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SELECTED TECHNICAL PROBLEMS WITH POLYMER APPLICATION ON SLIDE WAYS

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Key words: metal working machine, slide way, polymer.

Abstract

Slide ways are widely used in metal working machines, but the requirements concerning the smoothness of machine part movement and the repeatability of their stoppage at a determined position are still increasing. Polymers application enables to fulfill these requirements, for example with regards to numerical controlled kinematic pairs. Technical problems of polymer application on slide way elements are considered in the paper. The possibility of making and regeneration of epoxy resin ways is also described.

WYBRANE PROBLEMY TECHNICZNE PRZY STOSOWANIU TWORZYW POLIMEROWYCH NA PROWADNICE ŚLIZGOWE

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Słowa kluczowe: obrabiarka, prowadnice, tworzywa sztuczne.

Streszczenie

Prowadnice ślizgowe są szeroko stosowane w obrabiarkach do skrawania metali, ale ciągle wzrastają wymagania odnośnie płynności ruchu części maszyn, a także powtarzalności przy ich zatrzymywaniu na określonej pozycji. Zastosowanie tworzyw polimerowych umożliwia spełnienie tych wymagań na przykład w odniesieniu do par kinematycznych suportów obrabiarek sterowanych numerycznie.

Rozpatrzono problemy techniczne związane z użyciem tworzyw polimerowych na elementy prowadnic. Wskazano możliwość wykonania i regeneracji prowadnic z tworzywa na bazie żywicy epoksydowej.

Introduction

Polymers are widely used in heavy metal working machine construction. Such polymer application will be considered for slide ways of machines produced in FUM PORĘBA Ltd. Slide ways of lathe bed, as well as longitudinal, cross and tool carriage, are very important elements in numerically controlled machines. The shape and dimensional accuracy of ways, the smoothness and repeatability of carriage movement, especially in numerically controlled machines CNC, decide about the possibility of obtaining the assumed position determined by a control system, and thus about the accuracy of worked parts. The smoothness of movements and precise carriage positioning can be obtained by using polymer elements of slide ways. The application of polymers on metal working machine slide ways is partially limited by the permissible pressure, which can be applied for these materials. That is why plastic straps, mounted to metallic (e.g. cast iron) bed ways, are usually used. These straps are mainly made of polytetrafluoretylene and epoxy composites (KOŁODZIEJ 1993, KOSZKUL 1989, RYMUZA 1986).

Application of plastics on metal working machine slide ways

In FUM PORĘBA TURCITE-B SLYDWAY plastic (produced by the Busak-Shamban company) is used for bed and carriage ways of metal working machines. It is a thermoplastic usually produced in the form of a band from 1 to 6 mm in thickness, 200 mm in width and 800 mm in length. This material is characterized by a low friction coefficient, good mechanical properties, wear resistance and dimensional stability (*Folders of Busak+Shamban company*). An exemplary assembly of collaborating ways of the bed and carriage of the medium TRP-93 MN lathe is presented in Fig. 1.

Beds and carriages of lathes are castings of 250 cast iron. Slide ways of a bed are induction hardened and grinded. The hardness of the bed way surface is 48 ± 2 HRC, and its roughness is $Ra = 0.63$ μm. Carriage ways are covered by lining made of TURCITE-B SLYDWAY plastic. Linings are made of a band of length $L = 800$ mm, width $s = 40$ mm and thickness $g = 2.5$ mm, and glued to a roughly machined surface of the carriage way with a glue delivered by the plastic band producer. The sliding surfaces of the lining are scraped, and oil grooves are milled. In TRP 93 MN lathes the sliding couple of ways is cast iron – TURCITE-B plastic.

In the case of heavy TCF-125 lathes, with the cast iron bed covered by strips made of steel of hardness 55 ± 2 HRC and roughness $Ra = 0.63$ µm, the sliding couple of ways is steel – TURCITE-B plastic. Lathes of both types are numerically controlled in two axes. Such a way of controlling carries with it high demands relating to the accuracy of longitudinal and cross carriage positioning on an assumed dimension. The required accuracy of positioning, determined in technical acceptance conditions, is 0.03 mm on the whole way of a carriage movement along the Z axis. To cope with these requirements, the vibration created by friction and the 'stick-slip" effect between the ways of a bed and a carriage should be eliminated.

Measurements of the positioning accuracy of TRP-93 MN lathe carriages, in the X and Z axes, using a HP 5528A laser interferometer, were made. The measurements were carried out with a stoppage of 3s every 100 mm in the X axis and 500 mm in the Z axis. Five measurement series were performed. The results are given in Table 1.

Table 1

Errors of the TRP-93 MN lathe carriage positioning in the X and Z axes, according to the VDI/DGQ 3441 standard

Axis (mm)	V (m/min)	P (mm)	P_a (mm)	P_s (mm)	U (mm)
X 500	0.8	0.02	0.004	0.01	0.009
	2	0.14	0.003	0.008	0.005
	4	0.12	0.005	0.004	0.005
Z 2000	0.8	0.015	0.008	0.012	0.003
	2	0.02	0.009	0.010	0.005
	4	0.02	0.015	0.01	0.003

Exemplary values of positioning errors for the TCF 125 lathe are respectively $P = 0.0205$ mm, $Pa = 0.0033$ mm, $Ps = 0.0205$ mm, $U = 0.005$ mm. The positioning accuracy for both lathes meets constructional and working requirements. Linings of carriage ways made of plastics fulfill their tasks. It should be noted that this solution is technically much simpler and cheaper than for example rolling or hydrostatic ways. The permissible unit pressure, which should not be higher than 0.95 MPa, is a limitation to plastic lining application.

