Theory of Production Processes
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Lecture - 06
Technology of Patternmaking: Pattern Materials

Welcome to the lecture on technology of pattern making. So, in this lecture we will discuss about the pattern materials. So, we studied about the concept of solidification and also fluidity in the earlier lectures and the purpose of studying the solidification as well as fluidity is to see, that how the liquid metal has to go inside the cavity and how you ensure that the cavity is filled in proper time within a stipulated time and it goes into all the intricate cavities intricate details, it fills all the intricate details and then once it fills all the intricate details then the solidification has to start the thing is that how to make this cavity.

So, the cavity has to be same as what you what shape you want. So, basically for that you need something which basically keeps, you keep in the mould and then you take it out so that the cavity is generated. So, for that you need the pattern. Now what is pattern? So, pattern is nothing, but it is basically the replica of that cast product. So, pattern is the approximate that is modified in accordance with requirement of the casting process.

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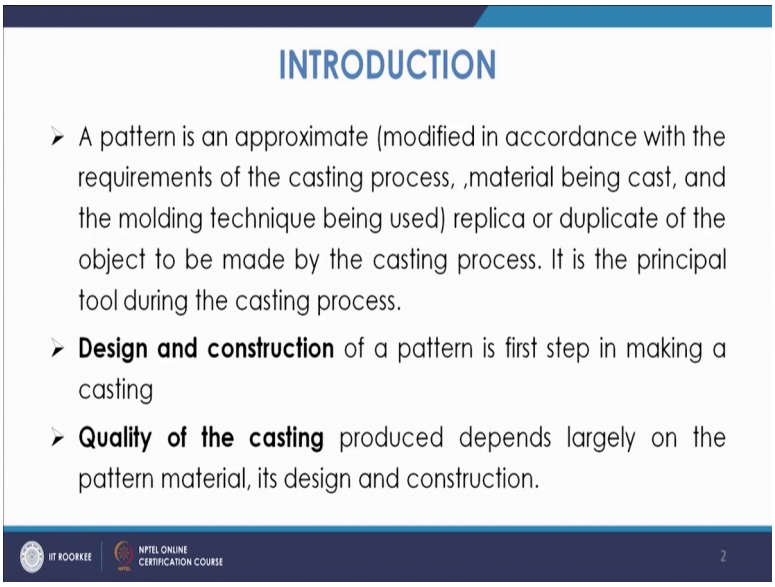

So, approximate replica or duplicate of the object to be made. Now why we call it approximate because it's not the complete replica of the final cast product the final cast

product what we see is basically coming after doing some treatment on it. After the casting process like when the casting is complete.

You are basically removing the burrs on the surface, you are finishing the surface, you are breaking all the attachments during that process you are giving a proper finish to the material or so, and also you are ensuring that metal has to them the material has to come out from them. So, pattern has to be removed from the mould when you are making the cavity. So, for that that's why it is approximate replica and it is written that modified in accordance with the requirement of the casting process material being cast and the moulding technique being used.

Now depending upon the casting process requirement like you may have the requirement that you must have a very fine finish of the surface, you may have the requirement that what kind of material you are casting or which kind of moulding technique, you are using depending upon that this approximate term will be justified how much it is close to the actual how much it is varying or deviating from the actual dimension design and construction of a pattern is first step in making a casting. So, the thing is that when we are making any casting. The first step is that you design and construct a pattern.

As we know that the pattern is basically the replica of approximate replica of the cast material cast unit which you are making. So, you have to design it you have to see that how you are making the pattern how you are constructing the pattern because ultimately as we know that if you have any material.

