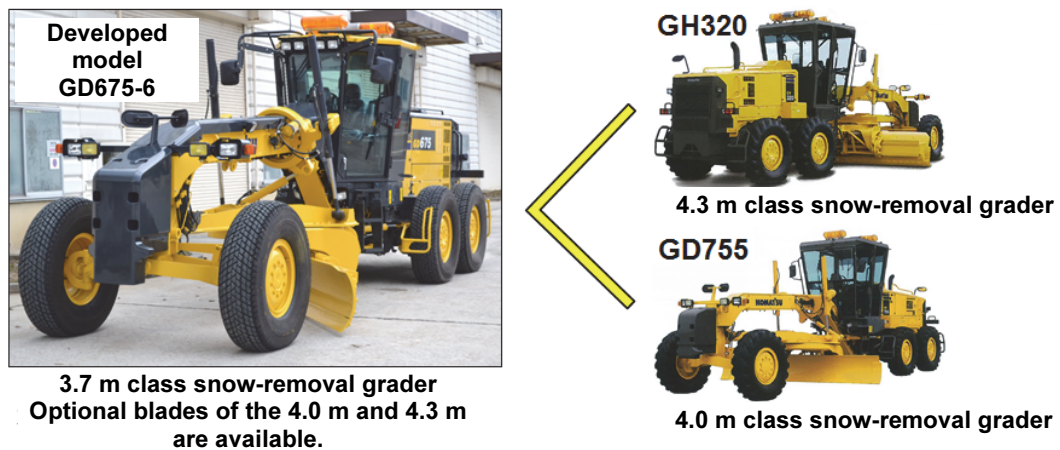


Fig. 11 Snow-removal grader

4.2 One person operation of snow-removal grader

In Japan, formerly the 2-person operation (operator and assistant) was obliged for the snow-removal graders by regulation. To design a 2-person cab, however, the visibility and layout of the controls for the standard earth-moving model had to be sacrificed, and the 2-person cab cannot meet the ROPS specification because of its structure. Therefore, approval of the 1-person operation of the snow-removal vehicle had long been awaited.

Komatsu had been worked for the approval of the 1-person operation against the background of the easy-to-operation features thanks to the recent improvement of the grader equipment (the standardization of the automatic transmission and the spread of the clutch type circle rotation unit) and based on the premise of improvement of the visibility, for the purpose of making the earth-moving grader and snow-removal grader to be one.

For the 1-person operation, securing sufficient visibility and a new technology that substitutes the assistant are required to be combined, so the installation of the side-view cameras and the two-way communication system have been

studied and adopted.

By mounting these devices, 1-person operation of the snow-removal grader was approved in the middle of the development of Dash 6, and therefore the snow-removal specifications were able to be unified to the 1-person specification.



Fig. 12 Cold area test



Fig. 13 Test of snow-removal model

4.3 Optional devices for snow-removal model

The devices that have been introduced for 1-person operation of the snow-removal model are described here.

These devices have been prepared as dealer options, which can be mounted irrespective of model specifications.

(1) Side-view cameras

In addition to the standard rear view monitor, the side-view cameras have been introduced to check overtaking vehicles and surroundings. The standard camera is mounted on the rear end of the engine hood, and the side-view cameras are mounted on the upper part of the cab, and the left and right images are displayed together on the added monitor. Accordingly, even when working by looking forward, it is possible to check the rear and surroundings using the monitors.

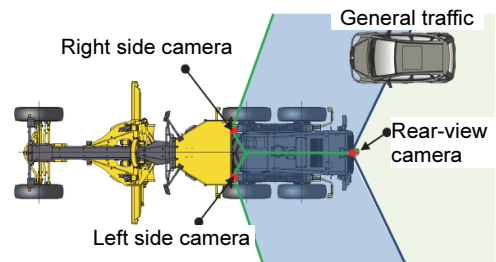


Fig. 14 Side-view cameras

(The circles on the upper part of the cab indicate the additional cameras, and the lower monitor is for the sides.)

