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METSÄTEHO

MANUAL

# TIMBER QUALITY PRESERVATION

**TIMBER QUALITY PRESERVATION MANUAL**

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All papers, inks and manufacturing processes used in the printing of this manual are environmentally friendly.

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# PREFACE

The information presented in this manual is based primarily on the research results of several years' worth of studies at Metsäteho. Participants in the realisation of the projects include, among others, the Finnish Forest Research Institute, KCL (Oy Keskuslaboratorio Ab), UPM-Kymmene Pulp Center, Lännen Laboratoriot Oy, Finnforest Corporation, Metsä-Rauma Oy, Myllykoski Paper Oy, Sunila Oy, Tehdasmittaus Oy (Metsäliitto Group), Koskisen Oy, Koskitukki Oy, Metsäliitto Cooperative, Stora Enso Metsä and UPM-Kymmene Corporation.

The manual forms part of the "timber quality preservation" information package which, in addition to the manual, includes a series of computer slide images. The slide series covers the economic significance of quality changes in timber, wood products and timber storage systems. The wood product categories are as follows:

- pine pulpwood
- birch pulpwood
- spruce chemical pulpwood
- spruce ground wood
- softwood logs
- birch logs
- wood product comparison.

The methods of timber quality preservation are:

- cold storage
- wetting
- water storage.

The transparency series is available on Metsäteho's website, which requires a user ID and password.

# 1 CONCEPTS

**Wood rot** – infected areas clearly darker or lighter in shade than healthy wood where the wood tissue has begun to decompose due to the metabolic action of rot fungi. As rot spreads, wood bulk density drops and fibre properties weaken, chemical pulp yield is also diminished and bleaching becomes problematic.

**Blue-stain (sap-stain) fungi** – a general definition of several species of fungi which cause dark discolouration, often bluish in colour, in softwoods. Blue-stain (sap-stain) fungi derive nourishment from the easily broken down components of wood cells, but are usually not destructive to the cell walls, thus the wood strength properties remain unchanged.

**Blue-stain (sap-stain)** – discolouration in wood caused by blue-stain (sap-stain) fungi.

**Stain** – general definition for discolouration in wood. Stain is usually caused by fungi, but enzyme reactions and bacteria can also cause discolouration.

**Rot fungus, decay fungus** – general definition of fungi which decompose living or dead wood.

**Hard rot** – wood rot in its early stages, the hardness of which does not differ essentially from that of healthy wood, although strength properties will have become weakened.

**Soft rot** – wood rot in which decomposition by rot fungus has proceeded to the extent that the wood has lost its solidity and its structure has begun to disintegrate.

**Brown rot** – rot fungus which breaks down wood cellulose and hemicellulose, leaving the lignin component unaffected.

**White rot** – rot fungus capable of selectively breaking down lignin. White rots cause either light-coloured white rot or brown corrosion rot White rot occurs most commonly in birch and corrosion rot usually in spruce.

**Corrosion rot** – during the initial stage of decomposition corrosion rot fungi break down both the lignin and the cellulose components of the wood, usually causing the wood to brown slightly as a result. As rotting proceeds, lighter spots appear on the wood as a consequence of high lignin fragmentation. Once the lignin is totally broken down decomposition continues with wood cellulose.

**Reinforcement pulp** – softwood pulp which adds strength to paper, and consequently good runnability on the paper machine or printing machine.

**Opacity** – a measure of the transparency of paper; non-transparent paper has high opacity.

# 2 CHANGES IN WOOD QUALITY

Fungi are the primary cause of anatomical changes in wood of both standing trees and timber products. The least harmless of the fungi from the point of view of wood material quality are the *mould fungi*, which commonly appear in felled timber. Mould fungi form mycelia on the outer surface of the wood and on cut surfaces. Abundant mould fungi growth can pose an occupational health risk to timber handlers.

*Discolouration / stain causing fungi* are a problem particular to felled timber. They do not usually decompose the wood cell walls, and are therefore non-destructive in terms of weakening the wood structure. Stain tends to lower the quality of saw logs, plywood logs and spruce ground wood.

*Rot fungi* feed on the entire wood material, thus decomposing whole fibres and other wood components and typically rendering the wood unsuitable for its intended application. The presence of rot also complicates the manufacturing process and weakens the properties and quality of the end products. There are two kinds of rot fungus: white rots, which initially target lignin, and brown rots, which initially target cellulose and hemicellulose.

