Course Name: Building Materials as a Cornerstone to Sustainability

Professor: Dr. Iyer Vijayalaxmi Kasinath

Department of Architecture,

School of Planning and Architecture, Vijayawada

Week: 06

Lecture 02

Milk Paints and Recycled Plastics

Hello dear students. In our last class, we saw about a very innovative building material called as bioluminescent paints. We saw how it is a very environmentally friendly option and alternative. We saw its application and we also saw that a lot of research still needs to be done in that domain. Today we will see two innovative building materials. One is milk paints and another is recycled plastics.

And we will see how these two have been integrated into architecture. So, today we will see about milk paints first and then recycled plastics next. So, what are milk paints? Paints typically consist of pigments, solvents, binders and various additives. Depending on the type of paint which could be acrylic, oil based, alkyl etcetera the components will change.

Regular paints typically have high volatile organic compounds or VOC content. These are not good either for the environment or human beings because human beings should not be exposed to this kind of pains for prolonged periods of time as it can cause health issues. Conversely, milk paint is derived from natural pigments and basic elements such as clay, lime and milk protein or milk casein. It is zero VOC paint because these natural earth pigments are safe for the environment. These paints are non-toxic and they do not release any offensive aromas or smell or fumes or any odor.

These are ideal for spaces especially where children occupy them. Let us briefly look at the history of milk paints. Now colonial American artists have travelled the new territories in quest of inspiration, bringing paintbrushes and lime with them. So an artist would get milk from a nearby farm to dilute their paint once they found a scene or an object to paint. All milk paint recipes still called for casein which is a protein present in milk.

Ingredients such as olive oil or eggs, wax, linseed oil and glue. These are derived from animal hides and frequently added to the milk paint recipe and each would have a

different outcome. So, it was actually an accidental affair of how milk paints started into human being. Now, paints were first packaged in metal cans with a tight fitting lid during the American Civil War era. The commercialization of paint manufacturing started with this breakthrough.

Large amounts of paints may now be produced fast and shipped across the nation. The use of milk paint decreased as a result of the produced paints oil bases. The paints protein could not be preserved in the metal containers, making it unsuitable for large scale manufacturing, storing and using. During World War II, chemists realized that lead and mercury which were included in many paints were a threat to human health. Paint manufacturers changed the formulations for oil-based paints as a result of this revelation.

Growing public pressure to protect the environment and minimize pollutants led to changes in the manufacturing processes of numerous items. The current recipe for milk paint is produced as a green alternative to commercial paints. Now, let us look at the advantages of milk paints. First is these are very simple and water based recipe making them easy to use. So, ease of use is the first advantage.

Ease of use. So, they are easy, simple. They are environmentally friendly and ecologically favorable. So, environment positive. They are non harmful, they are not harmful because they are non toxic.

Now, after drying there is no lingering smell and therefore, no odor after drying unlike VOC paints. Depending on the surrounding temperature, they dry quickly. They dry within 30 minutes to 4 hours depending on the outside temperature. So, they dry fast. And also they provide a breathable coating.

They are not dense like plastic, but they provide a breathable coating. It sticks to many of the surfaces like concrete or stone, untreated brick, raw wood, dry walls, plaster and so on. So, the adhesiveness is good on most surfaces. Paint right on existing finishes for a peely, chippy or crackled surface. So, we can paint these directly on whatever surface is available.

What we mean by that is primers are not necessary. So, there is elimination of one more round of chemicals. Especially when we use raw wood and porous surfaces. It sticks to latex with the addition of another ultra bond. Now it also remains usable for a minimum of two weeks after mixing it with water.

There is no need to hurry up its usage once you mixed with water because it can last a fortnight. It does not contain radioactive kaolin clays as filler. Traditional color palette

based on antique painted furnitures can be used. So the color palette is very earthy and it is suitable for traditional painting or antique painted furnitures. Now let us see how this is done.

Now lemon juice or vinegar or any acidic ingredient is combined with fresh milk. Solid curds and liquid whey are created when the milk's casein protein separates and curdles. After straining, the curds are usually dried in a heated oven or a sun. After this, lime slaking happens. So after adding water, calcium hydroxide also known as hydrated lime is allowed to slake or heat up and emit its steam.

Through this procedure, the lime is reduced to a fine powder that can be combined with the casein. After this, the dried milk curds are ground into fine powder and combined with powdered pigments for desired colours. The mixture is thoroughly blended and stored in airtight containers until they are ready for use. What happens in the modern context? Instead of fresh milk, powdered milk casein is used and it eliminates the curdling step. This makes the process much faster and simpler.

Many manufacturers offer premixed milk paint powders with pigments and other ingredients already added. This saves time and ensures consistent results. The pre-mixed powder is simply mixed with water to the desired consistency and applied directly to the surface. So, we saw the older traditional version as well as the modern version of milk paint. What are the advantages? The advantages are it's an extremely eco-friendly product.

