

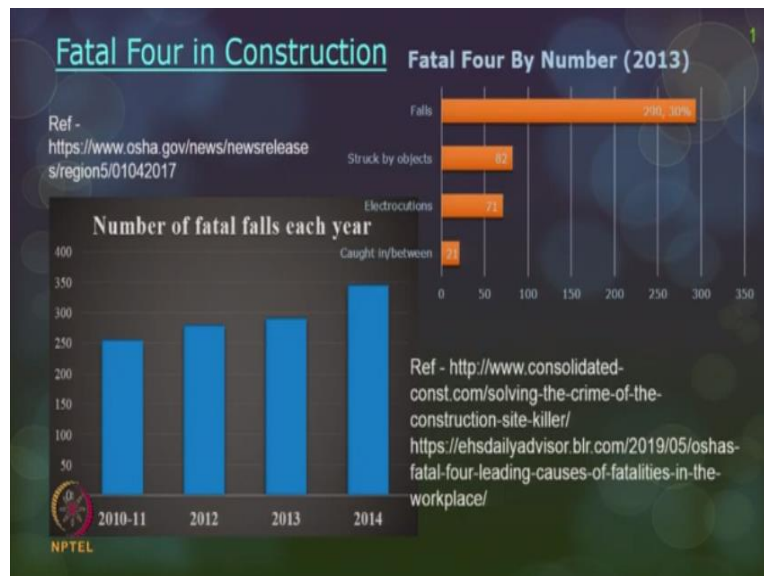
Safety in Construction
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Module No # 02
Lecture No # 08
Introduction to Fatal Falls

So, in today's class we will talk about fatal falls and what is the hazard on fall all about. So finally, this lecture and the subsequent lecture will be on concreting operation. So, one fatality will be followed by a particular operation where this fall hazard is too much. So, we will cover accordingly in the remaining few weeks. So, what do you mean by hazards in construction case? So, in construction it is based on the place or the mode of fatality.

The researchers have categorized the fatality into 4 different categories so number 1 in the rank is falls, the next is struck by or Cave-in, then we have caught in between and electrocution. So, this order it changes from place to place but falls is always ranked as number 1 in many of the construction sites. If you see the trend in falls even though so much efforts have been taken place in several construction firm.

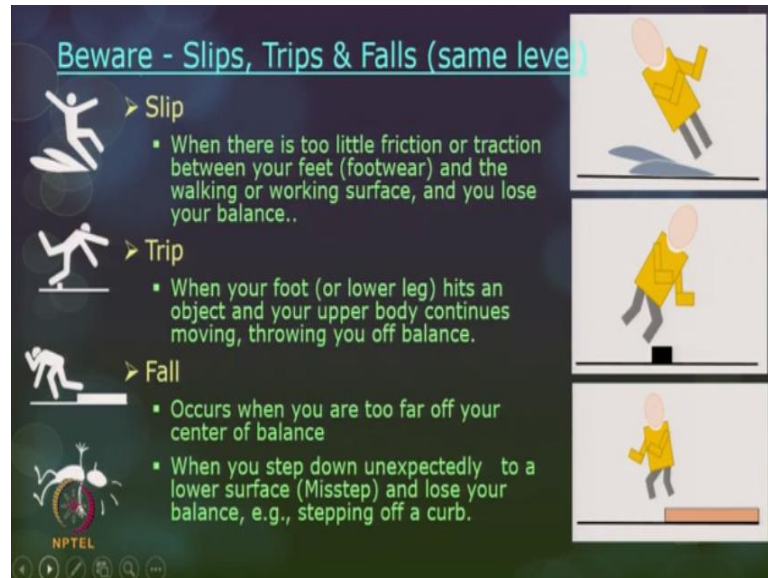
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The number of Fatal falls is still now on the higher side only and this is the record which I have taken from 2011 to 14 which also shows there is an increase in number in the number of falls. This is not that we do not take any preventive measure on falls but still the projects are little

complicated and complex in nature. And there are other issues also behind which the fatality in falls has not come down.

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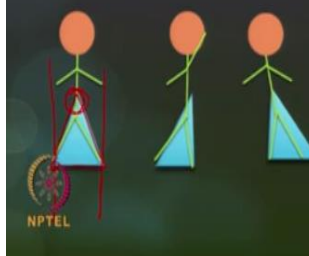

So now let us talk more about falls if you look at falls, there is actually fall on the same level or on the same floor on the walking or working surface that is how it is generally referred. So, falls is generally associated with 2 other terminology which is nothing but slips, trips and falls. So let us try to understand what is, this slips trips and falls? So, slip when there is too little friction or traction between feet and the working or walking surface.

Then you have imbalance and you fall that is primarily called slip. Trip is when your foot starts to move but you get hit with an obstacle but your body getting to move another is that you lose your balance and you just fall. So, slip or trip is associated with the fall and fall generally happens as a result of these 2 so falling on the same level or surface.

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Slips or Trips → Falls (same level) 3

- Reasons – wet floor, improper house keeping, Centre of gravity imbalances (awkward postures in jobsites)
- Impact – Minor injury
 - sprains, strains, bruises, contusions, fractures, abrasions, cuts
- Affected body parts - Knee, Ankle, Foot, Wrist, Elbow, Back, Shoulder, Hip, Head

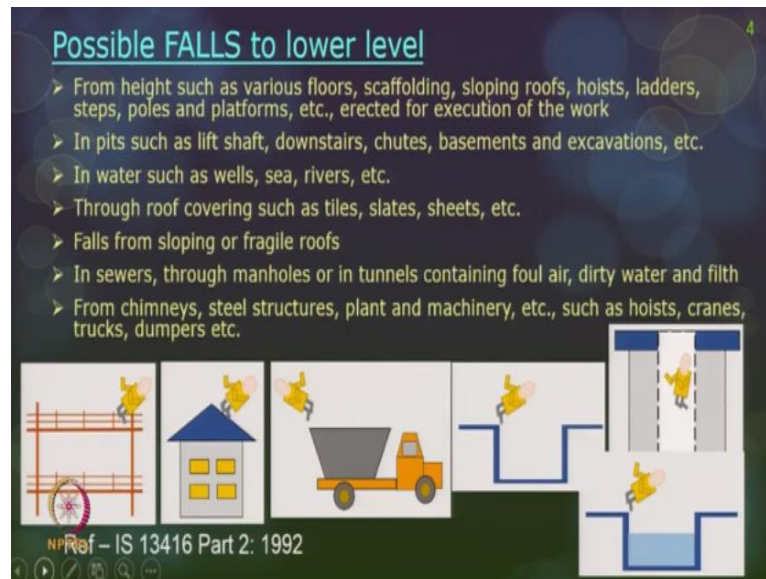
So, what is this real issue on falls? Even falls on the same level should be avoided. So, reasons for some of the falls on the same level as a result of slip or a trip can be a wet floor, it can be improper housekeeping you can see a picture of a construction site. Wherein know, all the materials are scattered all over the working platform and the center of gravity imbalances. Maybe you try to instead of getting stepping down a ladder and pushing to the ladder to other position.

And then trying to reach out for an activity or a material you try to know grab the material from the place where you put the ladder. So as a result, you are in awkward positions or postures in job sites. So, you lose the balance and then you try to fall off, an example can be show here so this is the person and the center of gravity is actually know can be marked as the triangle keeping in the lower to a chest level to your legs these are the 3 points.

And if you try to move your body wherein this middle point goes away from these 2 points then you lose your balance and try to fall off. So maybe you try to work something on your floor level or something away from your place and you try to extend sideways or upwards. As a result, body equilibrium starts changing and in there is a fall. Impact, generally whatever has been reported so far.

As a result of falls on the same level is only minor injury and this, we have seen earlier what is minor injury during the earlier classes. So, it can be sprains, strains, bruises, contusions, fracture and abrasions whatever you want. Affected body parts can be anyone of the body parts.

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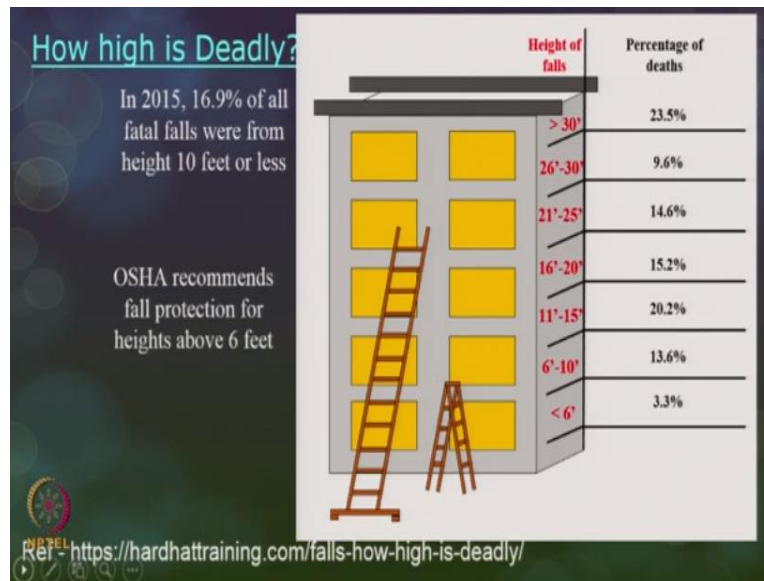


So, what are the possible falls to predominantly lower level not on the same level. Now we are really talking about the falls so there is an IS code which has given a very big list on what are all the possible falls to a little specific height or a lower level. So, from height such as various floors or scaffolding, sloping roofs, hoists, ladders or poles, platforms etc., which are all erected for execution of the work.

In pits, so always falls need not happen from a height above ground floor and then to the ground floor. It can also happen from the ground floor level to what we call basement or something like a pit or open hole or something. So, in pit such as lift shafts or down stairs or chutes, basement and excavations into water maybe you slip inside a water body. So, it can be wells, sea or etc., through roof covering such as tiles, slates or sheets.

And falls from sloping of fragile roofs in sewers through manholes are tunnels which can contain also other hazards like foul air dirty, water filth and so on. From chimney's steel structures, plant, machinery etc., such as hoists, cranes, trucks, dumpers and so on. So, this is not complete and falls can happen from anywhere so in any part of your construction work. So, we have to be very careful with the falls.

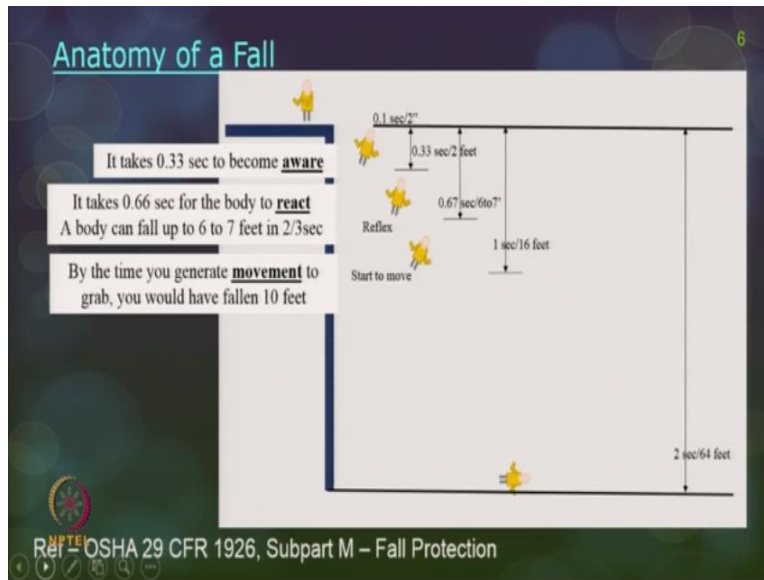
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So now the question that can come to you is what is the height below? Which I am, say if above which I should take proper precautions. So, there is also statistics on the fatal falls with regard to the height of the structure or from where the worker or person has fallen down. So, if you see the height of the structure it starts from 6 feet less than 6 feet to more than 30 feet height. And the percentage of fatality as a result of all is also given here so this is a record in 2015.

In 2015, 16.9% of all fatal falls where from height 10 feet or less so OSHA recommends any fall protection for height above 6 feet which is considered as an intolerable limit. So above 6 feet if you want to work in site, it recommends that there should be proper fall protection devices.

