Principles of Construction Management
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Lecture - 21
Introduction to construction safety

[FL] and welcome back to the series of lectures on Principles of Construction Management and today we start an entirely new topic construction safety. We will be talking about different aspects related to construction safety in this module. Today we will just do an overview of what construction safety in tales a kind of things that go on and so on.

Now I must acknowledge the help and support from my friends and colleagues in the construction industry and academic institutions who have help me repair this material. And I am especially grateful to processor KN Jha of the Department of Civil Engineering at IIT Delhi and Shri AK Tripathi and Shri Prabhat Narayan who are experts in safety and work in different places in the country for sharing the valuable information and having given me permission to use some of the material in some of the information in this present lecture and also in this module.

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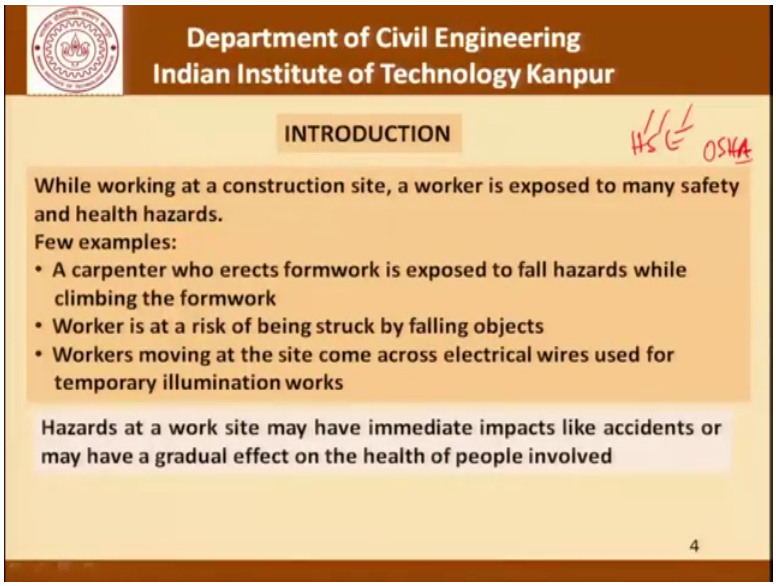

Now, to get started while working at a construction site a worker exposed to many safety and health hazards some of these examples could be a carpenter who erects formwork is

exposed to fall hazards while climbing the formwork. A worker is at risk of being struck by falling objects, he may just be walking on the ground and they are may be work going on at a height and a nut or a bolt or a screwdriver whatever it is may simply fall and hit among the head it need not be a worker. In fact, it could just be a passer by this happens very often when you are trying to do construction work, in built environment, in urban areas. Workers moving at the site come across electrical wires used for temporary illumination works they can flip on those wires, the wires can causes short circuit and cause of fire and so on.

If you are working in marine environment or near the water there is always the possibility that the worker may fall in water and there is a drowning issue involved. If there are operations like welding being carried out there is an entirely different set of hazards that are faced by construction workers. So, construction safety is an important aspect we do not want to have accidents at site and it is an important responsibility as far as the construction manager is concerned to ensure that the construction site is accident free hazards at work site may have immediate impacts like accidents or may have a gradual effect on the health of the people involved and that is why we often deal with accidents and health hazards together and the environment is often called HSE which is health safety and environment. So, these three things are very closely linked to each other and are often help together as far as the corporate policies are concerned. In fact, even regulatory authorities like the OSHA is the Occupational Safety and Health Administration.

This regulatory body which is a US regulatory body deals with occupational safety and health. We are of course, talking of occupational safety and health, as far as construction workers are concerned construction is there occupation and all that environment there basically involves concerns about their health and their safety.

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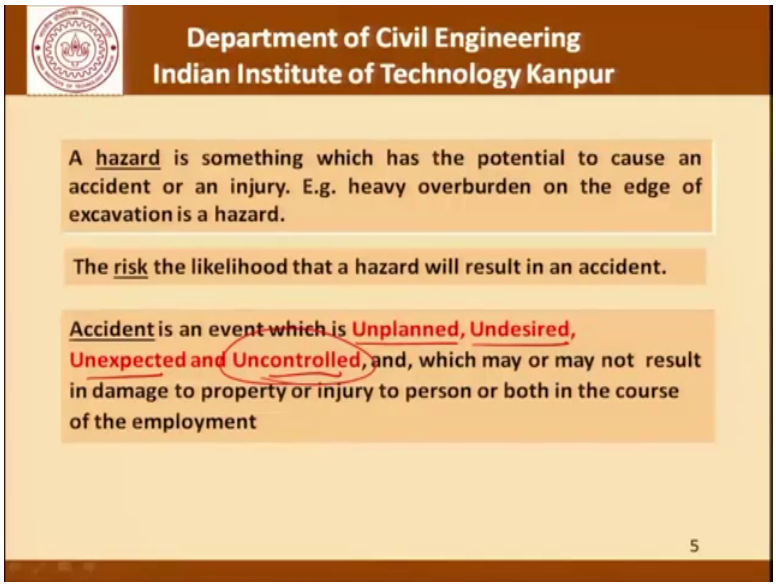

So, before we move further we should try to have more precise understanding of some of the words that we will use a hazard is something which has the potential to cause an accident or an injury. For example, heavy over burning on the edge of an excavation is an hazard. The risk is the likelihood that hazard will result in an accident and the accident itself is an event which is unplanned undesired unexpected and uncontrolled and which may or may not result in damage to property or injury to person or it may result in both in the course of employment.

So, these four words unplanned, undesired, unexpected and uncontrolled these are very important to understand in the context of an accident. All afford as far as safety is concerned is directed towards reducing the chances or the probability of an accident occurring at sight because it is uncontrolled at the end of it sometimes we really do not know what would be the result of an accident. It could be something which you will just not forcing now before we go further I would like to share with you some of the photographs of construction related accidents and; obviously, as a civil engineers we cannot be proud of them these are something which is a very very difficult situation for us to reconcile with and we must leave no stone unturned in ensuring that these kind of things do not happen at sites where we are in charge.

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This picture here is the collapse of floors in a multistory building. Now how that happened why that happened is a different matter. The fact that some of these floors have simply collapsed while the building is under construction is a matter of great concern, it could have happened because of faulty materials, it could have happened because of faulty designs, it could have happened because of faulty or bad workmanship in terms of erecting formwork removal of formwork and so on and that is exactly what is the issue. Construction safety involves handling these things learning lessons from them and ensuring that the accident is not repeated.

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This is another accident where we can see the collapse of a waffle slab. So, we can see that once an accident happens there is so much of reconstruction that has to be done, there is so much of loss that has happened that it is very very difficult to recover from that. The cost of an accident is simply very high those are things which we need to talk about and at least be aware of as construction professionals.

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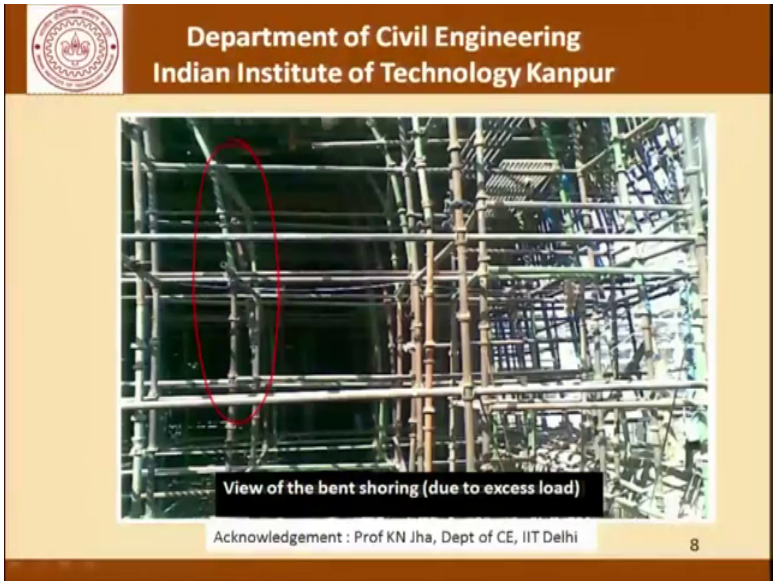

This picture here shows bent shoring, now this bent shoring could be on account of excessive loading.

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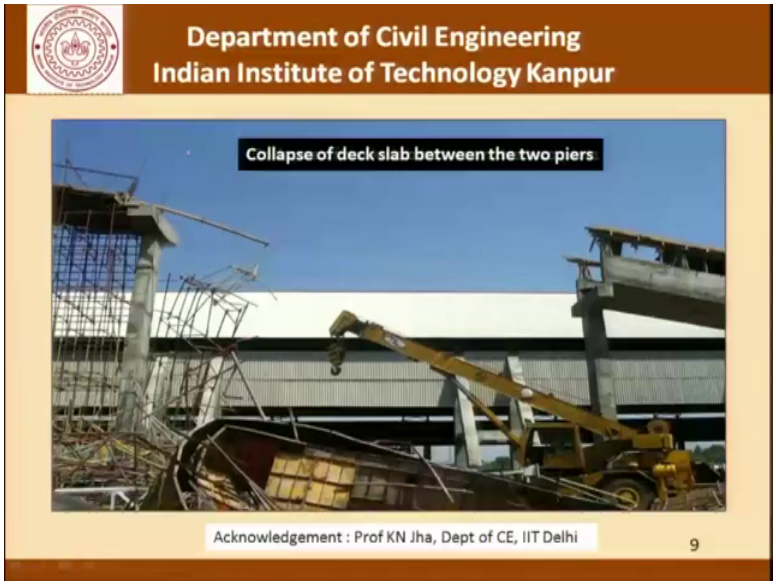

This is a view of a collapsed deck slab between two piers.

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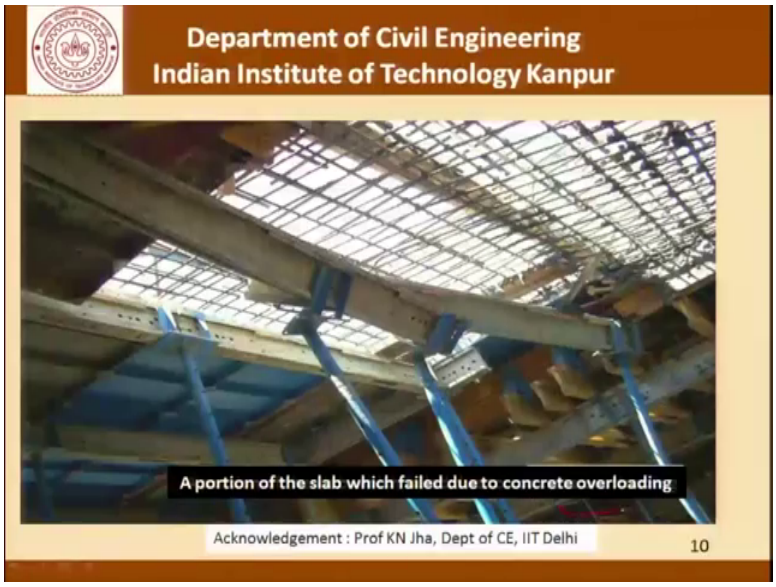

This picture here you can see this sky because the slab between the two piers has simply collapsed a portion of the slab which failed due to concrete overloading. Now there is no question of overloading as far as the structure is concerned the structure is not even in service if the causes overloading then it is loads while construction is going on, at that time you must remember that the concrete may not have achieved full strength. So, we have to be very careful and plan for what are the loads that are likely to come on their structure while it is being built and make sure that concrete at a given point in time has sufficient strength to with stand those construction loads.

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Here is another view of the portion of the beam and slab formwork that has collapsed. So, here is the entire slab which has just caved in here is the picture of the failure for launching girder you can see that working in built up areas has its own challenges, it has its own implications in terms of consequences of failure the effect on passes by and so on. Now this is yet another picture of an accident where there is a metro bridge span that has collapsed the intention of going through some of these pictures was not to discuss the accidents or discuss the causes of those accidents, but just to show you that construction accidents are very very painful to see their very painful to investigate, but yet it is an important that a construction manager understand the issues involved in construction safety and take steps that accident do not happen at their site and if each manager ensures that we will indeed have a accident free construction industry.

With this let us try to move on to some more discussion as far as construction safety related issues are concerned.

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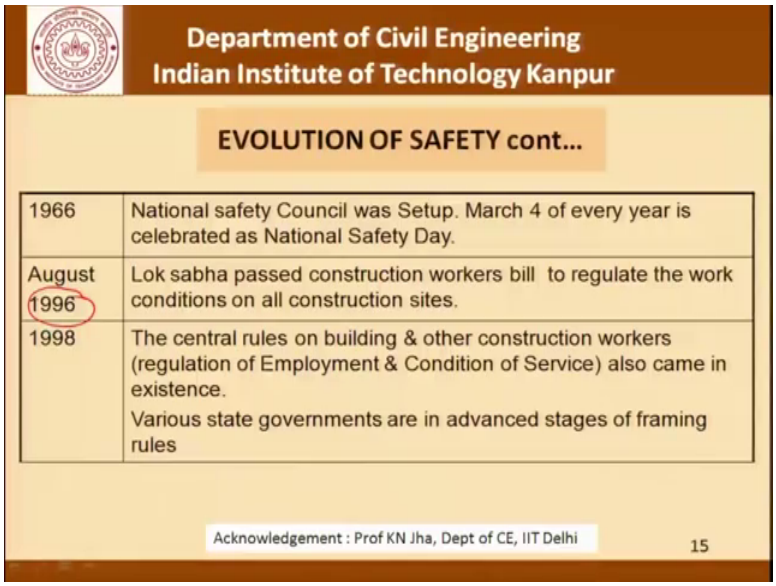

This slide here shows how over the last about hundred and fifty years different aspects of construction safety and industrial safety have evolved as far as the world is concerned and as far as India is concerned it was in 1996 which was a milestone when the Lok Sabah passed the construction workers bill to regulate the work conditions of all construction sites and the central rules on building and other construction workers call the BOCWA came into effect and various state governments are now in advance the stages of framing the rules. And I had leave it to you to try to understand or try to do a little bit of search and find out what these rules are will talk about it a little when we are talking about legal issues related to construction and also what are the provisions which are the states that have implemented them in India and so on.

