**Enclosure Design of Electronics Equipment**
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**Lecture - 16**
**Aluminum for common equipment**

Let me start the little bit of recapitulation and what was covered yesterday.

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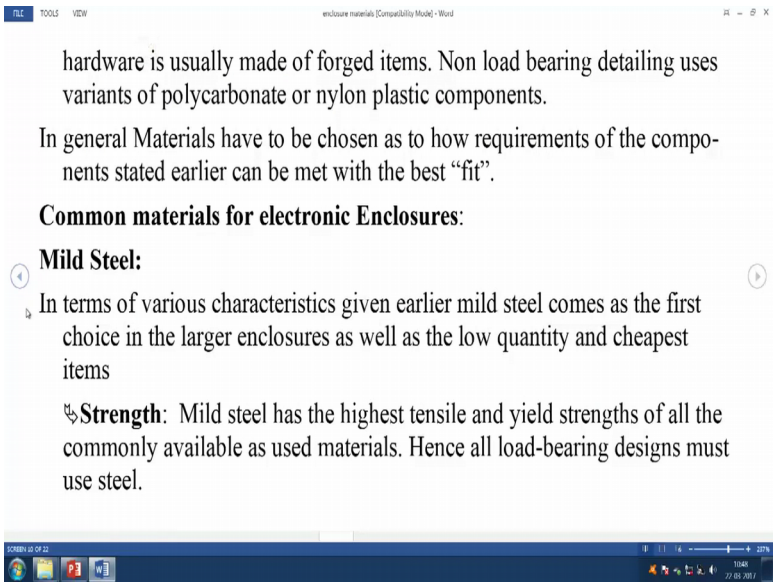


We started with mild steel; saying advantage of mild steel being it is strength has a highest tensile and yield strength all load bearing designs must we made with this.

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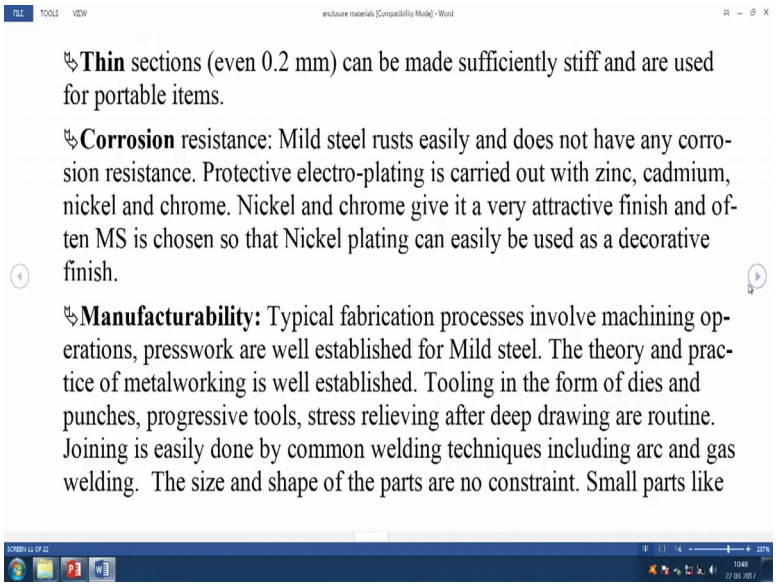


Next I talked about thinness; thin sections can always be made with mild steel as that used for portable equipment. Portable equipment need to be light the movement there light the thickness needs to be small because for a given what you call volume steel less steel heavier. What is some her little problem means? That corrosion resistance is not very good in the case of mild steel, rusts easily and does not have any corrosion resistance.

Protective electro plating is carried with zinc cadmium nickel and chrome. Nickel and chrome give it a very attractive finish and often ms is chosen. So, that nickel plating can easily be used as a decorative finish. This side given you an example of car bumper sents on saying earliest no they were made with mild steel and then as the thin thickness can be made smaller light weight also can be reduced and then everything is chromed.

So, even today except for some high performance bicycles, bicycle rims motor bike rims all those continued to be made a steel. So, though what mild is a what you call not a very good word to say, but still because of the small tresses of other materials compare to pure iron sheet and compare to very high carbon steels it is called mild steel because of the composition.