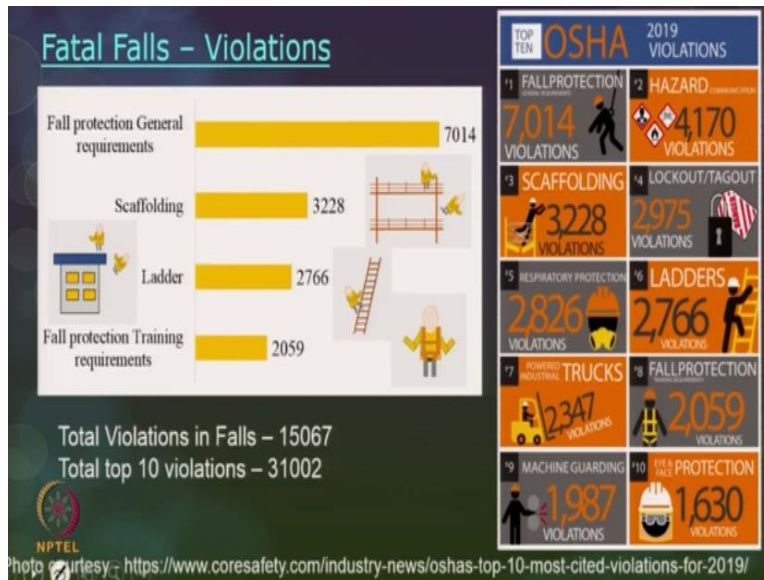
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So, what happens when a person is about to fall? So, anatomy of fall, you should first know why this fall is very dangerous and what happens when you try to fall? So, this fall is very dangerous hazard because of the reason that the minute you try to realize you are about to fall you would have fallen very you know much in depth. So, it takes 0.33 seconds to become aware that you are about to fall.

And in the 0.33 seconds your body would have fallen at least 2 feet. It takes 0.66 seconds for the body to react. So, in that 0.66 seconds the body would have fallen at least 6 to 7 feet and by the time you generate movement, you realize that you are falling and you try to grab something in close by. You would have at least fallen 10 feet and in 2 seconds the estimated fall is about 64 feet. So that is where fall is considered to be really dangerous.

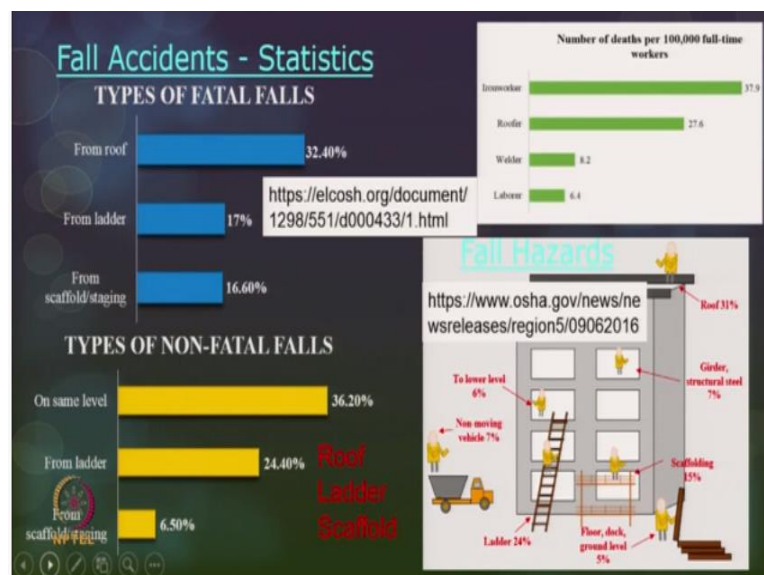
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So, if you see the violations, we can still prevent falls as explained in the first class many of these hazards can be easily prevented or at least minimized in the size if you fall or certain safety protocols. So, if you look at violations in 2019 there is an, compilations on violations as given by OSHA. So, among the 10 violations at least 4 violations with regard to falls where around 15000 something as against 31,000.

So, half of all the violations that happened in 2019. They are all related to fall only because of the violations. There, the falls are still happening in construction sites and which should be avoided.

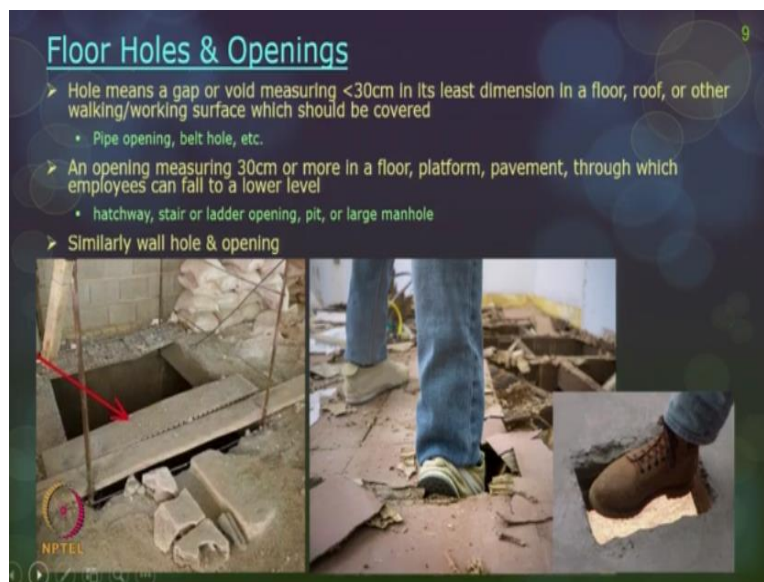
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Now some more statistics where are the real falls happening? We know falls are there but from where exactly the major fatality has happened. From roof, that ranks number 1 fatal falls, next is ladder and the third is scaffold so we are going to discuss only these 3 hazards in detail in today's class. Roof, ladder and scaffold, so types of non-fatal falls again from ladder and that is really high from ladder, lot of non-fatal falls have happened.

And the next one is from staging on scaffolds and who are all the workers who have been affected with the fatal falls are ironworker, roofer, welder, laborer and so on. So the list (10:06) is also as we little know a quite a number of people are really affected because of the fall hazards.

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So now let us start looking at each one of the hazards in detail. So number 1 holes and openings. So, holes are openings you know primarily it is an open space from where something falls or a person falls. So now what is the dimension? Dimension varies from OSHA and also IS code talks about the different dimensions and OSHA says something else. So that you can really refer to but in general logical sense if you want to understand what is a hole and what is an opening?

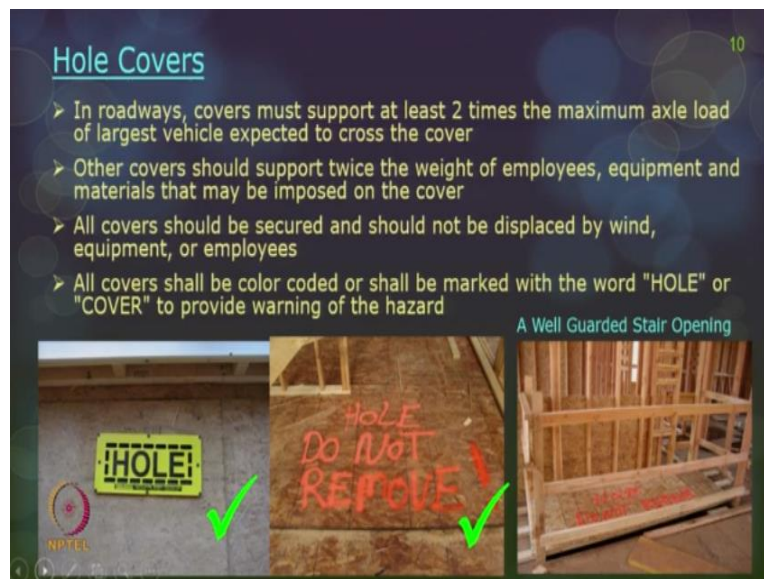
Holes are nothing but very small opening on your floor or your ground surface from where you may try to fall material or objects or you may also have a slip or a trip hazard. Some of the pictures here are all shown here will tell you what is a hole. And opening here really large gap or

void or a floor on working surface and where in a person and objects along with the person can also fall and have a hazard.

Hole means a gap or a void it can be in a floor roof or other walking working surface which should be covered and example can be pipe opening, belt holes and so on. And an opening which is measuring more than 30 centimeters or more as given by the IS codes so in a floor, platform pavement through which employees can fall to a real lower level. Example is hatch way, stair or ladder opening, pit or large manhole.

So similarly, there is a related terminology in walls when the same opening happens along the wall, or say similarly you have a hole and an opening also.

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So how do we now overcome this hazard for a hole there is a specific way to overcome you can have hole covers. So, the hole covers, again there are so many ways of thinking about what can be right cover and how to identify and show that it is hole cover. So, hole covers if you want to put it on a road way then this cover should at least support 2 times the maximum axle load of the largest vehicle that as passed through that cover.

In a given particular day maybe you think off a very large vehicle that is supposed to cross the road and the maximum axle road of that largest vehicle at least 2 times the load it has to be supportive this hole is to be able to tolerate. And other covers should support twice the load of

weight of employees, equipment, material whatever is supposed to pass on in that cover. And these covers should also be secured, should not be displaced by the movement of people and wind or equipment.

And all these covers should be brightly color coded and then nicely it is written maybe as warning, hole cover do not remove and all these can be done. The lot of ways of warning the workers those who are passing by that this is not an normal regular floor and it is a hole, cover just laid over there.

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Some more pictures on opening so this is a floor opening and this is a wall opening and both these hazards are not properly safe guarded.

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Then, unprotected sides and edges when you talk about wall openings and so on then other terminology which comes close by is, unprotected sides and edges. So, the edges in along a slab construction or may be a roof construction should also be properly safeguarded. If you see here, that is the rope for safeguarding but it is not a real protection and otherwise if you want to use rope as a safeguard measure then there should be standard practice of how to put the ropes.

So, this is a staircase edge protection you can see the staircase here and there is no edge protection at all even this floor is also protected properly.

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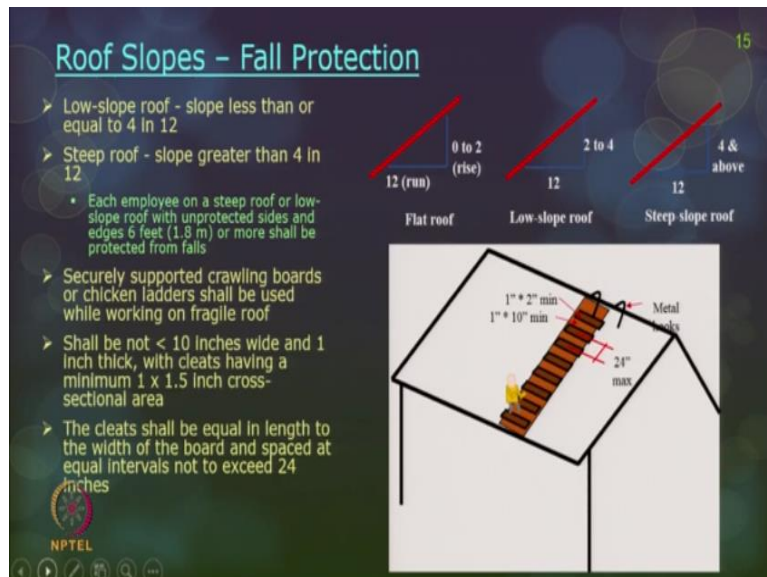
This is an unprotected sides and edges if you see here this complete opening is not at all safeguarded.

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This is also one edge of a floor and completely its unsafe there is no protection at all here.