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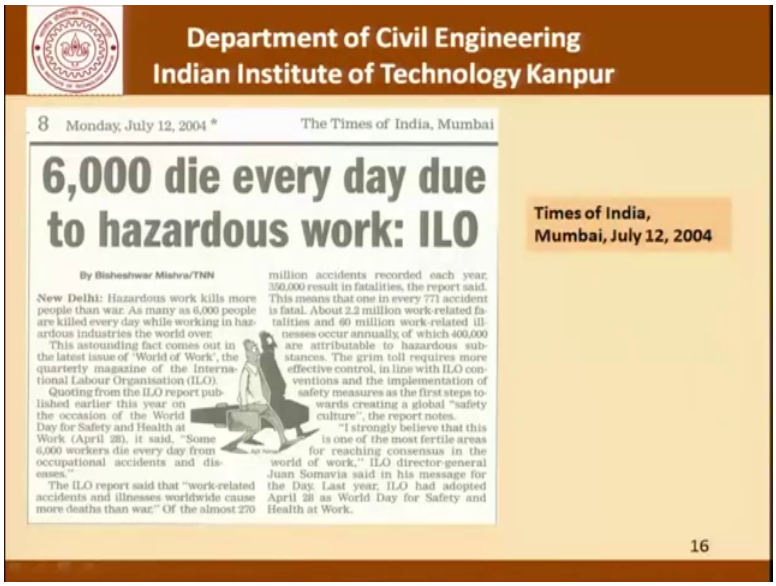

Now, this picture here just a snapshot taken from the times of India of 2004 and it says that 6000 people die every year due to hazardous work. Now when it comes to these numbers we have to remember these are statistics the number which have been collected by agencies from different countries and put together. So, there could be a few things here and there the exact definition has to what is hazardous work what are the standards that are prevailing in different countries whether the death occurs immediately after exposure to hazardous work does this number include health related deaths which are also of course, occupational health related issues or is it only accident related deaths those details are the fine print.

But the spirit of the discussion is that indeed occupational health and safety is a very very serious concern to the engineering profession and that is why we are talking about it here.

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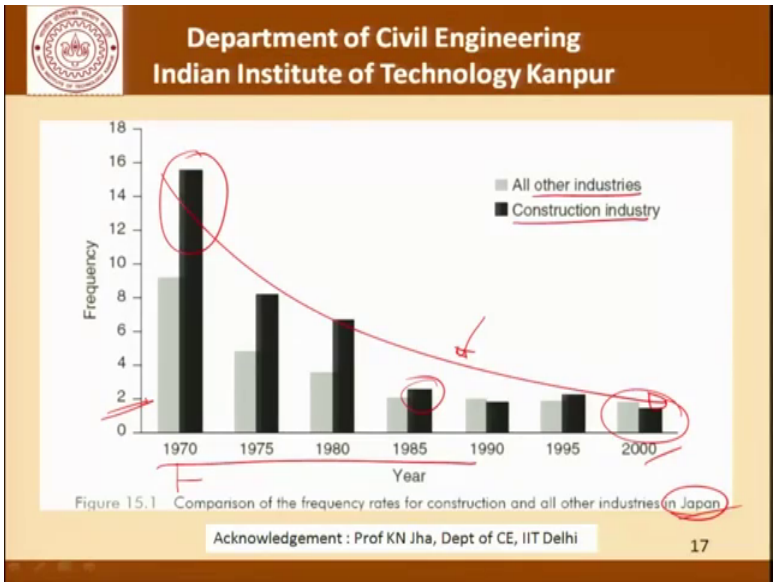

This picture here shows how the construction industry fairs with respect to other industries and these statistics are all other detect to about 2000 and a taken from Japan. There are different ways of looking at this picture and what I see is that up to this point here the construction industry the frequency of accidents was much higher than in the other industries. All these industries due to efforts which must have taken place around 1970 and so on, as far as the frequency has is concerned it has gone down so what can be stated is that in Japan due to whatever sustained efforts that were taken to introduce safety measures at sites introduced safety measures in the industry tighten the safety culture and so on there is a decline in the accidents.

What is equally important to understand is that in the 70 75 80 and 85 and so on the construction accidents frequency was higher than the other industries that in 2000 has finally, come to a situation where the construction industry frequency is lower than the other industry which means in the construction industry indeed put in a lot of effort to reduce the construction accident to bring down the accident rate or the frequency as far as construction sites is concerned. So, this is the kind of information that is very encouraging to see and I am sure there is a lot more to do.

Please see that the number here is only 2. So, there is about 2 to 4 this is the kind of number of accidents that you are talking about. I would like to invite you to go to the newspapers in any other source of information and try to find out what is the kind of

numbers of accidents that are taking place around you in the neighborhood it could be the city, it could be the state it could be the country we are all in India most of us and it could be anywhere else in the world, but please remember that this data is not easy to come by. There are lots of reasons for it and we are not getting into details of that, but yes a sustained effort can still be made and must be made.

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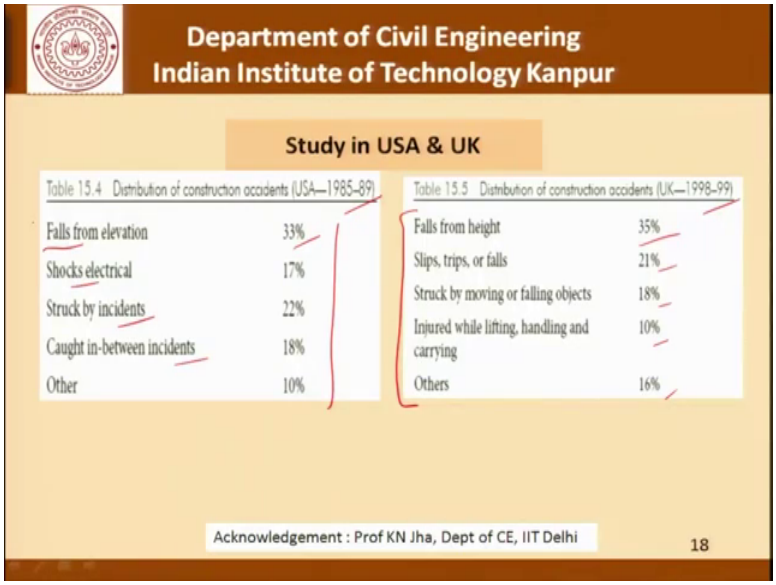

This is a study from the United States and UK and this data is even more dated its 89 98-99 and this gives us what is the breakup of the nature of the cost of construction accidents in United States and UK. We find that falls from elevation shocks is struck by incidents that is your hit by something caught in between accidents meaning that you caught between two objects and others this is the breakup as for the United States is concerned.

So, we find that fall from a height contributes to 33 percent a one-third of the total accidents. Fall from height in the UK in a different time period is about 35 percent. Trips, slips and falls is another 21 struck by moving in falling objects is 18 injury while lifting handling and carrying is 10 and the other is 16. So, it is not a matter of how we divide this, the issue really is to understand that there are different factors that contribute to an accident we have to be careful about things which cause an accident.

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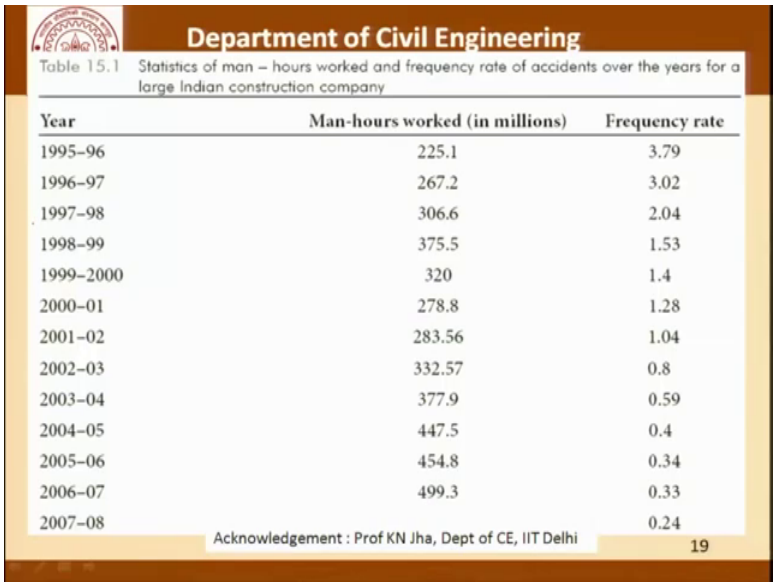

This is the information that we have about the Indian construction industry ranging from 1995 to about 2008 this is the million man hours being worked as far as the construction industry is concerned and this is the frequency rate.

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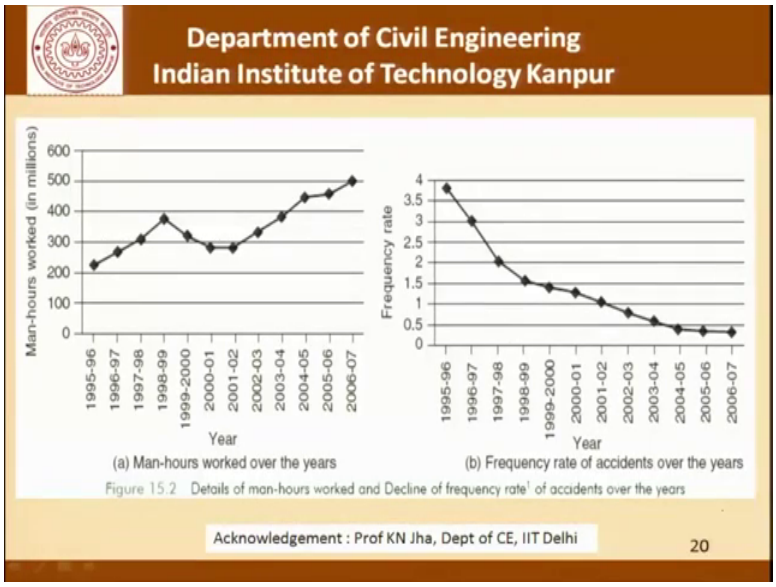

This picture here shows the man hours worked in millions and also the frequency rate it is the same data that we saw earlier.

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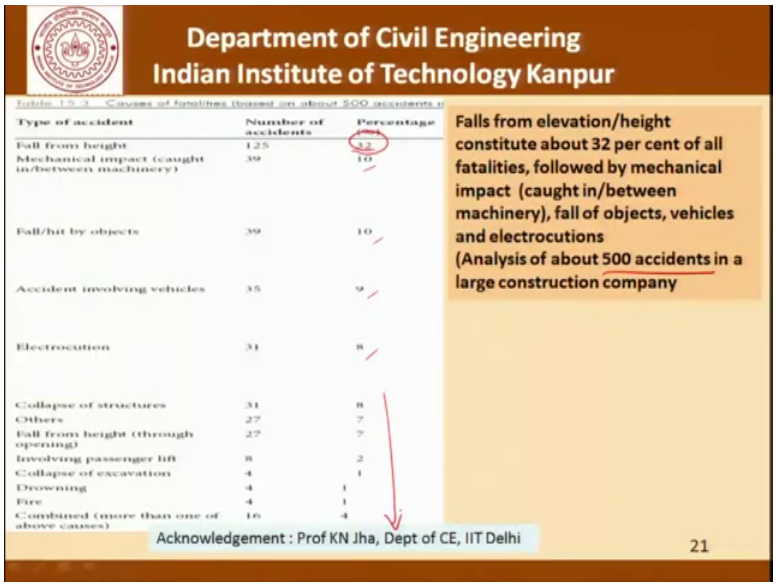

Now, this picture is an analysis of what 500 accidents and here in India we find that fall from heights again contributes about 32 percent mechanical impact which is caught in between the machinery is 10 percent, fall or hit by objects in other 10, accidents involve vehicles is 9, electrocution is 8 and so on the list goes. So, it is interesting to see that no matter what a fall from heights is about one third of the total accidents.

Now, it is interesting also to see that when we say fall from heights 40 percent of the accidents are taking place at heights less than 10 metres.

