Building Materials IV

Lecture 3

Famous Examples of Steel

So this particular building is the Walt Disney concert hall designed by Frank Gehry the way he comes up with his architectural style and language, so one of the important feature of this design is the way he's able to curve spaces and create forms according to those curves, so you can see that steel being used in such a context means that it is very versatile building material and can be even used in its curved most form. So we'll have a brief look at the Walt Disney Concert Hall and how steel is an important element, so the Walt Disney Concert Hall is in Downtown of Los Angeles, California fourth hall Los Angeles Music center and was designed by frank Gehry. So the exterior is a composition of undulating and angled forms so as I said the form of the building is undulating and angled the architect seems to have symbolized with musical movement and the motion of Los Angeles. So the designed developed through the paper models of and sketches, characteristics of Gehry's process so architect Frank Gehry process such that he creates models even though they were curved and the angle forms were realized in small scale and visualized as much as possible physically and then taken from. So the custom curvature demanded highly specific steel structures, including box columns, so this particular angled formed in the way the form was visualized by the architect demanded a highly specific material and steel seem to have suited that better as far as structure and box columns as such are considered. So visitors can glimpse the steel frame through a skylight in the pre-concert room and view the supporting structure from a stairway leading to the garden, so the thing with Frank Gehry style of architecture is that de-con or de-constructivism so you get to see de-constructed parts through which we can see the frame work of the actual building framework. So the visitors can actually see how the steel framework is used in the form of skylight and also in the form of supporting structures.

The next important building is one of the tallest sky scraper of its time in fact the tallest skyscraper during its time is called the Chryslers building and it has a crown feature at the top of its skyscraper and this feature is completely made of steel that takes u to how steel is being used was used extensively. So the Chrysler building is an Art Deco-style skyscraper so steel was so versatile a material that it's found its use in skyscrapers which are exposed to the most of atmosphere, so located on the East side of Midtown Manhattan in New York city. It is the tallest brick building in the world, albeit with a steel frame. So even though it is the tallest brick building of its time it had a steel frame which is very characteristic of it. So Van Alen's original design for the skyscraper called for a decorative jewel-like glass crown, so this crown the glass crown part was mainly characterized with steel and has become very iconic. The stainless-steel cladding is ribbed and riveted in a radiating sunburst pattern with many triangular vaulted windows, transitioning into smaller segments of seven narrow setbacks of the facade of the terraced crown. So you see the skyscraper the tallest part of it the glass crown which was visualized by the designer is totally clad with stainless steel and is ripped and riveted. We looked at two very important or two very massive architecture works had used steel extensively throughout its façade and so well be able to see how it is possible for us to look at steel as not just as a durable or a versatile material but also as a means of expression.

