Sustainability, Tile and LATICRETE

TDS 194

The following question (or a variation of it) is being asked more and more frequently: Is tile a good choice in regards to green construction, sustainability, the environment, and human health? The answer is unequivocally, yes! Tile is an outstanding component of green construction and sustainability, and, it is the intent of this document to explain why.

One of the biggest concerns, concerning future generations, is to whether there will be enough natural resources remaining to support the world's population (man, animal, plants, etc…). With this concern comes a new understanding and interpretation of the word "Sustainability". According to The Merriam Webster Dictionary, the meaning of the word sustainability is "being able to provide with nourishment"; "to keep going". While these are fairly simple meanings, the meaning of sustainability in the environmental aspect is slightly different. The most popular definition of the word sustainability comes from a United Nations Conference in 1987, where it was defined as "meet present needs without compromising the ability of future generations to meet their needs." While this is a fairly broad definition, the following definition is more specific for the construction industry;

"Sustainable developments are those which fulfill present and future needs while only using, and not harming, renewable resources and unique human-environmental systems of a site: air, water, land, energy, and human ecology and/or those of other sustainable systems." [1]

The Office of the Federal Environmental Executive defines green building **as "the practice of 1) increasing the efficiency with which buildings and their sites use energy, water, and materials, and (2 reducing building impacts on human health and the environment, through better siting, design, construction, operation, maintenance, and removal – the complete building life cycle."** [2] It is clear to see that the definitions of sustainability and green building are similar, and the roles of green building and sustainability are interrelated.

TILE & STONE vs. OTHER FLOOR FINISHES

While it would be nice to provide a simple explanation as to why tile and stone would be a good choice for a sustainable environment, it really is not that easy to do. Sustainability has more to do with the building environment than just recycling or reusing building materials. Sustainability requires a much deeper look into recycling, reusing, life cycle analysis, low volatile organic compounds (VOC), and biodegradability, all in relation to improving human health and minimizing the impact on the whole environment.

Other flooring or finish options, such as carpet, hardwood floors, vinyl flooring, and laminates make the assertion that they are "green", which may well be the case, but let's look at it deeper.

Carpet – manufacturers of carpeting products state that their product(s) are made from 100% recycled materials, which is an outstanding and noble practice. They have the ability to keep billions of recycled water bottles out of landfills every year and provide a safer environment for future generations. However, once manufactured and installed, how "green" is carpeting? Commonly known facts about carpeting include;

1. Carpeting has to be replaced, on average, every 6 years;
2. Carpeting collects dirt, dust, mites, allergens, and mold;
3. Carpeting shows wear paths very easily and quickly;
4. May have the capacity to off gas

Carpeting must be vacuumed on a regular and frequent basis and washed occasionally to maintain its appearance. So, while a large majority of carpeting is manufactured from recycled materials (e.g. plastic bottles) and the VOC content may be low, it still can harbor allergens, dirt, pathogens, and mites very easily which may have a negative effect on human health.

Hardwood – Hardwood materials are a common and beautiful type of flooring material. However, hardwood is manufactured from trees which are harvested, cut and milled to specific requirements, oftentimes from trees which require long growth periods. These floors are typically finished with a stain and/or finish which contain varying levels of VOC. It is not uncommon for some hardwood floors to be sanded and finished every 5 – 10 years, which can reintroduce any VOC present in the finish coating into the structure. The expected life span of a natural hardwood floor, prior to replacement or repair, is 50 years and requires regular cleaning, as well as sanding and reapplication of a hardwood floor finish (e.g. oil based urethane, water based urethane, moisture cured urethane, etc…). Hardwood floors are frequently specified for use in environments where hypoallergenic materials are required because it is easy to clean and does not harbor allergens, dust or other contaminants.

Hardwood may be applied using adhesives or mechanical fasteners in certain areas of the floor. Adhesives used may contain chemicals or materials which are not environmentally friendly, and hardwood floors are susceptible to high moisture vapor emissions from certain substrates and conditions.

Vinyl Flooring – Vinyl and linoleum flooring has been in use for over 100 years as a flooring product and is essentially made the same way today as it was at the time of its inception. It is sometimes billed as the original "green" flooring material, despite the fact, that tile and stone has been used for thousands of years as a flooring and wall veneer. Linoleum flooring is manufactured from some rapidly renewable resources, such as powdered wood/cork, linseed oil, and other materials over a fiber backing. Vinyl and linoleum are often recommended (unlike carpet) for use in environments where hypoallergenic materials are required or where people with respiratory problems live or congregate.