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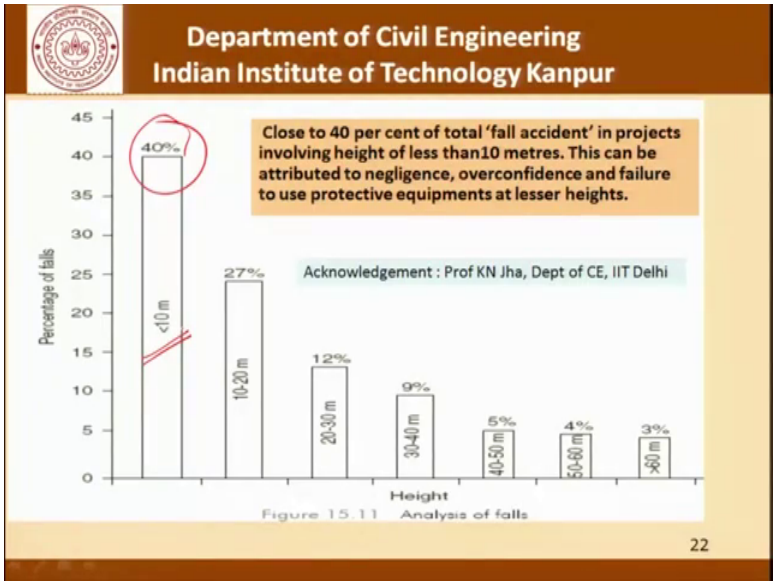

Now, this is a very interesting thing to look at because when we say heights there are two ways of looking at this discussion. One is heights may mean high rise structures were the pot towers where the worker is working at an elevation which is fairly high 60 metre 70 metres and so on. What we find in this statistic is that it is just 10 metres, 10 metres is about 2 to 3 story kind of a building from that height we have 40 percent accidents. Now that is something which is very difficult to digest because it shows negligence over confidence and failure to use protective equipment at lower heights. What happens is that workers and perhaps the management become complacent when the height involved is not very high. We allow the compromise on the standards which are required for working on heights. Not realizing that an accident is an accident and it can happen at any height.

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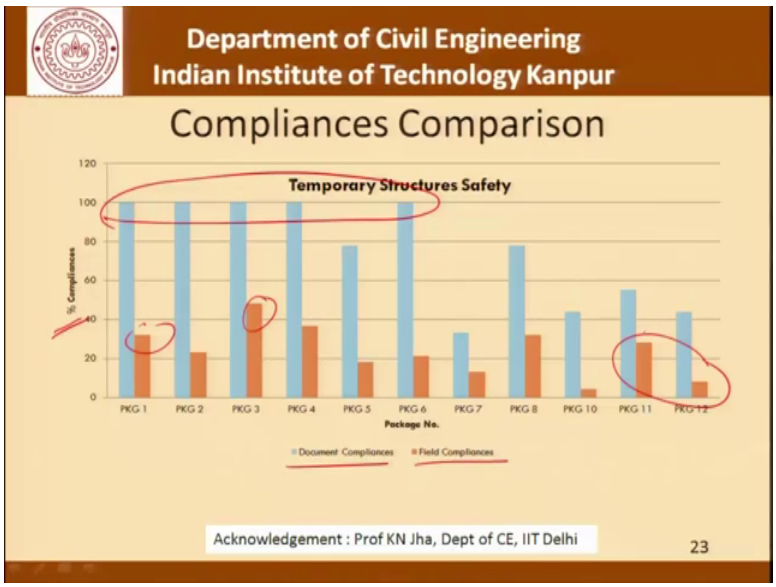

Moving forward this is the compliance comparison which Professor Jha put together with temporary structures there is something very interesting call document compliance and feel compliance. Now what we find is that the document compliance is very high in a lot of cases it could be has highest 100 percent, but the field compliance is very low now this is something which is another very very unfortunate thing is something which needs attention. That document compliance is high, but the fields compliance is low and this kind of data is very very difficult obviously, to get, but there has to be some basis to be able to draw this information we cannot; obviously, share that kind of discussion with you, but please remember and appreciate the fact that it is important that the field practices what is laid down in the document.

Unless that is done it is very difficult to ensure construction safety.

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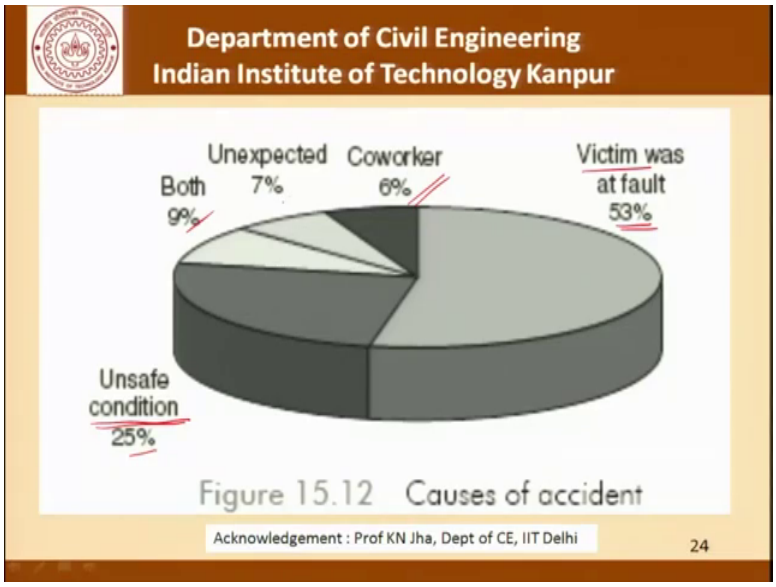

Moving forward as far as cause of accidents is concerned here we are introducing a few other things we are saying that the victim was at fault is 53 percent, there was some unsafe conditions which is 25 percent one-fourth, the coworker was it fall that is about 6 percent both were at fault is 9 percent and unexpected is 7 percent.

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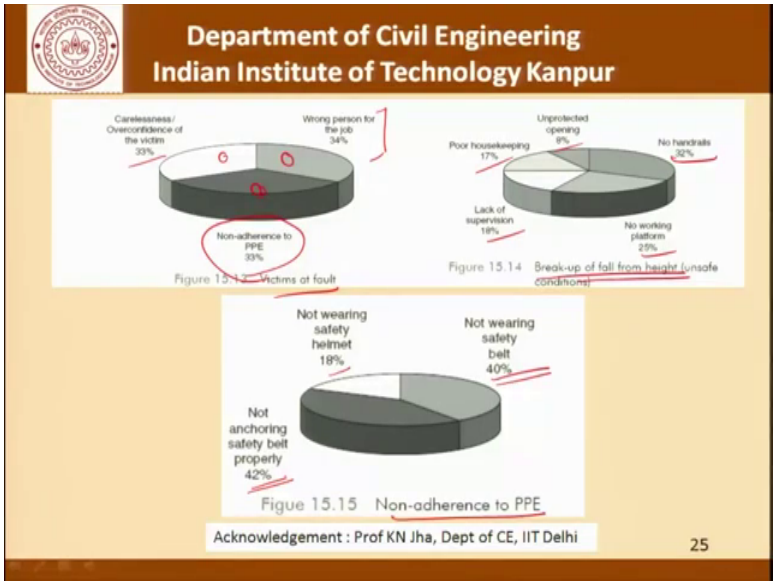

Let us try to look at a few other pie charts like this no handrails is 32 percent, no working platform 25 percent, lack of supervision 18 poor housekeeping 17 and unprotected

opening is 8. This is the breakup of fall from height. When we look at the fault of the victim non adherence to PPE which is the personal protective equipment wrong person for the job is 34 and carelessness overconfidence of the victim is 33.

So, very nicely one-third, one-third, one-third it really shows that it is a matter of complaint it is a matter of educating the worker to use the kind of equipment to follow the kind of norms which will make the construction site a safe place to work. As far as non adherence to PPE is concerned safety belts is 40 percent, helmet is 18 percent and not anchoring the safety belt properly is 42 percent. So, some of these things we will talk again when it comes to details of PPE and so on, but at this point in time when we were trying to talk about the different issues which are related to construction safety it is enough to understand that there is a whole lot of education that needs to be imported. There is a whole lot of analysis of data which has to be done in order that construction managers understand the importance of safety know where to concentrate as far as steps to reduce construction accidents are concerned.

From this picture and the previous one there is also very important conclusion that we can draw let me leave that question to you. What percentage of these accident do you think are preventable, what is the percentage of accidents which would not have happened if there was proper education and proper compliance of provisions. We will answer this question at a later point in time in this discussion, but for the time being just keep at the back of your mind.

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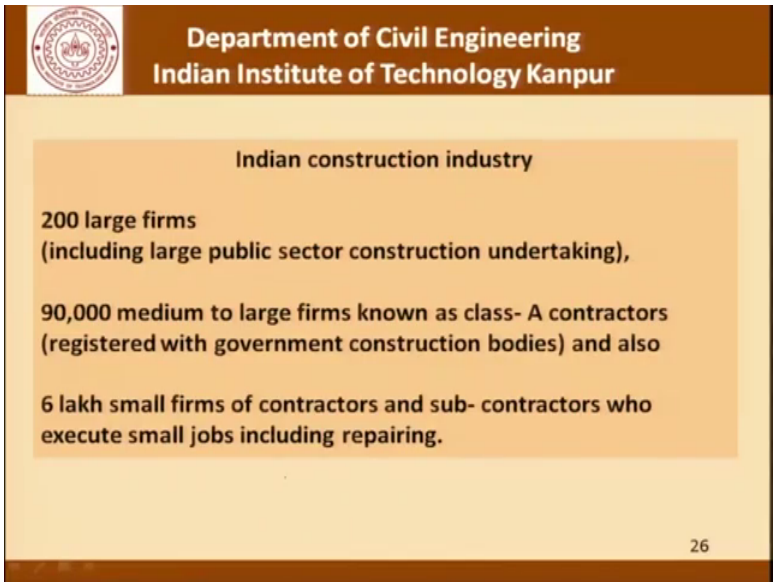

This slide tells you about the Indian construction industry there are 200 large firms including large public sector construction undertakings, 90,000 medium to large firms known as class a contractors registered with government construction bodies and there are 6 lakh that is 600,000 small firms are contractors and subcontractors who executes small jobs including repair.

Now, the idea of showing you these numbers is to basically make you aware of the challenges involved when it comes to implementing construction safety laws or construction safety rules.

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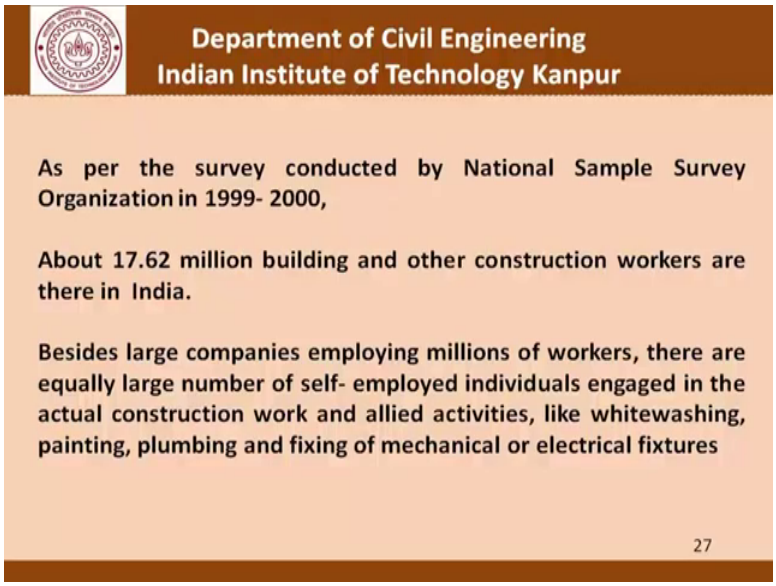

Now, as per a survey conducted by the national sample survey organization in 2000 about 17.62 million building and other construction workers are working in India different construction sites and besides large companies employing millions of workers there is an equally large number of self employed individuals engaged in actual construction work and allied activities like whitewashing painting plumbing and fixing of mechanical electrical fixtures.

In fact, the construction industry would be a very large employer of people in the country and that is true with a lot of developing countries where infrastructure is being built. So, the construction industry by nature is sometimes the labour intensive industry and that is very important appreciate and understand and keep at the back of your mind when we talk of provisions relating to industrial safety or construction safety as far as that diverse group of workers is concerned.

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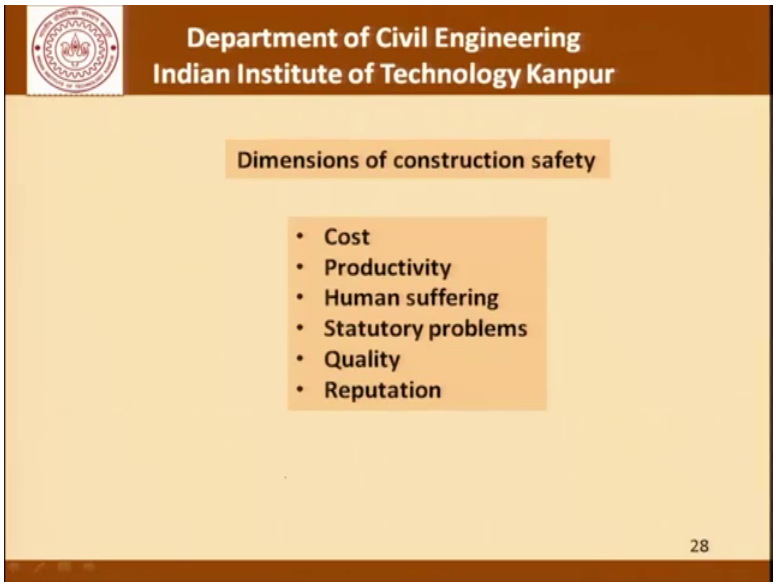

Now, before we go further let us talk of the different dimensions of construction safety studies. Cost of course, accidents is a cost involved we will talk about that in a subsequent lecture it is a direct cost indirect cost direct, cost to the company, direct cost to the worker, indirect cost to both of them and so on.