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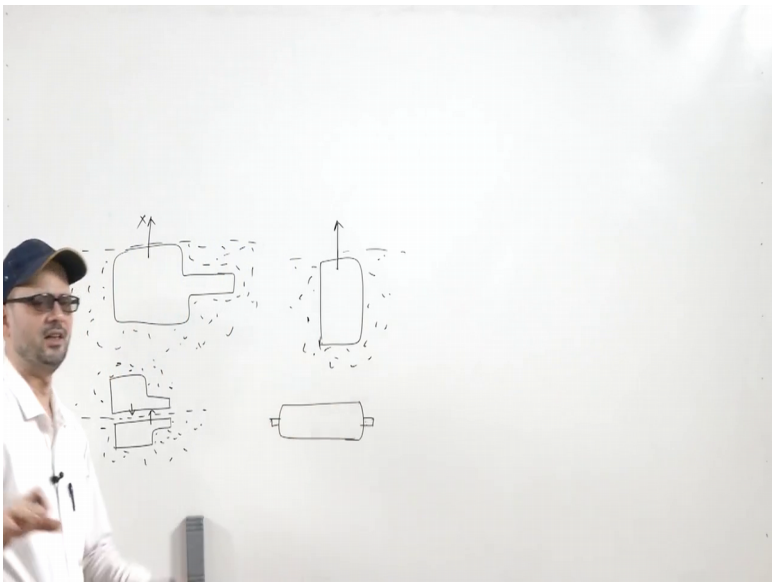

Any suppose this is the product which you want to cast. So, if you are completely putting this inside the sand and then you are trying to take it out you cannot take it out. So, while taking it out this portion will get damaged. So, you want to get this cavity in that fashion. So, you will have to design and construct the pattern many a times if you have the pattern in such a form.

It is simple then you can think of having the pattern in this form and you can take it out. So, from here once, you ram the sand from all the sides and take it out whereas, if you have the pattern in this shape and if you are ramming from the top then you cannot take it out. Because that will damage the mould here it cannot take it so, for that so, here this is not possible. So, for that what you have to do may be that you have to make it in two halves.

So, other half will be again here like that. So, one will be here one will be made by ramming in this portion and take it out in this way and another will be rammed in this portion and further you take it in this way and then the two cavities are joined. So, once you join these two cavities you will have a whole cavity of this type.

So, for that, the thing is that, when you are making any cavity you will have to design and construct in such a way that you can have the cavity and you can pour the liquid metal into it. Quality of casting produced will depend largely on the pattern material, its design and construction. So, how much will be the quality of the casting that will basically depend upon the pattern material.

Pattern material may be wood it may be wood it may be other materials it may be metal or so. So that basically changes the quality of the cast product mainly the surface quality, surface characteristics and also its design in construction. So, how it is properly designed how different dimensions are there which are completely matching with the actual dimensions or so, this way that becomes important.

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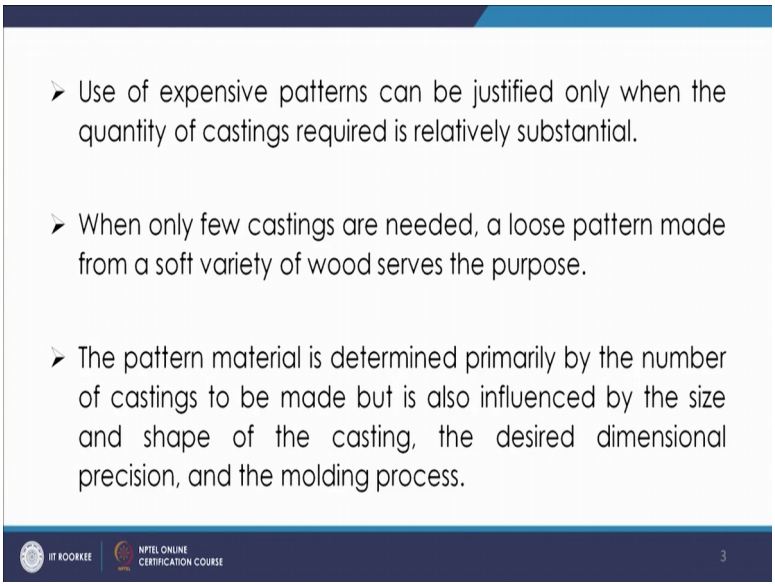

Use of expensive patterns can be justified only when the quantity of casting required is relatively substantial. Now the thing is that normally in earlier days the wood was available in large quantity and also there was not much of the hue and cry over maybe the dimensional changes, you used to make larger dimensions mostly to have more to give and you give deliberately more is a factor of safety. So, at that time you are not thinking of cost saving or so, in those cases and also you have ample of wood you are you are not worrying about it. So, wood was and it is cheaply available.

