Building Materials IV
Lecture 6

CGI

We will start with CGI. CGI is nothing but corrugated galvanised iron sheets. If you look at this image, this is actually a hut. It is made completely with corrugated galvanised iron. We will have a look at the history or the background. This hut that you saw in the background is a metal hut and it is called a Nissen Hut.

It was very popular during the second world war as a means of very cheap housing. A Nissen hut is a prefabricated steel structure made from half-cylindrical skin of corrugated steel. Originally designed during the First World War by the engineer and inventor Major Peter Norman Nissen, it was used extensively during the Second World War.

When you look at CGI, corrugated galvanised iron sheets. You have galvanized iron, a form of iron that is coated by galvanising it with zinc and then you make it corrugated. Corrugated is the process of making it rolled and textured such that it can be used more extensively. The Nissen hut was directly made from CGI sheets. Nissen, a mining engineer and inventor, constructed three prototype semi-cylindrical huts. This is how he started the experiment of constructing huts which are semi-cylindrical in shape. The semi-cylindrical shape was derived from the drill-shed roof at Queen's University, Kingston, Ontario. It was inspired from somewhere else but the material is what made it really famous. Two factors influence the design of the hut. First, the building had to be economical in its use of materials, especially considering wartime shortages of building material. Second the building had to be portable. You notice how this particular material has become really famous and used extensively. It was really cheap and portable. This was something that was essential and required during the world war times. At such a time, corrugated galvanised iron sheets were very useful. That's how they became famous.

We will also look at another interesting example of how corrugated galvanised iron sheets were used. This is called the Tin Tabernacle. This is nothing but a religious space. When we look at these examples, we will look at what made this particular material famous and how it was used and how it became particular.

A tin tabernacle is a type of prefabricated ecclesiastical building made from corrugated galvanised iron. Being a religious space, a religious building, prior to this religious buildings were made with granite, either stone or such materials that added to its grandeur as such. But here comes the use of galvanised iron which made it really cheap and thus extended the application of churches and religious spaces to various places such as church and remote areas,

which is why it was made really famous and also very economically viable. The technology for producing the corrugated sheets improved and to prevent corrosion the sheets were galvanised with a coating of zinc. Corrugated sheets were present, the galvanisation process was done so that it could enhance the properties of its material. Churches, chapels and mission halls were built in new industrial areas, pit villages, near railway works and in more isolated rural and coastal locations. Corrugated GI sheets are very economical, very portable, easy available and probably easy to make was made available to anyone in any place. Several tin tabernacles survive as places of worship, some have listed building status and some have been converted to other uses. You can see apart from being very cheap, apart from being very portable and available, it has stood the test of time, it is very durable as such.

What are CGI sheets essentially? Galvanized sheets are steel sheets which are basically coated with zinc include a range of hot dip galvanized and electrogalvanized steel sheets. You have steel sheets and zinc is added to enhance its properties. Zinc weathers at a very slow rate, so the coating generally has a long life. This is the purpose of adding zinc to it and this is what enhances the material, the galvanized iron. Zinc has a greater electronegativity than iron and hence provides cathodic or sacrificial protection to the steel. The process of galvanizing steel sheets was developed simultaneously in France and England in 1837. Both of these methods employed a 'hot dipping' process to coat steel sheet with zinc. You have steel, you essentially dip into hot zinc that essentially makes it corrugated galvanized iron. Today, the process of corrugation is carried out using the process of roll forming. Even though the process of making corrugated iron has changed, it still has the same properties and is being used extensively. Some applications we will be looking at in the case of galvanized iron sheets; Agriculture.

Grain silos, sprayers, pans and feeding troughs, etc. With agriculture, the spaces that were used had to be weathered after a point. Agriculture essentially builds the space. What happens is, after certain process of weathering, the space had to be rebuilt or redone. With the invention of corrugated iron sheets, this was gradually and very extensively reduced because it became a very durable material.

