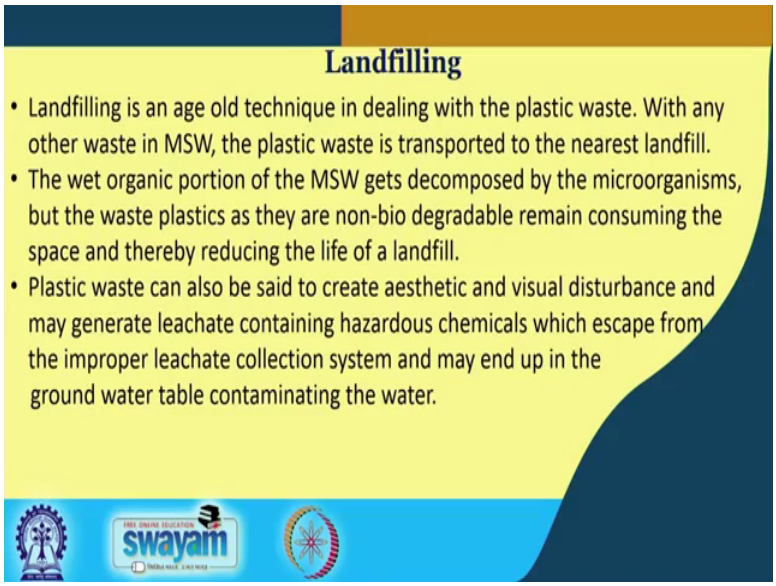
Plastic Waste Management
Prof. Brajesh Kumar Dubey
Department of Civil Engineering
Indian Institute of Technology, Kharagpur

Lecture – 29
Plastic Waste Management - Landfilling, Other Applications

So, welcome back. So, we will continue our discussion on Plastic Waste Management issue which is the kind of the topic for this particular week where we are looking at different plastic waste management options, different technologies, different methods. So, if you remember in the previous 3 videos for this week that we have already we have gone through we looked at the recycling aspect the mechanical recycling and also recycling of the source material.

And then, we also looked at waste to energy aspect we looked at the plasma gasification, pyrolysis. So, all those the different ways in which this plastic waste can be managed. So, if you cannot do any sorts of treatment say if you cannot have cannot do plasma pyrolysis, you cannot do waste to in plasma gasification, you cannot do incineration waste to energy or cannot be recycled for some reason then one of the option left is which is the least favored option is to go for land filling.

(Refer Slide Time: 01:21)



So, land filling we do not want to do land filling, but say if there is no other option left. So, if rather than letting the garbage scattered around let it letting the plastic being

littered we put it in a secure environment and land filling is not the dump sites that we see in India, its the land filling is essentially an engineered structure where you put some control in terms of the leachate treatment leachate collection and treatment as well as the gas collection.

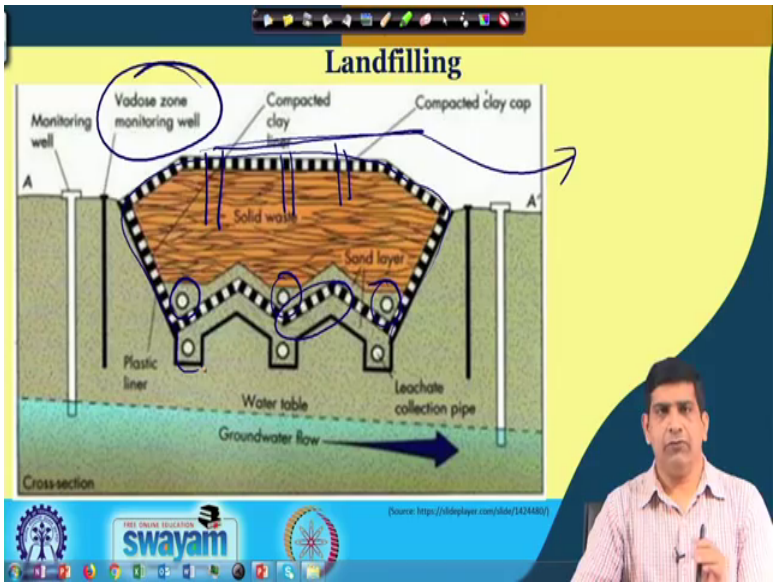
So, that is a its so, essentially it kind of you are trying to put your unrecyclable, non-recyclables, non-treatable plastic waste into the landfill and to put it in a secure environment. So, that the adverse impact from these plastic wastes is minimized. So, that is the whole goal here. So, landfilling is a very old technique it has been used for many many years and its with its used for municipal solid waste. It is also used for hazardous waste as well we have hazardous waste landfill. So, plastic waste essentially will come as part of the municipal solid waste. So, whenever we have this plastic waste its essentially if its a part of municipal solid waste.

