Building Materials IV

Lecture 4

Aluminium

This is an image of how aluminium can be extensively used in various ways we'll look at it from the ground up, so aluminium can be used in fences, can be used in doors, can be used in façade sheets, panels and cassette, it can be used in gutters, it can be used in solar panels, in chimneys, in roofing or tiles so you can notice the number of uses aluminium has and how important its going to be as an element in building construction. Furthermore,it can be used in curtain walls, it can be used in Shading devices, it can be used in garage doors, window frames and windowsill, balcony and shutters, so this is the endless extensive use of aluminium that can be applied in buildings today so we'll at aluminium in detail. We will look at two important projects more recent and new model which note the use of aluminium directly in the façade. This is sports hall designed for a school by FEA Studio. The corners of this aluminium-clad sports hall near the Iranian city of Bastam lift up from the earth to lend the irregular form a "cloud-like" appearance, so as we describe the features of this architectural project you'll notice the various ways in which aluminium is useful so what happens is it makes the building feel light so in itself aluminium is supposed to be a very very light material. White aluminum faced paneling forms an angular shell around the structure, so aluminum face paneling so aluminium can be used as panels for the facades of architecture. On one corner, this surface is sliced away to create a sheltered and welcoming entrance. So notice apart from being used extensive façade material it can be sliced up, cut up and opened and used in various angular forms. Cladding is also raised up along the edge of the main hall. This lightens the building's visual mass and provides views of the landscape from the facility, so then repeatedly the light feeling or light weight aspect of aluminium is highlighted here. This is an another quick project done by an architect, this is actually a residence for his mother, so you notice that it has been completely enveloped in aluminium sheets, so you can see how aluminum as a material is completely feasible to cover a whole building envelope. A pair of gable buildings clad in corrugated aluminium make up this house in Linkoping, Sweden, designed by architect Bjorn Forstberg for his mother, so as I said it is at residential level I showed you also a sports hall as well as a resident. So aluminium can be used versatilly in both cases. The residence is located on a long and thin plot. In response, Forstberg Ling split the house into two slender volumes that are offset from another. The raw aluminium on the facades and roof is maintenance-free, but maybe more importantly, it gives a soft reflection of the surroundings and changes expression according to the seasons and time of day, so you can look at two really important features or rather three the raw aluminum on the facades is maintenance free so you see that it is light weight, it is completely maintenance free which why it is used as a building envelope besides that it also has a soft reflection which reflects the surroundings and seasons and moods of the day and shows how it has extensive aesthetic values. So this shows how modern building technology use aluminum to a great extent and how aluminium is a modern building material, we'll be looking at that in detail now.

Aluminium: Modern Material

Modern building and construction is more than merely erecting buildings as functionally as possible. In addition to functional and economic criteria, aesthetic and design considerations together with ecological demands placed on building projects play an equally important role. As I said its very easy to maintain its competitively cheaper its easily available and also its very functional and besides that it also has the advantage of being aesthetic and design friendly so this means materials used are of major significance. Aluminium, the building material for the modern age, established itself as an important factor in the building and construction industry during the course of the 20th century. So it came about after and much after steel but it has established itself as an important material in the 20th century. Aluminium enables every possible architectural concept to be realized, regardless of whether it is a new build or a modernization. So you see how aluminium has now become the material of choice as it able to realize every possible architecture dream in form.

