Building Materials IV
Lecture 5

Plastic as a Building Material

What is Polymerization? Polymerisation is the process of joining together a large number of small molecules to make a smaller number of very large large molecules. It's quite contradictory the way we are looking at it but this is how polymers are. The reactants i.e the small molecules from which the polymer is constructed are called Monomers and products of the polymerization process are called Polymers. What happens is, a particular set of monomers, come together, react together and form Polymers. Products of polymerization process are called Polymers. Monomers come together in the process of polymerization to form Polymers. We will be looking at why are we looking at Polymers.

There are significant differences between the chemical and physical properties of polymers and those of monomers from which they are made. Monomers can exist by themselves but they have certain restrictive physical properties and chemical properties but when they come together with another set of monomers, they become very enhanced and defined in terms of physical and chemical properties, this is why polymerization is an important process. This polymerization process can occur by two different mechanisms, by addition polymerization and condensation. You can add monomers or subtract some of the monomer characteristics in order to form polymers.

Plastics, we will be looking into this in detail. Plastics are nothing but Polymers. It occurs from the process of polymerization. Plastic is the general common term for a wide range of synthetic or semisynthetic materials used in a huge and growing, range of applications. Everywhere you look, you'll find plastic. Plastic is something that is applied in every product right from toys to that of building materials. Use plastic products to help make our lives cleaner, easier, safer and more enjoyable. Plastics are basically organic, they can be either made using natural polymers or synthetic polymers. They are organic, same as wood, paper and wool. Raw materials for plastic products are natural products such as cellulose, coal, natural gas, salt and of course, crude oil. The term 'plastic' is derived from the Greek word 'plastikos' meaning fit for moulding, and 'plastos' meaning moulded. This defines a very primary characteristic of plastic. It can be moulded into any form which is a big advantage as far as plastic is concerned. It was derived from the greek word 'plastikos' which means fit for moulding and 'plastos' mean being moulded.

There are two broad categories of plastic materials 'thermoplastics and thermosetting plastics'. Every type of plastic is categorized as either thermoplastics or thermosetting plastics. We will

be looking at what they are and how they are made. Though thermoset plastics and thermoplastics sound similar, they have very different properties and applications. Understanding the performance between both of them can help you make better sourcing decisions and improve your product designs. Plastic is an important product being used to make other products and other surfaces and other building materials and cladding. In order to understand what plastic to use, you need to understand what plastics are, you need to understand what are thermosetting plastics and what a thermoplastic is.

The primary physical difference is that thermoplastics can be remelted back into a liquid, whereas thermoset plastics always remain in a permanent solid state. This is like a particular liquid that can be cooled and made solid and it can sometimes be remelted back into a liquid, in order to be recycled or to form other products. This is what defines particular characteric about thermoplastic from thermosetting plastic. Thermoplastics can be remelted, while thermosetting plastics cannot be done. Thermosetting plastics, once set into solid cannot be remelted. The primary physical difference is that thermoset plastics can be remelted into liquid. Think of thermoplastics as butter, butter can be melted and cooled multiple times to form various shapes. Thermoset is similar to bread in that way, once the final state is achieved, any additional heat would lead to churning. That is a basic difference between thermosetting plastic and Thermoplastic.

Thermoset plastics significantly improve the material's mechanical properties, providing enhances chemical resistance, heat resistance and structural integrity. We will look at what thermoset plastics are, and we looked at what thermosetting plastic and thermoplastic are, we will also look at the properties and their advantages. Thermoset plastics are often used for sealed products due to their resistance to deformation. Thermoset plastics cannot be deformed as such, which gives them a particular characteristic of being resistant to deformation. From the advantages are; They are resistant to high temperatures than thermoplastics. They are highly flexible in design. They possess thick to thin wall capabilities. It can be formed as thin as well as thick. It has excellent aesthetic appearance. It also adds value to aesthetics. It has high levels of dimensional stability and is also very cost-effective.

Thermoplastic is another plastic that we are going to be looking at. There are multiple thermoplastic resins that offer various performance benefits, but most materials commonly offer high strength, shrink-resistance and easy bendability. Thermoplastic has this unique advantage of shrink resistance and easy bendability. It can be bent into various forms as desired. Depending on the resin, thermoplastics can serve low-stress applications such as plastic bags or high-stress mechanical parts. The advantages of thermoplastics are - It is highly recyclable. Thermoplastics can be remelted back into liquid which allows it to be recycled in all

forms. It is aesthetically-superior finish availability. It has high-impact resistance. Remoulding and reshaping capabilities are very abundant. It is chemical resistant in most cases. It has Hard crystalline or rubbery surface options as well. It is very eco-friendly material and also has eco-friendly manufacturing advantages. We looked at the type of plastic and now we will look at its properties which make it ideal for use.