So, wood is normally used, but then slowly you know that depending upon the requirement of surface finish or wood not being available or there are many disadvantages also like storing of the wood for a long time maybe sometimes many of the wood which is available. They don't remain dimensionally stable or how long you have to use the wood in what atmosphere it is going to be used many a times you are using in a very robust atmosphere or with the sand used for long basically that erodes also from the sides.

So, based on that and based upon the conditions on which you are working if you are using it for very long run for many lakhs of units then it is better that you go for metallic patterns because that will long lasting its life will be larger. So, the thing is that you can go for expensive patterns when you are going to have going to use this pattern for a long time, but when only few castings are needed then a loose pattern made from soft variety if wood also serves the purpose. So, for that to have the economics in mind you also use the loose piece patterns or so the pattern material is determined primarily by the number of castings to be made, but is also influenced by the size and shape of the casting the desired dimensional position and the moulding process.

So, that we already discussed that we have to see that how many castings you are making what is the size and shape of the casting. So, that also because very large shape of casting is there very large pattern is to be made you cannot think of making a pattern of heavy metal like iron or so that because the handling will be difficult making also will be very costly. So, in that case you will have to have the alternate thought process to make the casting in such a way that same cavity you are making, but you use the minimum of the you know material and.

So that you can make the casting I mean pattern in a more easy manner. Also the dimensional precision as we discussed that when the precision is required to be more, you will have to go for the material whose dimensional stability is more like for metals normally that is more than that of wood. So, that way you are going to use the different materials moulding process you are using the manual moulding process, you are using machine moulding process based on that also because what kind of pattern you are going to use that also varies.

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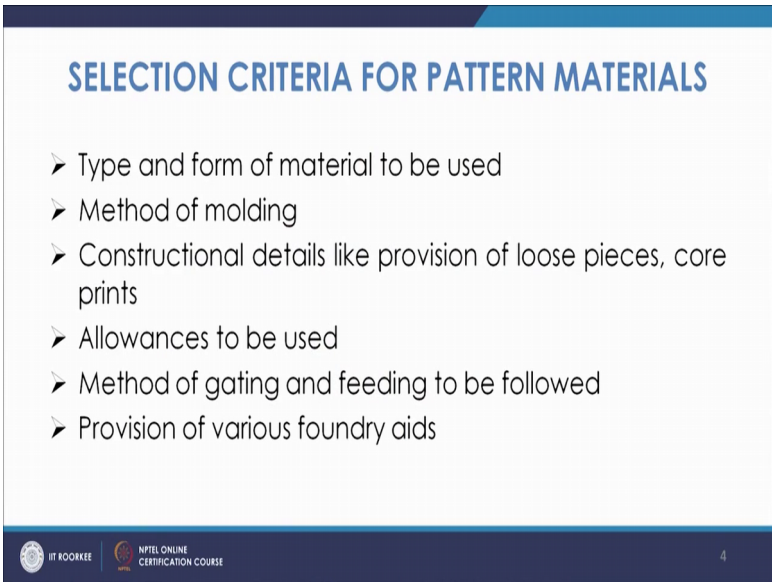

Selection criteria for pattern materials what are the selection criteria for the pattern materials like type and form of material to be used, what are the type of material, in what form you are using. So, that is the selection criteria one of the criteria method of moulding you are using the manual moulding or machine moulding high pressure moulding or so. Because the pattern is subjected to that pressure, because the pattern is in between it is kept inside the moulding material and then it is also pressed.

