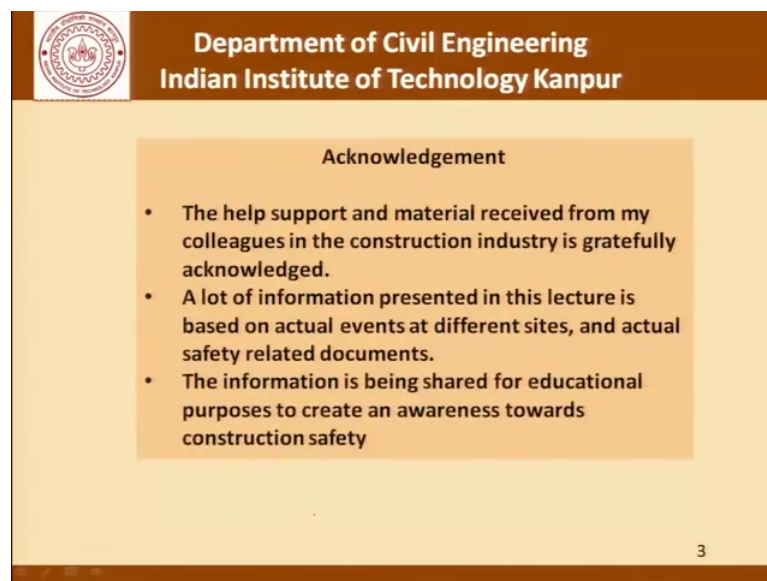


**Principles of Construction Management**  
**Prof. Sudhir Misra**  
**Department of Civil Engineering**  
**Indian Institute of Technology, Kanpur**

**Lecture – 23**  
**Accidents in construction industry – II**


[FL] and welcome once again to the series of lectures on Principles of Construction Management. And in the last couple of lectures, we have been talking about construction safety. And in the last class we had talked about some specific considerations or reasons because of which construction sites are more vulnerable to accidents. We will continue that discussion today and talk about some special topics which was left out from the last class.

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Now before we do that I must once again acknowledge the help and support and the material received from my colleagues in the construction industry and I must admit that a lot of information presented in this lecture is actually based on actual events at different sites and actual safety related documents of a few construction companies. And this information is being shared only for educational purposes to create an awareness towards construction safety.

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**Accidents in Construction Industry**

1. Housekeeping
2. Excavation
3. Working at height (including ladders, scaffold, and, general topics relevant to working at heights)
4. Electrical safety
5. Lifting & rigging
6. **Special topics**

4

Moving on this was our agenda for the last class, we have covered housekeeping right down to lifting and rigging and what was left for a subsequent discussion was some special topics. Now before we go to special topics and start discussion today let me show you some pictures of construction sites drawing from the kind of classification we had done last time.

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**Poor housekeeping at construction sites**



Source: [www.elcosh.org](http://www.elcosh.org) Source: [www.bloghse.com](http://www.bloghse.com)

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So, here are two pictures which show an extremely cluttered site and you can imagine that working in these sites is an additional challenge than working in normal

environment to self. The picture on the left has bars lying all over the place and the workers have to be very careful to avoid tripping on these bars as they move carrying a bar from one place to another.

Similarly, the picture on the right is another cluttered site.

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Compare to these sites, let us look at a site like this where there is construction material, there is scaffolding plates, there are all kinds of materials, but they are nicely start at one place, barricaded and the passage where people have to move is clearly defined and very neat. The same is the situation in the site on the right. So, we can see that these places where there are bars are sticking out and so on that has been nicely barricaded. So, that nobody really works into an area which is more hazardous.

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You will recall that we discussed safe work practices as far as excavations are concerned and these are pictures which show shoring and struts to support the shoring and providing access using ladders.

So, you can see with this ladder extends beyond this point of resting as far as the shoring is concerned, when you had spent some time talking about working with ladders.

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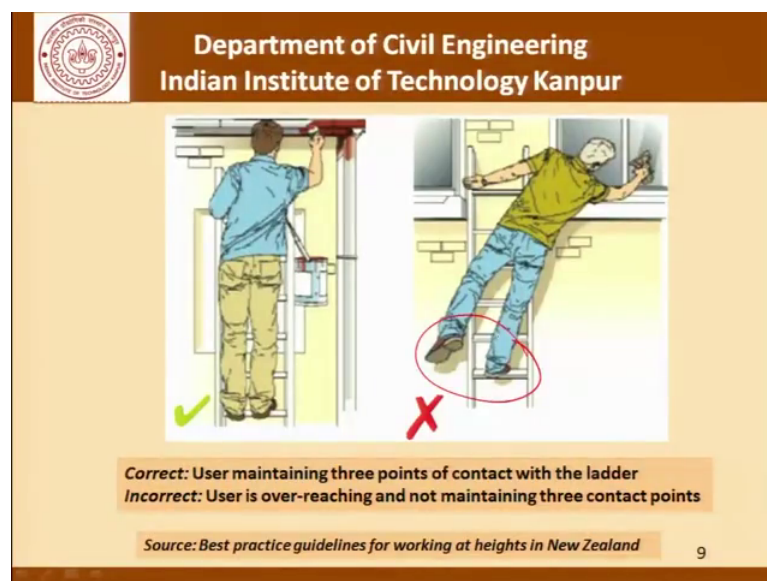


So, here we see some safe practices while working at heights with ladders and this picture here especially shows us how to handle a ladder. So, there is ladder should extend

the meter beyond this point, there is working between the styles, there is ladder secured at the top which is being shown here. There is an additional point of contact for the ladder which is given here the ladder on the level surface is secured at the bottom and so on.

