Road Recycler GS500-1

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KOMATSU has developed a new, high-function, high-efficiency road recycler, GS500-1, for the on-site sub-base course recycling method — one of road repairing methods. This paper describes the salient features of the GS500-1.

Key Words: *Road, Recycled Sub-Base Course, Asphalt, Road Machines, HST, Stabilizer, Foaming*

1. Introduction

Roads are one of the key infrastructures that support modern industry. The typical road consists of three layers: surface course, sub-base course, and subgrade course (from top down). These three courses have their own roles. Namely, the surface course secures the flatness and friction coefficient required of the road; the sub-base course secures the bearing capacity required of the road; and the subgrade course distributes the load applied to the road (**Fig. 1**).

KOMATSU manufactures various types of machines exclusive for road maintenance and repair which suit specific methods (**Table 1**).

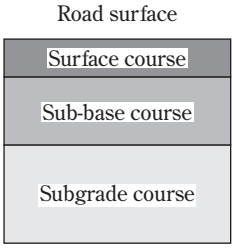
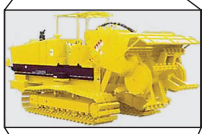


Fig. 1 Road structure

Table 1 KOMATSU machines exclusive for road maintenance and repair

	Wheeled road stabilizer	Crawler road stabilizer			Road cutter	Vibrating roller	
Type	GS360-2	CS210-1	CS360-2	CS360SD-2A	GC380F-2	JV100WA-2	JV130WH-1
							
Machine weight (kg)	21,000	16,110	24,400	24,600	28,960	11,300	12,700
Rated output (kW)	265	152	265	265	364	99	99
Overall length × overall width × overall height (mm)	9105 × 2450 × 3470	7500 × 2350 × 2630	9485 × 2980 × 3640	8840 × 2980 × 3640	10500 × 2480 × 2850	5600 × 2350 × 2990	
Typical method (content)	On-site sub-base course recycling method (reinforcing the sub-base course of an old paved road with an improvement	Subgrade/sub-base course stabilization method (reinforcing the ground by mixing lime/cement in the sub-base course and subgrade soil)			Cut & overlay method (cutting a paved road surface to make it smooth and removing the waste material produced by the process)	Subgrade/sub-base course compaction method (compacting the sub-base course of an expressway/housing/airport construction site and dump truck course)	

In 1980, the company put on the market the wheeled road stabilizer GS360 (rated output: 265kW) for sub-base course repair work.

In those days, motor transportation was growing rapidly and many of the trunk roads were beginning to suffer damage (surface cracking) to their sub-base courses due to the sharp increase in traffic volume. Under that condition, the on-site sub-base course recycling method that permits repairing a damaged sub-base course in a comparatively short period of time was adopted. The GS360 was very widely used to apply the method. (The on-site sub-base course recycling method is a road repairing method in which a damaged road is cut, crushed, and mixed with a suitable improvement material scattered over the road to recycle it as a new sub-base course material.)

Since the method does not require blockading traffic for many hours, the amount of repair work done by using it increased rapidly. As a result, a total of about 200 units of the GS360 were sold.

The on-site recycling method is still employed today. However, with the ever-increasing traffic volume, the roads with a recycled sub-base course are beginning to show marked damage to the sub-base course, calling for re-improvement of the sub-base course. Since lumps of the recycled sub-base course material are very high in strength, the GS360 can hardly be used to handle them efficiently. With the GS360, therefore, the advantage of the on-site recycling method mentioned above was diminishing. On the other hand, there was growing demand for a new method of recycling recycled sub-base courses due to some external factors, such as enforcement of the Construction Material Recycling Act, demand for the reduction of CO_2, and decrease in the construction budget (**Fig. 2**).

With the aim of solving the above problems and meeting the market demand, we have come up with a new road recycler, GS500-1, which features advanced new functions and high efficiency (**Photo 1**).

