THE RESISTOGRAPH
AND THE NON-DESTRUCTIVE ASSESSMENT OF TIMBER DECAY

Figure 1 *Timbers showing characteristic cracking and fungal growths associated with fungal decay (Environmental Building Solutions Ltd)*

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TIMBER IN HISTORIC BUILDINGS, churches and other structures is inherently susceptible to fungal and insect infestation and decay if it is not kept dry and well ventilated. Once the infestation has started it will continue to propagate so long as the conditions are favourable. Eventually the timber member will no longer be able to sustain loads, causing it to collapse and resulting not only in the loss of its own historic fabric but also the fabric of other elements which it supports. If left unchecked, decay can ultimately prevent the use of all or part of a building and can even lead to personal injury.

If, on the other hand, the decay is caught in time, simple measures can usually be taken to arrest decay and prevent its further advancement. Unfortunately few of the timbers in historic buildings are likely to be exposed to view, and in a conventional timber decay survey, the load bearing ends of the structural timbers are seldom available for direct observation and assessment. The majority of the ends of the joists, rafters, wall plates, rafter plates and beams remain hidden in concealed cavities and voids or below ground, or they are covered with various finishes and decorations. Behind these surfaces the organisms which cause the decay can thrive unseen.

A number of *in situ* methods for timber decay assessment are available, but most of these involve some destruction of the fabric to see what is happening behind the surface. These destructive techniques have had varying degrees of success in detecting decay and predicting the residual strength of timber members, and destructive sampling is neither sympathetic nor acceptable to the conservation of historic buildings.

Furthermore, remedial chemical treatments for woodworm, death watch beetles, dry rot and wet rots are very expensive and often cause more damage to the health of building fabric and people than the infestation itself.

THE CONSERVATION APPROACH

The key to the preservation of historic buildings lies in regular inspections using a range of non-destructive investigation techniques. These techniques enable the condition of timbers to be ascertained without opening much of the building fabric; they are therefore especially valuable in buildings of historic and architectural interest. A specific maintenance programme can be drawn up, usually using environmental control techniques with little or no chemical treatments, and ensuring that the loss of historic fabric is kept to a minimum.

Assessment of the activity of decay organisms involves the following:

- detection of decay organisms
- identification of decay organisms
- assessment of the viability of decay organisms
- quantification of the state of decay
- environmental conditions assessment
- structural assessment of decay.

Where decay organisms are present and actively causing timber decay without any external manifestation their detection presents a considerable challenge, and there are currently no completely satisfactory methods available. A number of non-destructive techniques employing high-technology equipment have been found to be useful for

Figure 2 *Use of the resistograph drill to inspect timber members (Environmental Building Solutions Ltd)*

advanced stages of decay, but earlier stages are often difficult to detect.

The most obvious signs of decay are the presence of fungal fruiting bodies and other fungal growths together with the distinctive cracking of the timbers *(Figure 1)*. However, these indicators often appear in the latter stages of decay, by which time the majority of the damage has already been done.

RESISTOGRAPH METHODOLOGY

A relatively recent development involves the use of a resistograph drill which drives a 3mm diameter drill bit up to 440mm into the timber member *(Figure 2)*. As the bit penetrates the wood the rotational resistance is shown on an LED display and recorded on a print-out chart *(Figure 3)*. This gives an immediate profile and permanent record of the internal condition of the timber.

Regions of sound wood are shown as high resistance to forward motion of the bit. As the bit enters a decayed region, the resistance to forward motion is reduced and a low signal level is recorded.

SITE INVESTIGATION

The resistograph drill does require a little time to penetrate into and back out of the timber member. Care must be taken to ensure the resistograph is kept steady while drilling, otherwise damage to the bit will occur. Care must also be taken to avoid any metallic obstructions that may be in the path of the drill bit.

Large numbers of timber members can be inspected in relatively short periods of time using the resistograph. This is useful since the longevity and cost-effective maintenance of historic timber structures relies on early detection of decay and preservation of the members.