Plastics are sufficiently strong and can be used for load bearing structural members. The strength of plastics can further be increased by reinforcing them with various fibrous materials. Like any other material, plastics can be reinforced with other fibres and made even stronger such that they can be used as structural members. Plastics prepared from phenolic resins, are only good in resisting weather effects. Apart from being structurally very stable and being used for structural members, it can also be weather resistant. Weather resisting effects can be added by using phenolic resins as well. Certain plastics are seriously affected by ultraviolet light. Plastics being organic in nature are combustible. These are properties that can also be disadvantages but they can be affected by UV light. They are organic in nature so can be combustible easily. But the resistance to fire temperature depends upon the plastic structure. The structure of plastic formation can be varied in order to make it fire resistant and to be able to resist fire temperature to an extent. Plastics generally possess sufficient durability, provided they offer sufficient surface hardness. Thermoplastic varieties are found to be attacked by termites and rodents. Since they are organic and natural in many cases, termites can also be affecting them and rodents can also attack it directly. Some other properties of plastic - plastics can easily maintain its shape throughout and not undergo plastic deformations. Not deforming in any condition is one of the important requirements of any building material. Plastics are able to maintain their shape for a long, durable amount of time. Plastics offer great resistance to moisture, chemicals and solvents. Many plastics are found to possess excellent corrosion resistance. Plastics are used to convey chemicals. We have noticed that plastics can be used in various cases where liquids are stored in them. It can be transported to various cases. Plastics have important functional use to the house and ship liquids as such. Plastics have low thermal conductivity and therefore foamed or expanded varieties of plastics are used as thermal insulators. They conduct heat to a very low extent. Being very low in thermal conductivity, they cannot expand in the case of heat when applied. They are used in thermal insulators as well. All operations are drilling, sawing, punching, clamping, etc which can be applied to wood or any other material, can be applied to that of plastics as well.

We will be looking at plastics as a building material and how are they applied in building materials. Flooring - plastic materials like Polyvinyl chloride (PVC) and polyethylene are used to make flooring less prone to wear and tear. Plastic tiles find their use extensively in areas where surfaces undergo high traffic and also a lot of wear and tear. PVC tiles, polyethylene tiles are

some of the tiles which are applied directly as tiles and as finishes in order to be able to counter this wear and tear. It can be also be used in roofing.

To protect the outer surface of the roof from damage, two layers of different plastic materials are required. Roofing is a very basic element in architecture. It is basically used to protect a particular space from the harmful effects of sunlight and UV light and can also be used to shield from harsh sunlight. How is this done? This is done with two layers of plastic materials which are required. The upper part is made of colored thermoplastic olefin or vinyl while the lower part consists of polyurethane foam which consumers less energy and keeps the interior of a house cooler. Apart from protecting it from direct sunlight and UV light, it also acts as an insulation and promotes thermal insulation. This application as a roofing material is very ideal. We talked about insulation in the roofing material. Apart from which, it is a material in itself, insulation of thermal properties is very useful in plastics.

Polyurethane spray is frequently used for insulation from constructing green or low energy buildings. In the need of sustainability and green design today. Green or low energy buildings use a lot of insulation in the form of plastic. Rigid polyurethane foam is known for its high thermal resistance which promotes temperature consistency. Polyurethane foam is also popular because it is lightweight, chemical resistant, and flame retardant. You'd notice the various advantages and physical attributes that help it becoming a better building material are abundant in plastic. Due to its closed cell nature, polyurethane insulation performs as an air barrier, resulting in significant energy savings. It can be used in sealed cases and insulating sound and other chemical weather resistant cases. This results in significant energy savings as well. Plastics are used directly in the form of Doors.