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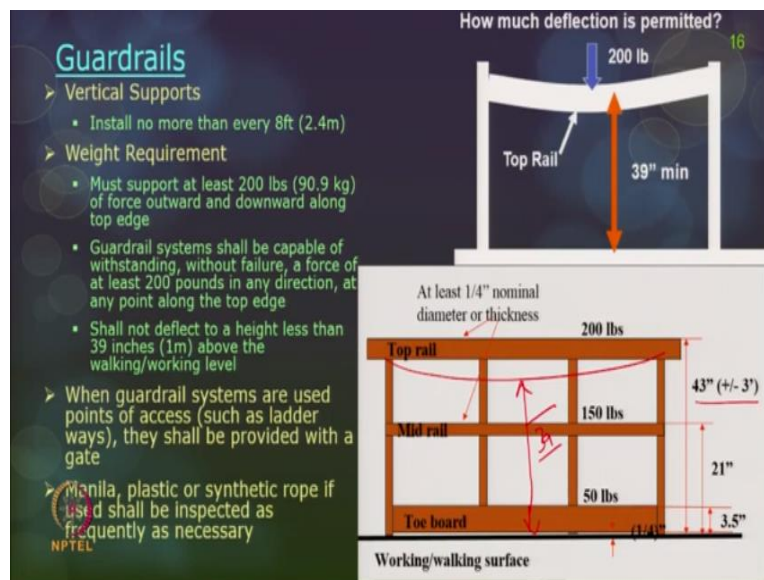


So, what are the ways to safeguard opening like this. Maybe it is an opening or maybe it is an wall opening or it can be an open edge or a floor. So, the only one way to protect is guard rails which we will see little later after understanding what is a roof, slope and so on? Because both these hazards require the same small protection so now in the roof slopes the roof slopes are

conventionally classified as 3 types, number 1 is flat roof, then you have low slope roof and other one is steep slope roof.

Flat roof, suppose if there is a run of 12 you have to have a raise of 0 to 2 then it is primarily called as a flat roof for the same 12 run you may have 2 to 4 then it is called a low slope roof and 4 and above on the run then we call it as steep slope roof. And each employee whether they are working on the slope roof or a steep slope roof should have a proper fall protection in place. And even for flat roof where that is an unprotected edges or slides along all the 4 corners. Then again there should be an adequate fall protection in place for those workers.

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So now, the fall protection as I told for any opening or any unprotected edges sides or for a sloped roof is primarily called guard rails. So, what is this guard rails? This guard rail is primarily nothing but a 3-line member 3 horizontal lines. The top line is primarily called top rails then we have mid rails and toe board and with adequate vertical planks along the support so that these 3 rails are position.

And the height of all these rails is also given, so the top rails should be least 43 inches in height and the mid one should be 21 and the toe board should be at least 3.5. And if you want to leave a gap between the floor and toe board it should not be more than 0.25. So, this is what are the dimensions of the 3 rails and if you talk about the load the top rails should able to withstand 200 pounds of weight which comes on it.

The mid rail at least 150 and toe board should be at least 50 and the thickness also it is all given here in this picture and as such the guard rail should be in place in the sides. Now if you talk about the weight requirement the entire guard rail should be able to support at least 200 pounds or 100 kgs of force on any direction along the top edge. It can be on outward, forward, downward direction whatever direction you apply that can be a deflection. And the deflection should not be more than 39 inches from the walking or the working surface.

So, if this is 43 plus or minus 3 and this deflection can go only till here so in this deflection is nothing but is mentioned as 39. It cannot go below that if that is the case then these rails have to be inspected and accordingly braced for use. And this guard rail is used if they are used as the point of axis for ladder ways or something then they should have a proper gate also. So that they are not disturbed and actually the people are walking in and move out is the guard rail in place.

If any site is using manila or plastic or synthetic ropes then they should also be tested very frequently in order to check for the strength requirements. Whether they are still withstanding the strength requirements or not?

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These are some of the pictures on where guard rails are in place. This is primarily and now floor opening and there is a guard rail which is painted in orange color which is bright which is actually visible from far off distance saying that there is a guard rail in place. This is a wall

opening which again has the guard rail in place and as a safety precaution this is also a floor and wall opening which has primarily a guard rail.

So, this is a wall opening and the guard rails are missing here and this is also a picture of a wall opening and where there is a guard rail missing. And suppose if the worker as to use tilts or elevated heights to reach the roof surface. Then accordingly the guard rail heights, has to be elevated and adjusted as shown in this picture.

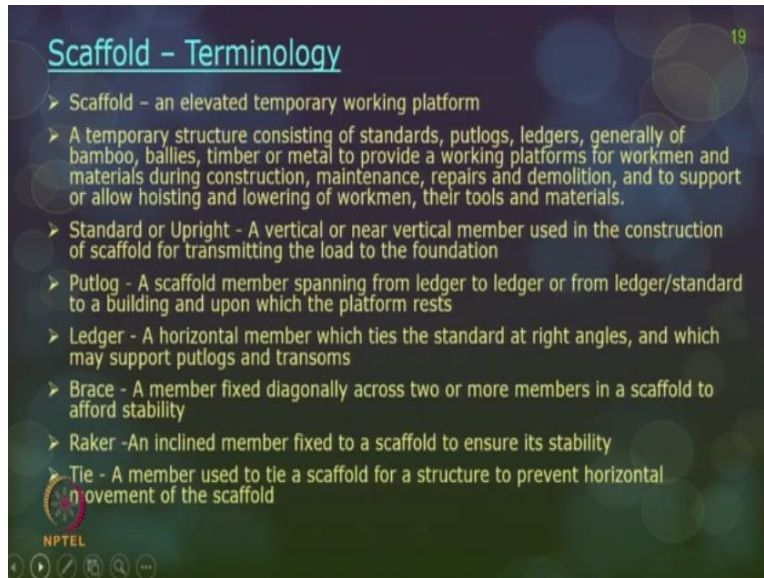
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So, we have discussed about the floor or roof openings and slopes of the roofs and also, we have talked about hole, covers and guard rails which are primarily major safety precautions for when you are working against falls. Now the next hazard is primarily a scaffold if you see scaffold now let us discuss what is, this scaffold? Where is it used? And what are the other terminology, types of scaffold and everything you see along with the safety precaution as well.

If you see a very simple scaffold in a small construction site it looks very simple like this with lot of you know logs on different places tied vertically and horizontally. Through which people climb and do the concreting and brick work and masonry work.

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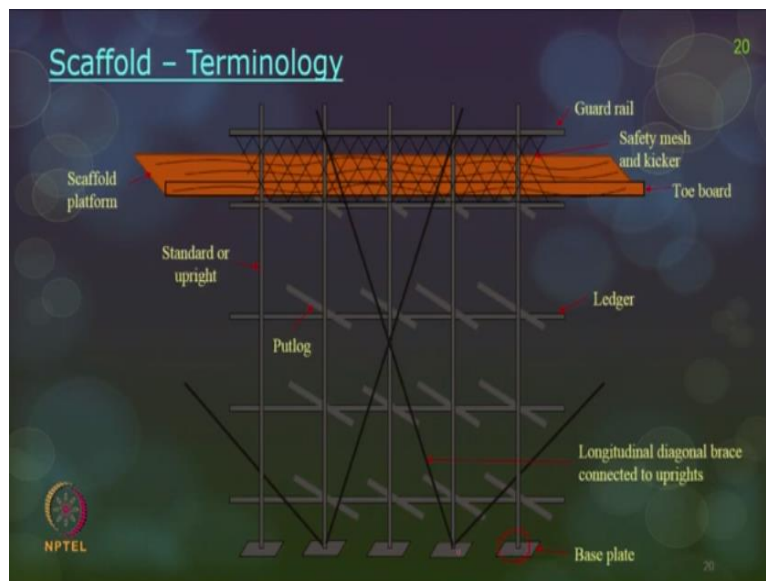
So, in general if you see this scaffold terminology, it is nothing but an elevated temporary working platform for enabling the workers to climb up on to the and reach the working place and this is temporary structure which consist of standards, put logs, ledgers and generally of bamboo or timber or even metal aluminium. There are so many scaffold materials, as come in place and also we have customized scaffold as well as commercially available manufactures scaffold also available these days.

To, provide a working platform for workmen and material during construction maintenance repairs and demolition to support or allow hoisting and lowering of workmen their tools and materials. So, the difference parts number 1 is standard or upright it is a vertical or a near vertical member used in the construction of scaffold for transferring the load to the foundation. So, these are the main member in these scaffolds.

The next one is putlog is as scaffold members spanning from your ledger to ledger or from the ledger or standard to a building and upon which the platform rests. And what is the ledger it is a horizontal member which ties the standard at right angles and which may support the putlogs and also the other staff members. Brace a member fixed diagonally across 2 or more members in a scaffold primarily to have the stability of the holes start scaffold.

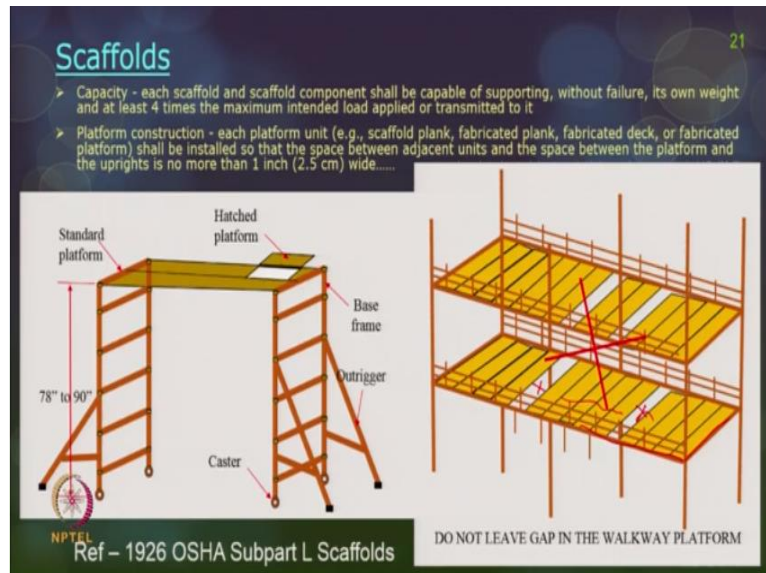
Raker it is an inclined member fixed to the scaffold to ensure stability and tie is used to tie the scaffold for the structure in order to prevent the horizontal movement of the scaffold.

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If you see some pictures of this scaffold, these are the pictures and all the parts are all labeled here. And if you see here if the scaffold platform is not stable you can also have an base plate so that this scaffold are firmly put in place.

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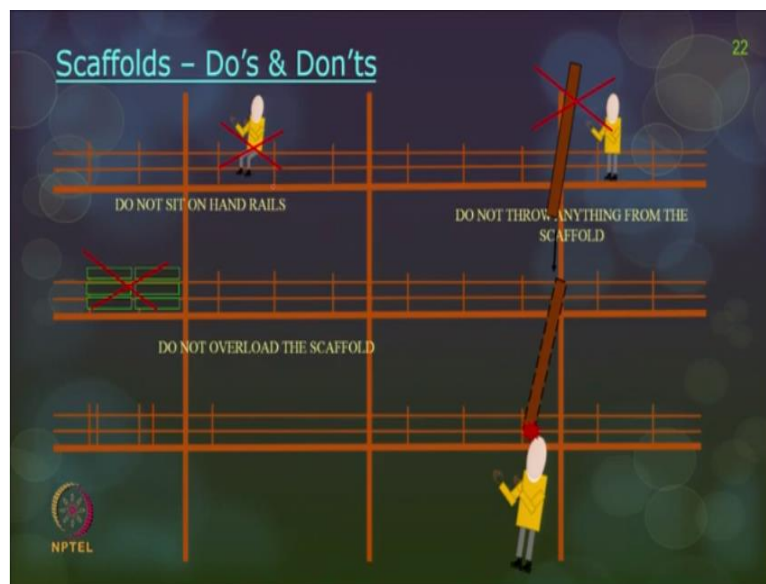


Now let us talk about each and every part of the scaffold and what does the safety requirements talk about. So, scaffolds capacity each scaffold or its scaffold component should be capable of supporting without any failure at least 4 times the maximum intended load. If you plan for a load x it should be at least able to accept $4x$ the load. And platform construction so each platform unit

shall be so installed between the adjacent units and the space between the platform and the uprights is not more than 1 and half centimeters wide.