When problem with these as I have told you being that we have this problem of corrosion. So, nickel chrome all these is done, then we have the manufacturability typical fabrication processes involve machining operations presswork and various type of things

called nibbling, joggling, embossing and ribbing or whatever you call it know, that is come very well because of the mild steel is of fabrication and peculiarly it is relatively ducktail, it is not a brutal material it does not break that easily and various types of hit treatment has possible to make it such that there is more elongation is possible or what is called ne link can be done easily.

After ne link even work related I am sorry process related hardening can easily be overcome. So, if you what to take your own tumblers or here we call it a steel glass, it looks like a oxymoron how can it be steel and how can we call it a glass. Earlier it is to be a water picture and eventually know it became a small tumbler, but then you do not tumbled also, what is you just carry the so called steel glass. It is made of a variant of steel which has that what do you call shine white color, but you have notice the generally there deep conical with a small taper occasionally the new process make them really really practical a without any taper.

All of it has done by drawing are pushing the material or strictures called deeper drawing deep drawing if you take a small eating plate probably it has just standard drawing procedure, and you do a bit of trimming. Why you mean existing on this is such things continued that application of that is very much important in are electronics also we need to make deep objects.

So, the advantages here is press work something related to this press work is are very well established theory and practice of metalworking is there all the time, you cannot calculate at punch load, you can calculate press load, you can find out what is particular condition of the material that can be used for operation is possible. Similarly tooling in the form of dies and punches progressive tools, stress relieving after deep drawing which has pock to you or all fairly routine. A lot of it as evolved after a people have observed the consequences of a previous operation.

If you try to bend something repeatedly it has a tendency to break can you overcome it that is how lot of these things have come about if theory explains of physical phenomena and certain conditions can be optimized; saying using a particular bend radius what is it that we can achieve and it is not the other the equation does not determined the physical process nature, because several of the parameters which are used in the proceeding or not known.

So, we may have a little problem on how to test whether you have learnt something here it not easy. Testability is not easy because it were remembering lot of these and reproducing that does not take is any ware; however, if I ask you a sample saying now go around and you know kindly collected sample and I want you in your hand, most slightly that is a ultimate test that you are taking the trouble of collecting it and you are not jump the cube by buying a kit we are already it is labeled and you fill it of an show. So, this is called a two stage rib drawing thing easy in the corner flash has been removed by punching and all that, it is red from a queue cad.

So, we still have this problem of how do you understand the process and then how do you implemented; that is the reason even the latest software tools talk about make a test piece find out what are the various allowances to be given and included in the in your calculations. So, I will get back to the slide here, tooling in the form of dies and punches progressive tools stress relieving after deep drawing are routine. Joining is easily done by common welding techniques including arc and gas welding.

So, we are all familiar with that welding were that you know sparks fly. So, probably it started with the earliest rod taint, eventually now we have electrical welding a one sort or the other. So much so, that we take it for granted and in fact, one materials join by any of these welding techniques rarely fail at the welder there fail somewhere else or other operations related to welding. Size and shape of the parts are no constraint very large parts can be done; small parts like links levers support bracket and such are easily fabricated using blanking.

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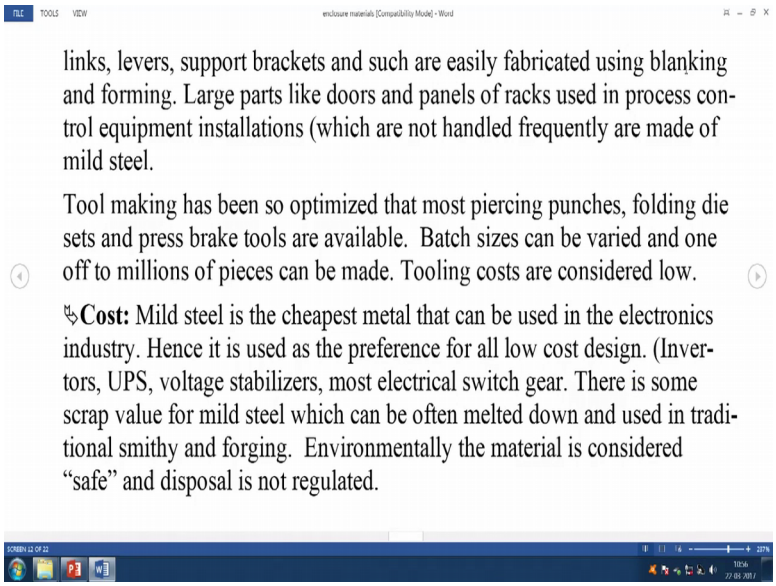