And its so, what if you cannot do any treatment or any you cannot treat the plastic you cannot do the waste to energy then you take the waste to nearest landfill. And were that if you in the landfill what happens is there are since its a its a mixture of waste you will have some weight organic waste, you will have some dry waste. So, weight organic portion they do decompose, but this waste plastic since they are non-biodegradable they remain consuming this space and thereby reducing the life of landfill.

So, that is why land filling of plastic waste is a kind of very least preferred option. We do not want to put plastic waste in a landfill, but if there is no other option at least it helps in securing the likely; we can put it in we can reduce the adverse impact from coming out from this plastic waste.

Because, they create problem in terms of aesthetics, they create problem in terms of the visual there disturbance and it can also in a landfill scenario; once this plastic gets broken down into micro plastic it can go through the leachate collection system. And then it can go also go to the groundwater table contaminating the water because the leachate treatment systems are not designed to remove these micro plastics. So, as we talked about micro plastics earlier they are very tiny plastics and then they may just get through the leachate collection system. So, that is a that becomes a problem; so, that is why again landfilling is an option, but not a preferred option.

(Refer Slide Time: 04:23)



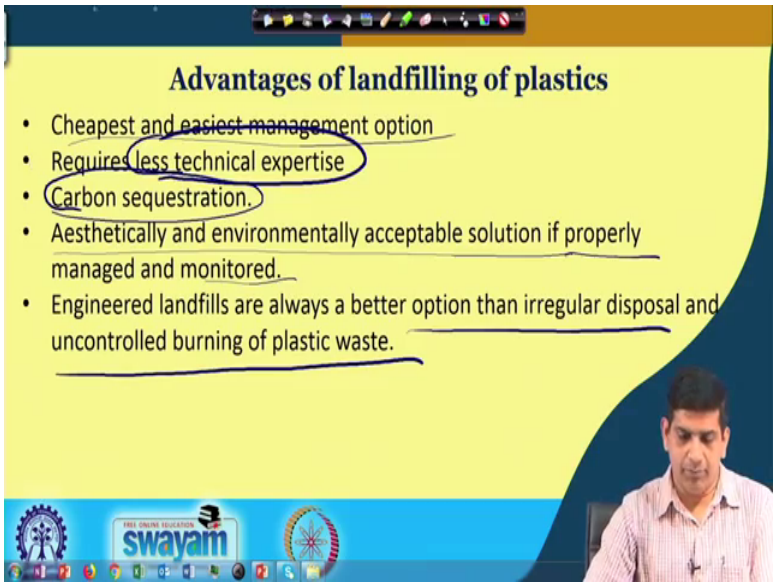
So, this is a typical landfill how it looks like and so, this you have a liner system at the bottom. So, you have this is your liner system where you have clay cape you have a compacted clay or combined compacted clay in association with the geomembrane. So, you have these liner system at the bottom on top of liner we have the leachate collection pipes which will collect those leachate. And so, then you have this plastic liner then you also have a clay and all around it we do monitoring wells where you look at how much you, if there is any contamination and leachate will be collected and taken out for the leachate collection.

And you also have the gas collection system which is not shown here. So, you will have a several gas collection pipes gas collection wells is drilled in here which will collect the gas. And then there will be a main header pipe which will take this gas out and can be used for energy and other sources. So, as you can see from the sketch landfill municipal solid waste landfill which we talked in great detail in our waste management course which again will be offered reoffer like a rerun in July so, but it is essentially like a huge polythene bag. So, it is a HDPE is your poly is your polythene there its your high density polyethylene. So, you can think about this like a huge as you can see this liner all around.

So, this is like a huge polythene bag which you have and you are putting garbage in there and you are trying to control the adverse impact coming out from those from those garbage. So, that is in terms of how the landfill works, again landfilling for plastic is the

least option. The number 1; is we say we try to recycle the plastic, if we cannot recycle because if its mixed can we cannot put it in a recycling system. Next we try to do is waste to energy resource recovery and all those we do not really want to put our plastics in the landfill. But, sometimes when you do not have any other option you have to kind of go for putting plastic in a landfill, landfill environment which sometimes its inevitable and you go for that.

