Site conditions and other factors affecting the installation and performance of hardwood floors

Introduction

This section deals with the effect of site conditions on the performance of hardwood flooring. Site conditions may be divided into two sections:-

1. Conditions prevailing at the time the floor is taken to site & installed.
2. Conditions prevailing after installation.

These two sets of conditions should be essentially the same.

Site conditions are all factors which can affect the performance of the floor. i.e. The temperature and relative humidity of the air in the building, the general condition of the building (i.e. Whether it is fully weather proof, habitable, heated, unoccupied, new, old etc.), the structural integrity of the building (especially the floors) and the amount of residual moisture in the fabric of the building and the subfloors.

The following pages explain how and why hardwood flooring interacts with its surroundings and why it is so important to create and maintain the correct site conditions before installation & during service. It is important for the specifier, builder and fitter to understand the larger picture so that any drying times are factored into the programme and potential problems dealt with at an early stage.

From past experience, specifiers and builders who are unfamiliar with the technical nature of hardwood flooring sometimes fail to allow for the necessary changes to subfloor construction or the importance of correct site conditions. This often leads to unnecessary complications and delays which could have been avoided with appropriate planning.

Much of the information may appear to refer to conditions in new buildings. This is because they potentially contain more moisture in the structure and there is normally more pressure to finish the job and move in. The same limitations factors also apply to wooden floors laid in existing buildings and it is important to ensure that they also meet the conditions explained below.
In addition, the correct site conditions will also ensure that other solid timber components, such as kitchen doors etc. do not expand or contract excessively.

How Wood Behaves

The moisture content of any timber is essentially dependant on the temperature and humidity of the surrounding air and the moisture content of any materials in contact with the wood.

Wood is a hygroscopic material which absorbs or loses moisture as the temperature and humidity of the air changes. It eventually achieves equilibrium with its surroundings, provided that the conditions are stable. The moisture content at this point is called the Equilibrium Moisture Content.

Similarly it will absorb moisture from any materials in contact with the timber.

The moisture content of the building fabric is initially the most critical factor, but once this is fully dried out it is the combination of air temperature and relative humidity which will eventually decide the equilibrium moisture content in the floor.
These are also good indicators of the dryness of the building fabric because as the building dries, the moisture passes into the surrounding air and increases the humidity.
Temperature and humidity should be monitored to assess if the building fabric has dried.

Any part of the structure which is in direct contact with, or near to the timber flooring, will transfer moisture to the flooring if it is too wet.

Any change in the moisture content of the hardwood floor will cause it to expand or contract - an increase in moisture content will cause expansion and a decrease will produce contraction. If the amount of movement is excessive the floor could expand, buckle and lift or shrink and produce gaps between boards.

The performance of a wooden floor depends on the correct combination of factors - the correct initial moisture content of the wood, the correct site conditions and the maintenance of suitable, stable conditions during the laying and over the life of the floor.

In practice, there will be differences between buildings which may be due to the type of construction, type of heating, geographical location and the owner's preference for hot or cool conditions.

For this reason it has been normal practice to acclimatise hardwood flooring in the property prior to laying. This is not always beneficial and can cause problems - see the guidelines on acclimatisation in the "**Laying Guidelines**" section.

The Importance of Moisture Content

Timber Moisture Content

The average moisture content of the majority of our floors is about 8 to 10%. It may be a little higher or lower depending on the batch. We consider this to be reasonable optimum moisture content for normally heated buildings in the UK bearing in mind the diversity of climate and construction types.

Underfloor heating systems usually require lower a moisture content of about 7-8%. Wood floors should only be laid over such systems if the following conditions are met. ie:-

1. Seasonal variation in temperature & RH is low.
2. The property is modern & well insulated.
3. The heating system is designed correctly to suit the property with a minimum of energy transmitted through the floor. See below for more info.

It is difficult to achieve a moisture content which is suitable for all conditions and we aim for a happy medium. At one extreme clients may wish to use it over underfloor heating and at the other extreme it may be used in an old building with less than adequate insulation or heating.

At about 9 - 10% moisture content, a floor would shrink significantly over underfloor heating, but perform adequately in a conventionally heated building. Alternatively a floor at 7-8%, installed in a partially heated house may expand considerably and could cause problems, but would perform adequately over underfloor heating.

