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Studies on wear characteristics of mineral cast structures

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Epoxy granite with good damping and thermal characteristics is emerging as an alternate material for cast iron used in machine tool structures. Wear test on epoxy granite material was conducted under dry and wet conditions using pin on disc arrangement. Tests were carried out using cast iron and steel discs and epoxy granite pin. It was observed that the coefficient of friction for the epoxy granite material is comparable with that of the cast iron structures in wet conditions. Also, the coefficient of friction between epoxy granite and cast iron was found to be lesser compared to that of epoxy granite and steel. The low coefficient of friction between epoxy granite and cast iron is an added advantage for machine tool structures with epoxy granite bases and movable cast iron components such as tool carriage, tail stock etc.

Conventionally, cast iron is used in machine tool structures, due to its excellent mechanical and thermal characteristics in the class of metallic materials. However, it was observed that, these structures are subject to self-excited vibrations known as chattering, when subjected to machining. This causes positional error between the tool and the work piece, resulting in inaccurate products [1]. Hence, a study of alternate materials that can improve the damping characteristics of the structure is significant. Further, the authors fabricated an epoxy granite lathe bed with 12% epoxy resin and 88% crushed granite particles. The structure was fabricated such that it has equal stiffness as that of a cast iron micro-lathe bed. It was observed that, the damping ratio of the fabricated epoxy granite lathe bed is higher than that of cast iron lathe bed [2]. In this study the wear characteristics of the lathe bed are studied using pin on disc experiments

Pin on disc test was conducted as per ASTM G99-05 (2010) standards, which describe the conditions for sample geometry and preparation. The epoxy granite test specimen (pin) of size 8 mm in diameter and 40 mm height was prepared using mineral casting techniques. Fine particles of granite were used in the fabrication to depict the top surface of the lathe. A chrome bearing steel (100Cr6) and a cast iron (FG250) of 140 mm diameter were used as the discs. A tribometer is used to measure coefficient of friction, friction force, and wear volume, between two surfaces in contact was used to conduct the pin on disc tests. A normal load was applied on the stationary "pin", in contact with a rotating disc. To simplify the contact geometry, a spherical tip was used for the pin in contact with the disc. Normal loads of 10 N, 30 N, 70 N and 140 N were used in this analysis to represent the mild, transition and severe regimes of wear [with a sliding speed of 0.5 ms^{-1}. Specific wear rate was used to evaluate the characteristics. Compared to the wear rate at smaller loads, a high wear on the pin surface was observed when loads were high, in the cases of applied normal loads of 70 N and 140 N.

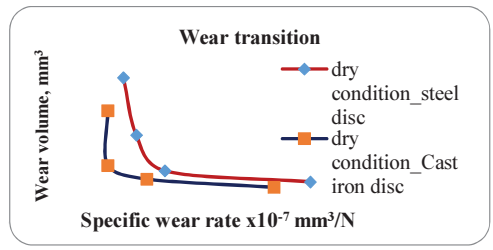

Figure 1: Wear transition regions

The wear volume, defined as the ratio of weight loss due to wear and the density, was calculated for the epoxy granite (pin) with reference to steel disc and cast iron disc. The weight loss experimental points under dry conditions, with reference to the specific wear rate, obtained during pin on disc tests with normal loads varying from 10 N to 140 N is shown in Figure 1 It was observed that in dry condition, the coefficient of friction between epoxy granite/high carbon steel is about 47% more than that of the cast iron/high carbon steel combination. Similarly, the coefficient of friction between epoxy granite / cast iron was about 56% more than that of the cast iron/cast iron combination.

References

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