Large part like doors and panels of racks used in process control equipment installations which are not handled frequently are still made of mild steel. Tool making has been optimized that most piercing punches folding die sets and press brake tools are available in that over designing one more. In fact, if you go to the manufactures skate lab of any all the punch equipment, you will see these so called prefabricated punches dies of various openings everything use available you need not boron nitrate make it. Tooling cost as such know are considered low you can go to any person who does this fabrication for you and depending on their load take an accommodate you.

Mild steel is the cheapest metal that can be used in the electronics centers used as a preference for all low cast design. Invertor's ups voltage stabilize stabilizers most electrical switch gear and must important it is highly recyclable. So, in case something is a problem you just strip the whole thing and then you can give it back for disposal, safe disposal unlike your other materials it is not so bad.

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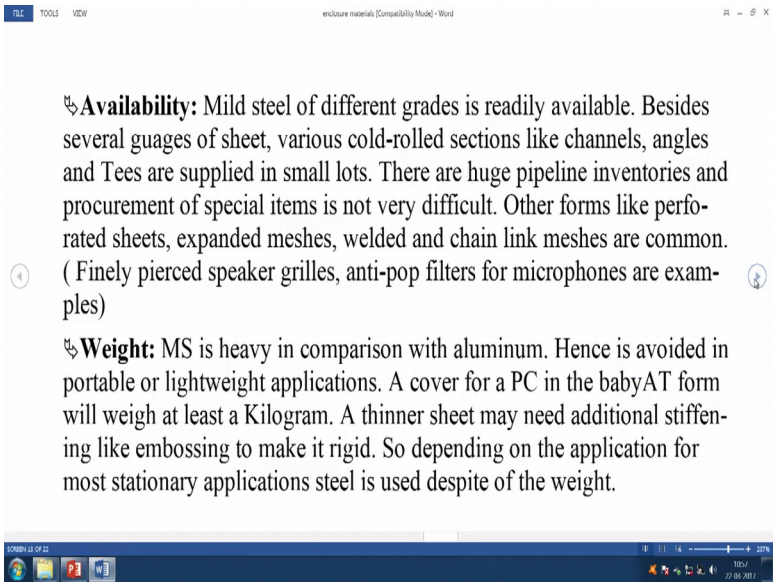


And mild steel of different grades is easily available besides several gauges of sheet cold rolled sections like channels, angels tees or supplied in small lots you just need to go to the store and by them. Very huge pipeline inventories and procurement of special items is not very difficult. Pipeline inventories means something from the original manufacturing place and all the way to the your last detail lot of stuff is stored in different place and all now, in case something is there in the catalog if you are ready to weight you can eventually get it. You have other things like perforated sheets expanded meshes weld and chain link meshes are common, speaker grilles anti pop filterers for microphones are all examples you have them everywhere.

So, it is real yesterday I showed you example of this wireless set, you remember (Refer Time: 10:51) steel item, this clip here on this steel item. Weight MS is heavy in comparison hence it is avoided in portable or lightweight, a cover for a pc in the baby at form will weigh at least a kilogram a thinner sheet may needed additional stiffness.

