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PROBLEMS OF SURFACE QUALITY OF GROUND HARDENED STEELS DURING DYNAMIC LOAD

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ПРОБЛЕМЫ КАЧЕСТВА ПОВЕРХНОСТИ ЗАКАЛЕННЫХ СТАЛЕЙ ПРИ ДИНАМИЧЕСКИХ НАГРУЖЕНИЯХ

This article deals with problems of changes of surface integrity components of ground hardened steels. Experiment fundamentals is samples preparation from hardened steel material by grinding at different cutting conditions, evaluation of origin values of surface integrity components and subsequently dynamic load in different surrounding. Changes of surface integrity components are monitoring in depending on dynamic load cycles count and kind of surrounding, in which to the load happened. Quality of surface and surface layer is dependence on cutting conditions a subsequently on surrounding in which will the components work. Evaluation of quality surface and product manufacture qualities are determinants factors for objective and correctly appreciation proprieties of components. From this experiment deduce conclusion, that aggressive surrounding isn't always unprofitable for material. This experiment showed, that in evaluation of quality surface and surface layer due to roughness, roundness and residual stress achieving same values while using oil supply in corrosion surrounding as while dynamic load in normal surrounding.
Keywords: surface quality, dynamic load, cutting conditions, corrosion surrounding, crack formation

Introduction

At present is very important evaluation of cutting conditions in dependence on surface quality and surface layer. The new trends in machining, construction of machining tools and machines, using of new cutting materials, cutting speeds raising and reducing of cutting fluids forcing us further to that is necessary evaluation of quality of surface and surface layer.

Important part of quality surface evaluation and subsequently using proprieties of components is Knowledge behaviour of component by load.

Experiment

The Experiment was provided in laboratory of Faculty of Production Technology and Management of J. E. Purkyne University in Usti nad Labem. Fundamental of experiment was prepared workpiece at different cutting conditions by grinding and subsequently dynamic load in different surroundings.

Prepare of Experiment Samples, Grinding.

The different cutting conditions were based on changes of these components:

- cutting speed (37 [$m.s^{-1}$])
- abrasive tool (grain – SG, CBN)
- feed (0,26 and 0,64 [$mm.min^{-1}$])

Dynamic load was provided in these different surroundings:

- normal surroundings / normal surrounding with oil supply
- corrosion surroundings / corrosion surroundings with oil supply

By all Workpieces initial values was measured of surface integrity components. Subsequently has been the Workpieces severally puts the dynamic load in different surrounding.

Evaluation of Surface quality

The components of surface integrity were evaluated on based of Standard for ever parameters of surface integrity components. The evaluated components were:

- roughness of surface (parameters Ra, Rz, Rt, material portion)
- geometric accuracy (roundness)
- residual stress

The dynamic load has been performed by relative motion of Workpieces end ceramics wheel. This motion is images in Fig. 1, for normal surrounding and on Fig. 2 is for corrosion surrounding. Quality of surface of all Workpieces has been measured and evaluation after five and seventy-eight hours.