Loss and productivity the site is closed, the debry has to be removed and only then construction work can start so there are delays there is a loss on productivity human suffering, injuries, deaths, disabilities, temporary permanent hospitalization, not only for the worker or the victim, but also their families and near ones it is a very very difficult and a painful situation. Statutory problems including issues such as being barred from future contracts the impact of accidents on quality, quality and safety are very closely related to each other and I am leaving it to you to think about this relationship how it exists and why it exists and the loss of reputation to the construction company. These are some of the dimensions of construction safety which must be kept in mind by the safety organization or the companies engaged in construction work.

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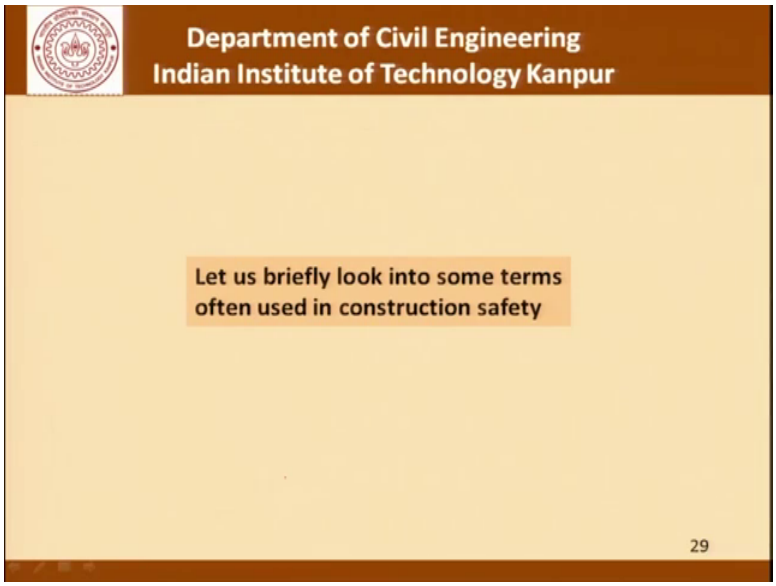

Now, let us briefly look at some of the terms used in construction safety.

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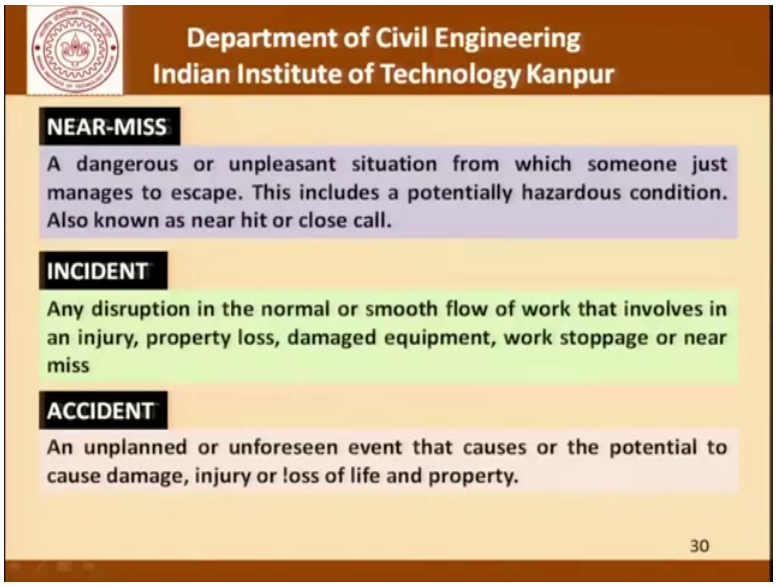

The first thing is a near miss it is a dangerous or unpleasant situation from which someone just manages to escape. This includes a potentially hazardous condition and is called a near hit or a close call, then we talk of an incident which is the disruption the normal or smooth flow of work that involves an injury, property loss, damaged equipment, works stoppage or even an near miss accident we have already seen in this

case I have just written a shorter definition and unplanned or unforeseen event that causes or has the potential to cause damage injury or loss of life and property.

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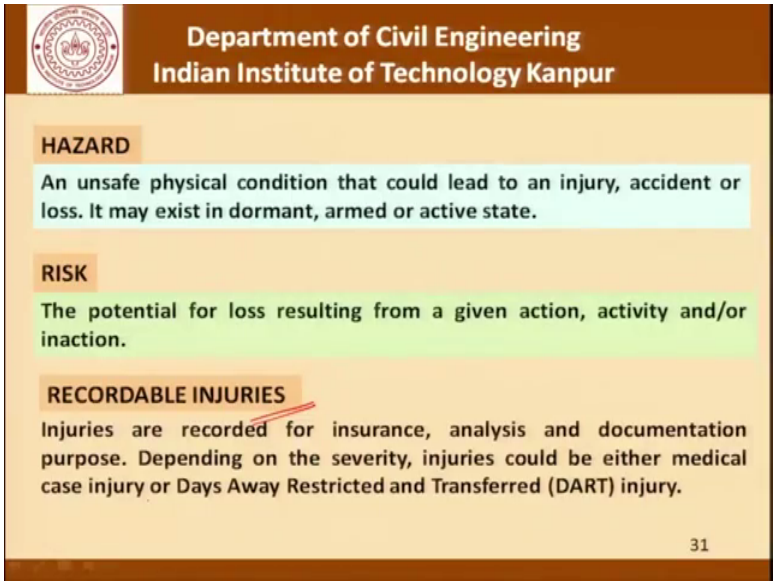

A hazard is an unsafe physical condition that could lead to an injury accident or loss it may exist in dormant armed or active state and the risk is the potential for loss resulting from a given action activity or in action and recordable injuries are injuries are recorded for insurance analysis documentation purposes. Depending on the severity of accidents the injuries could either be medical case injuries or days away restricted and transfer injuries when it comes to definitions such as recordable injuries it is important that these definitions are laid down in a statutory or contract documents. So, that there is no dispute or there is lesser amount of dispute on the statistics and the data.

So obviously, depending on a severity of an accident it has to be reported to a certain level of course, a fatality has to be reported right up to the top. Their compliance issues relating to regulatory bodies where it is no longer between the client and the contractor the government and the police the investigations have to be carried out in a different manner all those things are documented.

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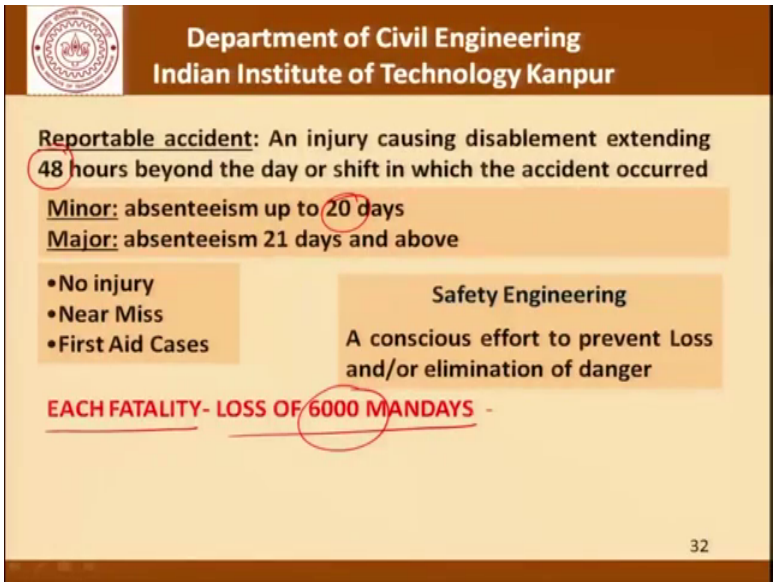

Reportable accident is one wherein injury causing disablement extending 48 hours beyond the day or shift in which the accident occurs that is how a reportable accident is defined. It could be a minor accident and a major accident also a minor accident involves a worker not being able to perform his duties up to 20 days and a major accident is one where the period of extends beyond 21 days. Then there are no injury near miss or first aid cases as far as statistics are concerned each fatality is taken has a loss of 6000 mandays and finally, safety engineering is basically a conscious effort to prevent loss and or elimination of hazards or risks.

I must also point out that these numbers like 48 or 20 or 6000 these are not leaving stone these are numbers which may vary from one standard to another and I will request you or call upon you to read some of the standards and find out what the different international standard say. For example, as far as fatality is concerned the Japanese standards have 7500 manday loss. So, that is basically saying that depending on the loss of mandays that you put here that will affect the statistics of safety. So, that is why it is important to have these definitions clearly understood and laid down.

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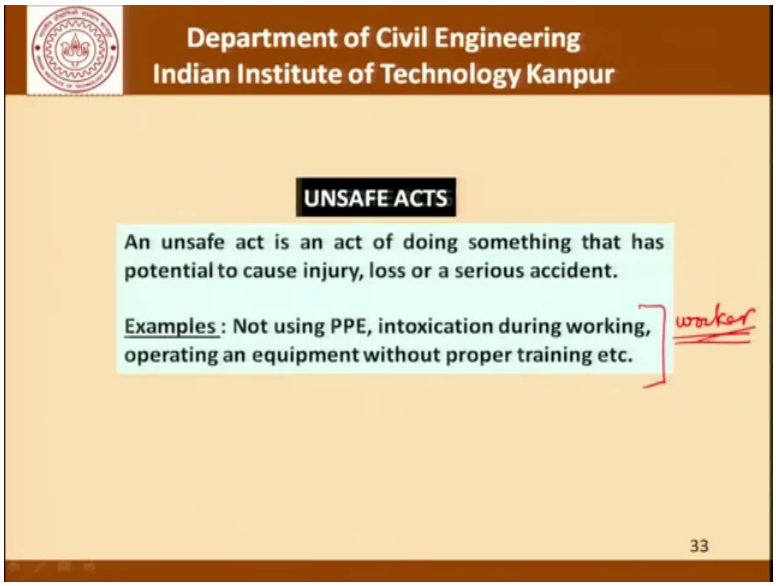

Now, beyond this point let us try to see what causes an accident there are several ways of looking at 8 and I am not getting into the details of the theory of accidents, but principally it is believed that there are unsafe acts which are responsible for an accident.

Now, an unsafe act is an act of doing something that has the potential to cause injury loss or a serious accident now examples of this unsafe act could be not using PPE intoxication during working operating an equipment without proper training and license. These are all attributed to or attributable to the worker concerned. So, the unsafe acts are actions of workers which cause an accident.

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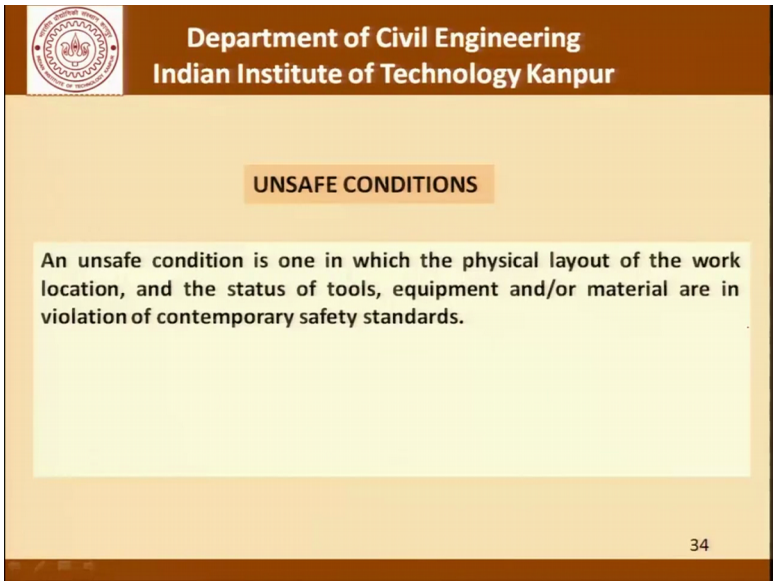

Unsafe conditions however, are slightly different. It is one in which the physical layout of the work location and the status of tools equipment and or material are in violation of contemporary safety standards. We will see several examples of unsafe acts and unsafe conditions as far as unsafe conditions are concerned some examples could be defective equipment, slippery surfaces, improperly arranged, the scaffolding, lack of PPE inadequate ventilation and illumination unshielded or protruding ends of reinforcing bars and so on.

So, these are related not to the individual workers, but to the site itself it could be related to the layout, it could be related to the status of the tools or the equipment or it could be just a violation of contemporary of prevailing safety standards. These are what constitute unsafe conditions.

