Welding Engineering
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Module - 1
Introduction
Lecture - 1
Introduction to Welding Engineering

Dear students, in this presentation, I will be talking about the introduction part of the welding engineering. This is the first lecture of the forty lecture series on the welding engineering. In this presentation, we will be talking about the manufacturing in general and the joining techniques, especially the introduction part, the need of the welding in different sectors.

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The selection of the joint for developing the variety of engineering component, we need to use the joints. So, for the different situations, the different types of the joints, which are available as an option how to select a particular joint? So that, the performance of the joint can serve the purpose and the comparison of the welding with other manufacturing processes which are available for developing the variety of components like costing, forming, machining and the welding also. There are varieties of manufacturing processes and other variety of welding processes is available, so how to select the suitable welding a process for a particular situation.

Additionally the advantages and limitation of the welding processes will also be taken up and the additionally are the applications of the welding in a specific sectors will be given as an example. We know that, in our daily life we use different types of the components and these are made of the different materials of the different sizes and shapes.

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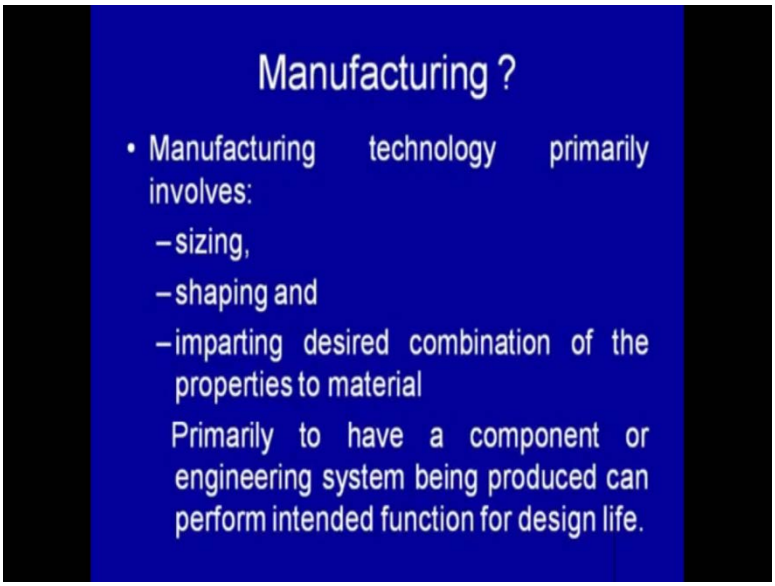

So, for manufacturing this components and engineering systems we use the different manufacturing processes and, when the components made of the different materials in different sizes and shapes this is done by using the variety of manufacturing processes. Manufacturing basically involves the sizing of the components, sizing of the raw material which may be in form of the square blocks, in form of ingots, in form of the locks and they are processed to get the desired size. And after getting the size they are further processed to get the shape which can serve the purpose and can help to develop the manufacturing component.

Further even after sizing and shaping the raw material into the into the desired component form the components do not perform intended function because of the poor the properties they have. Therefore, one set of manufacturing processes is also used to impart the desired combination of the properties to the materials.

So that, they can a serve the intended purpose and they can with is successfully for long during the service. So, the primarily this imparting of the desired combination of the properties to the material is done. So that, the engineering components can perform

successfully for the designed life. For example, in sizing we use bulk of the material in form of a rectangular piece or ingot and this is brought down to the smaller section size by say machining or by forming processes.

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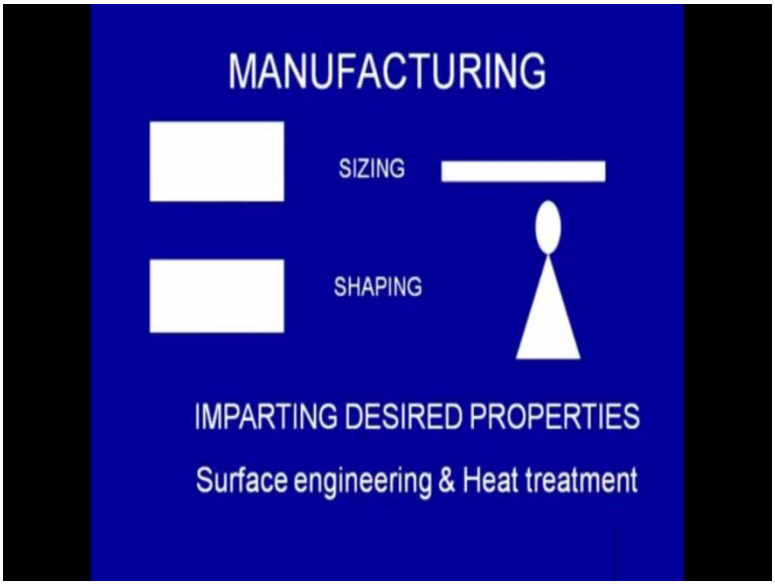

So, shaping means the simple shapes are required to develop the different, a simple or complex geometries for making engineering component. The properties imparting the desired properties to get the desired set of properties in the components of desired size and shape. So that, they can perform for long and this is achieved through techniques like surface engineering and heat treatments. In the surface engineering and heat treatment this two techniques help to impart the properties that are desired to the components so that they can perform for long.

For example, a simple complex system like a car uses variety of manufacturing processes. It uses variety of materials. For example, the aluminum alloys for making wheels and sheets for making the body for steel are cast-iron and even aluminum, a metal for making engine block. For example, in case of car there are varieties of components which are made by the different manufacturing process and each component is made of the different materials.

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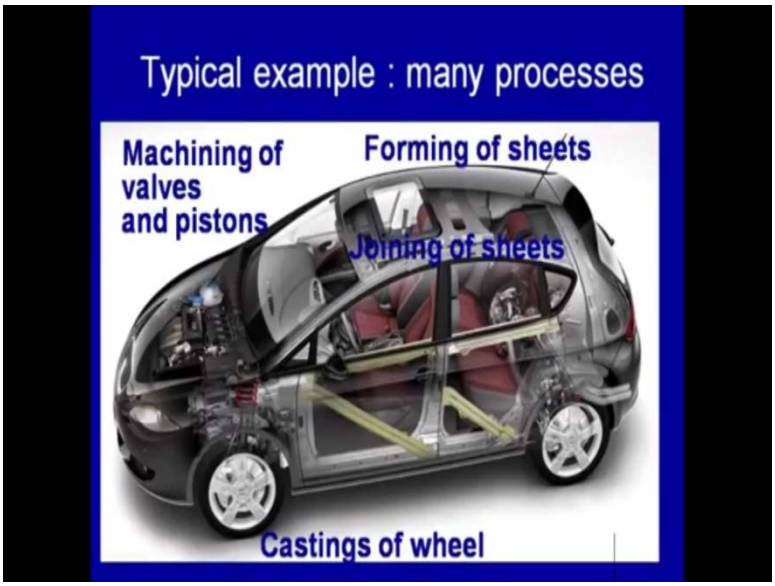

Say for example, the cars are the wheels of the car are made of the aluminum alloys which are manufactured by the casting process and the body of the car is made of the sheets which are given shape using the forming processes. The engine parts like valves and the pistons are made of the cast-irons aluminum alloys are a steels they are produced using machining processes.

So, similarly, the different parts of the sheets of the car body are joined together by the joining processes. So we can see in this example the four different types of the manufacturing processes are being used for making the important parts of the car. Joining is very extensively used in other development of the car components. For example, about three thousand to five thousand spot weld joints are used for making the car body and joining different parts of the car. That is why a lot of work in area of spot welding of the car components is being carried out in the processes have been optimize, especially the g i sheets are welded for making these components which impose the difficulty in development of the joint. Especially whether inference to the poor life of a spot weld electrodes while welding g i sheets of the car bodies.

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Similarly, another aspect is the enhancing properties of the components made either by the machining or welding or a forming or the costing. The life of these components is improved further by imparting the desired set of the properties. For example, the piston rings in the pistons or heat treated to improved the v r g distance and have the higher hardness. Similarly, the heat treatment of the wheels of the aluminum alloys is also carried out to increase this strength.

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So that, weight of the wheel can be reduced and thermal efficiency of the engine can be improved. To improve the travel logical life of the components used in auto motive systems the anodizing and the thermal aspect courting are also commonly used. The different manufacturing process if you see they vary significantly in respect of the approach which is used for giving the size and shape. Manufacturing processes based on the wave by which the particular shape is given can be classified as a positive, negative or the zero processes. The positive processes, zero processes and negative processes, this classification are based on the wave by which the particular shape is obtained.

For example, in the first two processes like the casting and forming primarily the shifting of the material from one zone to another take place and addition the removal of the material is not. That is why these are termed as zero processes where one in guard are the bulk material is shifted from one zone to another to get the desired size and shape.

Well in case of machining the unwanted material is removed from the bulk material to get the desired size and shape and that is why this system as the negative process. Where extra and unnecessary material from the bulk material is removed to get the desired size and shape and that is why it termed as negative process. To get the final size and shape sometime simple components and simple shapes are jointed together by welding and the allied processes. Since the combinations are addition of the material are simple shape components take place in this approach offer of manufacturing.

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That is why these are called positive processes and the grouping is based on the way by which bulk material is processed to get the desired size and shape. We have means recently and way of period time directly of the manufacturing processes have been developed the need to need for the development of different manufacturing processes a variety.

Because of the requirement of different sizes and shapes geometries are different ranging from very simple to very complex simple set geometries see can be obtained by forming processes. But the fore to obtained the complex geometries the machining and the casting process are used and for the different components made of the different geometries are developed of the different material systems having wide range of the properties and the physical properties, mechanical properties and the chemical properties.

These properties of the material which is being used as a raw material to get the desired size and shape of the engineering component significantly dictate the selection of the manufacturing process is the economically and successfully physical properties of the material. Say melting point and thermal exponential are very important in that dictate the selection of the manufacturing process. For example, it is easier to get the desired size and shape using the costing for the materials having the low melting point and comparatively low.

Thermal exponential coefficient, but the metal system having very high melting point will be difficult to bring in melting state to get this desired size using the costing processes. That is why they are processed using other advanced manufacturing processes are the machining processes the chemical properties of the material to be processed are also looked into while taking this is as a manufacturing process to be used. And these requirements fours many times to develop the newer process are also like chemical properties of the material will material having very good affinity with the environmental guesses. Like of season nitrogen and hydrogen they need especial pistons well processing and these as they let to the development of weld joining processes like gas, arc, welding and gas metal inner to gas welding processes and the laser welding processes.

Because the metal systems like aluminum, titanium which are very reactive to the oxygen and the other environmental guesses need production during the processes and that is why instead of using the silicon metal arc welding processes for joining. The aluminum and the titanium especial welding processes like inner to gas welding and tungsten inner gas welding process have been developed. Similarly, if the metal system is a insensitive for the corrosion and then at the time of selection of the manufacturing process is also this corrosion behavior of the material is considered mechanically strength mechanical properties of the material to process developed.