Some construction projects use doors made from a stiff polyurethane foam core with a fibre reinforced plastic (FRP) coating. You find a lot of applications of doors which are made from plastic today. It is very cheap, very easily made, easily available, can be readily fabricated and shipped across easily. These are made from a stiff polyurethane foam core. The core is made of foam and fibre reinforced plastic is another way of covering it and coating it. This makes it to be a very ideal material for door forms. The sandwich structure of these doors make them incredibly strong. It can undergo a lot of wear and tear. So, doors in public spaces or public utility spaces can be made from these plastic sandwich materials. Apart from that, it can boil, it can also be used for making walls and pipes. As structural insulated panel (SIP), it is a sandwich of expanded polystyrene amidst two slim layers of oriented strand board. Again a sandwich set of layers of plastic can be used to make walls that are particularly very beautiful and strong. It can also give you the advantage of being pre-fabricated, it can be a composite wall board and can be transferred easily to the workplace for a particular task. It can be pre-fabricated which

means it can be shipped at any particular given time, it can be readily available. Besides this, it also provides good support to columns and other associated essentials during renovation. When you are renovating or re-doing a particular set of buildings or retro fitting it, pre-fabricated fabric walls can be very useful, temporarily as well as for a longer period of time.

Pipes - today, buildings have used a lot of PVC pipes and PVC tiles and PVC finishes to particular metal pipes. Pipes are a very common area of use for plastics. Commonly made up of polyvinyl chloride (PVC), CPVC, acrylonitrile butadiene styrene (ABS) or polyethylene. Plastic pipes are flexible and very light in weight, making them easy to install. Apart from being easily available and flexible, it is also easy to install. All of these plastic materials are also highly chemical and water resistant, making them suitable for many extreme environments. Directly in terms of its applications and environments it is exposed to, chemical and water resistance makes it a very good material to be used which also makes it very easily applicable in terms of cladding. Other applications are that of windows and facade panels. Windows are prefabricated and readily available and can be picked right away. Ready-made windows are easily available. These ready-made windows, almost all of them or most of the time is made from plastic and various reinforced plastic forms.

Polycarbonate is used to manufacture building windows. This plastic material is strong, clear and very light in weight which makes it very ideal. Polycarbonate windows are considered more burglar proof than regular glass windows. Polycarbonates are used in bullet proofing as well as bullet shields used by cops and various other protective industries. Two plastic materials, vinyl and fiberglass are used commonly in the production of window frames. Fiberglass is extremely strong while vinyl is quite durable and also inexpensive. Apart from the other advantages, it is also inexpensive in nature. Applications of plastics in facade panels, exterior covering, carpentry is widely used. Directly as an expression of architecture and architectural use. Plastic finds a direct application. Sandwich panels covering with PVC (polyvinyl Chloride), plasticized plates and polyurethane foams. Sandwich panels - asbestos cement covering and polyurethane foam core are some of the various ways in which it can be used in cladding. It can be used in exterior coverings as well as various carpentry assisting situations.

Plastic Forming Process

We will be briefly looking at how plastic is formed.

It is a highly versatile material. We have looked at its properties, we have looked at its various applications. We have looked at its applications in terms of building materials directly. Plastic products are made using a wide variety of processes. There are 5 common techniques used to produce most of the items you see everyday. Heat allows the plastic to soften and then take on the shape of a mold or a foam. We have looked at why plastic is called plastic, it is actually another greek name for what is known as moulding. Moulding is its primary form or primary

characteristic. Heat allows plastic to soften and then take on a mould or a shape. There are different techniques that use gravity, that use vacuum, compression and centripetal force, etc, to push/pull the plastic into the mold. Following is a simple breakdown of the most common practices.

Injection moulding is a very common way in which plastic is made. This technique is widely used in forming thermoplastic materials. It is put in a hopper. A screw thread turns forcing the plastic material through a heater, melting it. The screw thread then acts as a ram and forces the plastic into a mould, where it cools and solidifies. This is how it is formed. This is used in making other smaller forms of plastic such as tv parts, toys and such.

Blow Moulding is a very famous form of doing it, in which bottles are made. Blow moulding requires a tube of plastic to be extruded. Extrusion formation is the basic characteristic of blow moulding. Plastic cools the two halves of the mould that are brought together and air is blow into the centre of the material through a blow pin. This is how blow moulding takes place.

Compression moulding is another form of making plastic. We have looked at how plastics are formed, there is a special type of plastic that is used in sealing of buildings, sealants and adhesives. It is called as an Elastomer.