So, it has to sustain that pressure. So, if at delicate parts you have to be careful and if it has to be rammed then in that case you have to have the material such a way that can withstand that much of pressure construction details like provision of loose pieces core prints. Now that is also to be seen that because many a times the core prints are those places on the pattern. So, if you are making the pattern in that suppose you have a core.

So, let us know, what is that core. So, suppose you are making placing a core. So, this core has to fit. So, it has basically to have the support. So, that support is provided by provision in the pattern itself. So, how much provision is there or know what kind of material should be there. So, that also is decided by is one of the factor which decides about the pattern materials.

What are the allowances to be used? So, that also if they apply allowances are more or less. So, that also is one of the criteria for the selection of material, method of gating and feeding to be followed and provision of various foundry aids. So, these are the criteria which are to be

kept in mind for selection of pattern materials. Now what should be the characteristics of the pattern material how it should behave? So, first of all it should be easily worked shaped and joined the pattern which you are making it is made in a pattern making shop. So, if you are making the pattern from wood, you will have the different machines wood cutting machines are there laser are there. So, you must the material must be such.

So that you can shape it in a way you want. So, that is the first criteria and wood basically is quite easily workable quite easily shapeable and also joined with glues or whatever it be. So, you can join them. So, that way wood serves the purpose apart from that you have other materials also like metals or so. We will discuss about different kinds of materials you have then next condition is light weight.

Light weight is important because it, if it is heavy and in case of manual movement it brings the fatigue to the worker who is carrying it or you will have to have the extra means to transport it or. So, if it is quite heavy. So, it should be lightweight if it is light weight then it is better. So, that is one of the desired cut characteristics of pattern material hard and durable it should be hard as well as it should have a long life. So, that is the fifth criteria resistance to wear an abrasion corrosion and chemical actions this is required because you are using it in a normally with sand or so, or environment where it is kept for long or maybe chemical attack may be there.

So, if it is resistant to such environment its better. So, that also should be kept in mind dimensional stability the pattern material must be dimensionally stable. We know that depending upon the changes in conditions the dimensional changes occur with the change in weather conditions. With the change in temperature conditions there may be changes in the dimension of the material.

So, you must select a material which should be dimensionally stable, mostly in case of wood it is seen that with us with the seasonal change is the variation in its dimensions. So, you should be able to basically see that you are having the material which has dimensional stability cheap and easy availability. So, that is very important the material must be cheap because if it is costly you will have to have the justification you can have you can go for costly pattern.

If you have a very long term planning if your production using the pattern is going to be for very large time and if it is the durability is there, durability has to be there in that case you

can go for some costly pattern, but it's better to have the cheap and easily available material, because if it is broken or if it is lost in that case you can easily again further make it repairable and reused many a times it gets some damage. So, in that case it should be you should be able to repair it and you should further reuse it. So, that is also one of the characteristic ability to take a good surface finish.

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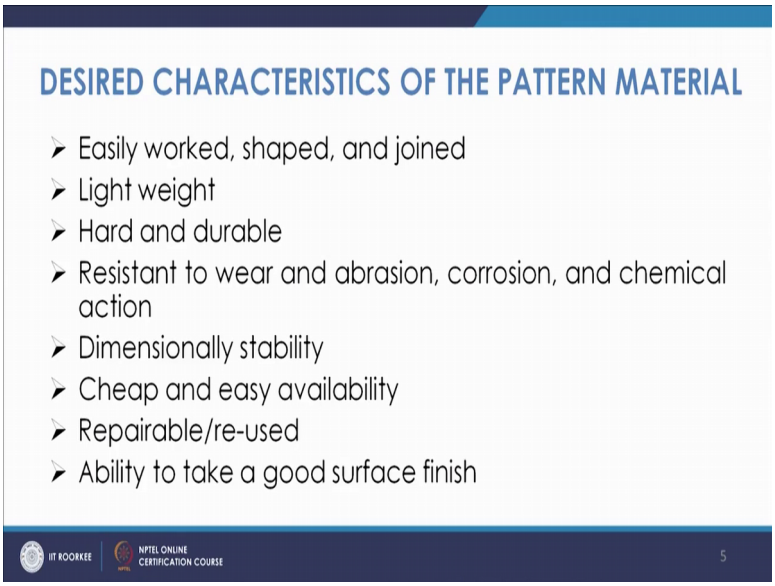