As let to the development of the manual manufacturing process like the material of the low yield strength are low desire strength and good ductility can be easily manufactured using the forming processes. But if this strength is very high hot hardness is very high they impose difficulty manufacturing by machining processes are other conventional machining processes this as let to the development of many advance manufacturing techniques. The dimensional properties on the components to be fabricated and the final component to be obtained also dictate the manufacturing process and this as let to the development of the many new manufacturing processes also like dimensional properties.

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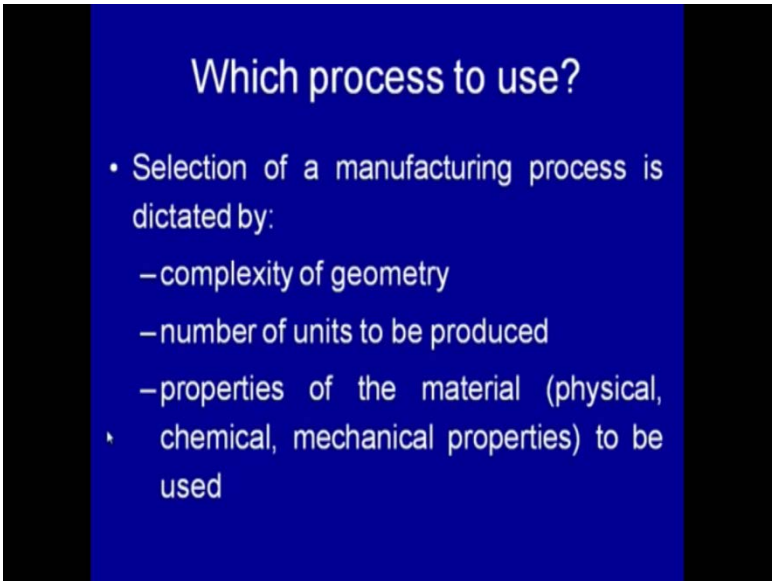

Like tolerance precise surface finished and the accuracy these properties i have requirement for our close controlled and the existence is in size and good surface finish as let to the development of manufacturing many manufacturing processes especially like

drilling very deep hole in the component. Having very high dept to diameter ratio as let to the development of the unconventional machining processes.

So, if you have many manufacturing process which one we used so, based on the requirements and a requirement of the component to be manufactured and other conditions a systematic approach or selection of the manufacture process must to be done. And this is a carried out by considering the number of points like the complex p of geometry of the component to be manufactured from the raw material. Simple shape components can be easily obtained by manufacturing process like welding and the forming and these processes also very high production rate is compared to the other welding.

Other manufacturing processes like the machining and the costing. So, the complexity of the component affects the selection of the manufacturing process like very complex geometries can be easily obtained by the costing and by the machining process. But, the simpler shapes completely simpler shape can be produced easily using the welding and farming processes.

Number of units to be produced also dictate the manufacturing process selection because it affects far low-volume we can select the simpler systems which are offering the low production rate and involving more manual work. For example, send costing can be used for making the few components, but if the large number of the components are to be produce and the die-casting and mechanizing casting processes are referred to justify in the high investment costs related with the die casting are presidio costing systems. The properties of the material like physical properties chemical properties in mechanical properties must be considered when selecting the manufacturing process.

Melting point physical properties is important for the welding and costing processes well. Chemical property is also important for the welding and the forming processes and the costing processes also. Mechanical properties are important. Mechanical property like strength and the ductility are important while looking for the selection of the manufacturing process especially machining and forming process.

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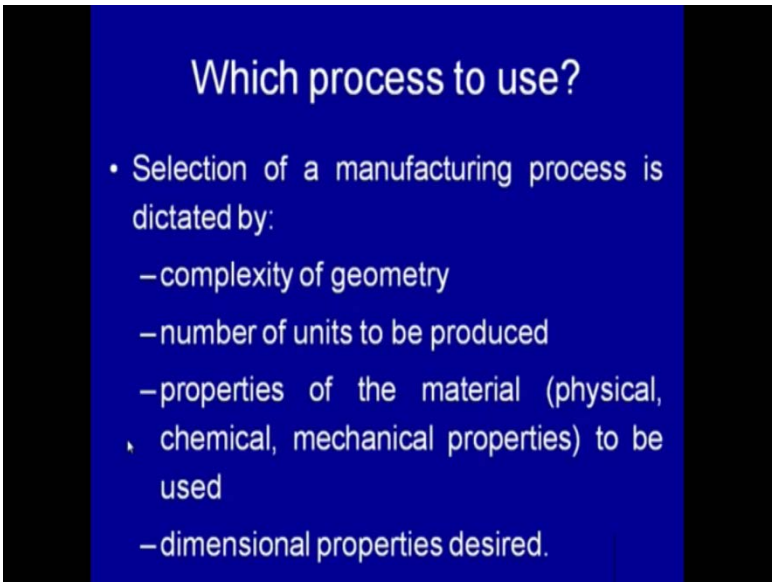

Similarly, numbers of components to be produced also affect the selection of manufacturer. The manufacturing process significantly say for few manufacturing for manufacturing few components we can use completely simpler process involving not much investment is the number of components to be produced are very high than we can go for high investment.

Because low-volume production cannot be justified for the high investment casting machine so, when the number of components to be produced are very high than we go for high-volume production. For example, as a few components can be produced easily using the send small casting process, but for manufacturing the large volume large number of units it is desired to go for the preside die costing and other mechanized costing processes. The properties of the material to be processed significantly dictate the selection of manufacturing process especially will reference to the physical chemical and mechanical properties and the dimensional properties desired in the component also affect the selection of manufacturing process.

For example, if weather very small size component to be obtained than we can go for processes like machining is costing. But, very large size components sometime the welding and the costing processes also used. Similarly, the surface finished the dimensional accuracy and tolerance desired in the component's dictate the selection of manufacturing process machining of very good tolerance and very good very close

tolerance of the components and very good surface finished can be obtained. By the costing and the forming process, processes do not allowed that much close controlled over the dimensional and finished desired. Most of the component produced either by welding or are costing are forming the required. Finally, machining to get the desired size and shape for variety of engineering application you know will look into further the categorization about the hero and negative processes.

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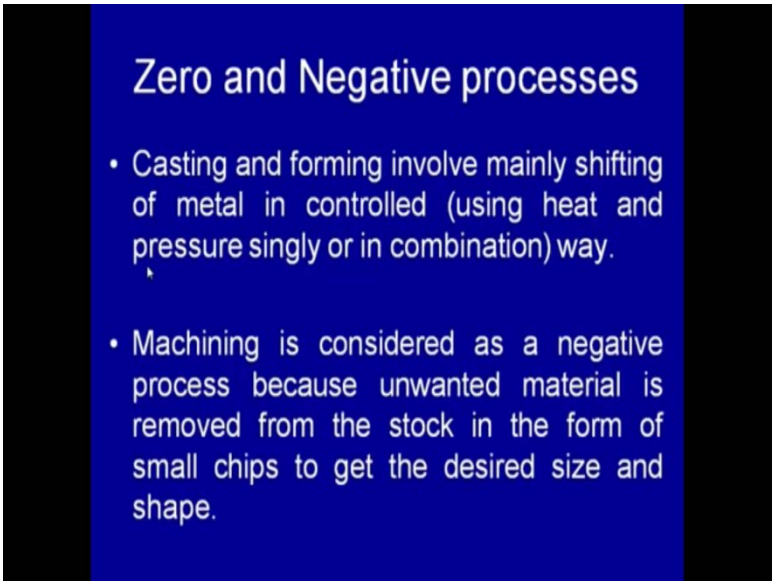

The casting and forming process mainly involved the shifting of the material in very controlled way and the shifting of the virtual from one size and shape to the desired one is obtained using the heat and the pressure singly or in combination. For example, in forming the pressure is used to deform the thing positively to get the to get the desired size and shape and this can be done with or without application of the heat. But, the casting involves the application of heat first to get the raw material in molten form and then get the desired size and shape by pouring into the mold. This solidification of the molten metal in mould can happened at the normal gravity conditions or under conditions.

So, both heat and pressure can be used singly are in combination to shift the material from one zone to the another and get the desired size and shape and this is done in very controlled manner. So, that desired finished and the tolerance can be achieved in the component being manufactured machining is considered to be as a negative processes

because unwanted material is removed from the bulk material in form of a very small chips and the desired size and shape is obtained. But, whatever the material is removed that we cannot use for any other purpose and this material is mostly removed in form of a small chips. So this also leads will loss of the metal worth which cannot be used for any other engineering application. It is simply used for re-melting purpose so that it can be recycled.

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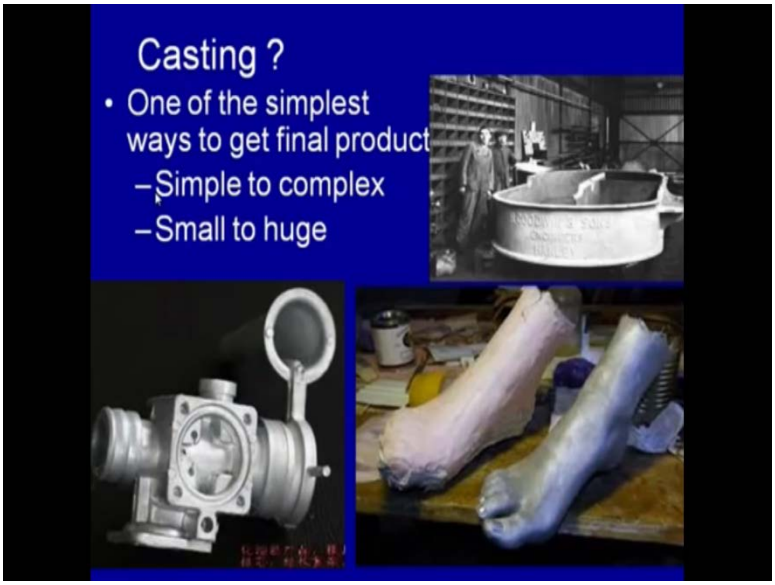

Will we looking into the greater detail of the zero processes to and which involves just shifting of the material from one zone to another. This is the casting one costing is one of the simplest rout, simplest and fastest way of getting the desired product. This is very popular and very common in the industry and used for making the components of very simple shape to the very complex chips are of a very small size to very yield sizes. The simple shapes can vary from making the simple ingot of the rectangle are square shape to get this the very complex shape like cylinder blocks and cylinder huts and size also can.

Varying from few m m to the few meters also which we can see the one big the component being fabricated using and the costing and the rather components which can be made using the costing processes. This is products indicate the geometry which can be manufacturing using the costing process can vary significantly from simple to the very complexive are from very small size to the big one. The basic in steps in costing involves

first development of the cavity which corresponds to the shape which is to be manufactured it is.

