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**Lecture 20**
**Waste Storage**

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Welcome back in lecture 20, we will talk about waste storage. The different concepts that we will cover are on household level storage of segregated waste, bulk waste storage, waste storage in public places, secondary storage, case study, we will do two case studies, one is on stationary compactors in Kolkata and the other is from for the city of Indore.

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So, all household level waste has to be stored in covered bins, that is the mandate given by SWM, solid waste management rules from 2016. So, the rule states that bins for storage of biodegradable waste shall be printed green those for storage, recyclable waste shall be printed white and those for storage of other wastes shall be printed black. So this is what as per the rules is what it says. But because and accordingly, in most municipal urban bodies, wet waste is stored in green containers, dry waste is stored in white containers. and domestic hazardous waste is sometimes stored in black containers and or red containers because it does not specify, the rule does not specify domestic hazardous waste specifically, that is why some urban bodies adopt the red color container.

And also as part the collection system that means this is how it is stored in the within a premise of a generator, but when it is being collected, that is, the collection agency can take this biodegradable waste in a green color container. But sometimes you will see that this dry waste is taken in blue colored containers also. So some differences are there, but this is what the rule states.

Now, how do we determine that the capacity of a waste storage container in my house. Now, there are different ways we can do that the first different criteria that we can use to do that, the first criteria is the frequency of collection. That means if waste is collected every day, then obviously I will store the waste that is generated in for one day, but if it is collected every two days, I have to make sure that I can store waste for two days and then only I can, dispose of it. So the container capacity would be almost double sometimes it is more it is double or something it is a little bit less than double.

And quantity of waste so, that quantity of waste generated per day by all the members of the household that gives us for one day and then based on the frequency we can determine the overall capacity of that particular bin. Now, for a household with 5 members, approximately we find that the container should be 12 to 15 liter capacity, which is like 0.015 millimeter cube and this is for dry waste and wet waste separately that means one container for dry waste one container for wet waste and this each container of capacity 12 to 15 liters.

And there has to be also consideration of spare capacity that means sometimes the waste has to be collected every day, but for unforeseen reasons, sometimes it may happen that the waste is not collected on a particular day. So in that case, if I do not have a container, I would it would result me take the garbage outside and throw it inside in somewhere outside where it is not supposed to and then you know use again the container for the rest of the waste.

So that is why at least we should have extra capacity for your 100 percent of you know that another day's waste. So, that means 100 percent spare capacity has to be there. So, in case of alternate days, that is if the frequency of collection is every other day, either I can go for a larger bin or we can go for multiple containers that means either I can have one container for green waste or I can have a large container of green waste which holds twice the capacity or we can go for two containers of the same capacity of 12 to 15 liters. So that can also happen for the dry waste as well.

And regular washing of wet waste bins. So for the wet waste part that is the biodegradable part, we should regularly clean the container because otherwise it will smell or it will create unhealthy conditions and also sometimes we end up using plastic bags, you need to avoid cleaning this container everyday people put a plastic bag inside of them put waste on it, and then they carry this plastic back to the waste collector. So that is a very bad practice because you are include adding plastic bag into that particular waste bin.

So, it is better to use the container directly and wash it every day after the waste is being thrown away.

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Now, special waste including domestic hazardous waste, this has to be as we have said that it could be stored in wet containers, like as I was saying that in some municipal areas also green container is used for wet waste, blue for everything else, and hazardous waste can be taken up in red containers.

Now, primarily, we have to completely segregate and store special waste separately, but we have to carry this waste this waste is not collected in every municipal area or urban local body. So, in that case, we have to carry this waste to a special collection center or to a retail outlet where there is a special scheme going on for collection of this kind of waste like they are returning but you can return batteries over there or you can return some newspaper over there. So, those kinds of spatial schemes sometimes I run by some retail outlets, we have to either take our waste there, or our collection center can be set up by the municipal body or this you will be the rule is as per a for every 20 square kilometers there should be one domestic hazardous waste center.

So, we have to take our waste to that center and deliver it after that in times when you know this container gets filled. So, that is how we have to also handle this domestic hazardous waste. So, in addition to that, when we are talking about household level waste, that is our household level generators, there is also yard level waste or garden waste that is many houses have got gardens. So the we should try to treat it on site that means we can go for composting and all locally or we use large standard containers for storage and it could be collected by the municipal bodies after a certain interval.