Most of our floors are installed in conventionally heated houses and the current moisture contents reflect this. As a general rule and to cover ourselves, we advise against installing our floors over underfloor heating systems.

If you do decide to use such a system, please bear in mind that the moisture content should be about 7 to 8%. Some of our flooring may dried to these moisture contents but please check well in advance if they are likely to be available

Where a conventional heating system is to be installed, then a moisture content of about 9% is acceptable. Timber with a lower moisture content could also be installed but adequate expansion allowance must be provided.

We supply a certificate with each order showing the average moisture content of the particular timber and production batch. This can be used to assess any potential movement. The floor layer should decide whether the moisture content is suitable on the basis of the site survey, their own experience and the expected conditions in the building.

If the hardwood flooring is to be laid in any situation where the moisture content is unusually critical, it is best to call us prior to ordering to determine the moisture content of the current batch of flooring so that you can assess its suitability. If it is acceptable, the order should be placed immediately because we cannot guarantee that the same batch will be in stock at a later date.

Understanding and Measuring Moisture Content

During kiln drying, the moisture content of the full load is controlled by monitoring of a number of critical samples within the kiln. The drying process is not an exact science but is based on years of experimentation, experience and the drying rate.

During the drying process, the boards are placed with laths between each layer of boards & the drying chamber is filled with packs of boards of the same species & thickness.
Air is circulated between the boards and the temperature and humidity of the air is controlled according to a drying schedule. This ensures that the timber dries without damage.

During the process the sample boards are checked to determine the moisture content and the conditions adjusted accordingly until the final moisture content is achieved. A final period follows which serves to equalise the moisture contents throughout the kiln.

One of the problems in achieving reasonably uniform moisture content is that virtually every board of timber will have a different drying rate. Factors affecting the rate of drying are:- Species type, thickness, wood density, how the board is sawn, growing conditions of the tree and position of the board in the kiln

If the timber is dried correctly, it should be free from splitting, surface cracks, internal cracks & tension and be uniformly dried throughout.

At the end of the drying and equalisation process there will be a spread of moisture contents and the average of these should lie within the range specified. In keeping with the usual statistical pattern there will be some values above and

below the specified average value.
Because of variations in density & sawing, even within one plank, some localised variations in moisture content may be noticed.

Consequently, the checking of moisture content (at any time) should by done with a reasonable number of samples and the average calculated. The larger the number of samples taken, the more accurate the average value.

Measuring Moisture Content - The moisture content of a sample of any material is the weight of water in the sample expressed as a percentage of the dry weight of the sample. The only true method of determining moisture content is to perform an oven test in which a number of small, representative samples are each weighed, dried in an oven, weighed again when completely dry and the simple calculation done. In practice this takes a long time and is only done at the kiln drying stage

Measurement of timber moisture content is normally done with an electronic moisture meter which measures the electrical resistance between two electrodes driven into the wood. It is reasonably accurate between about 6% and 30%.

If the readings are to be reasonably accurate, corrections must be made for the species type and the temperature of the wood and these corrections are only available with the more expensive meters. Simple meters merely give an indication of the moisture content, while others such as the **Protimeter Timbermaster** or the **Delmhorst J2000** incorporate these corrections.

Care should be taken because surface moisture contents are normally slightly lower than those at the core in well dried timber while those in badly dried timber may be considerably different. Similarly a surface reading could be higher than the core reading where timber has recently been exposed to higher humidities or surface damp.

Readings are very specific and only measure the moisture content of the timber between the electrodes and not the average moisture content of the whole board. A large number of readings must be taken in carefully chosen sites or samples and the results interpreted intelligently.

It is important to treat meter readings with caution. Even the most sophisticated meters have errors. We have found that some meters are accurate at a certain moisture contents, usually around 9 or 10%, but below this value they read too low and above it they read too high.
To compensate for this we have developed correction factors for all our meters and we apply these to give the best possible results.

Other types of meters are available. One such method uses an electromagnetic field to estimate the moisture content. It is non invasive and the accuracy is dependant on the correct assessment of the timber density.
It is fast and easy to use, but like the resistance meters it has its own inaccuracies. The main problem is that the density varies considerably within the same species and this is dependent on a number of factors such as geology, climate, soil fertility etc.

These meters, when set correctly, are extremely useful for checking a large number of boards & identifying any potential problems. We use them in conjunction with resistance meters to check all our timber.