(Refer Slide Time: 06:53)

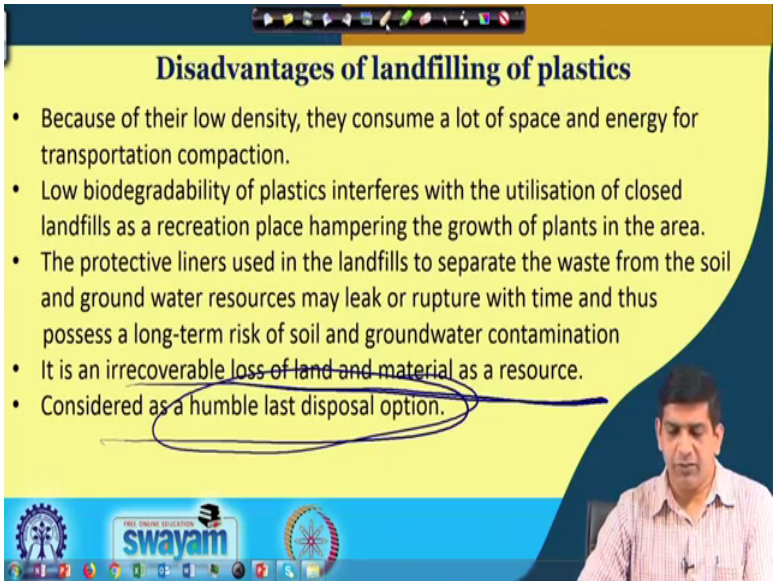


So, in terms of pros and cons we kind of talked about that its a cheapest and easiest management option. Now, requires less technical expertise because you just put the garbage in there you are not literally doing much, so, less technical expertise cheapest. So, that is how many times it gets used; it you are putting carbon in there and so, you can capture you can control the carbon getting out from there. So, you it is kind of part of the carbon sequestration you can think about that which is essentially carbon sequestration means that you are not letting carbon go to the atmosphere.

So, that is the whole point of carbon sequestration. It is an in aesthetically and environmentally its acceptable solution if it is properly managed and monitored. So, again landfill is used only when we do not have any other option left. So, that is the place where we use landfill especially for plastic waste. Engineered landfills are a better option than uncontrolled dumping and burning of plastic waste. So, that at least you are

controlling the environmental impact. So, that is the good part of land filling up like, if you do not have treatment options you can landfill this plastic.

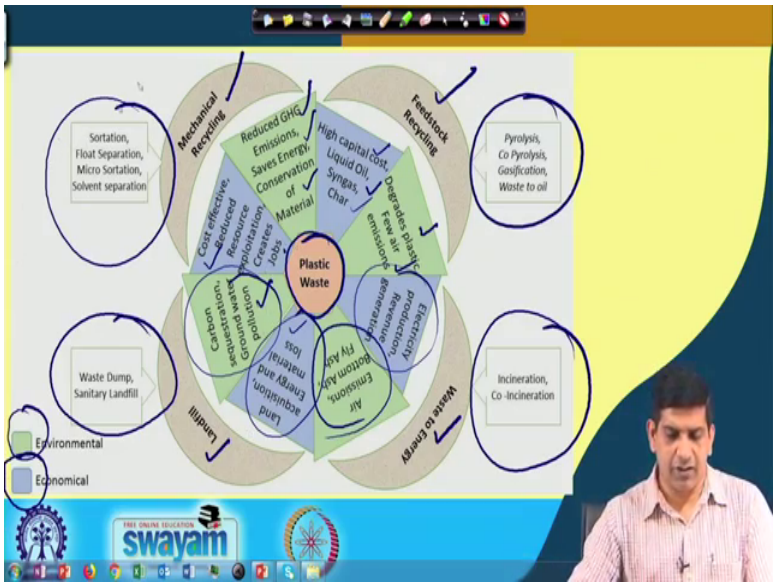
(Refer Slide Time: 08:07)



Disadvantage it is a its low density material, they contain a lot of space, a lot of energy for transportation compaction. Low biodegradability essentially there is hardly any biodegradability of plastic plastics zone biodegrade much easier. Bio plastics are there which will biodegrade, but most of traditional plastics they are designed to be non-biodegradable. So, they interfere with the close utilization of close landfills in terms of creating a recreation space. They also sometimes hamper the growth of plants in the area. The protective line are used in the landfill separate waste from the soil and groundwater resource may leak or rupture and future we do not know.

