Fundamentals of Manufacturing Processes

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Lecture – 07
Applications of Manufacturing Processes

Hello, I welcome you all in this presentation. This presentation is based on the subject related with the fundamentals of the manufacturing processes and today specifically we will be will be talking about the Applications of the Manufacturing Processes. In this presentation I will be talking about the main manufacturing processes and what for they are used.

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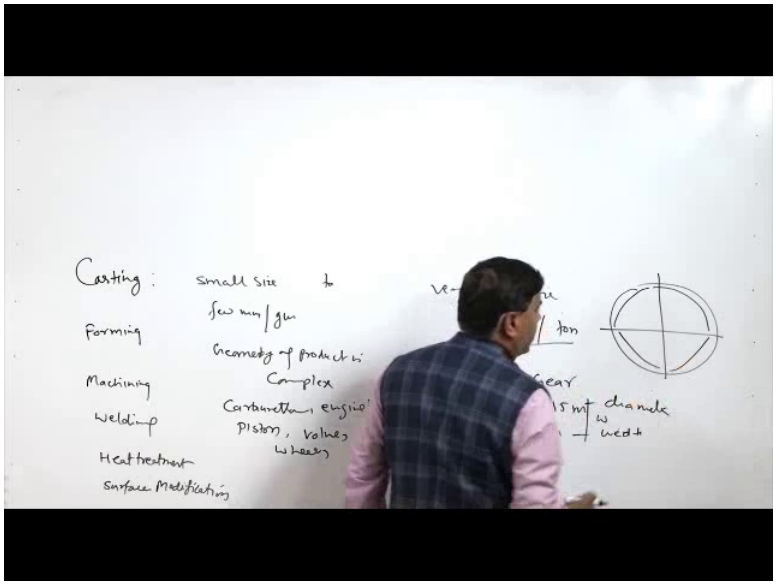

So, starting with the casting, forming, machining, and welding then like heat treatment and like surface modification or we can say surface engineering.

We will try to talk about these manufacturing processes casting we know that in case of the casting we have to melt the molten metal and put that into the mold so, that the desired shape can be achieved. This process is used for making a small size to very large size components, this maybe say of the few millimeters or few grams to like say few meters or even in weight in tons. So, the example is like most of the components where the Geometry of the product to be made Geometry of the product is Complex and we want to reach close to the final shape in one go then casting is the best route.

Most of the components related with the automobile industry for example, like Carburetor a engine block, Piston valves and Engine case, wheels, etcetera all these are made using the casting process, among the large size components like Girth Gear is a typical example where a very large size of like say a 10 to 15 meter in diameter, 1 meter in width, this is the diameter and this is the width of the Girth Gear.

Very large size gears are made using the casting process, similarly the large dia shafts large diameter shafts for example, shaft used in the hydropower industry they are of say diameter of 1 meter and a length maybe like 10 to 15 meter. So, such largest diameter shafts under the longer length shafts are made fast by the casting and therefore, they are forced well in case of the girth gear the it is prepared in portions or in parts like the entire gear of this sizes, it will be made in the 4 different a parts and then it is joined it together to give the shape of the gear.

This is what is there in the casting we will see in detail since the each process of the casting has the different kind of capability and therefore, a different types of the products are made using the different types of the casting processes.

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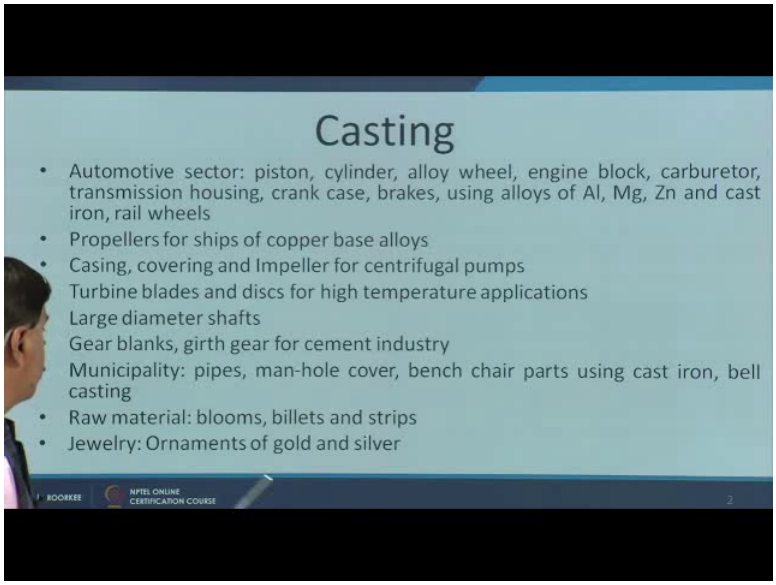

Now we will be going through the process specific capabilities, let us first see the entire range of the products which are generally made using the casting process for the different sectors. For example starting with the automotive sector, in automotive sector the casting is used for making variety of products like cylinder, alloy wheels, engine block,

carburetor, transmission housing, crank, case, brakes and these are made usually the use of the aluminum alloys, magnesium alloys, zinc alloys in cast iron and the rail wheels these are also made using the casting process.

