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ABSTRACT:
Conditions for successful wood flooring installation require control of the following ambient environmental conditions.

- Air temperature range.
- Relative humidity range.
- Substrate moisture content.

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KEYWORDS:
Wood Flooring, Moisture Content, Curling, Dimensional Stability, Delamination

DEFINITIONS:
Cupping: Deviation in the face of a piece from a straight line - a type of warp.
Checking: Small slits running parallel with the grain caused chiefly by seasoning
Splitting: Separation of wood fiber running parallel with the grain.
Plain Sawn: Broad grain and wide boards with annual rings 30 degrees or less to the face of the board.
Quarter Sawn: Straight grain and narrow boards with annual rings 60 to 90 degrees to the face of the board.
Rift Sawn: Similar to quarter sawn but accentuates vertical grain with annual rings 30 to 60 degrees to the face of the board.

Wood Flooring

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Introduction

Wood is an organic material with a cellular structure. The structure permits wood to absorb and to emit moisture in response to ambient atmospheric conditions. When the moisture content of wood changes, so do the dimensions of the wood. When exposed to extremes, the affects on a finished wood floor can be disastrous.
The results of moisture content change can be cupping, splitting, checking, and joint opening.

Case Study

The floating engineered maple floor shown below was installed in high-end condominiums over a loosely laid acoustic pad and a concrete substrate. Each 6 inch wide plank contained three strips of wood veneer. The photo clearly shows cupping at each veneer strip and at the edge of each plank.
When the study of this flooring installation was conducted, the unit was unoccupied, the RH was less than 20%, and the wood

Installation Conditions

Before beginning installation, the installer should inspect and test the area to determine the following conditions are within the flooring manufacturer's recommended ranges and at the design operating conditions:

- Ambient temperature
- Ambient relative humidity
- Substrate moisture content

These conditions should be documented by the contractor and must be maintained within the recommended ranges during and after installation, until the owner occupies the building.

Floor moisture content was less than 4.5%.
A sample of the floor was removed for observation of the conditions. The sample revealed that the flooring was not installed according to the manufacturer's instructions. No vapor retarder was installed over the concrete substrate. The glue in the tongue and groove plank joints was intermittent forming an incomplete bond between adjacent planks.
The photo below shows the results of severe cupping in the face veneer shown by the upward curling above the tongue joint. The veneer delaminated from the backing

because of the stress induced by the extremely low relative humidity within the condo unit. Flooring damaged this severely must be replaced.

Cupping was only one of the problems with this wood floor. Other problems included lack of expansion space at the room perimeters. This caused the floor to spring off the substrate and interfere with swinging door operation.

Conclusions

Cupping occurs when the moisture content in the flooring is unbalanced through the flooring. When the wood below the floor surface has a greater moisture content than the floor surface, the edges of the wood will bow upward, creating the cupping effect. The condition may be caused by the wood floor surface drying or by the wood below the surface absorbing moisture after the floor is installed. If the moisture within the wood flooring is returned to an equilibrium condition similar to the moisture content at the time of installation, the cupping effect will be reduced and possibly eliminated. Where the surface veneer has delaminated from the backing, as exhibited in the removed sample, the flooring must be replaced to correct the condition.

Changing the moisture content from green (saturated condition) to oven dry will cause solid wood to shrink the most across the grain. Quarter sawn lumber will shrink about half as much as plain sawn lumber. Selecting quarter sawn or rift sawn flooring with nearly parallel radial grain will reduce the dimensional changes from moisture content.

Composite, engineered wood flooring will exhibit shrinkage values less than solid lumber because the grain of the wood plies are alternated to help control the effects of changes in moisture content. However, engineered flooring should be designed as a balanced construction with the same number and thickness of plies on both sides of the vertical center to ensure stability of the composite.

The wood equilibrium moisture content (EMC) is a function of relative humidity and temperature of the surrounding air. As a rule of thumb, a relative humidity of 30 percent gives an EMC of 6 percent and a relative humidity of 65 percent gives an EMC of 12 percent, irrespective of temperature. These ranges are within the maximum moisture content range for milling wood and correspond to wood flooring manufacturer's recommended relative humidity range for installing and maintaining wood floors.

Selecting flooring with narrow boards will lessen the actual dimensional changes from moisture, making the changes less noticeable. Using a high quality vapor retarder under the flooring will minimize moisture differences between the finished (sealed) and back (unfinished) faces of the flooring.

For wood flooring installed in areas that are subject to wide variations or extremes in relative humidity, designers should consider including HVAC humidification and dehumidification capabilities to maintain an acceptable humidity range for spaces where wood flooring is used. The ambient relative humidity range for wood flooring installations required by most wood flooring manufacturers is 35% to 65% RH.

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