In that case we can have this micro plastics getting into the groundwater and I can lead to some soil and groundwater contamination and future and its a loss of land. Because, once you go for a landfill you are essentially losing that land and material as a resource. So, its a last disposal option. So, if you when you do not have any other options out there then it is a last disposal option with because, its at least helps in controlling the environmental impact. So, that is the good part of landfilling.

(Refer Slide Time: 09:21)



So, in so, if you look at the management options. So, this is we try to put together this chart to give you a kind of a big picture of what we are have discussed in this week so, far; so kind of a summary. So, we will try to go through this and it kind of recap this will be like a recap for you what you have done in last, what you have heard and read about in last three and half videos.

So, here mechanical recycling which we talked about and feedstock recycling, waste to energy, landfill and these to recycling with that is we were looking at. So, when we say mechanical recycling what we are doing essentially sorting, float separation, micro sought micro sorting, solvent separation using some solvent we are trying to separate different chemicals out there.

For land filling dump sites, sanitary landfill those are the place; here for feedstock pyrolysis, co-pyrolysis, gasification, waste to oil, waste to energy so, that is what we are talking about. Waste to energy incineration and co-incineration those are kind of waste of energy. So, here if you look at we have tried to have a 2 color coding here; one is the light green and that is the light blue.

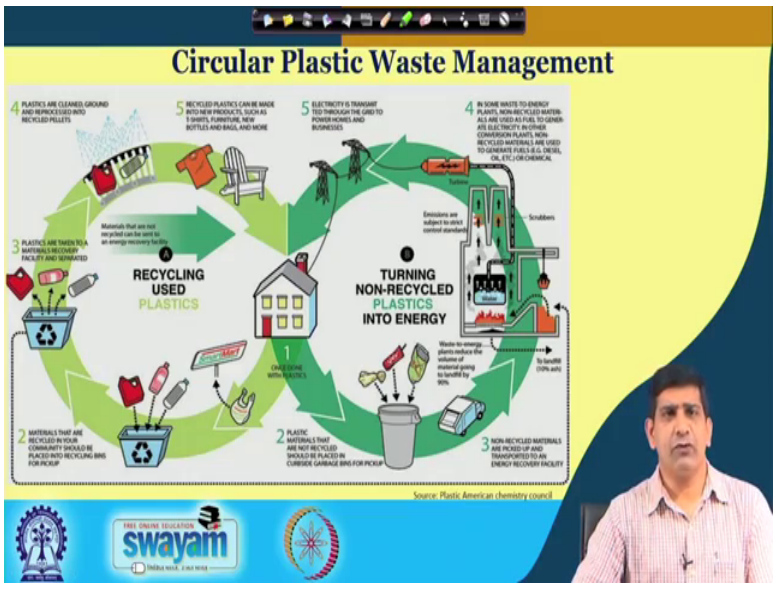
So, the light green one is the environmental factors, light blue is the economic factors. So, for each one of these categories we try to put these two factors there. So, if you look at the mechanical recycling its reduces greenhouse gas, saves energy, conservation or materials it is in from an environmental point of view the benefits.

Cost effective, reduced resource exploitation, create jobs that is the from an economic point of view. Similarly, for feedstock recycling degradable degrades plastic, few air emissions; high capital cost, liquid oil, syngas and char which can be used as a resource. Waste to energy electricity produced we can do the revenue generation, environmental issues air emissions bottom ash and fly ash management.

So, we have to kind of focus on that; for land filling land acquisition or is always an issue energy and material loss. And in the positive side in this kind of carbon sequestration it prevents it on water pollution. So, that is kind of (Refer Time: 11:47). So, let us say kind of a big picture if you like I just try to understand in a summary of course, we give end into detail for many of those aspects.

But, if you think of an summary for plastic waste management so, these are the some of these are the methods these are the most common ways of managing plastic today for a good portion of plastic. There are some other applications which we will talk about after this. So, there are some other applications of plastic, some innovative way people are coming up to putting those plastics in different products or different kind of applications. And we will see some of those in this week as well so, but this is kind I thought I will just put a summary there. So, that you can have a good idea of what we talked about and it will kind of recap for you for from the previous material.