So that means we also have if I do not want to do compost on my own garden or we want to use it at fertilizer in my own garden, then I can keep it stored in large containers and it will be collected by the municipality after certain intervals. But large gated communities and complexes where there are a lot of people staying together usually our internal door to door collection system of segregating is proposed that means the community should have their own door to door collection system and segregated waste has to be stored in community level bins.

So that means the community level bins should also be have separate containers for storing different kinds of waste which are segregated and bin designed now, because now we are dealing with not one household, we are dealing with many households, the size of this particular bins would be large, right? So it is not only large this because it is the size is much larger, it is typical for an individual human to lift it. So it would be lifted by mechanical means, right.

So, the vehicles which would be sent by the municipal body will probably have a lifting mechanism, which will lift this waste and then put it inside that waste to be put inside that particular vehicle. Now, that means if the container has to be lifted, that means it has to be

this container has to be a standard size or a standard design, because otherwise it cannot be lifted right. So, it obviously these are large size containers and they have to be of a certain standard design, then only they could be your where we can use a lifting mechanism.

So, typical design if it is a small complex or 12 households 60 litre tank, 60 litre bin is fine, we holds around 25 kilograms of garbage for 24 for a complex with 24 household, it could be 120 liter or say 50 kg bin for a 48 households 240 liter or 96 kg bin and so on. So, again we cannot keep on increasing the size of the container. So, in case there are more number of houses living in that particular complex, we have to go for multiples of this particular sizes.

So, we can have many of those particular wastes. So usually this kind of bins you will find that they are made of high density polyethylene HDPE and these are mostly made in such a manner so that these are durable and they are also tested and they are UV tested so that they are not you know they prevent infection and all this.

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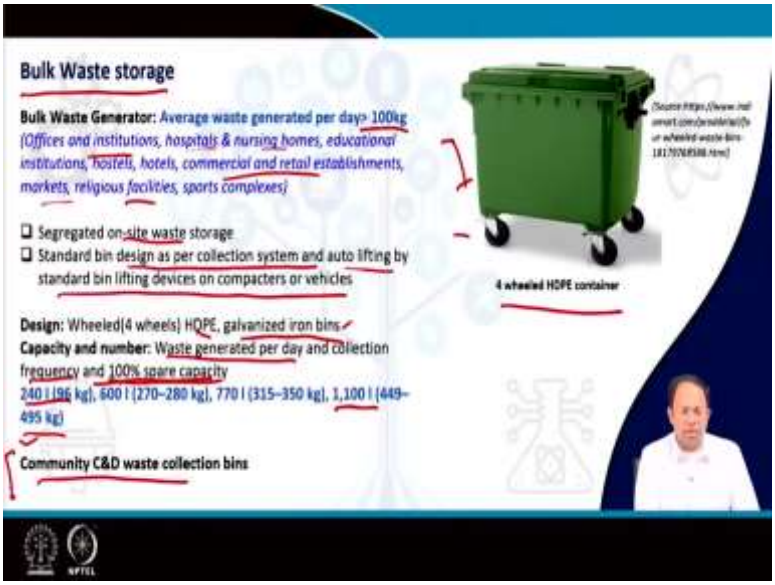


So as you can see that this is a 4 wheeled HDPE container so this kind of container if you will see in many kind of large complexes and also in case of bulk waste generators. So, what individual waste generators we can use smaller containers, but for bulk waste generators, who generate more than 100 kilograms of waste per day we have to obviously use larger containers.

So, this includes offices and institutions, hospitals and nursing homes. So, bulk waste generators could be any kind of, commercial or retail establishment or a market or religious

facility or a sports complex. So, these are all bulk waste generators, and we will have to put this kind of containers over there.

So, again, the containers could be of different colors based on what kind of segregation is done for that particular site, but, it is difficult to have different colors. So, we can put some signage's as well to say what kind of waste is holding and the standard bin designed as per the collection system and the auto lifting by standard bin lifting devices on compactors or vehicles.