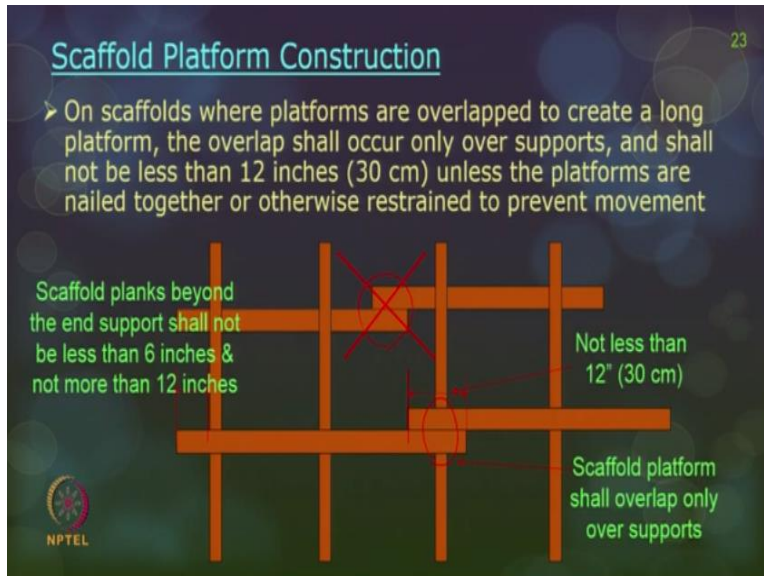
So, suppose if these are your standards, between your standard and your scaffold planks you can have not more than 1 inch width gap. And between the scaffolds planks you should not have any gaps and it should be so arranged so closely like this. And these are the outriggers in order to have a fixed mobile scaffold in order to keep it in position. And also, you can have hatch platforms for movement of people and material.

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Some do's and don'ts on the scaffolds. Do not sit on the hand rails, these hand rails are the guard rails are primarily for safety of the scaffold in order to prevent people from falling down. So, you should not be sitting on the hand rails, do not throw anything from this scaffold, it falls on the people or any public who are passing by that place. And do not overload this scaffold unnecessarily do not try to keep material more than what is necessary and even though it can support 4 times the load.

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Scaffold platform now let us talk about the platform. So, the platforms should not be when the platforms are to be overlapped in order to have a very long length of the scaffold. So, they can be overlapped only on the supports and this overlap should not be less than 12 inches or 30 centimeters in width. And this should happen only along the supports and not on the middle of the support.


And the scaffold planks beyond the end support shall not be more than 12 inches and not less than 6 inches. It should not be used as the cantilever action or something so people should not be loading material or something over there. But only for an end support and end vicinity, it can be extended.

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PLATFORM WIDTH

- Platform is not more than 2 m above the ground or floor
 - Painters, decorators or similar workmen - 300mm
 - Other types (men and tool only) 500mm
- Platform is more than 2 m above the ground or floor
 - Men, tools and material - 900mm



NPTEL

Now platform width, if it is not more than 2 meters then it is primarily used for painters, decorators and other people and other men and material also can use. For other men and material platform which could be 500 mm and for painters, decorators you have a platform, they need a platform width of 300 mm. If the platform height is more than 2 meters above the ground or from the floors from where material is lifted and supplied. Then you can have a standard platform width of 500 mm.

You can also have access ways or ramp ways like this and for usage and this is also a bad working platform for usage. And even though, workers have not used a proper PPE also in the particular picture.

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Scaffold End Platforms

- Each end of a platform 10 feet or less in length shall not extend over its support more than 12 inches (30 cm) unless the platform is designed for tipping load (cantilevered end)
- Side & End Brackets
 - Designed to support people ONLY
 - Brackets are not to be used on rolling towers
 - Brackets introduce overturning and/or uplift forces
 - Do not store materials
 - Only store materials on scaffolds which are for immediate use
- Do not overload platforms with materials



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Now the scaffold end platform as a cantilever should not be loaded up and use like a cantilever means. Unless it is specifically designed for tipping load which is primarily the cantilever action unless it is specifically designed and recommended. It should not be used as a normal platform the side and end brackets designed to support people only and not for equipment. And for other, only for inspections for checking something people can use but not for loading and storage of materials.

And these do not store materials and only store materials on scaffold which are for immediate use and if it is for a long-term use after 1 day or 2 day only, you need something then do not load those materials on to the scaffold. Also do not overload the platform too much of materials because it can have this trip hazard also when workers on passing by this scaffold.

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MEANS OF ACCESS to Scaffolds

- Means of access may consist of ladder, ramp, or stairway
- Stairways - For scaffolds exceeding 4m height, stairways are the safest means of access.
 - Treads and risers should be of uniform width and height in any one flight,
 - Minimum width of 1 m,
 - No unbroken vertical rise of more than 4 m,
 - Maximum angle of ascent 50 degrees,
 - Stair railings on all open sides,
 - Handrails on all enclosed sides, and
 - Standard railings and toe boards on all landings
- Ramps or Gangways
 - Advantageous for access to scaffold platforms from hoisting towers or from adjacent floor levels but are not practicable where there is appreciable difference in levels
 - If the ramp or runway is 1.5m or more above the ground or floor level, the open sides should be protected by standard railings and toe boards
 - The slope of the ramp shall not exceed 2 in 3
 - If the slope is more than 1 in 4, proper foot holds such as cleats shall be provided
- Ladders - Portable, hook-on, and attachable ladders shall be positioned so as not to tip the scaffold

NOTE!

Ref – IS 4912: 1978

Means of access to scaffolds, how do these workers are along with the equipment and material try to access the scaffold. So that means IS code and OSHA recommends 3 means as an access to scaffold. One is ladder, worker can use ladder or there can be ramps or stairways. Stairways are generally used when you want to the scaffold for a long-term purpose. For example a construction will take like for several months then it is not advisable to use a ladder or ramp better make a stair case.

Otherwise, ladder is safest means of use if it is for short term purpose and ramps are also used for easy lifting of materials and movement of materials. So, stairways for scaffold exceeding 4 meter in height stairways are the safest means of access. And how should these stair ways be for preventing from falls. The treads and risers should be uniform width and height in anyone particular flight.

And the minimum width should be 1 meters and maximum angle of ascent should be 50 degrees and the stair railing should be there on all open sides. Handrails should be there on closed sides and standard railings and toe boards should also be there on all landings. You should have safety precautions of guard rails and even on the landing. Ramps or gangways and its advantageous for access to scaffold platform from hoisting towers and from adjacent floor levels.

But if you have difference in level between the 2 platforms then ramps are the good source of solution. If the ramps or runway is 1.5 meters above the ground floor level then it is

recommended to have a protection with the standard rails and toe boards. And the slope of ramp should not exceed 2 is to 3 in the sense for every 2 meters in height the horizontal length should be 3.

If the slope is more than 1 in 4 in the sense so your horizontal is 4 and vertical is 1 if it is more than that. Then there should be a proper fall protection on either sides or the ramp should also have cleats in places. So, that it has creates friction for the moment of material and people. The last option is ladders there are so many ways of mains to access you have portable ladders there are hook on ladders and attachable ladders.

Hook on ladders and attachable ladders are generally designed along with the scaffolds. So along with the scaffold it comes with the proper design and portable ladders are designed separately. And we will talk about the safety of portable ladders and in the next few slides.

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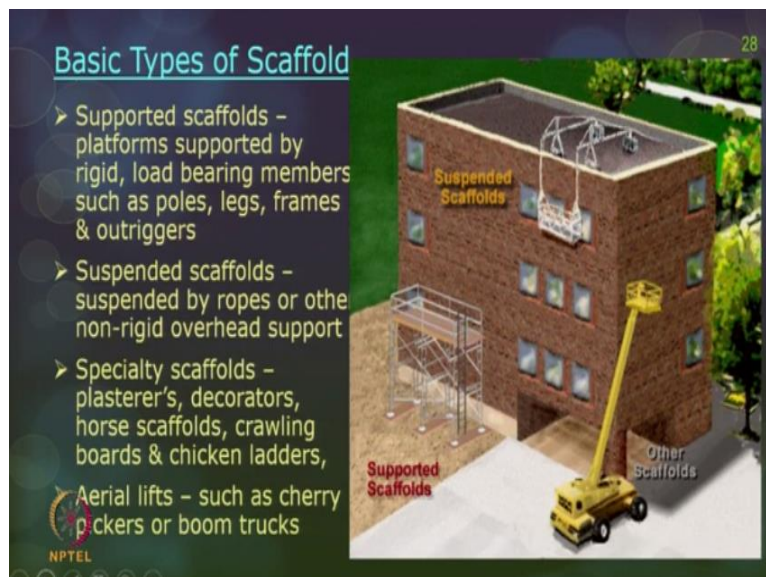


Some quick recap on hazards in scaffolds. So, this is a picture on improper scaffold if you see here the scaffold itself is not done properly. And there can be hazard or maybe a danger here poor housekeeping along the platform you should not be loading material on the platform. And also, the platform is not regular in the sense they actually know not aligned properly so that the workers may have a fall hazard.

So improper support, if you see here the ladder itself is not in place and the worker is trying to operate something with the roof. So this is an improper support, improper access you should also have a proper means of access for accessing a scaffold and this is not a proper access. If you see here, these are the improper access to reach and scaffold. Improper working platform if you see here all the planks are overlapped not on the supports.

But also, you should be secured so that the planks are not disturbed by the movement of people and material or equipment. If you see here, it is not properly fixed in place and no safety harness by the worker for working in scaffolds then incomplete walk way. The walkway itself has a huge gap or an opening unsafe act of using the scaffold for resting. So, these are all some of the pictures to show and this is what we have discussed on scaffolds.

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Now let us move on to types of scaffold. Researchers have classified the scaffolding to 3 types. Number 1 is supported scaffold which is called conventional scaffold. Supported scaffolds are all either fixed to the ground or they are mobile which can be still fixed to the firm or fixed to the ground. And these have platforms supported by rigid load barring members such as poles, legs, frames are outriggers and they are either mobile or they are permanently fixed to 1 place.

Suspended scaffolds are generally you know hanging scaffolds are from 2 rigid supports which are actually overhead. They are primarily from the roofs are somewhere above the building construction and from their, through ropes or strings there is a scaffold platform and from where

the workers try to finish up their work. The other one is specialty scaffolds and there are lot, of example in specialty scaffolds like horse scaffolds, crawling boards and so on.

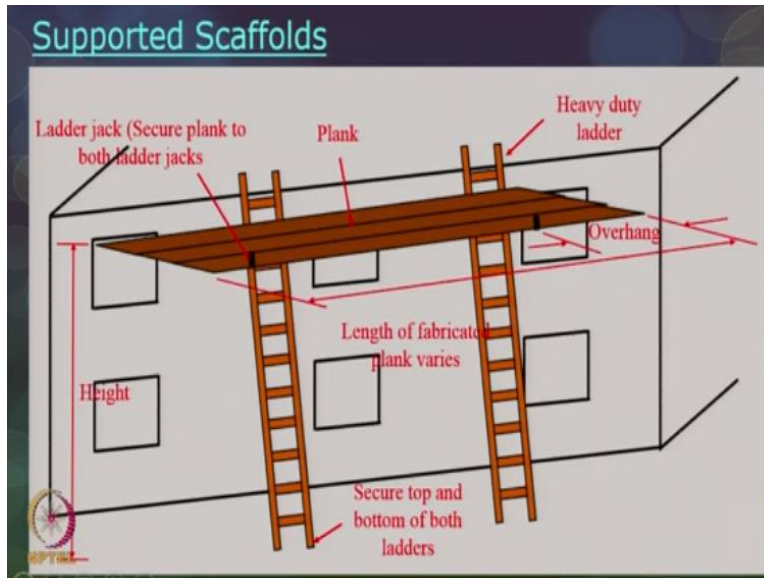
And the last one is aerial lifts. Aerial lifts are like cherry pickers and boomed trucks wherein using a truck on boom you can have a small aerial lifts and workers can reach the particular place and finish up their work. So, these are the 3 types of very famous 3 types of scaffolds and we will talk about the safety measures only for supported scaffolds and for suspended scaffolds.

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Now supported scaffolds there are so many types available number 1 is fabricated frame which we also called it as a poles scaffold and again there are so many types available there. The other one is mobile scaffold which can be moved from one place to another, along with the guard rails and the platform deck and access to the scaffold it can be moved.

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And the third one is ladder jack scaffolds which has 2 ladders along with the scaffold support and through which again there are several types of ladder jacks support are there. And with this also this, scaffolds can be moved and accessed.