# 3 SIGNIFICANCE OF WOOD QUALITY CHANGES

The significance of changes in wood quality in the different forms of wood processing depends on the degree of processing required. The less the wood material is processed, the lower its tolerance to anatomical change.

### 3.1 SAWING AND VENEERING

In sawing and veneering all defects, including discolouration, affect the processing result. The presence of rot renders the raw material useless.

### 3.2 MECHANICAL DEFIBRATION

In mechanical defibration the wood raw material is almost entirely converted into mechanical pulp, so any defects present in the wood are directly transferred to the pulp. Discolouration and darkening defects reduce pulp brightness, while rot shortens fibre length. Excessive roundwood drying hinders the debarking process, causing bark contamination of the pulp and loss of pulp brightness as a result. Dried timber produces darker pulp than fresh timber and also weakens the tensile strength and tearing resistance of pulp.

### 3.3 CHEMICAL PULP MANUFACTURE

In chemical pulp manufacture the pulp fibres are chemically separated from the other wood material components. The yield of chemical pulp is less than half of the net weight of the raw material used. In chemical pulp cooking, the lignin component of the wood cell tissue is dissolved by the action of the cooking chemicals leaving the cellulose fibres intact. In this case the presence of discolouration-causing fungal mycelia inside the cells does not affect the overall quality of the product. Furthermore, the produced pulp usually undergoes bleaching which removes any additional colouration. Rot, however, decomposes pulp fibres thus weakening the quality of the end product. Advanced rot also reduces yield.

# 4 TYPES OF WOOD ROT

## 4.1 ROT DURING GROWTH

Rot attack of standing trees is a universal problem. The wood-rotting fungi in question vary from region to region. In Southern and Central Finland *root fomes (Heterobasidion annosum)* is the most destructive species of standing tree fungus with respect to spruce. It has been estimated that root fomes is responsible for as much as 80 per cent of all butt rot in spruce. Root fomes rises from the base of the spruce tree, gradually spreading throughout the majority of the stem. Rot in spruce caused by root fomes is first evident as a line of discolouration between the sapwood and heartwood (Figure 1), which gradually penetrates the entire heartwood section, initially producing hard rot and later developing into soft rot (Figure 2). The same fungus is also the cause of Annosus root-rot of pine trees.

**Figure 1.
A violet coloured ring
is the first sign of root
fomes infestation.**

**Figure 2. Hard and soft rot caused by root fomes.**

Another fungus which rots the heartwood of standing trees is honey fungus *(Armillariella borealis)*. The fungus occurs in old, often deteriorated trees. Honey fungus causes so-called boot-lace rot, in which all heartwood material in the middle of the stem base decomposes (Figure 3). Honey fungus seldom spreads above a stem height of one metre.

**Figure 3. Honey fungus subsequently forms a cavity encircled with a dark border.**

Rot fungi infect growing trees via tree injuries caused, for example, during harvesting operations (Figure 4). The most common source of injury-induced rot is the red heart trunk rot fungus *(Sanguinolentum sp.)* Root fomes does not infect trees via stem damage. Injury-induced rot is typically identifiable as being asymmetrically located on the same side of the stem as the tree injury.

**Figure 4. Red heart trunk rot establishment via stem damage.**

Timber infected with growth rot is unsuitable for sawmilling or as raw material for mechanical pulp. From the point of view of chemical pulp, wood rot alters the added value potential of the product: the amount of long-fibre sapwood increases (with healthy sapwood), but total fibre yield falls (with rotten heartwood). The surface layers of large root fomes infected spruce logs can contain areas of long and intact pulp fibres. However, in advanced cases the structure of heartwood pulp fibres is degraded. The darkly ringed cavities of honey fungus infected timber often cause the logs to appear to be in worse condition than they actually are with respect to the small volume of the defect.

Delivery of timber subjected to rot growth defects to processing is not usually considered urgent from the point of view of quality preservation. However, the danger is that the surface layers of the timber are vulnerable to storage rot (Figure 5), which disintegrates the long chemical pulp fibres that are valuable to the chemical pulp industry. It is therefore important that timber containing rot growth defects is delivered to processing before storage rot sets in.