It is also important, because ultimately the pattern material when you are making the mould then Multimeter goes into it and the surface finish what you get of the mould same thing, you will get on the surface of the cast and surface finish what you get on the surface of the mould it will depend upon the type of pattern material you need you use. So, that way it should if it is quite having good surface finish it will be able to give you the cast with good surface finish.

So, these are the desired characteristics of the pattern material next is the type of pattern materials. So, we discussed that what should be the characteristics of a pattern material. Now mostly you have the pattern materials of following types like you may have wood and wood products which are easily available metals and alloys; because of its large durability more strength more specific strength or so, plasters which set quite easily and you can get the plaster patterns, plastics and rubbers which are quite light good specific strength then you have wax which is also used as a pattern in many cases for making the intricate shaped castings precision castings or so, apart from that you have. So, many pattern materials are

there which come in between these materials like you have expanded polystyrene which is used in case of full mould casting. So, that is a kind of plastics or so.

So, you have mostly the pattern materials of this type. So, taking the wood and wood products you know we discussed that since wood is the one which can be easily shaped or worked and you can it is light it is easily available and it is less costly than other materials. So, it is normally preferred. So, wood has you know it has the cellulose of 50 to 60 percent and 20 to 35 percent of Lignin a small amount of other carbohydrates. So, this is the structure of wood and normally wood is used when small quantities of castings are required, because if you take. If it is used in very extreme environment for longer time with sand then the surface will be rough and that will be reflected on the surface of the casting itself. So, that is normally desirable advisable when you have to produce small quantities of castings.

It has the drawback that it may warp or swell with changes in humidity. So, if the proper treatment to wood is not given or if the wood is of not that quality in that case it may warp or swell with the changes in humidity, many a times you must have seen that even in our house. If we bring certain furniture certain furnished furniture we prefer of certain wood and many times we don't bring from anywhere like we may anticipate that this may be worked many a times it loses its dimensions. So, it all happens, because of the improper, you know moisture content in the wood material and with change in season basically that deforms the shape.

So, for preventing the excessive shrinkage or swelling the wood is also given certain treatment that is known as seasoning of the wood. So, it has certain equilibrium content of moisture or water and that should be maintained; otherwise that swelling or warping is you know experienced. Normally, we use the different kinds of wood and these are Pine Mahogany, Teak, Walnut and Deodar and you have different properties for these woods like Pine wood is light each of working and ability to take good finish you have Mahogany which is hard strong and durable type of wood with negligible shrinkage or swelling after seasoning.

So, normally it takes a very fine natural polish and stains well and glues excellently. So, these are the qualities of this Mahogany wood and then you have the Teak wood.

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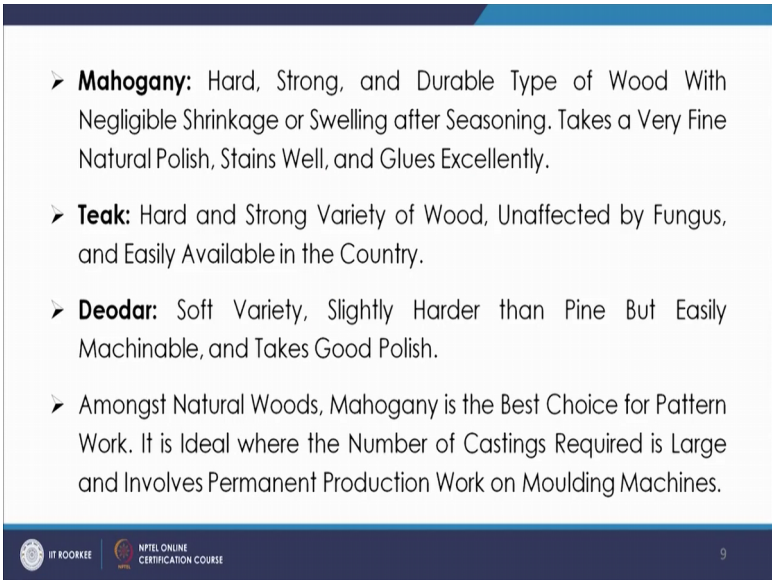

