Safety in Construction
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Module No # 02
Lecture No # 10
Full Hazard in Demolition Works

The next topic wherein fall hazard is very high, that topic is primarily demolition.

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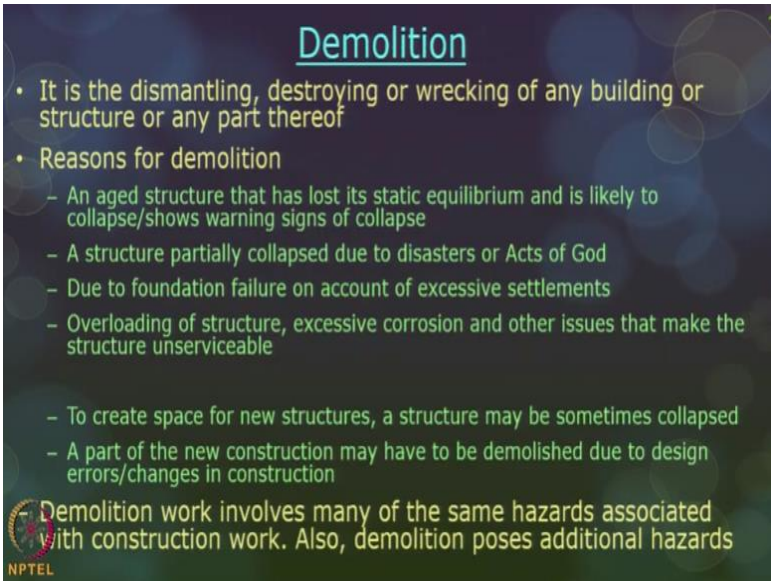

So, demolition also works in the same way like construction but in the reverse process. The only difference between actual construction and demolition is exactly in the reverse like a construction in terms of the sequence of operations. But demolition has the same hazard as with the original construction. And also, demolition has additional hazards also in apart from construction that should be you know understood.

Now what is demolition? Now we will start discussing about demolition and the hazards here demolition is the dismantling destroying or wrecking of any building or structure or any part. The reasons can be any age structure that has lost its equilibrium then you and it shows early signs of collapse. Then has to be demolished or a structure is partially collapsed due to any disaster or acts of god then it has to be demolished.

Or may be for want of space which is the last reason a structure may sometimes be demolished. Sometimes a wrong foundation design or failure in excessive settlement of the foundation and a structure is not suitable for its lifecycle. Then the structure has to be demolished. Overloading of structure, excessive corrosion are other issues which makes the structure unserviceable. For all these reasons a structure has to be demolished.

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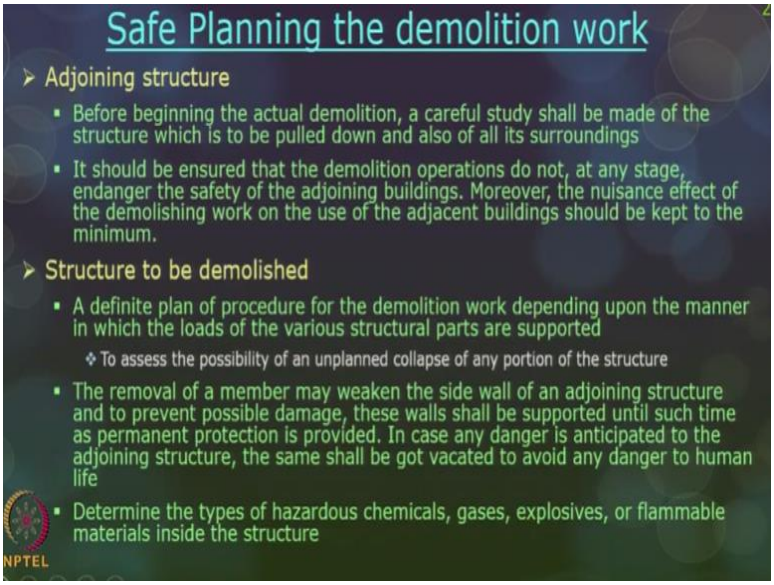

Now how do you start with the demolition? So safe planning on the demolition work, so whenever you want to start the demolition work it is not that you go to the site and start collapsing the whole structure. It is not done in that way first the area has to be studied ok. The adjacent structure in and around building which has to be collapsed has to be first analyzed so when you talk about the adjoining structure.

So, before the starting with the actual demolition so all the adjoining structure has to be first seen their foundations, their stability and how far this structure to be demolished is in line with the other structure? Everything has to be analyzed and then because the method of demolition also should not be affecting the adjacent structures. So, all those should be first cross checked. And also suppose if there is a hospital close by and so on.

Then the nuisance effect of the demolition also should not be affecting the neighbouring structure. And all these should be kept as low as possible so these all should be kept in mind. So, the adjacent structure and the area around the structure to be demolished first as to be thoroughly

studied. Then the actual structure to be demolished also has to be thoroughly studied why? Because that can be hazardous substances inside the structure or the structure can be partially collapsed.

So, the stability of the structure the way with which the structure is in place and so all these has to be first thoroughly analyzed. Because the method of demolition all depends on the actual structure. So indefinite plan of procedure for the demolition work depending on the manner in which the loads of the various structural parts are supported all has to be studied. To access the possibility of an unplanned collapse of any portion of the structure when the demolition happens all should be ascertained.

And wherever possible if there is a side wall of the adjoining structure then you should be thinking of the way to remove the member. So, all these should be thought of and permanent protection is really provided. When in case of an unexpected collapses in case any dangerous anticipated to the adjoining structure then you have to vacate the structure. In order to you know protect the life of the people who are occupying inside.

And also, you have to determine the types of hazardous chemicals any gases explosives of flammable materials inside the structure before you think of demolition. So those all has to be assessed first, safe precautions before the demolition work. And as usual, danger signs should be conspicuously posted all around the structure. The area should be barricaded and no entry of children, public should happen.

And also, any worker except the actual worker required for demolition work should be allowed inside the barricaded area.