So milk paints are environmentally friendly and they are biodegradable. They have unique aesthetics. They create a distinct matte finish with subtle variations in color and texture. They are durable because once cured milk paints are long lasting and resistant to chipping and peeling. Besides they are customizable because they can be mixed to create custom shades and tints offering versatility in design.

Let us quickly compare milk paints with other types of paints. Milk paints are made from natural ingredients as we saw which are mainly milk casein or milk powder, lime and natural pigments. Whereas chalk paints use mineral based pigments and latex paints use synthetic and chemical components. If we look at the texture, milk paints have a matte texture and they have a particular texture or a finish. Chalk paints are smooth and they have a vintage look.

Whereas latex paints are glossy like satin and some of them also have a matte finish. Milk paints are absolutely non-toxic. They are eco-friendly. While chalk paints have low VOC content. Lactic paints have potential VOC emissions.

So, from environmental point of view milk paints are the best to be used especially when we are dealing with spaces where children and elderly reside. So, with this we come to an end of milk paints. But in this class itself, we will see about recycled plastic. Let us look at recycled plastics. Now, polymers are the primary constituent of a broad variety of synthetic or semi-synthetic materials known as plastics.

Plastics may be molded, extruded or pressed into solid objects in a variety of shapes. This is due to their flexibility. Its widespread use is a result of its adaptability as well as a host of other qualities such as being lightweight, strong, flexible and affordable to make. Most plastics are produced using industrial systems. So plastics are made from compounds based on fossil fuels such as petroleum or natural gas.

Why is it necessary to recycle plastic? Plastic makes up a huge part of our solid waste. Right from the first thing we do in the morning which is picking up our phone to brushing our teeth, we are involved with plastic. Plastics take a long time to break down. Plastic pollution is a major problem and a huge problem. Recycled plastic can be put to good use.

Plastic recycling also conserves a lot of energy. Let us look at the mechanical recycling of plastics. So the process of recovering plastic waste by mechanical procedures such as sorting, washing, drying, grinding, re-granulating and compounding is known as mechanical recycling. Because mechanical recycling does not alter the material's chemical makeup, polymeric materials can be reused and recycled repeatedly closing the loop. Only recovered high value plastics such as those found in milk jugs or water bottles are subjected to this technique.

The best waste streams for mechanical recycling are those that can readily produce huge volumes of clean plastic of one type. The environmental advantages of using recycled materials instead of virgin ones typically surpass the environmental costs associated with their collecting, sorting, transportation and recycling processes. Additionally, the potential profits from selling recycled materials may offset these expenses. We also have the chemical recycling of plastics. The process of transforming polymeric waste into materials that can be utilized as raw materials for the production of plastics or other products involve altering its chemical structure.

This is known as chemical recycling. These basic building components have the properties of virgin or brand new resin because they can occasionally be endlessly re-polymerized. There are several ways in which the change can take place but none of them include fire or burning plastics. So, this can be used to plastic garbage such as chip bags

and chocolate wrappers that would otherwise be burned or disposed of in a landfill. Let us now look at the energy recovery. Now, certain products cannot be recycled using the technologies available today.

These used non-recyclable plastics are transformed into a variety of beneficial goods including fuels and power through the process known as energy recovery. The quantity of waste sent to landfills would be greatly decreased by using plastics for energy recovery. So, what are these processes? First is pyrolysis. Non-recycled plastics can be converted via pyrolysis into synthetic crude oil which can then be refined into waxes, heating oil, diesel fuel and gasoline. Thermal treatment, the process of burning a variety of non recycled materials to create steam for the production of electricity is known as thermal treatment.

Third is gasification. Through the process of gasification, non-recycled materials are transformed into sink gas or synthetic gas, which can be utilized to generate electricity or transformed into fuel or chemical feedstocks. Refuse derived fuel or RDF is a solid fuel made from solid waste that hasn't been recycled such as garbage. Fuel obtained from refuse can be utilized to generate electricity and power heavy industry machinery like cement kilns. Let us now look at recycled plastic as a building material. Plastic is becoming an essential component of human life and cannot be thrown away without proper disposal or recycling techniques.

Imagine the number of human beings on earth and the number of plastic toothbrushes that are being used and the number of plastic toothbrushes that are being discarded. When humongous amount of plastic gets discarded, we need to be a little reasonable and understand its recycling. Utilizing plastic trash as building material can help make the most of it and lessen the negative effects on the environment. Compressed dirt bricks filled with shredded plastic garbage. These are compressed earth bricks reinforced with shredded plastic waste made with PET bottles that have been crushed to a size of less than 6.3 millimeter and compressed with soil. When compared to regular compressed earth blocks without PET waste, the compressive strength of the blocks rose by 244 percent and 389 percent respectively with 1 percent of 6.3 millimeter plastic reinforcement. Now, the amount of embodied energy in a building is significantly reduced when waste plastic bottles are utilized as building materials. Instead of using bricks, we can use these materials for wall construction. As the proportion of cement used decreases, so do the carbon dioxide emissions from the cement making operations decrease.