Similarly, propellers for ships are made of the copper base alloys they are also made using the casting process, then for the components of the centrifugal pumps like casing, coverings and impellers for the centrifugal pumps are made using the casting process. In case of the thermal power plant like the turbine blades and their discs are for high temperature applications are made using the casting process large diameter shafts for hydropower industry girth gear blanks and girth gear for the cement industry.

And for various municipal products which are used by the municipalities like the cast iron pipes, man hole covers are also made of the cast iron bench chair parts are made of the cast iron, bell castings are made by the casting process and the casting is also used for making the raw materials in form of the blooms, billets and strips. When the material is extracted from the ore and then in molten state it is processed to produce blooms, billets, and strips by the casting process.

And it is also casting is also used for making the jewelry so, that ornaments of the different of the gold and the silver are made by the jewelers using the casting process.

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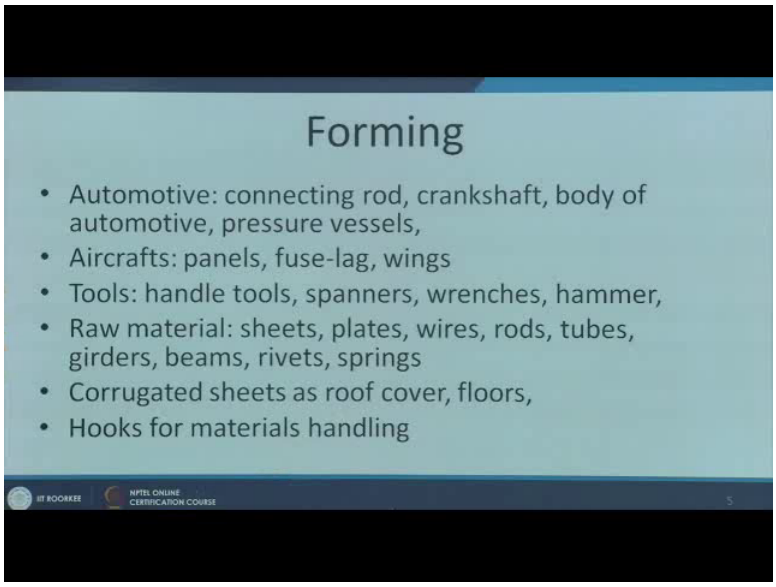

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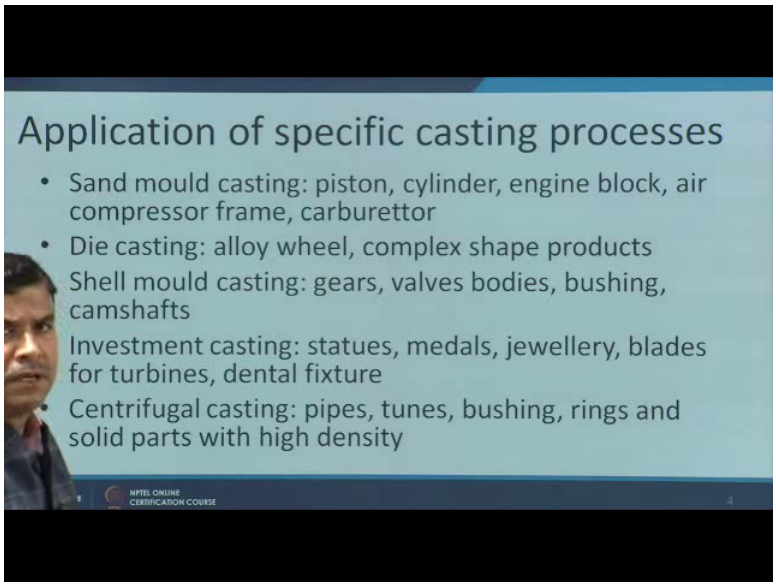

Now we will see that the different since the different processes, different casting processes have the different kind of capabilities and therefore, we need to see which process can be used for which kind of application or which kind of purpose. We will see that send mould casting process is normally used for making the pistons, cylinders, engine block, air compressor frames and carburetors.

Die casting which is used for making the alloy wheels and complex shape products when the volumes to be produced are much larger and the shell mould casting is used for making the gears, valve bodies, bushings and camshafts and, investment casting is used making for making the further complex shapes and that the geometries like statues medals, jewelry, blades for the turbines and dental fixtures and the centrifugal pumps sorry centrifugal castings method is used for making the pipes, tubes bushings, rings and also solid parts of the high density these are made using the centrifugal casting.

Since the each process has the different kind of capability and different kind of the production limitations or you can say the cost at which the product can be made by particular process is different and therefore, these are some of the products which can be made by the specific category of the processes. Now coming to the forming processes forming processes is another primary shaping process where primarily the deformation is used deformation using external force is used to get the desired a size and shape.