Automobile sector - car, bus, truck bodies, undercarriage work, air and oil filters, fuel and oil tanks, exhaust pipes, etc. Construction - coming to the more relevant part; Roofing, side walls, partitions, panels, valley gutters, louvers and endless number of occasions where you could use corrugated iron. You'd notice corrugated iron in a lot of applications where it is necessary to be cost effective or cost cutting. You've seen very cheap housing forms in group housing or in places where you have to cover temporary spaces, corrugated iron sheets, make very important use. Other household things like Trunks, ice boxes, tubs, buckets and other things have found to be made in domestic places.

We looked at the two important examples where GI sheets are being used and we noticed that cost-cutting, durability and easy availability has important advantages. Galvanizing is lower in first cost than many other commonly specified protective coatings for steel. Steel is used in many forms, various coatings are applied. Galvanizing it seems to be the most cheaply available first cost that is applied to steel. Let's maintain this cost for any building material or any construction material for that matter. The sheets have to have very low maintenance after it has been installed. CGI offers that to a very great extent. Long life, as I mentioned, those buildings are even registered today in building usage. The life expectancy of GI sheets is quite high in rural, urban and coastal environments. Reliability - Galvanizing is usually carried out as per standards and minimum coating thicknesses are applied. Having it in a very prototypical form, makes it very reliable in terms of the building material. Toughest coating, adding a few or more layers of coating makes it a very tough coating and hence more durable. It offers complete protection. Every part of the galvanized iron sheet is protected. When you take a building material or building material sheet for that matter, they are parts that have to be dressed differently, there are parts that have to be treated differently but in the case of CGI sheets, every part of the galvanized iron is already protected, so you don't have to add extensive measures. Galvanizing process is not dependent on weather conditions, so, like in the case of concrete or iron where curing is an important part of the finishing method, galvanizing iron does not depend on weathering conditions or such delays. Here, we come to an end with CGI sheets.

PTFE

We will move on to PTFE or what is called as Teflon which is more famous.

Again, we will look at two important examples that use PTFE extensively. This is a bus shelter at Aarau, you can see that the roof is completely made of tensile fabric. PTFE is not essentially a building material, it is actually a fabric but a tensile fabric that makes it easy to be used for roofing or such membrane covering related construction methods.

The Swiss city of Aarau, a cantonal capital has gained its own cloud in the shape of an organically formed bus station canopy with a reflective and semi-translucent skin. As I list out the various design features of these projects, you'd notice the important features that happen to be the advantages of these materials. In this case, it is the reflective and semi-translucent skin, a 120-metre long polyethylene tubes under the road supply the pneumatic air cushion with recirculated clean dry air, and another four tubes take the air back. What happens is, there is a skeletal framework of polyethylene tubes between which this translucent layer of material is added. Both the question and tubing are more or less airtight, the roof is highly economical to

operate. You'd notice that it is reflective, it is semi-translucent, now it adds the feature of it being very light weight and also it is very economical to operate. Supported by a steel table, the transparent canopy is made from an upper blue and lower clear PTFE-foil, printed with a bubble pattern that together creates a sinuously formed air-tight cushion. You'd notice that in many materials there are air entrapments that happen to make it a very weak material but in this case it is an airtight material. Also, you can create patterns on the material which is not available on every other material. Besides, it is also air tight which reduces a whole lot of other problems.

Here we look at another large scale project. This is actually a design office of a fashion brand in China by an architect called MAD. MAD architects have conceived a new design center for international fashion group Xinhe in the coastal Chinese city of Xiamen. They have described the design as a star-shaped layout that formalises a solid 'bone' structure frame. What they are trying to do is, they have a basic structure, basic set of buildings and what they have done is, they have covered it with a structural frame. Apart from this, they have also covered it with a membrane to make it look very transparent and lightweight. A translucent layer of PTFE plastic will be draped around the outside, allowing light to enter and creating wide views for the staff. We looked at it being very reflective, semi-translucent, it is very light in weight, it has air tight features, apart from which it also allows light to enter, gives a light feeling to the whole thing and also lets light come in, as a building material, these aspects are very important. According to MAD, this delicate sun shading skin will make the eight-storey building look 'elegant and floating'. This is an added aesthetic value for the building, which has been allowed by PTFE.