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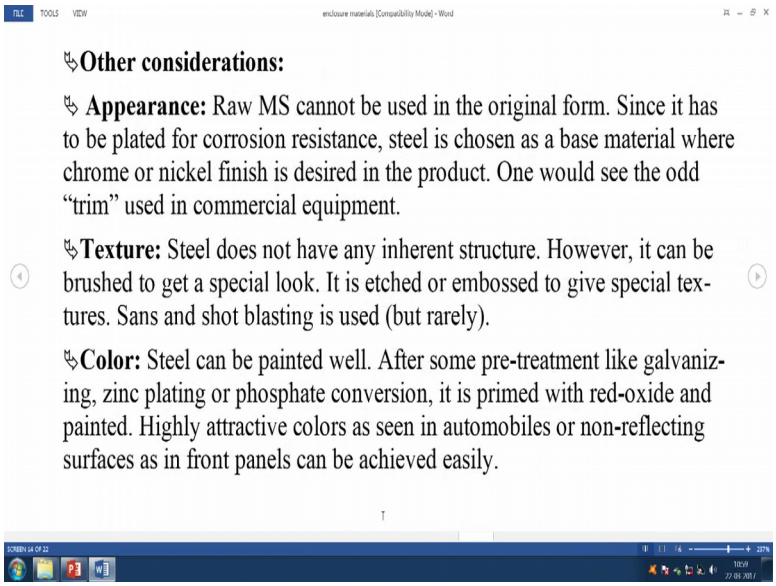


So, depending on the application for most stationary applications steel is used despite it is weight.

Appearance raw ms cannot be used in the original forms, since it has to be plated still is chosen as a base material where chrome or nickel. Steel does not have a inherent structure; however, it can be brushed to get a special look it is a etched or embossed to give special textures. Sand and shot blasting that is you take a sheet and then you direct some grid being you know through a here are some other medium many special texture you want can be made. You would a seen the tread steps that you see a cross sometimes if you have a internal stare cares you get the tread sheets with a 4 by 4 or embossing and all of it. That whole thing in the rolling operation itself somebody does say the dents are created and then it has ready for you and some of you must way familiar with structural rods which are called torch steel.

Somebody long ago took a patent actually you did a lot of thing and I mean lot of observation and analysis, were in analysis and observation go together why is RCC failing, RCC offend fails because the core reinforcement appears to move and the movement it is moves game is lost. So, to prevent to moving there started you know putting all sorts of features are made which was part of the manufacturing process. So, eventually now all invite to get a smooth rod is difficult most places you only get the tuff you know highest quality steel with the highest yield strength, but with the torcial

sections. Extending the thing to our application in case you want to have a textured surface, it is possible to make textured surfaces not impossible to make them. Steel does not have any structure, it is structures emboss to give special texture san and short blasting is used rarely to give that special texture.

Steel can be painted well after some pre treatment like galvanizing zinc plating or phosphate conversion; it is primed with red oxide and painted highly attractive colors as seen in automobiles or non reflective surfaces as in front panels can be achieved easily in steel. Quiet easily you can get this then finally, we have this pre plated steel.

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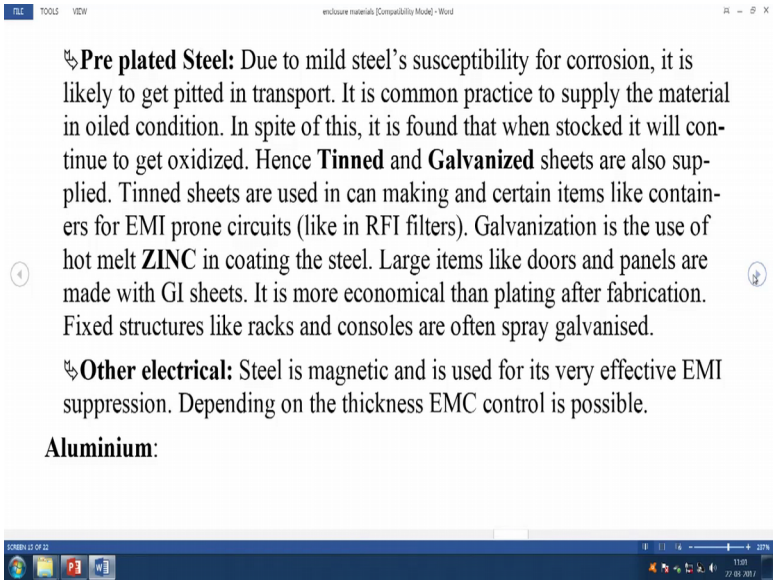


So, pre plated steel as the various advantages. So, even normally the because of susceptibility of corrosion, they probably know some oil get say there coated or it is spread it comes, but still chances are occasionally you find them damaged.

