



Mechanical processing and end-use products of birch, aspen and alder

Kivistö, Jari N. T.¹, Sipi, Marketta H.²

ABSTRACT

The utilization of birch (*Betula verrucosa*, *Betula pubescens*), aspen (*Populus tremula*) and alder (*Alnus incana*, *Alnus glutinosa*) in mechanical wood industry in Finland is imperfect. At the moment birch is the most important species and it is mainly used in plywood industry but also in furniture and parquet. The use of aspen and alder is considerably lesser. The problems concerning mechanical processing and the insufficient knowledge of wood raw material properties of these species have restricted the use of them and lowered the value of raw material. However, during last few years an interest in more effective utilization of these species has increased. The first paper mill using aspen as raw material has started in Finland in 1997. The growing and use of aspen is increasing and therefore it is even more important to know the use possibilities of aspen also in the mechanical wood industry. Birch as well as aspen and alder could be widely used, if their properties, mechanical processing and suitability for different products were better known.

The aim of this study is to clarify the mechanical processing properties of birch, aspen and alder, on the one hand their effect on the quality of the end-use products and on the other hand their dependence on the raw material, properties of tree stem and growth site and on the wood procurement. The most suitable end-use products for each species are defined considering the properties of raw material, end-use products and processing and the profitability of manufacturing. This paper presents some preliminary results of a survey directed to 585 enterprises in Finland that use birch, aspen and/or alder as their raw material.

The annual use and the most common and potential use objects for birch, aspen and alder as well as the worst problems related to the raw material and manufacturing of products were clarified using literature, inquiries and interviews. The results of this survey have indicated that most of the problems appear in sawing, planing and especially in drying. Deformations, shakes, cracks, colour changes and differences of moisture content after drying are the most typical problems that affect the quality of the wood raw material of birch, aspen and alder. The problems are often the same regardless of which end-use product is manufactured. According to this survey the most suitable end-use product for birch is furniture, for aspen sauna benches and panels and for alder panels and furniture.

According to the results of this survey the empirical study concentrates on the most promising end-use products of birch, aspen and alder and solves the problems appearing in processing of them. The most essential processing methods to concentrate on are drying, planing and gluing. The focus changes according the species, end-use product and processing problem. The main focus is in comparing the new high frequency-vacuum drying method with the common condense drying method; is it possible to get better quality by using this new method in drying and what kind of changes may appear in the wood under drying process. Naturally the changes of the mechanical processing properties after different kind of drying processes are also under special interest.

INTRODUCTION

The utilization of birch (*Betula verrucosa*, *Betula pubescens*), aspen (*Populus tremula*) and alder (*Alnus incana*, *Alnus glutinosa*) in the mechanical wood industry in Finland is imperfect. Birch has traditionally been used most of these species, especially in the plywood industry, but also in the furniture and parquet industry. Especially most of the best birch

¹ Research Scientist, Dept. of Forest Resource Management, University of Helsinki, P.O. Box 24, FIN-00014 University of Helsinki

² Professor, Dept. of Forest Resource Management, University of Helsinki, P.O. Box 24, FIN-00014 University of Helsinki

logs have been used as raw material of plywood industry. Aspen and alder have been much lesser utilized in the mechanical wood industry, but lately they have become quite popular. However, there are some problems concerning the properties of the wood raw material that make the processing of these species difficult. Also the best possible ways to process the wood material of these species have been forgotten for many decades just because of the small utilization rate of the wood material.

In the University of Helsinki, Department of Forest Resource Management, there is continuing a study called "Mechanical processing and end-use products of domestic birch, aspen and alder". The study is financed by the Academy of Finland. It started in 1.8.1998 and is supposed to continue until 30.4.2001. The aim of the study is to clarify the mechanical processing properties of birch, aspen and alder wood, on the one hand their effect on the quality of the end-use products and on the other hand their dependence on the raw material, the properties of tree stem and site as well as on the wood procurement. This paper presents some preliminary results of the first part of the study, literature survey and inquiries and interviews of the enterprises that use birch, aspen or alder as their raw material in Finland. The empirical study is based on the results of the first part.