**Figure 5. The edges of a log containing root fomes decay have become infected with storage rot.**

## 4.2 STORAGE ROT

Storage rot refers to any wood rot inflicted by decay fungi subsequent to felling and prior to timber use. In suitable wood moisture and temperature conditions the fungal spores germinate and the fungal mycelia begin to penetrate into the wood. The process is typically multi-phased involving initial host infection by stain fungi which create suitable conditions for subsequent infection by other decay fungi.

Storage infection in softwoods is first evident in the form of patches in the sapwood (Figures 6 and 7). In summer conditions blue-stain and other fungi can be evident in pine as soon as a couple of weeks after felling. Storage rot does not usually infect the heartwood. Softwood timber requires drying to some extent before fungal infection or spread can occur.

**Figure 6.**
**Storage rot in pine.**

**Figure 7.**
**Storage rot in spruce.**

**Figure 8. Storage rot in birch.**

The spread of rot in birch is facilitated by fast-growing, usually bacteria induced, brown stain which becomes established at the log ends. The moisture content of freshly felled birch is suitable for immediate establishment of fungal spores.

Types of storage rot fungi vary between softwoods and hardwoods. One of the most common softwood decay fungi is *Phlebiopsis gigantean*, the same fungus used in stump treatment to repel root fomes. Stump treatment to some degree accelerates and promotes the establishment of rot in butt logs. The practical purpose of stump treatment is therefore more for purposes of long-term storage, mainly of pine pulpwood thinnings.

Wood infected with storage rot is unsuitable as raw material for the sawmill industry. Birch logs containing minimal rot can be used in plywood manufacture, but some raw material from the log ends is lost. Storage rot infected timber is unsuitable for mechanical defibration (ground wood pulp/refined mechanical pulp), due to the resulting material dryness, fragmented fibre structure and brightness deterioration.

Wood infected with storage rot is traditionally used in chemical pulping. However, the infected wood is inferior to healthy wood as chemical pulp raw material because storage rot fragments the sapwood, which contains the best fibres. Advanced rot also causes yield loss. Storage rot is distinctly more harmful than growth rot, because the spread of rot from the surface rapidly degrades a large volume of timber.

# 5 STORAGE REQUIREMENTS

Timber storage requirements are influenced by stock turnover and the ratio between seasonal felling volume and operating volume. The average stock turnover varies according to the wood product:

- saw logs; stock turnover over 20 times per year
- birch veneer logs; 6 – 12 times per year
- pine pulpwood; 4 – 6 times per year
- spruce pulpwood; 12 times per year
- birch pulpwood; 4 – 6 times per year.

Because the majority of stored timber consists of pulpwood, it is important from a material utilisation standpoint to consider the changes that occur in pulpwood during storage. There are usually no long-term storage requirements for saw logs, the demand for which usually determines the timing of harvesting operations. The storage requirement for birch veneer logs varies seasonally and plant-specifically.