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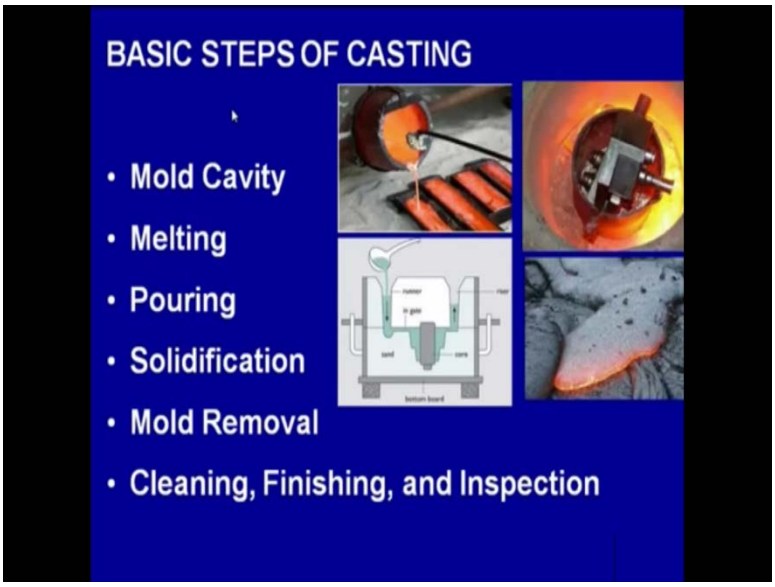

Basically about making the cavity of the component of the shape to be manufactured by the casting process. So, in this one first of the shape the cavity is a made and then that cavity is filled in by the molten metal. So, the material of which component is to be made is brought to the molten state by the melting one and the any external heating source can be used for this purpose. Like it can be bit farness can be induction farness are electrical resistance farness after melting the material. It is pouring into the mold of the desired size and shape or during the pouring care is taken especially to avoid the harness is turbulence in the mold.

The insertion aria section of the gas which can introduced variety of defects in casting and once the pouring is over the solidification of the molten metal takes place and once the solidification is over the things are obtained for the cast component are obtained and removed from the mold for this purpose manually. Either mold can be broken in case of send mold are in mechanize costing processes it can be ejected in mechanized manner. This is how the costing can be completed and once the costing is over it is cleaned to the removed the unnecessary extra material left over the surfaces in form of are the parting lines and then finishing can be done.

Using the and this both this cleaning and finishing can be done using the fettling process and then finally, casting can be inspected to check the integrate of the component or the presence of the defect. If any is there, and the costing this the costing process has been shown in schematically with the help of this diagram. Here the raw material in form of ingot is first brought to the molten state.

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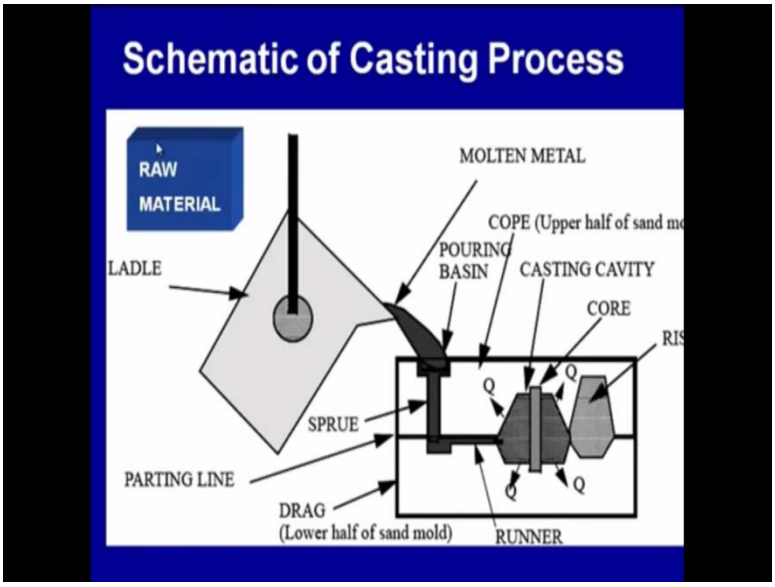

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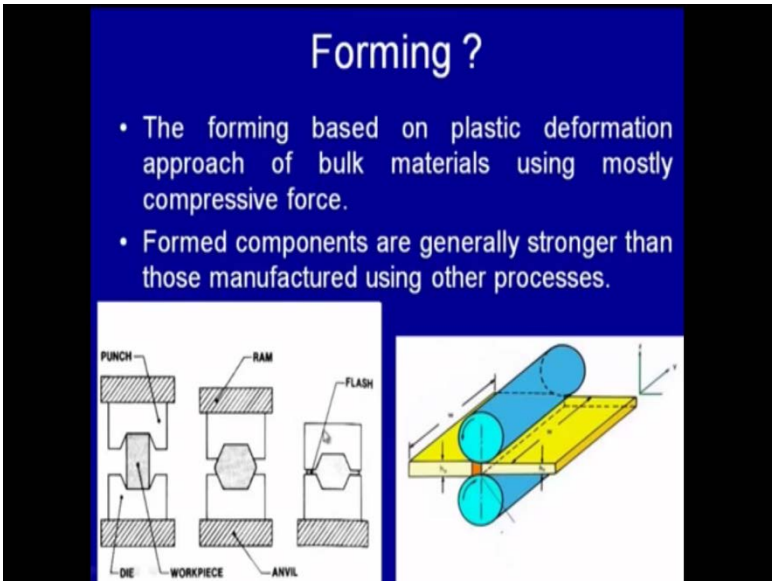

Using suitable farness and then molten metal is brought in form of with the help of ladle to mould the mould and then it is poured into. The mould is pouring is to be done

carefully so that the entire mould cavity is field in with the molten metal and was the solidification is over. The mould is taken of and the costing is obtained the forming is another zero process which involves simply shifting of the material from one zone to the another and this is done by plastic deformation.

The bulk material mostly using the compressive forces how rather sheer and the forces can also be used to the deform the material plastically and get the desired size and shape. The formed components are generally found to be stronger than those manufactured using other process because when the plastic deformation takes place material is work hard and work hardening mix material is stronger. By increasing the hardness and yield strength how this happens with them reduction in ductility of the metal and in the manufacturing process by forming it involves as I said the plastic the formation of the bulk materials. This is the raw material in form of rectangular black it is deformed plastically with the help of a punch so it is given first shape of this kind and then deformed further to close the die and cavity in filled in by the material so welding from means the by applying the force material is given some intermediate say and then.

Final shape is obtained is small amount of the material comes out of the die cavity in form of the flash so this plastic deformation causes the work harding of the material. Which intern increases the hardness and then strength, but the cost of the ductility and this makes the formed component. The stronger than those manufactured by casting are welding and the machining processes. This is another forming process where the bulk material is forced to pass through the rollers and then mainly thickness is reduced with this largely maintained and thicknesses reduced by a small amount.

So, this is a process is called the rolling one well metal is force to pass through the rollers to reduce in the thickness of the material. A machining is the another process if the basically the negative process where to get in the desired size and shape of the component the material unnecessary extra material is removed.

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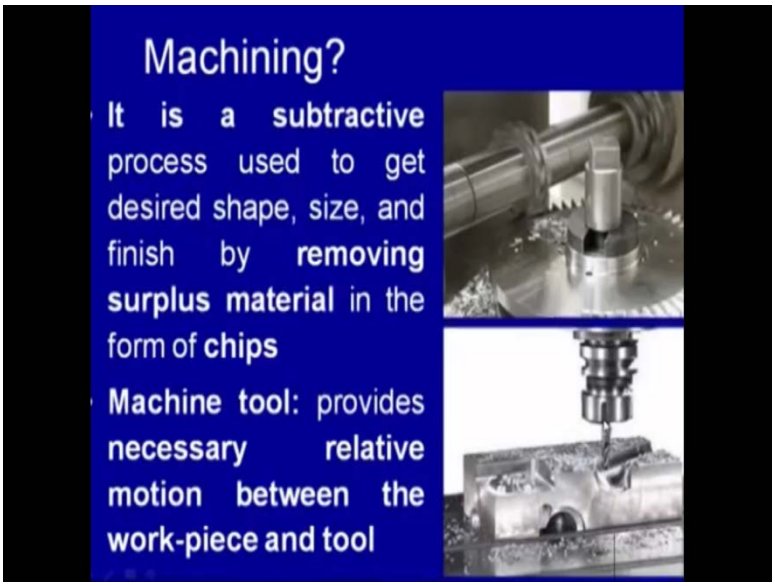

So, it is a obstructive process used to get the desired size and shape and finish by removing the surplus material. And in form of the chips you can see the one tool and the raw material is used to a to shape the material and get the desired size and shape of the components so here for the machining purpose machine tools are used. They will provide the relative motion between the work piece and the tool being used to get the desired size and shape.

By removing the unwanted material in a form of chips so to get the high and good degree of finish. It is important that the relative position between the tool and the work pass material is maintained firmly and that is why rigidity of the work welding device and the tool is very important. And this relative motion is the relative a speed between the tool and the work material also affects the accuracy and the finish which can be obtained. Another process this is a positive process this called joining.

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Where simpler safe components are a joint together to get the desired size and shape of the final component is called a positive process because the simpler part and the components are brought together or join together to get the desired configuration. The positive process used for assembling the different a members to get the desired configuration variety of the joining approaches can be used a.

For example, in this case a, the gas welding is being used to a four joining the two simple components. The brazing here in this cases been used for joining the two components, the adhesive joining can also be used. This is very common for a joining the two components having the metallurgical incompatibility because there is no melting or heating is involved. Mechanical joints like nuts and bolts systems can be used for making the joys and it is a very reliable and a offers good a strength of the joint and has been very commonly for making the assemblies. The fusion welds or use like say in this case the pipes have been joined together by fusing in the edges of the components to be welded is flat welding is another joining process which is commonly used.

In automating industry for joining the thin seats similarly, soldering for joining of a the thin and a small size component like a strips and the wires there commonly the common joints which are used a in industry for making a assemblies are can be put in three categories like mechanical joints were nuts and bolts, clamps and rivets are used for getting the desired size and shape.

