

# Slurry shield machine for Singapore Power

## – Handling long distance, high water pressure, and curved sections

*In 2014, Kawasaki designed and manufactured 6.9-m slurry shield machines that incorporated the technologies of hard-rock tunnel boring machines, and delivered them to Singapore. These shield machines come with such features as a large-diameter roller cutter and an overcutter to enable excavating digging through curved sections and long distances under high water pressure and other challenging conditions.*

### Preface

Kawasaki has seen growing demand in Singapore for cutting-edge tunneling machines that can handle long distances, high water pressure, and curved sections on top of the conventional function of drilling through hard rock. Kawasaki has been supplying shield machines that can bore through hard rock since 2005. Now it has developed and delivered a shield machine that can handle these requirements. Here we take a look at that machine.

### 1 History of Kawasaki shield machines

Kawasaki delivered its first shield machine to the Teito Rapid Transit Authority (now Tokyo Metro Co., Ltd.) in 1957. In the 58 years since then, Kawasaki has supplied more than 1,400 shield machines. The original shield machine, which seems primitive now, was essentially a steel cylinder designed to keep soil from caving in during the excavation process and was not even watertight. The steel cylinder served as a protective structure, i.e., a

Table 1.1

Model		Rear thrust articulated machine
External diameter (m)		6.9
Length (m)		11.65
Cutter head	Power (kW)	1,680
	Rotation speed (min <sup>-1</sup> )	Max. 6
	Torque (kN m)	Max. 6,250
Shield jack thrust (kN)		60,000
Number of roller cutters		46 + 2

shield, which enabled underground excavators to tunnel through the ground, hence the name of the machine. Kawasaki then went on to develop a full-face, closed shield machine equipped with a pressure bulkhead for enhanced energy efficiency and safety, articulated shield machines for excavating curved sections, and other types of machines in response to a range of tunnel construction needs.

To excavate through hard rock, the machine needs to be equipped with a special cutter and structural frame built to take reaction forces. That is why Kawasaki went to work on developing equipment that could cut through hard rock with the focus placed squarely on boring. Taking development beyond shield machines, it expanded into the field of open-face tunnel boring machines.

The shield machine featured here incorporates the functions of both types of machines.

## 2 Main specifications and structure of the shield machine

The shield machine's main specifications are shown in Table 1. The machine is equipped with a high-speed cutterhead and high thrust shield jacks designed to excavate through hard rock and handle high water pressure.

Figure 1 shows the structure of the shield machine. The shield machine has an inverter motor-driven disk-shaped cutter head at its front end. Built to tunnel through hard rock, the high-speed cutter head is fitted with a number of roller cutters resembling abacus beads which rotate at a maximum speed of 6 min<sup>-1</sup> (the maximum rotation speed for excavating soil is normally 1-2 min<sup>-1</sup>). These roller cutters rotate to bore through hard rock as the shield jacks push the cutter head against the hard rock surface to

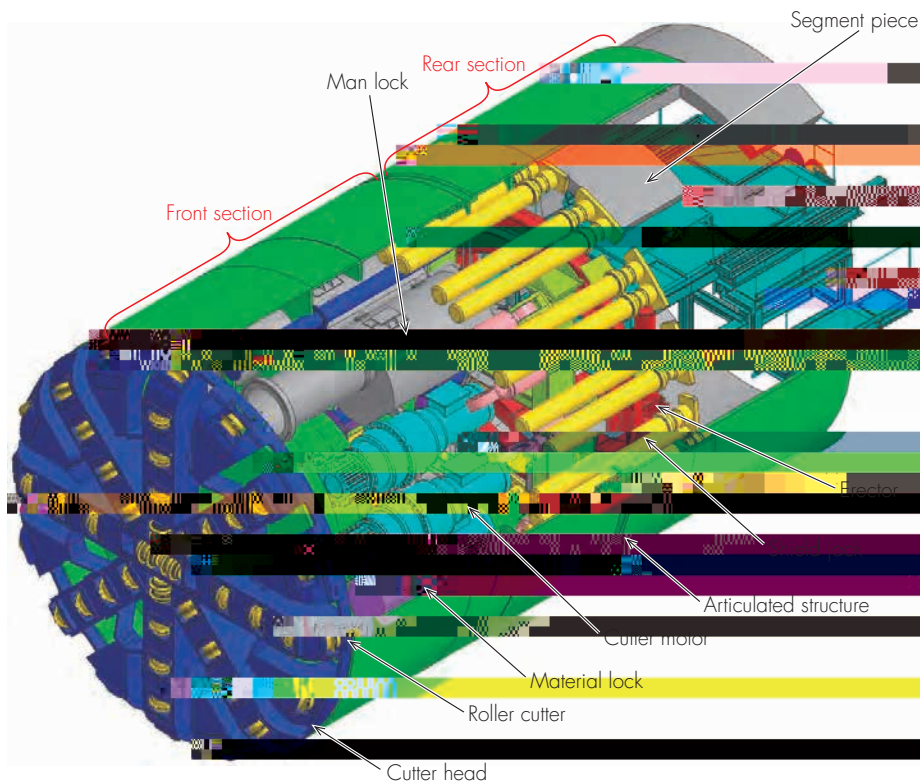


Figure 1 Structure of the shield machine

move the machine forward.

(ii) Twin man locks and material lock

Since this shield machine is used for long-distance excavation, the roller cutters will still need to be replaced relatively often. When replacing roller cutters, workers may need to work in a high pressure environment in order to prevent flooding. The workers need to go into a pressure chamber known as a man lock before and after

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