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Safety -Supported scaffolds

- Design each scaffold. Also Never fix the parts if they are not compatible
- Ground should be levelled before placing the scaffold. Mud shoes to prevent sinking of the poles into the ground
- Planks should be stacked as close as possible (no gaps) to avoid slips & trips
- End support of the planks should be 6 to 12" over
- Overlapping of planks to cover a large platform should be atleast 12" min
- To cover two right-angled planks, cross-planks may be laid. These cross planks should be secured first
- 14" is the width of platform
- Protected with guard rails
- Don't paint on the planks as they try to hide the damage
- Avoid the HT power lines
- Don't climb the scaffold along the cross braces
- Access by walkways, ladders, ladder towers or ramps (stair rails used)
- OSHA recommends angle of 20degrees with the ground for the ramps
- If the ramps are 6feet above the ground, guard rails to be installed
- Debris to be min on the scaffolds. Debris nets prevent objects from falling down
- If heavy objects are to be used in scaffolds, the area to be barricaded
- PFAs, PPE are supposed to be used

NPTEL

Now safety measures for supported scaffolds and again there are so many points listed out here but many of them will be really simple and easy for you to go through. If you go through along with the steps number 1 is all the scaffold should be designed and constructed properly. And if you want to get a commercial manufactured assembly then you should not have different manufacturer parts which can be you try to fix it in the site.

It should be from a single manufacturer or it should be compatible so that the coupling and others are all easily getting fastened. Otherwise, they are not advisable to be used in the construction sites. Design each scaffold and also never fix the parts if they are not compatible with each other. Never try to know hammer it or do something so that the parts are getting you know to pipes are getting connected or something.

So do not try to do any such practices in the construction site and the ground should be so level before you play the scaffold. And if the ground is not leveled or maybe one's side poles are sinking into the ground then you should have proper know platform or some base plates. So that the ground, the poles are all standing firm on to the ground without sinking moment. And the planks should be so stacked that as close as possible and so that there are no gaps in order to avoid the slips or the trips.

And the end support should be at least 6 to 12 inches over and the overlapping of planks should be at least 12 inches minimum and should happen only on the supports. And to cover right angle planks so generally cross planks can be raid. There is one scaffold this direction one scaffold in this direction and you wanted to cover these 2 can have cross planks and in order to do this. And these cross planks should be secured first and then only you should put the normal planks and finish up the right-angle planks.

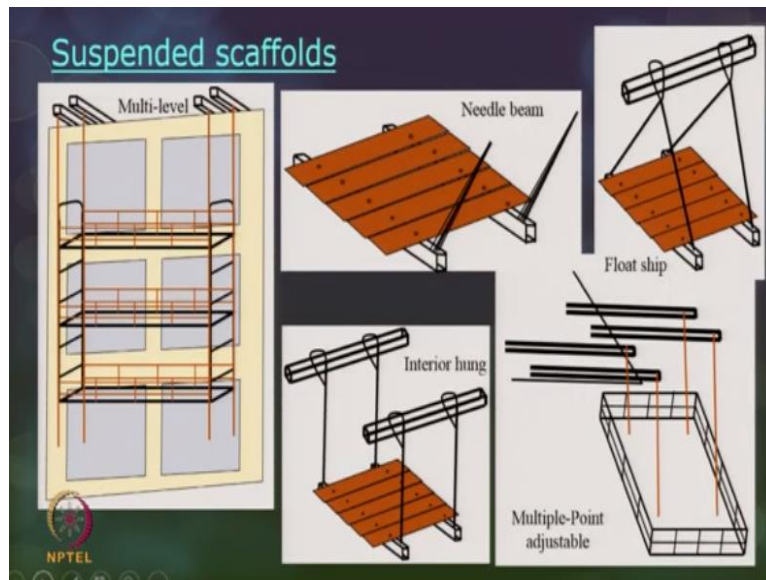
And 14 inches is generally the width of the platform and all platform should be protected with guard rails if the height of the scaffold is more than 6 feet and above you should have a proper guard rail protection. And do not paint a plank. What happens is most of the time there will be visual inspections on the scaffolds. So, any sprinters or any cracks or anything seen in these planks will go hidden if you start painting the planks. So do not paint the planks so that these damages are really visible.

And avoid any overhead power lines when you are putting the scaffolds so that it is not touching the power lines. And if you primarily use a metal scaffold, then you should be very careful and having a clear minimal distance when against a power line when you are using a metal scaffold. Do not clamp these scaffolds along the cross braces and always try to have access to the scaffolds either by ramps, chairs or ladders.

Then access by walk ways, ladders or ladder tower or ramp should always be used OSHA recommends angle of 20 degrees with the ground for the ramps. If the ramps are 6 feet above the ground, then you should have a guard rail. And always try to keep material as well as debris to be, minimum on the scaffolds. And if you are trying to have so many debris selecting on to the scaffolds try to have a debris net and at least the toe board should be little wider in height so that it is actually collecting the objects from falling down.

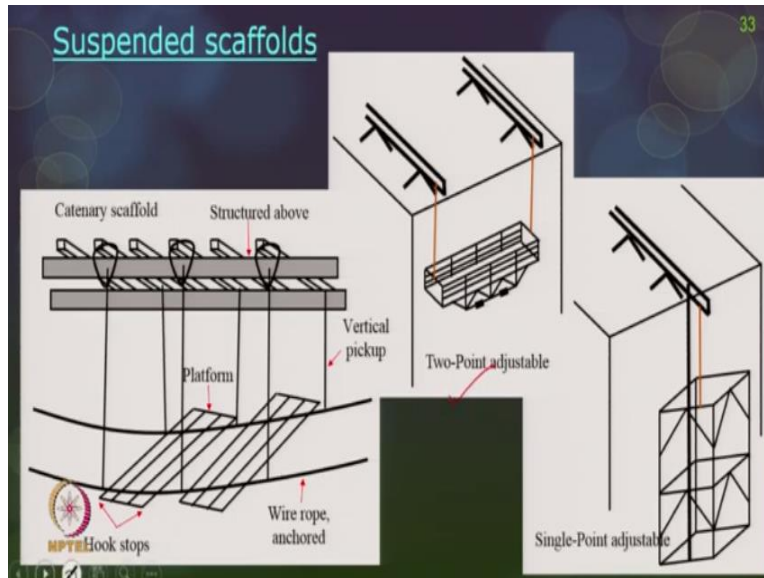
And also, if you think of material which can be tripping and falling down you can think still put a debris net. If heavy objects are to be used in scaffolds they should be barricaded and personal fall arrest systems and proper PPE are supposed to be used for the workers to work in this scaffolds and also for any workers and supervisors who visit the site and do the inspections. For all it is recommended.

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The next type of scaffold is suspended scaffolds as I told these suspended scaffolds are working platform of scaffold which are from a roof or any place which is above the construction. And from there is like a hanging support again there are so many types here multi levels, needle beam, interior hung, float ships, multiple point adjustable.

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Then 2-point adjustable, single point adjustable and you also have catenary scaffolds. So, most of the safety precautions which; I am going to talk about in this suspended scaffold will be easily fitting in for 2-point adjustable scaffolds.

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Safety - suspended scaffolds

- Design each scaffold & supervise construction - prevent scaffold collapse due to overload or instability
- Full inspection before use
- Pipes or any protruding objects could trip the passage of scaffold movement
- Maintain safe distance from power lines
- Outrigger beams - used to move the scaffolds up & down. Should be in a tie backs and should be strong enough. To safe more, outrigger beams should be attached
- Check & inspect the suspension ropes for wear & tear, abrasions or burns, kinks (knots) which stop the smooth movement of scaffolds
- Safety break should be designed if the speed of scaffold fall is high
- Electric-driven motors (no gas-driven motors) to operate the scaffolds
- Suspension ropes should be of desirable length & not short
- Limit the use of tools/debris to a minimum in the scaffold. Screens/nets can be put so that material doesn't fall down
- Don't lean on the scaffold so that it will not start to swing
- Don't use the materials to increase/adjust your height to the reach
- Use PFAs if any fall happens. Lifelines should be clear of obstacles
- Guard rails should be installed on all walking surfaces

Now, we will talk about the safety precautions again as I told all scaffolds should be designed, constructed, erected under the supervision of a skilled person. And you should do proper care while you are designing and constructing these scaffolds. Design each scaffold and supervise to prevent scaffold collapse due to overlap load or instability. And there should be a competent person to do full inspection before using the scaffold.

And every time you start using the suspended scaffold and it should be fully inspected and then only it should be used. And since these scaffolds are actually you know over hanging from the top support any pipes or any partition on to the wall or the surface from where the scaffolds are hanging should all be avoided and accordingly the scaffold should be suspended. Because it can have trip of the scaffold or it can be even had a trip or movement of the scaffold itself.

And again, maintain safe distance from the power lines and outrigger beams actually the beams from the entire scaffold is hanging at, and which is used to move the scaffolds up and down it should be in a tie back it should be very strong enough. And it should be having an equal strength of 2 times or 4 times the maximum intended load of the scaffold along with the people and material and equipment.

To safe more this outrigger beam should be very rigid and attached on to you particular place, check and inspect the suspension ropes now we are talking about the ropes. The ropes should be very clear from wear and tear, abrasions, burns, sometimes you may do some welding or you may use chemicals. And as a result, there can be a wear and tear on to the ropes so that should be inspected.

And there should not be any kinks or small knots kinks are nothing but knots when there is any knot it will actually have an unsmooth movement of the scaffold up and down. And as a result, it may have a scaffold collapse. Safety brakes should also be designed and because the spade of this scaffold also depends on the wind speed and so on. So sometimes this speed is too high during a fall during a descending movement.

There should be an adequate safety brakes so that the speed of this scaffold is really controlled in order to have a smooth movement in ascending and descending both the ways. And electric driven motors are generally advised to operate the scaffold rather than gas driven motors. In order to prevent fire protections, suspension rope should of desirable length and should not be too short so that the workers are actually you know trying to reach a particular place in order to prevent an awkward position.

We have talked about imbalance and awkward positions so the workers should be able to reach every place in the wall or in the construction site very easily and accordingly the suspension

ropes should be very long and in proper size. Limit the use of tools or debris to a minimum in the scaffolds so that what happens is sometimes these materials as debris can also move on the platform.

So, you should be trying to keep as minimal material on to the scaffold and advisable to have screens or nets because this is a suspended and moving scaffold. So, in order to have a safe precaution of falling objects or materials screens or nets can be put so that the material does not fall down. And do not lean on to the scaffold and what happens is? If you try to lean on to the scaffold or on to the wall surface then the scaffold will start swinging.

And when a scaffolding starts swinging and based on the load it can also have collapse or fall of material and persons. And do not use any material like for example some brakes or paint box or something in order to reach or height which is not in your vicinity. Do not try to do in order to increase or adjust your height to the reach of particular work space. Use personal fall arrest systems which is always a safe precaution when you are working on heights.


Life lines should also be clear of obstacles when there are more than one worker and 2 or 3 workers are there. Each of their life lines should not be moving here and there in sense every workers life line should be clear of obstacles and they should be having able to use lifelines properly when the fall happens. The guard rails should be installed on all working surfaces along with the debris mess if required we will prevent falling of person and falling of objects also.

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Safety – suspended scaffolds (Jhula)

- Jhula (Boatswain's Chair) – It has a seat to support a workman in a sitting position, supported by rope slings attached to a suspension rope
- Designed to support only 1 worker
- Seat dimensions - to support the weight of an average worker
- Seat slings must pass through 4 corner holes in the seat & cross on the underside of the seat



NPTEL


And as I told there is 1 separate suspended scaffold which we will discuss and aerial lifts safety we are not covering in this course. So can suspended scaffold is special variety of suspended scaffold called Jhula which is also called Boatswain's Chair which is primarily designed for one worker to sit and finish his work. It has a seat to support a workman in sitting position and supported by rope slings attached to a suspension rope.


So, designed to support only one worker and the seat dimension are all given here to support the weight of an average worker. And these seat slings should pass through the 4 corner holes should also be crossing on underside of the seat. On the underside of the seat, it generally has to cross on the sides so that it supports worker and he is comfortable in finishing up his work.