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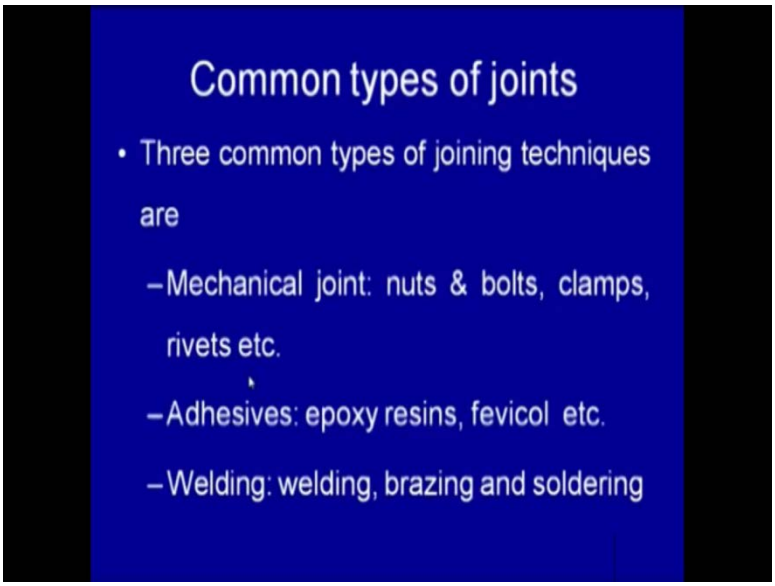

The configuration using the simpler shape components a adhesives like epoxy, resins and fevicols etcetera are used for those for joining those system, which are metallurgical incompatible and involves no heating the adhesives have two join the components a.

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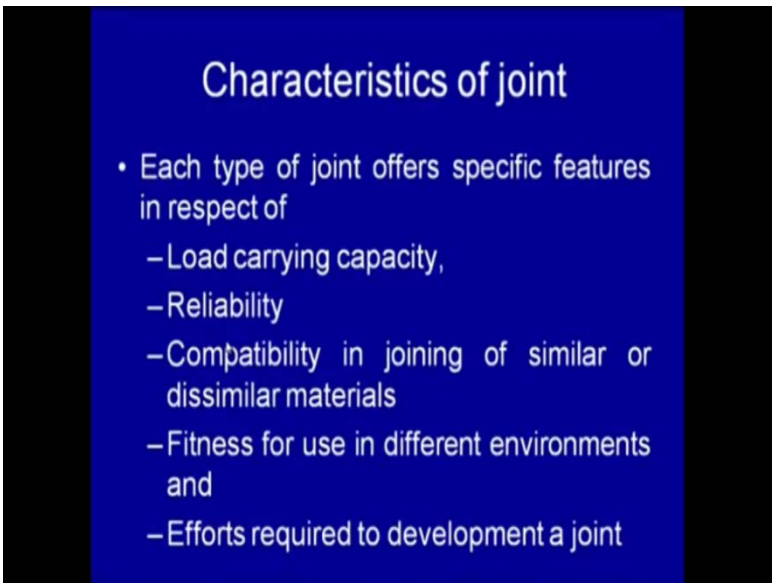

Significantly, without any difficulty the welding and its allied processes like the welding brazing and soldering are also commonly used in engineering industry. For development of the variety of components the elite's type of the joint whether it is mechanical joint adhesives or the welding unit's type of the joint offers a specific set of the properties in

respect of the load carrying capacity. Load carrying capacity of the mechanical joints is very good and a much higher than the other types of the joint like the adhesives and the welded joints. However, the strength of the welded joints can be higher than the base material itself that cost of the time they are not found to be very reliable. Reliability of the mechanical joints is very good as compared to the welded joints and the adhesives under the critical conditions the welded joints are not very commonly used however with development of the welding technology.

Nowadays the welded joints are pulse being used for critical application like in nuclear industry and the development are fabrication of the bridge is compatibility of a the material to be joined is another important aspect. Like mechanical joints can be used easily for joining the similar as well as the similar metals, but the welding imposes many difficulties well joining that the similar metals so joining of the similar metals. So, welding is not an issue, but the welding of the similar metals creates a number of problems. That is why if is them the metal systems be joined are metallurgical incompatible then the other joining processes like adhesives and the mechanical joints are preferred provided the service conditions are service requirements are fulfilled by the joints.

Another the important aspect related with the joint is fitness for use in the different environments like adhesives can degrade rapidly under then a or chemical and environmental conditions. So, they may not be fit for you. Similarly, the welded joints or a stainless steel weld joints in the harmonium environment another a chemical environment can degrade very rapidly that is why not the welded joints may not be good in certain specific environments especially the joints made of a specific metals. For example, the stainless steels are normally not used a in the chloride environment and a they are welding needs very careful consideration.

Similarly, the welded joints of a the structurally steel under the low-temperature conditions are also not found to be very fit for use. Because of a the low a ductility and the poor toughness of these joints and a be another the third means last important of point a specific features of the joints are characteristics of the joints is the efforts required for development of the joint. Each type of the joint needs the different level of inputs and a the expertise for making a successful joint.

Mechanical joints are comparatively simpler to develop as compared to the welded joints and the adhesive joints weld joints made very careful application of the welding processes and a designing of the joint. So, the early export persons can develop and a the successful joints specially for a critical applications. So, here we can see the each type of the joint whether it is mechanical or adhesives or the welded joints, they are different in respect of load carrying capacity reliability and compatibility of the materials to be joined fitness for used and efforts required for their development.

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The in light of a the availability of variety of options to make a joint. It is important to look into which type of the joint will serve the purpose and will help to perform the engineering system for long. So, the joint selection in this record a, become very crucial and therefore, this look into that what the requirement is we want the joint on temporary basis then it is better to use the rivets or nut bolts and the adhesives which are comparatively of not that permanent kind and the permanent joints. If we want permanent joints then the joints can be made using the welding or braze welding and the soldering, because have once if required that dismantling of a components of which main system is made then permanent joint imposes many difficulties. Therefore, the proper thoughts should be given what kind of the joint is required whether it is temporary or the permanent.

In accordingly suitable type of the joint is selected. The compatibility between the members to be joined should also we looked into if there similar type of the members are to be joined like a steel to steel welding or aluminum to aluminum then welding. It becomes a easy, but if the joining is to be done, you of the dissimilar metal systems then the brazing and soldering have preferred or adhesive and mechanical joints are used because in this processes either heating is not involved or if heating is there it is a very marginal. Which does not a affect the properties and the performance of the base metal.

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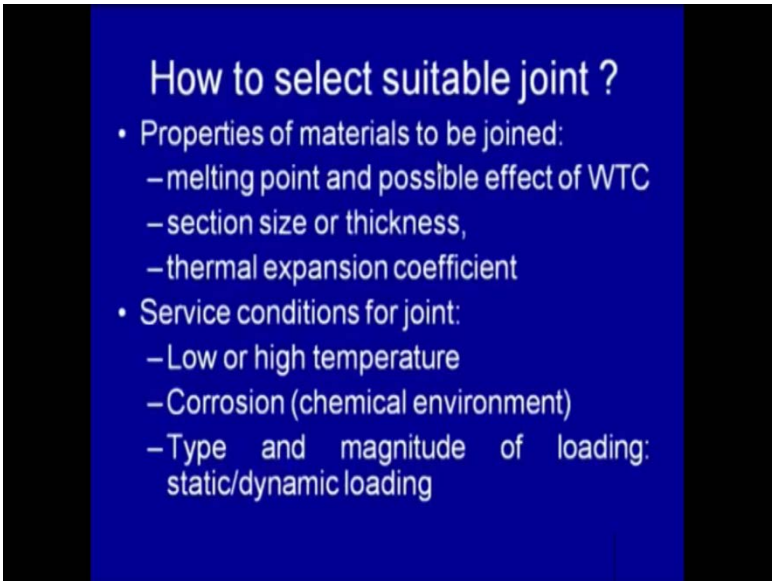

Appreciably and therefore, another important point to be considered for the selection of the suitable joint is metallurgical compatibility between the members to be joined a metal properties to be joined is also important. For example, the melting point and a possible effect of the well thermal cycle on the material to be joined these two things are important, because the if the metal system is of very high melting point then welding will be difficult. Better to go for some other options like a the mechanical joint, but if the weld melting point is low, comparatively low and effect on of the well thermal cycle is also not expected to be much then welding can be successfully used to the success size and the thickness is another important point.

For example, thin seats and wires can be easily using the soldering what thick sections the required welding by the electro slag welding process or some of dark welding process. So similarly, the thermal expansion coefficient is the joints to be. If the joints is

to be made between the members of a joint to be made of the material having the high thermal expansion coefficient then this can cause the problem of the high residential and the distortion tendency. So, it is better to go for the mechanical joints and the adhesives joints in the service load can be taken these as the adhesive joints are the mechanical joint. So, the properties of the material to be joined a affect the what type of a the joints should be a used under these are the physical properties inform of thermal expansion and the melting points and the dimensional properties like size and a the thickness of the component to be made.

Once a, before taking the decision regarding the selection of the suitable joint it is also required to look into what are the service conditions in which joint is expected to perform under these conditions may be looked in form of that whether the service temperature is low are the high if a the temperature conditions are the very low. Then the poor ductile behavior and low toughness of the welded joints can create problems. Similarly, the type of cracking in the welded joints can also because the free mature failure of the weld joints and the high-temperature condition and that that is why this high and low temperatures both the can be problematic for the weld joints. So, this point is important to be considered while selecting well selection is made regarding the joint among the mechanical and or the weld joins further the high temperature conditions may not be sustained by adhesive joints because they may decomposed and destabilize at high-temperature conditions lead to the poor performance and the life of the adhesive joints.

Like this, the particular properties affect of the particular properties and the selection of the joints. The service conditions of, in which the joint is expected to perform significantly, effect selection of the suitable joint and this conditions are like low temperature and high temperature and the corrosive environment. All the conditions in which the joint is expected to perform with their corrosive than the effective selection of the joint in a big way and then the type and the magnitude of the loading also effect the selection of the suitable joint. The low-temperature and the high-temperature, the conditions are very important because the performance of the joint is dictated by the low-temperature and high-temperature conditions significantly. For example, structuralize steel weld joint forms in very brittle manner and behaves a of and shows the low ductility and low toughness behavior.

And similarly, type for cracking is absorbed at the high-temperature conditions and the adhesive joints are all so can degreed high-temperature underuse the performance of that adhesive joints. If the joint is expected to perform under the service under the corrosive you conditions, then a weld joints so the poor performance as compared to the mechanical joints. So, it is important to consider whether the service conditions involved, then you specific mechanical environment or not. Similarly, a type of a loading for their it is a static bits static and it is a the dynamic the mechanical joints perform better than the weld joints and the adhesive under the dynamic loading that the static loads can be equally taken effectively by the adhesive loads.

Adhesive joints and the weld joints and the mechanical joints equally all there is the difference in the load carrying capacity. So it is important to consider the service condition in which joint is expected to perform with respect to the temperature and the environment and the type of the loading which can be there on the, on the joints. Another important which should be considered when selecting a suitable joint, is the economy other cost effectiveness and the cost of the mechanical joints is in general. We found to below are then the welded joints, but the mechanical joints sometimes increase weight of the system significantly weld that adhesive joints and the well joint help to lower the weight of the component.