Aluminium: Key advantages

So we'll look at the key advantages or the features of the aluminium which make it versatile. Strength vs Weight, weight of any material when the building is very large weight of the building comes into play so that is an important factor, as far as aluminium is concerned you heard of it aircrafts are made of aluminium which shows that it is a very light material so the Strength vs Weight of its volume is very important and is very less. Aluminium is 66% lighter than steel, steel is considered 5% lighter than most other metals and now you have something aluminium which is 66% lighter than steel itself so you can imagine the drastic reduction in sizes and the weight of the particular size. Aluminium sections are generally thinner and deeper than equivalent steel sections to achieve the required strength and rigidity since, Aluminium is not affected by moisture and aluminium windows do not warp, stick or rot. So right up to now every different disadvantage that is faced by materials has been eliminated as far as aluminium is concerned, it is extremely thin it is deeper, equivalent than steel sections, it is not affected by moisture its windows do not warp, stick or rot. So wood, iron anything of those matters can all be eradicated as far as disadvantage is concerned. Next important fact is the Low cost maintenance, so when a material is not only light weight it could also be low cost in maintenance, low cost especially concerned with maintenance it can become a really hit. Aluminium has a natural built in durability, most aluminum construction products are treated or coated. One way in which the oxidation process can be enhanced is anodization. So apart from being low in maintenance it can further be enhanced by offering protective coating to it like that in the case of anodization, we move on to other advantages Quick fabrication, time is of essence as far as any building or architecture is concerned because building any particular project takes large amount of time and if you are able to reduce it in some form or the other it'll be very useful so aluminum alloys for this factor to be considered so it can be quickly fabricated. One of the principal reason for aluminium'senduring and fast growing popularity is its compatibility with today's fast track constructionso todays construction is expected to be faster, so the fast track construction is kept checked and is just in time ordering. So overall materials can be added and brought back immediately to site so aluminium is favorable in that as well. Nowhere is this seen more clearly than in curtain walling, curtain walling is very very huge industry as far as construction is concerned in itself, so curtain walling uses lot of aluminium and distinctively shown in the low maintenance and quick fabrication as far as curtain walling is concerned the accuracy of factory finished sections allows rapid erection on site and allows internal finishing to produce more quickly. Easy control of quality as well, in such an enhanced material quality control becomes an important factor so if something offers even quality control to be easy then the material has to be very successful in terms of buildings. Although

basic material costs will always be important to specifiers they should be balanced against the cost of fabrication and subsequent service performance, so even though the basic material cost of aluminium is costly the cost of fabrication and cost of maintenance balances out to a great extent. This is an area where aluminium being ideally suited to highly automated manufacturing procedures to exact tolerances, offers many benefits. So the process of making aluminum is extremely automated which makes it very less time consuming in order to be produced so that adds to the part that can be fabricated easily and cost effectively. So we're talking about sustainability and green design is an important aspect of today's building industry and architecture industry so recycling is an important factor that is expected in all the building materials today and aluminium does not spare that also. The ability to recycle aluminium buildings product is also becoming more important as more building owners decide to deconstruct rather than demolish older buildings. So the practice today is when you want to replace a building or you want change it or you want to remove it what is done is not totally demolished its deconstructed and the parts are being recycled in order to be more sustainable so aluminium can be used extensively in recyclability. By doing so, they not only retain the scrap value of a material such as aluminum but also eliminate the environmental impact and cost of dumping it in a landfill. When you demolish particular building lot of materials goes waste and not only that the material is taken to a particular land fill and the space is wasted it becomes an environmental concern this is totally eradicated in the case of aluminum because it can be completely reused. Other important feature of aluminium is that it can be drawn in to various shapes. Because it is ductile aluminium can be formed into a number of shapes and profiles. It uses are by no means limited to a flat panels so its not just flat or used in particular angle it can be flattened out to various other shapes as well. Consequently, aluminum wall cladding systems can help create some of the most attractive and functional exteriors on building today. So apart from it being very functional, low maintenance durable etc. is can also be very attractive. In addition, large wall panels, either flat or formed, require fewer joints, producing fast and economical installation. So we talked about how quickly it can be fabricated furthermore the way the panels can be installed are very easy which eradicates the time, effort, cost required to install particular materials as such .

Aluminium

Aluminium is the most abundant metal in the Earth's crust but is rarely found combined in nature. So like rarer materials aluminium cannot be directly found in its original form it has to be extracted. Most commercially aluminium is extracted by the Hall-Heroult process, this is a process that evolved from time to time, a particular Hall process was present a particular Heroult process was present then over time it was found that the combination of these process help produce aluminum in a better way and that is commercially produced form of aluminium that is present today. In this process aluminium oxide is dissolved in molten cryolite and the electrolytically reduced to pure aluminium so that's how aluminum is made. Making aluminum is energy intensive. 5% of the electricity generated in the USA is used in aluminium production, maybe the basic cost or the cost of making aluminium can be very costly but its balanced out in its low maintenance and quick fabricating time etc., However, once it has been made it does not readily corrode and can be easily recycled these are another advantages even though it is energy intensive.