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General Safety - Scaffolds

- Scaffolds shall be provided for all work that cannot be safely performed from the ground, or from solid construction.
- Scaffold erection, whether supported or suspended shall be carried out only by skilled workmen under the supervision of a competent person.
- The erection, alterations and dismantling of scaffold should be done only under the supervision of men who are competent for this work. It shall be properly maintained.
- Red Tag shall be provided on the scaffold to caution that the scaffold is under erection.
- Scaffolding erection area shall be cordoned off.
- Use of cross braces as means of access to the working surface shall not be permitted. Use ladders or stairs.
- Lifting of scaffolding materials shall be done using Rope & Pulley arrangement.
- Working platforms shall be fully decked and provided with guardrails.
- Every platform, gangway, run or stairs shall be kept free from any unnecessary obstruction, material, rubbish and projecting nails. Grease, mud, paint gravel or plaster or any such hazardous substances shall be removed from scaffolds immediately to prevent slipping.
- Each supporting member used in the construction of runways, platforms, ramps and scaffolds shall be securely fastened and braced. Should prevent lateral displacement.
- If scaffolds are to be used to a great extent or for a long period of time, a regular plank stairway wide enough to allow two people to pass shall be erected. Such stairways shall have handrails on both sides.
- A scaffold platform plank shall not project beyond its end supports to a distance exceeding four times the thickness of the plank unless it is effectively secured to prevent tipping.
- All scaffolds or working platforms of any nature shall be securely fastened to the building or structure; if independent of the building, they shall be braced properly.
- Safety codes should be strictly followed. Standard safety requirements are just as important for temporary structures as they are for permanent structures.
- Safety nets shall be provided in case there is any possibility for the fall of persons from height.




 NPTEL
 Ref – IS 3696 Safety Code for Scaffolds & Ladders

General safety again a recap on the scaffolds that, we have talked so far. Scaffold shall be provided for all work that cannot be safely performed on the ground or from solid construction works. So, scaffold erection whether suspended or supported shall be carried only by skilled workmen or by a competent authority under the guidance of a supervisor. The erection alterations dismantling of scaffold should be done only under the supervision of a competent person.

And even the maintenance of the scaffold also should be taken care properly and suppose when these scaffolds are under erection it should have a red tag which says unsafe or used. And scaffold erection area should also be barricaded so that no public or not disturbing the scaffold erection. And also, there is no hazard happening. Use of cross braces as means of access to the scaffold should not be permitted and there can be proper means of access like ladders, chairs or ramps for accessing the scaffold.

Lifting of scaffolding materials should be done only with the rope and pulley arrangement and not by workers carrying along with them. Working platforms should be fully decked and not be able to be displaced and provided with proper guard rails. And every platform, gang way, run way or stairs should be kept free from any unnecessary obstruction maybe the material which are moved should not be left here and there. Any obstruction material, rubbish projecting nails and so on and even grease, mud, paint or plaster or any such substances which can create slip of the workers or material should also be avoided on this scaffold. And every supporting member used

in the construction on the run ways, platforms, ramps should be securely fastened and braced. Because that should prevent lateral displacement, these scaffolds are to be used for a great extent for a long period of time. Then there should be a proper stair case or stairway wide enough to allow 2 people to access to the scaffold should be laid down.

And these stairways should also have hand rails and adequate safety precautions from falls. This scaffold platform plank should not project beyond its supports and again this dimension all we have discussed earlier. And all scaffolds are working platforms of any nature should be securely fastened to the building or structure. And if they are independently standing away from the building then there should be adequate supports to prevent tipping of the scaffold.

And all scaffolds are working platforms should be fastened and there should be cross braces to prevent the collapse of the scaffolds. Safety codes should be strictly followed on all these temporary structures. Because these temporary structures are going to be supporting the permanent structure later on. So, it should be properly all safety precautions should be properly followed.


Safety nets should also be provided to prevent fall of persons from height if there is possibility of fall from height.

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Ladder

- Stairway or ladder – required at points of access where there is an elevation break of 19 inches or more
- An appliance or equipment usually consisting of two side rails joined together at regular intervals with cross pieces like steps, rungs or cleats and used in ascending or descending between two points at different levels
- Rope Ladders
 - Ropes on either side passing through holes in the rungs which are of planks
 - The diameter of rope shall be not less than 25 mm
 - Planks forming steps shall be not less than 38 mm thick
 - The steps shall be securely held in position by suitable means

Ref: IS 3696 Safety Code for Scaffolds & Ladders



Now, the next hazard that we are going to study will be on ladders. So far, we have talked about floor openings are roof opening and wall openings. Also, we have talked about slopes of the roofs then hole covers and guard rails as a safety precaution. And then we have discussed scaffolds types of scaffolds and all the safety issues in scaffolds. Now the access to scaffold from that point of you will discuss ladders.

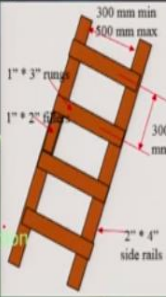
And ladders now, again there are types of ladders and safety precautions for each and every ladder is also little different from 1 ladder to another. So, ladder is an appliance or an equipment usually consisting of 2 side rails there are 2 side rails which are joint together at regular intervals with cross pieces and which is also called as steps, rungs or cleats. And primarily used for ascending or descending movement between 2 points at different levels. That is the definition of a ladder.

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Types of Portable LADDERS - Built-Up Ladders

- Built on the job to site requirements. It is not commercially manufactured
- They are temporary & are used until a particular phase of work is completed
- Side rails
 - Up to 24feet (7m - OSHA, 6m - IS) length continuous & should be atleast 2inch nominal stock lumber
 - Steps must be eliminated above the landing level
 - Surface of the ladder shall be free of splinters
 - Put ladder on a stable & level surface that is not slippery
 - Top and bottom of each built-up ladder shall be fastened securely
- Cleats/Rungs/Steps
 - Rung spacing shall be uniform and not over 300mm on centers
 - Making cuts in the side rails to receive the cleats is not good solution



Ref - IS 3696 Safety Code for Scaffolds & Ladders
OSHA FactSheet Safe use of Job-made wooden ladders

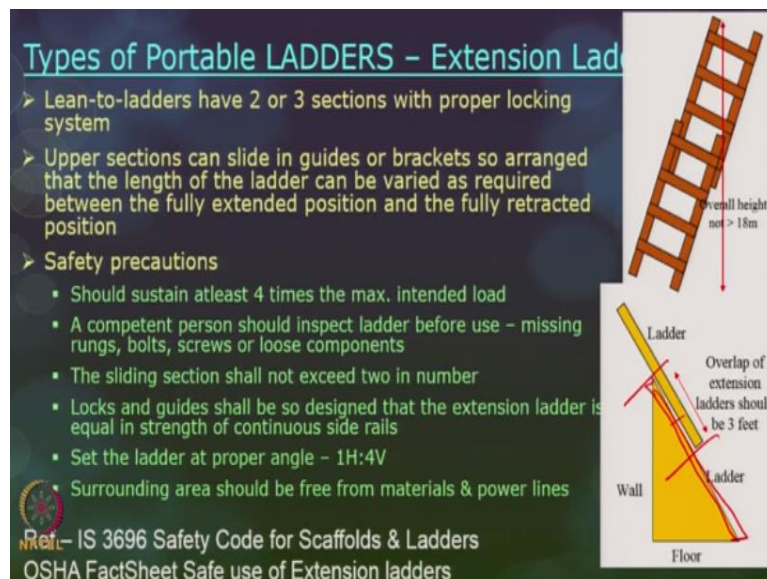
Now there are so many portable ladders which we are going to discuss in today's class number 1 is built up ladders. As a name implies built up ladders are job made ladders. So, these built-up ladders or built up on job site to suite any site requirement and it is not commercially manufactured it does not come with proper dimension. And primarily, the unskilled worker and skilled worker in the particular site they start fixing up the ladders for the suite the requirements of the construction site.

They are temporary and are used until a particular phase of work is completed and then they again dismantle and use for another set of work. So, this is a picture to show the built-up ladder and all dimensions are all given here. So, the side rails primarily it is up to 24 feet as given by OSHA and 6 meters is the length as recommended by IS code. So, it can be continuous and it should be at least 2 inches nominal stock lumbers.

So that it is having a sufficient length the steps that will be eliminated above the landing level so that people are not trying to climb above the landing on the top level from where the supports are there. Surface of the ladder should be free of splinters and put ladder on a stable and level surface that is not slippery if the slide is slippery it has to be cleaned or there should be slip air put in there and then the ladder has to be put in.

The top and bottom of the buildup ladder should be securely fastened and so that it is not moving or getting displaced with the movement of people up and down. The cleats rungs or steps the spacing should be uniform and making cuts in the side rails to receive these cleats is not a good solution because it will weaken the side rails. And it has to be actually fastened on to the side rails only and not cutting and embedding into the side rails.

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The next type of portable ladder is extension ladder as the name implies there can be 2 or 3 sections of the ladder which can be together. And you can have a adequate guides or brackets set up so that it can slide in and out in order to do a different reach of the levels. You can vary the

height accordingly and the maximum overall height has recommended by OSHA is not more than 18 meters.

When the extension ladder is on full swing and these are leaned to ladder having at least 2 or 3 sections generally they do not have more than 3 sections with proper locking system. And the upper sections can slide in guides or brackets, so arranged that the length of the ladder can be varied. As a safety precaution, you should also understand when these ladders are in the full extended position, it should have the same strength as if it is continuous rails that should be kept in mind.

And these ladders should be able to sustain at least 4 times the maximum intended load. A competent person should inspect the ladder before use for any missing rungs or any missing bolts or screws or lose components. And the sliding section as recommended by IS code is not more than 2 in number. Only 2 sections are allowed as per safety norms and the locks and guides should be so designed and the extension ladder is having an equal strength as if it is a continuous side rail.

And set the ladder at a proper angle the proper angle is generally 1 is to 4 what does it means is, 1 horizontal is to 4 verticals surrounding area also be free from materials obstruction obstacles any power lines close by. And whenever the extension ladders are overlapped, the overlap should be at least for 3 feet in distance that is as shown here. So, this is another ladder and this is another ladder. So, this extension should be at least should be 3 feet in the overlap should be at least 3 feet.

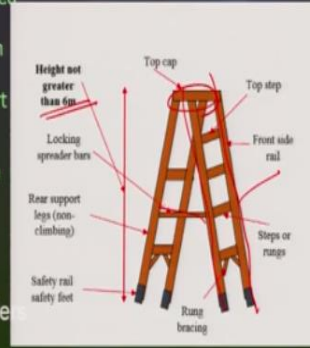
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Types of Portable LADDERS – Step Ladders

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- Self-supporting ladders hinged near the upper end with a spreader arrangement between the two sections. When in use, it's in the form of letter 'A'
- Safety precautions
 - Should sustain atleast 4 times the max. intended load
 - Overall height shall not exceed 6m (beyond 3m shall be equipped with rope or chain)
 - The other sloping side acts as a strut to support the ladder
 - Ladders shall be provided with an automatic locking device or spreader to hold it in an open position
 - Do not stand/climb on the top cap/top step
 - Do not reach outside ladder side rails

Ref: IS 3696 Safety Code for Scaffolds & Ladders
OSHA Fact Sheet Safe use of Stepladders



The next type of portable ladder is step ladder this is also called as A ladder because it as a shape of A when in full expanded position. So, self-supporting ladder hinged near the upper end. The upper end is actually close together with the spreader arrangement between the 2 sections when in proper use its actually looks like A letter and that is where it is also called A ladder. Safety precautions again this ladder should also be able to sustain at least 4 times a maximum intended load.

And this ladder has 1 side for the people to climb and for the other side it is only for a it acts as a strut and it is only for a support to support the ladder. The overall height should not exceed more than 6 meters and above 3 meters a ladder then there should be a proper chain and support for the ladder in order to prevent movement or tipping of the ladder. Ladder shall be provided with an automatic locking device or spreader to hold in the same open position.