Users of metal working machines from FUM PORĘBA confirm the very good working properties of plastic linings.

It is important that plastic linings should be lubricated and protected against contamination during their work.

Sliding elements of carriage ways of lathes manufactured in FUM PORĘBA are also made of other plastics, such as materials on the base of epoxy resin MOGLICE, produced by the Diament company (*Folders of Dia-*

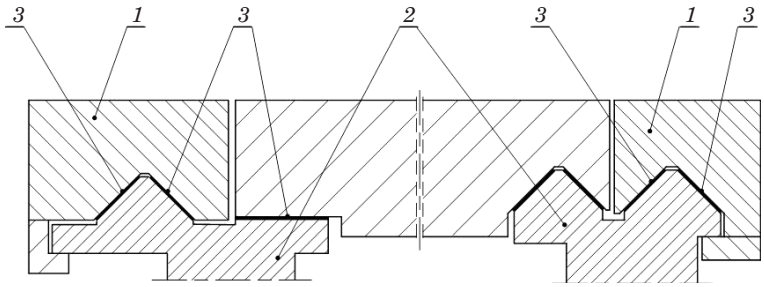
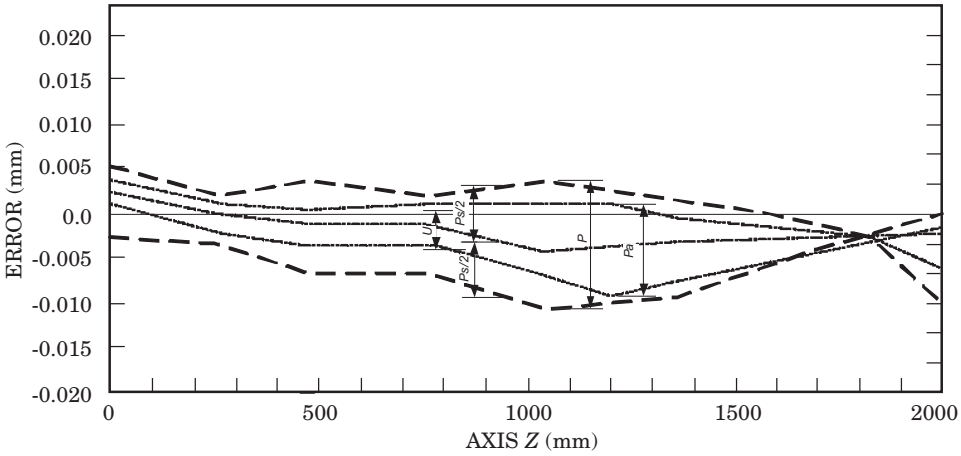


Fig. 1. Ways of TRP-93 MN lathe with a lining made of TURCITE-B SLYDWAY plastic: *1* – carriage, *2* – bed, *3* – plastic lining



MACHINE: TRP-93MNZ2M		+/– 3 sigma
NUMER: 7402-19-09001-02	DATE: 14.04.2004	P: 0.01599
BY: CZĘSTOCHOWA UNIVERSITY OF TECHNOLOGY	LOCATION: FUM Poręba	P_s: 0.01273
	SPEED: 0.8 m/min	P_a: 0.00850
AXIS: Z		U: 0.003000

Fig. 2. Diagram of TRP-93MN lathe positioning error along the Z axis, according to the VDI/DGQ 3441 standard (*Standard VDI/DGQ 3441*...)

mant company). This resin is put on a roughly machined surface of carriage ways, and then bed ways are impressed in it. This assures identical mapping of a sliding surface between a bed and a carriage. Carriage and bed mutual setting should be established earlier.

MOGLICE plastic is usually used during metal working machine repair, because it is the simplest method of regeneration and restoring of the machine work accuracy. Losses of way sliding surface can be filled with this plastic, which allows to eliminate casting defects.

Conclusion

The application of polymer materials on sliding way elements, in the form of linings, assures very good friction conditions and low wear of ways. The use of these materials in the construction of numerically controlled metal working machines is also advantageous as regards production economics. Polymer materials play an important role during the regeneration of sliding ways and other machine parts.

References

KOŁODZIEJ E. 1993. *Metodyka badań i doboru tworzyw sztucznych na elementy ślizgowe.* Monografia 158, Kraków, Wydawnictwo Politechniki Krakowskiej.

KOSZKUL J. 1989. *Prowadnice ślizgowe z tworzyw wielkocząsteczkowych*. Trybologia, 1: 13-17.

Folders of Busak+Shamban company.

Folders of Diamant company.

RYMUZA Z. 1986. *Trybologia polimerów ślizgowych*. Wydawnictwa Naukowo-Techniczne, Warszawa.

Standard VDI/DGQ 3441 – Statistische Prüfung der Arbeits – und Positionsgenauigkeit von Werkzeugmaschinen Grundlagen.

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