So now we'll move on to steel being a material of architectural expression, in addition to being a structurally versatile and adaptable material, steel offers the opportunity for architectural expression. Not all materials which are used in architecture are very significant in architecture assist to help the architecture or the architect to be able to express his design or aesthetic values completely steel is one such material the opportunity is much more abundant. Good quality detailing is vital because it affects structural performance, cost, buildability and perhaps most importantly, the appearance of the building. So prior to this the materials we used were whole and could either be sorted out and used in the building directly or it would be associated with other materials but as far as steel was invented the advent of steel it brought with it the added opportunities of creating detailing of where you could actually design the structural performance you could control the cost and buildability and also the appearance if the building so prior material were important aspect they have to be reliable and durable but rather to it steel gave rather bigger opportunities as far as appearance and the aesthetic value of the building is concerned. This was both very clearly visible as far as the Walt Disney Concert Hall was concerned as well as the tallest sky scraper during its time the Chrysler building. So although the choice of structural form is often the province of the structural engineer, architects should have an appreciation of the factors leading to the selection of the structure and its details. So before that architects had an important role in design but they were not or weren't required to control its structural decisions or structural capabilities until then, but with the advent of steel the ways it could be shaped the ways it can be used and the amount of opportunity it can offer it was essential of the architect to understand its capabilities and also appreciate the factor selection of structure and its details. For exposed steelwork, detailing is of much more interest to the architect, as it impacts on the concept of the building. So unlike detailing being rather amending sort of thing for architects it became a thing of a opportunity and interest as far as steel advent came about. Steel construction provides many advantages for architectural expression so building materials generally provide lot of advantages functionally even in terms of form sometimes but here came a building material that offered expression in terms of architecture itself. So externally exposed structures clearly express their function. Slender members can be designed efficiently, particularly using tubular sections. So apart from being aesthetically valuable you could also concentrate on the form and function of the building. The 'lightness' can be accentuated by openings in beams and by lattice works, so 'lightness' or light weight was an important feature of steel simply because it was almost lesser in weight as compared to the materials that were used prior. Curved members such as arches can be formed easily so as said steel could be turned and shaped in any form and various shapes so curved members became an easy thing to do such as arches. Tension structures are efficient and lightweight, particularly for long span enclosures. Connections can be designed expressively. So elements of architecture which were only supposed to be connections or structural elements now began to be included in design as far as steel use was concerned. The fire resistance of exposed steelwork can be enhanced by the use of intumescent coatings, oy by concrete, or water filling, so with the advent of sky scrapers and bigger buildings and huge buildings there are lot of concerns that do come about and fire proofing or fire retardant was important aspect. As far as steel is concerned you could make steel an already fire retardant material all the more fire retardant by adding coating or fire proof materials as such, besides as this to add the aesthetic value colors and finishes of painted steelwork can be used to great visual effect. So we looked at iron and steel how they can be painted or coated in various ways and this adds a lot to the aesthetic value of the building.

Steel: Innovative Use

We now move on to innovative use of steel, steel has been used for years and years ad still now it has been valid in the construction industry as well as architecture design so its innovative use has taken place in various sectors we'll be looking at it in domestic manner. Steel remains the top manufactures material to use when producing buildings as I said. Some of the world's most innovative creations such as skyscrapers, would not be standing if it were not for the power of steel. So yes as far as power is concerned we'll be looking at skyscrapers how it is innovatively used in various structures but in this case we'll be looking at more restrictive or rather domestic application of how innovatively steel is being used.

Agricultural steel buildings, so steel building in agriculture is very innovative or rather useful way of looking at steel as a material for buildings, this is simply because agriculture goes through a process of buildings which take place in the course of weathering, so when you build a structure as far as agriculture is concerned the environment in which agriculture is present is concerned, it goes through a lot of weathering and the structure has to be redone or repaired or address to it from time to time, but, with the advent of steel and using steel for agriculture buildings it makes sure buildings could stand for a long period of time without having to be worrying about any form of maintenance. The agricultural industry relies on knowledge and methods that have withstood the test of time. Unfortunately, wooden buildings which is mostly used in agriculture and other structures simply did not allow to follow that trend. So while most of the construction, architecture was developing around steel agriculture was very rather backward in that form, now that is changed with the use of steel being applied to agriculture buildings as well. A problem that many farmers and ranchers had had throughout the ages is the premature weathering of many of their most important buildings, so as I said weathering of the buildings happen during the course of the year. The innovative remedy for this issue? Steel buildings that were made to last and stand beautifully through the ages. So steel had this wonderful brand value added that it could be lasting more than quite a number of years so that made an added value as far as agricultural buildings are concerned and they've started using steel as an important material in agricultural buildings.

So rather un said use for steel in a particular form of architecture would be that of churches. The evolution of churches in the nation has been astounding, churches have developed from small scale to big scale to that of different styles and different sets and different variations. Congregations have expanded from small groups who met in modest wooden buildings to flocks of thousands. So at the time when churches were places of worship for a small group it is now developed to an enormous number of people meeting at congregational spaces. So with that the rapid scale increases in churches has resulted in stone or prior materials being used in construction being very difficult to be used, so the role of steel made it very easy in order to make this very viable. As churches grow, many look to steel buildings as their construction material of choice. Steel is creating beautifully-designed modern churches for great prices. Apart from being easily available being able to use in a larger scale it is also available in an affordable manner as compared to the other materials which are fading away.