Elastomer is a polymer with viscoelasticity, very weak in terms of inter-molecular forces which makes it easy to be stretched or elongated. It has high failure strain in structure formation. With the key properties of elasticity and resilience, elastomers are some of the most dynamic materials available in the marketplace today. Apart from plastic being used directly, they can also be used in elastic form in order to be used in steelant industries. Their ability to deform and recover under stress enables them to serve in a number of important capacities. Elasticity is the property of elastomers that allow them to return to their original form after being compressed, stretched or bent.

The properties of Elastomers make them ideal for many noise reduction and damping functions. We have now come to an important part, this is called as Decorative Laminates. Plastic takes an important place in the industry of decorative laminates. We will be looking at laminates and why are they important. The past couple of years have seen an extensive use of laminates and veneers in interior designing. When you take interior designing, laminates and veneers are the most important form of it, apart from lighting and other materials. They have a much functional presence in home and office interiors as well as hotels, institutions, etc. Initially they were used as a basic backing or covering material but now they have found a lot of

functional purposes as well as aesthetic value. Technology has given a great boost to their applications and has led to an advancement in their properties.

The market now offers a number of shades, textures, laminates and veneers that allow the users to choose according to the ambience they intend to create. Interior design has a lot of applications, it has to be durable, it has to be easily applied or installed. Besides that, they have a direct impact on the audience or the mood of the user or the space being used. Laminates or the basic final finish of laminates and veneers play an important role and plastics also have an impact on the laminates. Waxed edges, piano finish, bevelled edges, hand scraped and the availability in a host of other textures have made them ideal materials complemented with the cost savings and faster installation time. They also save a lot of cost and can be installed easily in a faster amount of time. With their flexibility, versatility and their ability to gel in with any design scheme, laminates and veneers prove to be a cost-effective alternative to wood, an environment-friendly practice. Wood, though extensively used in interiors is now being replaced a lot in laminate form because of the various environmental safe concerns via which it can be manufactured and used.

Laminates are engineered materials made from pepper and plastic resins. That is what basically a laminate is. Paper and its plastic resins are it's important, primary material to be made with. From furniture and cabinetry, their implementation today has extended to decorative walling and flooring too, where they can prove to be a good alternative to hardwood. Any surface from that of ceiling to that of flooring, can use the purpose of laminates to be covered. It is scratch resistant and requires a mere cleaning and more polishing effect. Their maintenance remains easier than that of veneers. Lending an elegant touch to all products, laminates are available in numerous design patterns, colours and textures.

Based on their different manufacturing processes, there are high pressure laminates, low pressure laminates and compact laminates. Laminates are nothing but paper and plastic vessels, they are pressed together in various methods and based on where the pressure is applied they can be differentiated. They are high pressure laminates, low pressure and compact laminates as well. Laminates available either for decorative or for industrial uses. Standard laminates are used in normal applications, post formable laminates are used in kitchens and offices where a neater look is required and in places like hospitals and restaurants where hygiene is extremely important, anti-bacterial laminates are used. The variety of laminates that are available today, have extended to the use of anti-bacterial levels as well. It is available in a wide variety of categories and can be used for particular purposes and not restrictive to any particular purpose.

Decorative laminates are hard and brittle sheets having a thickness of around 1mm, and are widely used as an overlay over wood, such as in the case of laminated table tops, wood panels and other wooden furniture. Not only can be used as a final backing sheet, they can also be used as a final overlay or a cladding over other materials not just for protective purposes but also for aesthetic values. The sheets have a decorative purpose, they have a decorative surface and are manufactured in a wide variety of colours, design patterns and structures. The following are the various types of decorative laminates and the different ways in which these laminates are usually classified. Manufacturing of decorative laminates - we shall discuss this and see how a particular laminate should be used extensively.

It involves soaking of brown paper, decorative paper and translucent paper in plastic based resins. This is what characterizes its structure. Brown paper which forms the base is soaked in phenol formaldehyde while the other two papers are soaked in melamine resin. The soaked papers after drying become hard and brittle. These papers are then pressed and bonded together under high pressure and temperature. That's how high pressure decorative laminates are formed.

We talked about High pressure laminates and Low pressure laminates. High pressure laminates are hard decorative sheets that are commonly fixed by carpenters over plywood while making the furniture. In the case of low pressure laminates (LPL) only the decorative paper is soaked in Melamine resin, and the laminated paper is then directly bonded to Particle boards or Fiber boards. This is how they are directly used in the form of final products. Thickness also differentiates the types of laminates that are available.