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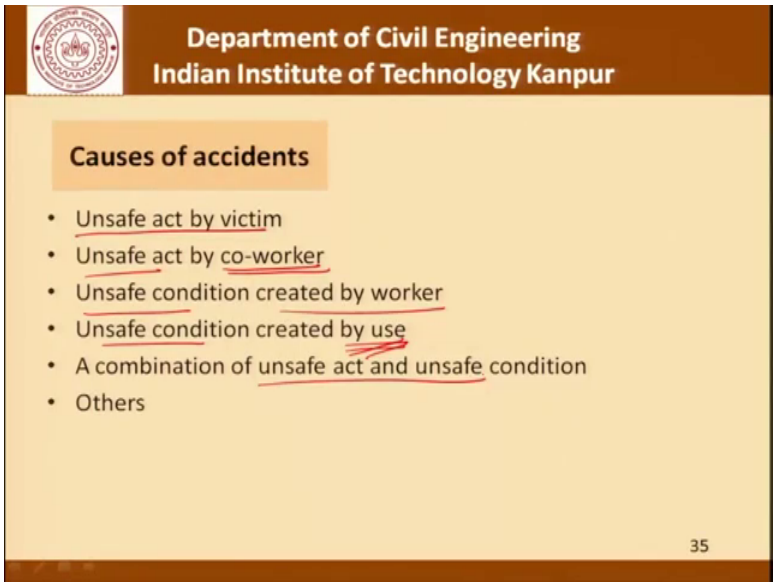

Looking at the causes of accidents in a little more detail they could be caused by an unsafe act of the victim himself or herself. They could be caused by an unsafe act of a coworker now you recall the kind of discussion that we had with those pie charts and you can relate some of the numbers to the discussion we are having now.

Unsafe condition created by the worker they are could be also unsafe conditions which are created by used. For example, if there is a sling row which is being used over a period of time it where is out. So, now, using an worn out sling row is an unsafe condition which is brought about by use. The fact that the worker continues to use it if it is with his knowledge then it becomes an unsafe act on his part. So, it is very difficult at times to distinguish between an unsafe act and unsafe condition, but we must understand or keep in mind this spirit of the discussion. The, a combination of unsafe act and unsafe condition and of course, there are some other reasons.

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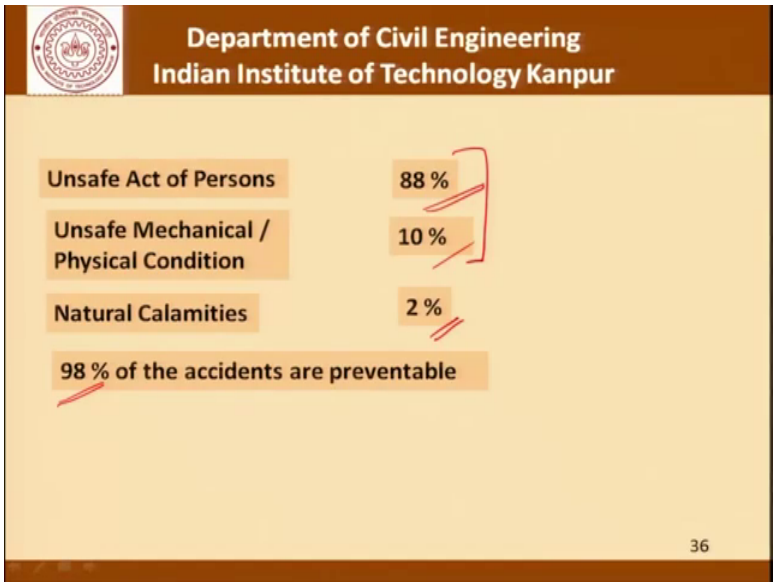

If you want to summarize if you say that there are unsafe acts of persons unsafe mechanical of physical conditions and natural calamities as the causes of the accidents and we try to assign some numbers as to what is their contribution to accidents. Unsafe acts of persons is 88, unsafe mechanical or physical conditions is 10 and natural calamities is 2.

What it shows is that 98 percent of the accidents are actually preventable. 88 percent are preventable by shear education of the workers themselves, if the workers do not commit an unsafe at 88 percent of the accidents perhaps would not happen. If they become conscious as individuals and as construction companies of those involved in the construction process become aware not to create unsafe conditions another 10 percent would be avoided it is only 2 percent of the accidents which will be difficult to avoid. So, 98 percent the accidents are preventable and this is an eye opening shocking kind of a statistic and this 98 percent whether its 98 or 95 is not an issue.

If you go back to the statistics that were presented in the pie charts there also you will realize that if we are able to put together everything somewhere and say that ok how many accidents were actually not preventable I do not think the number would exceed 5 to 7 percent in most cases.

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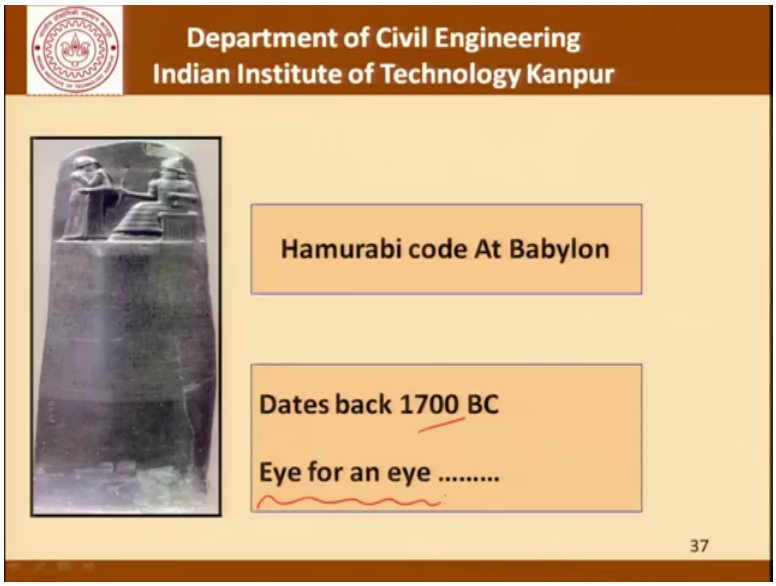

Now, this is the very interesting anecdote or a very interesting old story if you look at the Hamurabi code in Babylon which is dating for 1700 BC that is several years ago it was based on an eye for an eye concept. So, of course, construction work has been going on for a long time as far as human civilization is concerned and accidents are also not new. I am sure they were accidents even earlier when people were carrying out the exercise of building large structures small structures without the help of equipment.

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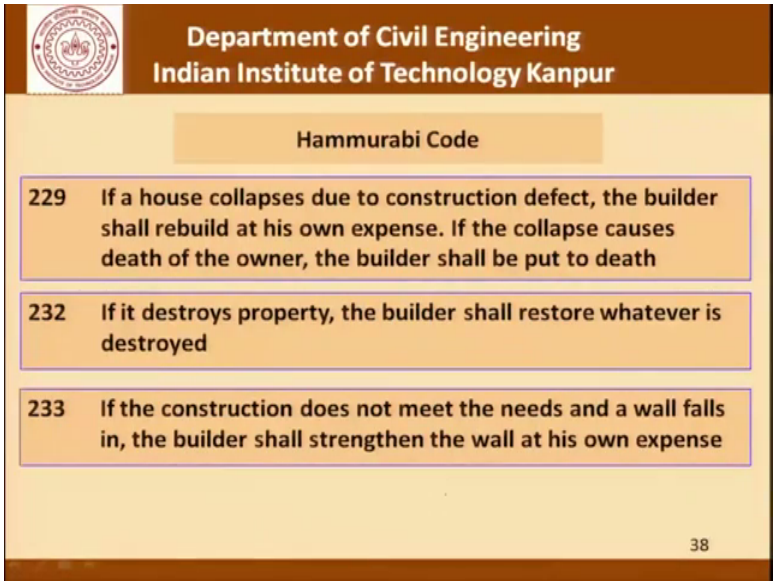

At that time if you look at some of the tablet us which have been found one of them says if a house collapse is due to the construction defect the builder shell rebuild at his own expense and if the collapse causes death of the owner the builder shall be put to death. So, this is more often eye for an eye kind of a concept if it destroys the property the builder shall restore whatever is destroyed and if the construction does not meet the needs and a wall falls in the builder shall strengthen the wall at his own expense.

So, basically the kind of discussion that we have today is very contemporary that we have a contractor or a construction company that carries out the construction work that person or that company has to take the responsibility of rebuilding in case of a defect liability and also ensuring the structure that has been built is safe an accident free. I will not go in to this accident causation theory is in any detail, but I am just included that for your reference.

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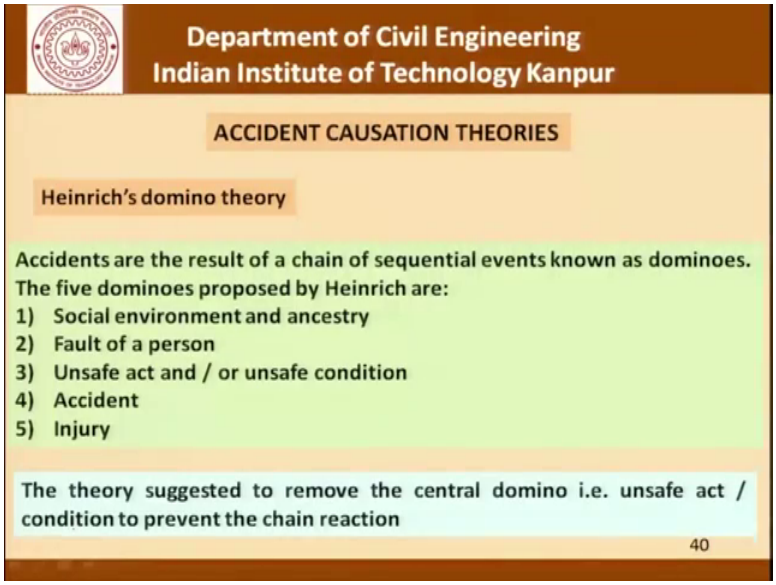

There is a very interesting and a very pioneering work from Heinrich with a whose domino theory says that accidents are the result of a chain of sequential events known as dominos in the 5 dominos propose by Heinrich are social environment and ancestry, fault of a person, unsafe act and or unsafe condition, accident and injury. And the theory suggest to remove the central domino unsafe act to prevent the chain of accidents.

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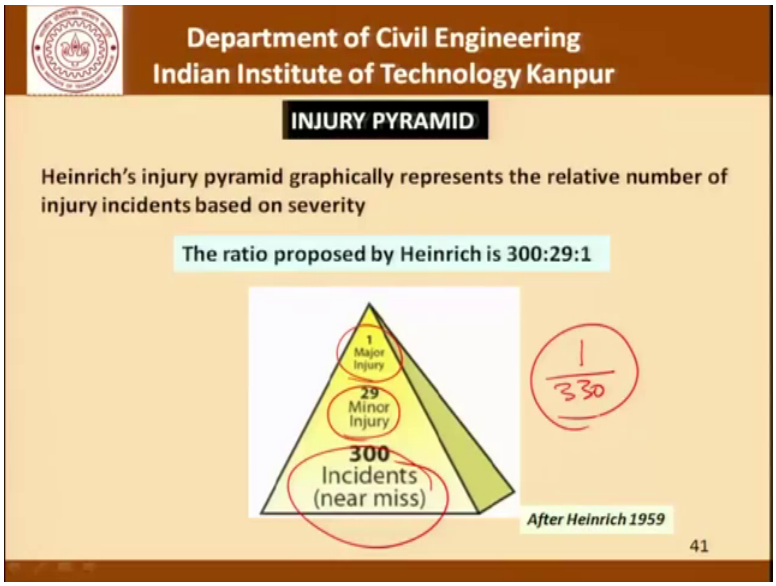

This is a very interesting injury pyramid proposed by Heinrich which says that for 300 near misses or incidents only 29 would have minor injuries and one major injury. Basically what it says is that only one major injuring will happen in 330 reportable accidents, but that itself is cause enough for us to take steps and prevent accidents. These axioms from Heinrich or industrial safety I am leaving it to you read because they are often focused on industrial environment which is slightly different from construction.

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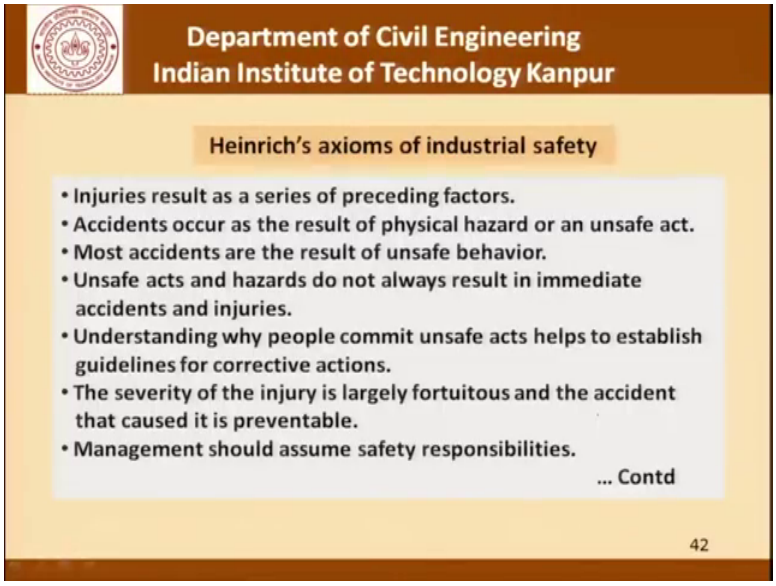

And best accident prevention techniques are analogous to best quality and productivity techniques and the supervisor is the key person in preventing industrial accidents and the cost of accidents include both direct and indirect costs.