# 6 PULPWOOD

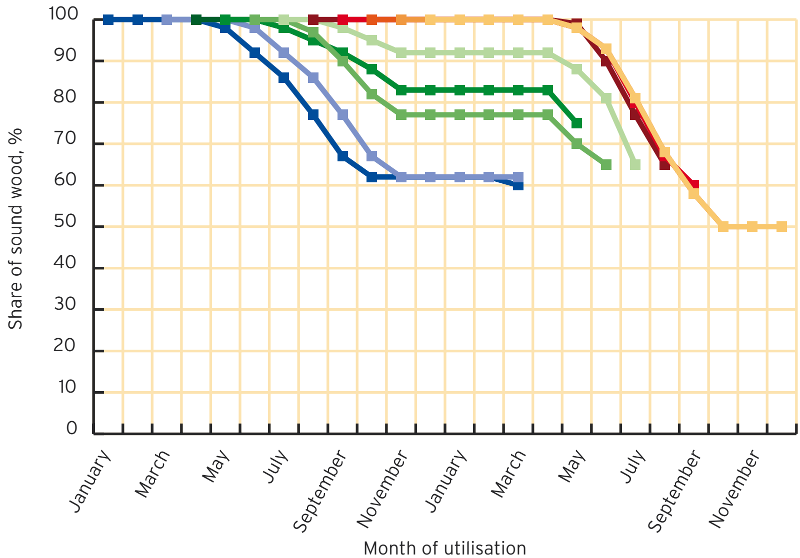
## 6.1 CHANGES IN WOOD QUALITY

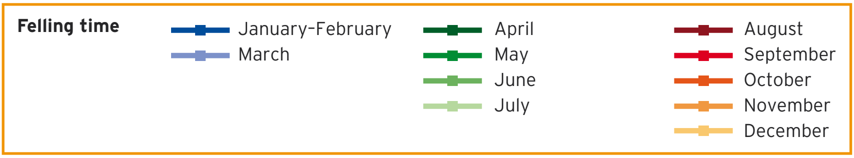
Timber quality preservation can be improved through utilisation and development of special storage methods. Selection of the optimum storage option should involve a cost-effectiveness examination considering the costs involved and timber quality advantages derived from improved wood quality preservation.

Changes in pulpwood stored at road-side landings have been found to be considerable in Southern Finland (Figure 9).

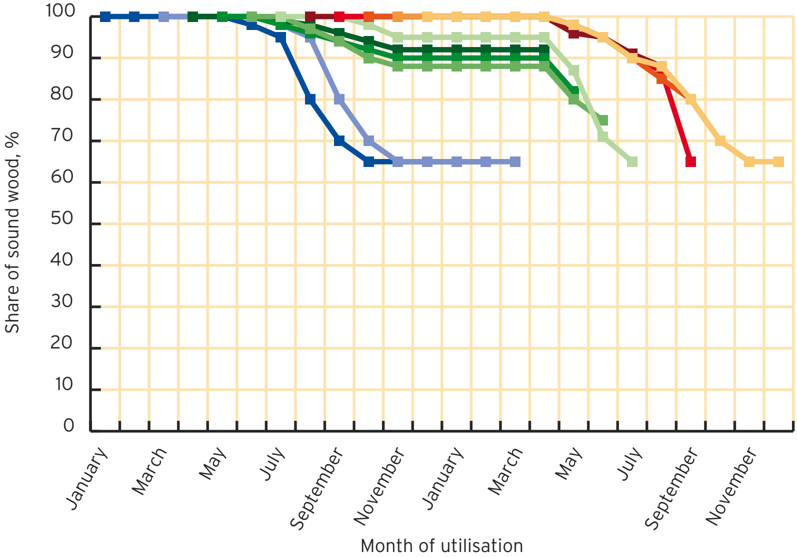
**Figure 9. Share of healthy wood in pulpwood during different usage periods and with different wood species. Healthy wood refers to the section of wood which is unchanged in terms of fibre structure, i.e. can contain stained wood in addition to totally healthy wood.**

**Pine pulpwood (Pinus silvestris)**

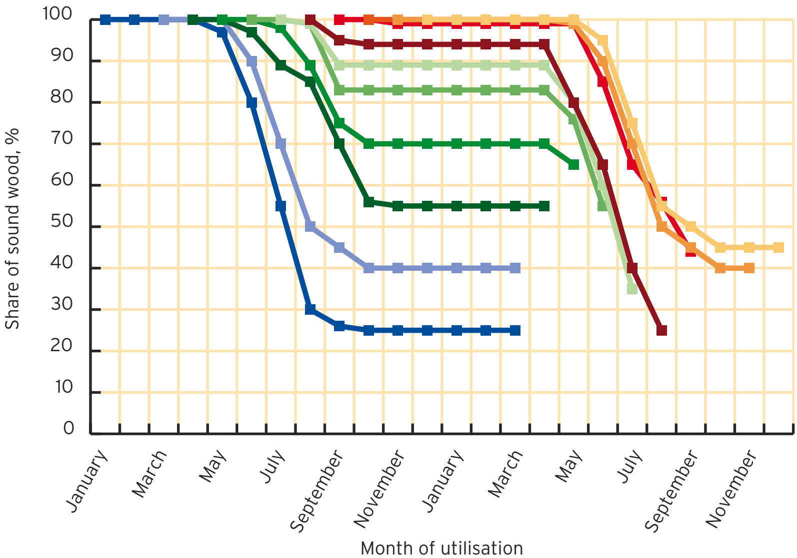





**Spruce pulpwood (Picea abies)**




**Birch pulpwood (Betula sp.; pubescens, pendula)**



The rate and degree of change in wood are greater with birch than with softwoods. Changes in pine occur faster and to a greater degree than in spruce.

