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IT'S ABOUT BALANCE

By Brian Beakler with Lew Migliore

Flatness is the key to a successful installation of tile, rigid resilient plank, LVP, wood and any other hard surface covering and carpet tile. Over the past several years the frequency of flatness issues experienced in the field has increased exponentially. Many of these problems are blamed on moisture, environmental conditions, installer error or user abuse. Blaming flooring material flatness on these variables is easy, however, in many cases, the reality lies below the surface and above the subfloor.

Balancing structures in flooring is a challenge and has been since manufacturers started to combine homogeneous materials to other materials to improve performance of flooring products. In the early days of applying coatings and backings to traditional resilient products, a great deal of development, design, engineering and testing took place. Those products were often installed in residential and commercial settings and tested for months or years. Along the way, observations were made, and designs were adjusted to ensure that these products endured time for customers. Brands were built on these innovative engineered products. As with anything, times change and so do market trends that are driven by consumer demands and expectations.

Accelerated aging of SPC wood

Other global economic variables have engulfed the flooring industry over the past 20 years, primarily the US's dependence on Chinese produced products. Chinese producers rapidly adapted to consumer needs and quickly scaled up to produce nearly every hard surface flooring product for larger global flooring suppliers. The race to produce new, performance or visual design differentiated products in LVT, LVP and engineered wood drove the acceleration of product quality decline. The institutional knowledge of materials, and combinations of materials, wasn't accurately translated from the knowledgeable sources to the new suppliers. The result was bowed, end lifted, cupped and crowned engineered wood and dimensionally unstable vinyl planks and tiles. This is what we call here the "shoot, ready, aim principle" of introducing product to the market, or testing in the field. Get it out there and we'll take our chances and figure it out along the way.

The reality of the issue around flat products is that in many cases the products are not manufactured properly. Yes, moisture exposure before and after installation causes issues with wood and other products, however, this is being used as a "crutch" for many inspectors and manufacturers, or those who call themselves manufacturers, who don't know what they don't know. It seems like every failure is installation or a "site-related" issue only because that is the easy out for a manufacturer and anyone who doesn't know or understand the products. Remember, if you don't control the product, the product controls you. To think that installation, moisture or any other factor is the reason for out-of-control products today is to be completely ignorant of the facts and science. Let's take a look at the key elements that can, and do, cause structural balance issues at the time of manufacturing in the most relevant product categories in the market.

Engineered Wood

Bowing
ENGINEERED HARDWOOD

Flatness in engineered wood planks is maintained by closely matching the moisture content of all the veneers to be laminated into a plank. If you've sold or installed enough engineered wood products, you've probably seen the output of not managing veneer moisture content well enough at the time of manufacture. Bow and end lift on planks out of the box are, in most cases, a result of gluing together plies that are too far apart in wood moisture content. Wood is a hygroscopic material, meaning it loves water. Wood also wants to be in equilibrium with its environment. As the environment changes (higher or lower atmospheric relative humidity), the wood will give up or gain water molecules and change dimension.

It is possible for veneers to range in moisture content from 5% to 12%. Think about what happens when multiple plies at varying moisture contents are glued together and "fused" into a composite and then converted into a product by sizing, profiling and coating. Let's say the storage environment is heated and dry in the winter. The veneer layer (s) that are higher in moisture content will shrink and change dimension, while the drier veneers in the structure only change dimension minimally or not at all. The result is twisted, bowed and end lifted planks. We see this in all engineered wood categories, from low end rotary faced products to composite core (MDF/HDF) products to high-end, thick sawn faced products. Certainly, the 9 to 11 ply birch cores laminated to thick sawn or sliced face veneers are more stable than 3/8", 5-ply rotary products, but they are not impervious to flatness from