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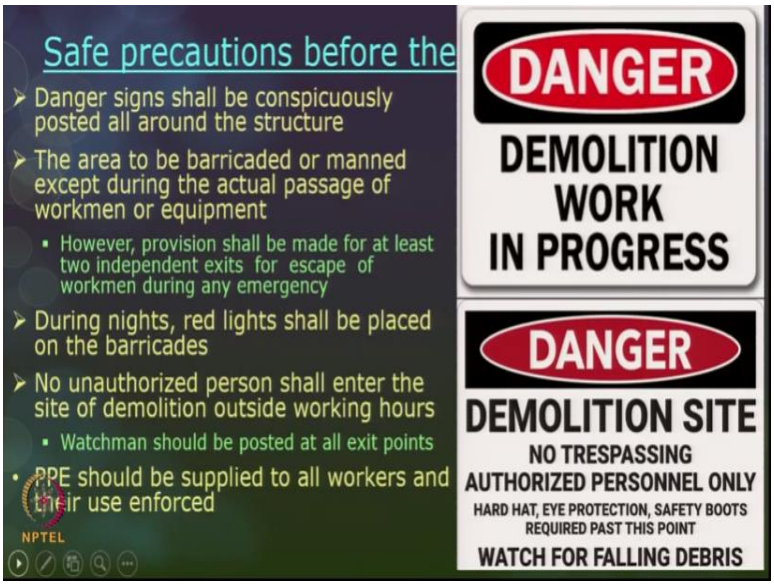

And provisions should be made for at least 2 independent exits even though you are fully barricading the duct area. At least 2 independent exits should be there in case of an emergency for the worker to leave the particular area. And even in the night, there should be red lights placed on all the barricades and on the structure to know that there is a demolition which has happened. Sometimes you collapse a structure and after you know sometimes it can be partial collapse continuing to happen.

So, if the area has to be warned of to the public that the demolition has happened and there can be some unexpected evenings which may happen. No unauthorized person shall enter the site of demolition outside the office hours. And even authorized people are not supposed to you know go unnecessarily into the site. There should be watchman posted at all exit points to prevent the entry of public and other unauthorized people.

PPE should be supplied to all workers and their use also should be enforced and they should know when to use what PPE? And everything should be known to the workers very clearly based on the type of demolition and based on the structure with which they are going to demolish it, should be known to them. Now before you start with the demolition again some technical issues what you have to do is? Number 1 is service lines electrical wires, telephone lines, water pipes, gas etc., which is actually entering into the particular structure which is to be demolished it should be switched off or relocated or rerouted and when the actual demolition is in process. So that unnecessary catastrophes should happen in while the demolition is going on. And prior to

altering or cutting of the lines the necessary approval should be obtained from the concerned authority and then this should happen.

If a structure to be demolished has been partially collapsed as a result of fire or explosion or other natural disasters. Then the walls or damaged roofs should be properly shored or braced suitably especially when you are going for a manual means of demolition. And the walkways and the passage ways should be provided for use of workman, who should also be instructed how to use the walkways and passage ways and these walkways and passage ways should be well built.

Ok there should be proper illumination, they should be inspected and they should always be free from debris for the quick movement of material and workers. All nails in any form of lumber should be withdrawn, hammered and they should be removed from the site. If there are loose planks and something and they should be placed or piled up for further cleaning and burning.

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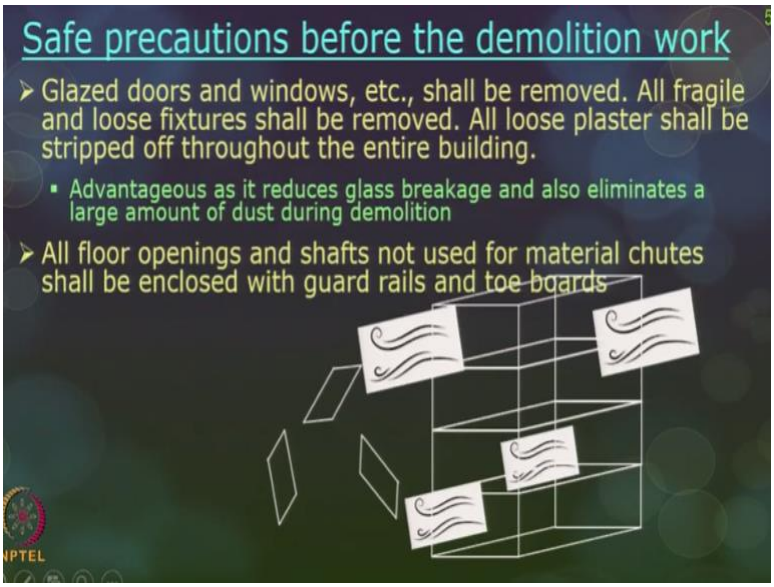

Then again some more safe precautions if there are glazed doors or windows or any glasses. So, they should be first removed because all these fragile and loose fixtures they may be very great hazard especially when you are doing the demolition. That can be a great hazard even to the public. And loose plasters also should be stripped off through the entire building. So that you can actually reduce the quantity of dust which starts coming out as a result of demolition.

So advantages to remove the glasses and plastering is to have glass breakage and other hazards safety hazards and also to eliminate lot of dust which comes as a result of demolition. So, all floor openings and shafts which are not used for material chutes use should be enclosed guard rails and toe boards as mentioned in the earlier class on what is guard rails.

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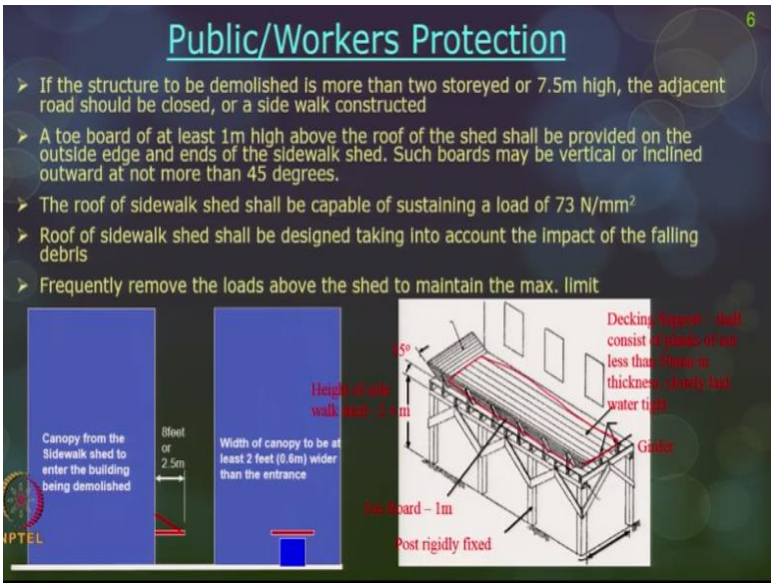

Public workers protection, so wherever possible the public should be avoided from into the site and workers should have a proper way if entry into the structure and exit. So accordingly, there should be a side walk shed which should be constructed. So, if the structure to be demolished is more than 2 storeyed or 7.5 meters height. Then the adjacent road should be closed and the side walk should be constructed. So, there are clear dimensions given on how the side walk sheds should be ok as given in OSHA IS codes.