PTFE/ Teflon, both are one and the same thing. Teflon is the registered name of the highly usable plastic material, polytetrafluoroethylene (PTFE). You have heard of Teflon. Teflon is used in coatings of footwear, you have teflon fans, teflon cooking utensils; that's how it came about. The reason why it is is famous in cooking is because it have very low friction, that also makes it a valuable material in terms of construction as well as for cooking and domestic purposes. Many common synthetic fibers are polymers, such as polyester and nylon. Similarly PTFE is also a common synthetic fibre. PTFE has many unique properties, which make it valuable in scores of applications. It has a very high melting point, it is stable at very low temperatures and it is extremely resistant to corrosion. It is also very slick and slippery, as mentioned earlier, very low friction level. This makes an excellent material for coating machine parts. Wherever this machine is required, wherever two buildings meet or wherever two materials for that matter. PTFE makes an excellent use. These are subjected to heat, wear and friction, for laboratory equipment which must resist corrosive chemicals, and as a coating for cookware and utensils.

We will look at its properties directly now. It is UV resistant, this is very important for a building material. It has excellent optical properties. As mentioned earlier, it can let in light. It has a semi-translucent property. It has a non-sticky surface. Very few products can ever stick to a Teflon coat. When you put a particular service with Teflon, there are very few materials that can stick to it as such. You can imagine it being used in places where there are a lot of wear and tear. It has outstanding performance at extreme temperatures. It has low coefficient of friction. Thus, there is no difficulty in sliding one surface against another. Teflon finishes are both hydrophobic and oleophobic which makes clean up easier and more thorough. Hydrophobic means it has nothing to do with water, any amount of water does not affect it, which makes it an excellent material in terms of building materials, which makes cleanup easier and more so, it is also easier to maintain. We looked an applications, we looked at the two important buildings that applied PTFE directly to their buildings.

PTFE is an incredibly versatile material used across many industries, thanks to its stable and durable characteristics and affordability. PTFE is one of the most affordable fluoropolymers on the market and has one of the best performance to price ratios. It is often used in construction projects for structures such as car parks, supermarkets and bridges. Spaces that need semi-transparent or a semi-private area of roofing or covering, PTFE has a direct application. Plus, its resistance against weather damage and general wear and tear make it extremely long-lasting material. PTFE is perhaps best known for its use as a non-stick coating for cookware. Even though it has a lot of uses in building technology and also machine technology and automobiles, it is most famous for its use in cookware technology. We will now move on to the next type of roofing material, this is polycarbonate sheets, simply called as PC sheets. Again, we will look at two projects that make use of PC sheets.

This is House of Tousuienn. The translucent polycarbonate walls of this house in Hiroshima by Japanese architects Suppose Design Office allow natural light to flood the interior from all sides. What happened was, the architects were posed with the design to be designed in a space closely packed on two other sides. They used PC sheets directly because it was very use to make light fall in and make it very airy and lively. Named House of Tousain, the three-storey building was designed by Suppose Design Office as the residence of a family of five, who also requested a space for storing and repairing a collection of motorcycles. You'd see it can be applied to any residential matter. It is surrounded on three sides by neighbouring buildings, so the architects added translucent cladding to allow light to permeate the interior without compromising residents' privacy. What they had to do was, allow more light in and give a lot of airy space in the whole building. PC sheets was helpful in achieving this effect. We used a thin and translucent material to replace the regular interior walls, where natural light can be maximized in the interior space. You'd notice that it could bring in light completely because of

its translucent nature. We look at another large scale project. This is a sports hall by arquitectes BCQ.