The correct moisture content is one of the most important factors affecting the performance of hardwood floors and we have very tight quality controls and conditions of storage to ensure that the flooring reaches the site at this value.

This entails continual monitoring of moisture contents at all stages of production and before dispatch.
In addition our timber and flooring is always plastic wrapped where possible, even between production stages, in storage and at the time of dispatch to maintain the correct moisture content.
If these measures were not taken, the flooring would absorb moisture from the surrounding air and eventually shrink after laying.

When flooring arrives on site it should immediately be stored carefully in dry heated conditions with an ambient RH of about 40% on a dry floor.
Alternatively it must be thoroughly wrapped in plastic, on all sides, to exclude the atmosphere in dry fully enclosed storage. Ideally the flooring should not be delivered until the site conditions are correct and stable.

See also the relevant sections in the **Grades & Range** section & in the **Survey** section

Concrete Moisture Content - The Floor Slab

It is difficult to to measure the moisture content of a concrete slab accurately. Electronic meters only measure the top surface of the slab unless holes are drilled and electrodes inserted.

The readings are not accurate because the conductivity is influenced by the mix, type of aggregate and whether any salts are combined in the concrete. Also a power floated floor has a compacted dense surface which retards the drying rate and surface moisture contents may be much lower than those at the core in the early stages of drying.

Timber and Concrete achieve different Equilibrium Moisture Contents (EMC) in the same set of ambient conditions. This means that in a room where the air conditions are 20ºC and 75% RH, the moisture content of any concrete would eventually be 5% and that of any timber would be about 16%.

Conversely, this means that a concrete slab at 20ºC with a moisture content of 5% would create a relative humidity of about 75% in an enclosed space next to its surface - for example in an upturned bowl or in a space between the slab and a new floor. If a piece of timber was placed in this space its moisture content would settle down to about 16%.

So it can be seen that the moisture contents are not comparable and it is important to measure the relative humidity of the concrete.

The test takes a few hours and is normally left overnight. There are two main methods. Both measure the RH of the air in contact with the concrete or the Equilibrium Relative Humidity (ERH). One measures the ERH on the surface of the concrete and the other the ERH inside the slab.

Timber is the most critical and moisture sensitive material in the building and virtually all species will reach a similar moisture content within the same set of conditions. By measuring the conditions in the structure which is in contact with the wood, it is possible to calculate the moisture content that the timber would reach in these conditions. Conversely it is sensible to define the conditions required in the concrete and surrounding material so that the moisture content in the timber floor remains stable.

Measuring Relative Humidity in Concrete

1). The Humidity Box- This is an upturned box which is placed on the surface of the slab. It is open to the slab and the joint is sealed. It is a measure of the moisture passing through the surface.
After about 24 hours the RH of the air in the box is in equilibrium with the concrete and its value is measured using a meter such as the **Protimeter Hygromaster** or the **Protimeter MMS**.
It is essential to place a number of these boxes in various parts of the room to assess the whole slab and preferably a number where the slab has the highest moisture content. This can be guessed at from experience - for example in corners away from air flow. These areas can be found quickly by using the search mode of the Protimeter MMS which uses a radio frequency sensor to find the wettest area. **For a link to Protimeter plc click here**.

2). The Humidity Sleeve(Developed by Protimeter) - This is an invasive test where a number of holes are drilled in selected areas (Found as above). Perforated plastic sleeves are inserted into the holes and capped. They are sealed so that they are isolated from the room environment but allow movement of moisture from the slab into the air within the holes. After about 24 hours the air has reached equilibrium with the slab and a probe is inserted to measure this value using the MMS.

Measurements may be taken after say 6 or 7 hours to give an approximate value of RH, but it is best to leave 24 hours for accurate readings. The sleeve is then resealed for future tests. This system is simple to use and permits easy and fast monitoring of the slab once the sleeves are in place.
The advantage of this method is that it it is a better measure of the RH within the slab and an indication of the moisture at depth which has yet to pass through the surface and this is especially so if the surface is power floated.

Maximum Slab Humidity - BS 8201 suggests that the slab should be a maximum of 75% RH or 5% moisture content. While this may be sufficient for some floor coatings it is far too high for kiln dried timber in direct contact with the slab.

Any timber in contact with a slab at these conditions would achieve an equilibrium moisture of about 16% and flooring, at 9%, would absorb moisture until it reached this value. This would cause an expansion of about 14mm per metre width of the floor and likely failure of the floor.