So, the side walk shed should be at least having a minimum clearance of 2.4 meters for the height of the sidewalk shed. And the toe board should be 1 meter high above the roof of the shed as shown here. And the toe board should be actually facing outward or it can be vertical and the when it is facing outward should not be more than 45 degrees. In order to cash the debris which falls onto the sidewalk shed.

The roof of the sidewalk shed should be very strong and capable of sustaining a load of at least 73 Newton per mm square. And the roof should be designed taking into account impact of falling debris that also should be taken care. So, this is a particular roof the decking of the support, it

should be having closed panels of not less than 50 mm thickness and they should also be water tight ok in order to have no leaking into the sidewalk sheds.

Whenever there is debris falling onto the sidewalk shed, frequently the load has to be removed so that the maximum permissible limit on the load above the sidewalk shed is maintained. So, these are all some of the tips on the side walk sheds. Sometimes a sidewalk shed may be a little far away from the site to enter the actual site to be demolished. Then accordingly a canopy structure can be installed to connect the sidewalk shed and your actual structure to be demolished.

So, the canopy should be at least 8 feet or 2 and a half meter in width and it should be at least 2 feet wider than the entrance with which wherein the workers have to enter. So that whatever falling debris are not falling onto the workers and the workers are ready safe on entering the structure to be demolished.

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So, the actual demolition operations and as I said more precautions should be taken. Especially in terms of safety for a demolition work as against a regular construction. Because a demolition operation also has the same hazard as equal to a normal construction work. And the only difference as I said is the demolition generally happens in the reverse form as construction. In construction you go from foundation the walls column floors and so on.

But in demolition you go from top floor to floor by floor down and then you go to the ground floor and then the basement. So, the demolition shall always proceed systematically storey by storey from top floor to the bottom floor and basement. And the demolition work should proceed in such a way that it causes least damage and nuisance to the adjoining building and members of the public. And also, it should satisfy all safety requirements to avoid any accidents

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Now there are 3 types of demolition which you should know manual number 1 is manual means mechanical demolition and the third one is induced collapse. And again, the all 3 have extremely opposite characteristics for example manual means is very slow in order to bring down a building. Because you use actually a concrete breaker or a pneumatic breaker driller for drilling and then breaking the whole structure.

It is a very slow process but in terms of hazard levels it is not too much hazardous in terms of dust pollution and so on. So, in that form a manual means is a good way of demolition. It is still applicable for smaller projects pneumatic drillers; concrete breakers are generally used for breaking down a structure. The next extreme case is induced collapse wherein you put explosives and through blasting you bring down the building in no second.

But if you see the noise, the dust pollution and so on is too high in case of an induced collapse. Then this method is generally used for high rise structures or where a structure is creating lot of warning signals on failure or sudden collapse. It is better to use explosives and bring down the structure in no second using a detonator. The feasible option among these 2 extreme cases is mechanical demolition.

And as the name implies there is a crane which has a steel ball and which starts moving and forcing onto the wall and onto the building and as a result the building starts collapsing. So, this is not that slow like a manual means not that very quick like an induced collapse but it takes moderate time for the demolition to happen. It is most widely used and it uses tools for crushing concrete and also for sheering steel if you have an RCC structure also so mechanical demolition is the most commonly used.

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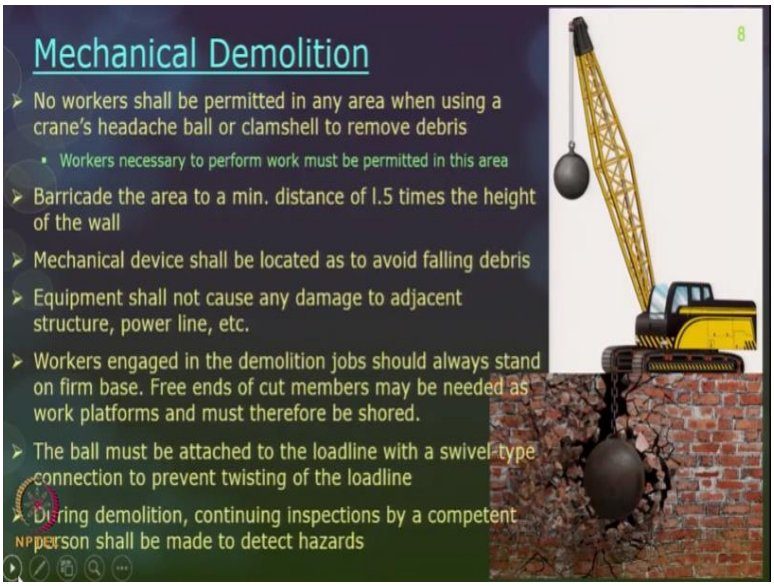

And we will discuss about safety precautions in mechanical demolition and as shown in the picture. There is a crane with a swirl, the swing motion with the steel ball and with that it acts onto the building and the building starts to collapse. Safety precautions, no workers shall be permitted in any area when using a crane headache ball or your clam shell is used for picking out all your debris.

So, no worker is allowed to enter that premises and workers necessary to perform work only they will be permitted to work in that particular area. And the area is supposed to be completely barricaded to a minimum distance of 1.5 times the height of the wall. Accordingly, the area has to be barricaded because this may have falling debris on quite you know wide area. Mechanical device should be so located that the falling debris is not actually falling onto the equipment and the equipment is giving a failure.

