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CONSTRUCTION OF HIGH PRECISION GRINDING EQUIPMENT

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Abstract

Advanced ceramics, thanks to their high strength at elevated temperatures, high resistance to wear and chemical attack, are becoming more widely used in industry. On the other hand, there is a growing need for aspheric optical surfaces free of sub-surface damage. The extending demand for parts made of brittle materials necessitates the use of high precision grinding. The grinding of brittle materials so far has been in brittle fracture mode, which results in poor surface finish. Ductile regime grinding can obviate these problems and produces mirror surface finish. At the Technical University of Budapest, Department of Manufacture Engineering, a high precision grinding machine has been constructed by mounting an additional spindle on a high precision lathe. This paper describes the reconstruction work.

Keywords: high precision grinding.

1. Introduction

In the recent years at the Technical University of Budapest, Department of Manufacture Engineering (TUB DME), several researches have been carried out in the field of high precision (HP) machining. Two HP lathes are available for these experiments at the department. As a result of several years' successful work accomplished techniques are developed for the machining of aluminium, coloured metals and hardened steels.

In 1997 a decision was made to enlarge the range of HP machining applications. Therefore, the second lathe was installed in the laboratory of the department. We have built an air-conditioned room with vibration isolated base. In this laboratory we would like to make grinding experiments on brittle materials, beside the machining of metals. To be able to realise this attempt, it was necessary to widen the application range of the machinetool, by a small modification in its structure.

Since this field of science is new in the Eastern-Central European region, first of all we had to make a study of the latest technical literature available in this field. On the basis of this several papers have been written about the theory of grinding brittle materials, and about the difficulties of constructing a HP machine element, [1] [2]. These papers provided a good starting point to determine the main goals

Fig. 1. The ULTRATURN UP1 high precision lathe

of the machine construction work (e.g.: rigidity, accuracy, tool materials, etc.) [3]. The preparation for the grinding experiments, which was started last year, has been finished. In the last year we obtained a high accuracy and revolution spindle with the appropriate supplying equipment (air filter set, electrical equipment, water chiller). The plans of the spindle setting up fixture were accomplished and carried out. The other side of the work was the preparation for the analysis of the future grinding experiments, which necessitated the construction of a measuring station capable for measuring the cutting parameters (cutting forces, vibration, acoustic emission). The measuring equipment has also been carried out.

2. The Grinding Equipment

We are planning to use the ULTRATURN UP1 high precision lathe (*Fig. 1*) for the grinding experiments. The machinetool was manufactured at the Machinetool Factory of Csepel, using the license of Hembrug. It is controlled with a NUM 760 CNC, which enables the machine to have 0.1 μm smallest positioning accuracy. The lathe has hydrostatic bearing spindle and slides.

In the case of grinding the role of the main spindle is taken over by the grinding spindle (90HF2X), which is made by Federol Mogul/Westwind. It has a maximum revolution number of 30000 rev/min, and possesses the required run out accuracy. The spindle is aerostatic, water-cooled, requires 3-phase electric network. It has to be supplied with filtered air free from oil and water as liquid or vapour, which is assured by an SMC AR4000-03DGS (UKA 518) air filter. To ensure maintenance free operation, the spindle needs a water supply (CHILLER

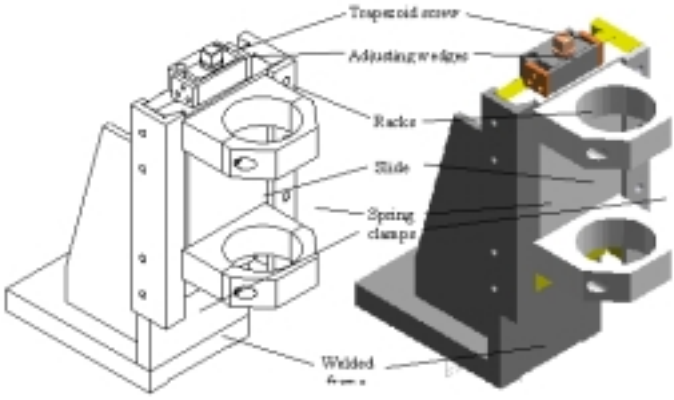

Fig. 2. The CAD model of the fixture

MAXI 300-42/289G/ 008) cleared of microorganisms and corrosive absorbents. The undesirable oscillations of the electrical net have to be eliminated, therefore a frequency filter (KEB RS3015-KD4) has to be connected into the electrical circuit supplying the spindle. The revolution number can be changed continuously with the help of a suitably selected controller (KEB COMBIVERT AC 3PH).

In case of the vertical setting of the spindle, planes, spherical and aspherical surfaces made of brittle materials can be ground. To manage the vertical setting up, a high precision fixture was constructed. The main characteristics of the fixture are: high accuracy, high static and dynamic rigidity, positioning accuracy under 1 μm.

3. Construction of Spindle Setting-up Fixture

After some small modifications on the preliminary outline of the fixture, detailed plans have been carried out. The CAD model of the fixture can be seen in *Fig. 2*. The positioning accuracy of the equipment is under 1 μm. The positioning is done in two steps. The first step is a coarse adjustment, which can be done with a trapezoid screw. The second step is the fine adjustment, which is managed by a pair of adjusting wedges.

The slide, which holds the spindle, can be moved without any play. After releasing the slide (during positioning), it is kept in position by spring clamps. The slidable parts of the fixture, the basis and connecting surfaces are ground. The manufacturing of the holes in the spindle holding racks was done after placing them in their final position on the slide, avoiding this way the misalignment. The connecting surfaces of the welded frame, which were subjected to relief annealing before machining, are also ground.

4. Summary

The preparation for the grinding experiments at the TUB DME has been finished. We have installed a high revolution grinding spindle with the necessary additional equipment in the high precision laboratory of the department. After several iterating steps we have designed a spindle setting-up fixture, which can be comparatively easily carried out. The fixture fulfils the requirements of the high precision technology.

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