If you look at the picture, you can see the same translucent material being used. It gives you a very light and airy feeling. It allows light inside and you can also have a semi private way of looking at what is happening on the inside. Barcelona studio BCQ chose translucent plastic panels for the walls of this municipal sports hall in Spain, giving the building an ethereal quality that helps it match the colours of the sky. Apart from being a durable light weight material, it gave an added value to the aesthetic appeal. Located in Olat, in the municipality of Girona, the sports hall was designed by BCQ as a simple and visually lightweight addtiion to its site in a green space along with one of the city's tree-lined avenues. In a space where there is nature, a lightweight addition was very essential and the use of PC sheets helped with that. Striped basing, running around the base of the ball, creates the impression that the main structure is raised above the ground. Again the lightweight feature is enhanced. These windows offer a glimpse of activities that take place inside. We looked at two important projects, we will look at what PC sheets are essentially.

Polycarbonate plastics are naturally transparent amorphous thermoplastic. With respect to plastic, there are thermoplastics and thermoset plastics. You can compare thermoplastic with that of butter. You could heat butter, it could melt and then reform it's solid state. But in the case of thermosetting plastic, this is not possible. Once converted into liquid, it cannot be reconverted into solid. Now, Polycarbonate is nothing but a thermoplastic. It can be heated to form a liquid and then cooled to turn back into solid. This is a peculiar feature, although they are made commercially available in a variety of colours, the raw material allows for internal transmission light nearly in the same capacity as glass. It is a great alternative for glass in many spaces. It has been replacing glass as it allow light as much as glass. Polycarbonate polymers are used to produce a variety of materials and are particularly useful when impact resistance and/or transparency are a product requirement. Apart from it replacing glass, it has the added value of being wear resistant or care resistant. It can handle any amount of impact resistance or it can handle wind or storms for that matter. PC is commonly used for plastic lenses in eyewear, making it very impact resistance, has its application in optometrics too. Other than that, it has some interesting applications in the case of protective gear, green houses or houses which have applications for plants, use a lot of polycarbonate sheeting. Digital disks, CDs, DVDs, blu ray disks, anything can be used, is made from polycarbonate. Exterior lighting fixtures are made from polycarbonate. Polycarbonate also has very good heat resistance and can be combined with flame retardant materials. In itself, PC is a flame retardant material. When you combine the other flame retardant materials, it makes it a very fireproof material, without significant material relation.

PC is classified as a thermoplastic as I mentioned. The name has to do with the way plastic responds to heat. As I said, it responses to heat in a way and can fall back to a solid which becomes an important feature. They possess desirable features such as lightweight, high impact strength, UV protection and better aesthetic value. This becomes an important reason of use in both residential as well as large scale uses, it can be used widely. Polycarbonate panels can withstand force and are virtually unbreakable. That is why they are used in the construction of bulletproof police shields. When you looked at riots or cops trying to prevent riots from happening, cops hold shields and these shields are very transparent, translucent for that matter but these are nothing but made of polycarbonate sheeting. You have a direct application of its impact resistance, how it's unbreakable. These panels are resistant to heat, sunlight, snow and rain which enable them to last for many years without fading or discolouring.

Polycarbonate is the most extensively used in building construction in the form of roofing. It's a lightweight thermoplastic material that's known for its ability towards withstanding extreme hot and cold temperatures. It's durable, reliable and a very ideal material for roofing. While this material is not used to cover an entire home. Polycarbonates can be used to cover patios, decks and conservatories. There are greenhouses or conservatories can have its application PCs. Even though PC cannot be used for the complete main roofing of a particular building. It can be used for the temporary decks and patios. These panels are available in a number of shades including white and smoky grey. They are often used in places where natural sunlight still needs to be able to get through. Letting in light is an important feature. These panels usually have a film applied that reflects harmful UV light from being able to enter into the structure. In addition to being able to withstand extreme temperatures, they are extremely durable. They can withstand strong winds, heavy rainstorms and hail.

PPGI sheets are nothing but pre-coated galvanized iron sheets. What happens is the iron sheets are usually painted after production but in this case its pre painted during its production which makes it a particular feature and has its particular applications. PPGI refers to factory pre-painted zinc coated steel, where the steel is painted before forming as opposed to post painting which occurs after forming. The term is an extension of GI which is a traditional abbreviation for Galvanized iron. The hot dip metallic coating process is also used to manufacture steel sheet. The steel thus produced in this process is a pre-painted, prefinished and ready for further processing into finished products or components to use material. We will now move on to other materials that are used for flooring finishes.

