Fine Print: The information below is not a research paper and no references are provided'; it is a compendium of material gathered during my years of practice. The information provided is generally correct, and the reader is invited to research the contents for verification. Any comments or criticisms are invited.

Other than the species group, moisture level has one of the most significant impacts on the strength of the wood products. Brown rot is one of the most damaging effects on structural lumber globally. One source indicates that as much as 20 billion board feet of timber is destroyed by wood rot in the United States each year. This is far greater than the amount damaged annually by fire.

Growth of wood destroying fungi is dependent on several principle factors:
- a suitable Moisture Content;
- suitable Temperature Conditions;
- a Supply of Oxygen;
- recent studies indicate that it requires an inorganic and an organic environment; the fungus requires both ionic forms of calcium and iron. These can be extracted from the surrounding substrate and helps with the breakdown of wood.

Moisture content is the weight of water contained in a wood sample, expressed as the percentage of the moisture to a sample of oven dry wood. Depending on the humidity, wood releases or takes on moisture from the air until the moisture content of the wood has reached an equilibrium. This is dependent on the Relative Humidity of the surrounding air.

Relative Humidity can fluctuate rapidly within a building space; the wood moisture level change is much slower. Without the influence of outside moisture, it is generally constant for each season.

Moisture levels, within an enclosed building are generally in the order of 11% to12%. Moisture levels in excess of 12% reduce the load carrying capacity of timber elements. In some instances, this can be considerable. Charts contained in the data file SP1 from the Canadian Wood Council indicate that at 17% the modulus of rupture drops to 82%, and the modulus of elasticity drops to 88% of tabulated values. Building Codes recognizes this provide for a reduction in stresses depending on the service conditions when equilibrium moisture content exceeds 15%.

As the moisture content increases to a value in excess of approximately 20% there is a greater threat of environmental deterioration of the wood fibre from fungal attack.

Decay of wood material is caused by low forms of plant life known as fungi. Depending on the fungi, different parts of the wood product are affected. Most common fungal attack affects the cellulose and hemi-cellulose material. The darker lignin is not affected and fungal attack leaves the wood with a characteristic darker colour. This type of fungus is typically called a brown rot fungus. It is more commonly known as dry-rot. The term dry-rot is a bit of a misnomer since all fungal attack requires moisture. Other fungi that affect wood products are white rot, which affects the lignin and leaves the lighter coloured cellulose and hemi-cellulose products. Some other fungi create wood stains and some produce a slimy surface. Brown rot producing fungi are the most prevalent. Brown rot deterioration is generally spread by spores released by the fungi.

It is generally accepted that brown rot fungus requires moisture levels in excess 22% at temperatures around 18°C. Some sites indicate moisture levels as high as 28%. Most decay spreads at temperatures that favour growth of plant life, but is usually slow in temperatures under 10°C and above 33°C and ceases when temperatures either drop below 2°C or rise above 38°C. The deterioration due to brown rot is progressive. At temperatures below 2°C and above 33°C the fungi becomes 'dormant' only to continue the deterioration when temperatures become more favourable. Less than one month of exposure to wetness will produce the conditions for deterioration to continue. Some common species of brown rot proceed at a rate that allows some latitude for reinspection and/or remediation. Wood products subject to fungal deterioration should be re-inspected every two or three years.

The effects of mold are becoming more prevalent. People, in general have become more sensitised; this has likely been caused by environment change. In addition, buildings are becoming more ‘air tight’ and there is less infiltration of fresh outside air. This has an effect of creating a higher humidity within the structure. In addition people are spending more time indoors, also raising the humidity. Lifestyles have changed and there is generally more moisture within a structure. People are doing more cooking using moisture, taking more baths and showers, etc.

The migration or spread of brown rot is interesting; once established the fungus spreads by 'sending out' hyphæ. These are tube like structures that permit the fungus to transfer moisture from the initial source into new dry, unaffected, wood material. This newly wetted material can now be affected by brown rot.

Concrete and masonry products that wood may be bearing on can also contribute to the deterioration. A source of moisture can wick through concrete and masonry materials for a distance of several feet by capillary action. This moisture can be the source for fungal deterioration.

The most effective manner to prevent brown rot deterioration is to maintain low moisture levels. This can be achieved by coating and maintaining a low moisture environment by ventilation or vapour barriers. Wood product should be isolated from concrete, masonry, or soils.

Some structure such as arenas and swimming pools have special problems that require the installation of mechanical dehumidification systems to reduce the air moisture and thus the wood moisture levels.

The spores from fungi are always present in the air. With the proper conditions over a period of time it will reduce sound wood products to a crumbly material with little or no substance.

Once the presence of brown rot is observed the strength of the structure is generally impaired.

Deterioration due to brown rot is pernicious. With the onset of brown rot deterioration, wood products may have lost 10% to 20% of their strength properties without any appreciable loss in weight or appearance. By the time brown rot is noticeable, 40% to 50% of the strength properties may have been lost.