Some vinyl flooring products utilize phthalates (plasticizers that give linoleum flexibility and resiliency) which is a material found on the International Living Building Institute (ILBI) "Living Building Challenge Red List". In order to be certified as a "Living Building" a project cannot contain, among other chemicals and compounds, any phthalates.[3] It is important to note that not all vinyl flooring products contain phthalates, so please check with the vinyl flooring product manufacturer for more information on their specific product(s). In fact, it may be prudent to check with the vinyl flooring manufacturer to see what other chemicals/additives are being used which may not be healthy and safe for indoor environmental quality. Vinyl and linoleum products use adhesives for proper installation which may contain chemicals or materials which are not environmentally friendly and may also be susceptible to high moisture vapor emission rates through concrete substrates.

Vinyl products and their adhesive, which may still exist in old buildings, can contain asbestos. Asbestos is a material which has a long and clouded history with health concerns (e.g. carcinogen often associated with mesothelioma, lung cancer, etc…). Removal of asbestos from structures requires expensive and complex mitigation techniques, so often the asbestos based flooring is simply covered with a new and safer veneer. However, if proper records are not kept or nobody checks the records, when the new veneer is removed it puts people at risk because the flooring which contains asbestos may be removed as well, with no one's knowledge! This possibility goes against the previously stated definition of sustainability.

Laminate Flooring – Laminate flooring is a layered synthetic material which has been fused using a lamination process and can simulate wood, tile or stone flooring. Laminates are usually manufactured using melamine resins and high density fiber board (HDF) and are covered by an appliqué layer and a clear protective layer. Laminate floor is inexpensive to purchase and can be installed by almost anyone from beginner to expert.

While many may feel that laminates are the ideal choice as a flooring option, it does have some concerns which may have an impact on health and safety. As stated earlier, laminate flooring is often manufactured from melamine resins which are manufactured from formaldehyde. Formaldehyde is a material which is found in ILBI "Living Building Challenge Red List" as a product which can cause health/toxicity concerns. Some laminate flooring products use a chemical process to reduce and/or neutralize formaldehyde emissions from the floor.[4]

There are also some other health and safety concerns with laminate flooring which should be taken into consideration. Moisture may cause laminate flooring to buckle, warp or soften, and may even allow for mold and mildew to grow under the flooring. Gapping between the boards may occur and peaking is common if proper allowance for movement is not made during installation. Laminate flooring can also be very slippery, which can lead to slip/fall injuries for adults, children and pets. All of the above mentioned concerns can cause health or safety problems so proper installation, inspection and care practices should be employed. Please contact the laminate flooring manufacturer for installation methods and possible concerns for their particular product(s).

Ceramic Tile and Stone - Ceramic tile and stone are multi-functional veneer finishes which can be installed in practically any environment. Tile and stone can be installed indoors, outdoors and submerged in any climate, almost anywhere in the world. Tile and stone can be installed on walls, floors, soffits, ceilings, countertops, and backsplashes in residential, commercial, industrial, and artistic applications. There are those who claim that tile and stone utilize natural resources which are not renewable, and they would be correct. There are those who say that a great deal of energy is used during the manufacturing process for ceramic tile, and they would also be correct.

The firing process during tile manufacturing requires a great deal of heat which is provided from a variety of heat sources. In fact, between 90 – 95% of tile manufacturing energy consumption is used to the firing of the tile. Research is being conducted and techniques established which utilize renewable fuels to fire a kiln from the beginning of the process to the end. Other measures are being used to reuse heat which remains from the firing process to supply energy for the drying ovens and for production of electricity used by the manufacturing facility. This will make more effective use of fuel which can ultimately lower the cost of manufacturing while benefitting the environment.

At the recycling level, dust collected during the manufacturing process and other conformation waste are being reintroduced into the manufacturing paste. Water is being reused and recycled in closed systems to minimize the impact on the environment. These steps and more have contributed significantly to reductions in energy consumption and post-production waste.

The health impact on both tile manufacturing workers, tile installers and building users have been steadily eliminated. The use of lead during production, used to provide gloss and visual depth to tile products in the past have been replaced with non-toxic compounds.[5]

As stated in USGBC LEED v4.1 Reference Guide for Green Building Design and Construction, under Credit Low Emitting Materials, Step-By-Step Guidance; Step 1; The product is inherently non-emitting. Examples of non-emitting products are stone, ceramic, powder coated metals, plated or anodized metal, glass, concrete, clay brick, and unfinished or untreated solid wood flooring, provided they do not include integral, organic-based surface coatings, binders, or sealants.