If flooring with a moisture content 9% is to be fixed directly to concrete without a DPM, the RH of the slab must be about 35-40% (or 2% moisture content) and <u>not 75% RH as suggested by BS8201</u>.
If this is not possible, there must be an appropriate damp proof membrane between the slab and the timber. Care must be exercised with the choice of DPM if the RH is significantly above 75%.

In practice it is very difficult to achieve 35% RH in the slab within a workable time frame and an appropriate DPM must be used.

The only exception would be an underfloor heating system with pipes embedded in a concrete screed. Provided that the screed had a DPM between it and the main slab and the heating had been running for long enough to dry the screed to about 25-30% RH - equivalent to a moisture content of about 7.5% in the floor.

Site Conditions and Hardwood Flooring

It must be stressed that everyone concerned should be aware of the importance of dry site conditions before, during and after laying hardwood flooring. The following guidelines should be observed. The conditions specified are much drier than those in BS8201 but they are essential for timber flooring which is dried to an average moisture content of about 9%:-

1. The overall fabric (walls, floors, timber etc.) of the building should be thoroughly dried out until there are no visible signs of moisture or condensation in the structure. In cold damp periods this will require artificial methods and dehumidifiers.
   The building should then be heated (with adequate ventilation) at its operating temperature until the floor layer is satisfied that the building is thoroughly dried out. Gas or oil fired space heaters should not be used to dry the building. They both increase the relative humidity.
   Timber framed buildings with dry lined walls will take less time to dry out than a traditional build with block walls, rendering and plaster. Summer builds will dry out faster than winter builds.
   The ambient temperature and RH in the building should be measured using an accurately calibrated hygrometer such as the Protimeter MMS or Protimeter Hygromaster. High humidies may mean that the building is still drying out.

   Site conditions for good stability are:- Timber at 8% moisture content and 20 Centigrade requires an ambient RH of 35%, at 9% it requires about 40% RH and at 10% it requires 45% RH.

2. All under floor concrete slabs should be initially air dried until the RH is 75% (5% moisture content - See below) and preferably less. This may take at least 1 month per 25mm thickness of slab for thin slabs (say up to 100mm), but progressively longer for thick slabs. E.g. It may take 12 months for a 150mm thick ground floor slab.
   At 75% RH this is still far too high to be in contact or near to the timber floor and a DPM must be placed between the concrete and the floor. See below for more info on this. Where possible, isolate any screed from the main slab to speed up drying.

3. Once the correct site conditions have been achieved, the wood flooring may be allowed to acclimatise (before laying) at the temperature and relative humidity expected in service or laid immediately with adequate allowance for expansion. Acclimatisation is not always the best option and can lead to unnecessary delays and problems during laying. See "ACCLIMATISATION" in the "**Laying Guidelines" section**

4. The floor should be laid at the same temperature and humidity as expected in service. See **Conditions During Use**

Sub-floors

The stability and performance of the finished hardwood floor is dependent on the quality and integrity of the sub floor.

Concrete Screeds & Slabs.

In general terms the wetter the concrete slab the greater the vapour pressure which drives the moisture out of the slab into drier regions.
DPMs such as epoxy resins, polythene sheet and building papers may appear to prevent movement of moisture, they only limit it to what is hopefully an acceptable value.
If the DPM is placed over a very wet slab at say 90% RH it will transmit more moisture than if the slab was at 80% - all other factors remaining the same.

As can be seen from the previous information the ideal RH for the concrete is about 40% for timber of 9% moisture content. As this is difficult to achieve in practice the best option is to reduce the slab RH to as lower value as possible so that it exerts the minimum vapour pressure on the membrane. Ideally the value should be reduced to 60% or less but always below 75%. The lower the value, the less vapour is transmitted. A suitable DPM should be laid as described below.

Existing slabs should be sound, dry & level, with a maximum relative humidity as described above. The slab must contain an integral damp proof membrane to prevent ingress of moisture from the ground and ideally another DPM between the site concrete and the final screed. This reduces the overall drying time as only the final screed need be considered.

Where floors are to be fixed directly to the concrete with adhesives, the surface should be very level, smooth, strong and free from contaminants which may affect adhesion. Use an epoxy DPM.

All concrete floors should have a smooth float finish and extra care should be taken near edges, corners and movement joints to ensure that localised irregularities do not occur. Self levelling compounds may be used to level up any uneven surfaces.