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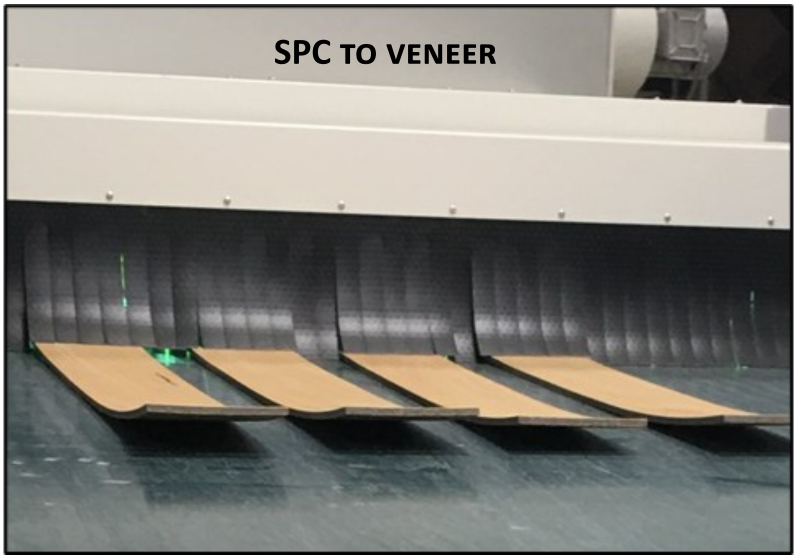
moisture mismanagement.

While there are good, flat, Asian produced engineered wood products, this is the not the norm. Many Asian produced engineered wood cores that are used in lower-end retail products contain low density and fast-grown wood species. The name of the game is “get it cheap”, so producers are using wood that has inferior anatomical properties that “normal” wood does not contain. The trade names of some of these species are “Chinese Poplar” and “Eucalyptus”. One scientific term for this abnormal wood is juvenile wood. The traits of juvenile wood (as compared to “normal” wood) are decreased density, higher shrinkage, and thinner cell walls. All these traits will manifest themselves as twist in planks as the product layers change dimension with changes in atmospheric moisture.

The best producers have quality checks on incoming veneer moisture content. Veneers are checked with a hand-held moisture meter and segregated into moisture categories. If the veneer is too high in moisture content, it is either rejected (back to the supplier) or re-dried. Another common practice is to “acclimate” the face and back veneers together for several days. This practice ensures that there is very little difference in the moisture content at the time of lamination, keeping the product much flatter. Most of the larger US producers do a good job of monitoring and managing veneer moisture content.

Moisture is the #1 issue with any wood product, from furniture to cabinets to flooring. Over my career, 90+% of all issues I have encountered were related to moisture, one way or another. Wood always wants to be in moisture content equilibrium with its surroundings, so it is almost always moving. People believe that by gluing wood to a subfloor will prevent it from gapping, cupping or crowning. Wrong. As the wood flooring moves to catch the environmental conditions it changes dimension. The force that it exerts on glue lines and mechanical fasteners can be significant. Typically, the strength of a glue line is greater than the strength of the wood. When this is the case, the wood will fail itself (break apart at a weak point in its anatomy). We see this frequently with engineered wood products that delaminate a veneer in its structure. Wood always wins! As we say, “wood flooring is still a tree in a different form on the floor.”