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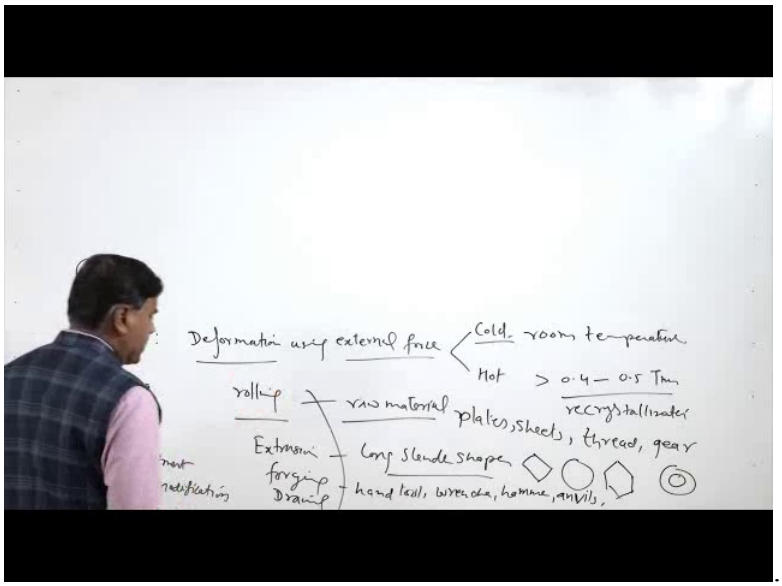

In this category basically there are 2 variants one is cold forming and another is hot forming, this is generally carried out above the 0. 4 to 0.5 times of the melting point that is the recrystallization temperature sorry this is done at room temperature, cold forming is done at a room temperature and hot forming is carried out above the 0.4 to 0.5 times of the melting point, this is the recrystallization temperature.

So, as far as the application of the deformation based processes for example, rolling, extrusion, forging, drawing these are some of the bulk deformation based processes, which are used for achieving the larger shape or the primary shape of the product which is to be made. But the target here their rolling is primarily used for making the raw stock material in form of the like say plates, sheets, it is also used for making the thread by the thread rolling, it is also used for making the gear gears through the gear rolling, extrusion is used for making the long cylinder shape a products with the reduced cross sectional area for the bars of the different cross sections like circular, cylindrical or hexagonal.

These a different cross sectional shapes can be produced and even the hollow sections can also be produces through the extrusion process, forging is used for making like say the hand tools a like a wrenches, hammers, anvils, connecting rod at connecting rod shafts etcetera are made using the rolling using the forging processes and the wires and the a rods or we can say the bars of the larger diameter are made using the drawing process.

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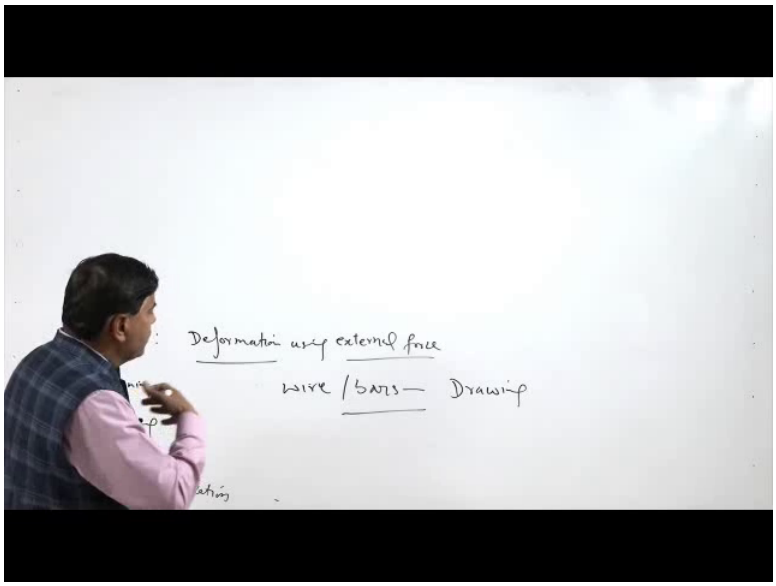

If we see here in the deformation based processes wires and bars are produced using the drawing processes, these are like based on the geometries these application is been described. Now we will see the product wise what for these processes are used, if we will see the forming process in automotive sector is used for making the connecting rods, crankshafts, body of the automotive component like the if we see the cars, trucks, buses, their body is made of the sheets and they are deformed using the forming based processes like sheet metal forming and the pressure vessels of for giving the desired shape to the pipe followed by the welding the in the pressure vessels easy means the pipes and a large diameter pipes are made using the forming processes for the pressure vessel applications.