So, it is required that we spend enough time and effort to identify the kind of precautions that we need to take or that we can take at a construction site to prevent accidents. Continue with our discussion on ladders.

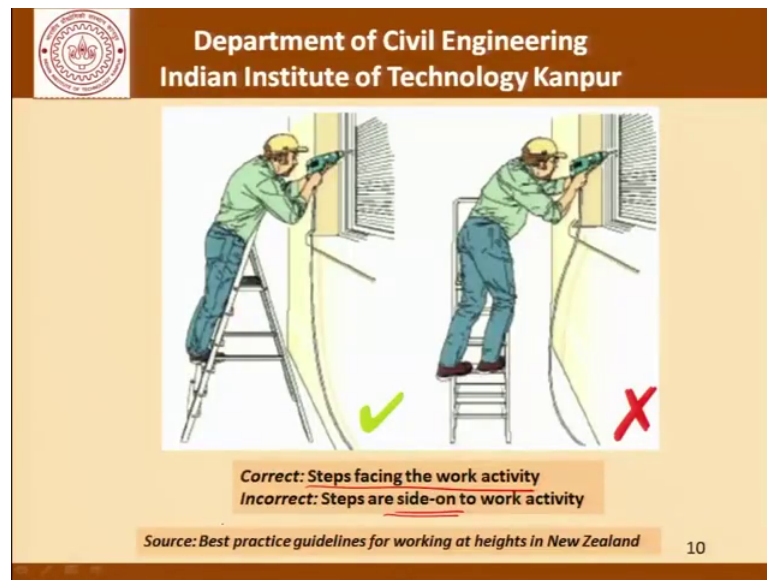
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Here we see a correct use of the ladder and an incorrect use of the ladder. So, you can see that this is a bad practice something which the workers need to be trained not to do.

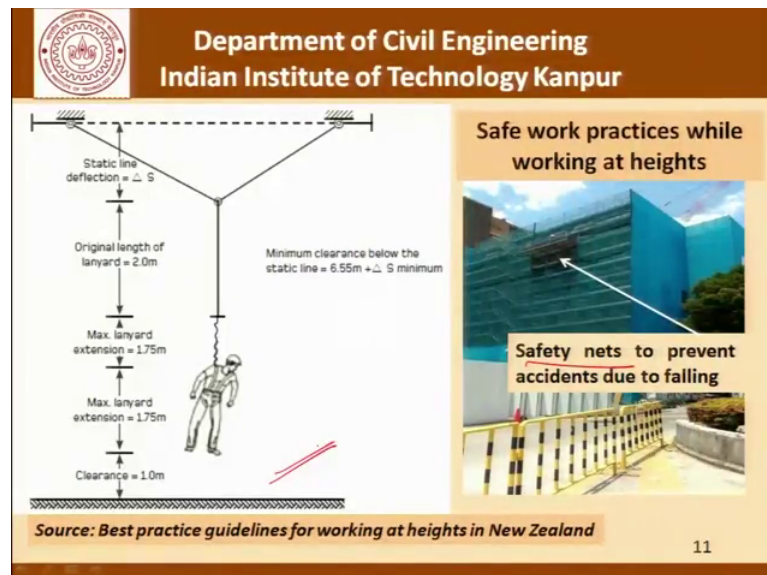


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Similarly if we see this slide, here also is an example of the right way of working with ladders and the wrong way of working with ladder. Facing directly towards the steps, facing the work activity and steps being side on as far as the work activity plane is concerned makes a lot of difference when it comes to safe working with ladders.

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Continuing with our discussion on working with heights here, we can see instillation of safety nets in a big way as far as a building construction site is concerned and this picture

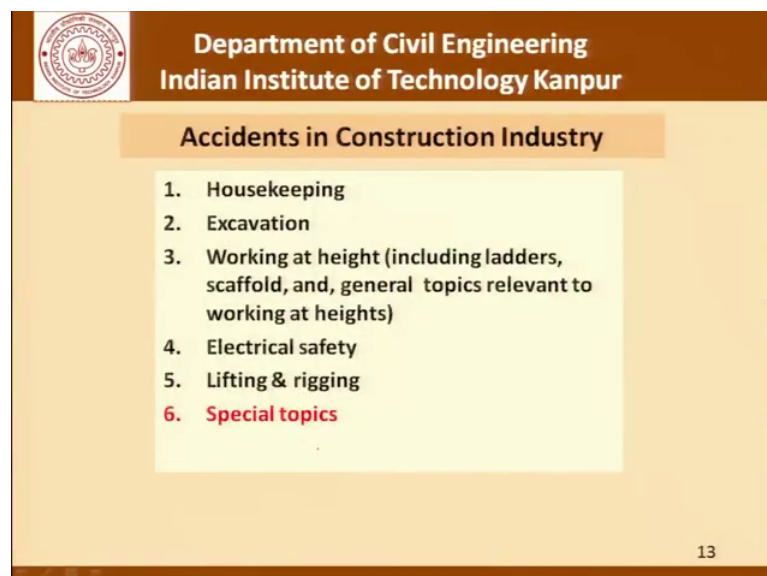
here shows us what are the different design considerations or theoretical considerations that go into the design of a harness.