And whenever the ladder is in use, it should be in the fully open position with the proper lock so that the ladder is not getting closed. When the ladder is moving close or not in the full open position it can have a tipping hazard. Do not climb or stand or try to do anything with the top cap or the top step and do not reach outside your ladder side rails. Again, it is primarily the awkward position, poster if this is the side rails do not try to extend or go above the side rails to reach out something. That is not advisable and you may have a fall hazard.

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General Safety Instructions – portable ladders

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- Always maintain 3-point contact when ascending or descending, the user shall have both the hands and feet near the ends of the rungs rather than middle
- To prevent slipping, a ladder shall be secured at the top & bottom end
 - If this cannot be done, a person shall be stationed at the base whenever it is in use. All rungs should be clean to prevent slips
- Shall not be used in horizontal as runways
- If the surface of the floor is smooth or sloping, the ladder shall be provided with non-slip bases
- No ladder shall be placed or leant against windowpanes, sashes or such other unsafe or yielding objects, nor placed in front of doors opening towards it
 - If used in driveways, passageways or public walkways, it shall be protected by suitable barricades
- Avoid overhead power lines especially when using a metal ladder

Ref: IS 3696 Safety Code for Scaffolds & Ladders
 OSHA QuickCard Portable Ladder safety

Now general, safety instructions for any portable ladders always maintain a 3-point contact when you are ascending or descending a ladder. So, the 3-point contact is either 2 hands and 1 leg on to the rungs so primarily you have to put the 2 hands on to the side rails and both the legs on to your rungs. And these 2 hands should be closer to the side rails on the rungs or on the side rails and feet also should be closer to the side rails only even though it is on the rungs.

And when you are trying to put both the legs on to your rungs then you should be able to put your one hand either above or below. So, at any point of time there should be a 3 point of contact on to the ladder. So, if you try to carry some material what happens is? You may not be able to use the 3 point contact on to the ladder and obviously you are going to have a fall hazard. To prevent slipping a ladder should be always secured in place even though it is a portable ladder.

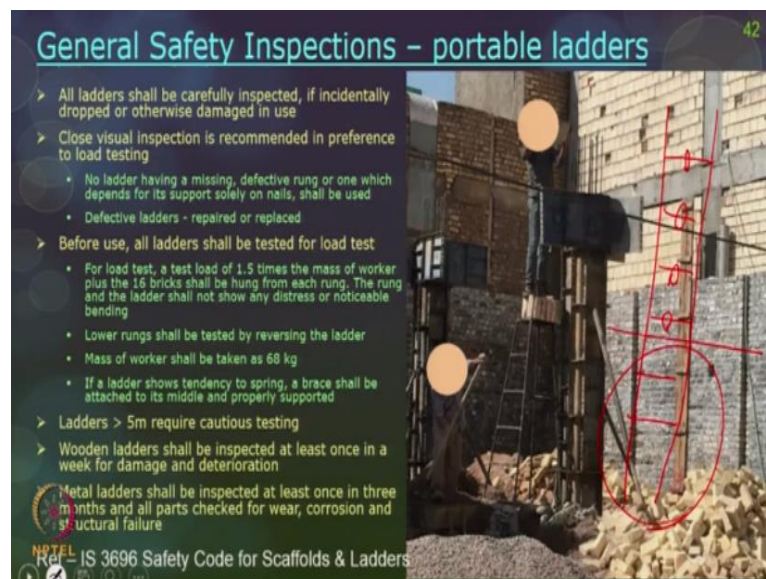
And whether it is to be used it has to be properly secured both the top and at the bottom. And when you are trying to climb or up or down the ladder. Always face the ladder and do not try to use the other way. And these ladders shall not be used in horizontal as runways for other purposes to meet 2 different positions along the horizontal ways. And if the ladder cannot be secured both on the top and bottom then there should be a substitute a person standing on the ground floor to hold the ladder firm.

So that you know the worker can climb and go safely all there are rungs should be clean to prevent slips. And also, the shoes used by the workers also should be cleaned to prevent slips and

trip hazards. The surface of the floor is smooth or sloping the ladder shall prevent with the non-slip bases. And no ladder shall be placed or leaned against any window panes that people are trying to open the window or may be any glass sheets or glass walls or any doorways or access ways or any unsafe or yielding objects.

Do not place the ladder at the top point on to your glass pane or something. So that you know you are having a hazard if used in the midst of dry ways passage ways or public walkways accordingly the area should be barricaded so that the ladder is not displaced or disturbed. Avoid overhead power lines which is a general precaution for all, who are working at heights especially when you are using a metal ladder.

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General Safety Inspections - portable ladders

- All ladders shall be carefully inspected, if incidentally dropped or otherwise damaged in use
- Close visual inspection is recommended in preference to load testing
 - No ladder having a missing, defective rung or one which depends for its support solely on nails, shall be used
 - Defective ladders - repaired or replaced
- Before use, all ladders shall be tested for load test
 - For load test, a test load of 1.5 times the mass of worker plus the 16 bricks shall be hung from each rung. The rung and the ladder shall not show any distress or noticeable bending
 - Lower rungs shall be tested by reversing the ladder
 - Mass of worker shall be taken as 68 kg
 - If a ladder shows tendency to spring, a brace shall be attached to its middle and properly supported
- Ladders > 5m require cautious testing
- Wooden ladders shall be inspected at least once in a week for damage and deterioration
- Metal ladders shall be inspected at least once in three months and all parts checked for wear, corrosion and structural failure

NRTEL
Ref - IS 3696 Safety Code for Scaffolds & Ladders

So general more safety precautions on portable ladders. So, all ladders should be carefully inspected if incidentally dropped or damaged and other wise used it should be inspected before usage. Close visual inspection is recommended even more than a load testing. So, no ladder having a missing or defective run or which depends on support only on nails or something should not be used.

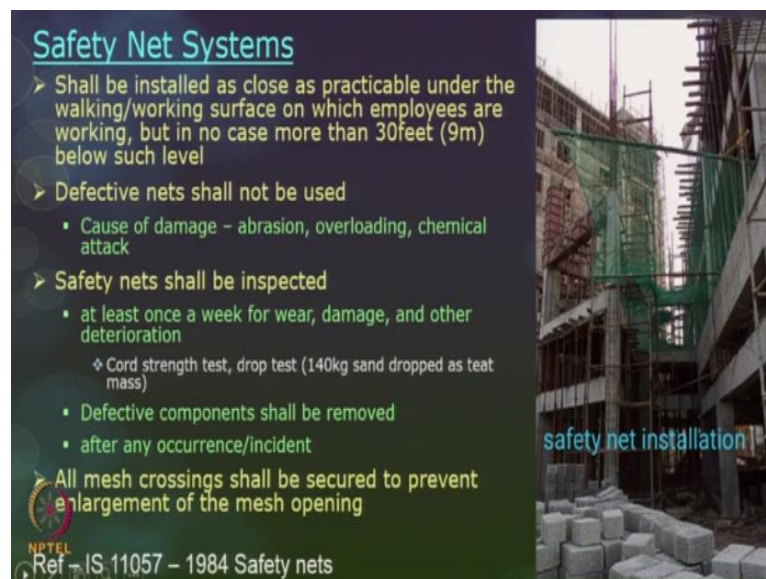
Defective ladders should be immediately repaired or replaced and then only they should be used. Then before use all ladders should be tested for a load test so how is this load test done? Suppose there is a ladder these are the 2 continuous side rails and there are lot of cleats or steps from all

these cleats there is board hung on every cleat or rung. And this load is actually 1.5 times the mass of worker + 16 bricks generally it hung from each of the rungs.

If the mass of the worker is generally assumed as 68 kgs and accordingly the load is put along all these rungs and looked for visible noticeable bending or deflection. If that happens in cross bracing has to be placed so that the ladder is fine so when half of the ladder is done the testing in this way the ladder is reversed so this bottom portion will come on the top again the same procedure is repeated on all the bottom rungs.

And the load test is performed so that all these steps are looked for bending support for any visible bending. And ladders more than 5 meters in overall height remains a cautious testing. And the wooden ladder should be inspected at least once in a week for any damage. And metal ladders can be inspected at least once in 3 months for all wear and tear corrosion or structural failure. These are the some of the thumb lines given in the IS codes.

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Safety Net Systems

- Shall be installed as close as practicable under the walking/working surface on which employees are working, but in no case more than 30feet (9m) below such level
- Defective nets shall not be used
 - Cause of damage – abrasion, overloading, chemical attack
- Safety nets shall be inspected
 - at least once a week for wear, damage, and other deterioration
 - ◆ Cord strength test, drop test (140kg sand dropped as test mass)
 - Defective components shall be removed
 - after any occurrence/incident
- All mesh crossings shall be secured to prevent enlargement of the mesh opening

Ref – IS 11057 – 1984 Safety nets

safety net installation

Next, we will talk about safety nets so this is again when you talk about for protection safety nets is one of the ways to safe guard people from falls. So, what is the safety net? So, this safety nets are primarily to catch worker or people from when they fallen down. So, this should be installed as close as possible under practicable under the walking or working surface from where employees are expected to fall.

And suppose if the height between the walking or the working surface from where the employees fall in the safety net is you should not be more than 9 meters below the level. And the defective net should not be used, the causes for damage can be so many reasons in a safety net. It can be abrasion, overloading, chemical attack and so on. Safety nets should always be inspected again visual inspection always do its purpose.

And, at least safety net should be expected once a week for wear, damage or other deterioration and also there are other proper test on safety nets. One is cord strength test and other one is drop test so how is this drop test done 140 kilograms of sand bags are generally dropped as a test mass and seen for deflection. So, this is within a permissible limit of deflection then it is passed and the safety nets can be continued for its use.

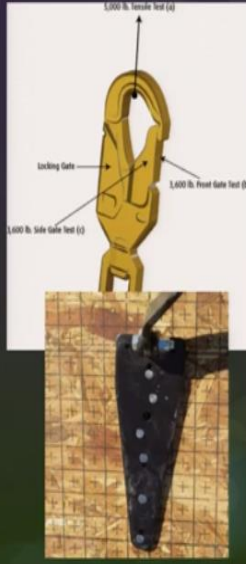
And if there are some defective components and the measures have all yielded and so on then those components will be replaced and then it can be kept for permanent use. And when should these inspections be done after any occurrence or incident the inspections on safety nets should be generally done. And all mesh crossings should be secured to prevent enlargement of the mesh opening.

If you see it is like a net it is like a cross net and the openings should be 10 dimensions. And that if it is expands then accordingly the safety net as to be repaired. The next fall protection measure is fall arrest system or personal arrest fall arrest system which we call in short form as PFAs. So, this PFAs, it is very easy to remember what is the PFA? If it is in ABC that is how when you search you will learn about PFAs ABC soft wall protection, it generally people say that is primarily your PFAs.

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Personal fall arrest systems

- A - Anchorages used for attachment of PFA shall be capable of supporting at least 5,000 pounds or twice the intended load
- B - Body harness means straps which may be secured in a manner that will distribute the fall arrest forces over at least the thighs, waist, chest and shoulders
- C - Connectors
- D-rings and snap hooks shall have a minimum tensile strength of 5,000 pounds
- Rope grab means a deceleration device which travels on a lifeline and automatically, by friction, engages the lifeline and locks so as to arrest the fall of an employee
- Lanyards and vertical lifelines shall have a minimum breaking strength of 5,000 pounds



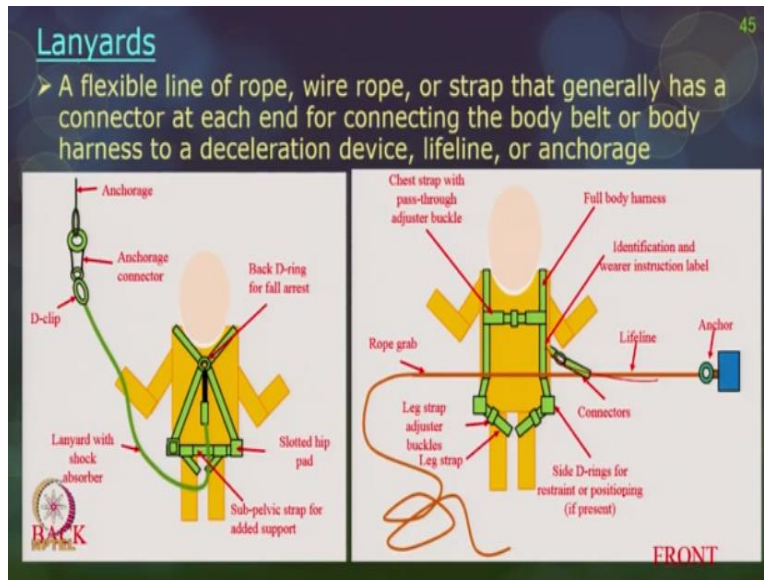
NPTEL

So, A stands for anchorages are the permanent support from where your fall protection devices are hanging. And these anchorages used for PFAs should be capable of supporting at least 500 pounds or twice the intended load. The next one is B, it actually stands for body harness or full body harness means the straps which run over the worker which can be secured in a manner. So that your lanyards, is actually distributing the load on to your complete body that is primarily it spreads the load on to your full body is primarily called full body harness.