The Samarpan Foundation, which is a New Delhi-based organization focused on ecological and environmental issues, demonstrated that their unique approach to building

homes utilizing PET bottles as bricks and fishnets for reinforcement could resist earthquakes up to 9.8 on the Richter scale. In addition that buildings have other advantages including being fireproof, comfortable during winter, simple to build and very sustainable. Now, we could also consider partial replacement of the aggregates in concrete mixtures with plastic waste. Cement, water, fine and coarse particles and these make up for concrete.

About 65 to 80 percent of the volume of concrete is made up of aggregate which influences the workability, strength, dimensional stability and durability of the material. The issue of an aggregate shortage at building sites can be resolved when waste materials are utilized as aggregate in the production of concrete which uses a significant amount of waste materials. Moreover, it lessens the harm that waste disposal and aggregate mining have done to the environment. It has been noted that adding waste plastic to aggregate can increase the concrete's resistance to abrasion and results in a lighter concrete.

Let us now look at plastic waste reinforcement. Now, corrosion is a common problem with steel fibers used for reinforcement in concrete. Water that is saline can damage the steel reinforcement. Numerous studies utilizing carbon fibre reinforced plastic or CFRP have been carried out on concrete beam samples to examine the use of plastic reinforcement. This is formed into bars and strips and placed in the same way as the RCC structures steel reinforcement. By utilizing plastic weight waste as reinforcement, corrosion and cracks were avoided.

Additionally, it improved the concrete elements durability and structural stability. The dry processed method is used to use plastic debris in road construction projects because using recycled plastic in building material in the form of using it for construction of roads can greatly relieve the stress on environment considering the amount of roads that we build. This method adds the plastic trash to the bitumen prior to mixing it with the aggregate. This procedure has been used in India's Pradhan Mantri Gram Sadak Yojana rural road construction projects. Tamil Nadu was the first state to start trials in this area and as a result a standard methodology and national guidelines for the use of this method in road construction projects were developed.

The results showed that no flaws were discovered in these roads even after a 5-year guarantee had expired. But 25% of the repairs made with standard materials required attention within the same time frame. Let us now look at a case study where plastic bottles have been used for building. In an effort to decrease waste, create jobs and provide housing for the community, the non-profit development association for renewable energies called as DARE in Nigeria created houses out of plastic bottles. Over 14,000 throwaway bottles have been reused by DARE to build homes in a community.

Bottles that are discarded are gathered from residences, restaurants and hotels. They are placed on their sides and filled with sand to form a wall, which is subsequently fastened together with ropes and mud. According to reports, the resulting bottle wall can survive earthquakes and even gunshots and it is 18 times stronger than one built with ordinary bricks. Because it can be built for as little as one-third the cost of traditional house, this sustainable construction technology also provides a more economical option. The initiative delivers a social benefit in addition to a sustainability benefit by generating employment possibilities too.

We will now look at another case study of a recycled plastic house in Karnataka. On the outskirts of Mangalore plastic for change is a for-profit organization that collaborates with neighborhood NGOs to give waste pickers a steady income and improved possibility constructed a recycled plastic home for a waste collector. The house took a maximum of 15 days to build and it cost about 4 and a half lakh and had an area of 350 square meters. It has a sizeable living area, kitchen, bathroom, storage space and patio. Steel is used for the structural framing of the home while cement is used for the foundation.

Recycled plastic is used to make both the roof as well as the wall. Low density plastics LDP and multi-layered plastics MLP such as wrappers and single use bottles are examples of hard to recycle plastic. 25 kilograms of recycled plastics are used to make each panel and up to 1500 kg of plastic were prevented from ending up in landfills. With care made to ensure that the house does not overheat in the summer, the predicted 30-year lifespan of the structure is maintained. For the benefit of the other community members, the organization intends to construct hundreds of these homes.

In conclusion, there is no doubt that it is challenging to totally eliminate plastic use from our daily life. Consequently, it may be applied as creative replacements for building materials, significantly lowering global environment and ecological pollution. When compared to typical construction materials, construction materials made from plastic waste can produce results that are either better or equal. By employing plastic trash as building materials, the use of traditional building material will be gradually reduced which will lessen the carbon footprint related to their production. So, in today's class, we saw two important innovative building materials.

One is milk paints which reduces the VOCs are environmentally friendly and second innovative material is how to incorporate plastic into construction industry. Incorporating both of these will definitely reduce the carbon dioxide emissions. With this stop this class and continue with yet another topic in the coming class. Thank you.