The changes that occur in pine and birch are distinctly greater at the log ends. This must be taken into consideration when assessing timber quality based on observation of log ends. The changes in spruce usually occur to the same depth throughout the entire length of the log.

## 6.2 STORAGE ALTERNATIVES

Water storage and log wetting are the most traditional of the storage methods. A newer, already widely established method is cold storage. In recent years a variety of different cold storage techniques have been developed and low-oxygen based wood quality preservation storage methods are currently under review.

### 6.2.1 Floating and water storage

Log floating and related water storage are the oldest and among the most inexpensive quality preservation storage methods. Most log floating is applied in pine and spruce pulpwood transportation.

In order to prevent changes in wood properties the timber is sufficiently dried before log floating to ensure that the bundle remains buoyant for the required period of time. During the drying stage the moisture content of softwoods easily drops low enough to enable fungal spores to begin establishment. For this reason floated logs can often be stain infected. Furthermore, any logs located in the bundle above the water surface are susceptible to continuation of any changes initiated during drying.

The extreme moisture difference between the submerged logs and those on or above the surface can cause problems during debarking and grinding of spruce ground wood. Timber held in water storage begins to darken as the storage water begins to warm in the advent of summer temperatures. In Finland spruce ground wood is mill processed up until the beginning of July at the latest in order to ensure pulp brightness remains good. The loading of logs into water storage from trucks or rail carriages results in additional loading and unloading costs. Storage of timber in water during the warmer seasons incurs the same or even greater quality preservation problems when compared to log floating.

### 6.2.2 Wetting

Wetting is a common storage method for ground wood. The objective is moisture and brightness preservation. However, wetting is not an entirely unproblematic storage method with regard to deteriorating wood quality.

Wetting can be a relatively effective method of maintaining a wood moisture content level sufficient for wood processing purposes. However, insufficient wetting causes a drop in wood moisture content, enabling sap-stain (blue-stain) fungi to become established. On the other hand, excessive wetting increases the risk of tannin discoloration in softwoods. Tannin discoloration is a particular drawback for spruce intended for mechanical pulp manufacture because tannin staining is difficult to remove during bleaching.

The amount of wetting water used also affects the level of timber quality preservation. In addition to quantity, the quality of the water used is important in ensuring successful wetting. Low water temperature is effective in preventing tannin discoloration. Water impurities have a direct influence on quality preservation; unclean wetting water is believed to result in deterioration of timber quality. Wetting water recycling increases bacterial levels in water and subjects wood to bacterial attack.

Wood held in large wetting storage sites should be circulated regularly. Timber felled in winter retains its quality in wetted storage sites better than timber felled in spring during the sap flow period. Therefore timber felled in spring and early summer must be delivered directly to processing while timber felled in winter can be held in wet storage. The replacement of winter felled timber with fresh timber for wet storage should be performed from midsummer onwards.

### 6.2.3 Cold storage

Cold storage is generally used for quality preservation of spruce ground wood felled during early winter. Cold storage enables preservation of moisture content and high brightness required of ground wood.

The location and size of the cold store directly affects the storage success and the costs incurred. In principle, the bigger the cold store the lower the costs of storage per wood cubic metre stored. On the other hand, unloading a sizable store is highly time-demanding and requires precise planning during unloading in order to prevent wood changes from taking place.

The location of the storage site affects storage efficiency and influences any possible additional materials transfer costs. The ideal location is on-site at the mill, as close to the usage site as possible in an asphalt covered, shady, wind protected position. Location at a harbour or in the immediate vicinity of a railway station yard is also advantageous. A local water supply of 60 – 90 $m^3$ per hour of is needed during cannoning of artificial snow over the storage stack.

In cold storage wood is stacked in a large, heaped storage pile. The wood pile is usually covered with a separate layer of the same wood which covers up any spaces between the stacks. The wood stack is then covered over either with artificial snow or with snow collected from the vicinity. Generally a sawdust layer is applied on top of the snow layer, although bark can also be used for this purpose. Gauze or used PM wire can be laid between the snow and sawdust layers. The chief purpose of this is to prevent sawdust from falling between the piles as snow melts, thus creating holes in the wood pile. The use of gauze or PM wire also helps maintain the moisture content of the stored timber.