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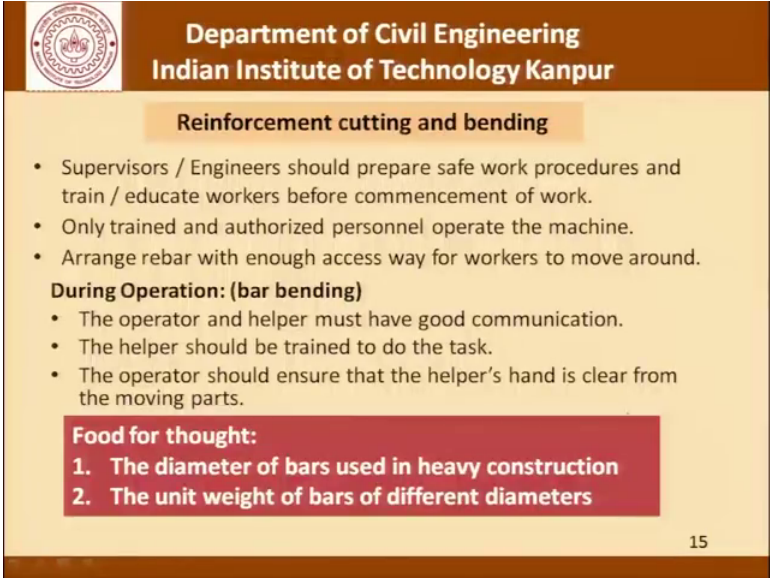
So, moving on here we see some unsafe electrical work practices at site. It could be non isolation of electrical parts, it could be defective cords and wires, it could be the cover not been provided on the junction box or it could be an unused opening which is not closed. All these becomes sources for increase in the vulnerability and susceptibility as far as accident is concerned.


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Now let us come back and continue our discussion on some special considerations or special topics in construction safety as far as their relevant from the point of view a construction site.

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**Reinforcement cutting and bending**

- Supervisors / Engineers should prepare safe work procedures and train / educate workers before commencement of work.
- Only trained and authorized personnel operate the machine.
- Arrange rebar with enough access way for workers to move around.

**During Operation: (bar bending)**

- The operator and helper must have good communication.
- The helper should be trained to do the task.
- The operator should ensure that the helper's hand is clear from the moving parts.

**Food for thought:**

1. The diameter of bars used in heavy construction
2. The unit weight of bars of different diameters

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So, first thing that we take up today is cutting and bending of reinforcing bars. Engineers and supervisors should prepare a safe work procedure and train and educate workers before commencement of work and only trained and authorized personnel should operate the machine. The bars should be arranged with enough access way for workers to be moving around. You recall that one of the first slide that I showed for a poor housekeeping slide involve basically workers moving around with reinforcing bars and this is precisely what is been talked about here that we must arrange and provide for an appropriate access way so that the workers who have to carry the bars for bending to the machine can do that without the danger or with the minimum danger of tripping. As far as the operation itself is concerned of bar bending the operator and helper must have a good communication. It is important that we understand each other's methods of work and the sequence of operations that each of them has to perform.

The helper should be trained to do the task; the operator should ensure that the helpers hand is clear from the moving parts. I leave you with the food for thought; the diameter of bars used in the construction industry special in the heavy construction. Try to find out what is the diameter of the bars involved? And then try to find out the unit weight of bars

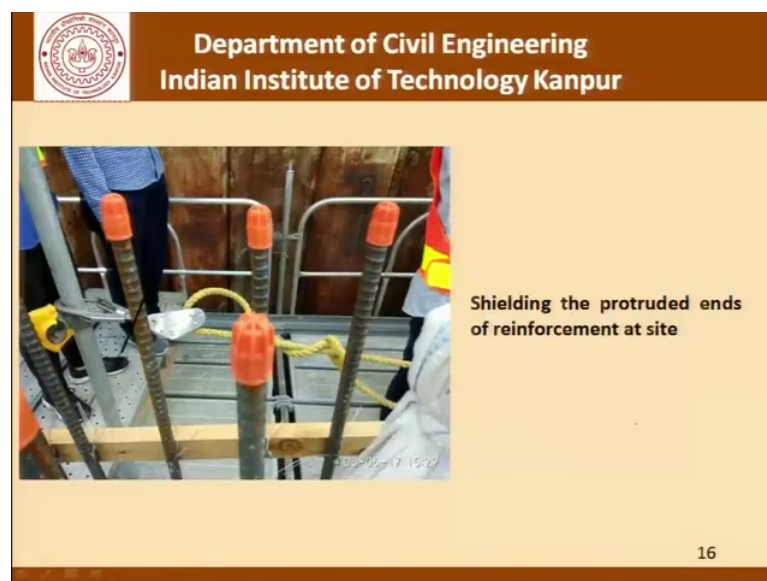


of different diameters. Why I am giving this assignment is basically that once you understand a per meter length of the bar of different diameters especially in heavy construction maybe let say 32 mm or even 25 mm for that matter, you will realize that handling a bar requires a fair amount of strength and a fair amount of effort. Much more so the effort involved or the power involved in the machines when they are bending these bars or cutting these bars is phenomenal.