Like in aircrafts wherever we want that aircrafts will be using the different sheets of the a aluminum, titanium etcetera, they are used for making the panels fuse, lag and the wings and the forming is also used for making the hand tools, spanners, wrenches, hammers. So, that they can be made of the higher strength and of the lighter weight that is a feature which is exploited in the forming.

Then the raw material these forming processes are also used for making the raw material form of the sheets, plates, wires, rods, tubes, etcetera, girders, beams, rivets, springs and then corrugated sheets are used for covering the roofs, floors and hooks are used for a material handling applications.

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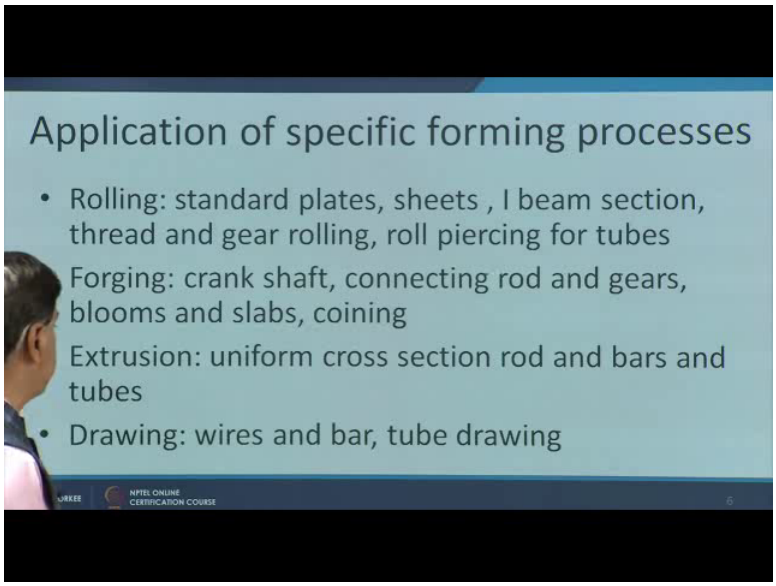

Now the process is specific applications of the forming processes include like a rolling for making this standard plates, sheets, I beam sections, thread, gear, rolling and the role piercing is used for making the tubes. Forging is used for making the crankshafts, connecting rod, gears, blooms and slabs and the coinings means the coins and the Extrusion is used for making the uniform cross section rods bars and the tubes and the Drawing is used for making the wires bars and the tubes using the tube drawing processes, machining we know that both the casting and the forming are the primary shaping processes which helps us to reach close to the desired shape and the size.

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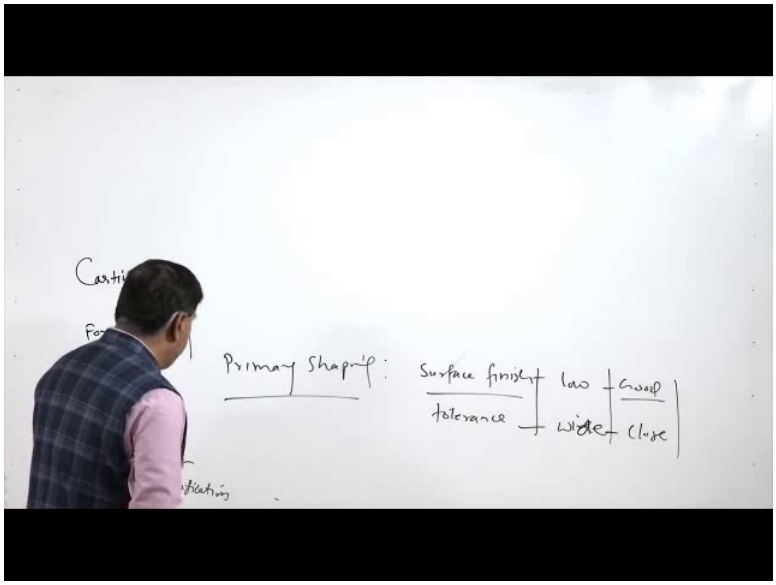

But the surface finish which is produced and the kind of the dimensional variation in terms of the tolerance this is a surface finish is low and tolerance is wide and they are wide and therefore, to have very good surface finish or as per requirement and close dimensional control it is necessary that all the cast and formed component are processed by the secondary processing which is called a machining so, that desired degree of the finish and dimensional control can be achieved.

So, basically the main application of the a machining is to control the dimensions and the surface finish a sometimes it is also used for the sizing purpose, but since the productivity of the machining is low that is why it is a rarely used for means it is not that common to use machining for achieving the desired shape in light of the productivity. However, the customized products when the very few number of the products need to be made then of course,, machining can be used even for the sizing purpose.