The equipment shall not also cause any damage to either power lines overhead lines or any lines which are above. And also, to the adjacent structures which are close by and the workers engaged in the demolishing job should always stand on a firm base. And the free ends of cut members can also be used as a work platform. But they must be properly shored and in fastened when the workers are using it as a base to stand.

The ball must be attached to the load line with the swivel type connection only so that it is not actually twisted when in action ok. The ball should go very freely onto the wall and coming back

and on to the wall so it should be a swivel type connection. So that it is not twisting and turning off. During demolition, continuous inspection by a competent person should be made onto the structure whether the weakened portions are still stable or not. And what about the collapse on the whole structure so that should be ensured so on.

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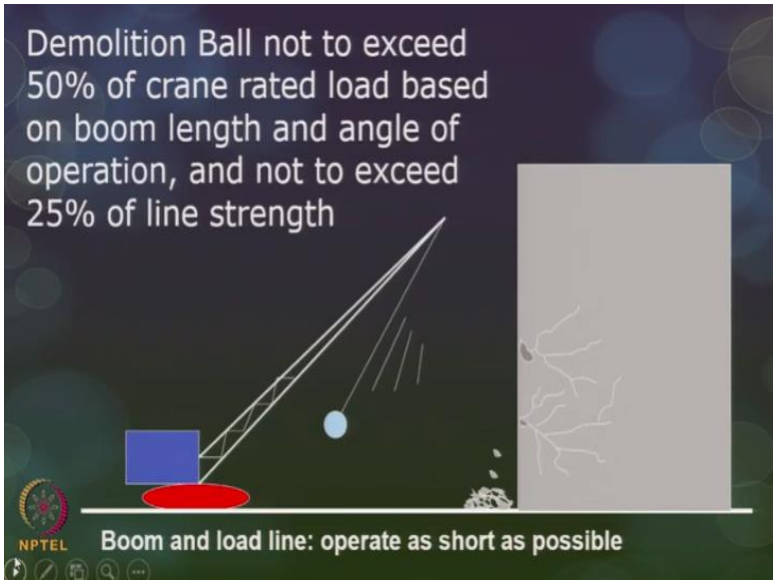

Now the demolition ball should not exceed 50% of the cranes rated load and also it is based on the boom length and the angle of operation ok. There should not be exceeding 25% of the line strength and also this boom and load line should be operating as close as possible. And also, you should keep the falling debris is not affecting the crane and the equipment.

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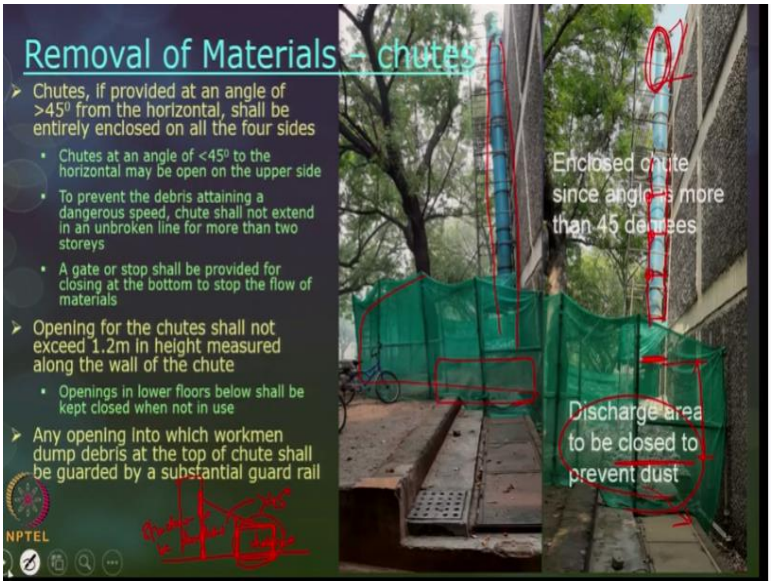

Now removal of materials, there are so many ways to remove the debris ok. That is what is a term, we generally use on the broken pieces of a structure. This debris can be removed from the structure through 2 means the 2 common means are one is chute and the other one is your floor or roof openings ok. Chutes if provided has to be at an angle of not of more than 45 degrees.

This is a building this is a load from where you are actually going to put and this is your floor opening. So, this angle is what I am talking about. This is a place for collecting all your debris. So, if a chute is having more than 45 degrees what happens is, the slope is very steep and as such it should be closed on all on the upper side also or all 4 sides preferably in this case it is a vertical chute.

Ok that is why it is fully closed and the area is also put with a debris net. So that there is no fall hazard outside the particular area it is barricaded completely and if the chute is at an angle of less than 45 degrees then primarily it is close to horizontal. So, it can come with a slow speed in that case you can have an upper side open chute also that is also possible. Suppose if you are having a very steep slope in the sense more than 45 degrees then what happens is the debris can come at a very dangerous speed and if you are having a broken chute with broken lines, maybe for example if you see this picture, I brought to show the chute connections only. These are the different chutes here ok if the lines are broken what happens is it may also try to damage the chute itself ok. So, the chute should be such a way arranged that it is having a continuous line.

But if you start giving a continuous line then it can come with a very dangerous speed at points ok there should be stops given to control the movement of debris and to fall onto the collector place. In this case this is the collector place this is a place where in the first time no debris is there and the debris is collected here and then removed frequently. So there should be a gate or a stop should be provided at certain places and before the closing of the bottom also in order to control the movement of debris coming out.

And then it should be removed from the chute and collected accordingly. Opening for the chutes shall not exceed 1.2 meters in height. For example, this is the level at which the chute is there and this is the floor level. So, this height should not be more than 1.2 meters and along the wall of the chute. And the openings in the lower floors below should be kept closed when not in use.

This is not regular demolition work so it is open but it is generally closed when it is not in use and every time it has to be dumped. And opening into which the workman dumped the debris, which is this opening so this is a primarily a parapet opening. So, this opening should have a proper guardrail so that the workman are not having a fall hazard. Whenever this particular opening is open and debris are coming in all other opening should be accordingly closed onto the levels below.

