ETH Swiss Federal Institute of Technology Zurich
Institute of Machine Tools and Manufacturing IWF

Investigation of the linear sawing process of hacksaws

Problem

The linear sawing process of hacksaws is characterized by a reciprocating cutting motion horizontally and perpendicularly to the surface of the workpiece, which is being cut. The stroke is produced by a mechanism with a clamped saw blade.

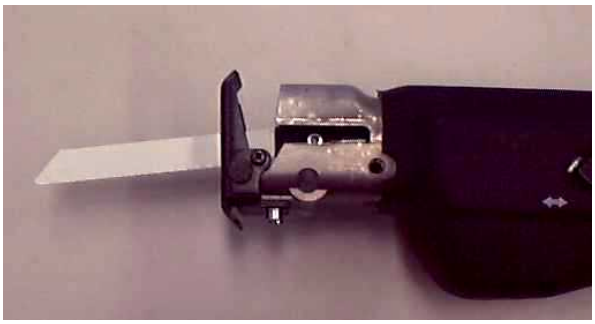

Figure 1: *Hacksaw machine with saw blade*

Through many sawing tests and thanks to many years of experience, the designer can develop new saw blades. But the decision basis for new developments is only available through the analysis of the experimental results obtained by these tests. These results are restricted to the wear of the teeth, the service life of the saw blade, the cut quality and the cut costs. The further development of new saw blades is also connected with expenditure tests, i. e. time- and cost-consuming. As a result, usually the majority of new developments refer to an optimization of saw blade concepts already existing, by using as basis the characteristics resulting of the saw blade check and the analysis of the sawing tests.
A more efficient new development of saw blades is only possible if the process of sawing is examined in a more thorough manner. Then, by entry of the characteristics of the sawing process and by an exact consideration of the evolution of the sawing process, a purposeful strategy of development can be defined.

Target

After an exact definition of the system boundaries of the sawing process and an accurate entry of all influencing variables, the linear sawing process with hacksaw blades can be examined. This investigation essentially covers the variables of the sawing process and their dependency to the most important influencing variables, as well as the observation and analysis of the elementary chip formation, the metal removal and the wear processes at a single tooth and at the entire saw blade during the cutting process.

The following topics are treated in this investigation :

- Kinetics of the sawing process
- Chip formation and metal removal in sawing
- Cutting forces in sawing
- Wear mechanisms und tribology processes
- Heat development, temperature gradients and heat dissipation during the sawing process
- Oscillations of the saw blade during the cutting process

Due to the extensive topics and number of entrance variables, the investigations of the idealized sawing process and the evolution of the sawing process under real cutting speeds were limited to steel, which is the most used workpiece material when sawing with a hand hacksaw machine.
Thanks to these investigations and the knowledge acquired through them, the evolution of the sawing process has to be more exactly described. The modelling of the sawing process is a principal objective and will lead to new saw blade concepts within the area of the linear sawing process.

Results

A model of the kinematics of the machine was developed. In order to check this model, the motion of the saw blade was filmed with a digital high-speed camera and processed with the program Matlab. The chip formation was also observed.

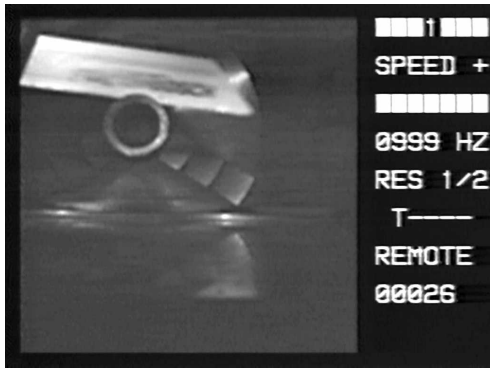

Figure 2: *Picture from the sawing process recorded with a high speed camera*

In order to measure the forces developing during the sawing process, the workpiece was fixed on a quartz three-components dynamometer. The hacksaw machine was hold by hand or clamped on a special testing system. The important results of these force-measurements showed the influence of the kinematic and of the manual control of the hacksaw machine.

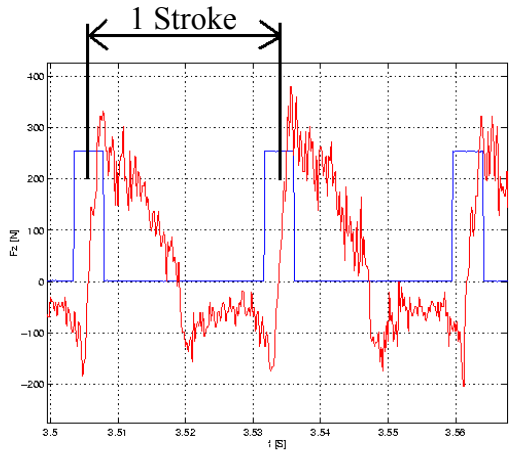

Figure 3: *Cutting force during one stroke for a test manually controlled*

It was stated by comparison of force-measurements that the forces measured on the testing system are very different of the forces measured when the hacksaw machine is manually controlled. Therefore the new testing equipment was optimized, in order to be able to reproduce the linear sawing process under manually operation.
Only then repeatable studies with the testing system can be executed and supporte the development of a model for hacksawing process.
The modelling of the cutting process of hacksawing was executed with the program of the company Third Wave Systems (Minneapolis, US).

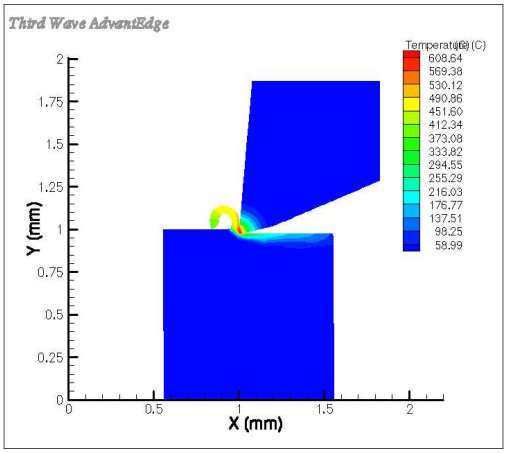

Figure 4: *Simulation of Temperature for one tooth during the cutting process*

The program was adapted for the hacksawing process with the help of the experimental investigations. So it is possible to simulate with some restrictions e. g. the temperature development, the stresses in the tooth or the strains of the chip in dependency to the parameters of the saw blade and the sawing process.

Status

The adaptation of the testing equipment and the modelling of the cutting process of hacksawing are completed.
The project engineer R. Zanella left the institute. Therefore the project gets a new target: Development of saw blades for machining of very hard materials e. g. ceramics, composites and glass-fibre reinforced plastics.

Partners

The project is promoted by the Commission for Technology and Innovation (KTI) under the project number 4407.1 and ends in February 2002.

Industrial Partners:
Scintilla AG, Zuchwill
Scintilla AG, St. Niklaus
WWL-Listemann AG, Mauren (FL)

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