If the floor is to be glued directly to the slab, then an epoxy resin DPM must be used.
NB - All the products, adhesives, levelling compounds and epoxies used must be compatible.

If the floor is to be fixed indirectly to the slab - for example with battens and the concrete is well dried, a polythene or building paper DPM may be used under or over the battens. Joints should be overlapped and taped.

Listed below are situations where an epoxy DPM must be used and the site conditions required:-

Wood Floors Bonded Directly to Concrete - Reduce concrete RH to 75% minimum & preferably 60%. Apply 2 coats of epoxy resin DPM. Allow to cure. Fix wood using appropriate adhesive or use self levelling compound if necessary and allow to dry before fixing floor. Where the flooring is bonded to concrete over an underfloor heating system and the heating system has fully dried the concrete to under 35% RH, no DPM is necessary.

Floors bonded to 18mm T & G plywood or chipboard which is bonded to the concrete floor - Reduce concrete RH to 75% minimum & preferably 60%. Apply 2 coats of epoxy resin DPM. Allow to cure. Ensure that the ply/chipboard is flat and has a moisture content of about 9%. Bond side to side with PVA and fix to the DPM using a flexible adhesive such as Sika T52 or T54. Pin and glue the board to the chipboard with correct adhesive. If the concrete slab RH is between 45 and 55% then one thick coat of epoxy should be adequate.

Existing Boarded, Chipboard or Plywood Sub-floors.

All joists and boards should be in good structural condition, level and free from rot or insect attack. It is advisable to treat any timber against fungal and insect attack regardless of the age or condition of the floor. The moisture content of the sub-floor should not exceed 14%. In any event always use a building paper under the new floor.

All composite boarding such as chipboard or plywood should be of the correct external/flooring grade and be firmly fixed to the joists and adequately supported. The under floor cavity should be well ventilated and the floor of the cavity should be covered with a damp proof membrane and over-site concrete (where possible) to prevent the ingress of water. It is advisable, for comfort, to insulate existing ground suspended floors before laying the new floor.

Useful, but not essential advice, is to use a damp proof membrane under all new floors and not just ground floors. This has the advantage of isolating the new floor from the sub floor and this prevents any migration of moisture during the summer months when the humidity is high.

New timber joists, battens and supporting timbers.

Timbers should have a maximum moisture content of 15% and be double vacuum treated with a solvent based insecticide and fungicide such as Protim 80. Avoid water based treatments such as tanalising because the timber must be re-dried to under 15% moisture content before use. Acclimatise in the room before laying.

Accuracy of All Sub-Floor Levels.

Sub floor levels should be accurate to within about 3mm over 3 metres and there should be no pronounced high or low areas. Existing uneven concrete floors may be corrected using a self-levelling compound provided that the differences in level are not too great. Ensure that all areas are dried out after treatment.

Existing wood floors which are distorted or uneven may be levelled by sanding with a floor sander.

Where wood floors have large deformations, perhaps because of subsidence or in a very old house, the floor may be levelled by fixing shaped timber battens along the lines of the existing joists and perhaps between. A strip floor may then be nailed to the battens. The sub floor must be in a sound structural condition.

Conditions During Use

BS8201 suggests a range of average moisture contents to suit varying conditions:-

Unheated - 15% to 19%;
Intermittent Heating - 10% to 14%;
Continuous Heating - 9% to 11%;
Under floor Heating - 6% to 8% (See later comments)

Our flooring is kiln dried so that the average moisture is about 8 to 10% and it is not recommended for unheated buildings or those which remain un-heated or exposed to increased levels of humidity for long periods.

The recommended ambient conditions for our flooring in service should be in the ranges:-
Average Temperature - 15ºC to 25ºC
Average Relative Humidity - 35% to 50% at 20ºC

Provided that the average conditions remain close to the ranges specified then reasonable short term variations should not affect the stability of the floor. As a guide line, a 1% change in moisture content across the floor could produce a maximum movement of about 2mm per metre width of the floor. See relevant section in the **Survey** section

Combinations of low temperature with high humidity will cause expansion while high temperatures and low humidity will cause contraction. A change in Relative Humidity of 5% will produce a change in moisture content of about 1% given enough time.