MATERIAL AND METHODS

The first part of the study included totally 82 inquiries and 81 interviews directed to different kind of enterprises using birch, aspen and/or alder as their raw material. These enterprises were located in different parts of Finland, Ahvenanmaa and Lapland excluded. The material of these inquiries and interviews gives information of the amounts of raw material, of the wood procurement as a whole, of the size and quality requirements, of the methods and problems in sawing, drying, processing, gluing and finishing, of the end-use products and also of the main client groups of the enterprises. The effects of the site, the wood procurement, the storage, the drying, the processing and the properties of the wood and stem on the appeared problems were also clarified.

RESULTS

The high quality raw material of birch, aspen and alder is not so easy to get in most parts of Finland. As logs the availability is the best. Simple cut timber and double cut timber are also quite often used as raw material. Figure 1 presents the shares of roundwood and simple cut timber as raw material in this survey. Those enterprises which participated in our survey used totally 169 000 m³ of birch, 8 900 m³ of aspen, 2 800 m³ of common alder and 400 m³ of grey alder as their raw material per year. The larger the enterprise was, the more frequently it used only birch. Often the biggest enterprises were not even interested in using aspen or alder as their raw material. As a whole, the smallest enterprises (turnover under 5 million FIM) were most interested in using new species in their production.

The enterprises in our survey usually purchased their raw material themselves. Some of the enterprises had their own suppliers or agents that delivered the wood raw material for their clients. Approximately 20 % of the enterprises used more than one method for their raw material service. The butt logs without knots or only with few knots were the most wanted sorts of logs. Many enterprises accepted also logs that were not quite straight if their quality otherwise was high. Also the so called "hard rot" was in some cases acceptable. Bends and shakes were usually not desirable in the logs. For the quality of simple cut timber the enterprises had different kind of quality requirements of their own. Usually they tended to use their raw material as economically as possible by sorting it carefully and by directing the right pieces to the right parts of the products.

Only a few enterprises used other sawing methods than the normal simple and double cutting, for example radial cutting or quarter cutting. 20 % of the enterprises made sawing, 17 % splitting, 22 % planing and 15 % gluing themselves in their production. Totally 56 % of the enterprises dried their wood material themselves. Most of them used condense drying kilns (44 % of the answers) and warm air drying kilns (37 %). Vacuum drying kilns were used only by 2 % of the enterprises. One reason to this is the high price of the vacuum drying kilns in Finland. Used temperatures were under 40°C for the condense drying kilns and 44 -70°C for the warm air drying kilns. Usually birch, aspen and alder wood is not dried in very high temperatures because of the worse deformations and colour changes that may appear in that kind of conditions.

Most of the raw material based problems appeared in sawing, drying and planing regardless of the species. Figures 2 - 5 present the locations of the processing problems in this survey. Drying was clearly the most complicated and difficult part

of the production. Various kind of deformations appear in all the species during drying, especially in aspen and birch timber. Also the colour changes are very common, especially during the drying of birch and common alder. The moisture content of the aspen wood varies a lot after drying even in different parts of the same plank. The moisture distribution is usually quite uneven inside the aspen timber also before drying. Those moisture differences make the further processing, for example planing, gluing and finishing, quite difficult. It is not easy to plane a good surface, if the moisture content in some part of the plank is considerably different than in other parts. Sharp cutters are very essential in successful planing of aspen and alder wood. The hardness of birch and different kind of cracks are the most common difficulties concerning the planing of birch.

In birch the problems in different parts of processing don't affect much to the rejection of the wood raw material. Still, about 40 - 45 % of common alder and aspen wood users said that the material-based problems affect moderately or much to the rejection, whereas the same share of the users of birch and grey alder wood was about 24 - 28 %.