Aluminium: History

So let's look at a quick history. The analysis of a curious metal ornament found in the tomb of Chou-Chu, a military leader in 3rd century China, turned out to be 85% aluminium. So that's how it started off, aluminium oxide was known to contain a metal, but defeated attempts to extract it as I said it went through a series of process in order to be formed and finally a favorable method was created. The first person to produce it was Hans Christian Oersted at Copenhagen, Denmark and he did it by heating aluminium chloride with potassium, so after various series of experiment they were able to produce the purest form of aluminium, so purest aluminum for the first time they are using sodium instead of potassium, potassium is initially used to release the original aluminium but later it was replaced by sodium which resulted in the purest form of aluminium which is used even today.

Aluminium: Uses

So we looked at buildings and how they were used directly we also look at other uses. Aluminum is used in a variety of products this is because of its particular properties we talked about in detail, low density, non-toxic, high thermal conductivity, excellent corrosion resistance and can be easily cast, machined and formed. It is also nonmagnetic and non-sparking, so more added features in terms of lightning resistance structures. It is often used as an alloy because aluminium itself is not particularly strong. Alloys with copper, manganese, magnesium and silicon are light weight but strong and are important in construction of aero planes and other forms of transport, so we talked about how aluminium is very very light weight so along with other element makes it hard and durable. When evaporated in vacuum, aluminium forms a highly reflective coating for both light and heat. It does not deteriorate like a silver coating would. These aluminium coatings have many uses. So the first building we looked at the sports hall had a white coating of aluminium surface so that it could be reflecting the surroundings around it this was something an important feature too. So this is done by evaporating it in vacuum and forming a reflective coating for both light and heat.

Aluminum: Cladding

So apart from is being directly used as an important material aluminium cladding is an important feature in facades today. Aluminium cladding is cladding that is created using a thin coating of aluminum on the exterior of the product, so when you have a particular surface the coating of if its exterior with aluminium is called as aluminium cladding. Cladding in general is the application of one type of substance or material over a different material, effectively creating a protective layer, so notice that structure can have a different core structure but it can be cladded with other material in this case which is aluminium which is very favorable and can be used to great extent. The use of aluminium is creating high quality cladding is common, so cladding is a protective layer since aluminum has many features that help in being more better, high quality cladding such as low maintenance, resistance to corrosion its durability etc. is used as extensively as cladding. A number of building materials are clad with aluminum, the exterior skin helps to protect the wood from weather damage, extending the life of the casting for a number of years so both the process we looked at the residential level and the sports house both use aluminum completely as a cladding and external envelope and the fact that its properties are enhance help it to be better responsive to the immediate environment.

Protection: Anodizing

Now we'll look at some brief techniques of how protection can be extended to these materials especially aluminium, we talked about how aluminium being very durable so adding these protective

layers makes it all the more enhanced. Anodizing is an electrochemical process that covers the metal surface into a decorative, durable, corrosion resistant, anodic oxide finish, so further more you make it weather resistant by anodizing it. Aluminium is ideally suited to anodizing, although other nonferrous metals, such as magnesium and titanium can also be anodized, so anodizing is a general process of coating it but it is not necessarily restricted to aluminium it can also be used in titanium and other metals. The anodic oxide structure originates from the aluminium substrate and is composed entirely of aluminium oxide. This aluminum oxide is not applied to the surface like paint or plating, but is fully integrated with the underlying aluminium substrate so it cannot chip or peel, so what happens is when you anodize form this protective coating aluminium, the actual material becomes part of this anodizing coating layer which makes it very highly efficient so it cannot peeled easily like other coatings. It has a highly ordered, porous structure that allows for secondary processes such as coloring and sealing, so apart from being anodized already and offer protective coating it further more can be colored and sealed and treated in various ways both aesthetically and purposely, so that is protection as far as aluminium is concerned.