The Effects of Heating and Climate on the Stability of Hardwood Floors

In reality it is often difficult to establish the exact set of conditions unless the environment is fully controlled. If the conditions are reasonably close to those specified, the floor can be laid provided the following precautions are taken:-

1. The timber may be acclimatised in the room where it is to be laid at the conditions expected in service or laid immediately and sufficient allowance made for expansion. See **"Acclimatisation"** in the "Laying Guidelines" section.

2. Expansion gaps are left around the perimeter of the floor and occasionally at intervals across the width of the floor depending on whether the floor is expected to expand at some point in its life (See **Laying Guidelines**). Also, if the floors are expected to expand considerably, they may be laid with a pneumatic floor nailer which does not drive the boards together in the same manner as a Powernailer and leaves slight gaps which provide additional room to expand.

The designer/Contractor should be aware of how the following factors affect the moisture content:

The time of the year when timber floors are laid.

Internal ambient humidity is higher during the summer months when heating systems are turned off. The RH outside is likely to be between 75% & 95% and that inside will depend on whether windows and doors are constantly open and also on the type of house construction.
It could well be as high as 60% to 75% after prolonged humid periods and this would lead to an increase in the moisture content of the hardwood flooring which, in turn, produces expansion across the grain.

In winter the external RH is similar to or higher than that in summer except for cold frosty periods when the RH falls considerably. However the internal RH is much lower than that in summer because the central heating dries out the air. It is likely to fall further if frosty outside.
This lower RH causes the moisture content of the timber to fall and the boards will contract accross their width.

Consequently floors with a moisture content of say 9% which are laid during the winter months in centrally heated conditions will be reasonably stable, but will expand during summer and allowance should be made for this expansion.

Conversely hardwood flooring which is laid during the summer months will begin to expand almost immediately and may achieve most of its expansion during this period. They will usually contract a little in winter. As before, allow for sufficient expansion.

We have recently surveyed a number of houses in this area and found the following winter conditions :-

1). House 15 years old - RH = 32% - 42% at 20ºC - 22ºC
Modern brick construction. Constant heating/rads.

2). Offices 30 years old - RH = 40% - 42% at 19 ºC - 23ºC
Brick construction. Heated during the day 8.00 to 17.00. Rads.

3). House 130 years old - RH = 32% - 42% at 16 ºC - 23ºC
Brick construction, solid 9" walls. Heated twice. Rads.

4). House 170 years old - RH = 40% - 52% at 14 ºC - 21ºC
15" solid brick Chapel. Wood burner 24hrs. Min central heating by rads upstairs.

5) House 300 years old - RH = 36% - 44% at 19 ºC - 23ºC
18" cobble/mortar construction. No DPM. Constant heating with rads.

It is suprising how similar these values are, considering the different types of construction and heating. In the centrally heated houses, the driest conditions are 32% at 23ºC which corresponds to a wood moisture content of about 7.5%.
The least dry conditions are 44% at 19 ºC giving a wood moisture content of about 10%.
The property heated by the wood burner ranges from 40% at 21ºC to 52% at 14 ºC. This is a range of wood moisture contents of about 9% to 11%.

The older houses have a greater range of conditions in different parts of the building while the newer houses have more constant values.

The geographical location of the building.

E.g. A cool high rainfall area such as North West Scotland is more likely to have high summer humidities and cooler temperatures than say Kent. The ambient conditions may produce a higher average moisture content in the floor throughout the year and additional expansion allowance should be made.

The Age and Condition of the Building and the Type of Heating System and its effect on the Performance of the Hardwood Floor.

Old buildings with less insulation, perhaps solid walls and an adequate heating system usually have higher humidities in summer and a greater variation in conditions between summer and winter.

This leads to more expansion and contraction in the hardwood floor than would be experienced in a more modern building. The initial expansion after laying will generally be greater in an old building and more cupping may occur across the board.

This overall movement can be controlled, to some degree, by ensuring that the floor is isolated from the structure and the environment.
Firstly by ensuring that the surface coating transmits as little water vapour as possible, is of a sufficiently high quality and is well maintained. Three or four coats of a water based polyurethane lacquer works fairly well.
Secondly, always ensure that the underside of the floor is isolated from the building fabric by using building paper, even under a first floor construction and turn the building paper up behind the skirtings.

Conversely, modern, well insulated buildings, especially those with timber frames and little internal wet work normally have more stable conditions, a lower equilibrium moisture content and experience less seasonal expansion and contraction.