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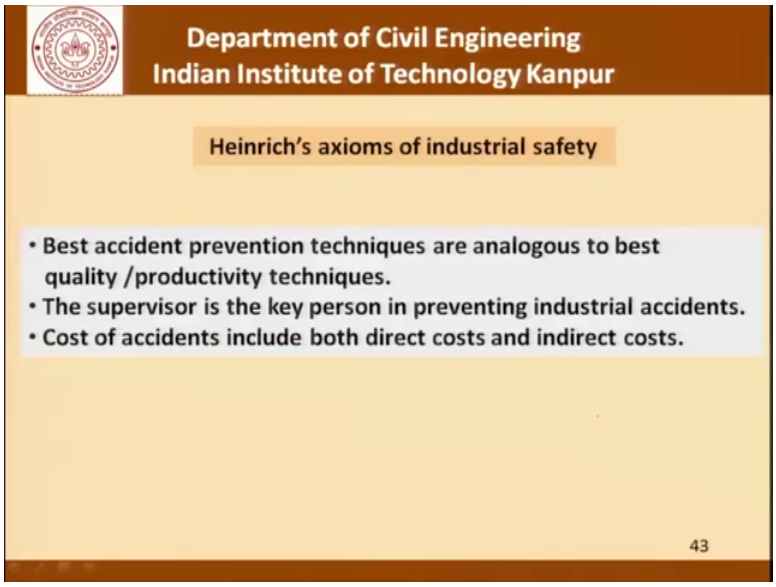

We have already gone through this discussion little bit earlier as to how the construction industry performs with respect to safety.

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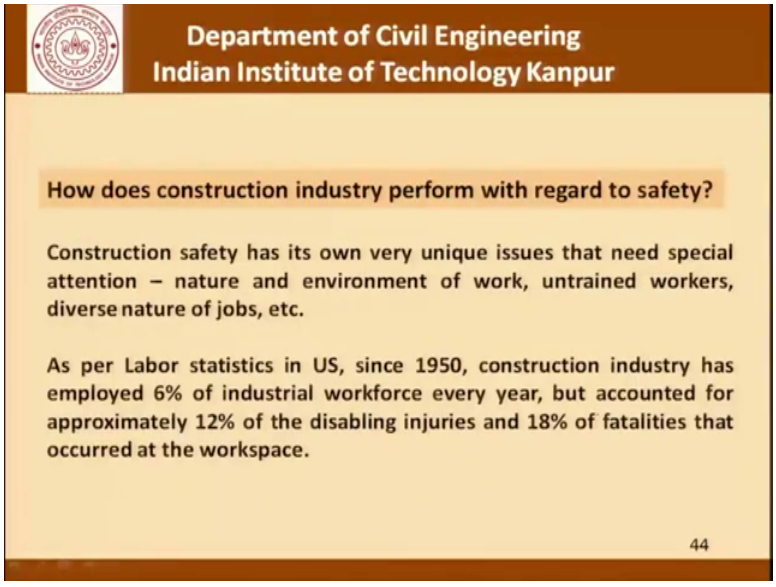

The construction safety has its own very unique issues that need special attention the nature and environment of work untrained workers diverse nature of jobs you have

already talked about some of this at the outset of the discussion today. And as per labour statistics in the united states since 1950 construction industry has employed 6 percent of the industrial work force every year, but has accounted for 12 percent of the disabling injuries and 18 percent of the fatalities that have occurred at the workspace.

This is the exactly the kind of statistics which we had shown for Japan where the information was available over the period of time that yes there was a time in construction industry was having a higher frequency of accidents of course, in this case its talking about fatalities. It had a higher accident rate and therefore, possibly the higher fatality rate, but that has come down over a period of time. As far as the United States is concerned this data is something which you need to do as an exercise if you are interested in this subject and get it better understanding.

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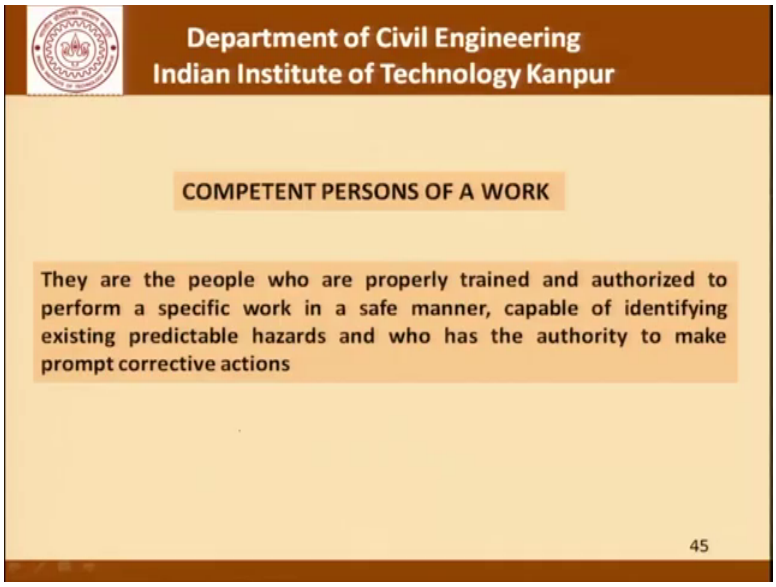

Now, one important thing that we must understand as far as construction safety is concerned that competent persons are very very important to be identified for all work. There are people who are properly trained and authorized to perform a specific work in a safe manner, capable of identifying existing predictable hazards and who have the authority to make prompt corrective actions. It is very important that people at construction sites do not try to do others work, it is very important that they understand the issues involved with training and handling different environments and different works even though they may look simple.

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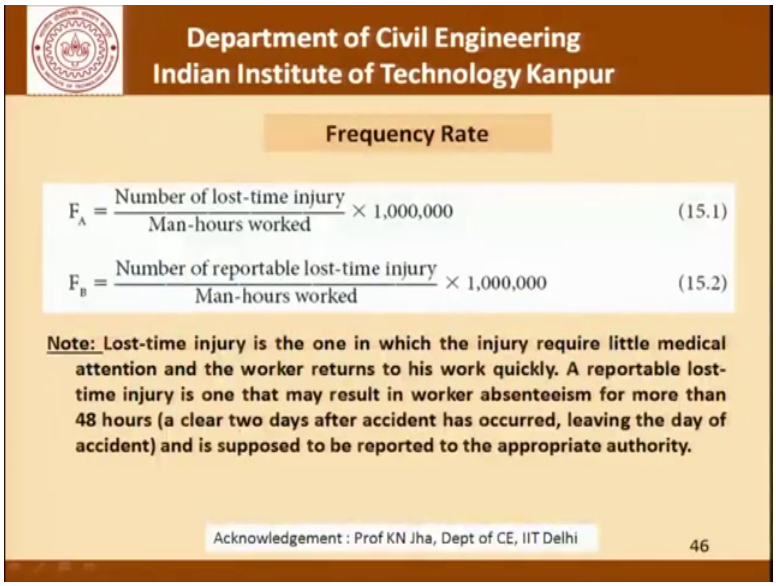

Now, it is important for us to understand some definitions of different statistical parameters which are used or can be used to compute the kind of statistics that we have been talking about - frequency rate, reportable accidents, fatalities and so on.

Now obviously, it is important that the man hours worked is something which has to be kept into; obviously, the number of accidents as an absolute number is one parameter, but those number of accidents have to be viewed in perspective with respect to the man hours that have been put in. So, if you are not working at all then; obviously, the chances of accidents are zero, but that does not mean that the frequency is zero. Only when there is a lot of work being done and man hours being put in then we have to see whether a company is actually having a low frequency rate or not. So, in this case we have man hours work in the denominator and we have statistics like frequency F A and F B which is number of reportable lost time injuries and number of lost time injuries total which is given to us with respect to a million here.

So, because a man hours will give a very large numbers it is multiplied by a million to get the numbers in a more reasonable range. Lost time injury is one in which the injury requires little medical attention and the worker returns to his work quickly. A reportable lost time injury is one that may take the worker to be absent from his work for 48 hours a clear two days after the accident has occurred and leaving the day of the accident and is supposed to be reported to higher authorities. Now of course, at different sites with

different clients with different regulatory bodies this appropriate authority could be different.

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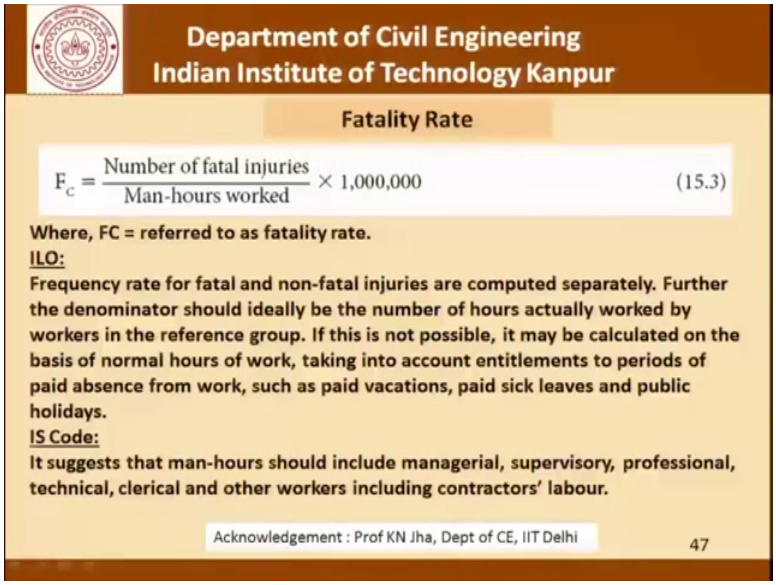

Fatality rate similarly is the number of fatal injuries again with a man hours work to the denominator. So, where as the ILO suggest that the frequency rate for fatal and nonfatal injuries are computed separately and the denominator should ideally be the number of hours actually work by the workers in the reference group and if this is not possible it may be calculated on the basis of normal working hours taking into account entitlements to periods of paid absence from work such as paid vacations, paid sick leaves and public holidays. Similarly as far as the Indian courts are concerned they suggest that man hour should include managerial supervisory, professional, technical, clerical and another workers including contractors labours.

So, this is what gives you the idea that it is not simple to compute the man hours worked who is man hours are we talking about - are we talking about only the workers at site or we are also including the workers who are working in offices supporting that site work. So, it is not that one is right or the other is wrong, it is only a matter of having a clear definition which is understood by all concerned and is followed as far as generating these statistics are concerned.

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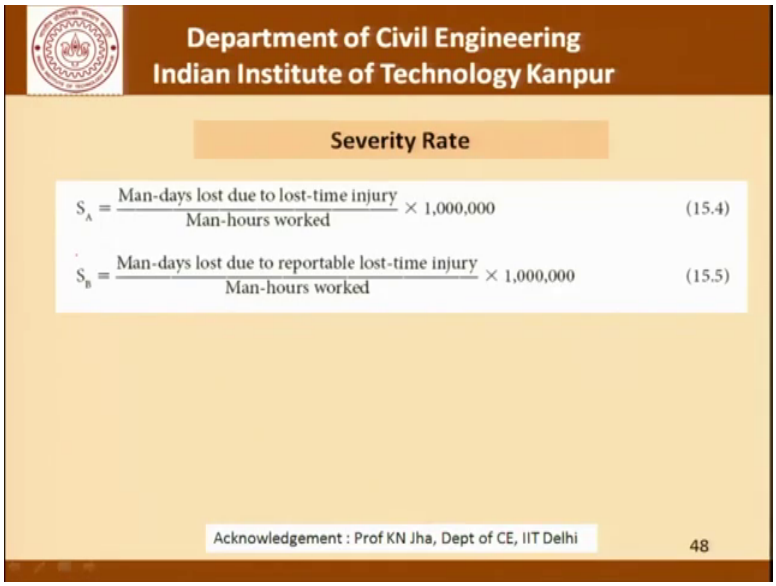

Similarly, when it comes to severity rate there is A and B which is mandays lost due to lost time injuries and mandays lost due to reportable lost time injuries again related to the man hours.

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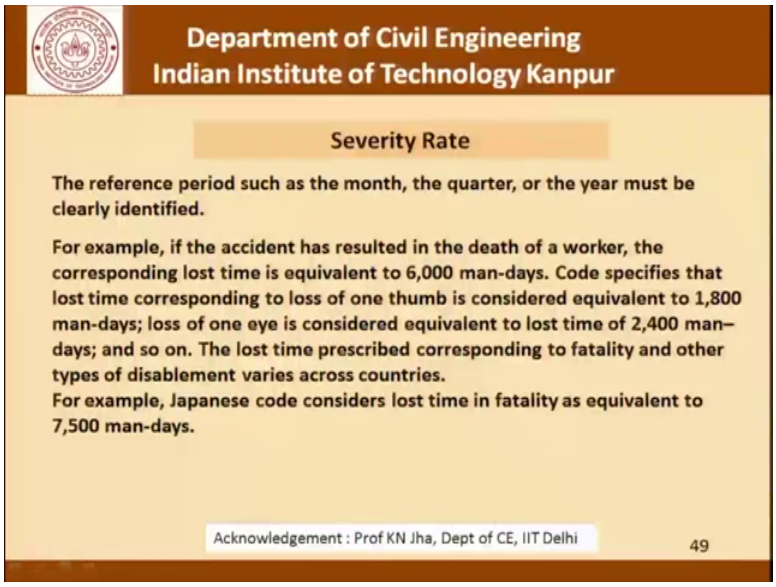

As far as severity rate is concerned the reference period that is the month quarter or year must also be clearly identified. So, for example, if an accident has resulted in the death of a worker the corresponding lost time is equivalent 6000 mandays we had mentioned this in a slide earlier if you will recall and the code specifies that the lost time corresponding

to loss of 1 thumb is considered equivalent to 1800 mandays, loss of an eyes considered equivalent to lost time of 2400 and so on and so forth.