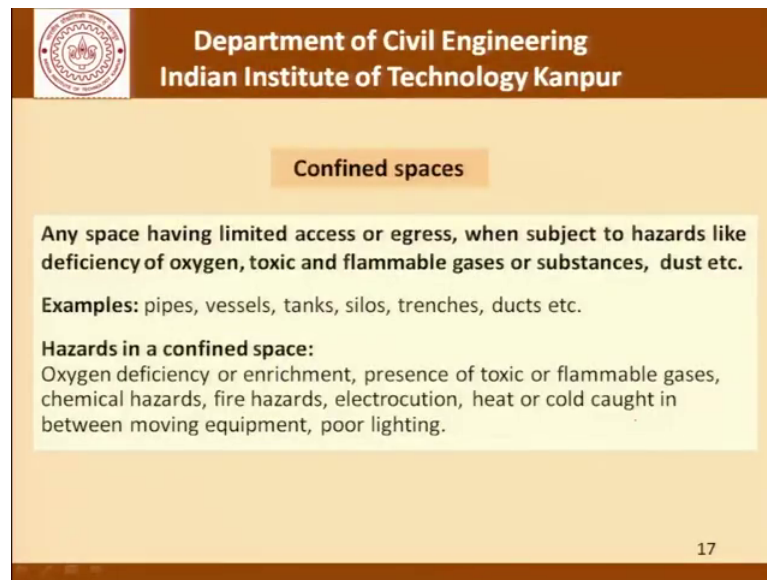
And in case there is any accident it could be a serious debilitating accident as far as the workers are concerned. So, please understand please do try to find out the diameters used in the heavy construction and the unit weight of the bars the length of the bars which is available at sites most of the time and how it is actually assembled when it comes to reinforce concrete construction.

Now, this picture here shows a very good practice of shielding the protruded ends of a reinforcement at site.

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**Confined spaces**

**Any space having limited access or egress, when subject to hazards like deficiency of oxygen, toxic and flammable gases or substances, dust etc.**

**Examples:** pipes, vessels, tanks, silos, trenches, ducts etc.

**Hazards in a confined space:**  
Oxygen deficiency or enrichment, presence of toxic or flammable gases, chemical hazards, fire hazards, electrocution, heat or cold caught in between moving equipment, poor lighting.

17

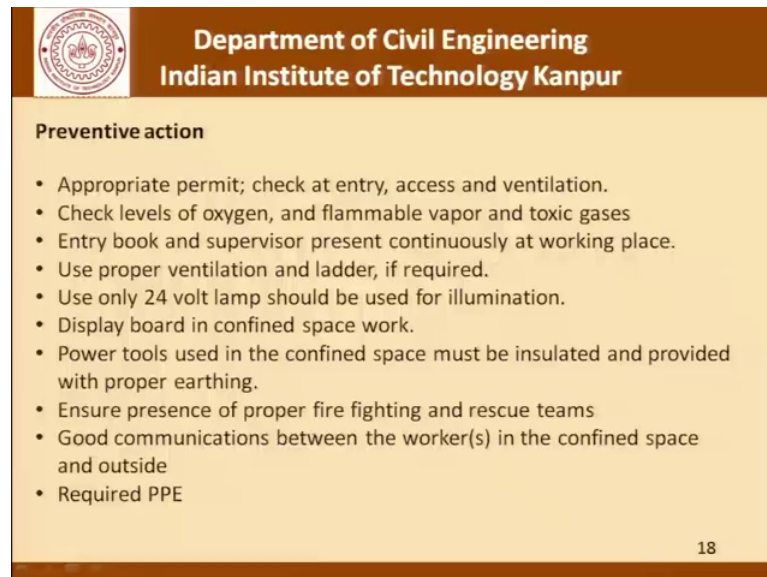
Here another example of hazard a situations in construction site is confined spaces. Any space having limited access or egress when subjected to hazards like deficiency of oxygen, toxic and flammable gasses or substances, dust, etcetera would qualify to be a confined space. Examples for this would be pipes, vessels, tanks, silos, trenches and ducts; you will recall the two slides that I showed you about the excavation work, but the picture on the right was something which could qualify as a confined space.

Especially if you are working let us say 3 meters, 4 meters or 5 meters below the ground. So, I call upon you to find out what is the technical definition of a confined space and at the end of it, it becomes a judgment that no matter what the definition is if there is a reason to believe that there will be limited access or egress. If the opportunity to the worker to leave that place in case of an emergency is limited that place becomes a confined space. And if it becomes a confined space the rules governing confined space handling become operational that is something which is a construction manager as a safety officer or a safety professional one must be aware of.

As far as the hazards in the confined space are concerned, it could be oxygen deficiency or enrichment, presence of toxic or flammable gases, chemical hazards, fire hazards, electrocution, heat or cold caught in between moving equipment, poor lighting and so on. So, there can be a situation where if in a confined space we suddenly see a moving equipment, there is no place to escape and that becomes a death trap more or less.

Similarly there would be challenges arising out of poor lighting in confined spaces. So, these are the kind of things which we must address when we are talking of confined spaces and the challenges posed in terms of safety.

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The slide is a presentation slide from the Department of Civil Engineering at the Indian Institute of Technology Kanpur. It features a brown header with the department name and a circular logo on the left. The main content area is yellow and lists 'Preventive action' with ten bullet points. The slide number '18' is in the bottom right corner.