According to the survey the most essential background factors for the quality of the wood raw material seemed to be the site, the right felling time, carefulness in harvesting and transporting and the suitable storage time and methods. Mixed forests offer the best site for the good quality trees. Winter is the best time for harvesting. The other good method is to fell the trees in summertime but don't take the branches away until autumn. So the moisture content of the wood will decrease a lot during a couple of weeks. According to the answers in this survey this way to handle the trees is good also because of the lower rate of colour changes in the wood. Careful handling of the logs during harvesting and transporting is essential for the good timber quality. Storage time and methods have an effect on the quality and processing properties of the wood material. The summertime storage is a big problem especially for birch; the storage time shouldn't be too long and the place should be good. For aspen wood the long lasting storage time may even be good; the internal stresses decrease a lot as the logs are stored at least one year before sawing. Of course, the storing methods have to be correct, if the quality is expected to be good. As a whole, the logs felled in summertime should be sawn as soon as possible. The long enough air drying before the other drying methods is useful for the timber of these species.

The biggest group of the birch products was the furniture. Sawn timber, solid wood panels, floors, tool handles, mouldings, stairs and railings and many other products were also mentioned as birch products. Sauna benches and panels were the most common aspen products. Other aspen products were for example ice-hockey sticks, furniture, sawn timber (also heat-treated timber), doors, tool handles, decorations and souvenirs, interiors, shingles and planed components. Panels and furniture were the most popular common and grey alder products. Panels and sauna benches made of aspen and alder were common products of smaller enterprises. Figure 6 presents the numbers of the manufacturers of the most common products in this survey.

Main reasons to use the birch, aspen and alder wood as raw material in the production were the beautiful appearance of the wood surfaces, good properties in production and use and of course the good market conditions. Birch wood is hard and permanent and the colour of the wood is light and beautiful. Aspen wood is soft and light, but also durable and permanent. The heat conductivity of the aspen wood is small. This is one reason why the aspen made sauna benches are so popular in Finland. The beautiful appearances and colours of common and grey alder wood are highly respected. In addition to this their processing properties are quite good.

The main client group of these enterprises were the household economies. They were the most important client group on the one hand of many small enterprises (turnover < 1million FIM) and on the other hand of many large enterprises (turnover > 10 million FIM). The other mentioned client groups were the furniture industry, the construction industry, public corporations, further processing industry and the interior entrepreneurs.

The enterprises exported their products mostly to the European countries: Germany, Sweden, Great Britain and Norway were the biggest export countries. Products were exported also to Far East, USA, Russia, Middle East and Africa. The bigger the enterprise was, the more obviously its products were exported also outside the Europe.

DISCUSSION

The main aim of these inquiries and interviews was to clear up the essential problems concerning the mechanical processing of birch, aspen, common alder and grey alder. Further parts of the study will base on the results of this survey.

A common feature of every species was that the majority of all the problems appeared in the first stages of the process, during the sawing and drying. Especially the successful drying is very important, when the further processing properties are supposed to be good. If there has been made mistakes during the drying, the wood may be very difficult to process further for example because of the deformations and shakes that may appear in the wood. Differences in the moisture content after drying may also make the further processing difficult.

Methods to solve the drying problems were often totally different in the enterprises. For example the storage of aspen as logs for 1 - 3 years before sawing was one mentioned solution to the wood deformation problems, but there were also many opinions against this method. The importance of the air drying of the planks and boards before the other drying methods was seen quite differently in different kind of enterprises, too. Big enterprises usually don't use this method but they take their wood material immediately into the process whereas some small enterprises consider the air drying before the kiln drying methods the one and only right method.