Cold storage is the most reliable method available for preserving timber quality. However, the limited operating life of the method somewhat restricts its use. In practice, only timber felled between December and the beginning of March can be cold-stored. Prior to December the supply of timber is usually insufficient for wood storage and, at least in Southern Finland, it cannot be guaranteed that timber felled in March can be delivered in time before the winter season ends in terms of snow cover.

### 6.2.4 Low-oxygen conditions

After the cold storage period spruce pulpwood (also birch veneer logs) that is felled in March/April exceeds use requirements. Although wet storage can to some extent be applied to this timber, an alternative storage system capable of preserving wood material quality is also needed.

Changes in wood material quality are caused by fungi and bacteria, in a similar way as occurs with foodstuffs. Inert gases are commonly used to aid food preservation. The same technique may also prove effective in the prevention of quality changes in wood.

Within the food industry carbon dioxide, nitrogen or combinations of both gases serve as inert gases for food preservation. The basic principle is the displacement of oxygen by means of inert gases. Storage trials using inert gas for wood quality preservation have not succeeded to date. However, tests indicate that inert gas application in low temperature conditions may prove successful in aiding wood quality preservation.

## 6.3 SUMMARY OF PULPWOOD STORAGE

One form of storage is highly efficient at preserving wood quality of **spruce ground wood** (including refiner pulpwood) felled in early winter – cold storage. Wetting can to a certain extent be successfully applied to ground wood felled in late winter and spring, but ideally an alternative storage method should also be found. Preservation of **softwood chemical pulpwood** via wetting, water storage or even cold storage would be economically advantageous. However, the large storage quantities required do not facilitate widespread use of these methods in practice. **Birch pulpwood** storage is the most problematic of all chemical pulpwoods. Without quality preservation storage, birch easily becomes infected with rot which significantly affects the pulp cooking result. Although cold storage preserves timber quality most effectively, the most practical method is wetting.

# 7 SOFTWOOD SAW LOGS

## 7.1 CHANGES IN WOOD QUALITY

Domestic timber harvesting is primarily scheduled in line with demand for saw logs and, as a result, saw log storage problems do not tend to occur at the same scale as experienced with pulpwood used in chemical pulp cooking. On the other hand, when saw logs are stored in spring or summer the changes they are subjected to occur rapidly and cause large economic losses. The most typical quality changes in saw logs storage occur with unprotected logs that are left in storage over the summer holiday period. Increased importation of saw logs in recent years has increased storage requirements.

The most common cause of loss of saw log quality is damage caused by bark beetles and other insects as well as damage sustained during harvesting operations and transportation.

### 7.1.1 Damage caused by insects

The swarming season for insects takes place in late winter or spring. Unbarked wood is vulnerable to attack by, among others, various bark beetles, longhorn beetles, weevils and pine shoot beetles *(Blastophagus piniperda)*. The most common insects occurring on pine include common pine shoot beetles, lesser pine shoot beetles *(Blastophagus minor)*, bark beetles *(Pityogenes quadridens)*, engraver beetles *(Ips acuminatus)*, six-toothed bark beetles *(Ips sexdentatus)* and timberman beetles *(Acanthocinus aedilis)*. In spruce the most common causes of insect damage are six-toothed spruce bark beetles *(Pityogenes chalcographus)*, 8-toothed spruce bark beetles *(Ips typographus)* and spruce longhorn beetles *(Tetropium spec)*. Furthermore, striped ambrosia beetles *(Trypodendron lineatum)* can colonise both pine and spruce timber.

Insects lay their eggs under the bark of felled softwood logs. The larvae gradually develop beneath the bark, tunnelling between the wood and the bark and on occasion also into the wood material itself. Insects carry sap-stain (blue-stain) fungal spores with them under the bark and larvae later further spread the spores into the wood. Saw logs commonly exhibit blue stain infection in early summer as a result of this process. The essential factor concerning such early summer blue-stain infection is that it is located beneath the intact bark as opposed to debarked sections or sections damaged by harvester feed rolls.

