

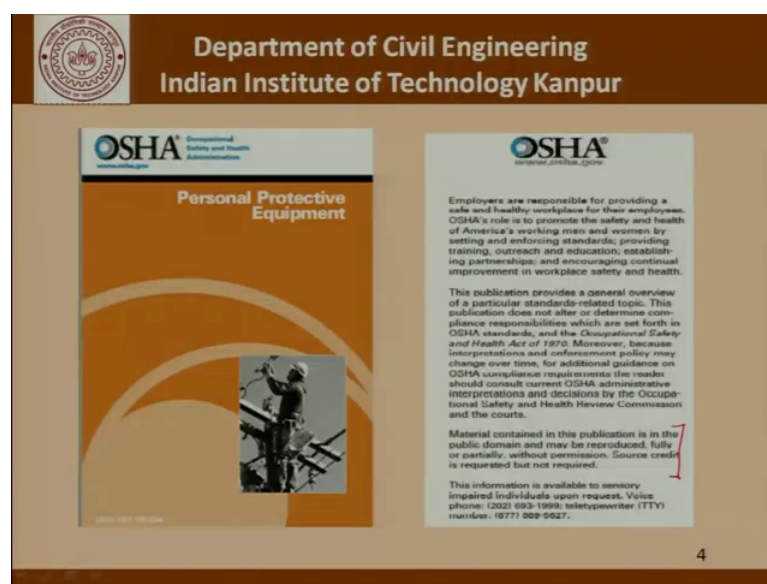
**Principles of Construction Management**  
**Prof. Sudhir Misra**  
**Department of Civil Engineering**  
**Indian Institute of Technology, Kanpur**

**Lecture – 24**  
**Personal Protective Equipment**

[FL] welcome to the series of lectures on Principles of Construction Management. And what we have been talking about is construction safety and we have gone through material which says that well of course, an accident is unacceptable. We should also understand that in case there is an accident all efforts should be made that there is minimum loss of life and property. So, coming to this effort; which is concentrated on the minimizing of life, minimizing of injuries to workers, the personal protective equipment, which is the subject matter of discussion. Today place a very very important role.

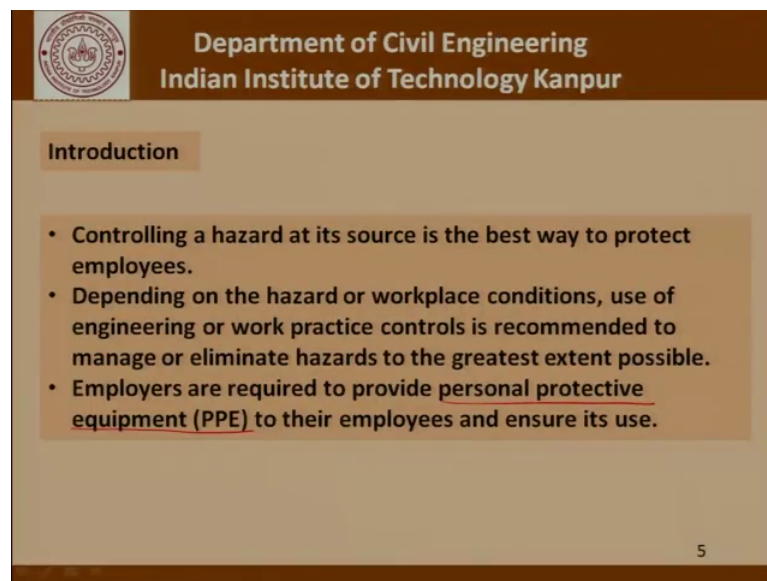
So, what we will do today is talk about the different personal protective equipment that is used and what is the roles of the employer and what is the role of the employees and so on in our discussion. Before we start our discussion on the PPE or the personal protective equipment, let me acknowledge the occupational safety and health administration whose booklet is largely the basis of our discussion today.

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And it is very interesting to note that as part of this booklet it is clearly written that material contained in this publication is in public domain and may be reproduced fully or partially without permission. Source credit is requested, but not required, whether it is requested or not I would like to acknowledge the effort made by OSHA in this direction. And this is a important a very interesting reference and I would expect hope that some of you find it useful please do go through that.

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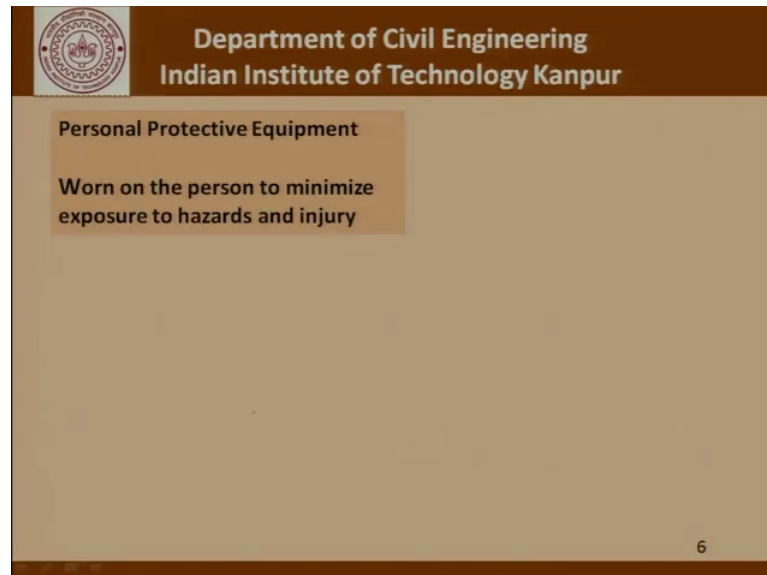