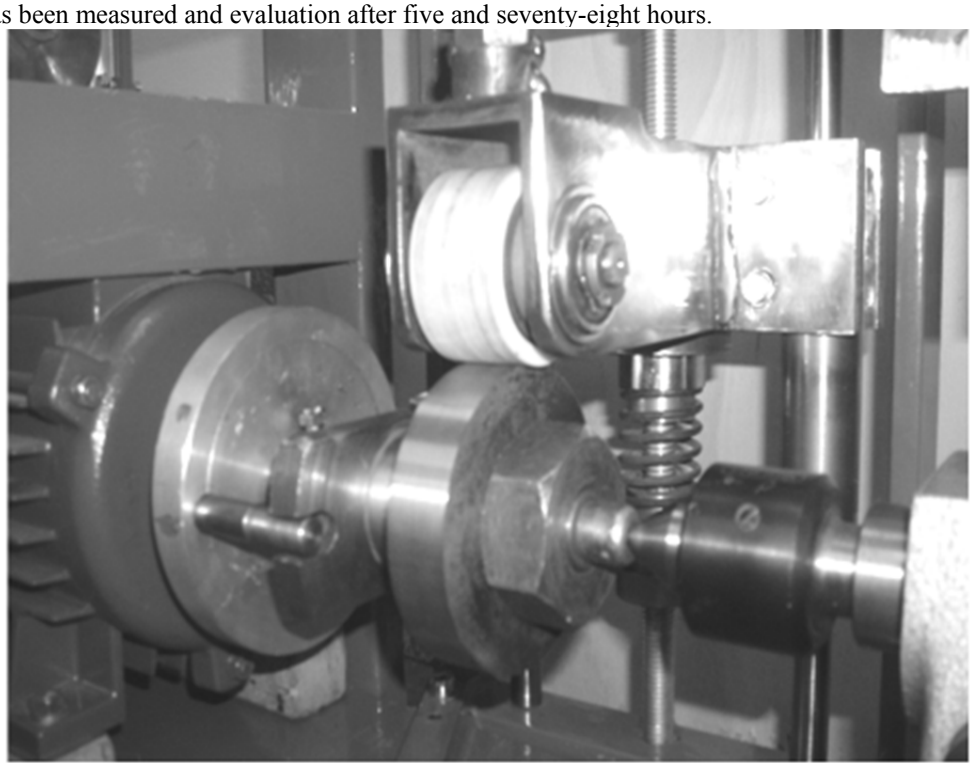

Fig. 1. Relation motion of Workpieces and ceramics wheel (normal surroundings)

Fig. 2. Relation motion of Workpieces and ceramics wheel (corrosion surrounding with oil)

Experiment and Results

The Quality of surface and surface layer has been evaluated in initial, after five and seventy-eight hours. Is interest how the quality of surface is changed in dependence on gaining dynamic load hours at the different surroundings .

Evaluation of surface topology - roughness

In Fig. 3 is images graph of roughness surface by grinding with CBN grain, cutting speed 37 [$m.s^{-1}$], feed 0,26 [$mm.min^{-1}$] and dynamics load at normal surrounding with oil and corrosion surrounding with oil.

On this picture you can see origin values of surface roughness 0,87 [μm] and subsequently course of curve in two surrounding with oil supply. The value of roughness of Workpiece dynamic loads at corrosion surrounding with oil supply show better value of roughness Ra 0,69 [μm] than Workpiece, which has been dynamic loaded in normal surrounding wit oil supply Ra 1,05 [μm]. This fact is valid as well as parameter Rz, how is showed in Fig. 4.

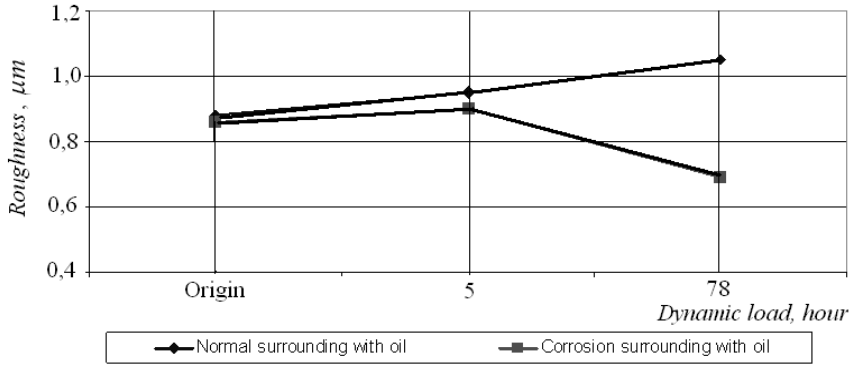

Fig. 3. Roughness of surface, parameter Ra, CBN grain

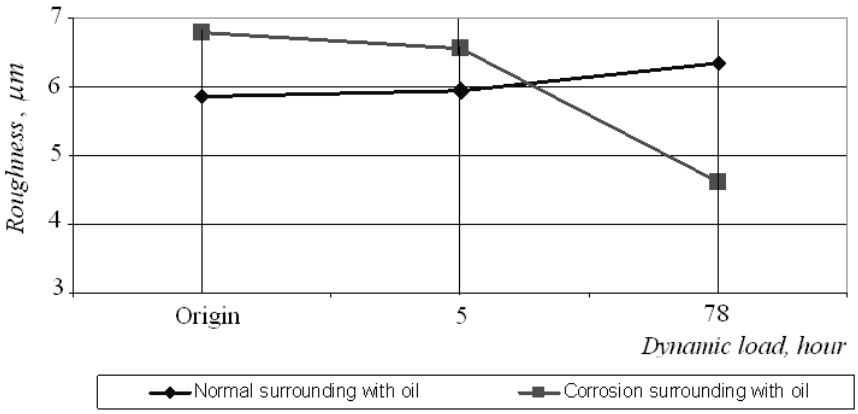

Fig. 4. Roughness of surface, parameter Rz, CBN grain

In Fig. 5 and Fig. 6 are showed profiles of surface for SG grain at two different surrounding.