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**Preventive action**


- Appropriate permit; check at entry, access and ventilation.
- Check levels of oxygen, and flammable vapor and toxic gases
- Entry book and supervisor present continuously at working place.
- Use proper ventilation and ladder, if required.
- Use only 24 volt lamp should be used for illumination.
- Display board in confined space work.
- Power tools used in the confined space must be insulated and provided with proper earthing.
- Ensure presence of proper fire fighting and rescue teams
- Good communications between the worker(s) in the confined space and outside
- Required PPE


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Preventive actions in this case would be appropriate permits; check at entry, access and ventilation. Check levels of oxygen and flammable vapor and toxic gases, entry book and supervisors present continuously at working place, use proper ventilation and ladder if required, use only 24 volt lamp for illumination, display boards for confined space work being done, power tools used in confined spaces must be insulated and provided with proper earthing, ensure presence of proper fire fighting and rescue teams, good communication between the workers in the confined space and outside and finally, use the required PPE.

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Source: [www.lhsfna.org](http://www.lhsfna.org)

  
Source: <http://rkmsgroup.ca>


  
Source: [www.hoffmannworkcomp.com](http://www.hoffmannworkcomp.com)

**Safe work practices when working in confined spaces**

19

These are some of the examples of confined spaces and we can see man holes, tunnels and pipes has definite examples of people having to work in confined spaces.

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**Hot work**

**Hazards**

- Heat
- Electrical hazards
- Cutting & welding
- Radiation

**Preventive actions**

- Read and understand the contents of the permit and follow them in letter and spirit
- Check area to prevent fire.
- Check gas cylinders and apparatus for leak.
- When welding be sure use mask and barricade working area.
- Check the fire hazards to prevent fire
- Ensure presence of operator and fire extinguisher
- Confine fire spark range with proof sheet, and do not place combustible material in fire spark range.

(Contd....)

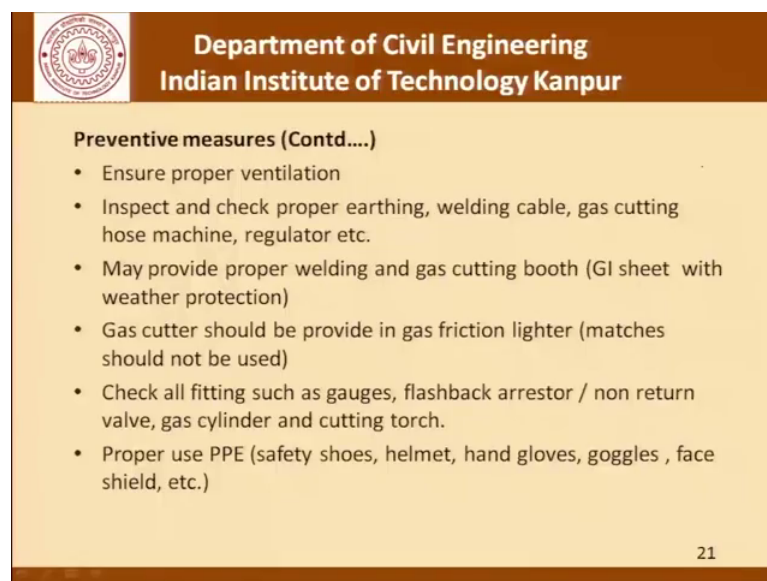
20

Moving forward let us talk about what is called hot work in the construction industry and hazards in this area would be heat, electrical hazards, cutting and welding and radiation. A kind of preventive action that we talk about in these conditions would include read and understand the contents of the permit and follow them in letter and spirit. I would like to

draw your attention to the word permit which has been often on as far as our discussion is concerned.

So, this is a system by which an announcement is made appropriate approvals are taken for a particular work to be undertaken in a particular area. So, there is a large site a certain area and if we want to carry out certain work, it could be confined space, it could be working at heights, it could be hot work in a certain area then there has to be a system in place. So, that approvals have been taken and other people informed of that nature of work being done for a particular period of time. Check the area to prevent fire because in case of hot work, it is extremely vulnerable for fire. Check gas cylinders and apparatus for leak hot work often involves working with flames and for that we often use gas cylinders and we must ensure that they are not leaking, when welding be sure that masks are used and the area is barricaded. Check fire hazards to prevent fire ensure the presence of an operator and fire extinguisher, confine fire spark range with proof sheet and do not place combustible materials in the fire spark range and let us continue with this list.

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The slide is from the Department of Civil Engineering at the Indian Institute of Technology Kanpur. It features a brown header with the department name and a circular logo on the left. The main content is on a yellow background with a list of preventive measures for hot work. The slide number 21 is in the bottom right corner.

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**Preventive measures (Contd....)**

- Ensure proper ventilation
- Inspect and check proper earthing, welding cable, gas cutting hose machine, regulator etc.
- May provide proper welding and gas cutting booth (GI sheet with weather protection)
- Gas cutter should be provide in gas friction lighter (matches should not be used)
- Check all fitting such as gauges, flashback arrestor / non return valve, gas cylinder and cutting torch.
- Proper use PPE (safety shoes, helmet, hand gloves, goggles , face shield, etc.)

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We must ensure proper ventilation inspect and check proper earthing, welding cables, gas cutting, hose machine, regulator and so on, may provide proper welding and gas cutting booth which could be made with a GI sheet with weather protection. That basically says that in the site, we isolate an area provide a lot of the right infrastructure in that area, but



that sometimes is possible, sometimes it is not possible and it depends on individual conditions.

Gas cutters should be provided with gas friction lighters and matches should not be used. Check all fitting such as gauges, flashback arrestors, non return valves, gas cylinders and cutting torches. Proper use of proper personal protective equipment, safety shoes, helmet, hand gloves, goggles, face shields, etcetera. We will talk about the specific PPEs and their specifications in a subsequent lecture, but the spirit of it I am sure is clear to you.