(Refer Slide Time: 12:39)



There is also a concept of circular plastic waste management. Now circular economy, circular plastic waste we will talk more in detail about circular economy and circular plastic waste management in the last week which is the week 8. But, since we are talking about plastic waste management; we thought I will just give you a very quick kind of summary of what really we mean in terms of circular economy when we talked about plastic waste management. So, in terms of plastic waste as you know you will have you have ones plastic leaves home, once done with plastic and leaves home, plastic material that are not recycled should be placed in curbside garbage for pickup.

So, you put it over there in the curbside garbage you have this plastic material, then non-recycled material are picked up and transported to an energy recovery facility. It goes to waste to energy plant where the energy is generated and you get the energy in some waste to energy plants non-recyclable material are used as a fuel to generate electricity. In other conversion plants non-recycle material are used to generate fuels that is diesel or etcetera or chemical. So, either it could be fuel or it could be directly using it the heat and from the calorific value and going for an energy. So, and then it goes to the grid and from the grid you get the energy to the house. So, this is turning non-recycled plastic into energy.

So, that is enough that is one way of where you try to do the waste into energy and the emissions are subject to strict controls and that is for energy. But, if you are trying to go for recycling again you have the plastic; it goes into the material collected. Plastics are taken for your material recycling facility, gets converted into grounded clean grounded processed and recycle pallets, from pallets making of new product. And material that are not recycle can be sent to energy recovery facility so and that is; so, that is one way where we are the we are getting the plastic in.

And we are trying to just use it in different fashion under like a group of industries and that is how we are trying to get energy out of that we are trying to recover resource out of that. And we that is kind of the concept of where you are trying to bring the plastic back into their plastic waste back into the economy that is the whole concept of circular economy and which we will talk more detail in the last week. But, this is a concept just an example of how circular economy concept can be used for plastic waste management.

(Refer Slide Time: 15:33)

So, there are some other examples of plastic users we will go over that little quicker this plus these houses are made with blocks made from waste plastic. So, this was done concepts Plasticos in Colombia. So, they took plastic and then made blocks and those blocks have kind of a layer of cement and other stuff on top to prevent as it to give a fire proofing. And then they are used in houses and they are pretty is strong they do meet like a sometimes the brick standard.

So, because we ourself we had a masters student couple of years back like around a year back and he did he took plastic and he we compressed it made a small bricks of those plastic. And then we tested traditional plastic the traditional bricks with this take plastic bricks and we saw that the does able to attend at least the level of a strength that it for the single historic building for a boundary wall, for even let us say purity post and all that it can be used it can be used in those applications.

(Refer Slide Time: 16:51)

Recycle plastic is used in paving stones, these paving stones are solid and cheaper and typically. And then typical paving slabs so, its available its it is being used.

(Refer Slide Time: 17:03)

(Refer Slide Time: 17:37)

(Refer Slide Time: 17:43)

Then let us see here you see an example of where the recycled plastic was used in building home. So, this is a BBC small report; so, I want you to watch this report and again I will keep quiet to you can listen to that report.

(Refer Slide Time: 17:51)

And that is how you will see that how the plastic is used in this particular structure which you see right in this particular slide.

(Refer Slide Time: 17:57)

So, let us look at this a small video and then we will talk about that.

(Refer Slide Time: 18:03)

(Refer Slide Time: 18:07)

(Refer Slide Time: 18:11)

(Refer Slide Time: 18:19)

[FL] bedroom, kitchen [FL] plastic [FL] waste plastic [FL]. Recycling of plastic; obviously, is wonderful business opportunity.

(Refer Slide Time: 18:25)

First thing as you know plastic cannot be stopped.

(Refer Slide Time: 18:29)

(Refer Slide Time: 18:31)

So, either we have to reuse or it will go to landfill.

(Refer Slide Time: 18:37)

(Refer Slide Time: 18:43)

(Refer Slide Time: 18:47)

(Refer Slide Time: 18:55)

(Refer Slide Time: 18:59)

(Refer Slide Time: 19:03)

(Refer Slide Time: 19:07)

(Refer Slide Time: 19:13)

(Refer Slide Time: 19:19)

So, as you saw that this was this house is not a simple like a brick and mortar house, it is all made from plastics, plastic bags which was and plastic were sorted out as you saw by the rag pickers they were sorting it out. And then it gets compressed and made into these plastic bricks. One of the if you watched it carefully you also saw that although it meets this standard, it meets the strength requirement.