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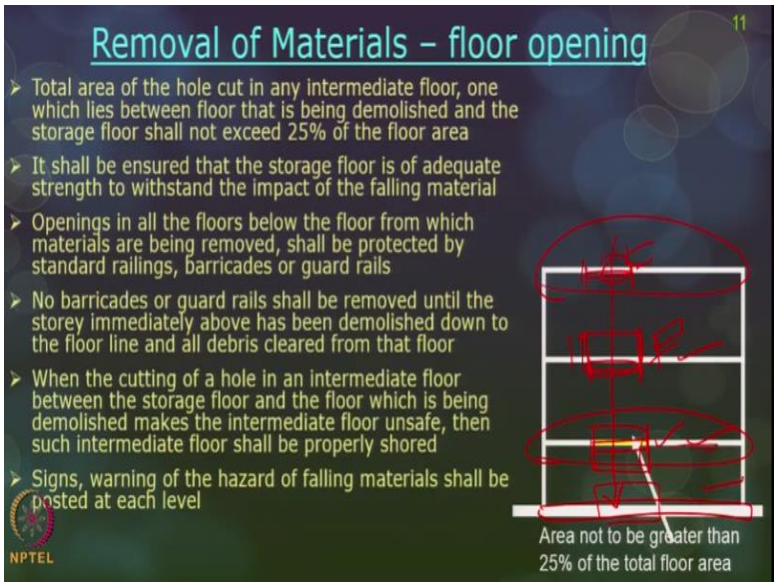

Then removal of materials through floor opening, and as I said sometimes most often the demolition material are generally collected into the building only. They are not collected and stored outside of the building. So, there can be floor openings into which the materials can be dumped onto the lower floor by throwing in into the lower floor. But there are some safety precautions for throwing of the material into the floor openings and collecting it onto the ground floor.

The total area of the whole cut, sometimes it can be a natural cut sometimes it can be cut specifically for throwing in and collecting all the debris. So, this area whatever it is cut for throwing in the material it should not be more than 25% of this complete wall area ok that should be the number one safety precaution. Because the slab will lose its strength and as such it may start getting failed. So, all the floors above should be accordingly cut when you are actually you know trying to throw in the material from in the in terms of floor or roof openings.

It should be ensured storage floor is adequate adequately strong enough. So, this is the storage floor it is adequately strong enough to withstand the falling material because it comes with a very great impact load onto the floor the openings in all the floors below the floor. So, this is the floor from where you are throwing the debris all the floors below should also be properly barricaded. So, there should be barricades left with the proper danger signs return saying that hazard falling debris ok.

So that people are warned of the falling debris and there should be a proper guard rails also at all the floors below and also onto the collector point. Openings in all the floors below the floors from which the materials are being removed, protected by standard rails, barricades and guardrails. No barricades or guardrails should be removed until the storey immediately below the floor has been demolished down to the floor line.

So unless this floor is completely demolished, this barricade should not be removed and it should be there in place only. And all the debris are cleared off from the particular floor when the cutting of a floor when you are cutting a floor primarily in order to create an opening for throwing on the debris. And in the planks are not sufficiently strong enough to support then accordingly bracing and showing has to be done in order to make the floor strong enough in order to do the cut portion.

Signs or warning of the falling hazards should be posted at all levels ok every level should have a sign of falling debris.

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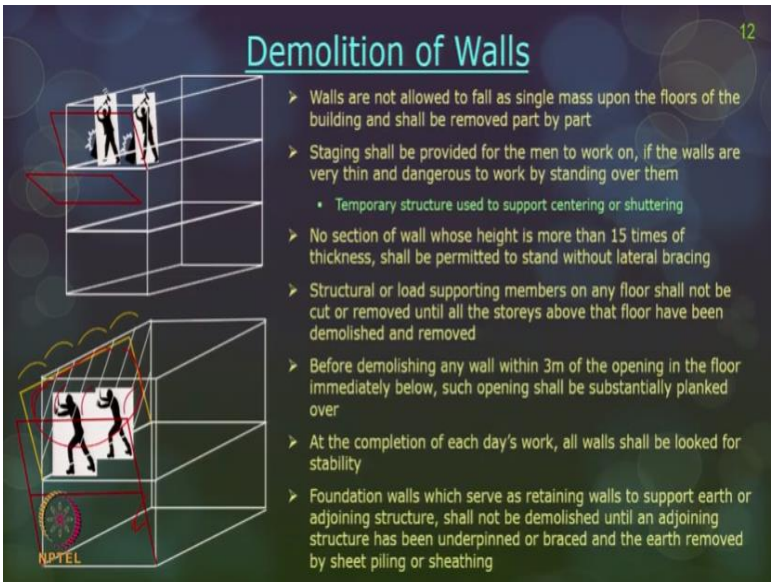

Demolition of walls, again there are lot of safety precautions given on each component of the structure to be demolished but walls are very critical so we will discuss about walls. Walls are not allowed to fall as a single mass ok. In the sense if you see here the workers are trying to push the one at a very great speed and make it to fall as a single mass. What happens is most of the load coming onto the structure is partially onto the walls and if the walls are collapsed the structure may automatically collapse and fall hazard of the workers may normally take place.

And the walls should be removed only part by part. So, the staging should be provided for the men to work on the walls are very thin ok and dangerous to work by standing over them. Then there should be another staging and the workers can stand over there and start among the walls. The temporary structure should be also be used to support your centering or shuttering there should be adequate precautions for maintaining the structure and for clearing off your walls.

No section of a wall whose height is more than 15 times of the thickness shall be permitted to stand without a lateral bracing ok. You have to safeguard the other sides of the wall and then only start demolishing a wall. As seen in this picture if you when the workers are trying to collapse this particular wall a portion of a particular wall and this wall starts automatically to collapse. Now can accordingly lateral bracing has to be there unless the wall height is more than 15 times the thickness of the wall.

It should not be allowed to stand on its own, structural or lower supporting members on any floor shall not be cut or removed until all the stories above that floor has been demolished or removed. A simple thumb rule is, do not touch any floor down below when the work is not completed on the floor above. Before demolishing any wall within 3 meter of the opening on the floor, the opening should be planned or it should be safe guarded with proper bracings and then only the wall has to be demolished.