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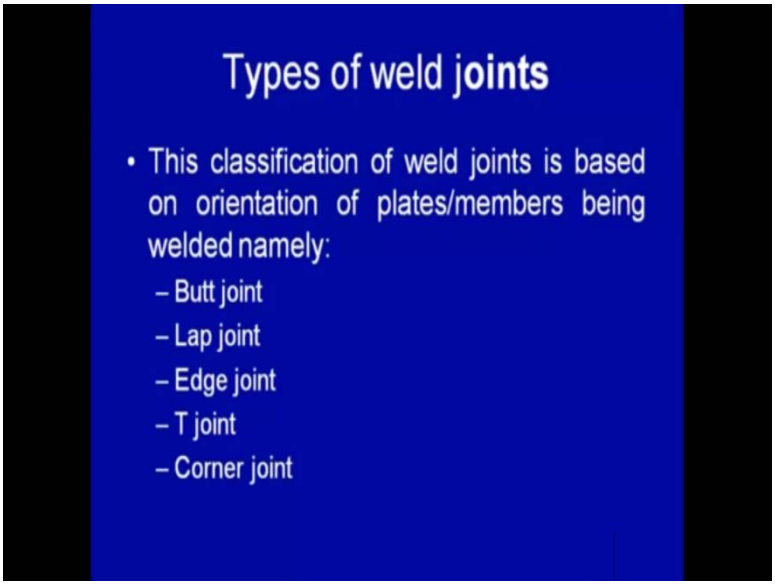

In a state, is required to develop the bell joints of the different members and plate's type's pipes, dupes, etcetera the depending upon the orientation. The members to be joint and the place to be joint the well joint can be classified in the five different ways so that the classification of the weld joints is based on orientation of the plates are the members ought to be joint. This can be the types of weld joint can be in the form of light butt joint where plates are, plates are the members to be members to be joint same plane and in case of the lap joint other the plates at the members to be joined overlapping position.

In case of the edge, joint the members to be joint or the plates to be joined or kept all those parallel where the edges under the joint is made along the a along the edge of the plate. This you can explain using the diagram that will be making just now and then the t joints where one plate is kept. One member is kept resent on the horizontal plane and another one is kept vertically and then joint is made mostly.

In this case, the plates are used for developing the weld joints and then in the case, of the corner joints where the corner of the and of the place are used where they are faced almost at a ninety degree where the angular variation can be up to in the fifteen degree from ninety degrees. From this we can explain using the diagram here, saw according to this say if we for making the butt joint at the plates to be joint area are kept in the horizontal plane each the butting each other's than by melting things surfaces of the plates rejoined the weld is made in case of the lap joint.

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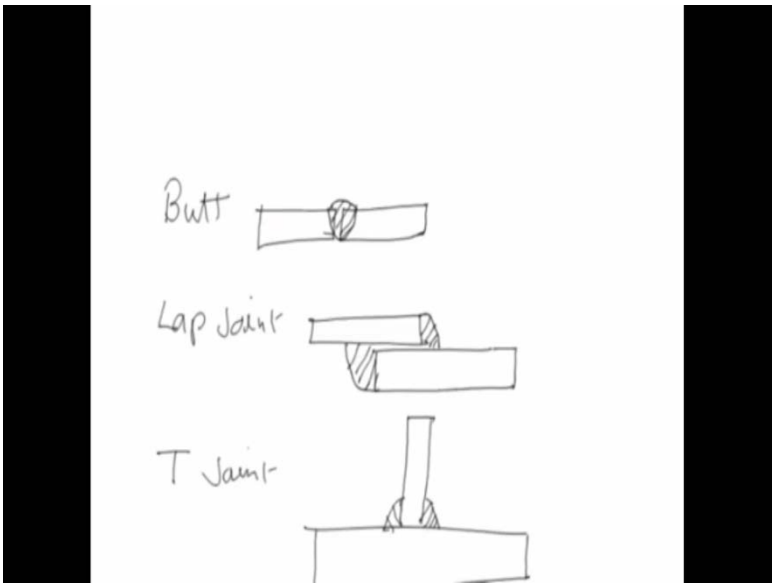

The plates to be joined or kept in overlapping position under than the weld joints is made like this near the end of the one of the plates is. So, this will be the single lap joint and if it is an both the sides then it will be the double lap joint and like t joint. In case of the t joint, one of horizontal plate is kept and now of this another member is brought vertically and then joint is made by putting in of led weld one side or in the both the sides.

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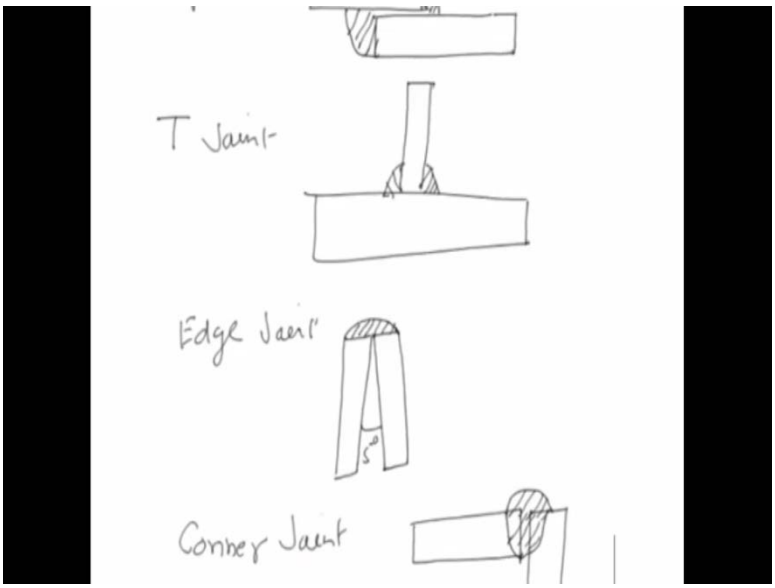

So, this is the t joint then edge joint, edge joint where the so the members to be joint are to or kept in almost parallel to each other where angular variation between the two can be has the as the fifteen degree of forty five degree. And the joint is made by putting in the weld metal at the edges of the for developing the edge joint and in case of the corner joint. In case of the corner joint the members to be joined or kept almost at ninety degree near the edges and by melting in these the spring surfaces of the of the members to be joined the corner joint is developed. It can be different ways for developing the corner joint where they can be done either one side or intro the sides. So, this is how we can develop the different types of the well joints as per the requirement of the industry for in developing the weld joints. Now, we will see that how the welding is different from other joint the techniques like soldiering or adhesive joints and the mechanical joints the welding process or found to be significantly different from others at joining techniques.

And because it would involve is very localized heating two brings the spring surfaces to morton state which is subsequently after certification results in metallic continuity and

the produced the weld joints. This is a special nature related with the welding causes very localized heating first near this spring surfaces while another areas away from the spring surfaces and the base metallically there are not a heated. So, this involves a very localized heating subsequently after heating once the molten metal is a obtained by a heating spring surfaces subsequently cooling starts cooling also very is with the location.

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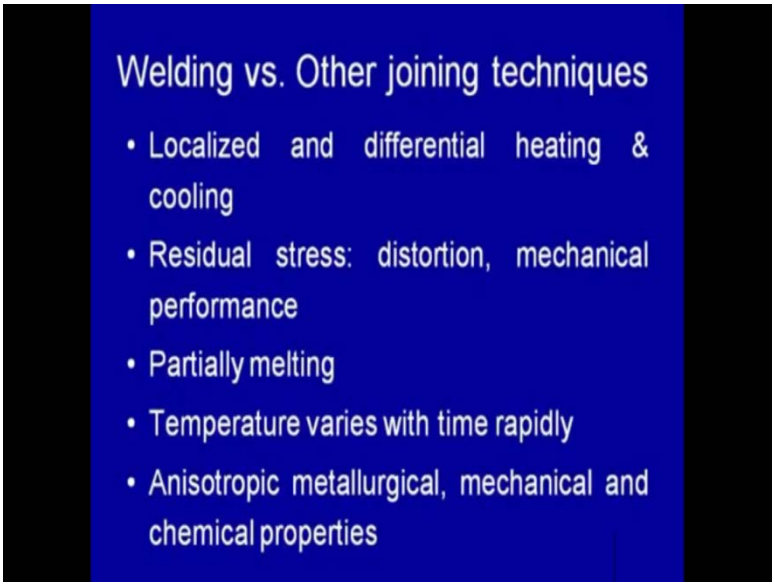

The very high cooling rate is absorbed in the near the weld or the weld centre and it basically decreases away from the spring surfaces. So, this a special nature of the welding practices is that it is involves a very differential heating and the cooling and this nature leads to variation in microstructure variation in mechanical properties and the development of the how that this kind of the differential heating and cooling is not observed.

In the other joining techniques, like the adhesive joints and the mechanical joints, so this differential heating and cooling ah occurring during this building causes the resoles restless this can be of the tensile in nature and or the compressive. This is the mostly is the resoles restless are tensile along the length of the weld and presence of resoles restless causes the distortion in the weld joint and the reduction the mechanical performance the mechanical performance of the weld joint is significantly dictate is reduced. This fact of the tensile strength and the fatigue life tensile residual stresses also

increase the cracking tendency of the weld joints. Another special nature of the welding process is that only a portion of base metal in is brought to the molten state.

While the other process the man in the soil ad straight is largely the room temperature so the partial melting of the base metal is this a very special feature after welding processes which are are not found in other joining techniques like the adhesive and the mechanical joints. The temperature during the heating and the cooling of the in process of the welding also varies as a function of time and this temperature variation becomes very rapid and its changes rapidly with the distance from the spring surfaces and from the weld centre.

So, this variation in temperature as a function of time causes differential expansion and contraction the different areas of weld joint which in turn leads to development of the residual stresses. This residual stresses as i said, can to distortion of the weld joints reduction in mechanical performance and isotropy in metrological properties are mechanical properties and chemical properties all is all so absurd and this the variation. In the different properties primarily occurs due to the temperature difference and the different level thermal cycles were experienced by race metal the weld region and also the heat effected zone.

That is why weld joint performance is found to a very significantly with the with respect to the direction of the weld that is called a longitudinal direction and transferred to the weld, or along the thickness of weld and it is variation and leads to very isotropic in nature or behavior in respect of a. Performance of a weld joint form a metrological and chemical coefficient of you the some other points based on which they can a compare the welding with the adjoining processors.

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The reliability of the weld joint in general is considered to be lower than the mechanical joints and that is why these joints have not been used very commonly of critical applications like in construction of bridges and the aerospace components. Nowadays with that advancement of the welding technologies the weld joints are no commonly used than in the fabrication of the components used in nuclear reactors and the aerospace components and bridges in even.

Nowadays all welded bridges are also being fabricated even in the legal area us so there has been significant prove meant in the reliability of the weld joints with the advancement of the welding technology. During the welding lot of material is a lost inform of the spatters and a however, this loss material inform of the spatter varies with the welding processes. This kind of loss not observed in case of other joining techniques like adhesive joining in the mechanical. At joining in the welding process the t welding of a the very minimum loss of the material inform of a spatter while the sealed it metal welding processes and the gas metal arc welding processes of the spatter which made in from two to five percent.