But, many times people are not ready to take it because the consumers are always worried about new stuff. So, they are also worried about what is the kind of what could

potentially be the negative aspect of this plastic home. And then but the other place where the gentleman whose the entrepreneur here is trying to make more like cells or more business is with the plastic tiles.

So, that is where the tiles as mentioned it is a less than a dollar. So, its you can look at maybe around 65 60 65 rupees per tile so, that is the price. So, it so, it has again it anything whenever you go for newer material newer stuff there has to be competitive. So, one thing this video was also talking about that if you go for a plastic house will you make a plastic house, it comes out to be costlier then regular house. So, and then people are people have a skepticism for plastic house at the first place and then if it comes out to be costlier than regular house. Then obviously, people will say that why should I go to for a regular house, why should why should like I not go for a regular house.

Why should I go for a plastic house it is cost me more and I have lot of uncertainty associated with that. So, that is why these things are struggle some time, but again things do move slowly and it will get done. So, these are so, the initiative which is happening in different places of the world including in India.

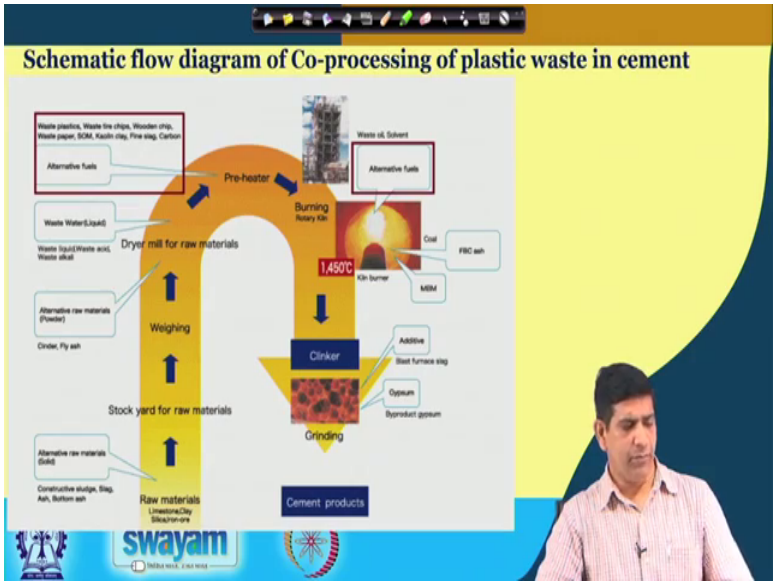
(Refer Slide Time: 21:29)

So, then co processing of plastic waste in cement kiln again that is happening for quite some years. It is you put it in alternative fuel and raw material in terms of in cement kiln, its simulates what does this have substitutes primary fuel and raw material by waste. One

of the advantage of recovery method of used in existing facilities eliminating the need to invest on other plastic waste practices and secure tend to secure landfilling.

So, you can use that as a fuel. So, that is as long as we can separate it up. So, different feed points are there, it can be the main burner of the rotary kiln, it could be rotary kiln inlet, it will be a pre-calciner, it will be mid kiln for a long and dry wet kiln. So, they are there are different places where this plastic waste can be fed and used as an energy source in these in co-processing of plastic waste in the cement kiln.

(Refer Slide Time: 22:27)



So, if you look at a flow diagram how things are done for plastic waste in cement; if you start from beginning you have the raw material limestone clay, silica and iron ore. So, you have a stockyard for raw material then you weight, then you have a dryer mill for the waste for the raw material, your-pre heater, burning, kiln burner clinker and then finally, grinding. So, that is how the whole process what the whole process works. So, you have alternative raw material in solid. Then you have alternative raw material in powder, you have flood like a you have cinders in fly ash.

Then you have waste water liquid waste liquid added, we have alternative fuels in the heater could be waste plastic waste chips wooden chips where the paper kaolin clay, fine slag, carbon and all that. So, that is you can have some preheating then burning which is then 14 or 1450 degree centigrade. Then you have say clinker and then you have like after clinker you have this grinding and you get the material in terms of gypsum or other

things that is being formed. So, this is a flow diagram for co-processing of the plastic waste in cement and that is how it is done.