Green housing, so in the world of sustainable technology green design all that steel has a very very important role as it is easily one of the most important environment friendly materials as far as its resource is concerned. So housing is very basic architecture requirement in any society and any community can be easily done with the help of steel, steel housing makes it very cost effective and very easily available. So nations see a ride in families and individuals in need, more cities are implementing green housing projects. The perfect building solution has to be steel.

Steel: Structural

We looked at how steel is an important material how it is used in structures and how it is being innovatively used, we'll now look at steel as a structural element because steel is supposed to very durable and strong material which allows its use directly in structural form. Various types of steel are used depending upon the application. The main content of structural steel after iron is carbon, so as I said iron with the addition of carbon making it an alloy is how steel becomes, so this is an important factor in which structural steel plays well. Structural steel sections are normally utilized for the construction of buildings, manufacturing sheds, transmission line towers etc., so anything massive that you look anything you look commonly in architecture we'll see use of steel construction of buildings all over, manufacturing shreds industries as such, transmission lines of power, power lines are usually transmitted with steel transmission towers. Structural steel is a category of steel construction made that is produced with a particular cross section or shape, and some specified values of strength and chemical composition, so structural steel is not just normal steel what happens is they create or make sizes of steel that have particular cross section which will help them act in compression and tension and thus be useful in structural capabilities besides being such cross section they're also have values of strength and chemical composition added to them. Structural steel composition, strength, size, shape, strength, and storage are controlled in most advanced countries, so once you have steel and once you know how to enhance it this is done in various methods by adding various different types of chemicals, by various ways if treating, by various ways of coating it with protective layers, this is controlled in different ways and steel has been used for different parts of the structure. The word structural steel includes a broad variety of low carbon and manganese steels that are used in great numbers for civil and marine engineering applications. So we can see that apart from being used structurally in architecture and building industry it can be used very well in civil, marine and other engineering applications as well, so low carbon and manganese are the alloys that steel very structural in character.

So we'll be looking at some of the types of structural steel. After iron, carbon is the most important element in steel. The increase of carbon produces materials with high strength and low ductility. The techniques used for the production of steel are high- computerized stress analysis, precision stress analysis, and innovative jointing, so it goes through lot of stage of analysis and designing in order to viable for structure, so it's not just you take up steel cut into pieces and use it. The types of structural steel sections normally used are beams, channels, flats, and angles, so everything the use of columns, beams have been replaced by steel structure so that forms steel beams, steel cannels, steel flats and steel angels. The main kinds of structural steel are generally categorized according to the under mentioned categories of chemical composition so we look at steel as I said I mentioned chemical composition is varied according to the structural requirements, according to that structural steels can be classified into two or three types they can be carbon manganese steel, the most widely used form of steel for structures, High-strength and low-alloy steels, this is how you probably vary the alloy levels treated accordingly for different structural purposes, High-strength tempered and quenched alloy steels, so three different types of structural steels. Carbon-manganese steels, the major chemical ingredients are iron, carbon and manganese, so I said adds to the strength. These are normally called mild structure steels or carbon steels, carbon is an important aspect in structural steels the strength and ductility are high, and being economical is therefore widely used, so as I said carbon and manganese steels are most widely used in structural and one of the most important reason is that it is economical apart being very strong and durable. High-strength, low alloy steels, this is a recent development in the steel industry.

Chemical elements are added to improve the strength, so basically between all the structural steels that are used the chemical composition makes the difference and the High-strength,low alloy are something of a more recent development and so as high strength tempered and quenched alloy steels. So once you have started using steel or any other material in structural purposes we also have to make sure it is protected well in order that it does not get affected by weathering agents as well as fire.