See Page 8 Regarding Excess Inventory Offer



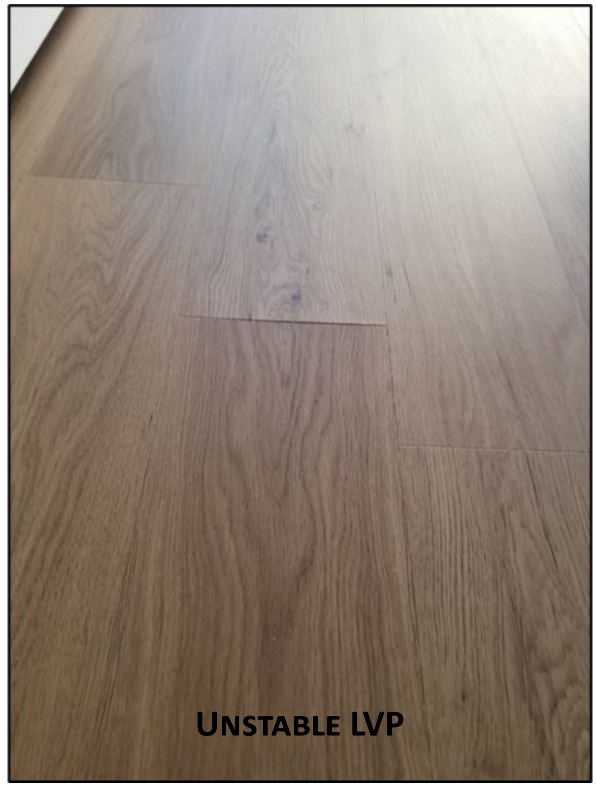
RIGID VINYL

With the explosive demand for rigid, “waterproof” flooring materials, manufacturers are rapidly trying to launch new products with differentiated features in order to grab market share. We have been seeing an increase in flatness issues with many of these structures. The initial waterproof composite (WPC) category was awful when it came to indent resistance, flatness and stability. Many of the initial composites were foamed (to make the product less dense) and contained wood or other organic filler materials. As you can imagine, the presence of wood in the composite added a material that loved water. This did not perfectly align to the waterproof marketing story.

With most filled polyvinyl chloride-based flooring materials, annealing is needed to relieve stresses set up during the extrusion process. Annealing requires re-heating the material (after extrusion and/or calendaring) to a point before cooling it again. This allows the material to relax and thus reduce the internal stress. Some of the earliest versions of rigid products were not properly annealed and the result was a product that was not flat. This process also applies to many plasticized, PVC-based products such as LVT and LVP. Most producers understand the annealing process and manage it well. However, it is clear, that some of the overseas producers still can’t get this process right.

Lamination of décor films, papers and wear layers presents another challenge in managing to produce flat products. Laminating PVC components is relatively simple. It takes heat and pressure to fuse layers. The difficulty comes with laminating layers that are not of like chemistry. Often an adhesive is required to combine these structures as the differing thermal profiles do not allow heat lamination. PVC has a relatively low glass transition temperature as compared to other resin binder systems. Glass transition temperature is the temperature at which a polymer starts to move from a solid state to a flexible state. So, when a PVC base is laminated to a non-PVC wear layer, they are probably not going to move at the same rate when exposed to temperatures as low as 100°F. When limestone filled PVC is exposed to temperatures as low as 95°F, it starts to expand. Imagine this type of PVC core laminated to a non-PVC décor layer or wear layer that is more thermally stable. The face of the product will not expand at the same rate as the core and the product will cup across the width. We all know that temperatures of ~120°F are routine in many areas of the US in the summer, and products that are transported in these environments are put at risk. This same rule of distortion also applies to PVC free products which would have you think they are more stable but in fact they are subject to the same physical forces.

Rigid Vinyl and Wood Hybrid



This is the newest trend in the marketplace, the combination of a rigid core to a thin wood veneer. Most producers haven't yet figured out how to keep this structure flat. Chances are, until a core material with a high glass transition resin binder are available, these products will never be balanced structures. We have tested many commercially available products of this composition and none of them stay flat at 95°F. It is easy to see why, if you take the information provided in the previous sections on how wood moves and how PVC moves.

Wood veneer adhered to rigid, filled PVC sets up a scenario where temperature drives expansion in the vinyl but not the wood. Wood reacts to moisture change, while the filled PVC core does not. Let's examine what happens to a product at 95° F in a low and high humidity environment. In a "wet" and hot environment, the wood in the laminated structure will expand in width. We know at this temperature the PVC is entering its flexible state. Across the width of the product, the wood's growth will be similar to the growth of the PVC core. Depending on the species of wood, composition of the core and thicknesses of the components, slight cup or crown may be present. Wood moves only minimally along the length, so, expansion of the PVC in the length direction will cause the plank ends to lift. There are several variables that can cause this explanation to be invalid, but the majority of products with 0.5mm to 1.2mm veneers adhered to rigid PVC will exhibit the issues described.