(Refer Slide Time: 23:53)

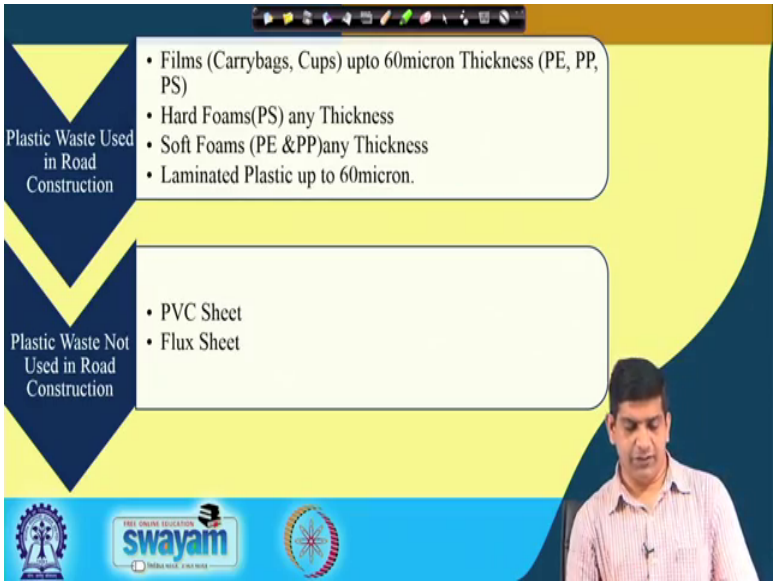
So, use of plastic waste in roads are also is quite popular nowadays; use of plastic in roads. The road construction uses was plastic popularly known as the plastic roads or they are found to perform better compared to those constructed with conventional bitumen. So, plastic roads mainly users carry bags, disposable cups and PET bottles that are collected from garbage dumps as an important ingredient for the construction material. Say if you look at this the other than the plastic carry bag the disposable cups and to some extent disposable come the PET bottles are easily recyclable.

So, there is a right competition of PET bottle going to the recyclables or going to the roads. So, that we need to kind of make a decision on that as a country. So, let us say its ingredient important ingredient of the construction material because, the plastic roads. When mixed with hot bitumen plastic melt to form an oily coat over the aggregate and the mixture is laid on the road surface like a normal or tar road. So, that is what its looks like.

(Refer Slide Time: 25:07)

So, why use plastic in road construction? It is durable, corrosion resistance; it is a good binder, economical make sense to do it, its longer life, maintenance free use a protection protect processing installation, lightweight improves aggregate impact value, increases melting point of bitumen. So, those things why it helps in terms of bitumen construction like road construction.

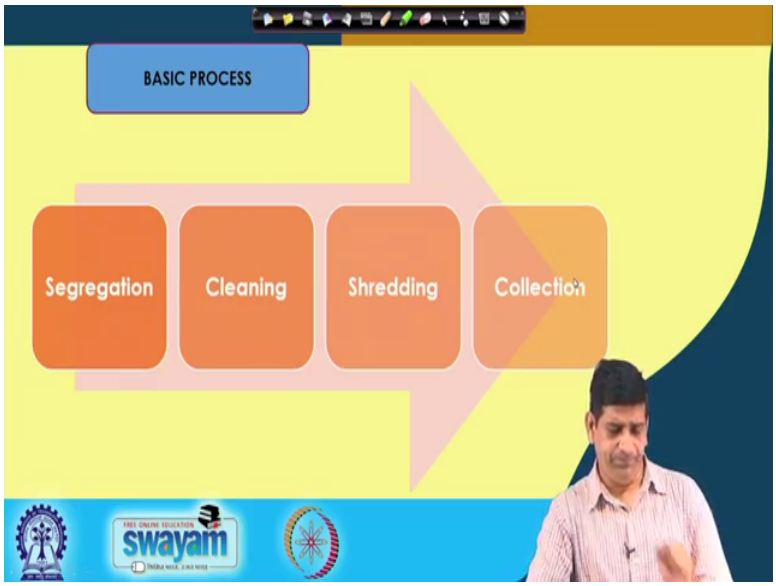
(Refer Slide Time: 25:31)



So, plastic waste used in road construction there are films, carry bags up to 60 micron, thickness 60 micron thickness; you have poly a polyethylene, polypropylene,

