# 9. CONTROLLING INTERNAL ROT

Internal rot is more difficult to deal with than surface rot. It can be treated at the same time as the surface preservative, or it can be done at any other convenient time - neither weather nor wood moisture content matter. The main way of controlling suspected internal rot is by inserting diffusible preservative into holes, drilled for the purpose, in the timber.

Internal rot will not be present everywhere in the structure - or, if it is, then the structure is probably not worth trying to preserve. Considerable effort needs to be put into the search for internal rot, using the methods described in section 6. Internal rot is most likely to be found towards the ends of timbers.

## 9.1 INSERTION OF DIFFUSIBLE PRESERVATIVES

If internal rot is known to exist in parts of the structure, or if it is suspected to occur then holes should be drilled into those places for the insertion of preservatives which have the ability to diffuse throughout the rotted volume and prevent the rot from spreading.

Holes should be drilled with a 15 mm diameter bit. If drilled from vertical surfaces, they should be inclined slightly below horizontal, and they should not pass more than three quarters of the way through any component.

The most likely situation for internal rot is near the ends of horizontal and inclined components, especially where end grain is not accessible. Holes in such places should be about 10 cm back from the end grain, and spaced about 15 cm apart. Obvious cracks and voids which would cause leakage from holes should be avoided. The presence and extent of internal decay should be determined as much as possible during the detailed inspection and this should be used as a basis for determining where holes need to be bored and how much preservative to apply. Apart from that, choosing where to drill holes, how deep to drill them, and how closely to space them, involves lots of guesswork.

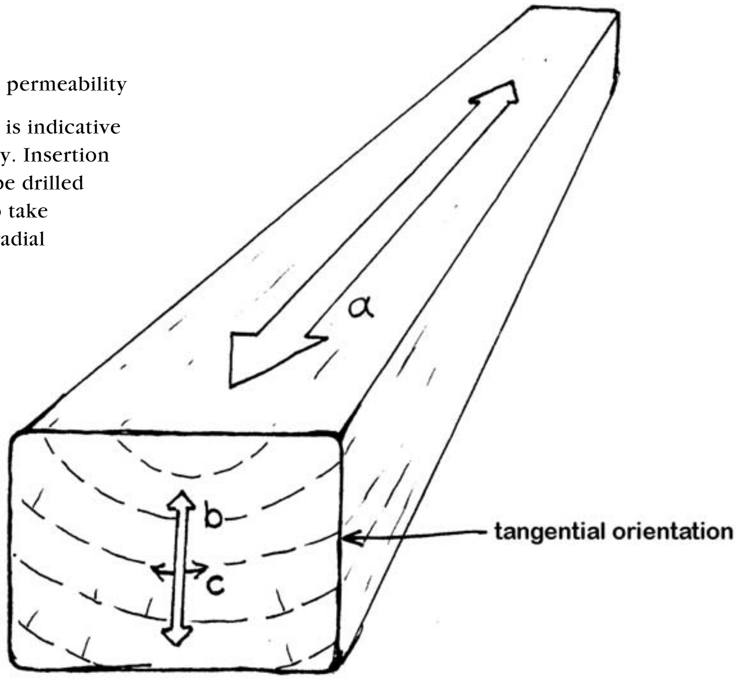
In many places it may not be necessary to drill holes specially for diffusible insertion. Timbers on bridges etc. formerly maintained by the MOW or the NZR were regularly subjected to inspection by drilling. (See fig. 6.) Holes 3/8 inch in diameter were drilled, generally at the ends of components, but also midway along any components more than 3 m long. These holes tend to cluster around any apparent defects in the timber. The holes were supposed to be plugged afterwards, but many of the plugs have since fallen out, and the holes have since served as entry places for rot. Some timbers now have entire constellations of holes already drilled, right where they are needed for internal rot control. As many of these holes as are needed should be drilled out to 15 mm diameter.

When drilling holes for insertion of diffusible preservatives give thought to the way the grain runs in the timber. Timber is most permeable along the grain, as is well known, so in any hole drilled most of the preservative will diffuse longitudinally. Looking at a transverse section, permeability is much greater radially (from centre to periphery or vice-versa) than tangentially (around the growth-rings). See fig. 15. This has important implications for the positioning of holes. Holes should normally be drilled as tangentially as possible, to maximise the opportunity for radial diffusion. What this means in practice will become clear if considered in conjunction with the way bridge timbers were cut.

Durable eucalypt logs have a narrow core of pith right through the middle, which is particularly prone to what is known as pipe rot. The durability of the heartwood increases radially outwards from the pipe, so that logs tend quite literally to 'rot from the inside out'. The old-time bridge builders knew about pipe rot, and durable eucalypt, for New Zealand bridges etc., was usually specified as 'free of heart' [i.e., pith] for timbers of cross section less than 8 x 8 inches, and as 'boxed heart' for larger cross sections. See fig. 16.