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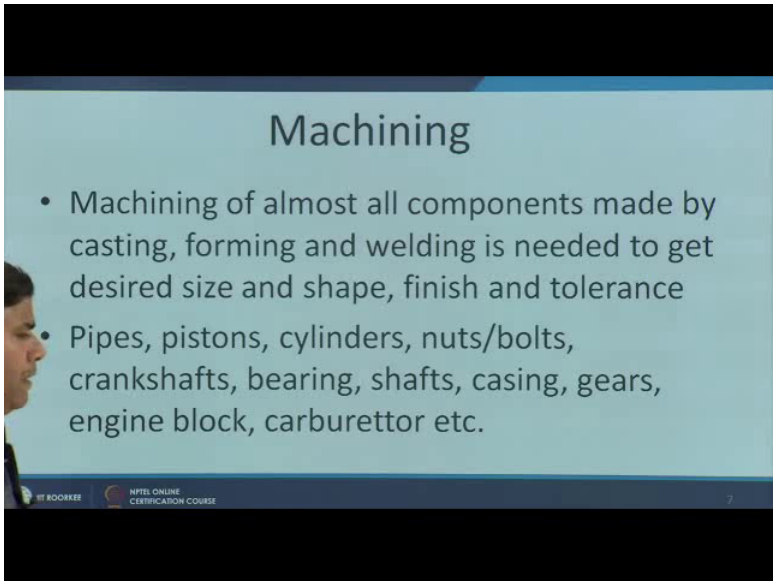

Thus the common application of the machining includes machining of almost all components made by casting, forming and the welding is needed to get the desired size and shape. So, that the desired degrees of the surface finish and the dimensional control or the tolerance can be achieved. Machining is used for making in the pipes of the desired lengths, the pistons, cylinder, nuts and bolts, crankshafts, bearing, shafts, casing, gears, engine block and carburetor etcetera all these are made by the forming processes

are of the deformation based processes need the machining for the desired dimensions and the surface finish.

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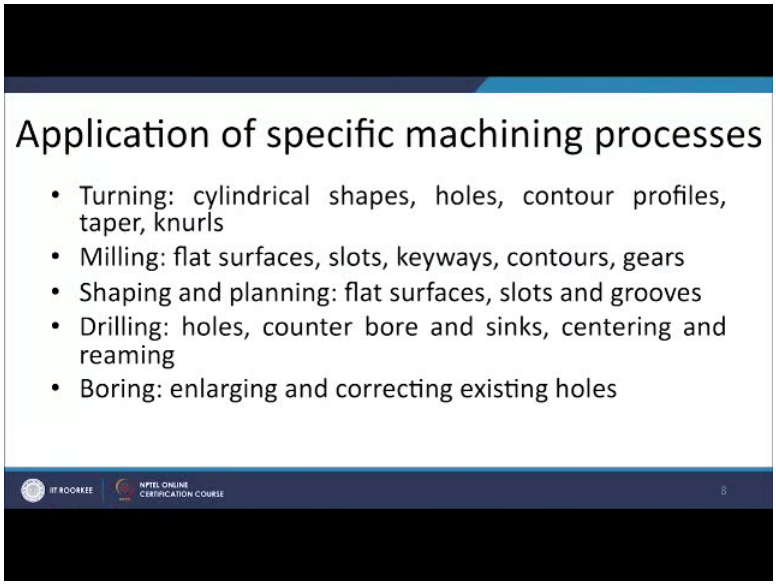

Now, coming to the machining process a specific application like machining is a very broad category of the process. Machining involves a like a machining one of the processes Turning is used for making the cylindrical shape products it is used for making the holes, contour, profiles, tapers, knurls, threads etcetera. So, various the geometrical features can be made using the turning, then Milling is primarily used for making the flat surfaces, slots, keyways, contours and the gears gear milling is very common for producing the gears. Then Shaping and Planning processes are mainly used for making the flat surfaces, slots and the groups and then Drilling is used for making the holes, counter bores, sinks, centering and the reaming a hole means drilling is the process which is used for creating the hole.

And then the counter Boring helps to make the partial enlargement of the whole and the partial conical hole is made in sinking. So, the partial the counter boring is basically say in a object we have a hole like this.

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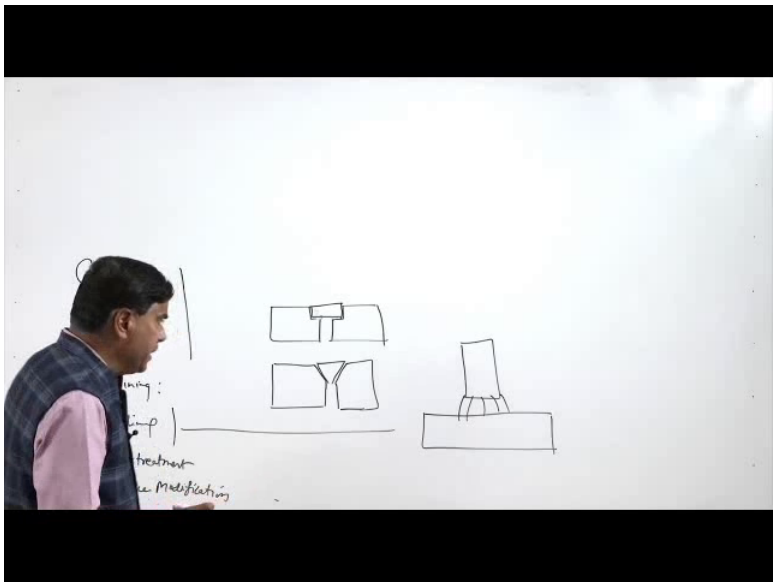

If the hole is a partially enlarged, this enlargement of the hole is dumb like this for the counter boring process. So, this is what is there in the counter boring and the same hole can be made for the counter sinking by developing the geometry in this way.