Copper

So now we look at copper as a building material, copper has been used ever since history started during the tie of utensils which was supposed to have a lot of medicinal values and lot of efficient scientific values as well. Like other materials its been very durable does not degrade very easily with weathering so that make it important material for building construction as well. This particular project is called as Rotunda, its actually the university of Virginia, this project was particularly inspired by the pan tern and its dome, you can notice that pantern was built in a different era of history where stone and lime stone can be used but here copper a more modern material was used and it was very successful and stands till today.

Copper has earned a respected place in the related fields of architecture, building construction, and interior design, from cathedrals to castles, and from homes to offices, copper is used for a variety of architectural elements, including roofs, flashings, gutters, domes, vaults, wall cladding, and building expansion joints. The history of copper in architecture ca be linked to its durability, as I said time immemorial for a lot of things in India also so the durability, corrosion resistance, prestigious appearance so copper has a really very grand way of looking at things and it becomes a part of its ethnicity its prestigious appearance is an important feature and its ability to form complex shapes, so copper is turned and shaped in various forms in domestic applications as well as bigger applications in terms of machines and now in terms of buildings as well, for centuries craftsmen and designers utilized these attributes to build aesthetically pleasing and long lasting building systems.

Benefits

So we look at the benefits of cooper its also a very good architectural material, it has excellent corrosion resistance, it has though oxide-sulfate patina coatings, so copper when exposed to the atmosphere it itself forms a oxide-sulfate platina coating which is the biggest reason why it is able to resist corrosion, this protects the underlying copper surfaces and resist corrosion for a very long time. Copper roofs are extremely durable in most environments. They have performed well for over 700 years, primarily because of the protective patina that forms on copper surfaces. So once you expose copper to

environment it forms a protective surface the patina surface which it was makes it a very durable material. Copper does not require cleaning or maintenance, so when a material stands the test of time for more than 500 or 1000 years you know that it is very easy to maintain and does not require much of cleaning and is very extremely durable. It is particularly suited for areas that are difficult or dangerous to access after installation, so when you have areas in architecture projects which cannot be accessed which are highly placed especially in skyscrapers as such, the use of copper comes very handy because it does not deteriorate or does not need very high maintenance.

Zinc

We'll now talk about zinc, zinc is an interesting building material simply because when its exposed to the atmosphere it changes its shape and color even though it does not happen over a period of days, it happens over a period of decades so when you expose zinc to a particular material it changes it colour according to the atmosphere it undergoes. In this particular picture we are looking at the Jewish museum designed by Daniel Libeskind, it's a museum for the jews history relation to holocaust how they were affected badly, so apart from having lot of angled lot of different forms used in the whole structure zinc cladding wa the main element that was used and apart ir being very durable and resist corrosion the architect Daniel Libeskind refers it to as the material that can change its character over a period of years as I mentioned by reacting to the weathering colours. This particular Jewish Museum zigzags with its titanium-zinc façade and features underground axes, angled walls etc., zinc panels offer three main benefits, zinc's best known benefit is its ability to keep away from corrosion, so we talked about how corrosion is an important aspect as far as building materials when exposed to the city are concerned. It is now one of the most commonly used metals in the world. Zinc is great ecofriendly construction for two reasons one it requires less energy for production compared to aluminium as such and other metals, and two zinc is completely recyclable, since it can be use produced from recycled materials taken from demolished or re roofed structures, so that adds a lot of sustainable features to its value.

Protection: Anodizing

We talked about anodizing, it is not only restricted to aluminum it can also be extended to other materials, the benefits of anodizing it protects satellite from the harsh environments, used in one of the world's tallest buildings, provide attractive, minimum maintenance, highly durable exteriors, lobbies staircases in skyscrapers and commercial building throughout the world. So its used extensively in all these places after being anodized, so as I said anodization is not restricted to aluminium it can be applied to zinc copper as well. Revolutionized the construction of computer hardware, exhibit displays for trade shows, scientific instrument and other product and also building materials mainly enhanced by anodizing, this is considered environmentally safe producing few if any harmful effects on land, air or water, so we discussed extensively about how anodizing can enhance the properties and how its also environmentally safe. The various advantages that anodizing offers are durability, finishing, corrosion resistance, lasting colour and its strength. Since anodized aluminium extrusion products have a protective layer, they are more resistant to wear, the finishing process creates a more aesthetically pleasing finish, corrosion resistance enhanced to a greater extent. The thick outer coating produced, along with proper sealing, increases the corrosion resistivity of the surface as it prevents further oxidization, so oxidizing is the biggest deterrent in terms of materials are concerned, so corrosion resistance is provided in case of anodizing for this case so lasting color, the color finish added to anodized aluminum is more enduring due to the surface obtaining more adhesive and porous qualities