So, Teak wood as we all know it is very strong and hard. So, very much it's also costly little bit then it has the property that it is unaffected by the fungus and it is also easily available in the country then you have Deodar which is again soft variety of the wood slightly harder and then Pine, but easily machinable in takes wood polish. So, normally these are the traits of different kinds of wood and among the natural woods Mahogany is said to be the best choice for pattern work. So, we prefer the Mahogany one it is ideal where the number of casting required is quite large because it is. It was said that Mahogany is hard and strong as well as durable.

So, when you have to go for larger number of casting in that case this is quite suitable. So, this is, it is the best choice for pattern work and for when it is you have the pattern required to be used in the moulding machines. So, permanent production work on moulding machine is required in that case this wood is preferred. As we discussed that wood has one disadvantage that it may because of the change in humidity and because of the change of weather it may start or it may work. So, we do the treatment like seasoning of the trim seasoning treatment to the wood and during that seasoning treatment basically it minimizes the effect of subsequent moisture variations by adjusting the water content of food near to equilibrium level under exposure to average atmospheric conditions.

So, basically you must have seen many a times the wood is, wood log is kept in the river flowing water river or it is kept in the skins are kept in the atmosphere and it is kept for two or three seasons or so, and then it is used. So, basically they are the kind of seasoning methods. So, that is done either natural or artificial method.

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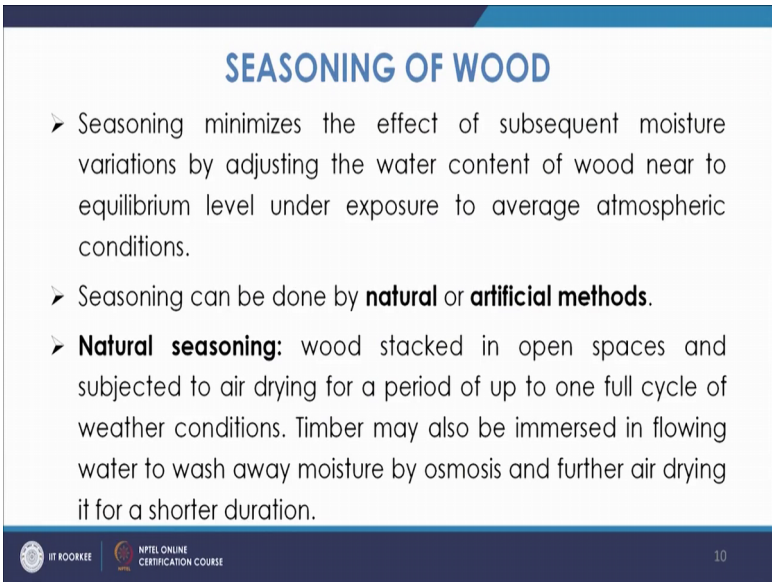

So, in the natural way it is kept in the open space stacked in the open space and air drying is done for period of one up to one full cycle of weather conditions, then also as we discussed that you can put in the flowing water to wash away the moisture by osmosis and further air drying it for a shorter duration. So, that way the equilibrium water content is maintained and then you have the artificial seasoning methods where the timber will be stacked in the drying kills and subject to fast drying by allowing hot air to pass through the kill chambers.

So, one is that the analytical method where the high frequency electric field is exposed to that and which it brings down the level of moisture to desired level. Similarly you can immerse it in a suitable salt solution and then exposed to air for drying. So, that way you can have the seasoning of the wood. Now you have different materials like you have metals as well as alloys.