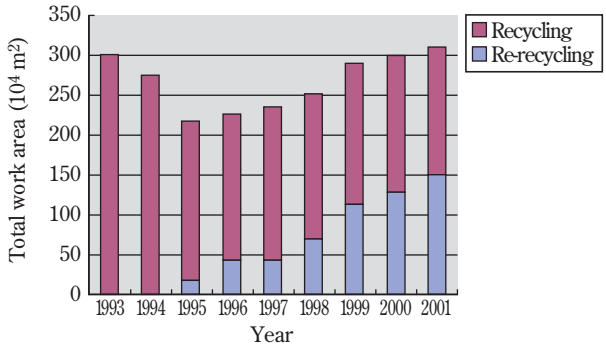


Fig. 2 Change in amount of sub-base course recycling work

Photo 1 Appearance of GS500-1

2. Aims of development

On the basis of information about the needs of our major customers, we set the following aims of development (**Table 2**).

Table 2 Aims of development and means of attaining them

		Means of attaining aims of development (Figures in parentheses indicate improvements on GS360.)
1. To permit working on even hard sub-base courses speedily	• Increasing engine output	SAA6D140E-3 engine; rated output: 368kW (up 39%)
	• Increasing rotor drum driving force	HPV160 x 2; rotor tangential force: 4,400 kg (2.3 times)
	• Securing stable tractive force	Four wheels with hydraulic differential lock
		Wide tire: 20.5 – 25 (14.00 – 24)
	• Increasing stiffness of work equipment support	Rotor load: 21,000 kg (2.1 times)
2. To allow for work execution without blockading traffic on the opposite lane even on narrow roads (minimum width: 5.5 m)	• Making vehicle body compact	Machine width: 2.65 m
	• Permitting side overhang of work equipment	Overhang: 100 mm right and left
3. To make it possible to scatter even conventional improvement material economically	• Permitting scattering of straight-run asphalt cement	Expansion nozzle
		Heater with generator
		Scattering equipment (with water tank)
		Air compressor
4. To increase the safety of work execution	• Improving field of vision	Lowered front part of machine
		Work equipment operation panel on each machine side
	• Providing emergency stop function	Engine emergency stop switch
	• Adopting dual braking system	Hydraulic brake + service brake
	• Securing neutral safety	Negative parking brake
5. To improve the maintainability of machine	• Facilitating cutting tool replacement	Compact driven-in cutting tool
		Rotor inching by motor
6. To reduce the impact on the environment	• Employing engine which meets Tier 2 exhaust emission regulations	SAA6D140-E engine
	• Reducing noise during work execution	Constant-speed generator driving system

3. Means of attaining aims of development

(1) To permit working on even hard sub-base courses speedily

① Increasing engine output by 39%

The KOMATSU SAA6D140E-3 engine that is clean and powerful was adopted to increase the work efficiency significantly.

② Adopting pumps manufactured by KOMATSU

The KOMATSU HPV160 was adopted as the rotor pump and the travel pump to transform the engine output into hydraulic energy efficiently (**Fig. 3**).

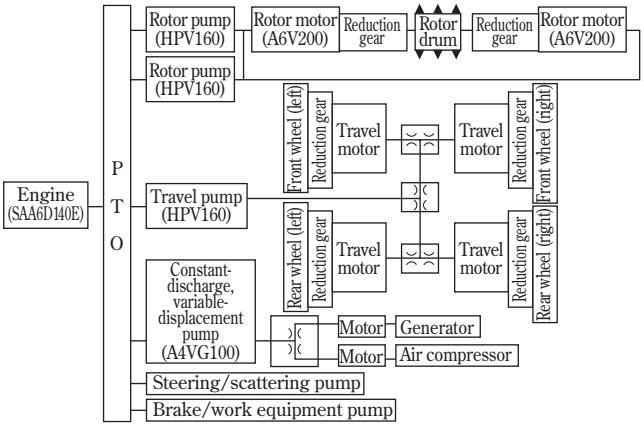


Fig. 3 Power train of GS500-1

③ Adopting two-speed motor for driving rotor

A two-speed motor was adopted to permit selecting the optimum rotor speed according to specific conditions (sub-base course strength, required particle size).

④ Adopting 4-wheel driving system

A four-wheel driving system with wheel motors was adopted to permit securing stable tractive force against even the reaction of a hard sub-base course. In addition, a four-wheel differential locking system was adopted to permit working on even a weak sub-base course.