At the completion of each day's work all walls should be looked for stability and inspection have to be for sure done. Foundation walls which serve as retaining walls to support their pressure or adjoining structures should not be demolished, until an adjoining structure has been underpinned or braced and then only this wall has to be removed and taken off.

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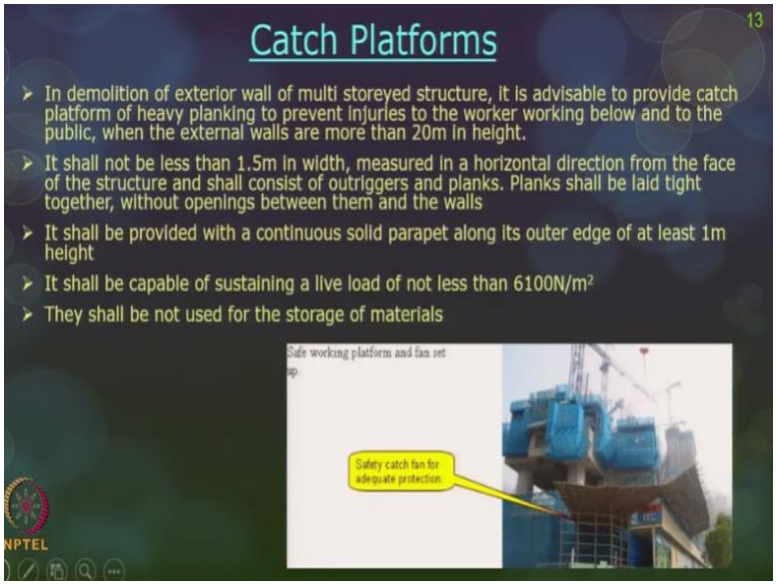

Catch platforms, sometimes there are lot of catch platforms in order when especially when you are a doing a multi storeyed building. And these catch platforms are actually outside the structure in order to collect all your debris. So, demolition of exterior wall especially in multi storeyed structure it is advisable to provide small catch platforms of heavy planking to prevent injuries to the worker working below and to the public when the external walls are more than 20 meters in height.

So, these catch platforms shall not be less than one and a half meters in width measured in a horizontal direction from the phase or the structure and shall consist of outriggers and planks and

the planks shall be laid tight together without any openings between them and also between the walls where in loose pieces do not try to fall off to the ground level. So, you should be able to catch all the debris.

The catch platforms should be provided with a continuous solid parapet along its outer edge at least 1 meter height so that even the bigger debris are all collected inside the catch platform and not falling off. So, 1 meter height is just like a guard rail protection only it shall be capable of sustaining a live load of not less than 6100 Newton per meter square and they shall be not used for the storage of materials.

So, as and when the catch platform has reached sufficient load it should be removed and started to reuse. So, after the debris are there, it should be transferred through the chutes and the catch platform is again you know ready collecting all your debris.

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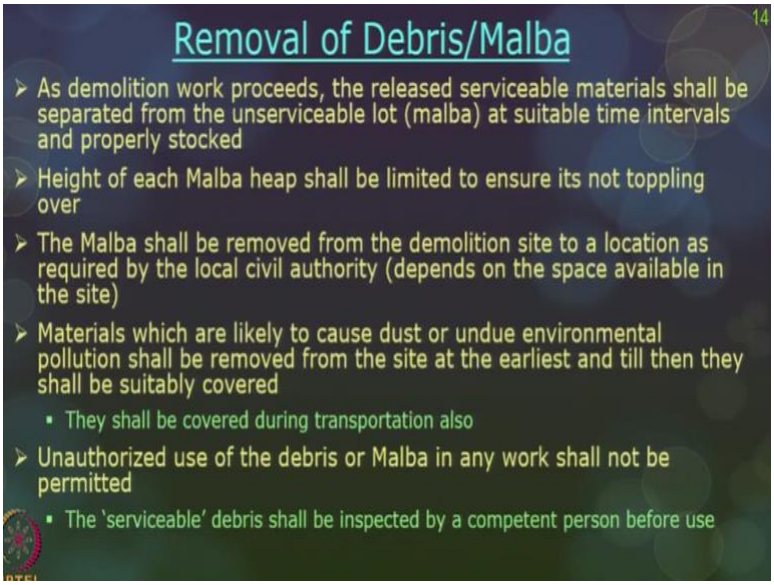

Removal of debris and malba so there are actually 2 terms which comes together. Debris is actually the serviceable component and malba is a component which has to be trashed or thrown away. So, as soon as the demolition work keeps going on and after it is complete. The released parts, is generally classified into 2 categories 1 is serviceable part and the other portion is unserviceable portion.

The unserviceable portion is generally also stored and stocked at suitable time intervals for clearing and disposal. In any case the height of the malba heap should be limited in order to avoid toppling over or falling onto people who are passing by and so on. And the malbas should be stored in the demolition site only and should be removed to a location as requested by the local civil authority. And depends on the space available in the site has to be stored and stacked.

The materials which are likely to cause dust or any undue environmental pollution should be removed from the site very quickly and till then they should be covered. So, during transportation also these dangerous substances are malba should be again closed and covered well transportation too. Unauthorized use of debris or malba in any work should not be permitted and even the serviceable debris which is used for recycling also should be inspected by a competent person before it is taken for use.

Now how do we classify the debris? Generally, after the debris are taken off there are so many types of debris which comes in. Which includes primarily earth, plaster, motor waste, bricks, blocks, concrete, glass, steel, wood or wall paper.