So, tinned and galvanized sheets are also supplied, I was making a reference to your car door yesterday. All car doors mostly are all embossed from free galvanized sheet galvanizing is nothing, but you know depending it is zinc otherwise there all zinc platted directly. So, a liter plating is called electro zinc, dipping in a hot bath is called galvanizing. They base material is usually mild still and then what is scouted and top of it is zinc. So, in case I have a done a mistake on that nomenclature kindly giving a feedback does not help, you can also give me feedback, but going check it out yourself by checking on the actual sections asking somebody what is it line that. Reading you will

take you near there round 90 percent and the last 100 percent is about your physically checking the particular things.

So, a smooth zinc platted steel you can feel it is smooth, but a galvanized sheet has you can say on crystalline structure on it. So, gi sheet it has a crystalline structure; now if you see with the wire which you was the steel iron wire way invariable a it was galvanized iron or variants of the. So, it. So, very very good process tinned sheets are used can making and certain items like containers for EMI prone circuits, RFI filters. Galvanization is use of hot melt zinc in coating steel large items and panels are made with gi sheets galvanized iron more economical than plating after fabrication fixed structures like racks and consoles are even spray galvanized. So, well I am not familiar with that is it I except that they there is a hot melt some device which will directly start spraying things on that may be instead of directing it like that may be it goes here and then the thing it is coated.

Steel is magnetic and assumes for it is very effective EMI suppression, depending on the thickness EMI control EMC control is possible electromagnetic interference in control for it. So, the opening inside is a very critical thing by some you feel now physics of I mean loss of physics miracle sly, any opening which is less than two and half millimeters that is small punched sheet with two and half millimeters opening generally keeps out all radiation I think there is a 30 megahertz limit.

So, things which between say 30 kilowatts to I am sorry 300 kilo watts to 30 megahertz is acts like an effective shield. Instantly that same 2.5 mm is used in your ip specification I do not know what came first whether the opening we can this much or 30 megawatt was a critical thing or ip came first, but all of them are nicely integrated in a made for each other things. So, that if you have a perfected sheet which has 2.5 mm small openings, you can safely using and most RFF applications of the lower frequency take up to 30 megawatts which is consider the old standard for the RFF equipment.

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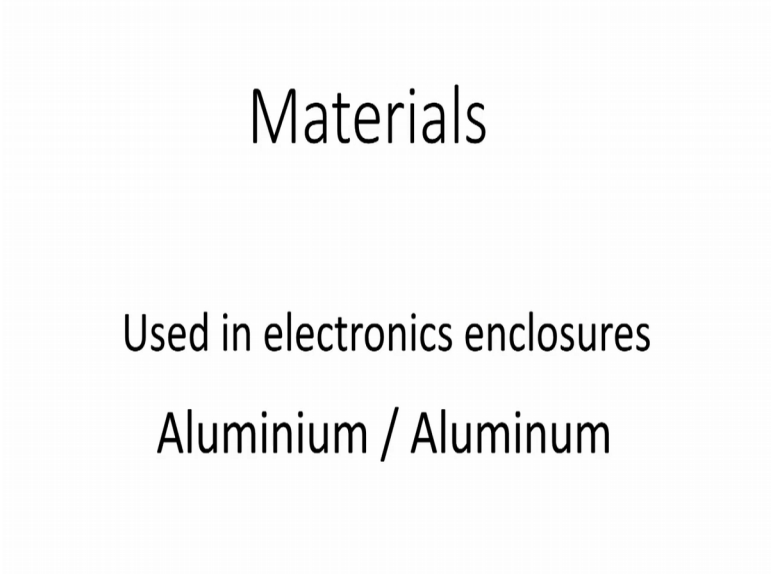


Next I come to aluminum; at this point while that first that first part of it I have red along with you, these available in both the formats you have a recording here then I have a power point presentation then I have text which have written up. So, I except that all of them will be available to you, but with that usual you know water mark feature. So, you can read it for yourself.