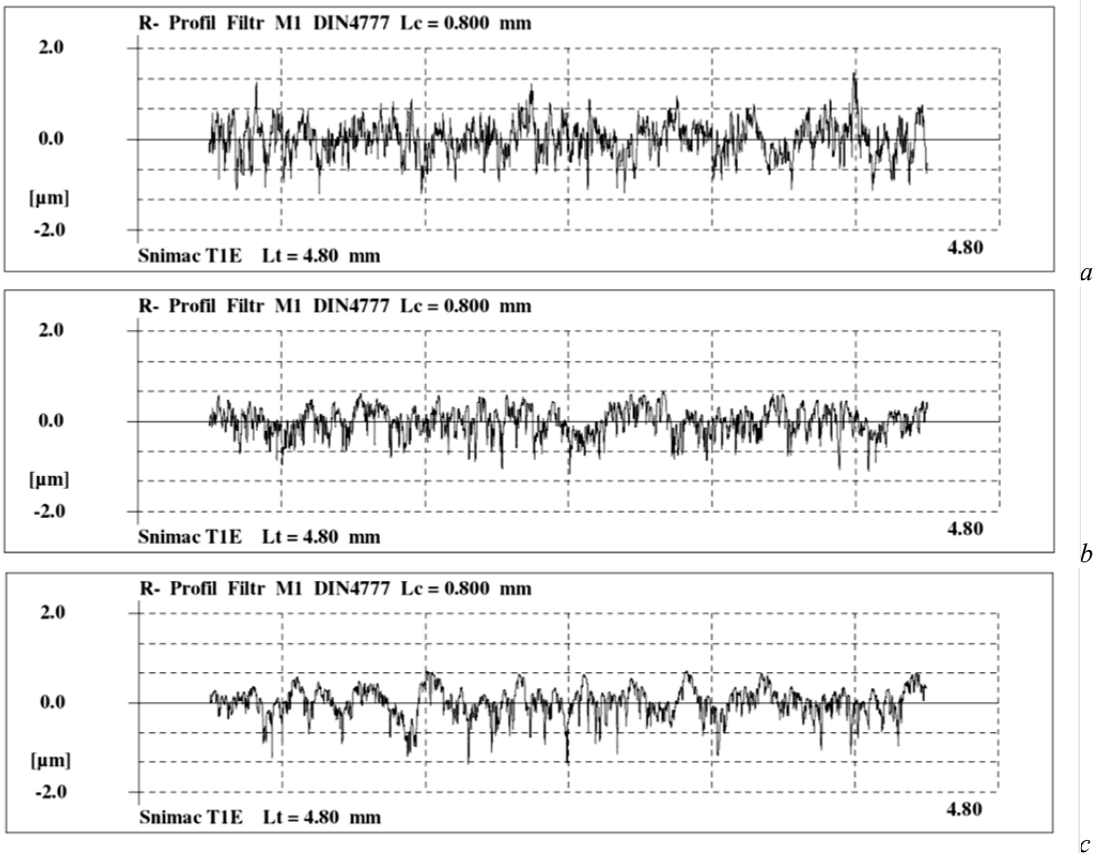

Fig. 5. Profile of surface, SG grain, normal surrounding with oil supply: *a* – origin; *b* - 5 hours; *c* - 78 hours