So, now coming to our discussion the first step as far as minimizing the damage due to an accident is concerned is controlling the hazard at its source is the best way to protect your employees. So, if somehow we are able to ensure that the accident does not happen, the hazard is controlled at the site itself where it is then the employees are exposed to the minimum danger. Now depending on the hazard of the workplace conditions, use of engineering or work practice controls is recommended to manage or eliminate the hazards to the greatest extent possible. So, elimination of the hazard at its origin is the best thing to do and we have to take engineering and work practice controls and that is what has been part of our discussion so far. Employees are however, in addition required to provide personal protective equipment PPE to their employees and ensure its use.

So, in the event of an accident, in the event of the injury to a worker the employers cannot take the defense that the worker did not use the PPE properly. It is the employer's

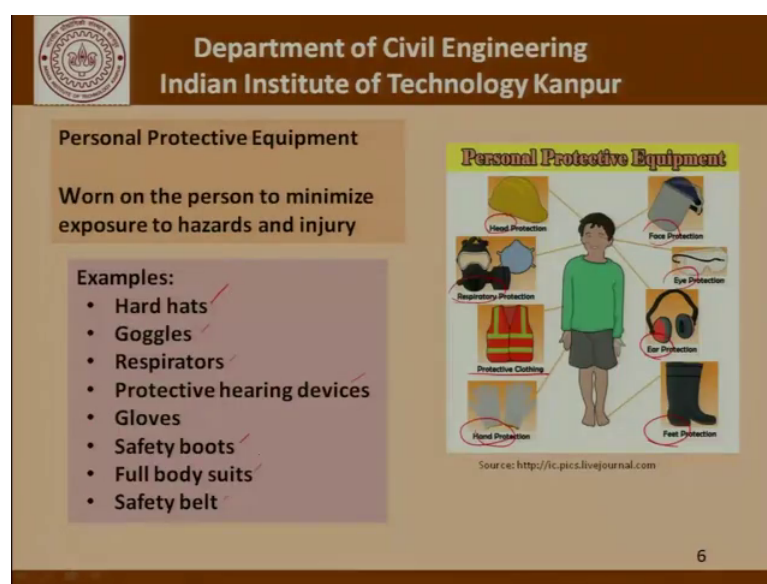
responsibility to not only provide the personal protective equipment, but also ensure that the worker is appropriately and adequately trained for that purpose.

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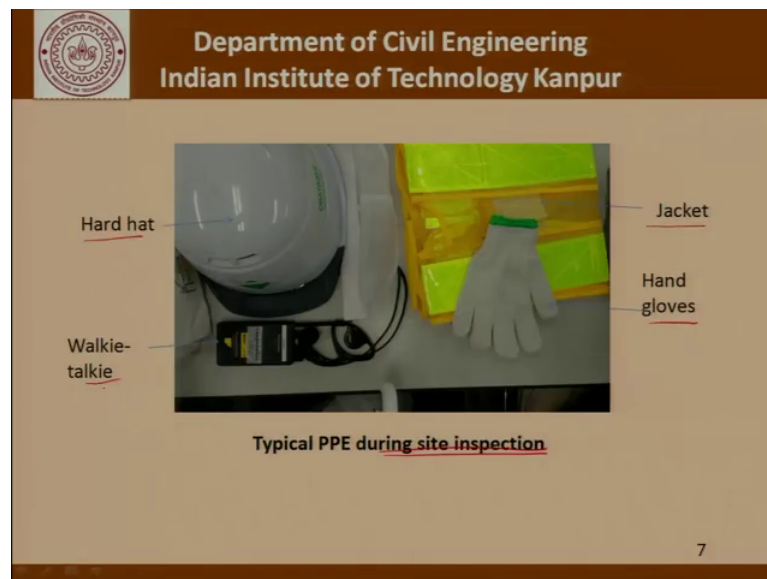
So, what is personal protective equipment? It is worn on the person to minimize the exposure to the hazards and the injury. So, we must remember that the PPE is not an accident prevention measure. It is basically a measure to ensure that the injury is minimized. It is a measure to ensure that the exposure is minimized.

