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TOOLS FOR HIGHSPEED GRINDING

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ABSTRACT:
This paper deals with investigation of physical and mechanical characteristics of grinding materials and evaluation shaping of these properties in abrasive tools. Experimental results of high power grinding are introduced. State of stress enumeration of rotating wheels and critical velocity of shaped grinding wheels are shown.
Keywords: Grinding wheel, high speed grinding, stress calculation, critical velocity

1. INTRODUCTION
Great importance in the manufacturing process has grinding, which except for traditional finishing cutting method becomes increasingly to the foreground as an alternative of other cutting methods. Besides common grinding method, its modifications such as high-speed grinding, in-depth grinding and efficient grinding have been used more widely. The high-speed grinding means grinding over commonly used cutting speed i. e. above 35 ms^{-1}. In-depth grinding is possible to characterize by withdrawing of the entire material allowance of one stroke (for example the whole depth of groove). Combination of high-speed and in-depth grinding denote as efficient grinding. Integrated using of these methods means technological progress, which importance some researchers equate to implementation of sintered carbide in the early forties.
High speed and high power grinding are special types of grinding that could be characterized by enormous increase of cutting speed (our experiment at TBU in Zlín was realized at speeds up to 240ms^{-1}) and stock removal is realized on one stroke of grinding wheel.

2. WHEEL SHAPE OF THE SAME STRENGTH
Benefits of high-speed cutting require the use of formed disc and the application of special grinding materials. When determining individual stress component in rotating wheel we come out from applied equilibrium of internal forces acting mass element annulus shaped segment, delimitated of the main plane tension. After assessing equilibrium formula in axis of symmetry direction, neglecting differential term secondary and high-order, implementation of conditions of compatibility and providing the validity force of Hook's law for fragile grinding specimen, we obtain duration of stress demonstrated on Fig. 2.
Using conditions of uniform material grinding wheel utilization, that's provided that $\sigma_\rho = \sigma_\tau = \sigma_{P\tau}$ and provided that border conditions are implemented. We obtain wheel shape variable in thickness, in the form:

$$b = b_2 \, [\exp \, (v_k^2 - v_\rho^2).\gamma \, / \, (2 \, g \, \sigma_{Rt})] \qquad (1)$$

