

Concrete Reasoning On Swiss Turning

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High-precision machining begins with a solid machine tool base. Its critical functions are to provide a thermally stable platform for the moving components mounted on it and to provide damping for the cutting forces channeled into it.

For many years, cast iron or steel weldments have been the materials of choice for most machine tool bases. But as tolerances become tighter, workpieces more delicate/complex and metals more exotic, machine tool builders are looking for better ways to build in capability for increased accuracies, better surface finish quality, deeper cuts and faster cycle times. In response, machine builder Maier has incorporated polymer concrete as the base material for its line of CNC Swiss-type machines.

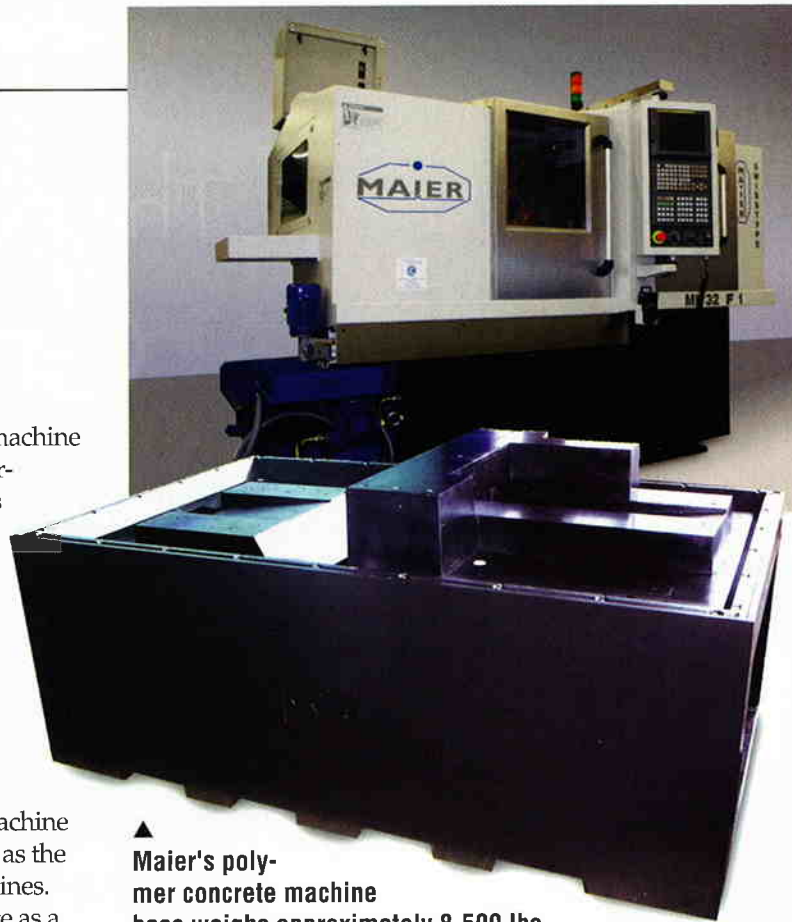
It's not a huge leap to consider polymer concrete as a machine base material. After all, the most precise machine tools—grinders—have used the material for years. Most CMMs use solid granite as a base material for measuring metalworking's most precise parts. Accuracies of as much as 0.0001 inch (0.00254 mm) can be consistently held on machines with polymer concrete bases. So if you are trying to up the precision ante for Swiss-type machining, the machine base may be the best place to start.

On Performing—Solid Results

Polymer concrete is dense, rigid, dimensionally and thermally stable, resistant to water and chemicals and will not twist or bend when stress is introduced. Most of all, it has superb vibration dampening qualities.

For machines that offer high speeds, high acceleration rates, fast positioning cycles and multiple tool changes, the number of rapid movements is increased and so is the need for the machine base to absorb the movements. For example, measurements have proven that polymer concrete diminishes vibra-

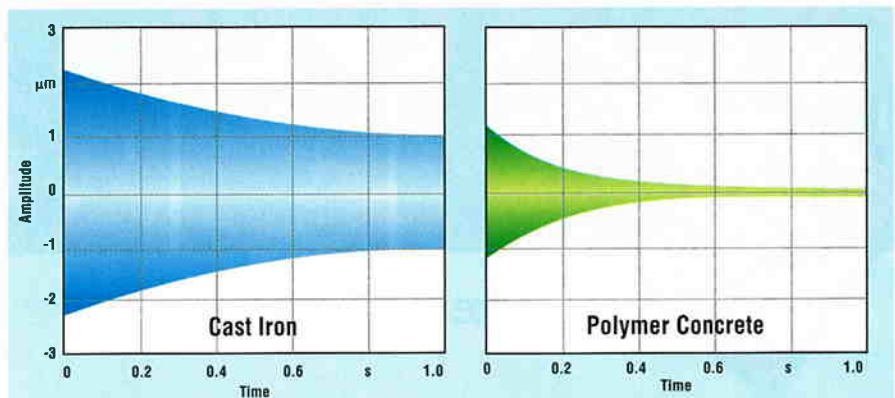
Polymer concrete machine bases ► virtually eliminate vibration during the machining process and will provide fast absorption (rapid diminishment of vibration) should oscillations occur.