Construction accidents can have minor injuries, major injuries which include temporary disability, maybe permanent disability and all that has to be finally, reduced to how much is the lost time. Now that last time is difficult to compute and therefore, codes also lay down certain number such as the number suggested here in order to assign a certain amount of severity to a certain accident.

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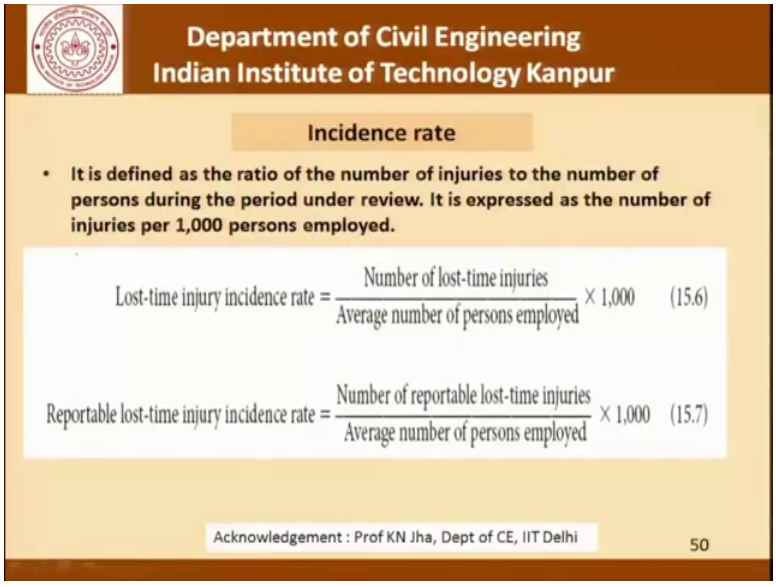

Similarly, the incident rate is defined as the ratio of number of injuries to the number of persons during the work period under review and is expressed as a number of injuries per thousand people employed. So, here we have two clauses - the lost time injury incident rate and the reportable lost time injury incident rate which is defined as given here.

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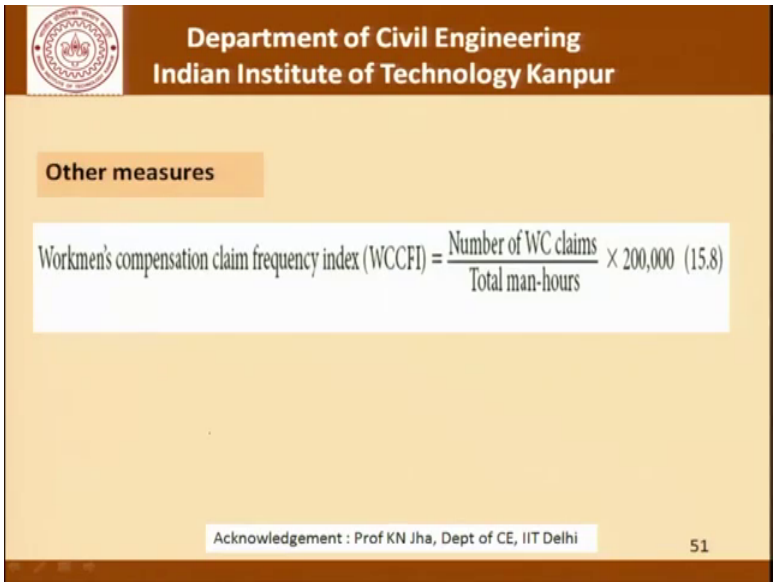

And then of course, there can be other measures which can be adopted to quantify the safety performance of a construction company. It could be workmans compensation claim frequency which is the number of claims to the total number of man hours worked.

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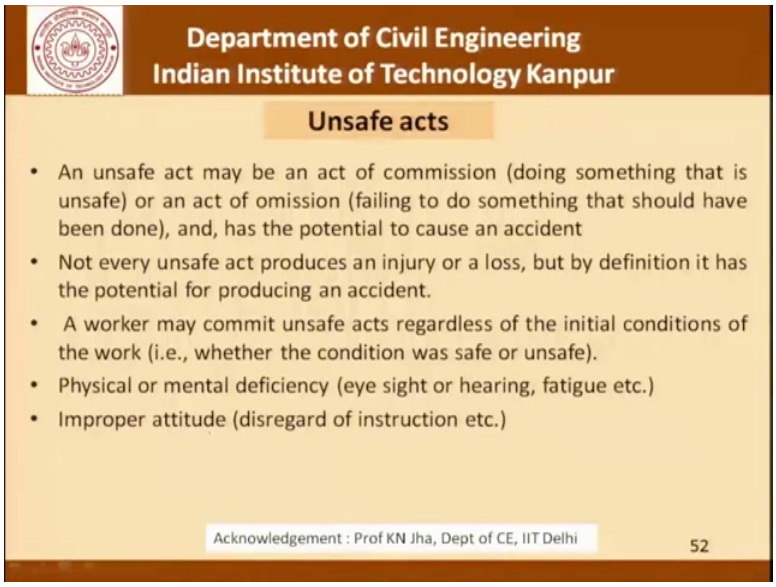

Let us come back to this discussion on unsafe acts and unsafe conditions once again and unsafe act maybe one of omission doing something that is unsafe or an act of omission which is feeling to do something which should have been done and has the potential to

cause an accident and not every unsafe act produces an injury or a loss, but by definition it has the potential of producing an accident.

A worker may commit unsafe acts regardless of the initial conditions of work whether the condition was safe or unsafe it could be on account of physical or mental deficiency, eye sight, hearing, fatigue these are conditions which could induce or cause a worker to commit and unsafe act improper attitude which is disregard of instruction it could include over confidence arrogance, and if you continue with this list cleaning, oiling or adjusting or repairing of moving electrically energized pressurized equipment while they are running.

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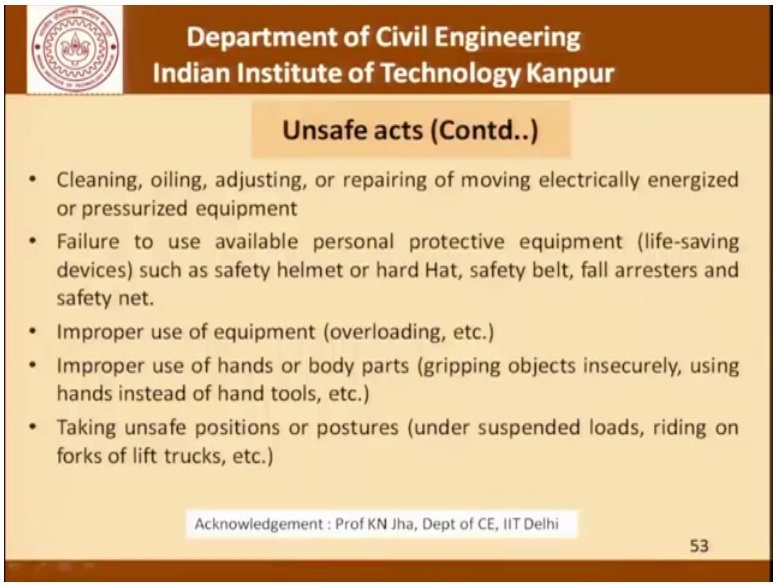

Failure to use available personal protective equipment like life saving devices such as helmets hard hat safety belts improper use of equipment which could include overloading. Improper use of hand or body parts gripping objects insecurely using hands instead of hand tools these are all things which are coming under the larger ambit of unsafe acts and; obviously, with the proper amount of worker training they can all be eliminated. Taking unsafe positions or postures for example, it could be under suspended loads riding on the fork of lift trucks time permitting will probably going to some of these actual cases of accidents arising out of this kind of unsafe behaviour on part of workers.

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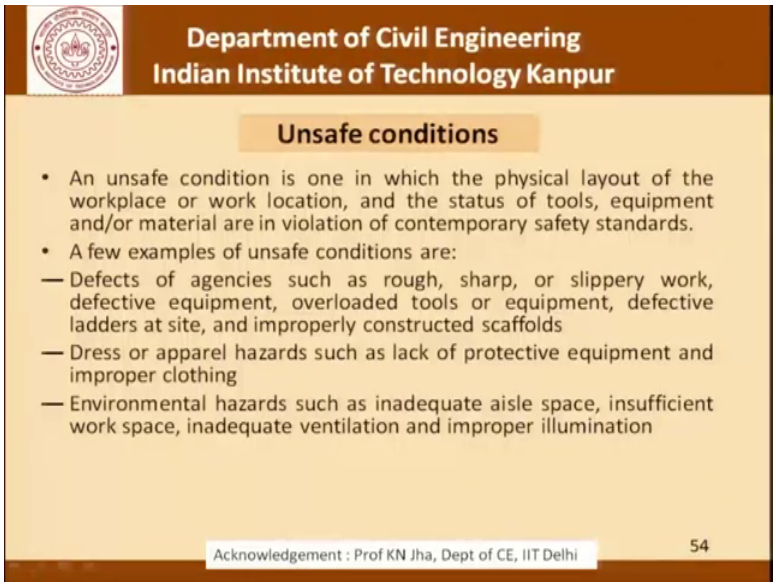

Now, coming to unsafe conditions that is one when the physical layout of workplace or work location and the status of tools this what we have already seen and few examples of these could be defects of agencies such as rough sharp or slippery work, defective equipment overloaded tools or equipment defective ladders at site improperly constructed scaffolds, dress or apparel hazards such as lack of protecting equipment and improper clothing environmental hazards such as inadequate aisle space, insufficient workspace, inadequate ventilation and improper illumination.

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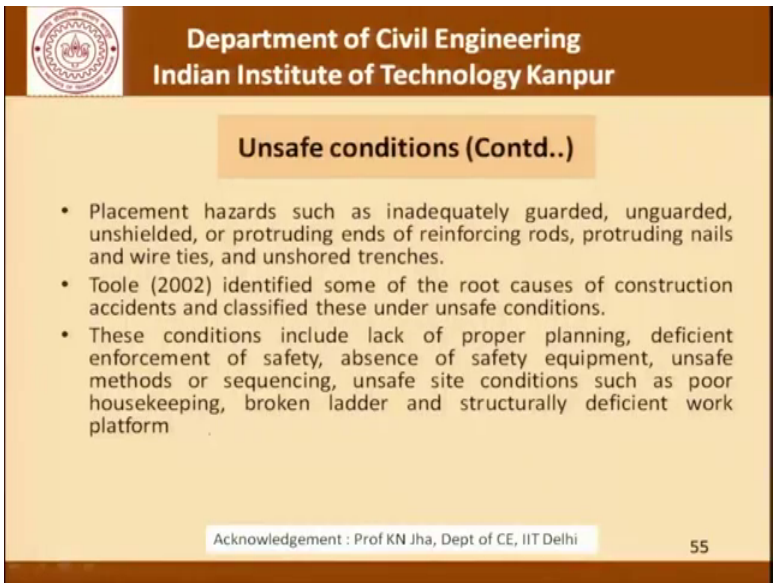

And if you continue with this list it could be placement hazard such as inadequately guarded, unguarded, unshielded, protruding ends of reinforcing bars, protruding nails, wire ties and unshored trenches. These conditions are basically due to lack of proper planning deficient enforcement of safety, absence of safety equipment, unsafe methods of sequencing, unsafe site conditions such as poor housekeeping, broken ladder structurally deficient work platforms and so on.

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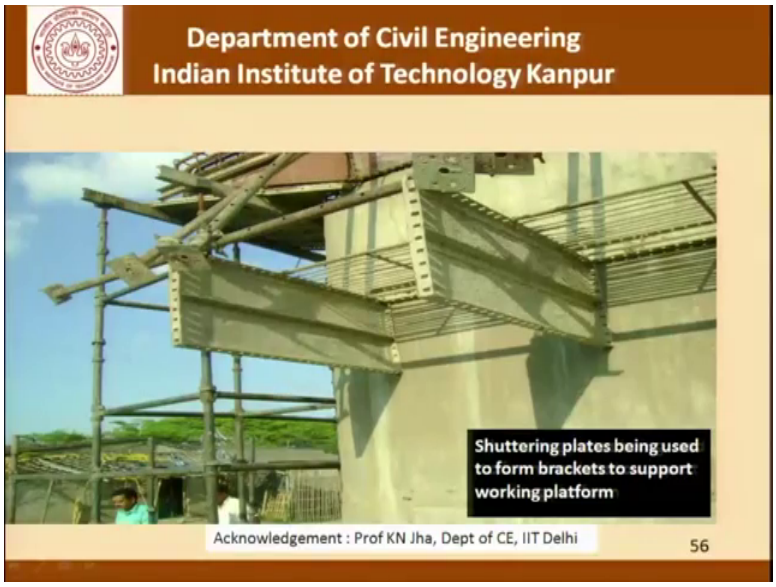

Now, let us take a look at some of the unsafe conditions and photographs from sites where we will be able to clearly see how safety norms are violated. Here for example, we see shuttering plates being used to form brackets to support platforms.