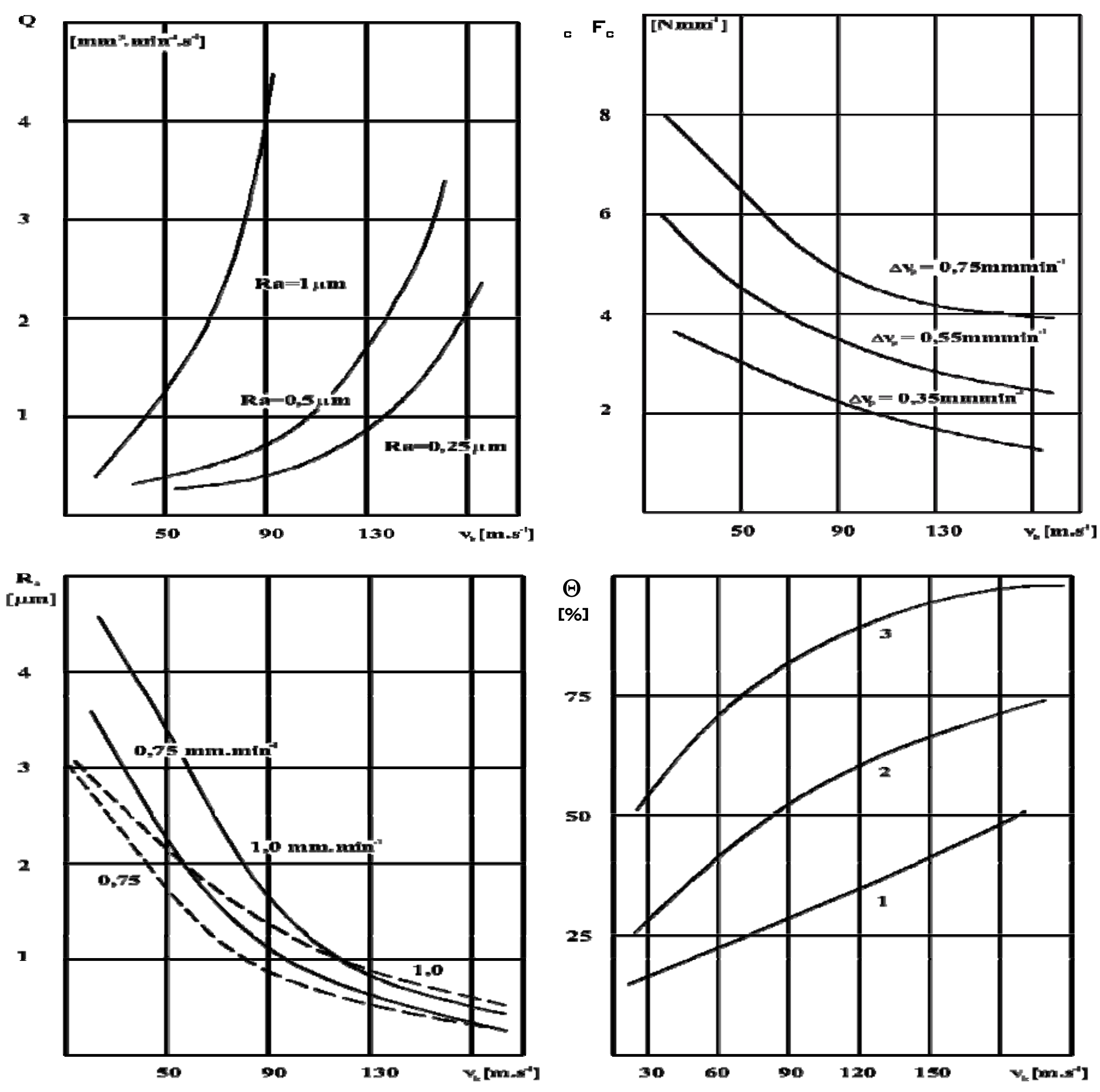

Figure 1 Influence of cutting speed on grinding

To form exponential variable width-shape wheel for experiments is, however, very sophisticated. Adjusting these tools when grinding would be difficult, inconvenient and unreal. From specific production compromise experiment has raised tool shape for high-speed grinding (fig. 3). Experimental tools have cylindrical working part and critical tension point (near constitutive hole) bigger latitude. Because of possible additional creation of compressive tension tools, which at a superposition with tangential stress increases safety of a tool, they have tapered clamping surface (TCS).

Results of accomplished shaped wheel experiments (TCS) show that for high-power grinding the usage of high hardness grinding tools and small size grinding grains is needed, which is in certain contradiction with requirements on maximum efficiency.

It is also shown, that increasing wheel width near hole markedly increases possibility of using this wheel for super-high-speed cutting. Tapered clamping part does not only increase safety factor (entrap appropriate biggest weight crack-up parts), but also markedly increases grinding wheel strength by subtracting compressive tension from tangential stress rising as a consequence of rotation.

From the aspect of strength in rotation tools without holes are beneficial. However; there are technical difficulties with clamping and accurate establishment of these wheels. Rotating wheel segments with taper clamping, where limitation element in tapered clamping flange is allowable compressive state of grinding material stress are preferable. Due to the fact, that compressive strength limit of grinding material can be up to six times higher than tensile, these tools are possible to use on markedly higher cutting speeds.

Evolutionary leap in possibilities of using shaped grinding wheels for grinding especially for high speed cutting means introduction of all-metal grinding wheels with thin abrasive layer on tool periphery. Due to the fact that in functional dependencies for state of stress determination specific weight of rotating wheel appear, it is possible to raise peripheral allowable speed by using metallic materials with lower specific weight such as dural, titanium. Discussions show wider possibility using polymeric material especially composite with kevlar or metallic fibers.

