"MAF-C" Series Floor-type Horizontal Boring Mills Provide High-Precision and High-Efficiency Machining for Large Parts

Machine Tool Division
Machinery, Equipment & Infrastructure

High value-added machining of large workpieces, e.g., higher-efficiency production and higher-accuracy machining, has become increasingly needed in recent years in many industrial fields where large pieces of machinery such as power generation equipment, industrial machines and construction machines are produced.

This paper presents the MAF-C series of floor-type horizontal boring mills with the world's highest-in-class performance. To meet these customer needs, the MAF-C series realizes high productivity through the improvement of its machining capacity and rapid traverse speed, while attaining higher accuracy due to the new perfect balancing system that was developed.

1. Features

(1) Highest-in-class machining capacity for high-efficiency machining

This machine is equipped with a spindle motor with a maximum output of 55/75 kW (continuous/30 minute rating) as standard equipment (80/100 kW is available as optional equipment) in order to realize high machining capacity. To enable machining with this high-power motor, the main structure is made of a casting with high damping characteristics and the ram that is near the cutting point uses ductile cast iron with toughness close to that of steel. In addition, hydrostatic bearings with good vibration damping characteristics, which are necessary for high-load machining, are used for all sliding surfaces. Furthermore, a spindle structure where the spindle motor and the uniquely developed compact gear box are integrated with the ram enables a shortened distance between the motor and the machining point, and results in higher torsional stiffness of the spindle.

Table 1 Specifications comparison table

			MAF-C	MAF-RSC (existing machine)
Boring spindle diameter		mm	Φ150 *Φ180	Φ150 *Φ180
Ram size		mm	420 x 420	600 x 600
Spindle output		kW	55/75 * 80/100	30/37 * 37/45
Spindle speed		min^{-1}	2,500	2,000
X axis travel (column longitudinal)		mm	5000 to 21000	3000 to 20000
Y axis travel (saddle vertical)		mm	3000 to 5000	2500 to 4500
Z axis travel (ram in/out)		mm	1250	1100
W axis travel (boring spindle in/out)		mm	1000	900
Rapid traverse	X	mm/min	20,000	15,000
	Y	mm/min	20,000	15,000
	Z, W	mm/min	15,000 * 20,000	10,000

* Optional

The realization of high-efficiency machining requires a reduction of non-cutting time, in addition to the improvement of the machining capacity. This machine enhances the rapid traverse speed of each moving axis to 20,000mm/min for the X and Y axes and 15,000mm/min for the Z and W axes, thereby enabling highest-in-class efficiency machining. **Table 1** compares the specifications between this machine and an existing machine.

(2) Motion accuracy compensation technology for high-precision machining

Horizontal boring mills, which have an extension of boring spindle and ram (Z axis position), have an inherent problem: the deflection of the ram due to their own weight and changes in the barycentric position causing deflection of the column, and as a result the motion accuracy such as the straightness and perpendicularity of each axis varies. For the realization of high-precision machining with horizontal boring mills, a mechanism that compensates for this motion accuracy is essential. Typically used compensation mechanisms include ram tension bar compensation and saddle suspending force compensation. When these mechanisms are used, however, the bending of the column changes depending on the ram extension, which results in changes in the barycentric position, and accordingly the straightness of the Y axis fluctuates.

The new perfect balancing system that we have developed (**Figure 1**) places a tension bar inside the column in addition to the aforementioned compensation mechanisms to compensate for the bending of the column, and then realizes the stable improvement of the straightness of the Y axis independent of the positions of the Z and Y axes. As a result, the Y-directional displacement in the case of the ram extension with a 600 kgf attachment is 6 μm/1000 mm, which is favorable in comparison to 3 μm/1000 mm in the case without any attachment (**Figure 2**).