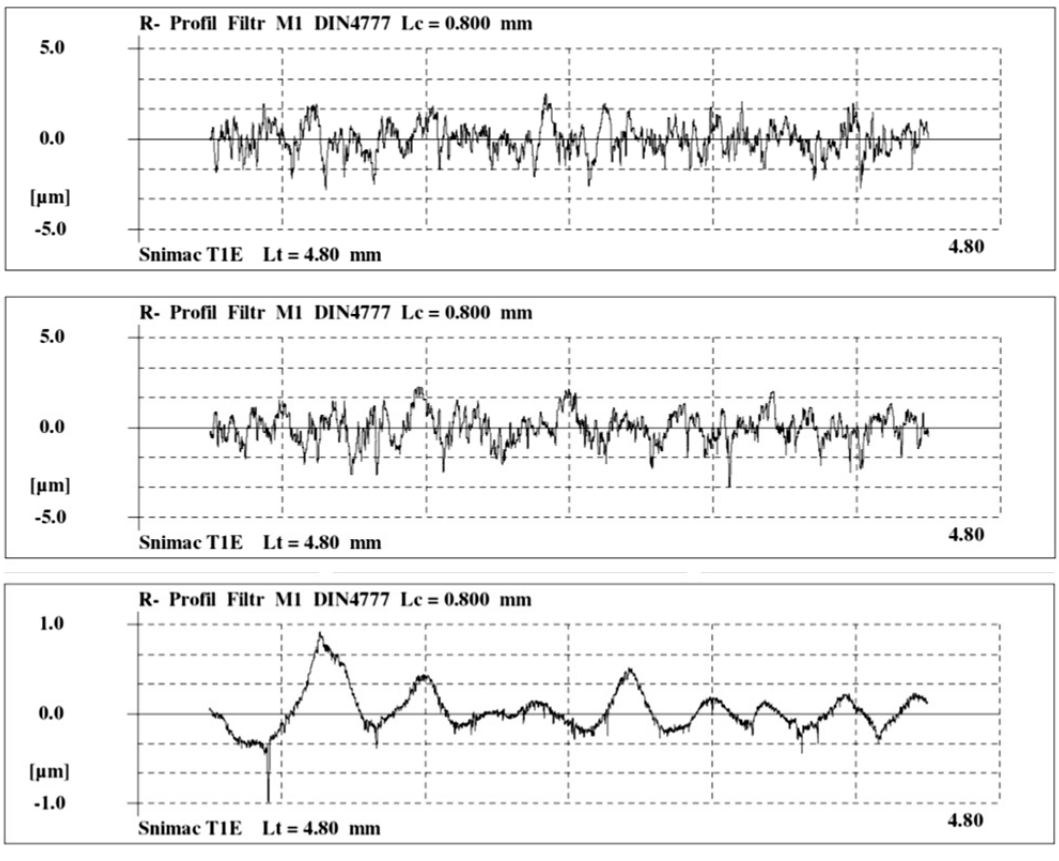

Fig. 6. Profile of surface, SG grain, corrosion surrounding with oil supply: *a* – origin; *b* - 5 hours; *c* - 78 hours

In Fig. 7 and Fig. 8 are showed profiles of surface for CBN grain at two different surrounding.

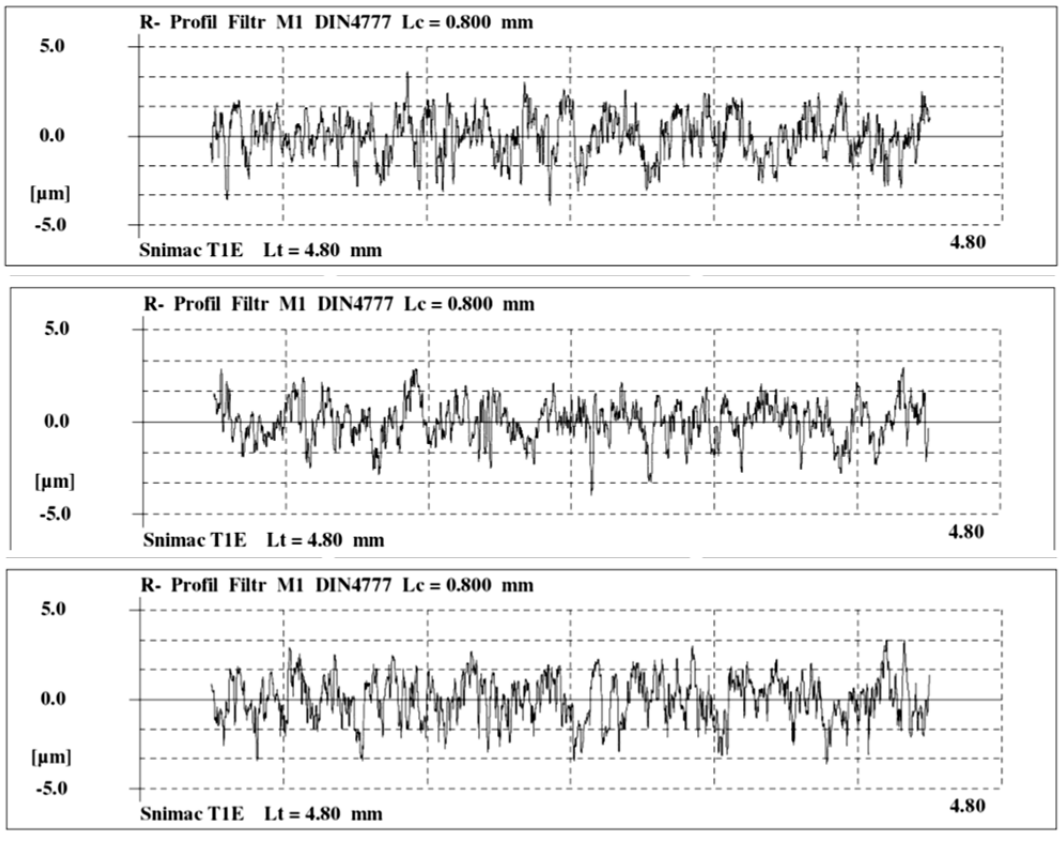

Fig. 7. Profile of surface, CBN grain, normal surrounding with oil supply: *a* – origin; *b* - 5 hours; *c* - 78 hours