So, as we discussed that when you need more durability of the material when you are going to use it for larger time then you go for metallic patterns. So, they are expensive. So, that's why, but they are they are dimensionally stable and durable. So, this is the advantage that they are, I mean dimensionally stable and durable although they are expensive. So, you are using when you have repetitive production of casting is required in larger quantities. So, that way you prefer this pattern material only in such cases.

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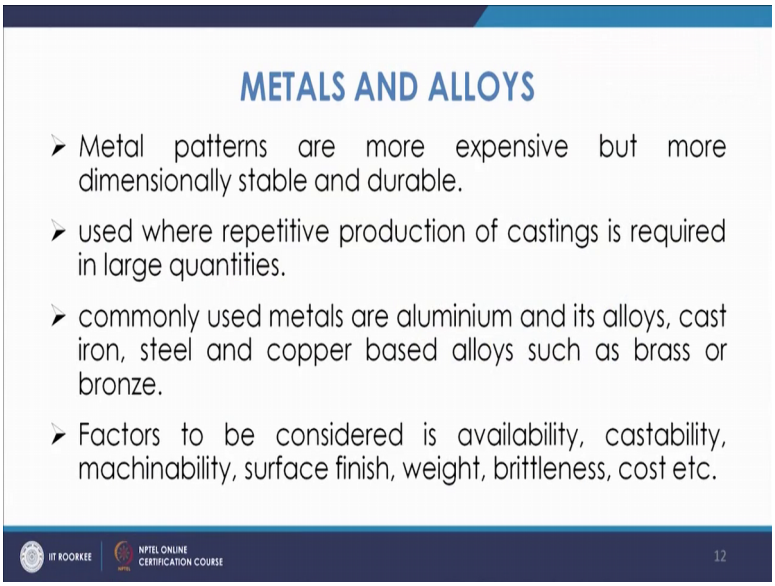

Commonly used metals are Aluminum and its alloys Cast iron steel and Copper based alloys such as Brass or Bronze which you can cast easily you have the material with good strength a good surface finish. So, that way these are the normal materials which are used you have the factors which you must consider is the availability cast ability, machine ability, surface finish weight brittleness cost.

All these factors are important because when you have to take any material it should be easily available if you have to further make it should not be the case that it is not available and you are going for another materials. So, that should not be, it should be visually cast able you are casting the material and getting that in certain shape. So, it should also good I have good cast ability then machine ability surface finish and all these properties should be there another important pattern material is the Gypsum plaster, Plaster of Paris.

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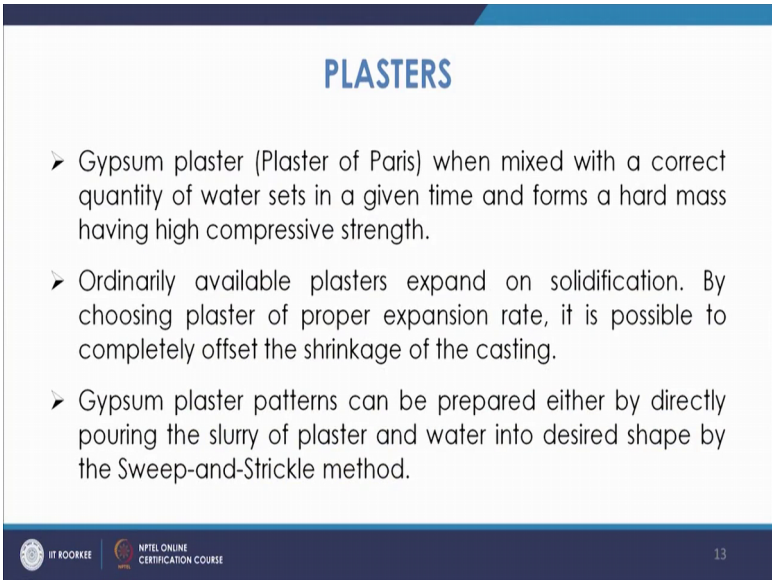

So, that it has the property that when you mix this with correct quantity of water, it sets in a given time and forms a hard mass having high compressive strength. So, basically because of this you have the cavity you put the plaster mixed to the water and then you are basically leaving it for some time it will have a hard mass of that is the type of casting you want. So, that will be a pattern.