⑤ Increasing stiffness of work equipment lateral extension mechanism (patent pending)

The work equipment is lifted and lateral-extended by a single mechanism to secure sufficient pressing load. This makes it possible to apply the pressing force of the lift cylinder directly to the rotor drum, though the machine is equipped with a lateral extension mechanism (**Photo 2**).

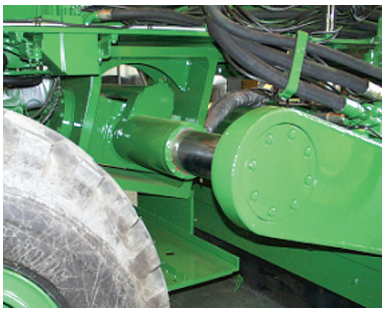


Photo 2 Work equipment support

(2) To allow for work execution without blockading traffic on opposite lane even on narrow road (minimum width: 5.5 m)

① The overall machine width of 2.65 m permits executing the work without blockading traffic on the opposite lane even on a narrow road whose width is barely sufficient for passage of large vehicles. (Generally speaking, when the road width is less than 5.5 m, large vehicles other than emergency ones are not allowed to pass.) This helps ease the traffic congestion and facilitates obtaining a work permit.

② The lateral extension mechanism permits the work equipment to overhang from the vehicle body and contract within the vehicle width. This makes it possible for the vehicle to pass by another large vehicle safely and perform work flexibly.

(3) To permit scattering improvement material economically (patent pending)

① The vehicle is equipped with an improvement material scattering system with the asphalt foaming function which converts inexpensive straight-run asphalt cement into an improvement material.

For scattering the improvement material, an expansion nozzle which sprays water over straight-run asphalt cement to foam it is employed. Air (from an air compressor) is mixed in the water (from a water tank with sprinkler pump) to produce a mist which foams the asphalt cement effectively. Since the asphalt cement is kept foaming for a long time, it mixes well with the sub-base course material (**Fig. 4** and **Fig. 5**).

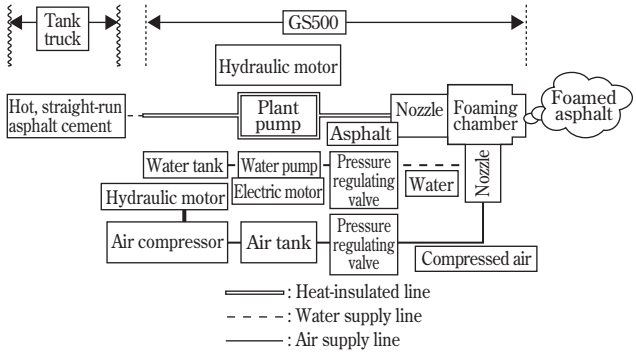


Fig. 4 Improvement material scattering system of GS500-1

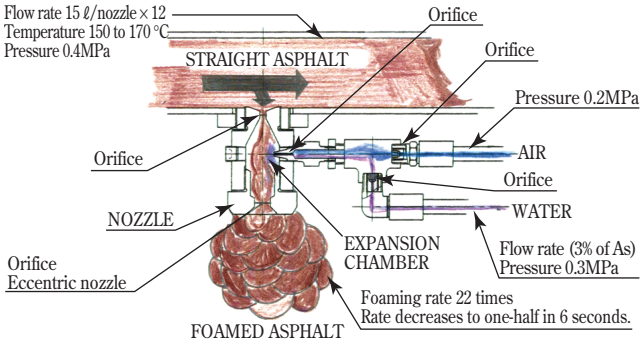


Fig. 5 Spray nozzle

② The improvement material scattering circuit is provided with a heater. The electric heater installed in the circuit for scattering improvement material permits safely handling even straight-run asphalt cement which tends to solidify easily. In addition, a constant-speed, hydraulically-driven generator which is unaffected by the engine speed permits preheating the circuit before starting the work with the engine kept idling at a low speed. This helps reduce the noise load on the environment (**Photo 3**).