Materials for Flooring

In this image you can see there are four different types of flooring. One is, carpet. The other is PVC, the other is Epoxy flooring and the other is hardeners. We will begin with Epoxy flooring.

It is the toughest and most durable finish. An epoxy garage floor coating is not paint. You'd notice that Epoxy flooring is used for garages, for places where there's hard wear and tear and high traffic. Paint for garage flows is a less latex acrylic product. When you use such things, it is not essentially able to handle that much traffic or wear and tear. Epoxy is an actual thermosetting resin that is applied as a coating. It is formed when you mix one part epoxide resin with one part polyamine hardener. Basically, what they do is, they harden the surface and make it viable for high traffic and high wear and tear. Light weight, this has to be dry and epoxy cures. What you do is, when you paint a surface, you have to wait for it to dry but in the case of Epoxy, it actually cures. It makes it a more viable hardening element. Besides looking nice, the hardened and thick application that you get from epoxy creates a coating that is very durable and resilient to impacts, chipping, chemical stains and surface abrasions. You can attribute all these attributes of high wear and tear to that of industrial areas to that of industrial areas, high traffic areas, public use buildings, etc, hospitals as well. The thicker coating also does a great job of covering over minor imperfections such as small spider cracks and flaws in the concrete. It makes up for the concrete disadvantages as flooring and when you add epoxy floor coating, it makes up for all those flaws. Because epoxy is a topical sealer, it is also anti dusting. Dust is an important element or problem as far as flooring is concerned where as far is epoxy is concerned, dusting is highly reduced or gradually made nil. Normal traffic on bare concrete can kick up the dusty powder that has a tendency of collecting on cars, tool benches and storage items as well as being tracked into the house. This has reduced to a great extent. It is also naturally moisture resistant. Besides that, it can create an easy clean seamless surface. For any surface or any flooring, maintenance or cleaning is an important aspect to be considered. Epoxy makes it very easy to be maintained. It offers an environmentally friendly flooring solution. In present day, sustainability and making a material be very environmental friendly is an important feature. Epoxy has that feature in it.

There are very environment friendly solutions for those interested in choosing green alternatives and building materials. Now, we move on to industry flooring hardeners. As the name implies, these are especially required or applied in industrial flooring. Oxychloride flooring hardener is ideal for heavy duty machinery movements. It has excellent load bearing capacity. While coating or a floor finish can have various features, a load bearing is an important feature as far as industrial applications are concerned. These can be laid on any sound surface like concrete, metal and wooden floor. It is long lasting and helps to overcome many problems faced day to day in the industry. The main problems faced in the industry are; wear and tear, high impact and high traffic. Used in most industrial flooring for high and heavy

traffic, these hardeners enhance the flooring that comprise the following characteristics; it withstands heavy traffic movements, it is excellent in load bearing, it does not generate dust or cracks or cement based floors, it is ready to use after 24 hours for manual traffic. Compared to other materials that have to be done over a period of days or weeks, this requires only 24 hours to finish. We now move on to PVC tiling.

PVC is nothing but vinyl tiling. It is a finished floor material used primarily and commercially and institutional applications. You take any public use buildings as far as hospitals, schools, anything that requires very low cost and durable material, flooring finishing, PVC will be formed. Modern vinyl floor tiles and sheet flooring and versions of those tiles sold since the early 1980s and are composed of coloured polyvinyl chloride chips formed into solid sheets of varying thickness. That's how that is formed and is used. Modern vinyl floor tile is frequently chosen for high-traffic areas because of its low cost, durability and ease of maintenance. Vinyl tiles have high resilience to abrasion and impact damage and can be repeatedly refinished with chemical strippers and mechanical buffing equipment. Another important advantage of vinyl flooring is, incase of damage, it can be replaced immediately because it has basically finished easily and has buffed. All you have to do is replace it with another tile. If properly installed, tiles can be easily removed and replaced when damaged. The advantages of PVC tiling; slightly softer surface options like tile or wood. Wood and tile have direct reaction to impact. Vinyl being a rather soft flooring when compared to wood or tile, makes it very viable in terms of impact resistance. Vinyl tiles are available in a huge assortment of colours and styles. Vinyl also wears incredibly well, makes it a long lasting equipment. It is extremely durable. Vinyl floor is very resistant to dirt and water, making it very easy to maintain. As far as cleaning and maintenance goes, vinyl is hard to beat. It is the most easiest to maintain, most easiest material to be found in terms of floor finishes. Requiring practically no maintenance after installation, vinyl needs to be swept and mopped occasionally to keep the floor clean. For any building material as well as the floor finish, its maintenance after installation is an important feature. As far as Vinyl is concerned, it is very easy to maintain.