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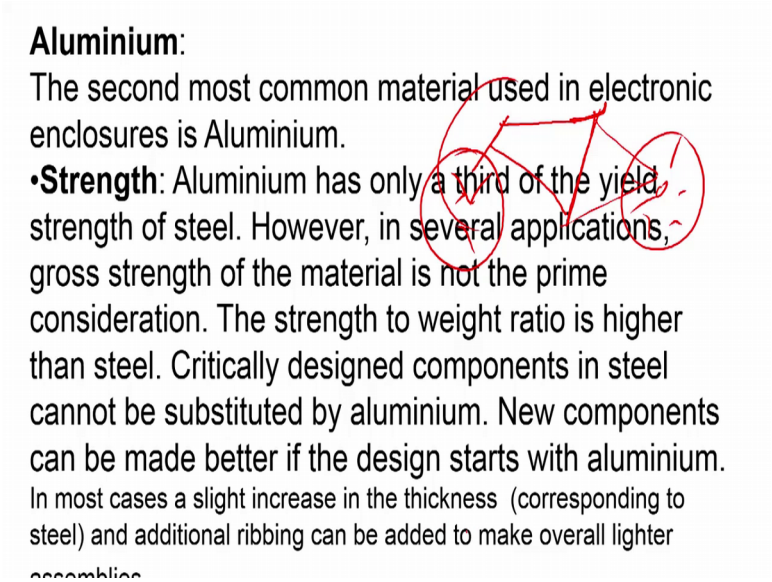


Second most common material used in electronic enclosures aluminum. Aluminum has only a third of the yield strength of steel; however, in several applications gross strength

of the material is not the prime consideration, strength weight ratio is higher than steel critically designed components steel cannot be substituted by aluminum it is realistic. it is something is been made as set only a steel structure can hold in, just like that know substituting one for the other does not help. I have given you already example of your bicycle frame if you have the basic trapezoidal bicycle frame, I hope you remember trapezoidal bike I just write it in the space that is available here.

So, I have slowly my bicycle is getting ready. So, triangle here and a near triangle here they were this all thing as been optimized, if you just blindly I want so blindly without due consideration for all the other operations, you just replace this trapezoidal frame with aluminum, you may end up with problems it is not stiff enough and we have all are problems depending unless grade is are critical and automatic replacement is not possible. New components can be made the design starts with aluminum. A slight increase in the thickness corresponding to steel and additional ribbing can be added to make overall lighter. Special grades called the 5000, 6000 and 7000 have been developed which are used in the aerospace.

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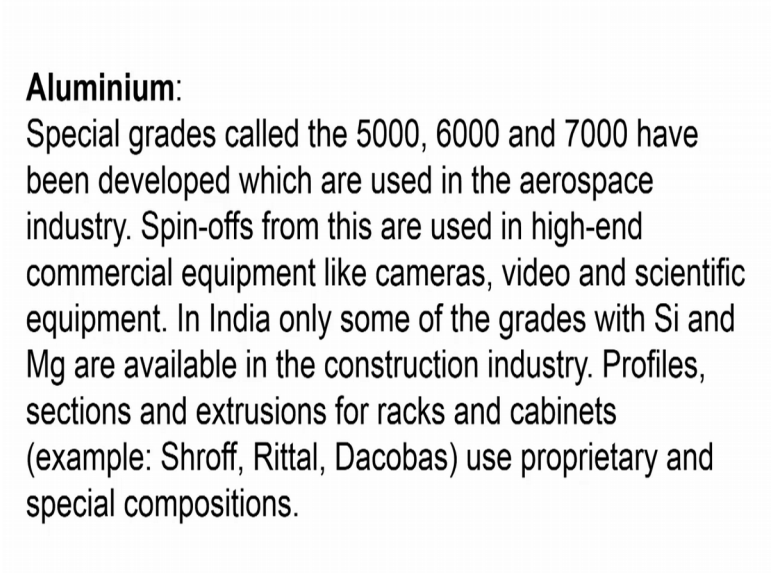


Spin off from this are used in high end commercial equipment like cameras video and scientific equipment in India only some of the grades with silicon and magnesium are available the construction industry. Profiles sections extrusions for racks and cabinets all the else are made with aluminum.