(2) Two-way simultaneous communication system

To work with one operator, the safety check from surroundings and the communication with other vehicles that are working together are important. For this purpose, the two-way simultaneous communication system has been introduced as a means to achieve this. It consists of the base unit installed in a grader and the extension units for other vehicle operators. Unlike conventional transceiver, four persons can talk at the same time. They can have conversation as if they were face-to-face even riding in separate vehicles.

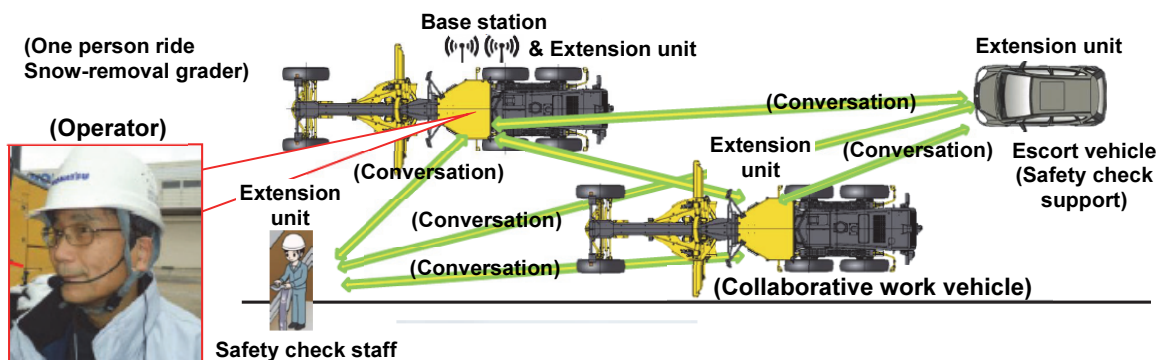


Fig. 15 Two-way simultaneous communication system

5. Conclusion

As the development of the countermeasures for the emission control of the grader was slow, the development of Dash 6 has been a revolution. GD675-6, as a result, has become the first heavy-duty special vehicle which conforms to the Japan 2014 regulation. Furthermore, besides the technologies that were described in this article, we were able to incorporate many know-hows and the voices of the market.

We will continue to study for the adoption of new technology and would like to develop more easy-to-use graders.

Table 1 Main elements of the specifications in Japan

Item	Model	GD675-6	
		Earth-moving model	Snow-removal model
Operating mass	kg	17845 (3.7 m*)	18285 (3.7 m*)
			18355 (4.0 m*)
			18485 (4.3 m*)
Engine model	Komatsu SAA6D107E-3		
Engine type	Water-cooled, four-stroke, direct injection, turbocharged, with air-cooled aftercooler, EGR		
Rated output (net) (JIS D0006-1)	kW/min ⁻¹ [PS/rpm]	1st - 3rd: 135 / 2000 [183 / 2000] 4th - 6th: 150 / 2000 [203 / 2000] 7th - 8th: 163 / 2100 [221 / 2100]	
Overall length / overall width / overall height	mm	9510 / 2410 / 3175	9765 / 2410 / 3410
Blade length×height×thickness	mm	3710×545×19 (3.7m*)	3710×545×19 (3.7 m*)
			4010×545×19 (4.0 m*)
			4265×580×25 (4.3 m*)
Maximum speed	km/h	Forward, 8th: 48.5	Reverse, 4th: 40.3

Introduction of the writers



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[A few words from writers]

In Japan, after the discontinuation of the Dash 3, the impact that the grader was no longer available especially for snow-removal work was so large and more than imagined that the newspapers reported it as a topic. For this reason, we have overcome the difficult development, hoping to anyway deliver the new graders to the market soon. We are grateful to everyone who cooperated in this development.

We are expecting that the GD675-6 vehicles will be used worldwide.