As thin as 0.6mm to 1.5mm are produced. Also other thicker types of laminates are also manufactured, called Compact Laminates which have a thickness ranging from 3mm to 30mm depending on their use or the purpose they serve. Compact laminates are self-supporting and hence do not need to be glued to woods or any other material. Both the top and bottom sides of compact laminates have decorative surfaces. Usage also determines the type of decorative laminates that are available. Basically, we talked about decorative laminates and industrial laminates. The type of use also categorizes them. For decorative laminates, the look and feel are the important aspects, they are commonly used to decorate and protect their furniture, that is the basic purpose. Industrial laminates on the other hand focus more on having a surface that has higher strength, higher resistance to scratches and wear and tear, which is very durable. The purpose of aesthetics and the purpose of high wear and tear and resistance to a lot of use is what differentiates Laminates based on uses. Industries use products such as circuit boards that are made using industrial laminate materials. Not just surfaces, circuit boards are even made from laminates. Depending upon surface finish as well, laminates are categorized.

Laminates are artificially created surfaces, they have a large variety in colours, patterns and textures. The finish, the availability of matter surfaces, smooth surfaces, patterns, textures also differentiate the type of decorative laminates that are available. Based on the surface finishing of the sheets, decorative laminates can be classified as; solid colour, floral patterns, gloss finish, matt finish laminates and wooden finish laminates. Apart from serving all these aesthetic values, laminates can serve the purpose of imitating other materials such as wood, such as tiles, stone or any other material that can be created.

Sizes also determine the various types of laminates that are available, durability is also an important form and a function that is served by laminates. Cost is an important factor in interior design, the way it can be maintained is also an important factor in which laminates are differentially available today. We will look at the principal way in which the structure is formed.

It is basically an upper protective layer that consists of high-strength or acrylic melamine resin. Then it has a waterproof layer which is usually made of paper impregnated with water-repellent substances. Besides that, it has a decorative layer of paper or furniture foil which forms a decorative or aesthetic value. It also has a base layer of high-density boards, particleboard or fiberboard that is formed. These are characteristics of the layer that mainly determine the quality of laminate. The quality of a particular laminate depends mainly on the MDA for the particle layer that was used. This layer is responsible for sound insulation, thermal insulation and the quality of the lock joint. The thickness of this layer ranges from 5 to 12mm. This forms the main backing of laminates.

We will be looking at some of the uses of laminates. It is used both traditionally and surprising applications as well. The most common recognizable use of laminates include residential countertops and cabinetry, office work areas, public restrooms and department store wall panels. It is a lot of wall panelling, a lot of panelling where cupboards are used, the doors of cupboards as well, cabinets and the countertops of residential furniture; all use laminates to a great extent. Laminate is also abundant in corporate offices, retail stores and other interior uses. It can be found in Casino slot bases, airplanes, mass transit seats, theme parks, rides, furniture and the uses are endless. High-traffic areas, including cashier/checkout stations, kick plates, restaurant tables and such can be found to use laminates. It should not be used in areas with extremely high moisture, humidity, extreme heat or cold, in aseptic rooms or outdoors. This is why I have been particularly mentioning interior design a lot with respect to laminates, it cannot be used in extremely high temperatures or extremely high moisture content areas with a lot of humidity.

The properties of laminates - it has high wear resistance, it has the property to withstand humidity to an extent as far as interior areas are concerned. It is resistant to scratches and dents produced by mechanical action. It has ease of installation which is very important in terms of interior design and installation requirements. It has simple maintenance which does not require special cleaning agents. Selecting a laminate is one of the most important processes as far as design process of interior design is concerned. Laminate class in accordance with traffic needs to be chosen. The greatest possible thickness in the panel is an important decision to be taken. The colour of a particular laminate should be combined with fully furnished rooms. The purpose of the room plays an important role in how you choose a particular laminate and the colour also. Diagonally laid laminate visually expands the space. Direct affecting of the ambience of a particular room can be controlled and enhanced by the use of laminates. The expense of material in such an arrangement increases. The various cost expenses increase based on the laminate and the various ambiances in which one needs to uprise and achieve.

One example is a bedroom. I have laid out how selection of laminate is particular restrictive to that of a bedroom. The furnitures present the way in which a mood needs to be achieved. This determines in which laminates can be used and how a particular mood of a room can be enhanced.