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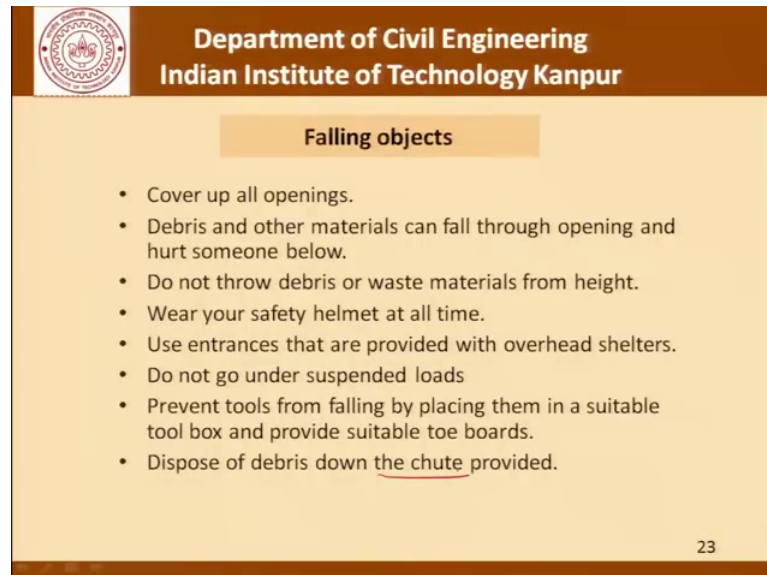


And these pictures here show you two examples of hot work; in one case you are talking of bituminous construction and another case we are talking of pipe welding and grinding and we can see a lot of sparks flying around. So, you can imagine that these sparks pose a major hazard as far as fire is concerned and effort needs to be made to confine these sparks to a local area.

Similarly, when working with hot bituminous mixes, one has to be very careful to protect your feet with the use of proper boots. And in order to warn people that the worker may be working it is also important that people in the neighborhood or near this work site are also warned that this is hot work and that is why we need a placard like this which is shown. Because the worker working with bituminous mixes or the hot bituminous mix would be wearing the right kind of PPE, but not necessarily a passerby not necessarily a

person not directly involved with the work and if he is not wearing that protection, that person might get injured causing an accident as far as the construction site is concerned.

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**Falling objects**

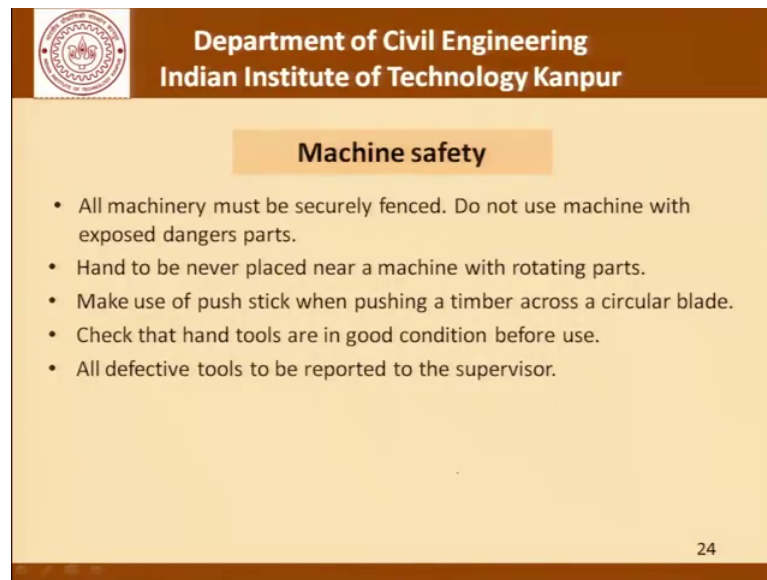
- Cover up all openings.
- Debris and other materials can fall through opening and hurt someone below.
- Do not throw debris or waste materials from height.
- Wear your safety helmet at all time.
- Use entrances that are provided with overhead shelters.
- Do not go under suspended loads
- Prevent tools from falling by placing them in a suitable tool box and provide suitable toe boards.
- Dispose of debris down the chute provided.


23

So, moving forward let us spend some time on falling objects; we talked about it briefly last time. Cover up all the openings because they become the source for objects to be falling through and hurting somebody or hitting somebody down below. Debris and other materials can fall through these openings and hurt someone below. Do not throw debris or waste materials from height. It is a very bad practice because somebody at the top may not necessarily know, if there is somebody walking around at a lower level or because of the action of wind and so on the place where you are targeting the debris to get deposited might change and hit somebody where you thought the debris would not even reach.

Wear your safety helmet all the time, use entrances that are provided with overhead shelters, do not go under suspended loads, prevent tools from falling by placing them in a suitable toolbox and provide suitable toe boards, dispose of debris down the chute provided. It depends on the kind of debris it depends on the amount of debris we may have to construct a chute through which the debris can be just dumped from the top and it reaches the bottom. The chute also becomes an environmental protection measure because it localizes any dust going into the atmosphere.

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**Machine safety**

- All machinery must be securely fenced. Do not use machine with exposed dangerous parts.
- Hand to be never placed near a machine with rotating parts.
- Make use of push stick when pushing a timber across a circular blade.
- Check that hand tools are in good condition before use.
- All defective tools to be reported to the supervisor.