Also stated in USGBC LEED v4.1 Reference Guide for Green Building Design and Construction, under Credit Low Emitting Materials, Further Explanation; Inherently Non-Emitting Materials; Naturally occurring materials and products that are made from inorganic materials either very low or no VOCs. USGBC recognizes that such products do not need to undergo testing to prove they do not emit VOCs. For the purpose of this credit (LEED v4.1 Low Emitting Materials), untreated and unfinished solid wood (not engineered wood) flooring can also be considered non-emitting even though such flooring will likely emit some amount of formaldehyde naturally. This applies only to flooring materials and not wood paneling or cabinetry.

LATICRETE manufactures a complete line of installation products (e.g. HYDRO BAN®, 254 Platinum, 257 TITANIUM, SPECTRALOCK® PRO Premium Grout^, LATAPOXY® BIOGREEN™ 300, etc…) which are UL GreenGuard Gold certified for low VOC content. For more information on LATICRETE low VOC products please refer to LATICRETE TDS 251 “Low VOC LATICRETE Products/LEED Certification”. Many tile installation materials (e.g. 4-XLT Rapid) also employ “dustless” technology which minimizes the amount of airborne powder during mixing.

Figure 1: UL GREENGUARD Gold certificate for 257 TITANIUM™

LATICRETE has eight production facilities around the USA and many other manufacturing plants around the world (e.g. China, Singapore, India, United Arab Emirates, Australia, Mexico, Brazil, Austria, and more…) to provide locally produced products from local raw material sources to most major population centers. For more concise information on recycled content, local raw material sources, manufacturing facilities, Product Specific (Type III) Environmental Product Declarations (EPD), Health Product Declarations (HPD), and VOC content for each particular project, please use the LATICRETE® LEED Project Certification Assistant which can be found at https://laticrete.com/en/innovation-and-impact/green-leed/leed-project-certification-assistant.

LIFE CYCLE ANALYSIS

To date, the best way to look at the impact of a finish veneer, as well as for all components of a structure, on the environment is a Life Cycle Analysis (LCA). An LCA is an across the board study of a product that begins with the extraction of raw materials, the environmental impact of extraction, the manufacturing process, impact on production workers and the surrounding community, recycled content, transportation, application, use, effect on users & building occupants, maintenance, end-of-usefulness, and the recycling, reusing or disposal impact on the environment. LCA is a comprehensive strategy for the evaluation of construction materials when the desired result is the safest, cleanest, healthiest, most durable, and lowest impact building projects.[7]

LATICRETE provides Product Specific (Type III) Environmental Product Declarations (EPD) for our Cement Mortar for Tile Installation, Cement Grout for Tile Installation and Cement Self-Leveling Underlayments. EPDs require a Life Cycle Analysis and take into account a 60-year life cycle for tile and stone installations. Please visit https://laticrete.com/en/innovation-and-impact/green-leed/environmental-health-product-declarations to access the EPDs and the current library of Health Product Declarations (HPDs).

The chart below, provided by Tile Council of North America (TCNA), shows the cost per square foot for installation and life cycle cost of maintenance, as well as the expected life of different flooring materials. In the chart below, the five tile categories are based on a 50 year expected life. This LCA study was conducted in 2005 by Scharf-Godfrey an independent construction cost consultant and the stated costs reflect high standards for installation and good maintenance practices. It is clear that tile has the lowest life cycle cost per year when compared to competitive veneer finishes. Because of the long expected service life and the ease of maintenance, tile is easily the best value in the flooring industry.

LIFE CYCLE COST FOR FLOOR FINISHES[8]

Floor Finish	Installed Cost*	Life Cycle Cost*	Expected Life (years)	Cost Per Year*
Quarry Tile	**$6.83**	**$16.13**	**50**	**$0.32**
Glazed Ceramic Floor Tile	**7.00**	**16.30**	**50**	**0.33**
Glazed Porcelain	**8.34**	**17.64**	**50**	**0.35**
Mosaic Tile	**8.20**	**17.50**	**50**	**0.35**
Unglazed Porcelain	**8.30**	**17.60**	**50**	**0.35**
Natural Hardwood	9.31	20.80	50	0.42
Travertine (Turkish)	12.50	21.80	50	0.44
Marble	21.00	30.30	50	0.61
Laminate	8.84	17.77	25	0.71
Man-made Hardwood	9.58	18.51	25	0.74
Portland Cement Terrazzo	14.88	24.27	30	0.81
Stained Concrete	12.40	24.60	25	0.98
Carpet	3.22	6.50	6	1.08
Resin Terrazzo	8.50	16.53	15	1.10
Sheet Vinyl	6.90	13.90	10	1.39
Poured Epoxy	8.18	15.18	10	1.52
VCT	3.91	18.35	10	1.83
* Per Square Foot				

For reference, the expected life of carpet is 6 years with an installed cost of $3.22/ft^2 and a yearly cost of $1.08 it would cost over $73.00/ft^2 over 50 years while a glazed porcelain tile would cost $25.98 over the same 50 year period (assuming all costs stay the same).