So, again, these are bulk waste these are collected by the municipality using certain vehicles and using these vehicles have got certain lifting mechanism. So, our design should be such that our design of storage should be such that these are aligned with this kind of devices or this kind of vehicles, so, that we can easily transport the waste.

Again 4 wheeled HDPE containers and also galvanized iron bins, both are used. So, these are even larger than this HDPE containers and usually you will find that capacity is ranges from around 96 kilograms or 240 liters to around 100 liters or around 495 kilogram of waste. So, there are different sorry 1100 kilograms or 1100 liters or 500 kilograms of waste.

So, large like very large containers like this can be also utilized or small containers like this can be utilized. So, it depends on what kind of vehicle what kind of lifting mechanism is actually utilized and also in here also we go for 100 percent spare capacity.

So, first of all as per the collection frequency and the waste generated per day we determine what should be the size of the container and as per and also we should have 100 percent per capacity similar to residential waste storage systems. Then, along with this community C and D waste common construction and demolition waste collection is also done in similar kind of bins. And these are again separate bins could be kept for your construction waste as well.

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Now, coming to waste storage in public places, the rule is, we this storage containers are provided at a distance of 25 meter to 250 meter along streets as part the context, like very important streets we can are very, very busy streets we can have it at 25 meters, whereas, the streets are not that important or it is not that busy we can have it every 250 meters these are also provided at parks, markets, public places, transit areas, bus and railway stations, so that when people are walking along the street if they need to throw something they can throw it in this kind of garbage bins.

So, in this image, you can see that this is the two containers of one green color for wet waste and the for other waste papers and other kinds of material drivers. This is the blue color container this is our architecture department at Indian Institute of Technology, Kharagpur. So, we have this kind of two containers in front of our department.

Similarly, over here you can see in indoor dry and waste storage in a park is also is stored in this kind of container.

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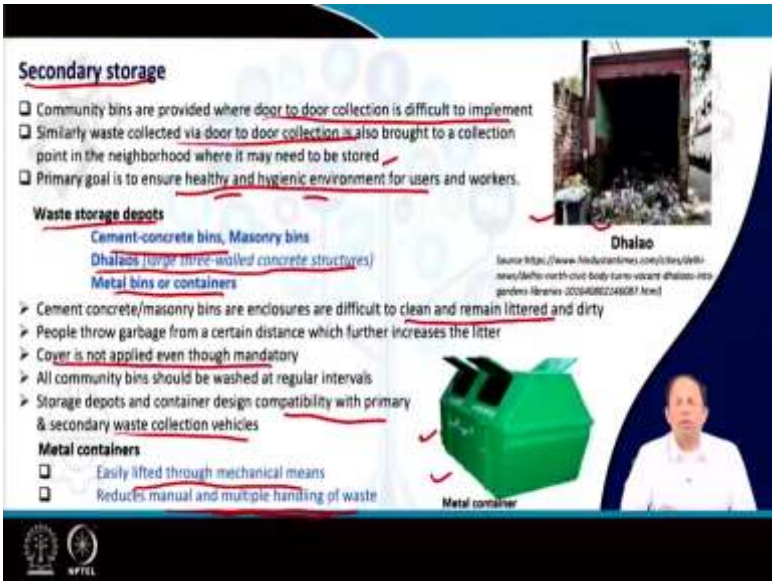


Now, once the waste is collected from your house by a vehicle by using any kind of collection mechanism, it is now brought to a secondary storage unit. So, that means once individual in door to door collection individual smaller wheel barrows or smaller vehicles can bring the waste to a collection point or which is known as a secondary storage and from there the waste is transported either to transfer station or to the final disposal point. So the recycling centers and so on.

So, this secondary storage is where more amount of waste from the locality of that particular area comes in. So, this is one kind of storage and the other is in some areas where there is no door to door collection system. We usually collect waste through community bins. So community bins are provided where door to door collection is difficult. And so that so those community bins also, every day people come walk a certain distance from their house, maybe 100 to 250 meters and 100 to 150 meters and then they throw their garbage in the community bin.

So, either this kind of community bins or this collection points in the neighborhood, where waste collected by door to door collection when it comes there, this kind of waste needs to be stored. So, that means either we store waste in the community bins or at this transfer points or this particular secondary storage points.