Remediation is often a matter of obtaining the original construction documents to review the manner of construction and locate the source of the water intrusion. Does the owner have a copy? Is a copy available from the city or municipality through their building department? Does anyone know who constructed it? To undertake a study, there are many questions that have to be answered.

After the initial report, it is often necessary to undertake a detailed condition report. From this, the client can be provided with a 'Scope of Work' for the repairs? Remedial action could be quite an undertaking depending on the extent of deterioration, and, the scope of the work.

The extent of remediation can be determined by codes for the local jurisdiction. For example, Ontario has a Part 11 to their building code that permits alterations to existing buildings with the essential intent that they be compliant with the code at the time of construction; Other jurisdictions do not have this provision and it may be necessary to bring the building up to current code. In addition, the original buliding may not have been up to code in effect at the time. It may be necessary to discuss any shortcomings with building official for the area.

There may have been changes in building code such as an increase in loading due to 1:50 return period for snow and rain loading, change in importance, etc. Climate change may bring other 'surprises' and if the structure isn't brought up to current code there could be issues. If the work is undertaken as an insurance claim, upgrading the structure to current building codes may be an issue and not be covered as part of the insurance policy.

Is seismic design required? Brown rot causes a loss of strength and toughness. Seismic design may require the services of a Geotechnical Consultant to provide the foundation factor. Is the original foundation construction known? The foundation will likely have to accommodate the lateral loading due to wind and/or snow loading.

Does the client require construction to other standards such as FM Global, etc.

The material properties should be determined. It is unlikely that construction to any type of CSA certification can be determined. To use the current code provisions for ungraded lumber will likely provide an unworkable model and the building official/client may have to be consulted.

The spores released by the mold fungi can cause serious health issues. There can be an irritation of the throat and nasal membranes. In addition to eye irritation, some people have sensitive skin that reacts to the mold. Sensitivity may be heightened depending on the person’s reaction. The degree of reaction is generally determined by the person’s sensitivity, the type of mold, and the length of exposure. Mold often causes asthma and in people with a compromised immune system more serious and life threatening issues can develop. Mold has been linked to serious long term effects, such as anxiety, depression, sleep disorders, short term memory loss, and confusion. There may be difficulty focusing on a topic.

CMHC used to consider that for mold to be an issue, there had to be an area of 10 ft^2 that was affected. This is a fallacy and likely presented to minimise the concern for the occurrence of mold. People can be highly reactive to the presence of mold.

There are numerous methods of repair; this depends on the use and the degree of deterioration. Remediation may be as simple as removing the source of moisture and cleaning the affected area with a detergent. In past, it was common to use a mixture of detergent and household bleach. There is some indication that the use of bleach can modify the genetic structure of some molds and in the process, create toxins. The current approach is to avoid using bleach.

For small areas of damage, the deteriorated material can be removed by a stiff wire end brush and rotary drill. The exposed surface should be treated with a topical fungicide to reduce further damage. The fungicide carrier should not be detrimental to epoxy bonding. The damaged area can be replaced by a cementitious epoxy material bonded to the wood. This can fill an irregular void left from removal of the deteriorated wood. Penetrating epoxies can be used.

Remediation can be costly and very time intensive.

Treatment of the wood material using chemical products such as boric acid is known to halt the growth of brown rot and to help prevent the occurrence of brown rot fungi. Also a broad spectrum fungicide is prescribed.

Steps to Brown Rot Cleaning and Remediation
All material that ‘’shows decay or visible fungus should be removed.
Material ‘adjacent to the damaged area should also be removed. Hyphae from the damaged area may be located in these areas.
The damaged area should be wire brushed to remove any affected material. A stiff rotary brush, similar to that used of automobile repair work can be used. It should be noted that it may be necessary to remove too much material. On one project, it was necessary to remove nearly three-quarters of the area of some timber arches to effectively clean the rot away. Alternate support may be required. Dust and debris shall be removed. The effects of cleaning may be biohazardous. The cleaned area should be treated with an anti-fungal chemical.
The area for three or feet adjacent to the damage should be effectively cleaned using an anti-fungal disinfectant.
Replacement of the damaged area has to be undertaken. This can be done using pressure treated material or fillers that do not permit the flow of moisture.
All sources of moisture have to be eliminated.

Botanical Description of Serpula lacrymans

Kingdom	Fungi
Sub-Kingdom	Dikarya
Division	Basidiomycota
Class	Agaricomycetes
Order	Boletales
Family	Serpulaceae
Genus	Serpula
Species	S. lacrymans

From another source, a *recent study on the evolutionary origin and spread of this species using genetic markers (amplified fragment length polymorphisms, DNA sequences and microsatellites) on a worldwide sample of specimens suggested the existence of two main lineages, a nonaggressive lineage found in North America, and an aggressive lineage found on all continents, both in natural environments and buildings.*

Prepared by Dik Coates, P.Eng.
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