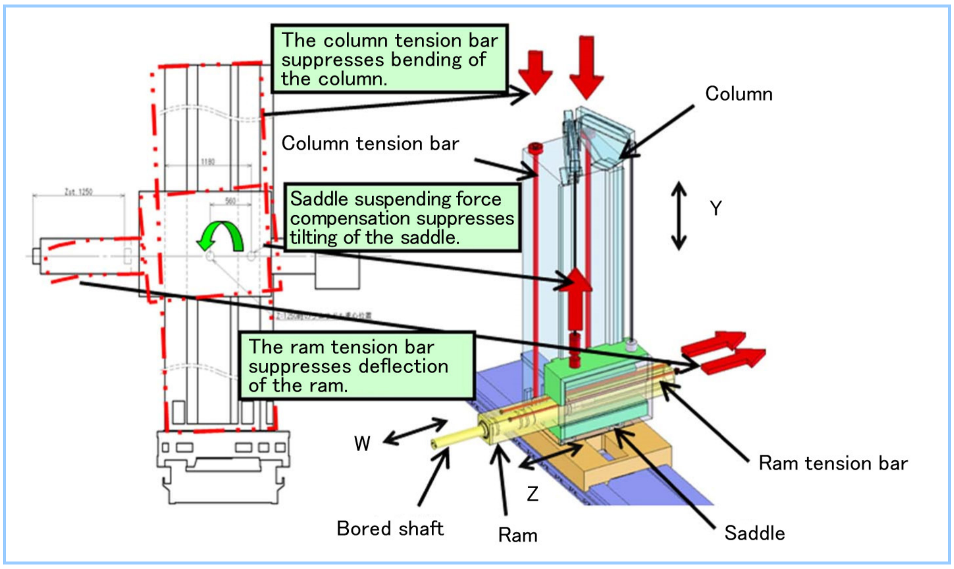


Figure 1 New perfect balancing system

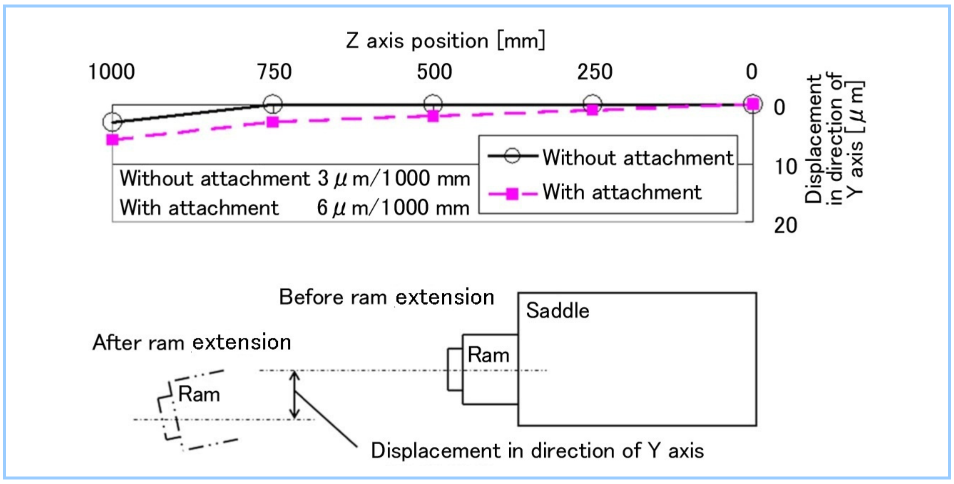


Figure 2 Measurement of displacement in direction of Y axis

(3) Extension of machining capability

To make it possible to cut deeply in a small bore, the overall stroke of the Z axis and the W axis is extended to 2250 mm. This enables deep cutting that was impossible in the past and improvement in the efficiency of cutting conditions such as increased cutting depth in exchange for a reduction of the tool length. In addition, the ram size is reduced from □600 to □420, and a space that was too narrow for the ram and could not be machined without a long tool or attachment in the past can be machined now.

2. Machining examples

This section presents respective examples of high-efficiency machining and high-precision machining realized by the technologies described above.

Figure 3 shows Φ250 large-diameter milling at the height of 3000 mm with the ram extension of 800 mm. In this case, high-efficiency rough cutting at the cutting rate of 1500 cc/min is attained. This machine can be equipped with a high-power right angle head with the maximum output of 55 kW, delivering the high cutting capacity of 1134 cc/min.

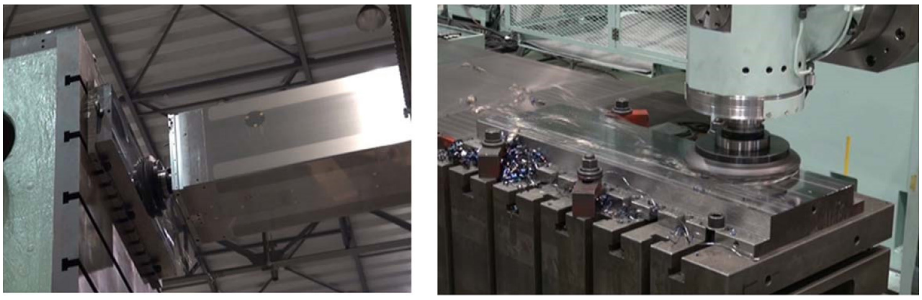
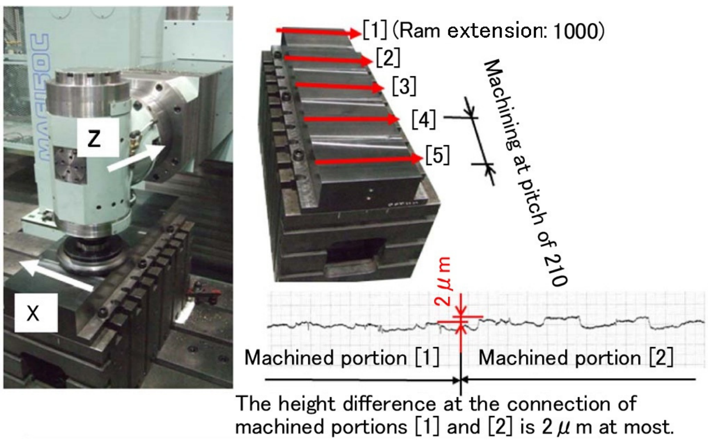


Figure 3 Example of high-efficiency rough cutting with Φ250 large-diameter milling

Figure 4 shows an actual workpiece finish-machined (high-precision machined) with a right angle head for the verification of the effect of the new perfect balancing system. The machine cut the workpiece in the direction of the X axis, moving the Z axis at a pitch of 210 mm from the position where the ram extension (Z axis position) is 1000 mm (the distance from the gauge line is 1550 mm). The height difference between each pitch was 2 μm at the most, so the effect of the new perfect balancing system was verified.



<Cutting conditions>

Workpiece : SS400	Cutting width : 210 mm
Milling diameter: Φ250	Feed rate : 0.13 mm/insert
Spindle speed : 250 min^{-1}	Cutting depth : 0.3 mm
Ram extension : 1000 mm →160 mm	

Figure 4 Right angle head finishing (high-precision machining)

We will henceforth work on satisfying a wide variety of customer needs and realize the further improvement of productivity with the high-precision and high-efficiency MAF-C series.