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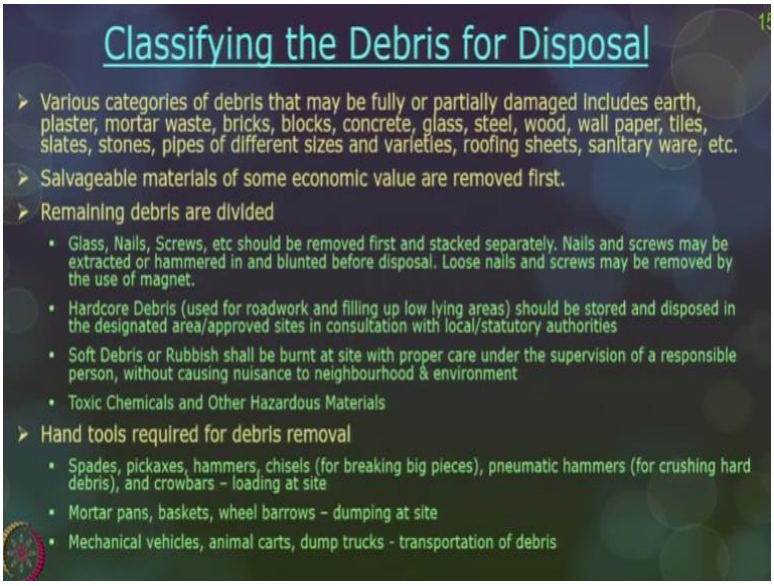

Tiles, slates, stones, pipes of different sizes and varieties, sanitary ware and so on like this you get so many varieties of debris which comes in. And some may be partially damaged some may be fully damaged also. The salvageable materials, which can be of some economical value are all

removed first which can be reused. Generally, these salvageable materials are removed before even the demolition starts place ok.

Sometimes in induced collapse, when the structure has to be brought down in no second then after the induced collapse again the serviceable or usable materials are first relooked at and then they are removed from the debris first ok. Then the remaining debris are accordingly classified into dangerous hard debris and soft debris ok. Dangerous debris can be glass, nails, screws etc. which can create a punch hazard or cut hazard to the workers should be removed first, stacked separately or it should be buried in a ear marked place and should be kept there. Nails and screws can be extracted either by hammering in or blunted after removal. Or if there are loose nails and screws, they can be removed using magnets as well the hardware debris shall be reused for road work or filling in some low-lying areas and so on. And they should be stored disposed into the designated areas as advised by the local authorities.

The soft debris should always be burnt. They can be wood chips or some trashes of plaster or something they can be burned in the site with proper care under the supervision of a responsible person or competent person or it should be thrown away into the into the earmarked site for dumping without causing any nuisance to the neighborhood or to the environment. Sometimes debris may also have toxic chemicals and other hazardous substances those should be trashed as per the safety act.

The hand tools required for debris removal, spades, pick axes, hammers, chisels for breaking big pieces pneumatic hammers for crushing hard debris crowbars are generally used for loading of the debris in the particular site. Mortar pans, baskets and wheel barrows are generally used for dumping the debris in an ear marked site. And mechanical vehicles animal carts or dump trucks generally used for transportation of debris.

Again, safety should be maintained while you are loading and unloading of debris and including transporting the debris.

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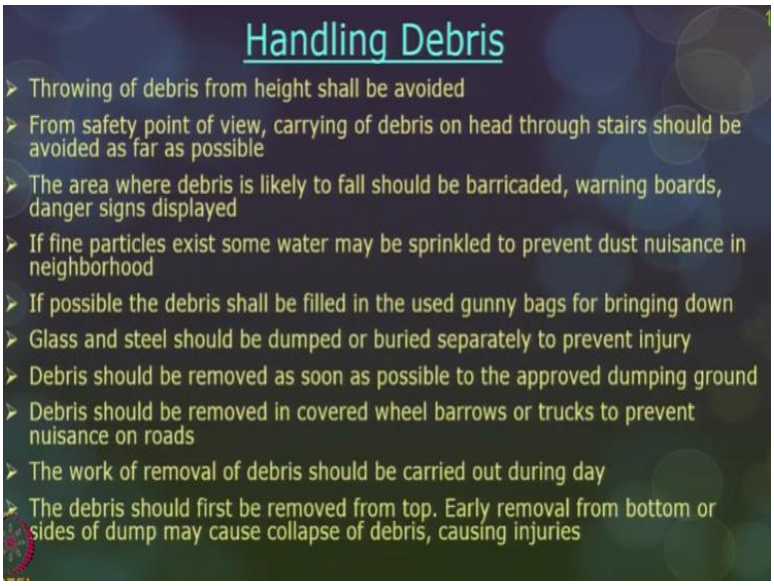

Handling debris, throwing off debris from a certain height are generally avoided from safety point of view carrying of debris on head using a mortar pans or any other substances through stairs should be avoided as far as possible. Because it can cause environmental pollution or it can fall and have a slip or a trip hazard. The area where the debris is likely to fall should be barricaded warning boards and danger signs are displayed until the area is completely cleaned.

If fine particles exists and you suspect of any dust nuisance water can be sprinkled. So that it is not creating a nuisance or dust pollution throughout. If possible, the debris shall be filled in used gunny bags for bringing down from the stores from the floors above and also can be stacked in 1 particular area in the site. The glass and steel shall be dumped or buried separately to prevent injuries to workers.

And the debris should be removed as far as possible into the dumping ground and according to the classification be moved to the dumping area as already planned by the site engineers. The debris as far as possible should be removed in covered wheelbarrows or trucks to prevent nuisance on the roads and also to prevent environment pollution. The work of removal of debris should be carried out only during day unless very emergency it can be carried out in the night.

And again, all other extra precautions has to be taken care of when the debris are handled at night. The debris should first be removed from the top because if you start removing it can have collapse of the debris causing injuries.

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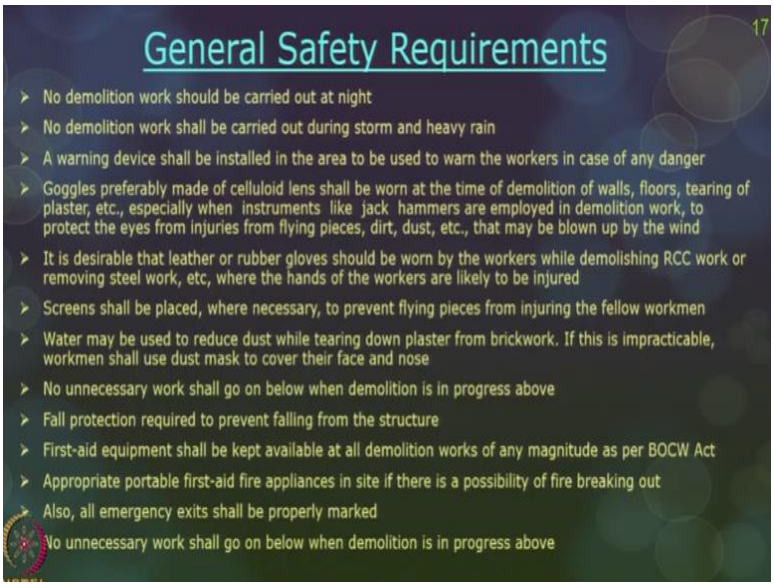

General safety precautions, no demolition work should be carried out in the night unless it is an emergency. No demolition work should be carried out when there is a rain heavy rain thunder storm and so on. A warning device shall be installed in the area to be demolished to warn the workers in case if there is any danger. Goggles, preferably of celluloid lens should be worn by the workers during demolition.