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Here we see shuttering plates being used as pedestals and even worse they are kept on loose soil.

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These picture show a view of access to the workplace again it is a misuse of shuttering plates.

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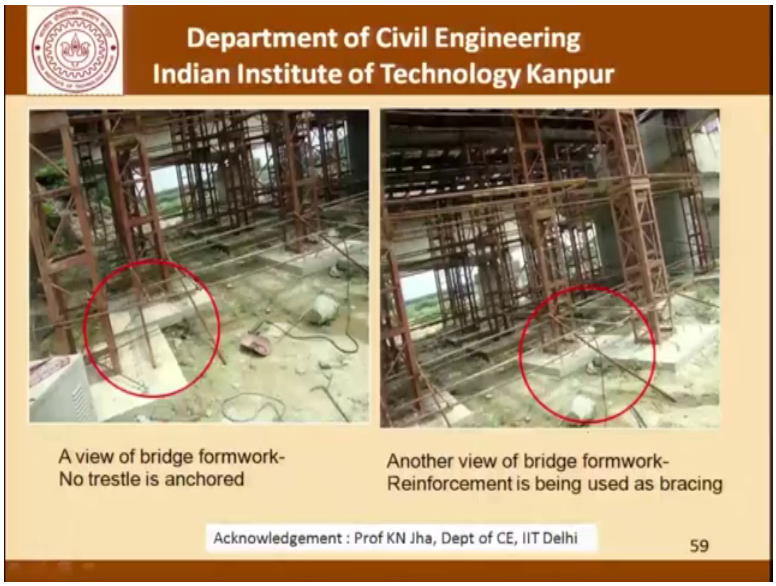

This is the view of a bridge formwork with trestles not anchored and another view where the bridge formwork reinforcement being used as bracings. It is important to understand that no matter what the worker does the management must ensure a clean site it is important for the execution team to have good housekeeping and good practices being practiced at site and therefore, such conditions are unsafe conditions arising out of misuse of tools misuse of material and so on.

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Now, in this case we see that there is absolutely no control on the public movement in a risky works zone so; obviously, if there is an accident in this case it is not the worker who will be injured, but somebody who is not connected directly to the construction work at all. The question is whether it is the constructor's responsibility to also ensure that people who are not related, who are not trained to enter the construction site should they be allowed free access there have to be provisions there have to be ways and means by which the site is barricaded.

The same thing is here we find a small boy standing on the shuttering plates.

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Here we find foot plates not in proper contact with concrete pedestals.

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We find working platforms with no hand rails or foot guard.

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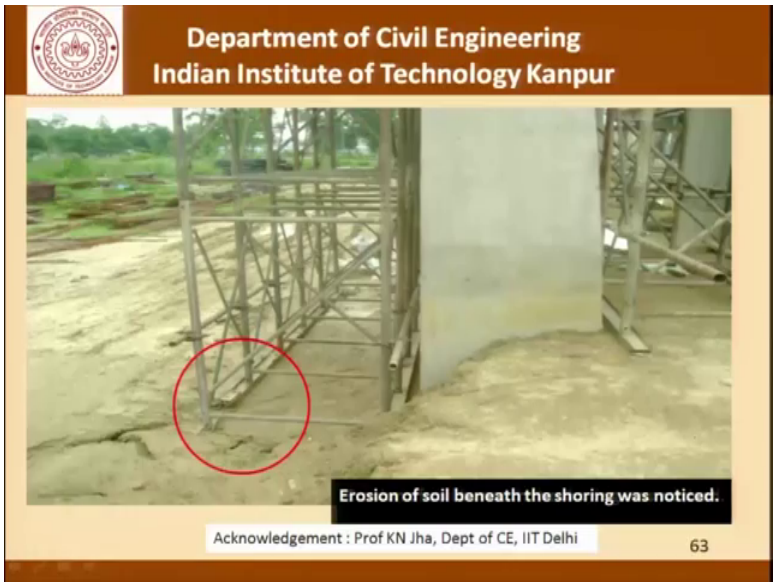

We find shoring where there is erosion of soil beneath.

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This is the case of a damaged link which needs to be removed from service.

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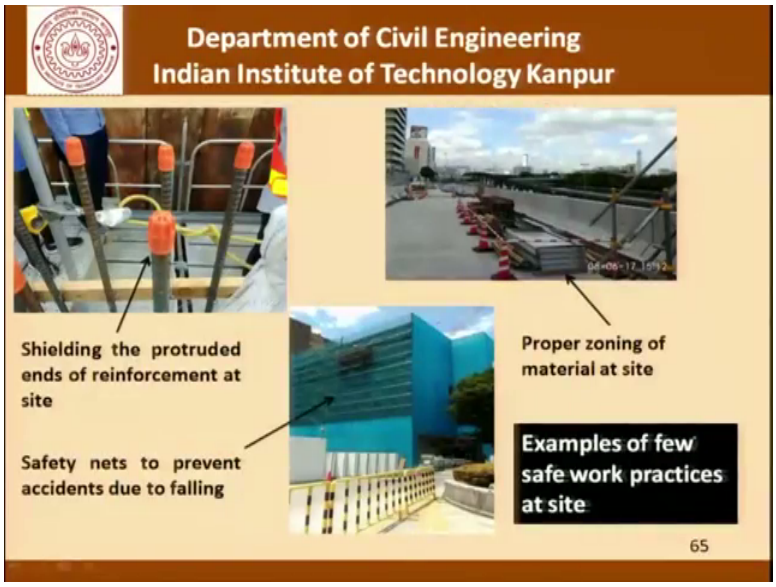

Now, after seeing so many poor housekeeping slides this is an example of a better management where there is shielding of protruding ends of reinforcement, safety nets and proper zoning of the materials at site. So, it is not that it cannot be done it is only a matter of having the will to actually do it.

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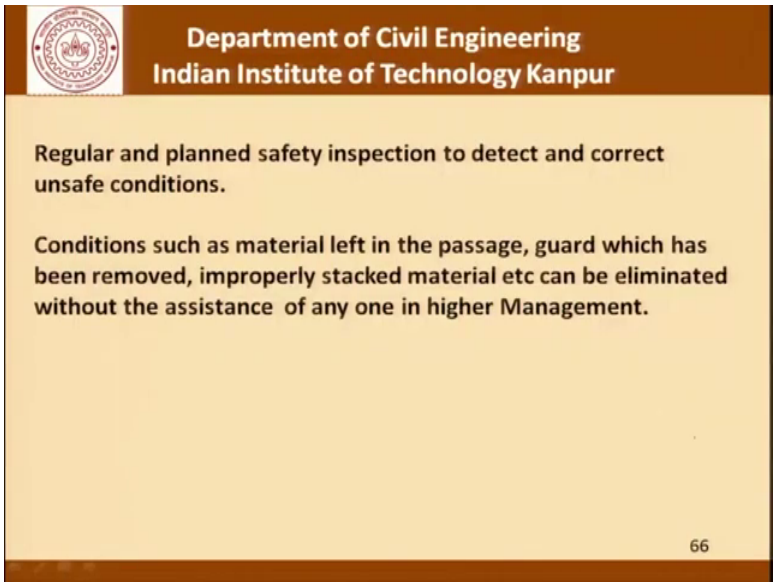

Regular and planned safety inspections to detect and correct unsafe conditions are a very important part and that is what I said that it is the management responsibility that a culture is enforced at sites where unsafe conditions are not allowed to prevail. Conditions such as material left in the passage, guard which has been removed, improperly stack material can be eliminated without the assistance of anyone in higher management. It does not go try to the top of the company to introduce or to ensure compliance with these simple things.

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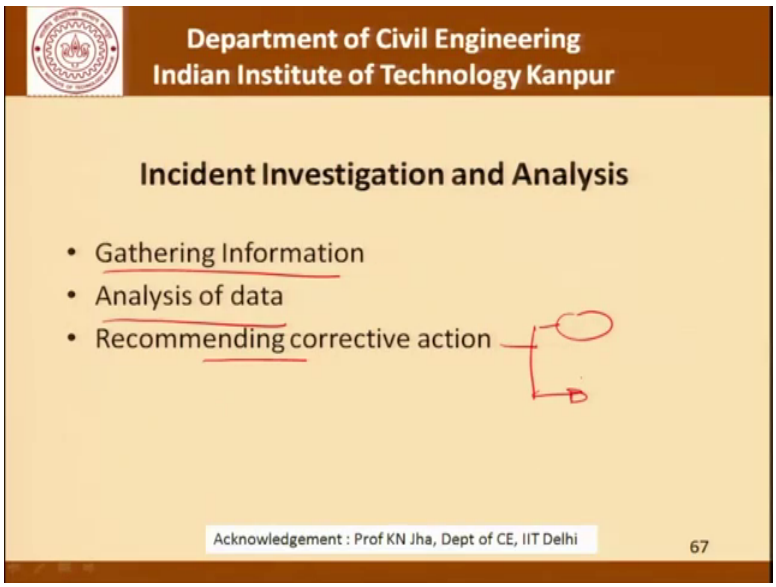

One important part before we close the discussion today is that relating to incident investigation and analysis. There are three parts to this one is gathering information, the other is analysis of data and then it is recommending corrective action. This also comes into ambit of the responsibilities of the safety group.

The first thing is gathering information now this information can be gathered either by photographs or by inter going people going through CC TV footage, using technology for this purpose and then carrying out an analysis. Finally, recommendations should always be in two or three parts - one is what went wrong in this particular incident and action against people who were found to be negligent.

The second part of the report or recommendations should always be preventive steps for the future as to what steps need to be taken so that they accident does not recur. It is very important that been investigation and analysis are carried out not with the intension of a witch hunt or trying to fix responsibility and making somebody escape road, but with the honest professional desired to get to the bottom of the cause of the accident and eliminated.

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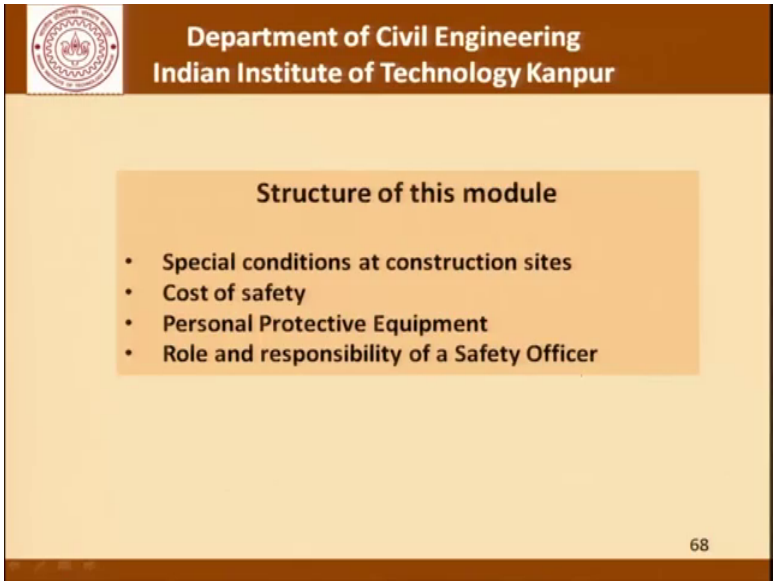

As far as this module on construction safety is concerned we will cover these aspects, a special conditions at construction sites, the cost of safety, personal protective equipment, and the role and responsibility of a safety officer this discussion will be carried out within the framework that we have defined today.

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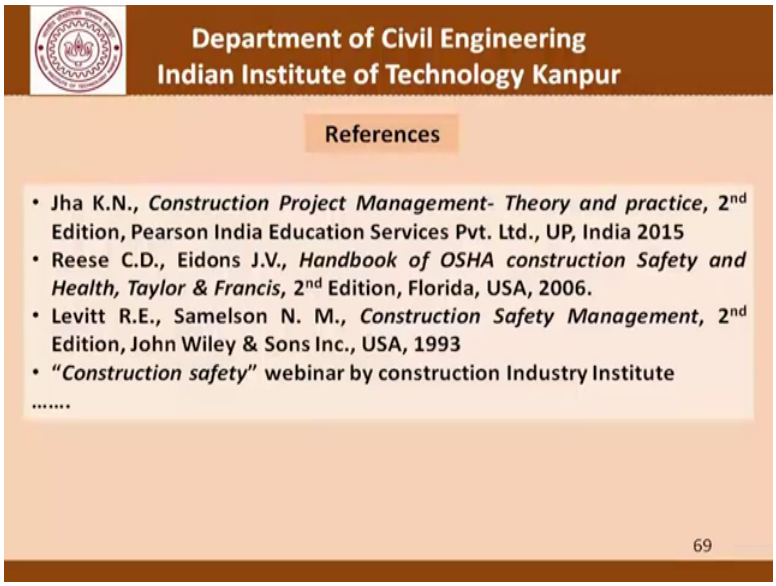

With this we come to an end of the discussion today and you would have noticed that I have taken a lot of material from this book from Professor KN Jha and you will find it a very interesting read if you want to know something more and I look forward to seeing you in subsequent discussions.

Thank you.