41st IAHS WORLD CONGRESS
Sustainability and Innovation for the Future
13-16th September 2016
Albufeira, Algarve, Portugal

LINOLEUM AS FLOOR COVERING: CHARACTERISTICS, APPLICATION AND MAINTENANCE

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Keywords: Linoleum, Resilient floor covering, Execution, Maintenance

Abstract *Nowadays there is an attention in building or rehabilitating using quality and durable materials, especially in floor coverings, since they are used constantly and are subjected to great mechanical actions. The environmental concern is also present in the choice of sustainable materials, which does not harm the environment, in their manufacturing process and in their posterior degradation.*

This paper seeks to present the linoleum, namely its properties and characteristics, execution methods, and maintenance recommendations. Therefore it seeks to systematize relevant information regarding linoleum and to promote its choice as floor covering.

The paper begins to refer the origin, manufacturing and characteristics of the linoleum as building material. After that is make a brief indication of the application methods. At last is indicated cleaning recommendations and maintenance methods.

Linoleum is pretended to be shown as a material of excellence and this paper intends to help professionals in the choice of an environmentally friendly floor covering. Linoleum, being a resistant and durable material, is composed by sustainable raw materials, and is adequate for a multiplicity of locations as floor covering.

1. INTRODUCTION

When choosing a floor coating it is necessary to consider the local aesthetic aspect and the compatibility with the utilization that the compartment is intended to.

Floor coatings are under regulations and legislation to ensure compliance with quality and durability requirements and ensure the satisfaction of the users, as well as the suitability in each case.

Linoleum emerged in the 60s of XIX century, having been subject of several improvements in order to adapt to the growing demands of the market. Initially appearing in few colours and patterns, with the growing popularity, the variety of colours, patterns and thicknesses in which it was marketed was improved. Its use was common in restaurants, offices, banks, schools and public buildings, which fit in its functionality and aesthetics. Linoleum was manufactured with oriental patterns, floral or other designs, imitating the look of ceramic tiles and in various thicknesses [1].

Linoleum as floor coating has been gradually replaced by vinyl floor coating, which has similar properties like resilience and durability, and offers lower cost. With the increasing of environmental concern and the promotion of natural materials, with less environmental impact, linoleum has been increasingly regarded as floor coating option due to its composition of natural materials and their more environment friendly properties, by comparison with other solutions.

Being manufactured in roll or tile, linoleum is available in a variety of aesthetic options, in order to be adaptable to several spaces, such as hotels, hospitals, offices and recreational spaces, among others.

The multiplicity of colours and patterns that are marketed (figure 1 left) associated to the easy and quick installation (due to the development of new adhesives and glues) as well as the low maintenance and long service life (over 30 years) favours the choice of this material as a floor covering.

In the application of a floor coating, it is necessary to consider the use of the space that it is intended to. Linoleum is a floor coating with good mechanical resistance to the movement of people, has easy maintenance, it is recyclable, antibacterial, anti static and hypoallergenic. It has high durability materials (if properly cleaned and maintained) and appears on the market in various aesthetic options. Linoleum is a product of organic raw materials from sustainable crops and is therefore a floor covering with low environmental impact.

With its acoustic properties, linoleum contributes to the sound insulation local percussion noise that is applied. It could be used as floor coating or as decorative wall covering.

2. LINOLEUM

In 1863 the British Frederick Walton patented linoleum, the first resilient floor coating which is still used today. The first factory opened in 1864 in Staines, near London, next to the river Thames, becoming known worldwide by the term 'Staines Lino'. This factory closed around 1970, being celebrated *in situ* for a statue of two factory workers 'Staines Lino Factory'.

Until 1892, linoleum was manufactured only in a color called natural brown. With increasing popularity, it has also been produced in red, blue, gray, white and green, by introducing the option of multi-colored patterns (figure 1 right). Prior to the World War I, by a process similar to silk printing, coatings with patterns and ornaments could be manufactured in England. The World War II led to the fall of linoleum production level, and then recovered a few years after World War II, since the product was already recognized as floor coating [2].