We now move on to carpets, another flooring finish. Carpet, you might be able to recall, it has various uses, various purposes, various types that are available today. It basically started out as a floor finish or as a flooring coating between the main floor and the use impact. Carpet is a textile floor covering typically consisting of an upper layer of pile attached to a backing. That is what a carpet is basically made of, a pile. This pile is usually made from wool but since 20th century, many polymers have also been used. The pile usually consists of twisted tufts which are typically heat-treated to maintain their structure. This is how a carpet is made. What a carpet does is, it cuts of a direct contact from a cold tile or a cold surface of any human interface. Carpets are used for a variety of purposes, including insulation, a person's feet from a

cold tile or concrete floor, making a room more comfortable as a place to sit on the floor. Reducing sound from walking, so, acoustic insulation and adding decoration and colour to the room. Apart from having these very functional purposes, it also adds to the aesthetic value. As I said, insulation. Carpet can help save energy as it is an important contributor to the insulation of the indoor environment. Adding to the insulation or heat value of the room is very important, this reduces the energy impact. Acoustics - several studies find that carpets absorb sound and carpets with padding further enhances this ability. It also provides Acoustic insulation. It is easier to maintain because it does not have any breaking parts, you don't have to replace it because of its broken tiles, etc. Carpeting is less labour intensive to clean and maintain, than hard surface flooring, because of this and as mentioned, can cost less to maintain as well. Safety as far as other stuffs are concerned, slip-and-fall accidents or any other kind of accidents that originated with carpets are greatly reduced.

We will now move on to the final part of the lecture, we will now talk about Sealants. The main difference between Sealants and Adhesives is that sealants typically have lower strength and higher elongation than adhesives do. Sealants have this elongation feature which makes it an important material in terms of ceiling. When sealants are used between substrates having different thermal coefficients of expansion or differing elongation under stress, they need to have adequate flexibility and elongation. You have sealants being used for various purposes other than just sealing in particular. Sealants generally contain inert filler material and are usually formulated with an elastomer to give the required flexibility and elongation. They usually have a paste consistency to allow filling of gaps between substrates. When compared to adhesives, this has a more paste kind of consistency. Many adhesive technologies can be formulated into sealants. While adhesive can be an adhesive, it can also be a sealant but a sealant cannot be an adhesive.

Sealant is any material placed in a joint opening generally for the purpose of weather proofing a building. The main purpose of a sealant is to weatherproof a building so that water, air, excessive light or UV cannot penetrate into it. Designed to prevent the passage of moisture, air, dust and heat through all joints and seals of the structure. Sealants despite not having great strength convey a number of properties, they seal top structures to the substrate and are particularly effective in waterproofing processes by keeping moisture out that are also acoustically relevant. They can provide thermal and acoustical insulation and may serve as fire barriers. Apart from being all these particular features, they also serve as fire retardants. They may have electrical properties as well. Sealands can also be used for simple smoothing or filling as well. Apart from being used as weather proofing, it can be used just to seal two materials such that the joints are not visible. So, the various applications of seals would horizontal to vertical, metal to metal and masonry to masonry and control joints. Basically, joints are

important application as far as sealants are concerned. With this, we come to the end of this lecture. What we have learned through this lecture is, we have got an idea of various roofing materials categorized as light weight, their reasons for their development and uses. The reasons for lightweight roofing and light weight materials.