Underfloor Heating and Solid Wood Flooring

Heat Loss

All buildings lose heat and the amount of heat loss will depend on the age & shape of the building, its location, degree of insulation, ventilation etc. If the building is to be maintained at a constant temperature, the heat loss must be balanced by the heat input from the heating system.

Older and perhaps more traditional buildings are usually draughty & poorly insulated and there is a high level of heat loss both through the fabric of the building and via air changes. In consequence the heat input required to maintain a constant temperature is high.

Modern buildings and especially timber framed houses are well insulated, designed to conserve energy and in consequence, suffer little heat loss. They require only a low energy input.

Traditional buildings of the type built from the 1930's to say 1990 have varying degrees of insulation and are generally not very energy efficient.

The effect of underfloor heating on hardwood flooring in various types of buildings

The under-floor heating system is an active part of the building and the total heat input is transmitted through the hardwood floor.

In the traditional building with large heat losses, more heat has to be pumped into the building to maintain the temperature thereby increasing the floor temperature & the difference in temperature between the floor surface and the air.

The high temperature in the wood floor coupled with low air humidity can produce a lower moisture content than expected as low as 5 or 6%. If the original moisture content was say 8%, the timber would shrink about 4 to 6mm per metre width of flooring during a prolonged period of heating. When the heating is turned off and the humidity rises, the moisture content could increase to 10% or 11% causing an expansion of 4 to 6mm width per metre width of floor over and above the original 8% average moisture content.

The overall change in moisture content of the floor from summer to winter is thus from 5% to 11% at worst i.e A maximum of about 12 mm per metre width of floor. It is this range of movement which is unacceptable, causing large gaps which open and close with the seasons.

In the modern well insulated building with minimum heat loss the energy input is low and the floor may only need to be 3 or 4ºC, on average, higher than the air temperature. Also, this type of house experiences less seasonal fluctuations in humidity & temperature & this helps maintain stability.

This reduced surface temperature may lower the moisture content of the floor a little - perhaps to 7% or so - causing a little shrinkage and in summer this may rise to perhaps 9% or so causing a little expansion. The range of seasonal expansion and contraction is considerably less than in an old house and similar to that experienced with conventional heating systems.

However there is no hard and fast rule about the suitability of the house and heating system, it will depend on many factors, i.e .U value, room geometry, air circulation, geographical location etc. plus the design of a suitable heating system. Each room must be considered separately because rooms will have different U values and air exchange depending on the area of windows, number of doors, etc.

It is essential to have the plans of the building examined by a competent heating engineer early in the planning of the building so that amendments may be made, if necessary, to accommodate an under floor system. If it is not possible to use an under-floor system they will tell you. It is essential that you use a company that understands solid hardwood floors.

If there is a choice whether to use underfloor heating or not, it is better to use a conventional system because this will be less aggressive and, in general, cause less movement during service.

South Facing Conservatories and Sun Rooms

During the summer months, the temperature and humidity within a closed, south facing conservatory are likely to considerably exceed the recommended values and solid wood floors should be used with care. Automatic ventilation and temperature control may be used to regulate the conditions and a solid roof and blinds will eliminate the worst effects of the sun.

In general we do not recommend laying wood floors in any conservatories which receive the sun for a good proportion of the day. Sun rooms with a tiled roof are usually OK, but it is worth considering blinds which may be drawn if the house is left unoccupied for any length of time. Please ask for advice.

Movement in Service

Seasonal variations and levels of heating cause hardwood flooring to expand and contract. Under normal circumstances small gaps may appear during winter, especially towards the end of winter and after particularly cold and dry periods (when the heating has been turned up). These will close up again during the summer months and the whole cycle is perfectly normal for solid wood flooring.

In practice the flooring responds very slowly to changes in ambient temperature and humidity provided the floor is well sealed and isolated from the rest of the building.

It may take several months for the moisture content to adjust to normal seasonal changes and even then the change is unlikely to be anywhere near the theoretical maximum. Major problems are usually connected with moisture within the surrounding structure, unsuitable underfloor heating systems, large long term changes in ambient conditions, poor installation and the initial incorrect moisture content in the wood flooring.

Note:- Global warming is changing the climate of the UK. Longer summers and warmer wet winters are forecast and already seem to be here. This means that the central heating will be turned on later and that floors will be exposed to higher himidities for longer periods during the summer months. For the majority of floors this should not be a problem, especially when laid in more modern houses. However floors in older houses may expand significantly.