Now, let's examine a dry, hot environment. When wood dries, it shrinks. The shrinkage force exerted on a PVC core that is flexible and expanding in dimension causes severe cup across the width of the plank. Planks will often lift on the ends due to a small amount of wood shrinkage and expansion of the core. Again, there are circumstances and combinations of variables that would create flatness issues that are different from what has been described.

There are cores, namely "mineral" cores, that are much more rigid and temperature stable than SPC (solid polymeric core). If the rigidity of the plank is matched to the thickness of the laminated veneer, a successful structure can be produced. There are a few on the market today. These producers have realized that the key to building these structures lies in the type of core and the thickness ratio of core to veneer. One of the downfalls of mineral core products is the ability to apply a clean profile for a floating installation. The mineral core is less homogeneous in nature and has the tendency to break versus cut cleanly when machined. The most successful products have a simple tongue and groove for this reason.

There are currently companies working on providing solutions for successful hybrid products. I would anticipate that within the next year, there will be cost effective, rigid and thermally stable cores for use that are aligned to better match wood to balance structures successfully. PVC has been so popular only because it is inexpensive, and it has been used for decades in resilient flooring. It is also easy to process and compound with different, inexpensive fillers. Newer material developments are now enabling cores that are manufactured from post-industrial and post-consumer waste streams. However, it is imperative the feed stock for recycled content also be balanced lest it upsets the stability of the products. The other side of the equation is helping to reduce the shrinkage in wood. A new, low-cost treatment has recently been developed for helping wood stability by altering the ability of the wood to take on moisture and change dimension. Look for these structures to be much more balanced and better performing than current structures in the marketplace.

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High-Performance Factory Coatings

Another area that causes imbalance in thinner, plasticized resilient products is the use of high-performance factory coatings. On many occasions, curling edges on factory coated resilient tile and thin LVT/LVP are blamed on instability of the vinyl core. Several of these commercial products have historically had thin protective coatings applied to ensure the product gets installed successfully and without damage.

As manufacturers try to drive a value proposition and meet the commercial customer needs of delayed maintenance, less maintenance, high resistance to staining and scratches and lower gloss levels, new high-performance factory applied coating technologies have been developed for products that have never accepted these types of coatings. To achieve the performance criteria, these UV-cured coatings have a high cross link density to provide a “tighter” surface to resist staining and surface scratch. The crosslink density is the amount of polymeric cross linking of a material that takes place when cured. On thin resilient products, like commercial tile, these coatings can shrink significantly when they are cured into a brittle film. If the tile is not able to resist the force applied to it from the coating film, it will lift slightly on the edges or pucker.

Flatness issues with these types of products can also occur from small dimensional changes of the resilient product itself. Most of these high-performance coatings are stable to temperature once cured. This means that the film remains stable while the product changes. If the tile base cools and contracts, a slight “dome” can be seen. If the tile base warms and expands, the edges will lift. Many times, installers cannot see these dimensional issues when they are installing, or even when the installation has been completed. Sometimes it takes the right light source or a higher gloss level (with first maintenance) to see these issues. And sometimes it takes some time for the metamorphosis the product is going through to appear.

One other product that can react to changes in stability is carpet tile with thermoplastic backing. Some new backings contain polyolefin which has a low melt point or glass transition. If the backing experiences uneven heat distribution during manufacture, the carpet tile can be imbalanced and will curl, cup, edge lift and expand.

Remember this important point. Adhesives will not and cannot control the internal forces of imbalanced flooring materials. Anyone who tells you they can is lying to you.

Furthermore, the manufacturing of hard surface, laminated, layered or varied component flooring material is a constant challenge of maintaining the balance of the chemistry of the products and the process of manufacturing them. If you don’t understand this, you won’t understand the products. It is our job to understand these products and how they're made so that we can help you.

This is a lot of information to swallow; we know, but it is important it be known and that you understand the characteristics of these products and how they react inherently and in the installation environment. So now you see that all the physical changes in the product after installation are not the result of the installation being bad. I've said this before, installers cannot create physical changes in the material after its installed. What you see most often is the product itself reacting to influences within it or imposed upon it.

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