C is for connector which connects the lanyards to your rope to your life lines and you have also called D-rings and snap hooks and this should also be having minimum tensile strength of 5000 pounds. Rope grab, it is a deceleration device which travels on a life line and automatically which can know by friction engages the lifeline and so that you are actually know having your limiting distance from your anchorage point to the reach of your workplace.

The Lanyards are the real say life time vertical life lines which a worker uses and this should have a minimum breaking strength of 5000 pounds.

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Again, there are so many types of lanyards like for example single leg lanyard and double leg lanyard, shock absorbing lanyard and so on. Single leg lanyard means from the worker you have single point of anchorage, double leg lanyard is from the worker you have 2 points of anchorage. So double leg lanyard is considered more safer in terms of protection than a single leg lanyard.

So, what is a lanyard? It is a flexible line of rope or a wire rope or a strap that generally have a connector at 1 end for connecting the body belt or body harness to your lifeline or anchorages. The parts are all given here so this is the full body harness from where you have the lanyards which is connected to your lifelines. And this is anchor point and this is the rope grab is primarily helping you to adjust the length of your lifelines. And then there are other adjustors on every point are all given here.

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These are some of the hazards in personal fall arrest systems, for example this is not a permanent anchor. The lanyard is not anchored properly to a permanent anchor and this person is actually used as an anchor for the lanyard again these are not a proper ways of using a lanyard.

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Protection from falling objects

- PPE - Hard hat
- Erect guardrail systems to prevent objects from falling from higher levels
- Erect a canopy structure and keep potential fall objects far enough from the edge of the higher level so that those objects would not go over the edge if they were accidentally displaced
- Barricade the area to which objects could fall, prohibit employees from entering the barricaded area, and keep objects that may fall far enough away from the edge of a higher level so that those objects would not go over the edge if they were accidentally displaced
- Chutes
- Toe boards

Next protection from falling objects, so PPE is compulsory, try to wear hard hat when you are passing by place where this is a hazard of falling objects. Erect guards, rails system along with the debris net so that objects are not falling from higher levels. Erect a canopy structures there is a public path way or something it is better to have a canopy structure. So that these falling objects are not, on to the public or to the workers who are passing below the site?

Which may go accidentally you know, may be on to the workers. Barricade the area and try to have the public access to a different side which is also a good suggestion to do in order to protect people and the workers from the falling objects. And try to have maintained chutes and these chutes should also be having a proper safety net so that the materials are actually caught into the particular place a shown in the pictures.

And toe boards can also be little higher high so that the object are not falling down these are some of the protection measures from preventing objects from falling down.

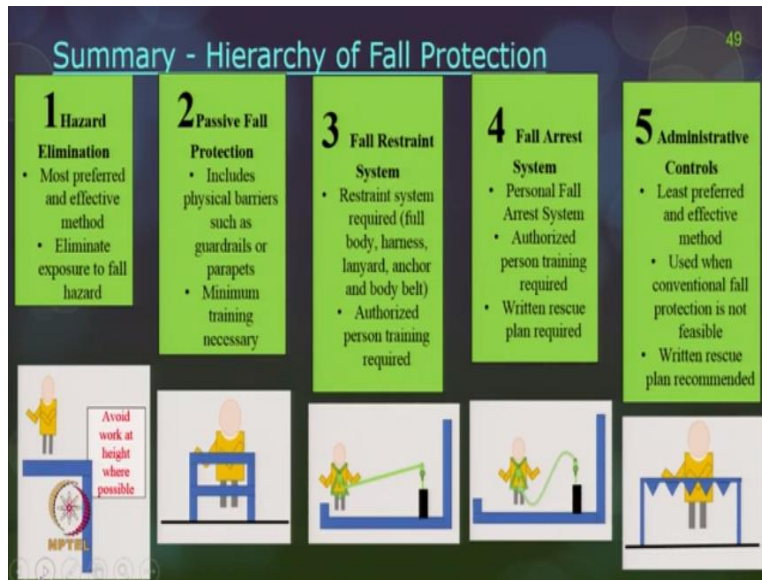
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Then protection of men from falling down, protection under scaffolds where persons are required to work or pass underneath as scaffold and screen or canopy shall be placed. And these screens shall extend our distance of at least 1 meter beyond the edge of the scaffold above the passage to catch material which may fall can be even a net with a mesh of 25 mm is also satisfactory. Protection of supervisory or inspecting officials these supervisory staff inspecting officials or any person; who have to go to the vicinity of the scaffold.

They should wear a proper helmet or a safety hard hat. Within a zone of at least 10 meters to be protected from falling objects, they cannot also know not go too close. So, they can be in the vicinity 10 meters from the area where falling objects hazards takes place.

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Now summary of fall protection we have seen the possible hazards and also the ways to protect workers and the construction site in order to achieve a no fatality accident site. So, elimination is the first hazard elimination wherever possible try to work on the ground floor in order wherever you think you may fall down then, try to avoid those hazard places. That is the number 1 step in fall protection.

The next we call it as a passive fall protection include physical barriers example is guard rails and parapets. So that know they actually serve as a fall protection for workers who are working in the vicinity. The next one is fall restrain system it is nothing but your PFAs where in the stretch of your lanyards or your life lines will not be reaching till more than the hazard. You can reach within the vicinity but it will not allow you to reach beyond the place varying you may fall off.

So, it will restrain from falling the other one is fall arrest system suppose if you want to cross beyond that fall hazard area and you want to reach out something then you are life lines will allow you to extend. And if accidentally you try to fall off also you PFAs will be able to safe guard. This is nothing but active fall protections the last one is administrative controls which is considered to be a least preferred and effective method. And used when the conventional fall protection is not feasible.

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Fall Arrest vs Fall Restraint system

- What is a Fall Arrest System?
 - A fall arrest safety system typically includes an anchor point or series of anchor points, a safety lanyard or self-retracting lifeline, and a harness
 - This system must be designed to “arrest” or stop you before hitting the lower surface in the case of a fall
 - This gives you the freedom to walk all the way up to a fall hazard to do your work
- What is a Fall Restraint System?
 - A fall restraint safety system keeps you from getting close enough to the fall hazard to fall
 - You are free to do your work without concern of falling and possibly injuring yourself because you are unable to reach the drop
 - In a **fall restraint system**, therefore, the worker is restrained from reaching a **fall hazard**. ... **Fall arrest systems** protect you after you **fall**: they stop the **fall** before you hit the surface.



So, this fall arrest system and fall restrain system let us discuss little bit so both these systems generally have PFAs as a back bone. In a fall arrest system, they are deigned to arrest or stop few before hitting the lower surface in the case of a fall. So, it is like we will not fall. It is like a dog and leash. So, with the leash the dogs can move only till the leash length same way it is nothing but a fall arrest system we will not go beyond the certain limit and try to fall.

The next one is fall restrain system so the worker is restrained from reaching a fall hazard you may be free to do your work without concern of falling and possibly no injuries will happen. Because even if you fall your lanyards and PFAs will try to not make you fall down. So, fall restrain system is restrain from reaching a fall hazard and fall arrest will protect you from hazard after you fall.

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Summary – FALLS in Construction Sites



- 1 Eliminate the risk**
Avoid work at height where possible or locate plant and equipment in safe locations where there is no risk of a fall
- 2 Guard the hazard**
Hole Covers
Guard Rails
Safety nets
- 3 Protect the worker**
Fall Restraint System
Fall Arrest System

Why fall protection?

Fatal Heights: The Untold Deaths of India's Construction Workers

CONSTRUCTION WORKER DEATHS

1092 DEATHS
248 WOUNDED

Period: 2013-2014

Ref: <https://www.ndtv.com/video/news/truth-vs-hype/fatal-heights-the-untold-deaths-of-india-s-construction-workers-464660>

- **Fall Hazards**
 - Roof/floor openings
 - Roof slope
 - Scaffolds - ladders
- **Before you fall/ fall prevention**
 - Holes - Covers
 - Openings - Guardrails & Fall restraint system
- **After you fall/fall protection**
 - Fall arrest system
 - Safety nets

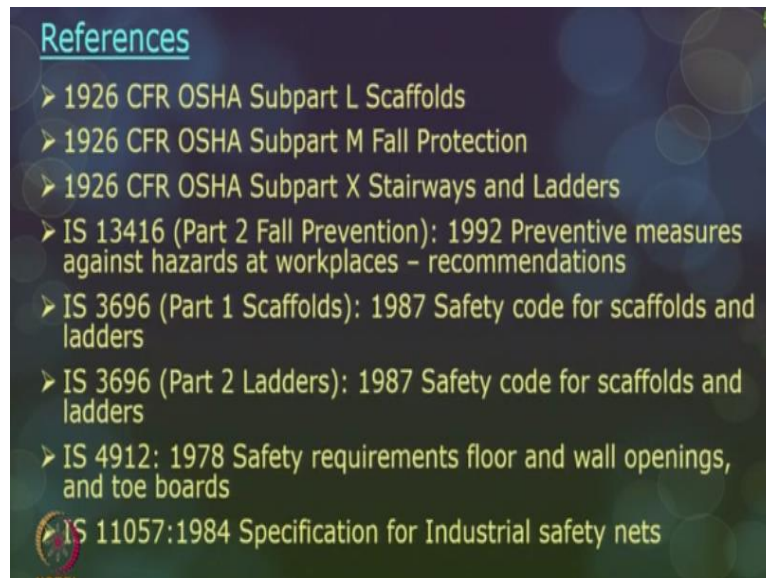
The falls in construction site, again summary, so eliminate the risk, so avoid working at height wherever possible or locate plank and equipment in safe location where there is no risk of fall at all. So, number 1 eliminate totally number 2 is guard the hazard either you can use hole covers for small openings or you can have guard rails and safety nets. These are all passive protection or I would say is an environment protection. So, workers can work even without proper PPEs are something still they will not have a fall hazard.

Number 3 is a double precaution to protect the workers primarily have a PFAs in place that can be in terms of fall restrain system or fall arrest system. So how is this, I have arranged fall hazards. Today we will have classified the hazards in terms of roof or floor opening roof, slopes and scaffolds and ladders primarily as a, needs to access its scaffold. So, we have discussed all these hazards and before you fall what are all the ways to protect for protection.

Holes for holes there is covers for any openings and unprotected edges are openings you can have guard rails. And also, a fall restrain system this is before you fall after you fall when you may have to have safety nets and you can have a fall arrest system. Here again guard rails of the environment fall restrain system is primarily environment protection like an, structure protection. And fall restrain system is on to the worker same way after you fall safety net is primarily a structure and fall arrest system is on to a worker.

So even in 2017, the fatal heights there was an NDTV coverage which talks about untold death of India's construction workers primarily on fatal heights. And if you are interested you can go through this there are so many articles which talks about fatal heights even today on the claims, compensation and so on. So better use hard hats and better you use proper PPE is when you are in the construction site especially while working on heights.

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Now all these lectures and slides that I have covered today are from all, these references. Half of them are OSHA and half of them are from IS codes OSHA subpart L which is on scaffold. Then subpart M fall protection subpart X is stairways and ladders. And IS code 13416 which talks about preventive measures against hazards and workplaces again it talks about part 2 is on fall protection or fall prevention.

IS 3696 part 1 is on scaffold and part 2 is on ladders. IS 4912 safety requirements of floor, roof openings and also on toe, boards. IS 11057 it talks about specifications for industrial safety nets. Thank you.