Fig. 15: Radial permeability

Size of arrows is indicative of permeability. Insertion holes should be drilled tangentially to take advantage of radial permeability.




The idea of this was to avoid having any pipe rot in smaller timbers, and to make sure that in larger timbers any pipe rot was in the middle, where it had least effect on strength. Appropriate and inappropriate locations for diffusible insertion holes in such timbers are shown in fig. 17.

The next thing to consider is the way moisture is likely to be moving within the timber. Water is most likely to be entering from the end grain, bolt holes etc., moving along the grain and passing back out to the atmosphere along all surfaces but especially tangential (i.e., quarter-sawn) surfaces and sun-warmed surfaces. The movement of boron will tend to be similar. If boron rods are inserted near where water enters, there will be a slow movement of dissolved boron away from the entry point, and a gradual accumulation of boron where the moisture is evaporating. Holes therefore need to be drilled close to end grain, on either side of bolts or dog spikes (e.g., in a rail sleeper), and at the shady, damp ends of beams.

The speed at which boron diffuses is dependent on many factors, but moisture content is crucial. The higher the moisture content the faster the diffusion. There will be very little diffusion at less than 30% moisture content. Boron diffusion will be from highest concentration to lower concentration and will probably be greatest where the moisture content is highest. Therefore in a beam where water is being absorbed at an end and through bolt holes in the upper surface water evaporation may be from the upper and sunny sides whereas the boron may diffuse out to the damp lower and shaded sides. It is probably appropriate to space holes 150 cm apart across the grain, and 60 cm apart along the grain (where necessary). Each 10 cm long rod in theory will preserve about 5 litres of wood, but this is rather meaningless since diffusion is a dynamic process, and rods which diffuse rapidly will be replaced. (Not sure that boron diffusion rates are affected by moisture content over a certain level, check with Kourosh.)

It is quite likely that many of the holes drilled will intersect pipe rot or other cavities. Each hole can be tested by blowing into it, and only those that are airtight should be filled.

Fig. 16: Pipe rot in 'boxed heart' beam. Bridge on Waihi goldfields railway.

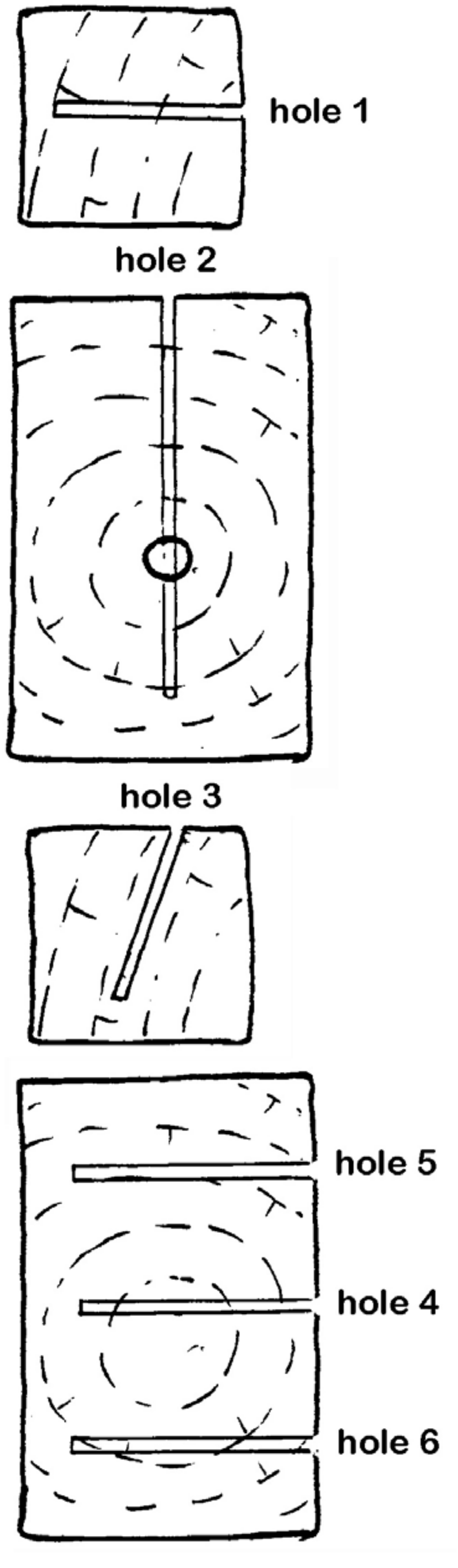



Fig. 17: Drilling holes in timber

Timbers in 'holes' 1 and 3 are less than 8x8 inches and have been cut 'free of heart'.

Beams in 'holes' 2, 4, 5, 6 are larger than 8x8 inches and have been cut with 'boxed heart'.

Holes 1 and 2 are radial and would give minimal diffusion.

Additionally hole 2 intersects pipe rot, and so would leak.

Holes 3, 5, 6 will give best possible diffusion.