FUTURE OF SUSTAINABILITY AND GREEN BUILDING

As time goes by, the resources of the world are being diminished, and it is up to the current and future generations of humans to ensure that the resources available last for as long as possible. Creating structures which minimize the impact on the environment, use less vital resources, maintain the health and well being of the building occupants, and provide some of the raw materials for future construction is a goal for the architectural and construction industries. No longer can a building be designed for "cradle to grave" standards; instead, the new mindset must be "cradle to cradle". In other words, once a building has reached the end of its useful life, the contents and structure will be used to build newer and better structures without taxing natural resources taken from the environment and processed to a finished material.

New construction codes are being developed and implemented to ensure that green construction and sustainability are fully utilized in the future. The International Code Council (ICC) will soon make available the International Green Construction Code (IGCC) to establish standard building practices for the design of high-performance green buildings which will be a jurisdictional compliance option. The Collaborative for High Performance Schools (CHPS) is already being used as the standard for the construction of educational facilities around the USA. The Building for Environmental and Economic Sustainability (BEES) Technical Manual and User Guide was developed by the National Institute of Standards and Technology to provide a systematic methodology for selecting building products that achieve the most appropriate balance between environmental and economic performance. The Tile Council of North America has developed the Green Squared^{SM} Certification Program (ANSI A138.1) to further define the sustainability of ceramic tile and provides the manufacturers of tile and tile installation materials with the most comprehensive "Green" standards in the industry. The International Living Future Institute has implemented the Living Building Challenge (LBC) to help ensure a global transformation toward true sustainability. The LBC comprises seven performance areas (petals) which are site, water, energy, health, materials, equity, and beauty which are broken down into 20 Imperatives, each focusing on a specific sphere of influence.

The development of new technologies even allows for ceramic tile installation to improve the environment and actually create energy. For instance, ceramic tile is being produced which has the capability of lowering common air pollutants (CO, NOx, SOx) and reduce, or eliminate, bacteria on the surface of tile.[9], thus creating a healthier environment. Tile and stone installations can also utilize piezoelectric elements to produce electricity from people who are simply walking on the floor. Installations already exist in Japan and the United Kingdom which create energy from walking or dancing on the tile. This is technology currently not available in flooring finished with carpeting, laminates, hardwood or resilient materials.

LATICRETE International has taken a proactive stance in the evolution of green building and sustainability by producing materials which utilize recycled content, are manufactured regionally from essentially local raw materials, and have low VOC content, as well as VOC emissions which easily achieve UL GreenGuard Gold certification. LATICRETE products contain no wood or metal which also minimizes the impact on the environment. You can rest assured that tile or stone installations which utilize LATICRETE products provide permanent, trouble free installations and provide no health or environmental concerns to the building occupants or tile installers.

[1] Tom Bartuska, Bashir Kazimee, and Michael Owen. "Defining Sustainability." A Comprehensive Urban Regenerative Process: 11 Nov. 1999 http://www.arch.wsu.edu/09%20publications/sustain/defnsust.htm.

[2] Cassidy, Robert (Editor-In-Chief). "White Paper on Sustainability." Building Design and Construction. Nov. 2003 http://www.bdcmag.com.

[3] McLennan, Jason F. "Living Building Challenge™ 2.0: A Visionary Path to a Restorative Future" International Living Building Institute. April 2010 https://ilbi.org/lbc/v2-0.

[4] Laminate flooring. (n.d.). In *Wikipedia*. Retrieved February 4, 2020, from http://en.wikipedia.org/wiki/Laminate_flooring.

[5] LOBO, Carla. "Ceramic Tiles: A Sustainable Architectural Skin." http://rice.iuav.it/230/1/13_lobo.pdf.

[6] LEED Reference Guide for Green Building Design and Construction, v4.1 Edition Document Addenda. United States Green Building Council. November 2017, https://www.usgbc.org/leed/v41#bdc.

[7] Bogo, Anthony. "CTC Graduate Field Report Subject: Ceramic Tile – Missing In Action on the Green Building Front." Ceramic Tile Institute of America (CTIOA), www.ctioa.org/pdf/ceramictilemissingreen.pdf.

[8] Tile… The Natural Choice – TCNA Green Report: Life Cycle Cost Study. Tile Council of North America Handbook (TCNA) for Ceramic, Glass and Stone Tile Installation insert. 2019.

[9] www.active-ceramic.com.

^ United States Invention Patent No. : 6,881,768 (and other Patents)

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