Now, the thing is that normally the plasters which you are making in this way they are spending on the solidification. So, basically in the normal case when you are making a liquid metal to solidify it sinks and in this case it solidifies. So, you can have the adjustment in that case in normal case because it shrinks you are giving certain shrinkage allowance. Now that can basically be. So, this problem.

So, this way this is advantage in the sense that you can choose the Plaster of Paris for a proper expansion rate. So, that shrinkage of the casting can be offset. So, shrinkage allowance you can get it rough that allowances you are giving, you need not worry about it the Gypsum plaster patterns can be prepared either by direct directly pouring the slurry of plaster and water into desired shape by the sweep and strical method.

So, that there are methods like you can pour it or by sweep and strical method also, you can have this preparation of this Plaster of Paris pattern. You have the plastics and rubbers hard plastics such as urethanes these are there which are offering another alternative and we are offering often preferring this because the plastics and rubbers. They have come very strongly as a replacement to these metals and alloys because you have many processing methods of

plastics and plastics have the most advantage in the sense that they are quite light they are very much inert to chemicals. These are some of the methods they are, they are anti corrosion properties then all these properties make them very much suitable. So, you can very easily make them fabricate them join them with glues.

So, these are the basically properties which are making these plastics and rubbers very much versatile pattern material and they are very much replacing the materials I mean metals in many cases. So, plastics you have like you have may have the thermosetting plastics and thermoplastic plastics and thermosetting plastics as you know they are very quite hard or so.

So, you can have the use of either of the plastics and because they have very good specific strength so, that way you are using them as a very potential pattern material another alternative they are used as an often preferred with processes that are that use strong organic bonded sands. So, that way if you use another pattern material somewhere and when you use these organically bonded sands they stick to it, but in that case of plastic materials plastic pattern materials this is not that case. So, that way it becomes advantageous.

You have another process like full mould process where the expanded polystyrene is also used in that case the metal goes into it and that gets vaporized. So, this way it is used you also use the wax as the pattern material in case of investment castings. So, you have both thermosetting and thermoplastic materials used as patterns and you have thermosetting plastics are used for making long lasting and durable patterns.

As we know that thermosetting plastics have good strength and for shorter run you use the thermoplastic materials and in thermosetting variety you have epoxy and polystyrene regines thermoplastic type you have polystyrene. So, polystyrene resins are there in thermosetting and polystyrene is among the thermoplastic, Silicon rubbers are also used for dyes in special cases.

So, Epoxy resins has become very popular nowadays. So, you can go through the literature and see about these different kinds of plastic materials and now, because it has very good strength to weight ratio. So, it is very much preferred it has low cost of working good resistance to be abrasion, and it is immune to the action of moisture and also many in many cases in the chemicals or so. So, that's how it is preferred you have waxes also as a typical pattern material used in the investment casting. So, you have different kinds of wax like per paraffin wax, canova wax, then celiac waxes, beeswax and different kinds of waxes. So, as

you know that in the case of investment casting the wax is there which is kept in certain shape by the use of the dyes and then it is coated with the ceramic materials and then the pouring is done before that the wax is basically fired out by hitting the mould and then pouring is done.

So, wax has pattern has also have to be certain properties like should we look as content high tensile strength, good wet ability resistance to oxidation low shrinkage is low melting point all these are the requirement for a wax pattern, and you have how it is done like blending of waxes is done, then you are you have the process like injecting the liquid wax into the dye then making the dye, further it is used with it is coated with the ceramic materials and this way the wax patterns are used. So, these are the pattern materials which are used. So, this way we discussed about different kinds of pattern materials which are used in the case of pattern making.

Thank you very much.