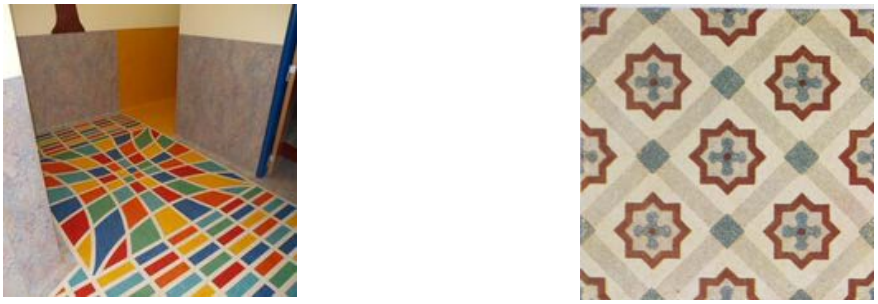

Figure 1 - Linoleum in kindergarten (left) and Linoleum standard (right)

By 1970, with the emergence of new synthetic options in the market, with lower cost than linoleum, there was a decrease in its the demand. By 1973 with oil crisis, the cost of raw materials of synthetic coatings increased significantly, turning linoleum into a viable option again, in economic terms. Since then, linoleum has become a material of choice for floor coverings, competing with materials of synthetic origin and always maintaining its integrity as organic material from natural raw materials [2].

Linoleum is present in various historical buildings around the world such as the prison’s canteen of Alcatraz, in San Francisco, California; the Kremlin in Moscow; White House in Washington DC; the German Parliament; Buckingham Palace in London; Anne Frank's house in Amsterdam; the University of Sorbonne in Paris [3].

Linoleum is an organic material produced from natural raw materials in a process with low environmental impact since their constituents can be found in nature or are waste from other industries [4]. Having no additives to improve their properties, they are given only the materials that compose it:

- Linseed oil (or flaxseed oil) is the main constituent of linoleum (figure 2 left), being extracted from flax seeds by a process of cold pressing. The process is developed in several stages: seed cleaning, stripping, drying, milling, pressing at low temperatures, and finally decanting and filtering the oil. The linseed oil acts on the linoleum as a ligation product between all the materials through their reaction with air [4].
- Resin pine (figure 2 right) is extracted from pine tree through a process called gumming. This process consists in performing cuts on the trunk and collecting the resin through a container. The gumming period lasts nine months, from the beginning of March to the end of November, corresponding to the time when resin production is higher due to the heat. The pine resin gives linoleum its mechanical properties [4].

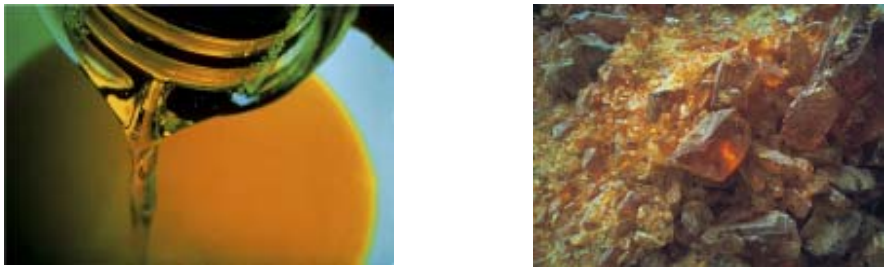

Figure 2 – Flaxseed oil (left) and resin pine (right) [5]

- Wood flour (figure 3 left) is a waste of the transforming wood industry, and is a material which promotes recycling and reuse of industrial areas. Wood flour gives linoleum durability and resistance to compressive stresses and tensile stresses [4].
- Cork flour (figure 3 right) is similar to wood flour and is a waste from the transforming cork industry, encouraging the full use of this natural material taken from the cork tree through a sustainable process. Cork flour provides flexibility properties to the linoleum due to its elasticity and compressibility [4].

Figure 3 – Wood flour (left) and cork flour (right) [5]

- Calcium carbonate is abundant in nature, being the main constituent of limestone. It is obtained by the extraction of stone, disassemble, fragmentation and grinding. Calcium carbonate provides stability to the linoleum [4] through its properties: non-flammable, water-insoluble, high melting point (1200 °C) and high decomposition temperature (470 °C).
- Pigments used in the linoleum are ecological ones (figure 4 left) not containing heavy metals. They allow the production of various colors and aspects, providing aesthetic adaptability for use as floor covering in various areas [4].
- Jute (figure 4 right) is an herbaceous plant of the linden family, being grown to obtain fibers with which are manufactured and have the same name. Being composed mostly of cellulose (about 64%) its application in the manufacture of linoleum is a natural enhancement and promotes strength and compactness to the product [4].

Figure 4 – Red pigment (left) and Jute plantation (right) [5]

Linoleum presents antibacterial properties due to the linseed oil and pine resin, inhibiting the growth and multiplication of harmful microorganisms.

Linoleum is a product with low impact on the environment, which makes it a sustainable material. From its constituents, flax and jute are raw materials obtained by harvesting, the extraction of pine resin is an ongoing process and wood flour and cork flour are, as mentioned, waste from industries of wood and cork, respectively. Calcium carbonate is obtained from the limestone, existing in abundance in nature. Having no additives or other artificial components to increase its durability, linoleum has a lifespan of over 30 years and could be pickled [3].