So this loss of material is also metal wroth because those spatters cannot be used for any other purpose ability of the welding processes. In respect of the finishing and the dimensional accuracy is the general poor because the weld joints which are produced have typically ripples on the welded surface and these need to be removed. The most

seemed to a widening kind of the stress concentration effect related with poor surface roughness of the weld joints further due to localized heating and cooling causes the poor dimensional control over the weld joints each are produced in.

Therefore, the dimensional accuracy and the spring surface and the components fabricated using welding comparatively poor as compared to and that of the mechanical joints and the adhesive joints. Another point is related with criticality of application and the use of the a joining techniques as i said because of the poor reliability of the weld joints. These are normally not recommended critical applications but, nowadays with the advancement of the technology the weld joints are to be used in for critical applications other web then need a special treatment.

Once the joint these developed, each may involved shot paining all the post weld treatment and the treatment for moving the residual stresses. There are present in the weld joint and others specific features to the welding which is not common with the other joining techniques is the reduction in ductile to brittle transition metal systems, which very good toughness under ductility.

Under the normal temperature conditions there this behavior changes very appropriately and it shows a very brittle. The low toughness behavior and the low-temperature conditions so especially the weld joints made of the structural below minus twenty degrees centigrade show very brittle less and they r not able to take the impact loads and that is why many times there’s these behaviors leads to the catastrophic failures. The weld joint now we look into some the advantages jaw offered by the welding.

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As a technique to a joint different components and get the desired size and shape welding office the permanent joint which results in as an integral part of the workplace. So, this works the joint is made and member of the joint form as an integral component of the main component fabricated by or main parts fabricated by the welding the joints can be stronger than the base metal. Depending upon the metal been used for the development of weld joints the strength of the joints can be ah greater than the base metal or the weaker if the weld joints is subjected to for very severe loading conditions normally the joint or made using the fuel metal's which of the greater is strength then the base metal whenever this happens we say that the efficiency of the joint is greater than hundred percent. Because the joint efficiency is a measured from the ratio of tensile strength of weld joints to that of the base metal.

So, it is the weld joint stronger then the base then the joint efficiency comes greater than the hundred and other important and the good features of the weld is that it is results in the metallic continuity between the members being joint. So, there is hardly any chance for a getting to the corrosive liquid. Corrosive medium in between the members being joined and the joint form a an integral part the main assembly that joining the welding economical also once the infrastructure respect.

The manpower and the system and the welding as been developed then the large welding tell develop in the weld and to have the required joints economically. So, and other

important feature of the welding it is not respect restricted to the factory environment because the joining can be done at the site also for making the repair or for reclaiming the one of the components.

So, and this can be done in addition to the joining the factory conditions. So, this is this helps to helps to perform the repairs and there that get the desired size and shape in a components not necessarily in the actually environment. But also, what the site in the difficult situations provided, we can provide the desired source of the power which can be done using in the suitable generator of the regular power supply you is not available in addition to the advantages.

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The welding spaces money a limitation also their money disadvantages components are a little the welding because only expertise person can produce the sound joint especially critical applications. That is why cost related with the label for developing the weld joint is in general high even a small carelessness on the part of the worker can lead to the development of the joints with a poor integrity and the poor reliability. Which may not be good for critical applications further joint is a joint made by the weld the is permanent in nature.

So, if the dissembling members of required due to any reason than this becomes a problem and that is why the firmness joints made by the welding creates problem in the dissembling. If required is frequently causes the damage to the opponent, if they are

assembled using the cutting or the mechanical force than others limitation associated the welding these. The release of the hazardous fumes and vapors that are generated during the welding in handling of these hazardous fumes in the vapors frequently causes irritation in a in his other health issues. So, these smoke hazardous the smoke and the vapors must be taken out of the welding period efficiently using suitable suction and the arrangement. The especially the welding of the zinc and the ten less in steel hazardous fuse generated must handle a.

Taking care of case fully to avoid any adverse effect of the performance on the health of the weld us that are in place the poor reliability of a joint is all. So, one of the major concerns very careful assessment of the base metal in respect of the mechanical metrological properties is required before taking the decision about the welding and the once proper welding procedure is established for developing a well joint only. We can develop a weld joint of a reasonably good reliability otherwise in general the careless on the part of the welding procedure is specification for implementation of the welding by the workers frequently lead to the poor reliability under which is a therefore, these are not preferred for critical applications how you will see that.

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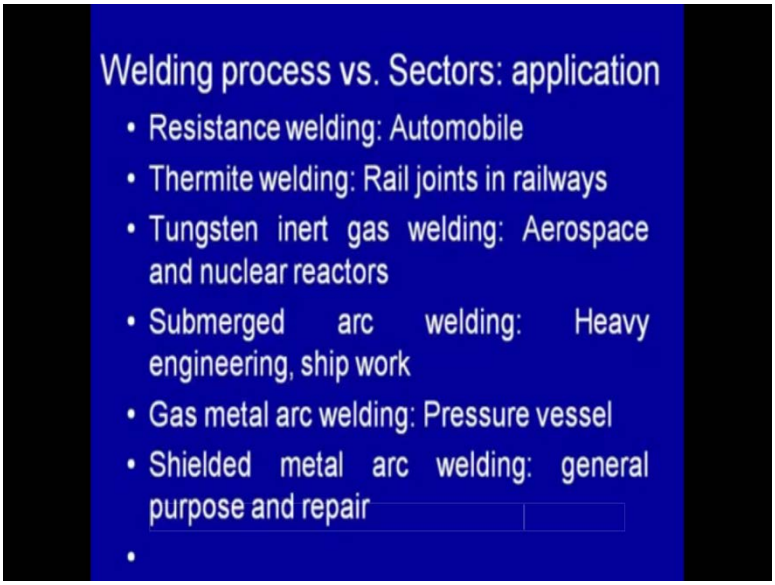

Now, the welding these used the different sectors from the application point of you the resistance welding mainly used auto metals sector of a joining then feeds. For example, car bodies and the components, that might welding is used for joining their rights in the

railways like termite. Welding is commonly use for a making the right joints in the railways.

That is in the chemical processes where using exothermic reaction lot of heat is underrated cheese used for a melting is of this spring surfaces of the rail to develop the weld joints is a gas welding is used a only narrow space and the nuclear reactors. Cosmetic process offers very high quality of weld joints due to a very effective yielding hand the short arc line and that is why the aerospace the nuclear reactor weld joints commonly a made using the inert gas welding process. Somewhere dark welding process is used in for the and industry and the shift work because some where's dark welding process using a very high current and rates lot of heat and helps to melts to springs as a this is off thick place and that is why it is commonly used in.

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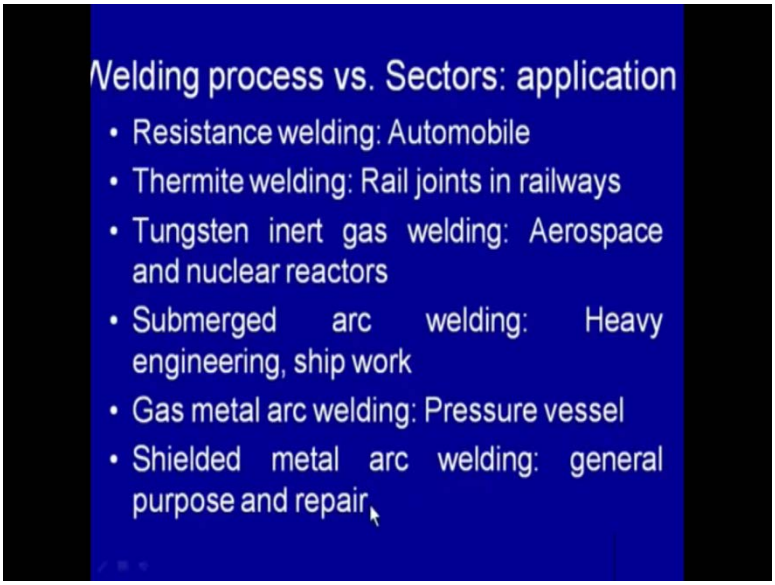

Heavy engineering industry and for fabrication of the ship a structures the gas metal arc welding process offers the goods yielding and high pressure vessel and that is why it helps in fabricating very good weld joints pressure vessel industry. The shielded metal arc welding process is a very commonly used for depositing the weld metal for the general-purpose further fair fireplace and it is said that approximately eighty percent of the weld metal deposited using the shielded metal arc welding process that those who use a the shielded metal arc welding process.

For general applications, that are not mostly in the trend and the weld is and this somehow trend to deposit in the weld metal so that the metallic continuity can be obtained you will see some other applications.

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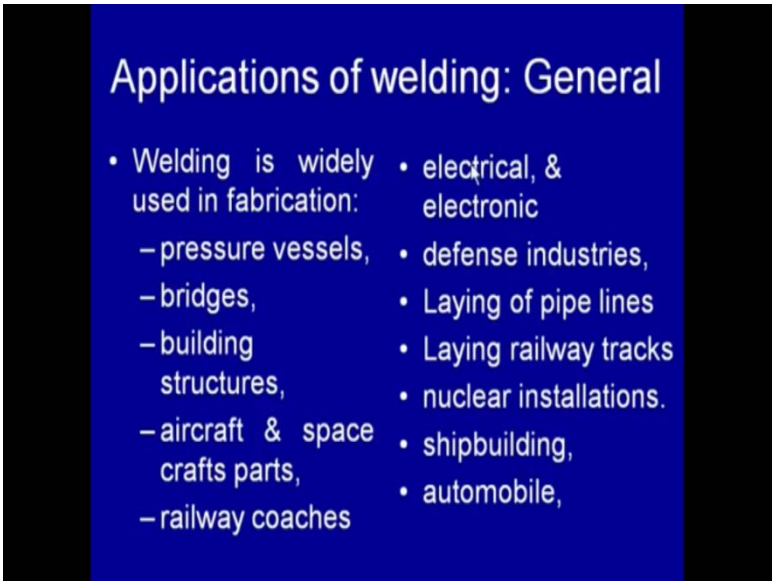

H a specific component wise where welding is used for development of the joints involves like welding case pressure vessel of welding components in construction of the bridges welding of a bars and beams for construction or developing joints in trust joints of stresses and there are used in building a structures and the towers. When joining very

critical components used in aircrafts and the spacecraft parts so the the welding these also known that joining the ten less a steel and a steel sheets for a fabrication of the railway coachers.

Additionally for joining the different electronic circuitry components and the electrical compliments welding is commonly used electrical and electronic industry the defense industry the military systems are fabricated.

With the help of the welding process similarly, in a natural gases sector along pipelines are lead and a joint together why the welding process laying off a the railway tracks and there's joining and their joining by termites termite welding process is common nuclear installations. In this shipbuilding sector also the welding is commonly used in auto mobile sector like a motorcycles scooters and cars very commonly involves the welding especially in spot welding at joining the different components. If you see, what are the specific a components and the parts which are rejoined together?