Because there can be falling debris or flying debris which can place as small dirt dust etc., which can be blown away through the wind and which can cause injuries to the eyes. In the same way it is desirable to wear a rubber or leather gloves because when demolishing RCC work or removing steel work your hands are safe and not likely to get injured. Screens should be placed where necessary to prevent flying pieces of falling pieces from injuring the fellow workmen. Water may be used reduce a dust and while tearing down plaster from the brickwork.

If this is not practically possible, the workers are supposed to or advised to wear proper face masks and respiratory masks. No unnecessary work shall go on below the floor when the demolition is in progress above the particular floor. Fall protection to the workers should be maintained to prevent falling from the structure. First aid equipment should be kept available in the demolition site as per the BOCW act which we will see which you have seen earlier.

Appropriate portable first aid appliances fire appliances also should be available in case of any fire breaking out all emergency exists should be properly marked. In case of an emergency, workers should know how to be evacuated.

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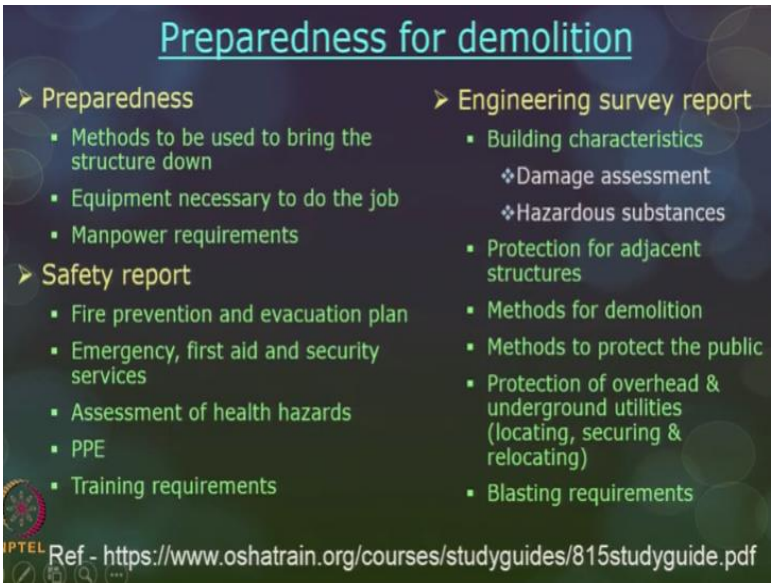

Preparedness for demolition, again a recap, methods to be used to bring the structure down has to be thoroughly studied based on the structure to be demolished and the adjacent structures. Equipment necessary to do the job has to be thoroughly planned, man power requirements always try to do the demolition work with the minimal skilled labors. Then safety report, fire prevention and evacuation plan has to be there, emergency first aid security services has to be there.

Assessment of health hazards in terms of toxic chemicals or even if it is concrete structure, the dust coming out of cement breaking and so on has to be thoroughly analyzed. PPE has to be recommended to the workers and the mandatorily PPE has to be worn and training requirements has to be given to the workers in order to do the demolition. Engineering survey report should be talking about the building characteristics.

The damage level which has been happened in the building and the strength of the retained building hazardous substances present inside the building and demolition has to happen. Protection of adjacent structures whether underpinning has to be done on to the remaining structures when you are actually demolishing the particular structure. And even the choice of the

equipment used for demolishing is also based on the location and type of your adjacent structures.

Methods for demolition methods to protect the public protection of overhead and underground utilities like for example electric lines, water, gas etc., everything has to be taken care of. And whether it is locating the utilities or securing the utilities or relocating the utilities has to be taken care of in your engineering survey analysis. If you want to use blasting for collapsing a structure then all blasting requirements has to go as per the IS code and OSHA requirements.

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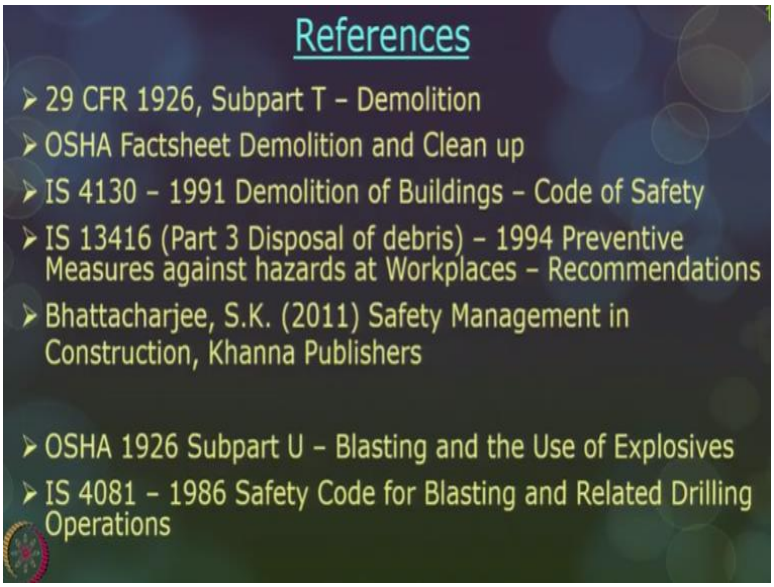

So, this complete lecture was taken from these references. Subpart T, on demolition, then IS code IS 14130 are demolition of buildings code of safety, IS 13416 on disposal of debris primarily the part 3 and also few references and books and the blasting is as per 2 notes. One is on OSHA sub part 2 talks about blasting and use of explosives and IS 4081 also talks about safety code for blasting and related drilling operations. If you want to use blasting as a method for induced collapse, then you can go through these additional references. Thank you.