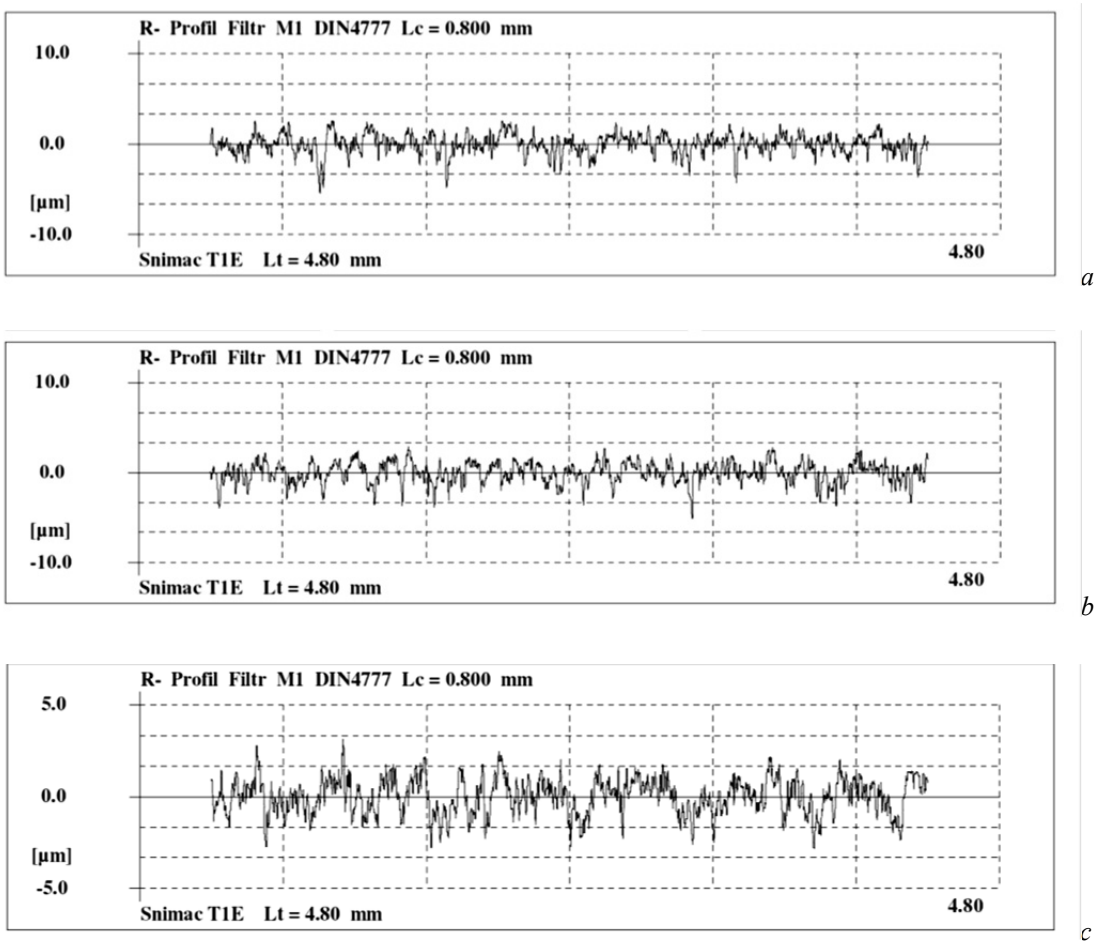

Fig. 8. Profile of surface, CBN grain, corrosion surrounding with oil supply: *a* – origin; *b* - 5 hours; *c* - 78 hours

In Fig. 9 and Fig. 10 are showed curves of Material portion of surface profile (Abbott-Fireston curve) for SG and CBN grain at corrosion surrounding with oil supply after dynamic loads (seventy-eight hours).

These curves are important for individual finished operations of machining evaluation in light of appraisal of functionality machined surface, their loads and problems of wear and durability. The parameters of these curves are value Rpk a Rvk, which describes profile of surface in light of quantity peaks and valleys in base profile of surface.