It is essential that sufficient expansion allowance be incorporated in the floor. In addition it is worth considering installing a dehumidifier to run in summertime.

A Summary of Important Advice

As the popularity of hardwood flooring has increased over the years, so have the number of problems. The majority of these have been due to incorrect site conditions, poor installation or a combination of both.

These have mostly occurred on new builds and renovations where wet work has influenced site conditions.

Installation work is often undertaken by builders, joiners and others who may be excellent tradesmen, but have too little knowledge of the technical aspects of hardwood flooring.

Clients, architects and contractors may not be aware of sensitivity of hardwood floors to moisture and may not allow sufficient time for the fabric of the building to dry out at the end of the contract.

Everyone involved from the architect to the fitter should have a thorough understanding of the products and how they behave.
A summary of advice and some do's and don'ts are listed below. Please read all the sections:-

General Advice & Notes For All

Always use an experienced professional floor fitter.

Ensure that the moisture content of the new floor is correct and suitable for the type of building and its eventual use.

Ensure that the flooring is made by a reputable manufacturer.

Allow sufficient time for the building to dry out.

Always use the heating for a few weeks prior to fitting.

Always monitor the air temperature and relative humidity prior to fitting. Do not fit if the conditions are wrong.

Always test the relative humidity of the concrete floor slabs prior to fitting.

Always wait until the site conditions are correct before laying.

Always use an appropriate damp proof membrane.

Take more care with new builds and renovations than with existing, occupied buildings.

Architects & Contractors

Architects & designers need to ensure that the flooring, sub floor and the method of fixing are incorporated into the design from the start. Methods of fixing will affect floor levels and membranes need to be incorporated in the sub floor. Clients should be made aware of the potential time needed to dry out the building.

Incorporate DPM's between floor screeds and the main slab were appropriate - to reduce drying times.

Incorporate the method of fitting and the appropprioate sub floor at the design stage. It may not be possible to retro fit the floor if the subfloor is too high or of the wrong construction.

Plan the work so that all wet work is finished as fast as possible.

Plan the work so that heating is installed and running as soon as possible.

Dry out the fabric of the building. This includes all floor slabs, brick & blockwork, rendering & skimming.

Plan in sufficient time taken for the structure to dry out.

New builds & renovations with wet work take longer to dry out.

Timber framed buildings with little wet work dry faster.

Thick floor slabs take much longer to dry than thinner slabs relative to their thickness.

Avoid under floor heating if possible. It is possible to lay a wood floor over such systems, but it does require considerably more care at all stages.

Only consider underfloor heating in buildings which are highly insulated. Avoid older buildings with poor insulation.

Always run underfloor heating sytems for several weeks prior to installation to dry out the screed.

Contractors

Main contractors need to be aware of the importance of site conditions and the need to complete wet work as fast as possible.

Make the building weatherproof as fast as possible.

Finish all wet work as fast as possible & allow the building to dry naturally for as long as possible. This may be speeded up with de-humidifiers.

Install heating as fast as possible & <u>always</u> run for several weeks to complete the drying process. Use dehumidifiers if necessary.

Make allowances for, and plan in the time needed to dry out the building.

Use an experienced floor fitter unless your staff have sufficient knowledge & expertise. Ensure that he is competent. If you use your own staff you will be liable for any failure.

If you or your staff fit the floor make sure that they understand the technical implications and have the necessary equipment to survey the site and install the floor.

Installers

Floor fitters must have a sound technical understanding of how timber behaves and how site conditions influence the timber.

Installers must have sufficient skill, experience and equipment to fit the floor.

Installers are responsible for ensuring that the site conditions are correct and that the floor is fitted correctly. If the floor fails, they are responsible and will carry the cost of replacement or repair.

Always assess the site and test site conditions with the appropriate equipment. If conditions are not acceptable, do not fit the floor until they are. It would be helpful to make written records of survey details and results.

Always lay an appropriate DPM to suit the site conditions.

References.

BS 8201

- British Standard Code of practice for flooring of timber, timber products etc.
- **CP 204** In situ floor finishes.
- **CP 209** Care & maintenance of floor surfaces - Part 1.
- **GBG 28** Parts 1 to 5 - Published by the Building Research Establishment.
- Further references are to be found at the end of **BS8201.**