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**Corrosion** resistance: Aluminium has inherent corrosion resistance. Exposed parts will not corrode but may form patches from atmospheric contaminants. To avoid patches, bichromate passivation is employed. Anodized parts are especially stable and common. Enamel painting (after etching) and powder coating has to be given.

So, at this point I will see other I can go to a rack which are likely to find.

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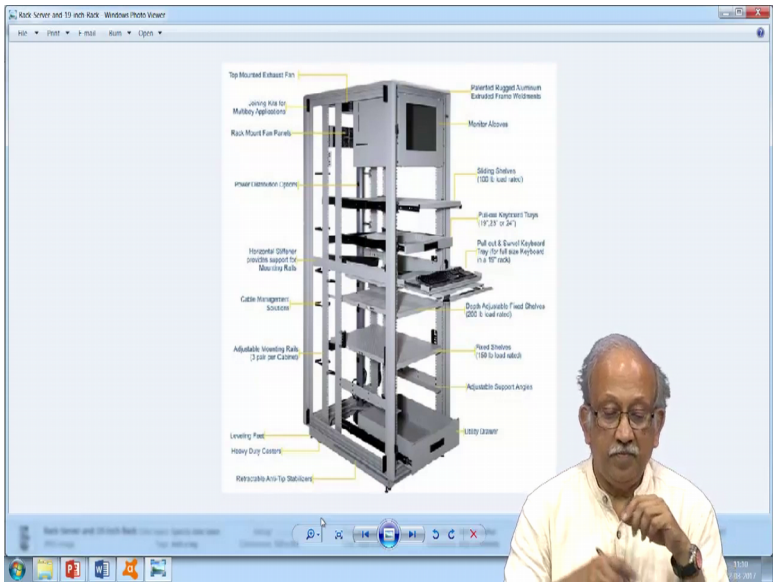

Anywhere I have just randomly taken it from the internet, and to see here this vertical members are there depending on the design it is possible for us to make it out of other aluminum or steel. Originally they load bearing things all this vertical items is vertical items used to be once upon a time made in steel, but right now all of them have been replaced with aluminum exclusions. This picture as quiet the same as what you had in the other picture.

Now, you see here we have a beautiful place for a monitor, when your place here for a keyboard and since electrical familiar with you, then this utilityade drawer and then make this whole thing most of the load bearing things in this case are made with aluminum. Except a few things like this drawer and this some fixed shells and all that everything else comes with the a perforated section probably this is the vertical section which you find.

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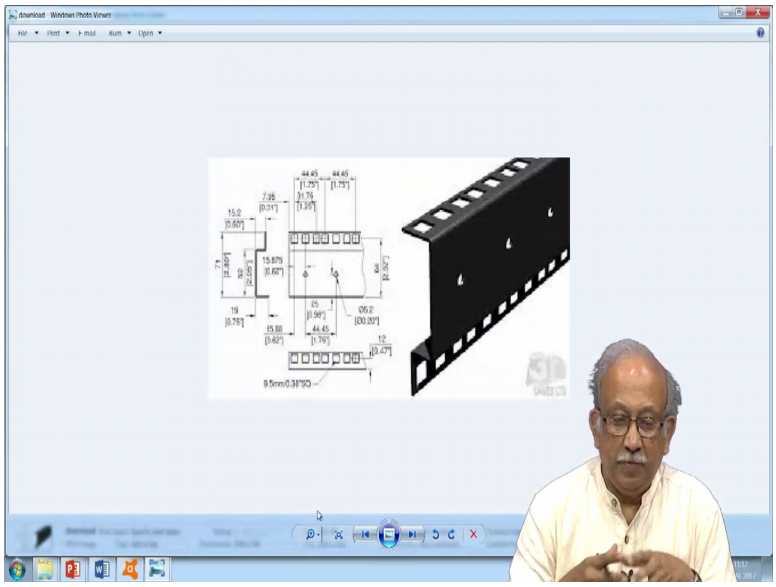

So, some of them have been made with mild steel; mild steel punching this things is very easy.