Photo 3 Generator for electric heater

③ Even scattering emulsified asphalt (in the form of a fluid at normal temperature) which can be stored and transported easily is possible.
By switching the cock on the scattering circuit, it is possible to scatter even emulsified asphalt. Hence, the machine is capable of meeting diverse work specifications.

(4) To increase safety

① The operator's seat was positioned at the center of the vehicle body. In addition, the front part of the vehicle body was lowered to improve the front view.

② In order to secure a sufficient view for the operator during machine operation, the operation panel was arranged at each side of the operator's seat. The operator can manipulate the work equipment while confirming the conditions at both sides of the machine (**Photo 4**).

Photo 4 Operation panels at both sides of operator's seat

③ The emergency stop button permits the operator to stop all the machine functions at the touch of the button in an emergency (**Photo 5**).

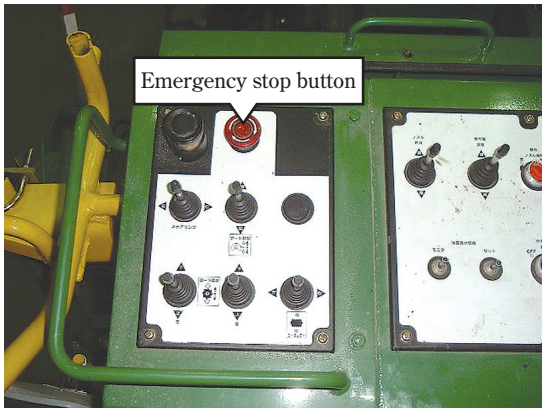


Photo 5 Emergency stop button

④ The brake system is the combination of a hydraulic brake and a hydraulic servo disc brake. In addition, a hydraulically-released negative brake is provided as the parking brake. If the engine is stopped by the emergency stop button, the parking brake is applied automatically.

⑤ In addition to the neutral position of the drive gear, the neutral safety function that prevents the engine from being started unless the rotor drive and scattering equipment are in stop position is provided.

(5) To improve maintainability of machine

① The front-end cutting tool that is the main consumable part of the machine is installed by the drive-in method whose reliability has been proved by KOMATSU road cutters. This facilitates the cutting tool replacement work.

② Like the road cutter, the rotor drum of the machine is equipped with an electric motor for replacement of the cutting tool. This facilitates inspection and replacement of the cutting tool when the engine is stopped. In addition, a switch for cutting off the engine starter circuit to prevent the engine from being started inadvertently during the replacement work has been installed in the work area.

(6) To reduce impact on the environment

① The machine is equipped with the SAA6D140E-3 engine that has cleared the Tier 2 exhaust emission regulations for construction equipment of Japan.

② Since the scattering of straight-run asphalt cement has been made possible, the emission of CO_2 during the preparation of emulsified asphalt at the plant has been reduced significantly.

③ Since the electric heater for straight-run asphalt is driven by the machine power supply, the occurrence of waste mineral oil is restrained.

4. Conformation of machine performance

As the first step, we laid out a recycled sub-base course on our test ground and checked the work efficiency of the machine and the particle size of the sub-base course material with the cooperation of the major road construction company that placed an order for the machine. In addition, we checked the performance of the scattering equipment using improvement material on the ground. The test results were almost as expected.

As the second step, in order to verify the machine performance in actual improvement work, we applied the foamed asphalt method to a sub-base course (area: about 12,000 m^2, depth: 30 cm) which had been recycled with cement. As a result, we could confirm that the machine is sufficiently practicable (**Fig. 6**).

5. Concluding note

The machine successfully recycled about 40,000 m^2 of sub-base course by May 2003 (**Photo 6**).

The machine is very highly evaluated by the customer. Satisfied with the machine performance and interested in the machine versatility, the customer has plans to apply the machine to various methods.

Under severe conditions exemplified by enforcement of the Construction Material Recycling Act and reduction of the construction budgets, the individual road construction companies entertain much expectation of the machine. We would like to continue making the utmost effort to live up to their expectations.