TIMBER ANALYSIS USING THE RESISTOGRAPH

Analysis of timbers using the resistograph can provide the most up to date and accurate assessment of decay. If only 10 per cent of the timber is decayed, it is pointless destroying the other 90 per cent of the timber to make certain the rot is eradicated. The resistograph inspection ensures that repairs are confined only to the decayed areas of timber and allows significantly more accurate costing and repair schedules to be produced.

DENDROCHRONOLOGY

It is also possible to ascertain the dendrochronology of timber members with the use of the resistograph.

Dendrochronology, or 'tree ring dating' as it is also known, identifies the year in which timber was felled by comparing the varying thickness of the rings visible in the end of a sawn timber. In a good year with favourable growing conditions a tree grows more than in other years, resulting in a thicker tree ring. Over the years a pattern develops of thicker and thinner rings which correlates with those of other trees of the same species, particularly in the same locality. Data is now available, giving likely tree ring variations for most areas of the country for dating purposes.

The usual method of inspecting tree rings is to take either a complete slice through the trunk or a core sample drilled through the timber leaving a hole of up to 15mm. The rings are then measured under a microscope. The resistograph, on the other hand, works by detecting the width of annual rings by their relative resistance, since the ring itself is comprised of soft and hard sections corresponding to early and late wood respectively. This method is also well suited for one-sided or multi-layered members, and leaves a much smaller hole (3mm).

ADVANTAGES

Many historic structures can no longer be considered truly contemporary of their time because a lot of their timber has been replaced with the modern equivalent.

Accurate information on the condition of the timbers should be obtained before carrying out expensive and disruptive repairs. The use of resistograph techniques at an early stage ensures that repairs are only carried out when and where necessary. An hour's inspection using the resistograph can provide an instant, precise, non-destructive analysis on site, which can save many thousands of pounds of unnecessary remedial timber treatments and exposure works.

The resistograph has been used in a wide range of projects, even on trees.

Examples of historic buildings and other structures that have been preserved using resistograph technology include the Grade I listed Victoria Law Courts, Birmingham; Somerset House, London, Railtrack's 19th century Grade A listed Moy Timber Bridge in Scotland and the 1960s innovative laminated timber platform canopies at Oxford Road Station, Manchester.

This method arguably provides the most cost effective, long-term, holistic and environmentally sustainable conservation solution for the restoration of timber structures including bridges, jetties, transmission poles, historic buildings and monuments. ■

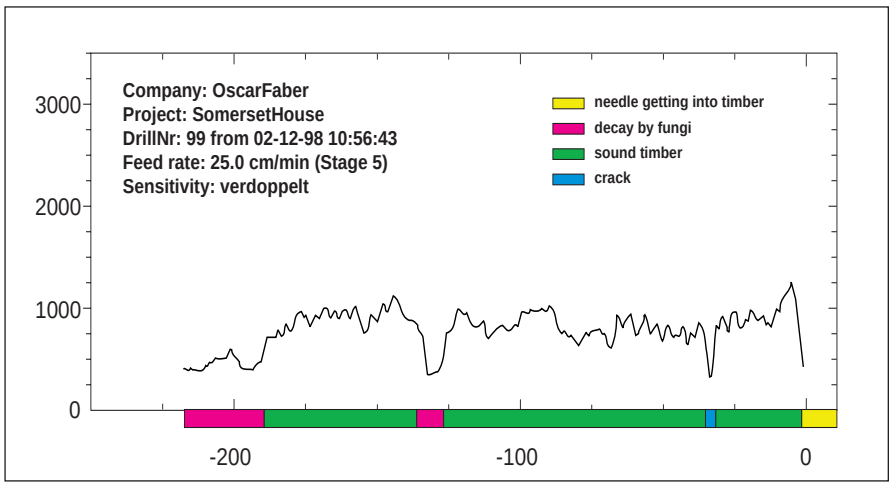

Figure 3 *Sample of print-out chart from resistograph showing regions of sound timber and decay by fungi and beetle larvae (Environmental Building Solutions Ltd)*

FURTHER READING

Singh J, *Non-destructive investigation*. Building Research Information, 1991.

Singh J, *Building Mycology, Management of Health and Decay in Buildings*, London, Spon, 1994.

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