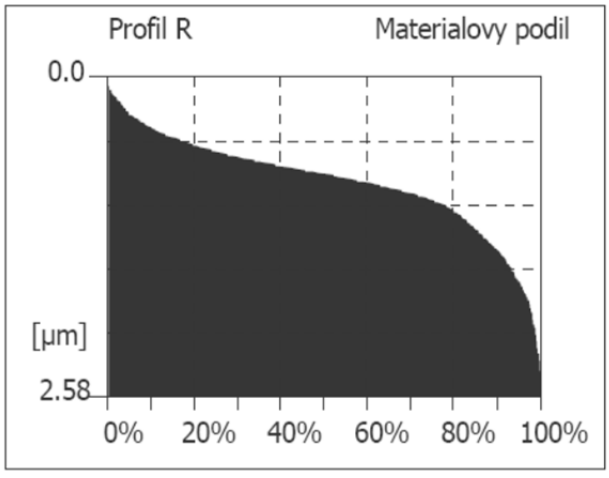

Fig. 9. Material portion of surface profile, corrosion surrounding with oil supply, SG grain, after 78 hours dynamic load

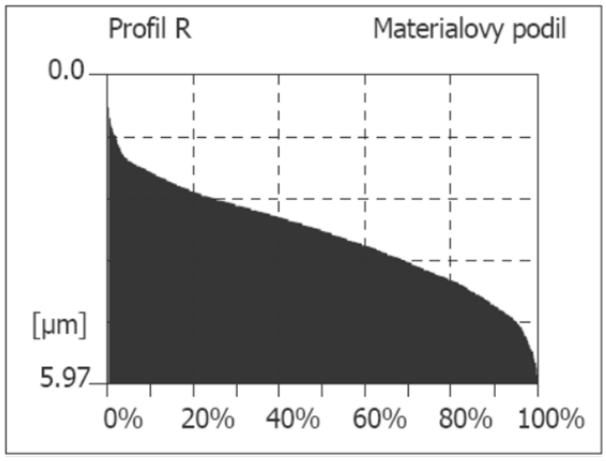

Fig. 10. Material portion of surface profile, corrosion surrounding with oil supply, CBN grain, after 78 hours dynamic load

In Fig. 11 and Fig. 12 are showed curves of Material portion of surface profile (Abbott-Fireston curve) for SG and CBN grain at normal surrounding with oil supply after dynamic loads (seventy-eight hours).

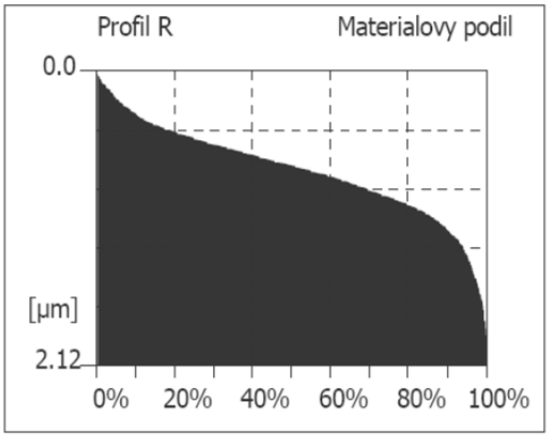

Fig. 11. Material portion of surface profile, normal surrounding with oil supply, SG grain, after 78 hours dynamic load

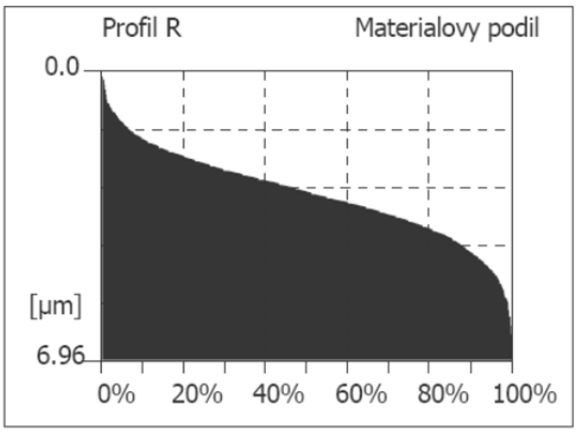

Fig. 12. Material portion of surface profile, corrosion surrounding with oil supply, CBN grain, after 78 hours dynamic load

Evaluation of geometrical accuracy, roundness

The geometrical accuracy is one from basic requirement on production of parts in required accuracy. All machining tools have different precision, which is dependence on geometry of edge and material of tools. It existing many dates entry, which influencing machining process and subsequently quality of surface and using proprieties of parts.

In Fig. 13 and Fig. 14 are images pictures of roundness surface by grinding with SG and CBN grain, with cutting speed 37 [m.s^{-1}], feed 0,26 [mm.min^{-1}] in corrosion surrounding with oil supply.