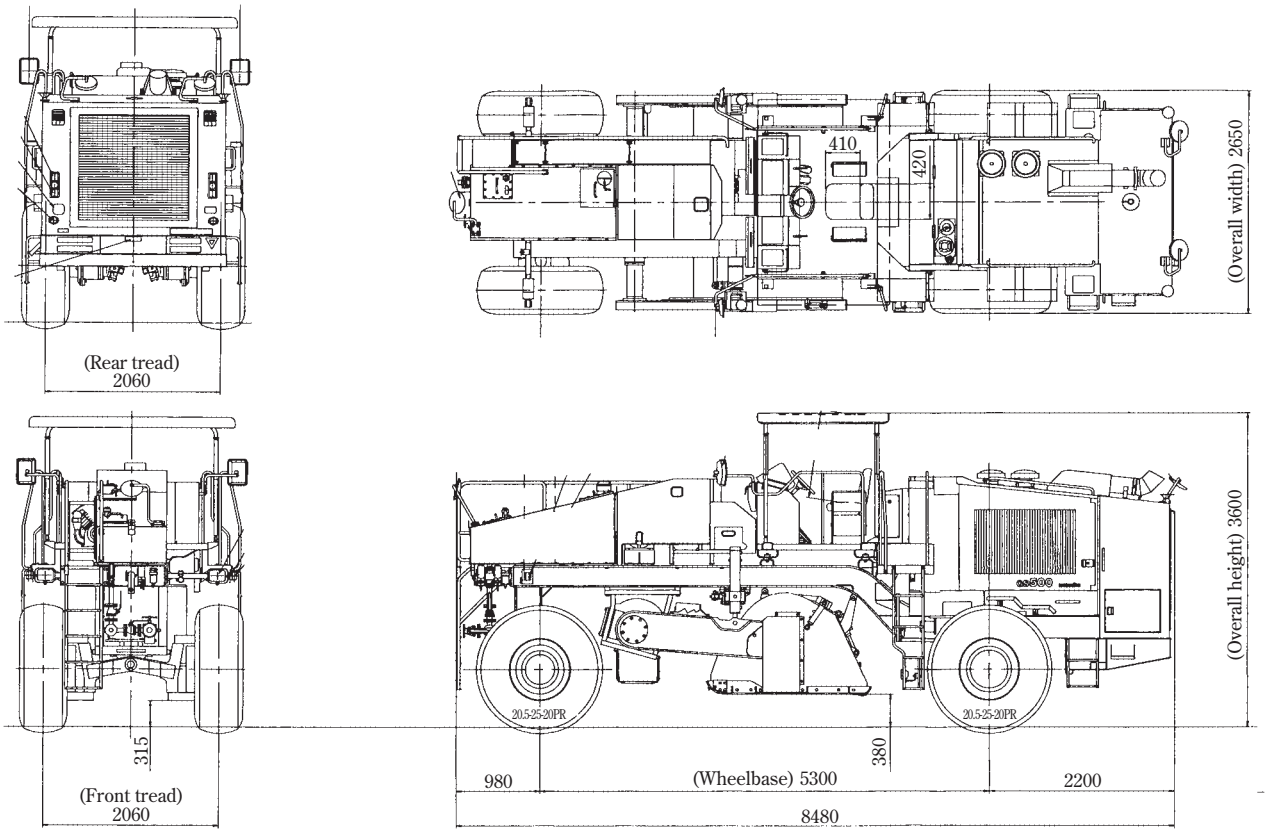


Fig. 6 External dimensions of GS500-1

Photo 6 Scenes of sub-base course recycling by GS500-1

Introduction of the writer

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[A few words from the writer]

Roads are important facilities which support modern industry. Maintaining roads while using them resembles maintaining the production facilities of an industrial plant. The major difference is that the roads have not positive backup. If the machine for road maintenance fails, the recovery of the road functions is delayed and the physical distribution is interrupted. In order to prevent such a situation, we focused on improving the reliability of the machine for road maintenance. However, not a few customers dislike the black box. In the present development, therefore, we stuck to 'simplicity' and 'low technology,' except for the main components. In the future, we would like to see whether the results of the development will come up to our expectations.