Now, they have been able to substitute this with aluminum also instead having a separate piece like this, there able to make start they design with aluminum and then you can optimize this things. Main thing about alu aluminum is it has an inherent corrosion resistance exposed parts will not corrode, but may from patches from atmospheric contaminants to avoid patches bichromate passivation is employed. So, potassium bichromate solution is made and something is done in this is dipped in it and taken out.

Anodized parts are stable in common, that is declare is nothing, but aluminum oxide layer conventional electro plating makes the part are over job as the cathode, but in the case of this thing the anode this forms the anode and then some material gets carried away and oxidation takes place and then they seal it and all that they advantage in the

end is that you have a very stable invert layer on the top which was good does what we are looking for.

Enamel painting after etching and powder coating can be given. So, the movement you have this powder coating you have an advantage especially of powder coating because the skin that is found by that powder after baking it is generally very impervious to outside contaminants. So, in inherently it has a pleasant appearance, non reflective or reflection can be control any color of your choice.

So, these days various furniture items and all that that want you plating anymore, and plating involves still some chemicals, which are not easy to dispose of and then the case of powder coating I think except for maybe decreasing and washing and little bit of solvents, it is probably a little more what you call environmentally friendly. So, I am no expert on it correct may if sing easiest as I have told you 90 percent you can learn by looking at books and all that last 10 percent it go to princes and check.

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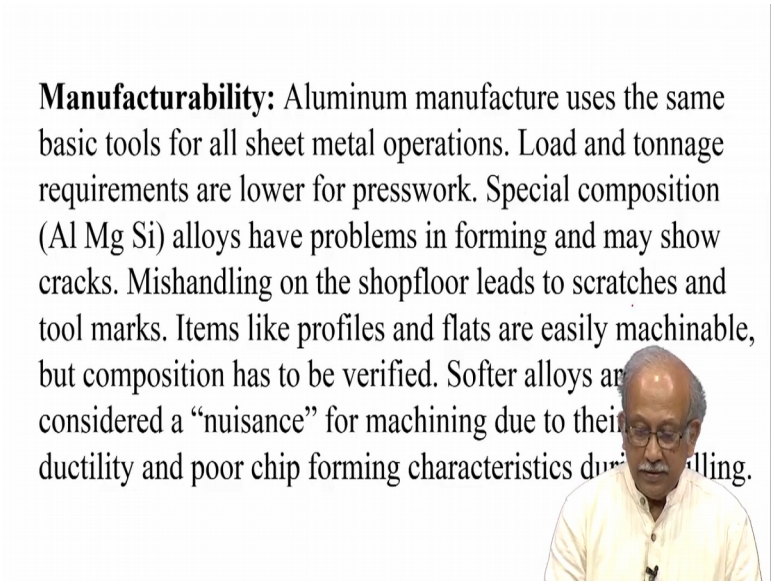


Aluminum manufacture uses the same basic tools for sheet metal operations. Load and tonnage requirements are lower for presswork special composition alloys have problems in forming and may show cracks. So, something is made so that it is strong and also it is stumped during hit treatment naturally it will become little.

So, there are in various stress that can be done and possible for us to make are accommodate design of front for these things. Mishandling on the shop floor leads to scratches tool marks items like profiles and flats are easily machinable, composition has to be verified, softer alloys are considered a nuisance for machining due to their high ductility and poor chip forming characteristics during billing. Machining is not easy they were looks likes you have a nice machine and you load the job and everything comes out lot of practical considerations are there.

They only safe good material as of noise steel brass inherently bass brass is a you can chips form they break easily and the noise finish can be obtained, and then over brass you can plates most of them and it is good, but ridiculously expensive and not strong enough for us.