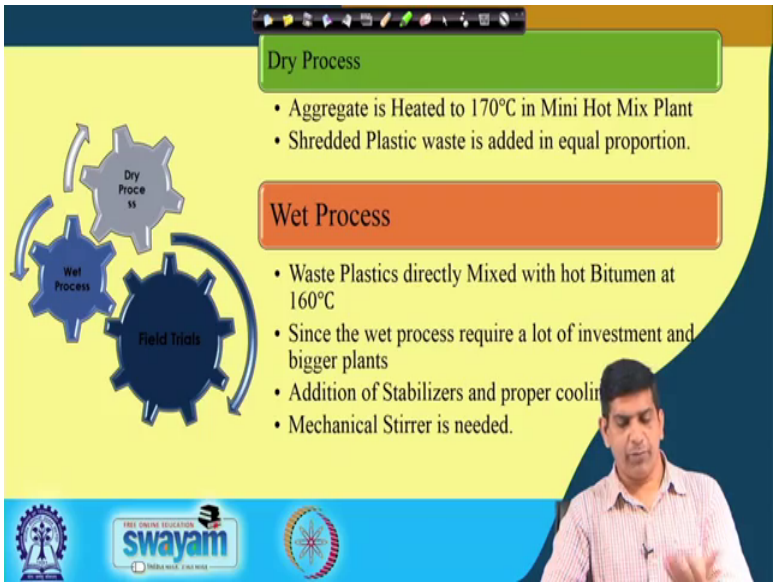
polystyrene. Hard forms of any thickness, soft forms of any thickness, limited plastic cups up to 60 micro. So, these are the one which can be used in road construction; what cannot be used is PVC sheet and flux sheets. So, those two cannot be used in road construction.

(Refer Slide Time: 26:05)



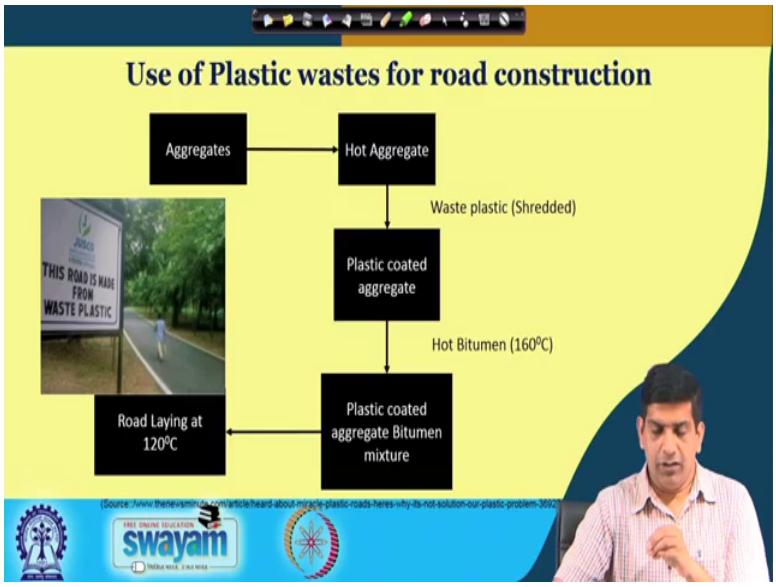
So, once you have the basic process here is you segregated you clean it, you shred it and then you collect it.

(Refer Slide Time: 26:15)



After collecting you go through the dry process and the wet process. Dry process is aggregate is heated to 170 degree centigrade in many hot plant. Shredded plastic waste is added in equal proportion. In the wet process a waste plastic is directly mixed with hot bitumen and at 160 degree centigrade. Since the wet process requires a lot of investment in hardware plants so, we are focusing on dry part only. So, then there is an additional stabilizer, proper cooling, system pathetically stabilizer is needed and all that.

(Refer Slide Time: 26:47)



So, its the dry process which is more popular and which you will see mostly used. So, in terms of dry process plastic when we go for the road construction you have aggregates, hot aggregate, plastic coated aggregate, plastic coated aggregate bitumen mixture. So, and the road length is typically done at the range typical range of 120, 140, 150 degree centigrade. So, overall this is how plastic waste is used in road. So, we will talk more about that in the coming video. So, far so, this so, we have been focusing on plastic waste management different aspects, so, we looked at traditional ways of different ways of managing plastic waste.

Now, this in this last video which will be after in the after this will we have the last video. And there the focus will be that how it is being used outside landfill, outside a recycling stream what are the things that are being done to make plastic waste management more competitive. Like a been getting the informal and formal sectors kind of a good interaction in terms of making this plastic waste management a great success.

So, with those kind of discussion let us stop here and we will continue this discussion of plastic waste in roads. And some other issues in the last video which will be the last video for next video which is will be the last video for this particular week which is week 6.

So, thank you enjoy watching and I hope if you have any questions please do not hesitate to put on the discussion form.

Thank you.