Hole 4 will give little diffusion and risks leaks.

Boron comes in the form of fused glass-like rods 12 mm in diameter and 100 mm long. The rods are easily snapped so that each hole can be filled with as many rods or bits of rod as it will hold. Paste is best inserted with some sort of caulking gun or grease gun, fitted with a thin tube which will reach to the bottom of the insertion holes. The threaded plastic plugs are driven in with a hammer (the thread is for removal purposes only).

Each hole should ideally contain both a boron rod and boron paste. Boron paste contains a 'quat' fungicide/surfactant which gives an instant hit, plus glycol which helps the boron to diffuse at lower moisture contents. The rods are a more concentrated source of boron but will diffuse more slowly, and thus maintain the fungitoxic situation initially created by the paste. The general rule is to drill a 15 cm hole, one-quarter fill it with paste, push a boron rod right down into it, and top up any leftover space with more paste. Then hammer in a plug. Any non-airtight holes that seem to have intercepted a sizable void can be filled with foamed preservative [see section 16].

Any holes which are not needed should be filled with preservative anyway, then permanently plugged with over-diameter (16-18 mm) preservative-treated dowelling at least 5 cm long. Most inspection holes will have been drilled radially, so they are not particularly useful for diffusible insertion purposes.

Because diffusible preservatives are on the move all the time within the wood and probably being lost from the wood there is a need to occasionally monitor the status of the insertion holes. The rate at which preservative disappears from the holes gives important clues about what is happening inside the timber. At least some holes should be checked carefully at the first annual inspection [see section 14.1]. The threaded plastic plugs are opened with a screw driver. Holes less than half full should be topped up and closed with a red plug. Holes more than half full should be topped up and closed with a brown plug. During subsequent annual inspections red-plugged holes should be topped up every year, and brown-plugged holes topped up every second year, at least until rates of preservative diffusion are better understood. At some stage further holes may be drilled to allow boron concentrations to be assayed. Depending on the results it may be decided to shorten or lengthen the intervals between top-ups.

## 9.2 TREATING INTERNAL CAVITIES WITH FOAM

Cavities within timber components cause special problems in achieving control of internal rot. Diffusing preservatives are likely to drain into such cavities and be lost. There is no way the internal surfaces can be sprayed with CNL, and it would be prohibitively expensive to try and fill them with CNE.

### 9.2.1 Preservative foams

There is a technique well developed overseas which should be quite feasible in New Zealand. That technique is to inject a foamed boron preservative into the cavity. The foam, with a consistency similar to whipped cream, expands in the cavity and comes into contact with the entire internal surface. Then, over a period of hours the foam collapses against the sides of the cavity, transferring the boron to the adjacent wood.

Fig. 18: Injecting Polegel with a caulking gun.

The holes earlier found not to be airtight have presumably intersected cavities which have developed from pipe rot or other internal rot. Some inspection holes will also have intersected cavities. Further holes may be drilled specifically to gain access to cavities. Other cavities will already have usable openings. All these openings can be used to fill the cavities. When foam starts oozing out of cracks or openings these can be temporarily dammed with clay, building paper or whatever. Knowing how much foam to put in will be largely a matter of guesswork. Holes treated with foam rather than rods/paste can be identified by being closed with a green plug.

### 9.2.2 Foam fillers

It may be desirable in many instances to fill the cavities permanently. This is best done with rigid closed-cell moisture -cured foam. Such foam is long-lasting, unaffected by solvents etc., impermeable to water, and not attacked by insects or colonised by plant growth.

It can restore considerable strength to hollowed-out components. (This is the sandwich - construction principle, in which thin high-tensile strength surfaces are separated by lightweight filler to create very light but very strong objects. Surf boards are a good example.) The polyurethane foam will bond quite strongly to the wooden surfaces, and prevent boron being washed off the surfaces, and it will act as a barrier to loss of any boron diffusing through adjacent wood.

Polyurethane foam is best procured in oversized aerosol cans, for which the price works out at about one dollar per litre of foam. Each 750ml can will give about 20 litres of foam. Because the foam is cured (i.e., hardened) by moisture it is important that all surfaces of the cavity be moist. If necessary they should be sprayed with water beforehand. The foam is then squirted into the furthest recesses of the cavity first, then filled gradually back to the opening. Curing will be hastened by not pouring more than a 10 cm thickness of foam at a time. After the previous layer has become touch-dry it should be lightly sprayed with water before the next layer is poured. Foam surfaces which will remain exposed can be given a smooth hard finish by spraying with water to induce rapid curing before expansion is completed. Polyurethane is reasonably resistant to UV, but exposed surfaces will still benefit from a coat of paint.

Polyurethane foam is wonderful stuff but it is literally a genie which cannot be put back into its can. Once it is out of the can it keeps expanding and expanding, and it will stick to anything, often with unexpected and comical consequences. It is worth experimenting with it on something unimportant and obscure before tackling anything important and high-profile.