The risk of insect damage can be reduced by transporting felled timber from the road-side landing as soon as possible during spring. If this is not possible, damage can also be reduced by storing the logs in large, high piles. Insects will only colonise the outermost layer of logs, which in the case of a sizeable log pile is a relatively small proportion of the total quantity of stored timber. Use of pesticides for field storage site protection is forbidden for environmental protection purposes.

### 7.1.2 Long-term storage during summer

During summer storage of softwood saw logs blue-stain and seasoning cracks tend to appear at the log ends. During midsummer and late summer blue-stain infection of softwood logs mainly originates from air propagated sources, the spores of which penetrate sections of the log where the bark is damaged or missing. Initial establishment of hard rot is also possible during this stage.

## 7.2 STORAGE ALTERNATIVES

Protection methods available for the prevention of quality changes of saw logs include wetting, short-term water storage and, in exceptional cases, cold storage.

### 7.2.1 Wetting

Wetting is the most typical protection method for saw logs. It is usually carried out at the sawmill log store. Wetting maintains the moisture of the wood and can even increase it. This prevents the establishment of blue-stain fungi and stops the propagation of drying splits. Long-term heavy wetting can cause permeability defects caused by bacterial action, which are visible on sawn timber as darker patches of wood. Discolouration caused by bark tannin can also spread into the surface layer of the logs. This has no essential significance for saw logs, as the stained sections tend to be located in wood sections destined for chipping.

### 7.2.2 Water storage

Softwood logs cannot be kept for long periods in water storage. A safe storage period for pine logs is no more than 4 weeks and 6 weeks for spruce logs, where the water temperature is above 15 °C. Logs stored for longer periods in warmer water conditions during summer are prone to permeability defects. Furthermore, resulting bark loss during later handling processes can cause problems for conveyors due to clogging and covering up of photocells with loose bark fragments. In water storage of logs it must be ensured that logs or parts of logs that are above the surface do not dry out and thus become exposed to blue-stain fungal infection.

### 7.2.3 Cold storage

Cold storage of softwood saw logs is quite an effective means of timber quality preservation. However, the method is only applicable to winter felling lots that are planned for use in late summer or autumn. The milling process of softwood saw logs stored in cold storage differs from those of ground wood. Because saw logs are graded and sawed according to size class, a proportion of the logs unloaded from the cold store end up being stored for lengthy periods in unprotected conditions prior to sawing. These exposed logs are vulnerable at least to mould infection, although colour defects are also likely.

## 7.3 SUMMARY OF SOFTWOOD SAW LOG STORAGE

Softwood saw log storage is usually unproblematic. Long-term cold storage is a viable storage option for winter-felled timber. Wetting is an effective short-term storage option during summer months. Storage of cut-to-length timber during the insect swarming season requires particular care.

# 8 BIRCH LOGS

## 8.1 CHANGES IN WOOD QUALITY

The storage requirement for birch logs is markedly greater than for softwood logs. Birch logs are generally accumulated in connection with harvesting of other wood species. Consequently, harvesting and use rarely coincide. Of all Finnish commercial wood species, birch is the most sensitive to quality changes. Quality changes in birch occur via the log ends. It is extremely rare for stain or rot to become established via the log surface. Birch log discolouration (Figure 10) occurs extremely rapidly at the log ends. The exact cause of the discolouration is not fully understood, although the most likely explanation is the oxidisation of resins and/or bacterial action. The discolouration defect renders the wood highly vulnerable to rapid successive rot infestation. Rot becomes established considerably faster in birch than in softwoods.

**Figure 10. Discolouration in veneers.**

Another defect which occurs during birch log storage is seasoning splits. During rotary cutting any splits at the ends of the peeler bolt complicates fastening of the bolt to the lathe spindles and results in splitting along the edges of the peeled veneer. The most damaging seasoning splits are those which occur on the log surface (Figure 11). They cause splits which run the full veneer width, rendering the entire veneer unusable for plywood manufacture.

**Figure 11. Veneer splits.**

Quality monitoring of the birch logs is not easy. Log ends usually appear unchanged or reveal only minor defects. The actual defects only become evident when a log disc is sawn from the log ends.