Steel: Structural Protection

Fire-resistance rating is the time taken for the steel that is being tested to attain the temperature fixed by the standard. So what happens is as far fire is concerned the material is considered fire resistance by the number minutes it takes to burn down or contain the fire, its not that when the metal is exposed to fire it doesn't mean that it does not burn at all but the amount of time it takes to burn, the amount of time it takes to hold up to the fire until the measures are taken in order to douse the fire is what decides the fire resistant is good or not of a particular material. So fire resistance taken for steel that is being tested to attain the temperature fixed by the standard. Structural steel needs external insulation that is also called Fire proofing, to prevent the deterioration of steel in the occurrence of afire,as I said. On heating, the steel expands and becomes softer, and finally the structural integrity is lost. So this what happens every material including steel burns down it compromises after a point but the number time the number of minutes or hours it takes to burn down and lose its stability is what matters. So if sufficient energy is provided steel may also melt. The transfer rate of heat to steel can be reduced by using fireproofing materials, so this is where the protective coating comes in to play. While concrete structures may be able to resist fire damage without extra fireproofing, concrete may deteriorate, particularly if the moisture content is high, so concrete on the other hand does not need to be fired proof separately in order to be fire resistant but still requires this, but as far the moisture content is concern you can see that steel is able to repel moisture much much when concrete is compared

Steel structure advantages

So we look at the basic or very useful advantages if steel structures, so there are many advantages to building with steel, High quality, aesthetic, these are two things which govern the use of any architectural material in the field today, the material has to be high quality which is not easily met and the material also has to aesthetic, so if the material is high quality it becomes costly if it's very aesthetic it becomes very costly but this is comparatively controlled as far as steel is concerned, it has low maintenance cost, compared to other buildings which go through lot of weathering etc. the maintenance of steel is very less, its environment friendly, its component can be reused and recycled which makes it very sustainable, components are functional, other than using steel for aesthetic or form purposes it can be used for functional purposes like for structure as we talked about, its strong, durable and stable, enables good design and safety, it is sustainable to temperature effects, as I said steel has a very high melting point so the variations in terms of temperature does not affect steel, its rigid and dimensionally stable, another important aspect of the material used in architecture is its dimensional stability, so steel is very rigid and dimensionally stable making it very enhanced and good, construction is fast compared to other materials, resistant to termites so that so that totally takes out he dis advantage of the wood, so the resistant to termites and other insects for that matter and other destructive insects, cheaper than any other construction method and it offers faster construction so those are the important advantages of steel and why it is an extensively used material, we'll further look at more advantages. Some common types of steel buildings are "straight-walled", "arch" and "clear

span", so steel building has developed to such a way that it can be called as steel architecture spanning rigidly large spaces, spanning rigidly long spaces, building spaces that are very very tall or like in the case of sky scarper steel buildings have been very viable. Straight-walled and the arch type refer to the outside shape of the building, so the particular shape of the building is in terms of its structure so such a way steel plays an important role in that. So you notice that how it is able to design the structure of the building and also the form and its envelope. Steel arch buildings are the most cost effective and structurally sound. They are commonly used on the agricultural industry. Straight-walled buildings provide more usable space when compared to arch buildings so within steel architecture itself there are different type of buildings and that's how extensively it becomes to be used about. They are also easier to blend in to existing architecture, so apart from being a separate element it can also be an additive or rather cladding kind of element. Straight-walled buildings are commonly used for office spaces. Clear span classification refers to the internal construction, other than just being a façade material its also be able to be an important part of the internal construction or the structural framework. Clearspan steel buildings utilize stronger overhead support beams, thus reducing the need for supporting internal columns. Clearspan steels buildings can be used to store large commercial aircraft or used as public arenas, so you can see the strength to which steel is used it is used in airports, public arenas and stadiums.

Steel: INSDAG

We'll now briefly talk about INSDAG or Insdag as its called. This is the Institute for Steel Development and growth is an organization in India its meant to promote the safe and worthwhile use of steel and its alloys, so what they do is set about giving set of parameters or design standards for steel based design and they also offer lot of promotional programs that helps you understand steel better help you understand various recent development in steel and also its capabilities. INSDAG among other efforts, have released parameters for both design and structural as well as detail considerations of steel and its use in building construction, various legal codes one has to follow as far as steel construction is concerned one has to refer to the INSDAG parameters that are set by them. Their parameters are standards to be met by constructions and as a mode of promoting steel use education they also hold workshops and seminars for better understanding of steel, this is an ongoing thing even today INSDAG has lot of design competition that student and architects likewise participate through that they promote the use of steel and how it could be understood better so as I said besides they also hold design competitions to welcome innovative use of steel in the field.