▲ Maier's polymer concrete machine base weighs approximately 8,500 lbs, providing a sturdy vibration-free foundation.

tions eight to ten times faster than gray cast iron. Obviously the more the vibrations are absorbed, the easier it is to make faster, deeper cuts while maintaining maximum accuracy and longer tool life.

By employing polymer concrete, a more thermally stable, sturdier machine bed can be built. The polymer concrete material offers a high-heat capacity combined with low-heat conductivity, allowing the base sufficient time to react to temperature influences and fluctuations because of outside heat factors and internal heat sources including pumps, engines, guidance and spindles. This minimizes deformations that might be caused by temperature changes and provides high machining accuracy.



An Interesting Mix

Polymer concrete is comprised of several substances that make it an efficient, reliable and economical material. The substances include mineral fillers, quartz gravel, stone flour, a small percentage of epoxy-binder and various additives. To create the optimal grain mixture, the grain sizes of the mineral fillers (quartz) and rocks (basalt) are tuned to a grading curve of high-component density. The grain sizes of the aggregate used to create Maier's polymer concrete base range from less than 0.003 inch (0.1 mm) to as much as 0.62 inch (16 mm) (gravel).

Epoxy resins are applied as the bonding agent, providing high elasticity, low internal tensions, minimum shrinkage and good longevity. The epoxy resins react with a hardener without splitting off a low-molecular connection to a 3D network. In addition, other additives are included to improve process, adhesion and exhaust in the polymer concrete.

All of these components are measured, mixed, poured and consolidated in molds. The molds can be made of wood, steel or plastic. While in the mold, the substances need to be completely wet, and then the hardening or "curing" takes place.

In order to obtain reproducible material properties, all the individual components of the bonding agent (resin and hardener) and the filler mixture must be proportioned correctly. A series of metering screws and dosing pumps are used to ensure the weight for the fillers falls between 90 and 93 percent and/or the bonding agents are between 7 and 10 percent.

The mixing process takes place in two phases and is a continuous process using mixing screws. First, the portions of the various grain sizes and the bonding agent components are mixed to meet the finished grading curve. Second, to create the optimal connection of the polymer concrete material, a complete wetting of the fillers with the epoxy resin bonding agent takes place.

To cast the machine base, the mixture is poured directly from a machine or a foundry ladle into the mold. Processing efficiency is critical because the amount of time that the mixture remains processable is limited. With epoxy resin-based polymer concrete systems, the "pot" life is approximately 5 to 6 hours. During the pouring process, the mold gets vibrated in order to compress and de-aerate the mixture.

Heat development (exothermic reaction), as high as 113° F (45° C), during the hardening process reacts with the epoxy resin, and the bonding agent begins to solidify. Any higher heat than 113° F during this process would have adverse effects on the machine base because of stresses from cooling and shrinkage. It takes 12 hours for the blank machine base to be proved from the mold, so in general, one base can be produced per day.



Correct sizing and proportion of the aggregate used in the polymer concrete base is a critical step in the process. The ratio between solid material and binder runs about 90-to-10.

Polymer Concrete In Comparison With Cast Iron And Steel

Characteristic Values	Unit	Polymer Concrete	Cast Iron	Steel
Density	kg/dm ³	2, 3	7, 15	7, 85
E-Modul	kN/mm ²	30-40	80-140	210
Tensile Strength	N/mm ²	10-15	150-400	400-1600
Compressive Strength	N/mm ²	110-125	600-1000	250-1200
Bending Strength	N/mm ²	25-35	250-490	-
Damping (log. decay)		0,02-0,03	0,003	0,002
Thermal Conductivity	W/K°m	1,3-2	50	50
Specific Effective Heat Capacity	KJ/kg°K	1	0,5	0,5
Thermal Co-Efficient Of Expansion		14-16	11	12

The material can also be formed very flat, with a smooth, mirror-like finish, all of which helps ensure accurate positioning of machine-to-base when compared to joined cast iron or steel weldments. Moreover, because the casting process is relatively cold, electric conduit and hydraulic lines can be cast in the base.

Machine bases are often measured according to rigidity statistics. Polymer concrete can be classified as an isotropic, homogeneous material that has a higher rigidity than cast iron material. Since the polymer concrete base is so dense and its sections are massive, it weighs considerably more than a typical cast base. In this case, increased mass is beneficial for a sturdier base, which in turn, improves vibration dampening.

Unlike conventional metals, a polymer concrete machine base will not rust, making it an effective choice

when coolants/liquids are used during the machining process. This eliminates the need for corrosion protection measures and reduces the number of metallic part failures (for example, guideways, contact surfaces). In addition, polymer concrete does not absorb water, so moisture expansion is avoided.

Polymer concrete also provides low combustibility and flammability because it is composed of 93 percent non-combustible materials. The material is environmentally friendly, and significantly less energy and power consumption is required to manufacture a machine base.

When all the material characteristics and performance data are considered, it makes sense to have a polymer concrete base under a lathe. The odds are the industry will be seeing more of this material applied to other machine tools in the future. ■



For more information about Swiss-type machines from Maier, call Methods Machine Tools at (978) 443-5388 or search **PM Online** at www.productionmachining.com