The cost-effective significance of the quality loss in birch logs is emphasised, because there is a continuous lack of good quality birch logs. Changes in wood quality that take place during the summer months reduce the quantity of good quality timber available. Plywood mills can experience seasons during which manufacture of certain high quality products is not possible because peeled birch veneer can't be stored.

The abundant importation of timber presents an additional challenge concerning quality preservation of birch logs. Imported birch veneer logs are felled in winter and delivered to mills during winter and spring. The majority of this timber is scheduled for use in summer and autumn.

## 8.2 STORAGE ALTERNATIVES

Quality preservation of birch logs has been under development for some time, but for the present the only moderately reliable method available is cold storage. Wetting and water storage are also in common use. However, there is currently no known method of ensuring the quality preservation of winter or spring harvested birch logs through cold storage.

### 8.2.1 Cold storage

The principle problem of cold storage is the short storage preparation period. Only logs felled before the beginning of March are sure to reach cold storage in time. Cold-stored birch logs virtually retain their quality. However, a small degree of discolouration may occur on the log ends.

Cold storage of birch logs is made more problematic by a high degree of log length variation and log camber. Birch log stacks cannot be made as tight as softwood stacks. As a result, snow often falls into the cavities between the logs towards end of the storage period.

### 8.2.2 Wetting

Birch log wetting has long been employed as a timber quality preservation method. In practice, however, the level of quality preservation of birch log wetting varies considerably: in some cases wetting can achieve almost total discolouration prevention, whereas in the worst cases discolouration becomes rife and rot can even penetrate deep into the ends of logs.

In wetting, the quality and quantity of water is important. The purpose of wetting is to counterbalance the evaporation of moisture from the stored wood. The water also, at least partially, rinses away fungal spores which settle on the logs. However, bacteria can be introduced to the log pile via the wetting water. Water quality therefore has a significant effect on the wetting result. The aim is to use cool, or cold, clean water only. If the water used has a high nutrient content it can create a rich substratum on the log surface which will play host to a wide range of bacteria and fungi. The method of implementation of wetting is therefore important from the point of view of the final result.

### 8.2.3 Water storage

Water storage is one of the oldest forms of birch log preservation. The method retains and even increases the moisture content of the stored timber and discolouration can be reduced. In some cases moisture preservation succeeds so well that during long-term storage some of the stored timber sinks. For this reason birch logs are stored in water in bundles, sometimes along with other wood species as "corks" for added buoyancy. This reduces sinking and facilitates the location and retrieval of sunken logs.

The logs located on the surface of the birch log bundle in water storage should be wetted to prevent drying. However, relatively few logs tend to remain exposed on the surface of birch bundles.

The temperature and cleanness of the water used affects the preservation of timber quality in water storage. The warmer the water, the more rapidly and readily changes occur. Water storage sites often remain in the same use for decades. As a result, years of storage at the site will have lead to the formation of bacterial strains in the water which further accelerate colour changes.

## 8.3 SUMMARY OF BIRCH LOG STORAGE

Cold storage preserves birch log quality. Wetting reduces quality changes only if carried out correctly. Water storage prevents drying and rotting problems and with short-term storage can reduce colour defects. Since wood changes in birch initially occur via the log ends, the degree of quality change can be reduced by cutting logs as long as possible.

# 9 STUMP TREATMENT

When considering the possible changes which take place in timber during the summer period it is also worth taking into account the effects of the stump treatment agent used. The stump treatment agent is sprayed directly onto the stump at the felling stage, but some of the agent comes into contact with the exposed end of the butt log. The stump treatment agent generally used is Rotstop, which contains the fungal spores of the Phlebiopsis gigantean fungus. Phlebiopsis gigantean is among the most common causes of storage rot in softwoods.

The rot fungus spores are sprayed liberally onto the freshly cut stump of the felled tree in connection with felling. If the conditions are favourable the spores can germinate at an exceptional rate. Usually the pace of summer harvesting leaves no time for problems to materialise before sawmilling, the spores being killed off during kiln drying of the sawn timber. If, however, stump-treated softwood logs are left for a long period of time before sawing or the sawn timber is not kiln dried, the softwood logs may undergo far greater quality changes than usual (Figure 12). Stump treatment agent induced problems can also occur in long-term storage of pine thinnings (i.e. the majority of butt logs).

**Figure 12. Stump treatment agent induced colour defects.**