So, the primary goal when we are considering storage of this waste in the urban areas, the primary goal is to ensure healthy and hygienic environment for the users as well as the

workers. So, our community bin designed or our intermediate storage design or secondary storage design would be in such a way so that they are healthy and hygienic.

So, there are different kinds of designs for this kind of bins, or waste storage that is done. One is cement concrete bins, or it could be a masonry bins. So, it is just an enclosure made of cement concrete or it is a masonry enclosure, where you create this kind of small wall around a particular area and people throw garbage inside it, or it is also something known as a dhalaos or a large three walled concrete structure as shown in this particular picture. So, it is like a small room and people throw garbage inside and then there are metal bins or containers as you can see in this particular picture.

So, these are the three kinds of containers you see in this kind of situations where people throw their garbage. So, obviously, if cement concrete and masonry bins are enclosures, these are difficult to clean, and they remain littered and dirty most of the time, why? Because people throw garbage they do not want people do not want to go to the near to this particular area and they will keep on throwing the garbage to this particular enclosure or this kind of containers from a certain distance.

Now, when they do that, obviously, they will end up throwing the garbage which may fall in the in the enclosure or which may fall in the surrounding area, which causes additional litter and the next person who comes does not even go to till that distance throw it from even further. So, that keeps on increasing the area that gets littered right and it creates a very unhygienic and unhealthy or even aesthetically displeasing area environment.

So, in case of this kind of bins, like open bins and all because people are throwing garbage from a distance usually people do not put on the covers they are kept open, but by rule we are by law, we are we should have cover has to be applied which is mandatory. So that is one problem. And all community bins should be also washed at regular intervals, whatever material it is made of it should be washed and storage depots and container design should be compatible with primary and secondary waste collection vehicles.

So, that means as if we are storing waste, this kind of a metal container probably the it should be in such a way so that this could be lifted by a vehicle or a lorry and by the mechanism, that chain mechanism they have got they will fit the chain to this particular container they will lift it and they will put it on the lorry and then take it to the final disposal point. So, that means the design has to be compatible with those kinds of mechanisms.

So, metal containers are usually preferred in today's context, instead of this cement container concrete or masonry bins or dhalaos because these are easily lifted through mechanical means and also reduces manual and multiple handling of waste. That means you, like as you can see over here a lot of human agency is involved where they have to clean this area, they have to shift the garbage, but in case of metal containers, people throw the garbage inside they could be directly lifted by a lorry. So, people do not have to handle the garbage or to handle the waste.

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So, as you can see in this particular image, our primary collection vehicle that is this one this is a small auto rickshaw with us paper at the back. So, this is where it is collecting waste from door to door and then it is coming to a secondary storage and putting this garbage inside this particular container by via this tilting mechanism. So, the primary collection has to be designed in such a way so that this treating is possible or the design of the metal container should be such so that when the vehicle comes and fills in the garbage will be easily transferred to this particular metal container.

Similarly, from secondary storage to compact that means after the waste is stored in this particular secondary storage container, then it needs to be put up into this compactor vehicle which will take the garbage to the landfill site. So, over here also you see the garbage is, this bin is lifted and the design of this bin should be such that this lifting is done very, very easily. So this is what has to be considered when we design this secondary storage.

So, typical design is something around 1100 litre capacity for 4 wheeled bins or containers, they are lifted through using this compactor units like over here are 3000 to 7000 litre capacity metal containers. So, these are much larger in size, these are lifted using dumper places system like in the earlier one the container that we showed it is we pit hooks and chains to this particular or we can use the lifting mechanism attached with the truck and we can lift the particular container and it could be used by this dumper placer system or sometimes even a hook lift container of 8 cubic meter or larger which are multipurpose bulk waste containers which we can use this hook lift mechanism also to lift the waste. So, these are different designs of waste containers for secondary storage which could be adopted as per the requirement or as per the collection mechanisms of that particular area.