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By welding like joining welding is commonly used for development of the transport tankers char used for transporting oil water and milk reading is also used for welding tubes and the pipes chine's and a l p g cylinders and the welding these needs for a developing a furniture is in form of gates doors and the door frames and the bodies.

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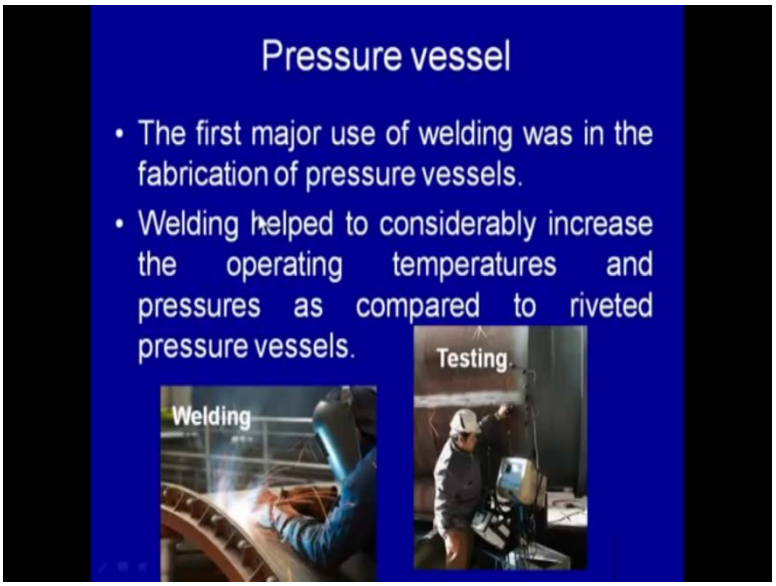

Welding is a very commonly used for breaking the goods like refrigerates washing machine microwave who once if you see how it is a used in a specific factors and welding has found a's first major use in the area of pressure vessels for developing different components this welding. These helped to considerably increase the operative temperatures and the pressure conditions under which these the welded pressure vessel on the be used as compared to the pressure vessels.

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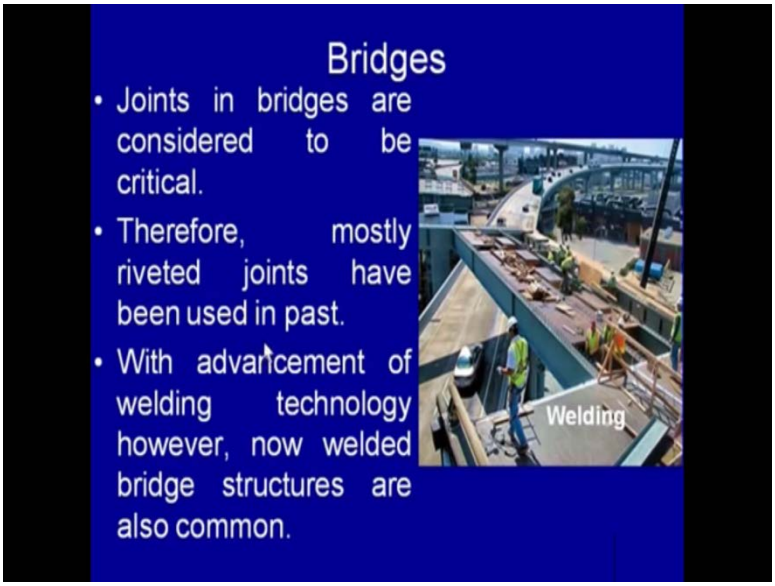

You can hear the component the pressure vessel component being welded and the followed by that are testing the testing is a very important pressure vessel to ensure the integrity of the weld joints was these work under very severe conditions of the term pressure and the pressure. Any sort of the leakage or the weakness can lead to the disastrous accident that is why careful welding is required in case of pressure vessels and the summer's dark welding and the mid-welding process all. Very commonly used in the pressure vessel sectors.

And bridges the constructions of bridges a required the joints weights can form just successfully and a very high reliability the joints and bridges are considered to be a critical because it is associated the life and with the loss of property. Therefore, mostly riveted joints have been used in the past which of or high reliability, but with the development of the welding technology. As now, let during the application of the welded joints in the bridges structures and a know all welded we just structures also being used in India and even the welded structures being a loud for construction of the bridges in all areas.

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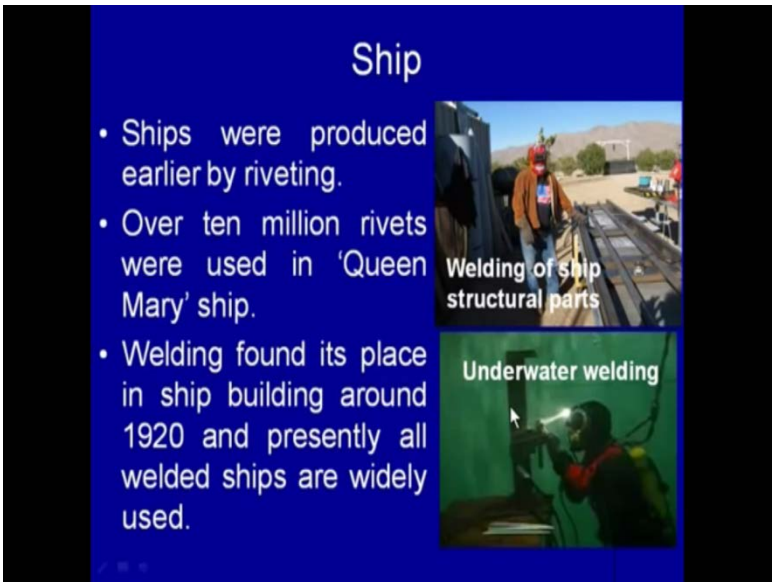

The ship are a ships were is one of the biggest industry where the welding is very extensively used for development of weld joint however earlier the ships were produced by riveting only for joining the different components over ten million rivets were used. For example, in case of the queen marry ships and the welding founds it is placing ship

building number around nineteen twenty and presently all read the died ships are commonly used. You can see here the welded structures of the ship and frequently it is required to carry out the repair work under the water conditions case of ships to check the leakage or to repair the broken components so the welding of is commonly. Used in development and the repair of the shift structures in the buildings arc welding is.

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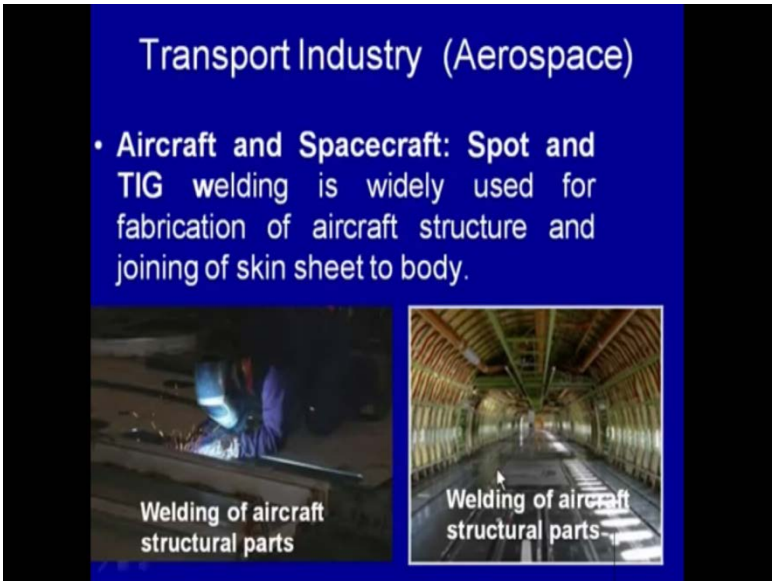

Extensively used for fabricating steel structures such as stresses towers in construction industry this figure the shown example of that welding being used for joining the

stresses. In the transport industry welding is been extensively used in the aircraft and the spacecraft both the spot welding and the teak welding is extensively used for fabricating of any aircraft structures.

And for say joining of a skin sheet to the body we can see here the welding of aircraft the structural parts y by dick welding and you can see here that how the welding of the aircraft structural part is being done then in surface transport the railways involves very extensively use of the welding.

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Fabrication of the structures fabrication of structures related with coaches and wagons and for overlaying of the wheels joining of the rails by welding machines and for repair of the crack or the damage cracks by termite welding. You can see the joint made by the termite welding and here some repair work is in progress so here wherever the localized damage takes place and either due to the v n due to the development of the cracks things is repaired by the welding in variably. That is why in the railways welding is extensively use in auto motive sector the fabrication of the auto mobile components like chesses body and structures fuel tanks and joining of door and door hinges require welding and it is common to have way the part welding in the for joining.

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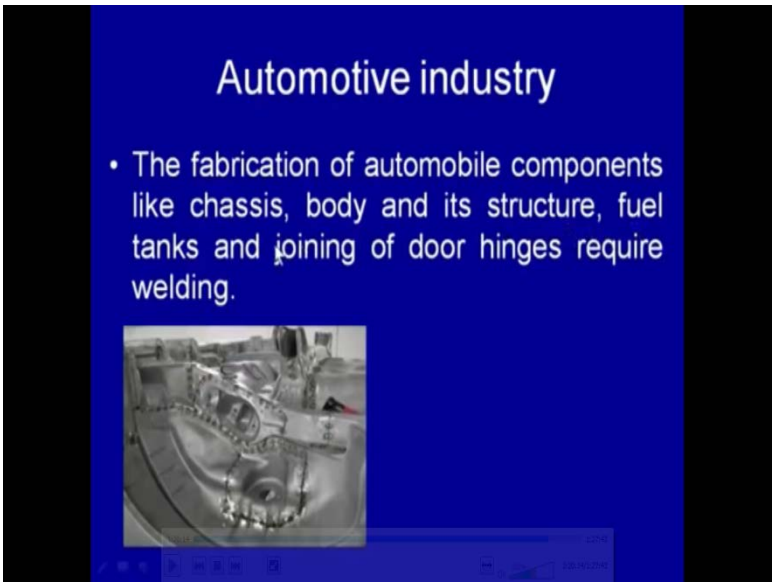

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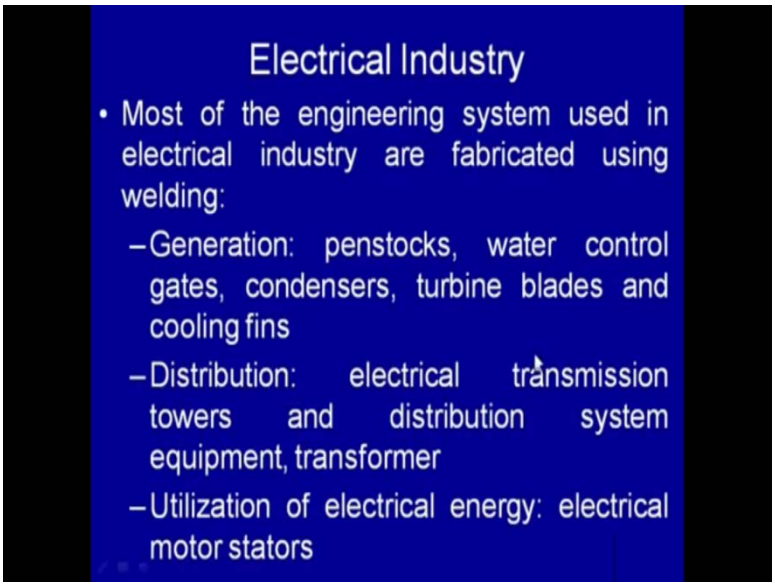

The body parts of the car and the fuel tanks in the two wheeler industry most of the engineering system used in electrical industry fabricated using welding starting from the generation to the applications side involving first-generation then distribution and utilization of the electrical energy. So, the generation various components like fabrication of the panic stocks water control gates condenses turbine blades and cooling fins are fabricated using the welding, thereafter for the distribution electrical transmission towers and distribution system equipment transformer need the welding for development of their systems and the component. Similarly, utilization of electrical

energy in this sector in this area of the electrical industry that the development of a the electrical motor status and other electrical machines requires welding to get the desired size. And the shape the electronic industry micro joining his extensive used for a joining the tin small size shape.