At the end of its life, linoleum could be energetically valued, being used as fuel, since it generates a high thermal energy that exceeds the degree of heat required for its production.

Linoleum characteristics vary slightly depending on the brand and their intended purpose, such as linoleum with acoustic properties which has greater thickness and less flexibility.

The thickness of a resilient floor covering is one of the most important items for their

choice, since it is a property that influences the flexibility, resistance to marks and soundproofing. The thickness of the linoleum is subject to rules and regulations and may range from 2 mm to 4,5 mm, depending on the type of linoleum [6].

Linoleum is subject to a classification that categorizes it taking into account the type of use - domestic, commercial or industrial - and considers the expected use intensity of the space. Given this classification, linoleum in the category of domestic use is suitable for high traffic areas such as living rooms, entrance halls or dining rooms. Within the category of commercial spaces, depending on the type of linoleum, linoleum could be suitable for very intense traffic areas, which includes classrooms, hotels, department stores, schools, offices, halls of reception and courts to multi-purpose [7].

Linoleum as a floor covering material is subjected to stress tests, including chairs with casters, cigarette burns, light fastness, fire resistance, thermal resistance, electrical resistance, and flexibility. With the completion of these standardized tests, linoleum is presented as a suitable material for offices, resistant to diluted acids, oils, fats and conventional solvents. This product does not stand, however, prolonged exposure to alkalis. It also has antibacterial properties and is resistant to the bacterium MRSA (methicillin-resistant staphylococcus aureus) present in hospitals and likely to cause damage to human health [7].

Regarding the property of resistance to brands, linoleum is categorized depending on the residual marks after a static load test. This is, a linoleum with less thickness has a lower tolerance than a thicker linoleum seen that the flexibility of the materials is largely different. The reference values of residual marks may range from 15 mm for simple linoleum thickness of 2 mm until 40 mm for the thickness linoleum equal to 4 mm [7].

In an urban environment, with strong daily presence of noise, even with the new isolator design solutions sometimes it becomes important to achieve the acoustic correction of a space for the floor covering. Being subject to rules that impose a maximum acceptable level of noise, this may be relevant. As such, the linoleum has acoustic properties, and the material in its simplest state can attenuate up to 4 dB, while the acoustic linoleum (thicker to promote the attenuating effect of noise) decreases approximately 17 dB [7].

To be considered a coating suitable for large foot traffic areas, such as hospitals and halls, linoleum has to provide slip resistance in order to avoid falls and to provide the safety of users. As such, linoleum checks a slip resistance class that indicates safety footwear using a maximum tilt angle of the surface from 6° to 10°, this being wet or oily. According to standards (DIN 51130) this coating can be seen as suitable for entrances and staircases accessible from the outside, shops, restaurants, hospitals and schools [7].

3. LINOLEUM AS FLOOR COVERING

Linoleum can be applied in many kinds of floors: concrete, wood, ceramic tiles, pre-

existing resilient coatings, aluminum, stainless steel or copper [8]. It should not be applied in asphalt substrates, bases that contain any adhesive residues, concrete substrates with excessive moisture, resilient floor covering highly textured, or bases with heating under floor to reach temperatures above 27 °C.

Before its application, the rolls or tiles must be stored for a period of 24 to 48 hours at a temperature of 18 °C, which should be maintained in the place of installation and 48 hours after. Like the temperature, the air humidity at the local of application should be kept between 50 % and 60 %, because of the adhesive, for the correct installation of the floor coating [9].

Before the installation of linoleum, in rolls or in tiles, it is necessary to plan the sequence of work to ensure the amount of material necessary in both solutions and the necessary adhesive for attachment. The area where the linoleum is to be installed must be maintained with sufficient ventilation during the entire process and, due to the flammable abillity of the coating, there should not be any sources of ignition or burning in the area.

3.1. Fixation of the floor covering

For fixing the floor covering adhesives or glues are used, which must be selected according to the substrate type, environmental conditions and the back floor coating.

The glue's drying time varies depending on the type of glue used and it is between 24 and 48 hours. Because of that the coating could only be put in use after this time [9]. If the glue curing time is not respected and the floor coating is put in use before that period of time, a load on the coating may cause irreversible marks.

The adhesive should be uniformly applied, using a trowel with adequate teeth due to the viscosity of the paste and the kind of substrate. The using rate of glue for acrylic emulsions or alcoholic solutions varies between 250 and 350 g/m^2 [9]. During application of the adhesive the recommended amount must be respected, otherwise the coating will not adhere well to the substrate.

After the application of the adhesive and the floor coating, the work must be completed by passing a metal roller (figure 5 left) with movements from the center to the periphery of the floor coating, in order to press the floor coating against the substrate and avoid entrapping air bubbles that could cause blistering phenomena later. The roll must be passed again after cutting the joints of the coating [9].