24

Another special condition as far as construction sites is concerned is the use of machines. We cannot live without using machines at a construction site and we have to observe certain precautions. All machinery must be securely fenced. So, that they do not fall do not used machines with an exposed dangerous parts. Hands should never be placed near a machine with rotating parts whether it is a peddles to fan or any such machine.

Make use of push sticks when pushing at timber across a circular blade, check that hand tools are in good condition before use, all the effective tools must be reported to the supervisor. It is important from the employer's point of view where all tools and tackles are maintained and defective tools are not used, but at the same time it is the employee's responsibility, it is the workers responsibility to ensure that the tools that we are working with are shown proper respect. The tools should not be mishandled and used for purposes other than what they are meant for only then will they have a long life.

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Source: [www.ehs.ucsb.edu](http://www.ehs.ucsb.edu)


  
Source: [www.accident-claim-expert.co.uk](http://www.accident-claim-expert.co.uk)

**Safe work practices – machine safety**

25

And here are some of the pictures of using safe practices when handling machines.

(Refer Slide Time: 17:46)

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Chemical cleaning	Preventive actions
<b>Hazards</b> <ul style="list-style-type: none"><li>• Pollution of environment.</li><li>• Toxic gases</li><li>• Machinery or equipment hazards.</li></ul>	<ul style="list-style-type: none"><li>• Work permit</li><li>• Barricading working area.</li><li>• Display of signboards</li><li>• Check the all flange, nuts/bolts, valve and connection before during the work .</li><li>• Inform all nearby employees and workers</li><li>• Use the proper PPE such as safety shoes, safety goggles, helmet, pvc / rubber hand gloves.</li><li>• If there any choked line and valve then use a wooden hammer and remove the obstacle</li></ul>

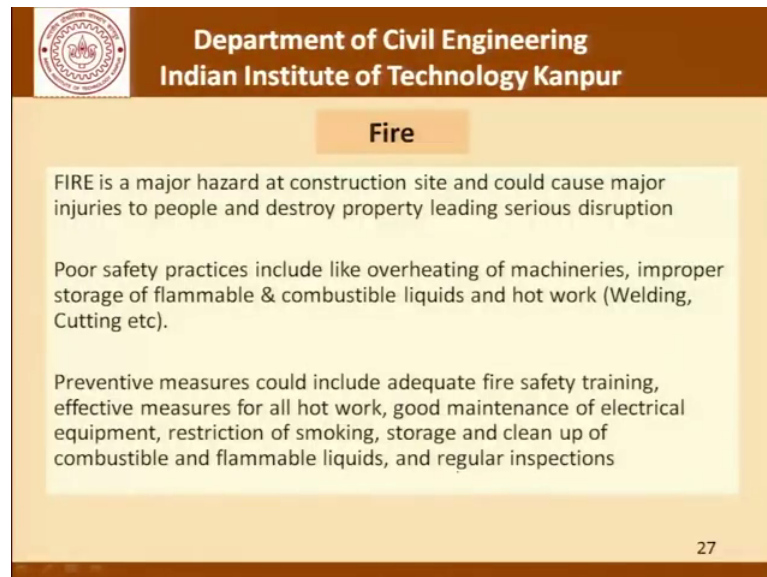
26

Chemical cleaning is another area, which has a small application as far as construction safety is concerned at sites.

And the hazards involved are pollution of the environment, toxic gases and machinery or equipment hazards. And the preventive measures were obviously, include work permits, barricading of work area, display of sign boards, checking of all the flanges, nuts, bolts, valve and connections before and during the work, inform all nearby employees and

workers, use of proper PPE such as hand gloves, safety shoes, helmets and if there any choke lines or valves, then use a wooden hammer and remove the obstacle. It is important that it is ensured that all the lines are free they are not choked.

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**Fire**

FIRE is a major hazard at construction site and could cause major injuries to people and destroy property leading serious disruption

Poor safety practices include like overheating of machineries, improper storage of flammable & combustible liquids and hot work (Welding, Cutting etc).

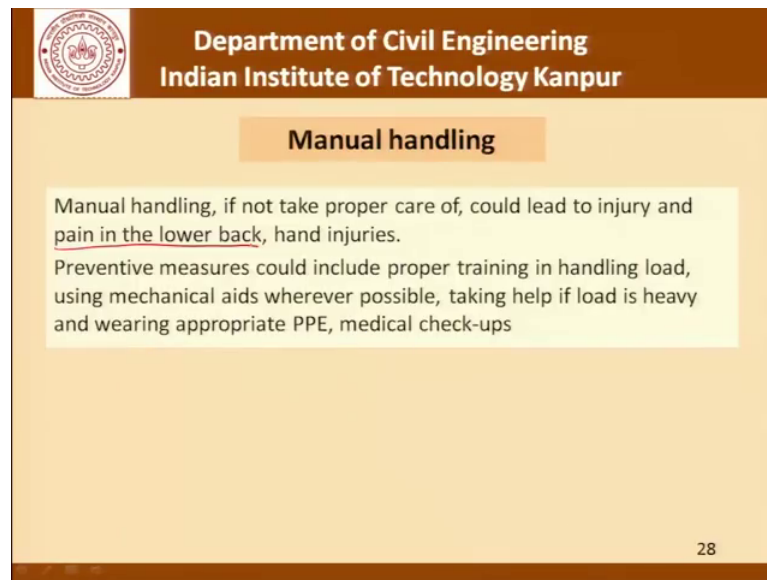
Preventive measures could include adequate fire safety training, effective measures for all hot work, good maintenance of electrical equipment, restriction of smoking, storage and clean up of combustible and flammable liquids, and regular inspections


27

We will not spend too much time on fire. Fire is a major hazard at construction sites and could cause major injuries to people and destroy property leading to serious disruption of work. Poor safety practices include allowing overheating of machineries, in proper storage of flammable and combustible liquids and hot work which is welding and cutting and preventing measures would include adequate fire safety training, effective measures for all hot work, good maintenance of electrical equipment, restriction of smoking only to smoking areas, storage and cleanup of combustible and flammable liquids and regular inspections. Of course, fire engineering and fire safety is a very vast topic and I am touching upon this only for the sake of completeness and we would probably need an entirely different course to talk about the hazards of fire and how it is handled from an engineering point of view.