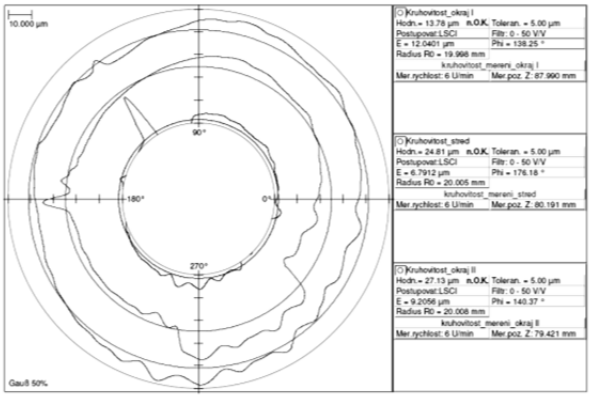

Fig. 13. Roundness of Workpiece, corrosion surrounding with oil supply, SG grain, after 78 hours dynamic load

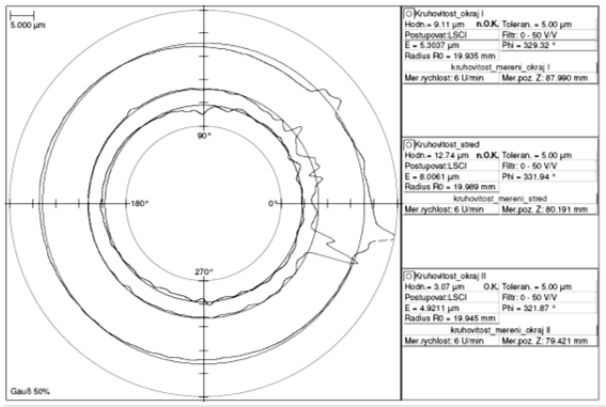

Fig. 14. Roundness of Workpiece, corrosion surrounding with oil supply, CBN grain, after 78 hours dynamic load

In Fig. 15 and Fig. 16 are images pictures of roundness surface by grinding with SG and CBN grain, with cutting speed 37 [m.s^{-1}], feed 0,26 [mm.min^{-1}] in normal surrounding with oil supply. The values of roundness were measured in three places on Workpiece. Final value is average value from these measured dates.

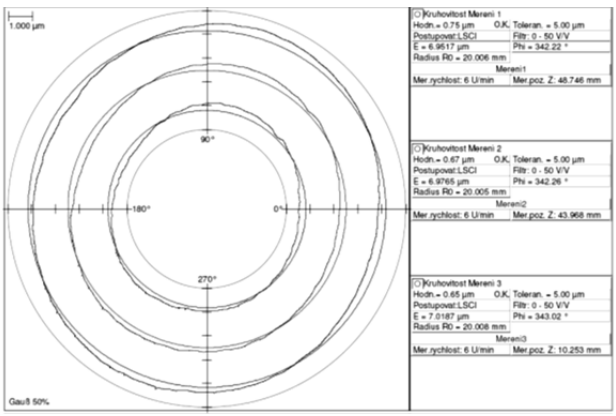

Fig. 15. Roundness of Workpiece, normal surrounding with oil supply, SG grain, after 78 hours dynamic load

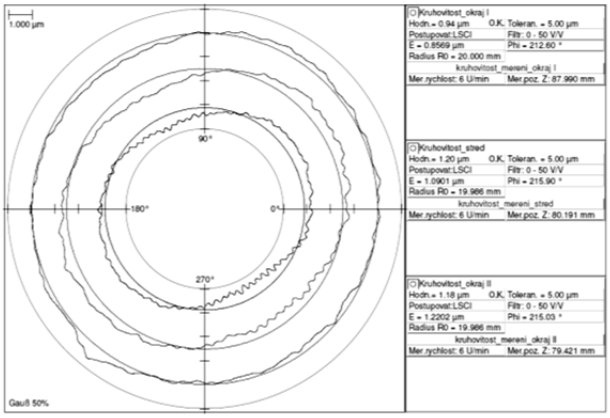

Fig. 16. Roundness of Workpiece, normal surrounding with oil supply, CBN grain, after 78 hours dynamic load

Residual stress

Residual stresses are very dangerous, because they are in material and parts existing without action of the external force. In Fig. 17 are showed courses of residual stresses of Workpieces grounded with SG and CBN grain.