A conical shape geometry is produced for the sinking purpose, countersinking purpose and this is the can say enlargement of the hole partial enlargement of the hole diameter is called counter boring and the centering is we still used for developing the center. So, that it can be used for holding the job between the headstock and tailstock or it is a first step for drilling the hole at particular locations of centering is done, where rimming is basically the finishing process of already existing hole. So, that through the closure control over the surface finish and the dimensions can be achieved.

Boring is the machining process primarily used for enlarging the shape of a enlarging size of hole and also correcting the existing hole if a hole has been located in correctly and if it is of the smaller diameter then it can be correctly placed. So, correcting the whole location and the enlargement of the whole diameter is achieved through the boring and grinding is used to for a achieving the desired surface finish and the dimensional control and mainly used for making the in the process of a manufacturing of the crankshaft, camshaft and the flat surfaces coming to the welding.

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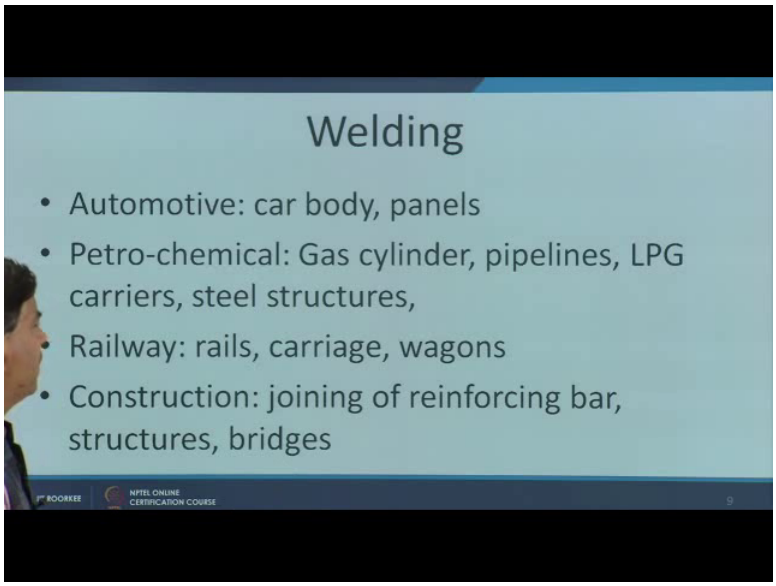

Welding is used for achieving those geometries which otherwise cannot be made by the forming or the casting processes or the machining processes, what we do, we take the simpler shapes and then they are joined together by one or other joining processes. So, like it is also used for making the complex shape gears or complex shape components and the geometries using the simplest shapes and the typical application of the welding in the like say in the different sectors include the joining in is involved in automotive sector for a joining the car bodies with the structure of the car.

And the panel members in petrochemical industry it is used for make a fabrication of the gas cylinders, joining the pipelines and LPG carrier tanks and the steel structures which are a used the (Refer Time: 22:04) and then in railways, it is used for making the rail joints through the thermite welding process, also joining is commonly used for fabrication of the coaches, a carriage and a wagons and in construction industry it is used for joining of the reinforcing bars structures and the bridges.

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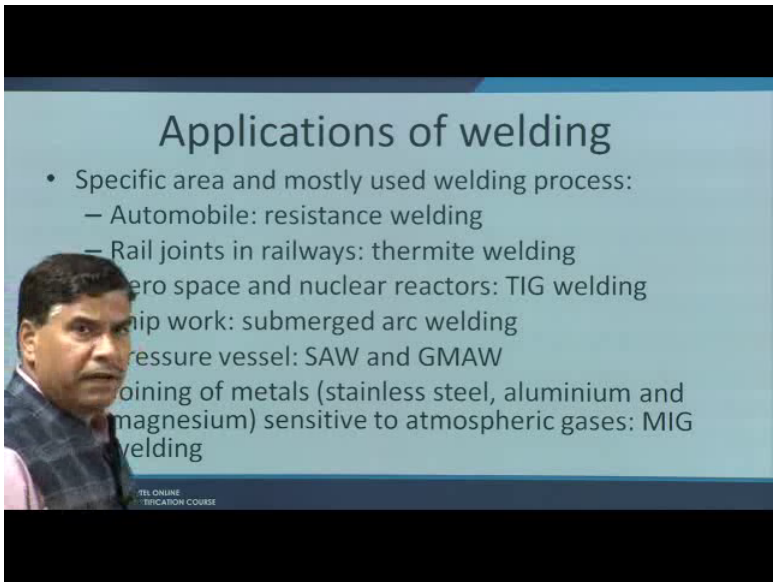