The problems in sawing, splitting and planing were often various kind of deformations and shakes caused by the tensions in the stem or by the drying. Difficulties to plane a good surface to the timber were partly caused by the differences in the moisture content in the wood. Finishing was typically quite easy, if the wood was dry enough and if the moisture content was equal in the wood. In finishing some problems were caused by the colour changes that usually appeared into the wood during the drying. As a whole, drying was absolutely the most important processing sector to be concentrated on in the experimental studies. Also the effects of the different drying methods on the quality of the wood material and on the further processing properties seemed to be an important topic for the further parts of the study.

In the experimental part of the study there will be compared two drying methods: the condense drying and the new high frequency - vacuum drying, which has been developed in the Lahti Polytechnic, Faculty of Technology. At least two of these four species, birch and grey alder, will be taken into the experiments. There will be two felling times: February /March and June / July. In June and July the trees will only be felled, and the other parts of harvesting will be made in the next autumn. There will be used different times and methods of the timber storage before the drying in these two ways. The quality of the timber will be investigated before the drying and again after the drying. The changes in the cell level may also be investigated. Some experiments will be directed to the planing, gluing and possibly to the heat treatment of the timber which is dried by using these different methods.

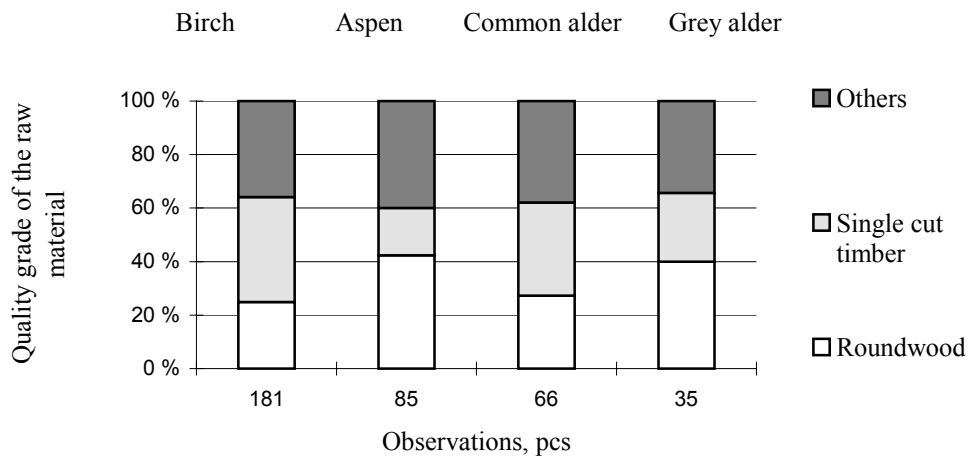


Figure 1. Quality grades of birch, aspen, common alder and grey alder wood as raw material.

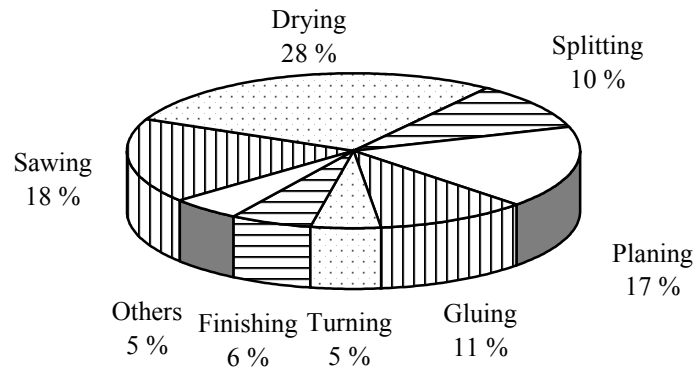


Figure 2. Location of the problems in the processing of birch wood.