3.2. Joints

The joints are very important elements in floor covering whereby their treatment must be considered carefully otherwise may result problems likely to affect the durability of the floor coating. In linoleum's application the cuts made should be clean and straight in order to facilitate the closing of the joints.

For the closing of linoleum joints, it is done the heat-welding process with specific welds for linoleum. The heat welding promotes a homogeneous melt between the edges of the joint being performed with the aid of a hot air gun and a suitable welding rod. It provides a permanent tightness of the coating and thereby durability [9].

The heat welding must be carried at least 24 to 48 hours after installation of the floor coating [9]. If the welding is performed prior to the said time, it may result in changes in the glue in the area of the joint due to thermal influences which may interfere with the joining process.

Initially the notch is made by using a cutting machine with a U-shape so as to provide the best possible contact between the floor coating bead and welding [9].

The depth at which the notch is carried out depends on three factors: type of floor coating, floor coating thickness and diameter of welding rod being used. However, the depth should not exceed, in any case, half the diameter of the bead of weld or 2/3 the thickness of the floor coating, corresponding at its maximum to 2,5 mm [9].

The temperature at which welding is performed should be adequate to the type of coating and the weld bead. For the linoleum this temperature is between 350 °C and 400 °C. The hot air gun must be equipped with a nozzle fast welding and must be assured that it is at the correct temperature before performing the welding [9].

Before starting the hot welding process, the welding speed, temperature and pressure applied should be assayed in a sample piece. It is recommended an average welding speed of 2 meters per minute [9]. After the welding process it is necessary to eliminate the excess material through two steps, with a slider guide and a spatula (figure 5 right).

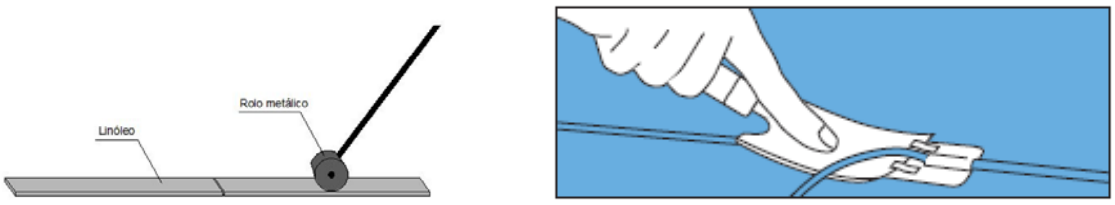

Figure 5 – Passage of a metal roller (left) and slider guide and spatula (right)

3.3. Conservation and maintenance

All floor coatings require proper maintenance in order to maintain their characteristics and durability. By following a maintenance program to protect and preserve the coating, increasing its useful life and reducing the possibility of future expensive repairs.

Newly installed linoleum floor coating could only be subject to cleaning three days after

its application and only after 5 days it could be cleaned with the aid of a rotary washer [8]. Depending on the type of floor coating and the volume of traffic to which it is subject, it will be necessary to adapt maintenance and cleaning. The colour and the pattern can influence the appearance of the coating, since they can assist in masking stains and dust, in this case an average colour or a high contrast pattern allows better results [10].

A daily preventive maintenance should be done by controlling the existence of dust and debris deposited in the floor coating, through normal existing traffic on site. The existence of rugs in the access areas reduces the remaining of waste in the coating. These rugs should have high friction, reverse non-staining linoleum and should have regular cleaning [8].

The regular maintenance should be performed in order to maintain the floor coating appearance level and it consists on the removal of loose dust and waste (by aspiration or washing), removal of stains and spots (with a damp cloth and mild detergent), surface cleaning with a rotary washer and a neutral detergent (pH 6 to 8) to remove irregularities in the brightness of the coating and promote a uniform appearance [10]. After drying the coating may be applied 3 to 5 layers of polishing and in areas subject to high pedestrian traffic or aggressive agents must apply sealant to a tough stains before polishing [8].

4. CONCLUSIONS

Currently in Portugal there is a decrease in the use of linoleum as floor covering, passed over by vinyl, particularly in public buildings. When linoleum appeared it had a complicated maintenance, being needed a periodic application of wax, and because of the lack of moisture control, linoleum had improper behaviour during service life or under extreme events.

There are still doubts about the choice of the linoleum as floor covering. If all requirements are met, the floor coating is properly chosen and executed, linoleum is presented as a good option compared to other floor coatings. It is always needed consideration over the type of use that space will have, the type of support under de floor coating and environmental conditions that it will be subject to. Only this way could be ensured that the linoleum is suited to the requirements both of habitability and safety and durability.

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