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**Manual handling**

Manual handling, if not take proper care of, could lead to injury and pain in the lower back, hand injuries.

Preventive measures could include proper training in handling load, using mechanical aids wherever possible, taking help if load is heavy and wearing appropriate PPE, medical check-ups

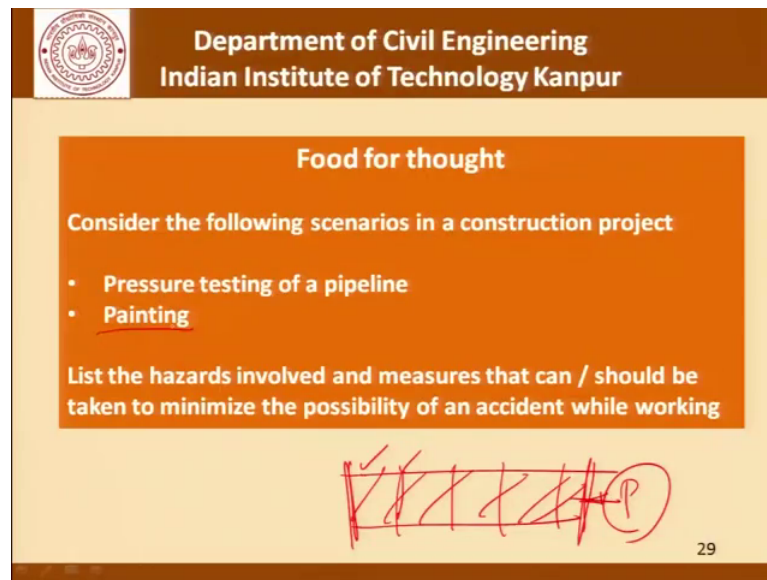
28

As far as manual handling is concerned very often we have workers and labour handling heavy loads, having very specialized kind of loads. Please remember that even handling a 20 kg bag is not easy. A 20 kg bag handling versus reinforcing bar which is spanning let say 3, 4, 5 meters having the same weight are two different things.

And therefore, if not properly taken care of manual handling could lead to injury and pain in the lower back and hand injuries. So, here we are talking of not only accidents, here we are also talking about health of worker. And health is also one of the very important assignments or it is very much within the scope of work as far as safety is concerned. So, the safety group is charged not only with the responsibility of ensuring that there is a safe environment for working which is accident free, but also charged with the responsibility of ensuring that the environment is such that long term effects such as pain in the lower back, they do not come and haunt the workers.

For preventive measures could include proper training in handling load, using mechanical aids where possible and taking help if load is heavy and wearing appropriate PPE and periodical medical checkups. Close the discussion for today, I would leave you with a problem for. In fact, two problems; let us consider the following scenarios in construction project.

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**Food for thought**

Consider the following scenarios in a construction project

- Pressure testing of a pipeline
- Painting


List the hazards involved and measures that can / should be taken to minimize the possibility of an accident while working

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Pressure testing of a pipeline and painting, we have in this discussion today and in the previous class talked about specific scenarios, excavation hot work, confined spaces welding and so on. So, I am giving you two scenarios; pressure testing of a pipeline and painting. Pressure testing means that we have set up a pipe line which has several joints and finally, what we want to do is to put a flange here, put a flange here and try to fill this pipeline with the fluid and apply pressure. So, we want to make sure that the pipes are in good condition, the joints are in good condition and the pipeline itself is worthy of views; it needs the requirements. So, this is what is accomplished or this is what is the object of carrying out, what is called a pressure test of a pipeline. Similarly there could be a situation where we are painting a large tank. In these two cases, list the hazards involved and measures that can or should be taken to minimize the possibility of an accident while working.

So, much the same way as we have done in the previous slides; try to do these two assignments on your own and try to figure out how we can work? Or how should we work when we are working for these two cases? With this we come to our close for the discussion today.

(Refer Slide Time: 22:32)



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**References**

- Jha K.N., *Construction Project Management- Theory and practice*, 2<sup>nd</sup> Edition, Pearson India Education Services Pvt. Ltd., UP, India 2015
- Reese C.D., Eidons J.V., *Handbook of OSHA construction Safety and Health*, Taylor & Francis, 2<sup>nd</sup> Edition, Florida, USA, 2006.
- Levitt R.E., Samelson N. M., *Construction Safety Management*, 2<sup>nd</sup> Edition, John Wiley & Sons Inc., USA, 1993
- *Best practice guidelines for working at heights in New Zealand* by MBIT, New Zealand, 2012.
- “Construction safety” webinar by construction Industry Institute

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And here is a list of references which will help you understand the whole idea of construction safety and construction safety management better and I look forward to seeing you once again in a subsequent discussion.

Thank you.