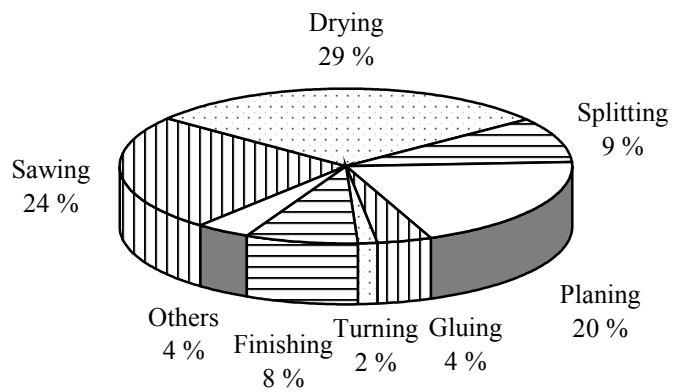


Figure 3. Location of the problems in the processing of aspen wood.

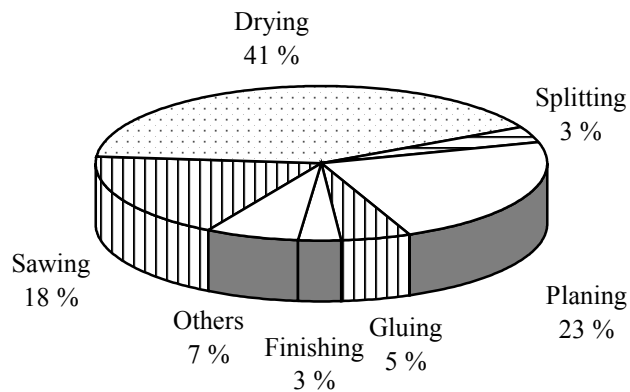


Figure 4. Location of the problems in the processing of common alder wood.

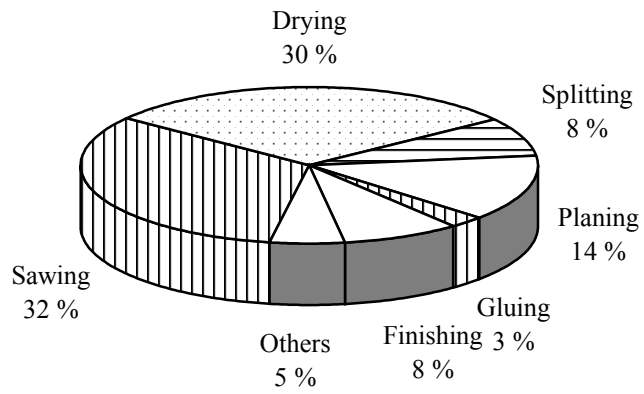


Figure 5. Location of the problems in the processing of grey alder wood.

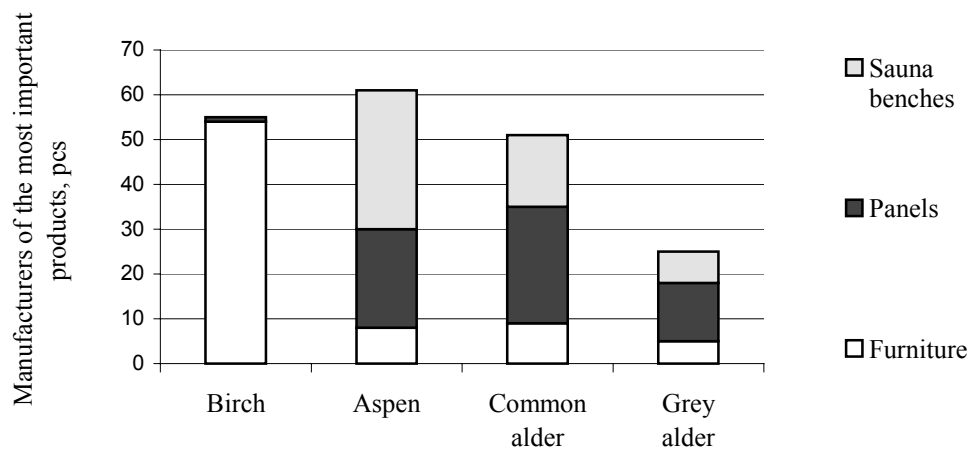


Figure 6. Manufacturers of the three main products in the survey.