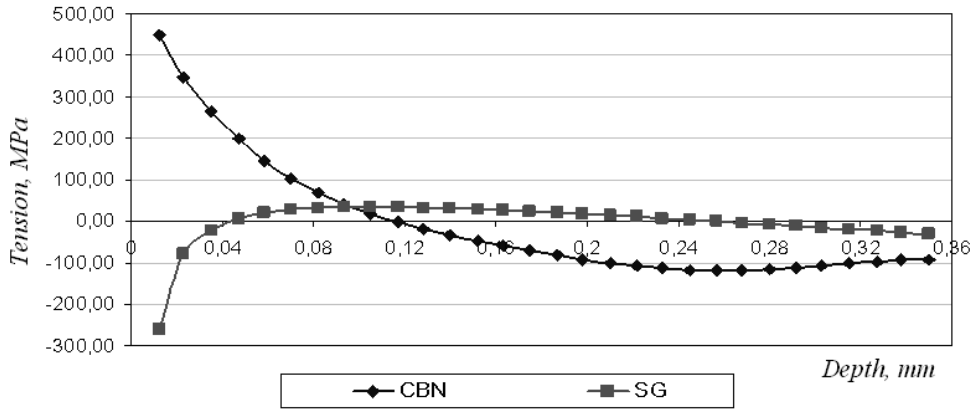

Fig. 17. Residual stresses of Workpieces, SG a CBN grain, origin (without load)

In Fig. 17 are showed course of residual stresses curves. Both curves of stress beginning on opposite side of graph, for CBN grain is origin in tension zone, SG grain have origin in compression zone. Measured depth has been from depth 0 [mm] into 0,3 [mm].

In Fig. 18 are showed courses of residual stresses of Workpieces grounded with SG and CBN grain. This picture images course of residual stresses curves. For SG grain is evidently process of curve in compression zone from -2700 [MPa] on origin surface to -30 [MPa] in 0,3 [mm] depth. Again for CBN grain is evidently process of curve around zero or near below zero in compression zone. Course of curve for SG grain is typical for this.

Curves of course residual stresses in compressions zone are to advantage for subsequently using components in engineering, for dynamic straining parts working in different surrounding in light of crack formation, degradation a limiting state and durability of components.

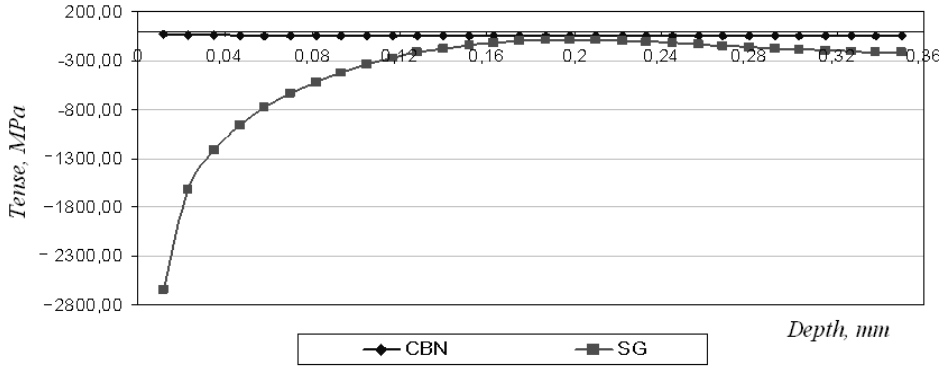

Fig. 18. Residual stresses of Workpieces, SG a CBN grain, corrosion surrounding with oil supply, after 78 hours dynamic load

Conclusion

Quality of surface and surface layer is dependence on cutting conditions a subsequently on surrounding in which will the components work. Evaluation of quality surface and product manufacture qualities are determinants factors for objective and correctly appreciation proprieties of components. From this experiment deduce conclusion, that aggressive surrounding isn't always unprofitable for material. This experiment showed, that in evaluation of quality surface and surface layer due to roughness, roundness and residual stress achieving same values while using oil supply in corrosion surrounding as while dynamic load in normal surrounding.

Анотація. *Стаття присвячена проблемам зміни поверхневої цілісності компонентів загартованих сталей. Основою експерименту є підготовка зразків із загартованої сталі шляхом шліфування її при різних умовах різання, оцінки значень поверхневої цілісністності внаслідок динамічних навантажень в умовах різного оточуючого середовища. Зміни поверхневої цілісності спостерігаються в залежності від кількості циклів динамічного навантаження та типу оточуючого середовища, у якому відбувалось навантаження.*

Ключові слова: якість поверхні, динамічні навантаження, режими різання, агресивне навколишнє середовище, утворення тріщин

***Аннотация**. Данная статья посвящена проблемам изменения поверхностной целостности компонентов закаленных сталей. Основой эксперимента является подготовка образцов из закаленной стали путем шлифования её при различных условиях резания, оценки значений поверхностной целостности вследствие динамических нагрузок в различных окружающих средах. Изменения поверхностной целостности наблюдается в зависимости от количества циклов динамической нагрузки и типа окружающей среды, в которых производилось нагружение.*
Ключевые слова: качество поверхности, динамические нагрузки, режимы резания, агрессивная окружающая среда, образование трещин.

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