So, in case of secondary storage, earlier we were talking about 100 percent spare capacity, because it was a residential area or a bulk generator. So, it is fine, but in case of secondary storage, where waste from many areas come there the chance of more amount of waste being stored is higher right in case of some area waste is not collected. So, we need to have more extra excess capacity. So, error 200 percent of average daily expected waste storage is actually taken as the spare capacity. So, that means, normal average daily expected waste storage requirement, we take double of that and that is the capacity that we design for this kind of secondary storage system.

Maintenance wise cleaning at least once a month painting at least once a year to prevent corrosion particularly for metal, metal containers and replacement of broken parts as part requirements. And periodic inspection of depot flooring screen walls every three months. So, secondary storage is not only the container, but also the area which is where the container is placed or that enclosure where garbage is being thrown. So, they are also periodic inspection of the floors, screens, walls all these are also conducted every three months.

And secondary storage of street sweeping for silt from drains for that also we have to provide separate storage containers where this waste from or this silt from drains which are once drained cleaning is done the silt and lifted and put on the side of the road. So this could be collected by our waste collectors and they could be also stored in some separate containers.

Why separate containers, because this kind of waste is can contain a lot of pathogens because it may contain some about the sewage. And it is better not to mix this waste with the other waste because those may be going to a composting plant or they may be going to some recycling facility. So it is better to keep this waste separate.

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Now, coming to two case studies, the first case study we will talk about compactor units in Kolkata. So, in this image you can see this is one compactor unit, it is just a storage container with this arm, where people can come with wheelbarrows, and they can tilt the wheelbarrow into this particular arm and this particular mechanism where the garbage is stored and this is lifted and put directly inside the compactor, then the compactor, some units of this contractors are stored in this particular enclosure and as per the space available and all the competitor sizes could be determined.

So the number of competitors that are utilized is like always wants to be there at site. So that whatever vehicles are bringing garbage could directly delivered the garbage into this compactor, another one can be in the transport that is it has been carried over to the disposal site and one could be spare capacity. So in that way we can design the number of compactor units in a particular secondary storage collection point, secondary storage point.

So this project in Kolkata was taken up during the year 2012 by Kolkata Municipal Corporation under the Kolkata environmental improvement project, which was funded by ADB and this improved this project improved the collection efficiency and the transportation as well. Because these are covered containers, there is no spillage of waste and so on. And also as you can see that it is seamless transfer of the primary collection, primary waste that is collected by a primary collection it is seamlessly transported put inside this container and then this container this compactor have been transported via lorries and so on. And these compactors are fitted with hook loaders so that using these hooks these are lifted into the lorries and all or the transport vehicles.

So, in Kolkata 78 sites were selected under the JNNURM program. And this based on the available space and waste generated in the service area, custom designs were created for this compactors and then the compactors were ordered and then they were they were developed a deep cut mechanism for manual feeding like over here the cart is being tipped. This is the mechanism is there where you can put in garbage, wheelbarrow feeding and one to two meter cube auto tippers. Could be also utilize that instead of wheelbarrow also, we can use this automatic the vehicle with auto tipping mechanism like we showed one example in the previous slide, where the back portion tips automatically so these are compatible with both kind of designs.

Enables transportation of waste in close containers. Littering is stopped at secondary storage site, allows night transportation because in the morning all this way these are collected and in the evening. Because we do not require any kind of manpower, just the vehicle comes in use the hook lifts to lift this particular compactor and transport it. A seamless integration with primary collection system as we can see over here designed as per available area, training and capacity building of the staff to operate this kind of mechanism.

So, this is a very successful case of secondary storage. And of course, you know the collection system for this particular in Kolkata.

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Then coming to the case study of Indore, Indore is the cleanest city in India. And the reason for it is they do very general proper segregation of waste at source. Now initially, in this particular city, it was a two bin system where biodegradable waste was kept in green and

non-biodegradable waste was kept in blue. And this is as per Swacch Bharat mission rules and all. And then in 2017, what they did was they started, they found that people are, following these rules, they are putting waste, they are doing proper segregation and all. So they thought that why do not we take this further, right.

So they suggested further segregation of this non-biodegradable waste into sanitary and hazardous waste. And this was done as per the Swacch Survekshan toolkit. So this was some, policy document which came out, which suggested for getting some sort of points for this kind of system, you need to, you know, even segregate sanitary waste and hazardous waste.