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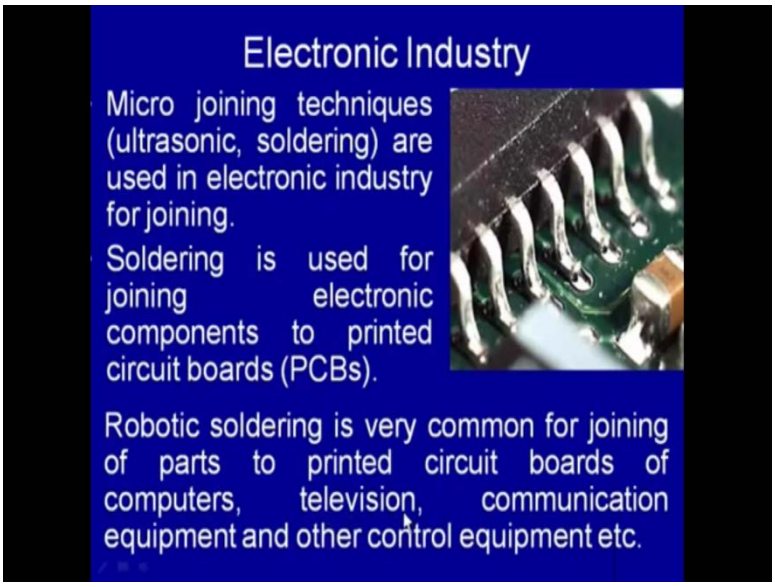

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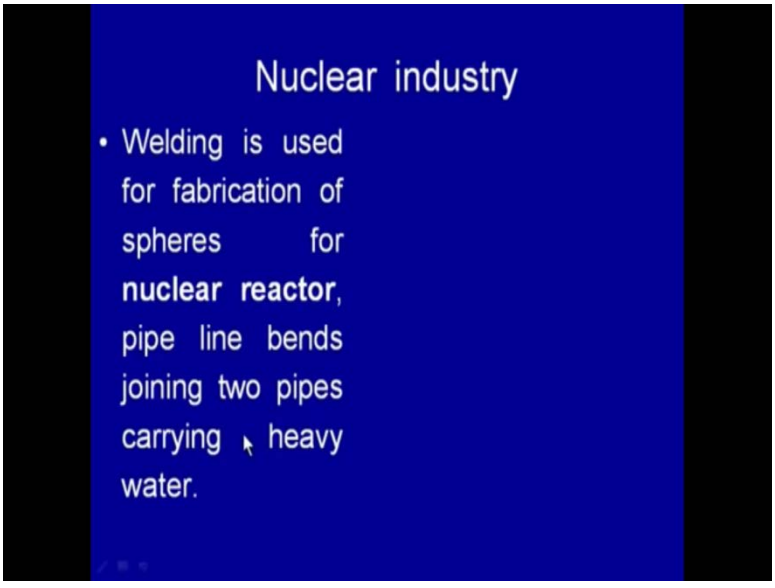

Components micro joining techniques like ultrasonic and the soldering are used in electronic industry for joining the different components soldering is used for joining electronic components to the printed circuit boards. And the robotic soldering is

commonly used for joining the parts of the printed circuit boards of computers, television communication equipment and other control equipments. In the nuclear industry the welding is used for fabrication of this space of nuclear reactors. Pipeline bents joining two pipes for carrying the heavy water here and typically example of the shall of a then nuclear reactors and here you can see.

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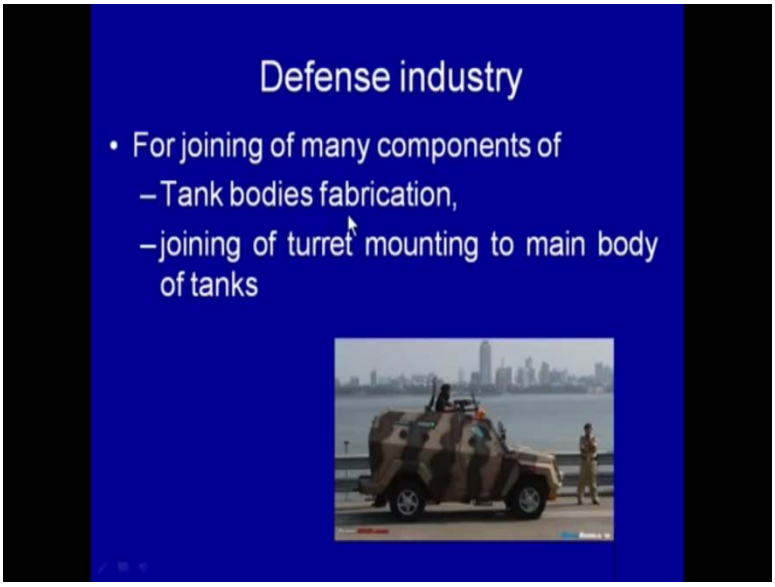

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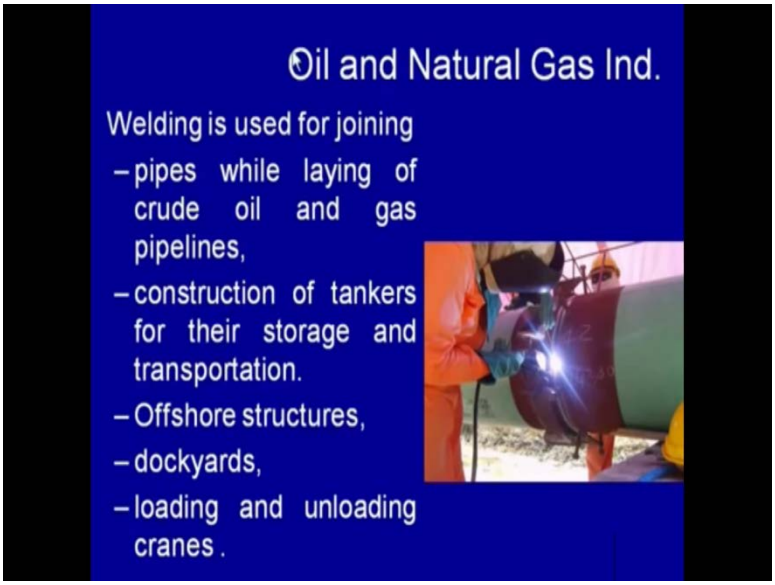

That the different thing defense industry joining of many components of that bank bodies fabrication joining of turret mountain to the main body of tanks involves the use of the

welding for development of the products in oil, and natural gas, and industry welding is used for joining.

The pipes by laying the crude oil and gas pipelines so far laying the pipelines to join different pipes it is a required, use the welding in the constructions of the tankers for the storages. And transportation also involves the use of the welding for fabrication of the tankers offshore structures are established with the help of the welding for joining the different components. Similarly, in dockyards and loading and unloading cranes and also involve the use of the welding for fabrication of the structures. So, here we can see another set of the joining techniques which involves very small amount of the heat energy for melting.

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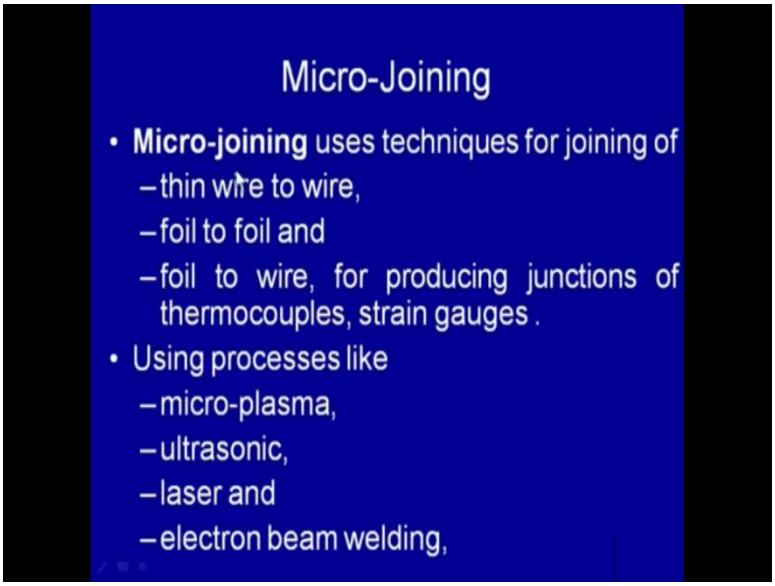

And the developing joints of the thin components micro joining uses the techniques for joining of a this technique is used for joining of a thin wire to wire, foil to foil, or foil to the wire for producing the junctions of thermocouples and the strain gauges. And this is done using the processes like the micro plasma ultrasonic laser and electronic beam welding. All these processes apply very high energy density for melting a small components rapidly and thereafter certification of the metal as to the will of the weld joint without compromising much on electrical and thermal properties.

And these joints frequently are not expected to take the load and that is why these are of a small cross-section and made using and the low the processes like micro plasma ultrasonic laser and electron beam welding processes.

So, here we have seen in this presentation that for manufacturing different engineering components made of the different, but reels we use different manufacturing processes like moss seeming welding cresting and the forming to get desired size and shape of a. It is important to consider its properties and performance expected from it we have also seen that welding is completely.

Welding is used for developing the components of a and there are different ways for making the joints which can perform the intended function welding is how different from other joining techniques in number of ways. If applied this can be very successfully used to take up the load and to with instant under the surface conditions, successfully for long in the coming lectures will see that how the welding processes can be classified. And what are the various aspects relatively heat generation and the kind of the methodological aspects with a welding that the way y, which integrity of the wields joints can be inspected. And how to establish the performance of weld joint for established for static as well as further dynamic loading.

Thank you for your attention.