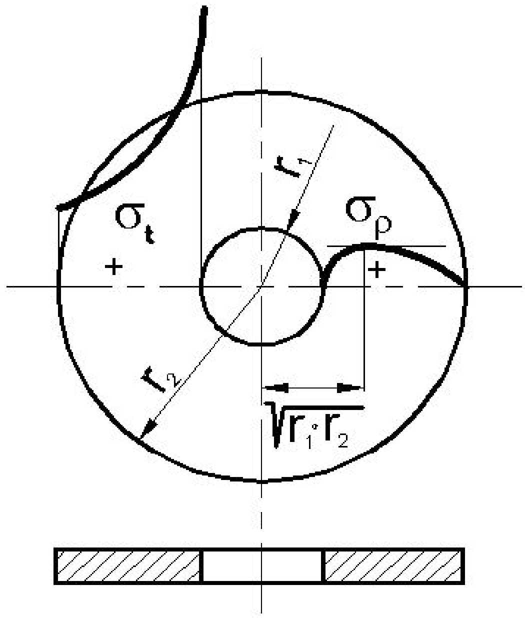

Figure 2 Stress progression in rotating

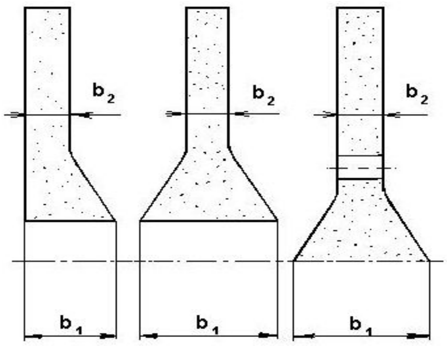

Figure 3 Example shapes of rotating wheel with tapered clamping

Certain possibility of a capacity grinding wheel TCS escalation increase offers increasing of vertex angle of tapered part which consequently call into existence new tooling method of so-called fly-cutter grinding, that is especially suitable for high-speed and high-power grinding of short flange shaped parts. Such a tool is advantageous in terms of safety, better possibilities of inlet ways of procedural liquid to the cutting place, cutting stability, chances of using grinding segment, etc.

At the testing station developed at TBU, FT in Zlin preliminary strength tests of grinding tools similar in dimension and tension were done. The objectives of the tests were to find behavior of wheels at super-high speed, influence of pressing on on wheel bearing capacity, determination of the influence of filling material between metal and grinding wheel and to verify cooling operation.

Using grinding segment instead of ringlet allows considerably higher cutting speeds because at a dangerous spot, i. e. on inner diameter, none tangential stress exists. so tool bearing capacity on disruption is characterized explicitly by strength of a circular ringlet.

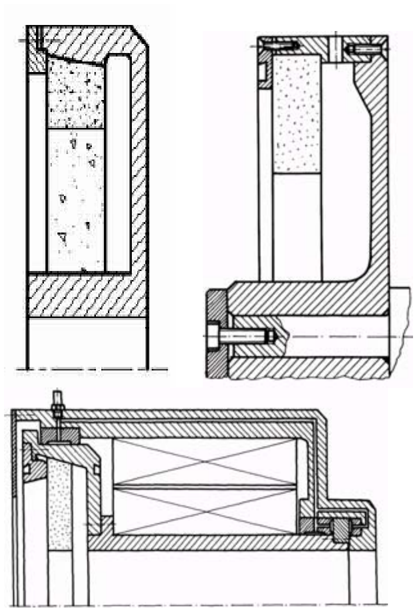

Figure 4 Shape of circular wheel for experimental testing

3. CONCLUSION

Analyses and results of experiments show possibilities of the escalation of tool strength under rotation by constructional adaptation of grinding wheel. The article mentions possibilities of the shape improvement and quality material for grinding, combining newly developed firmer adhesives, if needed all-metal grinding tools, enables safety application of cutting speed markedly excessing 100 ms^{-1} and thus, productivity improvement of grinding operation.

Interesting possibility of grinding wheels shaping for super-high-speed grinding is using of patented circular grinding. This method shows possibilities of marked tuning grinding. Engineering design arrangement on circular grinding allows relatively simple automation of the process with multiple productivity increases in elements for industry.

4. ACKNOWLEDGEMENT

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