So that is why the university the USP, also introduced this kind of a system. So this was to this was even accepted by the public. And of course, there is a lot of awareness campaigns that was taken up trust building sessions. And also they did some, so these are like the positive. These are the positive steps that they have taken, or they have these are the steps which actually helps encourage people to do segregation further, but they also had some deterrents as well.

For example, this unsegregated waste was not collected. That is that is the deterrents, that is if you do not segregate it, we will not collect your waste. So that is why people were made to segregate waste. So some on their own, they have done it people who do not wish to do it, they were made to do it by making this mandatory. So, over here you can see that the current segregation practice in Indore is to have biodegradable waste, non-biodegradable waste, which excludes plastic then plastic waste in separate container, sanitary waste, domestic hazardous waste and E waste. So, these are all separate waste these are being collected by the municipality.

And if you remember from our earlier lecture, we have talked about the case of Goa Panaji as well. So, there are also a lot of segregation is being done, but this is done over here in the collection stage itself this kind of segregation is in the primary collection stage itself, Indore is doing this kind of segregation. And because of this segregation, this enables further waste processing and resource recovery. And you can see this particular primary collection vehicle where biodegradable, non-biodegradable, domestic hazardous, electronic and sanitary waste is collected in different containers green for biodegradable, blue for non-biodegradable, this black is for domestic hazardous waste, blue is for E waste and yellow is for sanitary waste.

So, this is how they have designed this system. So, in addition, litter bins were placed all across the city which is blue and green colored litter bins. So that we have shown in public places we need to have these two colored containers at certain intervals. And during the pandemic, they introduce a new yellow bin for mask and glove recovery. So, in addition to the blue and green, they introduce a new yellow bin where people can throw their masks and gloves which are hazardous. So, this is not sanitary waste, we use the yellow color and accordingly this bin was introduced.

So, over here door to door collection system is employed when garbage is less than 50 kilograms. And for the rest bulk waste generators a separate system is being followed, that means door to door collection is done by primary collection system. And this is for generator who generate less than 50 kilograms of garbage per day. For other generators we hear, instead of 100, we are considering 50 for bulk waste generators, they are proposing a separate system for collection.

So overall, if you can see there using different kinds of containers, different kinds of storage mechanisms for different categories of waste, and every ULB is different as per the as per the vision of the particular ULB as per the recycling, this contracts or the recycling arrangements that they have got with different recyclers or, other agencies different ULBs determine what sort of segregation it should be done. And accordingly for that kind of segregated waste, we have to also provide storage containers.

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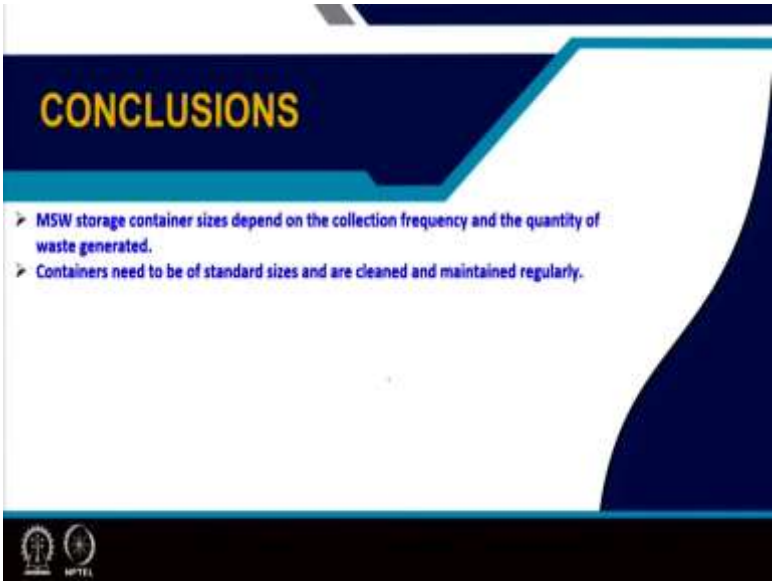


So, these are some of the references you can study. So, to conclude, MSW storage container sizes depend on the collection frequency and the quantity of waste generated and containers need to be of standard sizes and are cleaned and maintained regularly. Thank you.