Now, we will see the process specific applications of the welding process. So, like say automotive in a in case of the automobile industry resistance spot welding is extremely is very commonly used each car has about 4000 to a 5000 number of the spots, which are produced by the spot resistance spot welding process, rail joints normally uses thermite welding for producing the but joint. Then in aerospace and nuclear industry, TIG welding is invariably used for producing the quality joints. So, that in the reliable and the sound joints can be used with the minimum adverse effects in the heat affected zone due to the welding then the in the shift work for making the largest structures by joining the simple plates the submerged arc welding is a normally used so, that the metal can be deposited at a high rate and the desired dimensions can be achieved.

In presser vessel industry normally the submerged arc welding and the gas metal arc welding is used and then joining of the metals like for joining the metals of the joining the reactive metals like in a stainless steel presence of chromium makes the oxides easily. So, it is welding becomes difficult using the normal shielded metal arc welding process or gas welding process similarly the aluminum and the magnesium both these from their oxides which are effective in nature and therefore, a proper protection is needed during the welding of these metals and therefore, gas metal arc welding or the tig welding is normally used for joining the metals which are reactive in nature.

Now, coming to the heat treatment process needs a applications there are various heat treatment processes. We will try to talk about the heat treatment processes although they are different types of the heat treatment processes. So, we will talk about the heat treatment for the ferrous metals like steels and for aluminum alloys.

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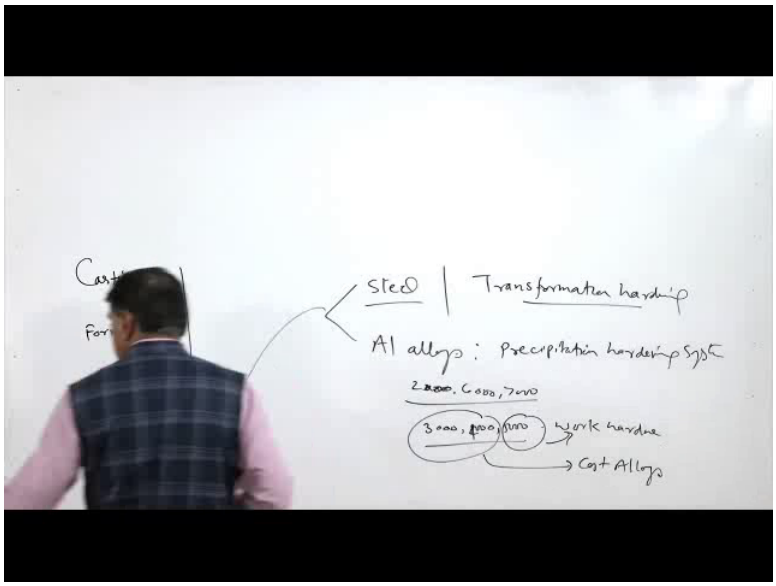

So, for steel we know that these are the Transformation hardening metal systems and these are the Precipitation hardening systems although there are some systems which are work harden able like 2000, 6000 and 7000 series aluminum alloys are the precipitation hardenable. On the other hand 3000 and 5000 and also 4000 and 5000 series aluminum alloys are the work hardenable or they are.

So, among these 5000 is basically the work hardenable and 3000 and 4000 systems are the cast alloys, basically the in among the heat treatable systems I will try to talk about, in case of the transformation hardening systems and for a precipitation hardenable systems.

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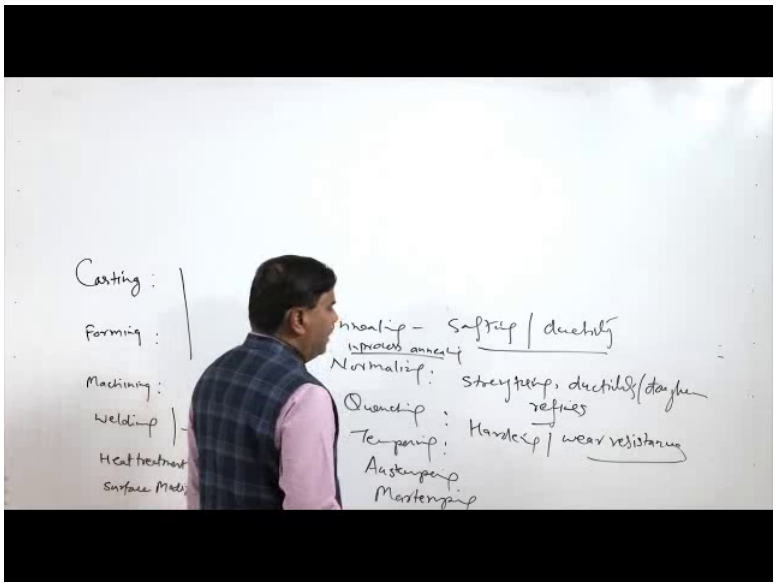

We will talk first about the heat treatment of the steels, the normal heat treatment processes are like Annealing, Normalizing, Quenching, Tempering, then Austempering and Mar tempering. This is mainly used for the softening inducing the ductility, so that it can be and so, that it can be used for the further processing there are various variants like process annealing is one of them which is in process annealing in process annealing which is used during the deformation based processes. So, that require ductility and softness can be induced, this is used for relieving the residual stresses as well as the strengthening the steel as well as improves the ductility and toughness both and it also refined the grain structure.

