Polymer Composite Bases for Machine Foundations

By Justin Sly

Vibration damping is just one of the many benefits of using polymer composite (or mineral cast) bases or filled structures in modern machine tool design.

A PROPERLY DESIGNED BASE FOUNDATION IS crucial to the success and longevity of the machine. Designers have historically resorted to steel, cast iron, fabricated tubular steel, and granite as machine foundations. These structures are designed to provide a solid platform to mount sensitive componentry specific to the individual performance of the machine. While these designs and materials have worked well for many years, a new option is growing in popularity with gear manufacturers.

Polymer composite castings, also referred to as mineral castings, provide superior vibration damping and other advantages over traditional machine base and foundation materials. Epoxy polymer composite technology migrated to the United States from Europe beginning in the late 1970s. The process combines different grades of aggregate (crushed quartz, granite, or basalt) with specially formulated high-strength thermoset epoxy resin and additives. This mixture is then added to open cavity molds or used to backfill fabricated steel structures to create a rock solid foundation for which to mount equipment and components.

For example, Star Cutter Company in Elk Rapids, Michigan, uses a 4,700-pound base casting for its NTG 4RL tool and cutter grinder (see Figure 1).

“For Star, the mineral cast base product from BaseTek has allowed us to create bases for our machines with unique design features,” said Jason Walter, the plant manager at Star Cutter Company. “Their highly accurate, repetitive casting process has proven to deliver consistency from base delivery to base delivery. In the machine design, we have realized a well-damped, thermally stable base on which our kinematic axes are built.”

Star Cutter Company represented by Star SU LLC is exhibiting at IMTS 2016 (Booth #N-6924) on September 12-17 at McCormick Place in Chicago, Illinois.

Additional casting examples are shown in Figures 2 and 3.

Figure 1: 4,700-pound base casting and fully assembled machine

BENEFITS OF POLYMER COMPOSITE

The following are several reasons why leading engineers consider polymer composite in modern machine tool designs:

Vibration Damping

The polymeric matrix of the material provides damping ratios that are 20 to 30 times greater per identical geometry than steel or cast-iron materials (see Table 1). Also, the polymer casting can shield from external vibration such as a forklift or another machine operating nearby. (See Figure 4.)

Design Flexibility

Polymer composite bases are cast at room temperature and offer the ability to easily combine plastics, stainless steel inserts, steel, or cast rails as an integral part of the base.

Table 1: Vibration damping ratio polymer concrete
of the casting. PVC pipe and structural steel tube can be used for wire ways and dedicated fork-lifting. The need for uniform wall thicknesses is eliminated, and internal drains, cooling lines, deck slopes, and cavities can easily be incorporated in the casting.

Cast to Finish Tolerances
Polymer composite bases precisely replicate the tooling for flatness and feature tolerances. The surface finish on the mold is represented on the casting. This process eliminates or minimizes the need for secondary machining.

Fast Delivery and Lower WIP Inventory
Once the mold is built and released to production, bases can be cast and shipped within days. Short lead times reduce work-in-progress (WIP) inventory while engineering changes and modifications can be made quickly.

Corrosion Resistance
Polymer composite bases are resistant to most common acids, alkalis, solvents, oils, and cutting fluids. This eliminates the need to paint the base or add expensive protective coatings. The casting can be painted to match a particular color schematic but not required.

Environmentally Friendly
Castings are created using a cold casting process requiring a minimal amount of energy consumption. Disposal is easy. Once cured, the polymer is considered non-outgassing and has no special disposal requirements.

Cost Effective
The ability to combine multiple assemblies into the same casting along with the ability to eliminate or minimize post-cast machining operations saves both time and money. Not having to paint the base for corrosion protection is an additional savings.

Polymer composite bases are ideal for compressive type loads and require the base walls to be thicker or solid compared to traditional materials. Involving the casting manufacturer early in the design process will help address common casting questions such as minimal wall thickness, draft angle for internal cores, insert placement in relationship to the edge of the casting, tooling recommendations, and weight restrictions.

BACKFILLING STRUCTURES WITH POLYMER COMPOSITE
Another option that machine builders use to dampen vibration and add stiffness to their design is to backfill the structure with epoxy polymer composite. The polymer fill is a solid option for machine builders that are comfortable with using a fab steel structure
but struggle with vibration issues. It’s ideal for low-volume or custom applications. It offers the vibration damping with the ability to grind and machine the steel fab. It also offers a low cost and quick turnaround. And no mold or tooling is required.

Examples of weldments and fabrications filled with polymer composite are shown in Figures 5 and 6.

MOLDS AND TOOLING OPTIONS
Molds and tooling used in the casting process can be constructed out of a variety of materials and is driven by the number of castings required and as-cast features. Tools can be wood, fab steel, aluminum, plate steel, or any combination of the four. The following are some typical mold options.

* Heavy-duty wood molds are often used for proof-of-concept or limited production. They provide a relatively low-cost temporary pattern that will yield general shape and most likely require a post-cast machining operation. (See Figure 7.)
* Sheet metal fabricated tooling offers a higher yield and better as-cast feature tolerances than the wood mold.
* Aluminum tooling offers both a production yield and is good for complex features in the polymer casting. (See Figure 8.)

CONCLUSION
Polymer composite bases are accepted worldwide as a modern alternative for machine base design. If designed properly, the benefits offer gear designers and engineers another option for their base design. Polymer composite bases provide a stable and repeatable foundation to mount critical equipment that will last the life of the machine.

Visit BaseTek at Booth #N-6335 at IMTS 2016 on September 12-17 at McCormick Place in Chicago, Illinois.

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