Steel: Alloy

We looked at steel, steel in itself is an alloy but there are also other variations of steel alloys which can be created. Alloy steel is steel that is alloyed with a variety of elements in total amounts between 1% and 50% by weight to improve is mechanical properties. Any material in its self can be its complete or full capability achieved, so it is usually alloyed with other materials in order to enhance its properties, so in this case steel is alloyed to an extension from 1% to 50 % of other alloyed materials to enhance its properties, so Alloy steels are broken down into two groups: low alloy steel and high alloy steels. Strictly speaking every steel is an alloy, but not all steels are called "alloy steels", steel in itself is an alloy but in order to make it more enhanced in terms of its properties it is alloyed with further more materials. The simplest steel are iron alloyed with carbon which is basic steel. However, the term "alloy steel" is the standard term referring to steels with other alloying elements added deliberately in addition to carbon.

Common alloyants include manganese we walked about manganese and carbon being an important structure steel, nickel, chromium, molybdenum, vanadium, silicon and boron. These are the various different types of metals that can be alloyed with steel in order to suited variably. Less common alloyants include aluminum, cobalt, copper, cerium and so on. We'll look briefly at some important steel alloys. So steel when I add with Chromium the feature that it adds are it adds hardness, increased toughness and wear resistance, so you see apart from steel itself being enhanced in terms of properties adding these alloys makes it all the more better properties such as hardness, toughness and wear resistance, adding Cobalt makes it easy in terms of cutting tools, so it can be used to make cutting tools, so Manganese increases surface hardness, improves resistance to strain, hammering and shocks, a most viable and favorable for building construction and structural elements, Molybdenum this increases strength, improves resistance to shock and heat, so you notice that each and every alloy has different set of properties that it enhances, Nickel increase strength and toughness, Tungsten adds hardness and improves grain structure, so adding grain structure helps in its texture and other aesthetic values, it provides improved heat resistance as well, so Vanadium increases strength, toughness, shock resistance, improved corrosion resistance as well, Chromium Vanadium alloy along with steel improves tensile strength, so this also were used as an important structural element, it is hard but easy to be bent and cut, there are various things we looked about steel drawing sheets from steel is an important aspect of steel because for a material to be drawn into sheets makes it viable to be rolled, makes it viable to be various forms and shapes to be able to adhere to various curves or angles that can be created, so steel can be dawn very well in to sheets particularly in two ways in Hot rolled manner and Cold rolled manner.

Hot rolling is a mill process which involves rolling the steel at a high temperature, as simple as that, so heat is taken to a highest temperature and is rolled completely and when steel is above the recrystallization temperature, it can be shaped and formed easily, and the steel can be made in much larger sizes. So like that in the olden days when the heated iron or any metal turn the spaces, this can be done to a very extensive measure by making steel reach high temperature and rolling it. Hot rolled steel is typically cheaper than cold rolled steel due to the fact that it is often manufactured without any delays in the process, so hot roll steel is simple process, so you rise the temperature of steel to great extent and you make them into sheets and roll them, but as far as cold rolling is concerned you need to do two or three more stages in order to achieve the final product, therefore the reheating of is not required this is the case in cold roll. The uses of hot rolled steel would be products such as steel bars used in the welding and construction trades to make railroad tracks and I-beams, for example. So everything from welding to construction to changing the shapes and features and forms of steel has been used in any form which makes steel very favorable in the use of construction, so here hot rolled products help in welding and construction trades.

Stainless Steel

We also look at stainless steel which is an important building material we can look at two important building constructed recently one is the Bird's nest Beijing's National stadium, and the other is the Sydney Harbor made with completely stainless steel. Stainless steel is the most perfect form of steel hence it is being used extensively in many projects, so the various properties, application of stainless steel can be studied and you can also learn that it is one of the most sustainable metal that can be used in architecture today.