УДК 811.111 : 621.9.06

I.Karabaniuk, S.Khomenko

Alternative construction materials

Belarusian National Technical University
Minsk, Belarus

The machine tool structure performance depends on the mechanical and physical parameters of the material used to build it. Hence the materials and their properties were researched and these results were compared with the traditional cast iron. Stone based materials were analyzed: ferrocement, polymer concrete, epoxy granite, hybrid composites (constructions made of steel weldments that filled stone based polymers and fiber reinforced polymer matrix composite bolted and adhesively joined structures).

Vitor Ducatti et al. designed and developed twelve lathe bed prototypes in actual scale with the following materials: cast iron, cast steel, fiber reinforced mortar, polymer mortar, reinforced-polymer mortar and ferrocement. And the results of the static analysis showed that ferrocement, polymer mortar and reinforced polymer mortar had improved flexural strength, stiffness. It was also shown that from the point of view of dynamic behavior cast steel had higher natural frequency. The use of alternative materials in structures increased overall vibration damping [1].

Mani et al. presented testing results of cement concrete parameters (1:1.6:2.4 by weight) cement : sand : aggregate, water cement ratio (0.55) with polymer materials, prepared with two different types of binders (epoxy and polyester resin) with the same aggregates (crushed quartzite and silica sand). The aggregates: binder ratio (88:12 by weight) were used. The coarse aggregates were comprised of crushed quartzite of sizes

ranging from 10 mm to 2.36 mm. The fine aggregates were comprised of siliceous sand of sizes ranging from 1.18 mm to 150 μm. And also the samples contained CaCo3 microfiller (94:6) with 88% of aggregates in proportion to weight. Two types of polymeric binder were used. Epoxy resin (GY-257) was added to polyamide hardener (HY-840) and the resin: hardener ratio was 1:0.5. Polyester resin was (Crystic- 196 general purpose resin) added to a catalyst (50 % solution of dimethyl phthalate in methyl ethyl ketene peroxide), and the accelerator (1 % solution of cobalt naphthanate in styrene). The analysis revealed that polymer concrete gave higher compressive, split-tensile and flexural strength by a factor of 2-4 and 3-6 than cement concrete. And the author concluded that the effect of microfiller was more pronounced in the case of epoxy- concrete than polyester-concrete [2].

Cement concrete exhibits inferior strength and other mechanical properties. Epoxy granite is a particular type of polymer concrete prepared with fine granular particles of granite material as a filler and epoxy resin as a binder. Epoxy granite exhibits excellent mechanical properties such as high damping and compressive strength as compared to polymer concrete materials. Granular size of the material ensures more ductility and the use of epoxy resin with good adhesive properties ensures high strength and reduced deformation due to creep [3]. Considering the benefits, irrespective of its high cost, epoxy granite is emerging as a promising alternative material for precision machine tool structures [4].

Based on literature survey, polymer concrete, carbon-epoxy and glass-epoxy fiber composite sandwich structures (Hybrid Composites) are being developed for high speed machine tool and other structural applications. Sandwich structures contain steel faces, inserts, aluminum rings, and C.I columns for improving the structural stiffness of the composite. Mostly in current research synthetic fibers are used. However

ranging from 10 mm to 2.36 mm. The fine aggregates were comprised of siliceous sand of sizes ranging from 1.18 mm to 150 μm. And also the samples contained CaCo3 microfiller (94:6) with 88% of aggregates in proportion to weight. Two types of polymeric binder were used. Epoxy resin (GY-257) was added to polyamide hardener (HY-840) and the resin: hardener ratio was 1:0.5. Polyester resin was (Crystic- 196 general purpose resin) added to a catalyst (50 % solution of dimethyl phthalate in methyl ethyl ketene peroxide), and the accelerator (1 % solution of cobalt naphthanate in styrene). The analysis revealed that polymer concrete gave higher compressive, split-tensile and flexural strength by a factor of 2-4 and 3-6 than cement concrete. And the author concluded that the effect of microfiller was more pronounced in the case of epoxy- concrete than polyester-concrete [2].

Cement concrete exhibits inferior strength and other mechanical properties. Epoxy granite is a particular type of polymer concrete prepared with fine granular particles of granite material as a filler and epoxy resin as a binder. Epoxy granite exhibits excellent mechanical properties such as high damping and compressive strength as compared to polymer concrete materials. Granular size of the material ensures more ductility and the use of epoxy resin with good adhesive properties ensures high strength and reduced deformation due to creep [3]. Considering the benefits, irrespective of its high cost, epoxy granite is emerging as a promising alternative material for precision machine tool structures [4].

Based on literature survey, polymer concrete, carbon-epoxy and glass-epoxy fiber composite sandwich structures (Hybrid Composites) are being developed for high speed machine tool and other structural applications. Sandwich structures contain steel faces, inserts, aluminum rings, and C.I columns for improving the structural stiffness of the composite. Mostly in current research synthetic fibers are used. However

synthetic fibers are hazardous to human health and environment. In order to overcome the above problem, natural fiber can be used for making the composite. Thus natural fibers can be considered as potential materials for making machine tools structures in the future.

Epoxy granite material was found to exhibit good mechanical properties such as high compressive strength and damping ratio as compared to other composite materials. It can be concluded that epoxy granite material (consisting of granite aggregates (80-90 %) in the range with epoxy and hardener in the range (10-20%) of total weight), and fiber–epoxy composite (consisting of fiber (60%) with epoxy and hardener (40%) of total weight) exhibited suitable properties for machine tool and other structural applications.

References:

1. Kushnir E., Mahendra P. and Terrence Sh. Material considerations in optimization of machine tool structures / E. Kushnir, P. Mahendra and Sh.Terrence // Proceedings of 2001 ASME International Mechanical Engineering Congress and Exposition. – 2001, November 11-16, New York.
2. Rao S.B. Metal Cutting Machine Tool Design a Review / S.B. Rao // Journal of manufacturing Science and Engineering. – 1997. – Vol.119. – P.713–716.
3. Hawlader M.N.A., Mansur M.A., Rahman M. Thermal behavior of ferrocement / M.N.A Hawlader, M.A. Mansur M.A., M. Rahman // Journal of Ferrocement. – 1999. – Vol. 20. – P. 231–239.
4. Satoshi Ema, Etso Marui Suppression of chatter vibration of boring tools using impact dampers / E. Satoshi, M. Etso // International Journal of Machine Tools and Manufacture. – 2000. – Vol. 40. – P.1141–1156.