On the other hand quenching is normally used for the hardening purpose, so that the wear resistance can be strength and the wear resistance can be enhanced. On the other hand the tempering is used to induce the toughness and it is normally carried out after the quenching. Since the quenching increases the hardness at the cast of the toughness, in order to induce the toughness and relieve residual stresses if any has been developed, then that is the toughness is induced or toughness is improved and the residual stresses are also relieved.

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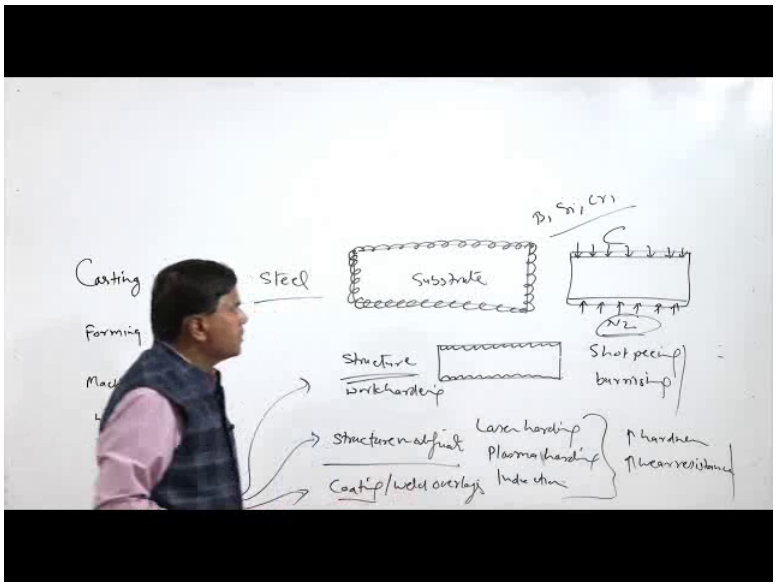

Residual stresses relieved and the toughness is improved after the tempering, similarly austempering and martempering are also used for making the high strengthen the tough systems a tough steels. Coming to the surface modification, surface modification there are various approaches like the just the structure at the surface is modified like burnishing, shot peening are the examples, where a controlled surface layer deformation is achieved to enhance the surface properties like hardness, rear assistance etcetera.

So, like shot peening, burnishing are the examples where localized surface layer deformation is achieved in order to improve the surface property and this is based on the like surface layer a structural structure modification as far as work hardening. There is another case where just a structure is modified there is no work hardening effect structure modification, in this case we have like the laser hardening or like a plasma hardening is used.

In both these cases I had normally the medium carbon steel which is quite hardenable. So, of the beam is directed and, it gets austenite and then sometimes self quenching or the external quenching can be used for the hardening purpose. Induction hardening is also one of the example where just a structure is modified purpose of all these processes is to increase the hardness of this steel surface, wear resistance can be enhanced so, that is the purpose of improving the wear resistance.

There is another category of the surface modification process where development of the coatings and the weld overlays. It is based on the simple concept that if the material is of the substrate material is of the poor properties then the suitable material having the desired properties for working in a given environment like if this hardness is low then we will be depositing the hard material layer either by a suitable coating method or by welding method. Then if it is not that hard or if it is corrosion resistance is poor then we will be applying a layer of the corrosion resistant material. So, I mean to say the properties which the substrate material does not have those materials are applied having the desired properties. So, that the surface is which are the functional surfaces having the desired surface properties.

Basically surface properties are modified by applying the material having the suitable properties in form of coating or in form of weld overlays and sometimes a certain elements are diffused onto the surface like the carbon content is low if in steel then the carbon is diffused in carburizing. That martensitic transformation become easy for hardening purpose, similarly for nitriding, nitriding nitrogen is induced, iron nitride is formed which is harder. So, as per the application as per the case different elements are introduced like carbon, nitrogen, boron, silicon, chromium all these are introduced suitably. So, that they at the surface layer they are enriched in order to achieve the desired combination of the properties which is primarily improving the hardness and wear resistance in case of the surface modification.

I will summarize this presentation in this presentation I have talked about the application of the a main manufacturing processes which includes like casting process, forming process, machining, welding, heat treatment processes and surface modification processes.

Thank you for your attention.