during the anodizing process. So aluminum or any material in that matter is actually very plain and smoothened out so by adding anodizing coating it becomes more adhesive and porous and thus the color is able to stick to it much more than before, the strength of anodized aluminium surface is harder than pure aluminum, second only to diamonds with respect to its crystalline structure, anodizing in aluminum makes it so strong that it comes only second to diamond which makes it harder as a surface.

Powder coating

So there are other methods of protecting as well powder coating is one of them. Powder coating is a dry finishing process that has become extremely popular since its introduction in early 1960s, all heard of powder coating and how it is a very intensive process it is also advantages in various ways and we'll look at it, 15% of the total industrial finishing market powder is widely used by doing powder coating. Powder coatings are based on polymer resin combined with curatives, pigments, leveling agents, flow modifiers and other additives. These ingredients are melt mixed, cooled, and ground into a uniform powder, a process called electrostatic spray deposition is used, so what happens is the powder is sprayed throughout and this powder forms a coating which is very protective in nature. The application method uses a spray gun, which applies an electrostatic charge to the powder particles, after application the addition of heat the coating chemically reacts to produce long molecular chains which results in high cross link density which what makes it stronger and protective. This type of application is the most common method of applying powders. Powder coating is a high quality finish found on thousands of products you come in contact with every day. Powder coating protects the roughest toughest machinery as well as the household items you depend on daily, so lot of products that we use furnish of metal things comes with a lot of coating and powder coating is an important coating that is applied to it in order to be protected from corrosion etc.

Painting

So another way of protecting metal surfaces is painting we all heard of that, paint consist of a pigment dispersed in a binder and dissolved in a solvent. The most common methods for classification of paints is either by pigmentation or by their binder type. A modern paint system comprises a coating application of paints or alternatively paints applied over metallic coatings to form 'duplex' coating system. What happens is you paint over the particular metal structure you let it dry you let it stick to it forms a protective coating in terms of it being able to resist corrosion being able to keep away dust and being very resistant to the weathering process that it goes through. Protective paint systems usually consist of primer, intermediate/build coats and finish coats.

Chrome plating

Chrome plating is another type of protective layer adding to the metals so often they two are simply chromed, so when you talk about various automobile parts being added chrome you talk about chrome plating nothing else. The chromed layer can be decorative, provide corrosion resistance, ease cleaning procedures or increase hardness. Chromium plating continues to be the coating of choice for many metal finishing applications demand for chrome's bright lustrous finish, so when you talk about chrome you talk about the lustrous finish the colour as far as interior applications are concerned as well as in exterior applications. In architecture in interior design lustrous finish are difficult to achieve and that is being fulfilled by using chrome plating. Chromium has with stood the competitive challenges due to its unmatched aesthetics as well as its superior technical capabilities, including exceptional corrosion

performance. We'll talk about the stages of chrome plating degreasing, you manually clean it, various pretreatment it goes through, placement into the chrome plating vat, and application of plating current, this is the various stages of chrome plating, the lustrous effect that is maintained is done in this way. Chromium plating has been carried out on a commercial basis since 1924. It started of basically in chrome plating auto mobile parts, in the coating application it is plated as a thin layer over nickel to provide an economical and highly corrosion resistant deposit.

Stove Enameling

Next we look at Stone enameling, Stone Enameling is a wet paint process that uses specialized staving paints. The paint is applied by spraying before curing, stove enameling is the best paint finish for metal parts.

Besides that there is also Melamine polishing. Varnishes the way I heard is an important way of protective coating. Varnishes are transparent, hard, protective finish or film that is primarily used in finishing. Its traditionally a combination of drying oil, a resin, and thinner or solvent, so these are the various ways in which material can be protected.