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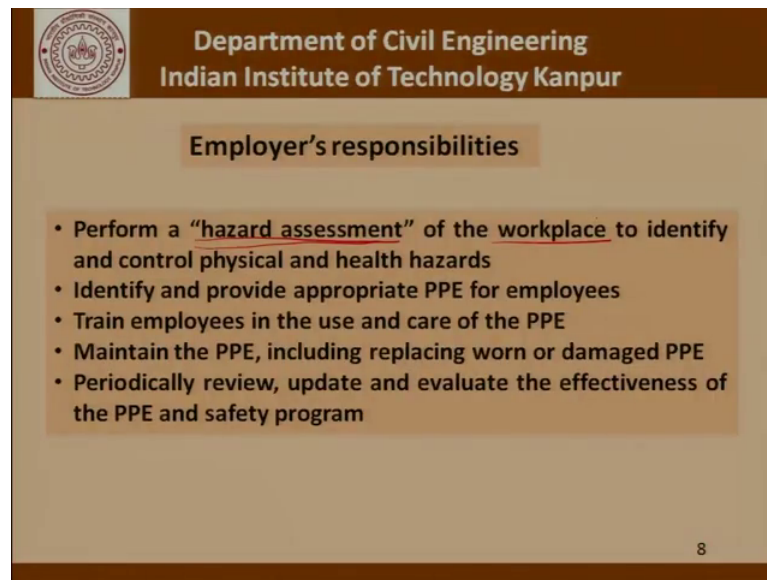
Now, here is an example of what PPE is all about. So, if we see here. So, we need to protect the head, we need to protect the eyes, the respiratory tract; that is the nose, we need to protect the faces such, we need to protect the ears, there is protective clothing which affords overall protection, we need to protect hands, feet and so on. So, it depends on what kind of a hazard that you are working with. So, depending on that you can wear hardhats, goggles, respirators, hearing devices, gloves, safety boots, full body suits, safety belts and so on. So, this is a classification of what these different PPE can be.

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Now this is just an example of what a good site would do, even when somebody comes for a site inspection or a visit something like a hard hat, a jacket and gloves and a walkie talkie is part of a kit that is kept ready for all the visitors. So, these visitors they come take this, wear this on the person before they go to the site. Usually there has to be a small pep talk which trains or educates the visitors as to how to handle these equipments or how to handle any of these gear.

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**Employer's responsibilities**

- Perform a "hazard assessment" of the workplace to identify and control physical and health hazards
- Identify and provide appropriate PPE for employees
- Train employees in the use and care of the PPE
- Maintain the PPE, including replacing worn or damaged PPE
- Periodically review, update and evaluate the effectiveness of the PPE and safety program

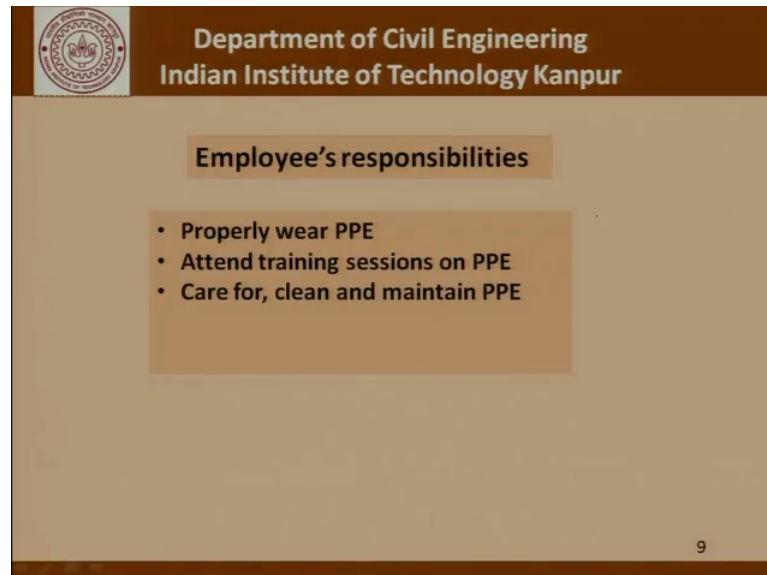
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Now, coming to the employer's responsibilities the first step; obviously, is to perform a hazard assessment of the workplace to identify and control the physical and health hazards. We have already talked about in the previous lectures that as far as the construction site is concerned it depending on where it is located, the kind of hazards that a person the worker working there or a visitor is likely to be expose to a different. If it is a marine site or a site in the middle of the river or it is a high rise building, it could be a tunnel depending on the kind of environment that hazards involve a different. And that is why the first step is to perform a hazard assessment of the workplace and find out what are the hazards that are involved and then only we can make a decision as to what is the kind of PPE that would be necessary. So, identify and provide appropriate PPE to the employees, train the employees in the use of PPE and how to take care of it.

So, for example, if it is a helmet or a jacket or gloves, it is not enough that these are simply provided. The employees must be able to use them and they should know how to take care of them. Maintain the PPE including replacing worn and damage PPE. So, obviously, the construction sites could work for several months, several years sometime and therefore, something like a glove or something like the jackets they may need replacement for whatever reason and it is the employer's responsibility to ensure that they are replaced when requested. Periodically review update and evaluate the effectiveness of the PPE and safety programs. This goes without saying that having made

an assessment once is not enough, this kind of an exercise has to be carried out periodically as part of a safety officer's job.

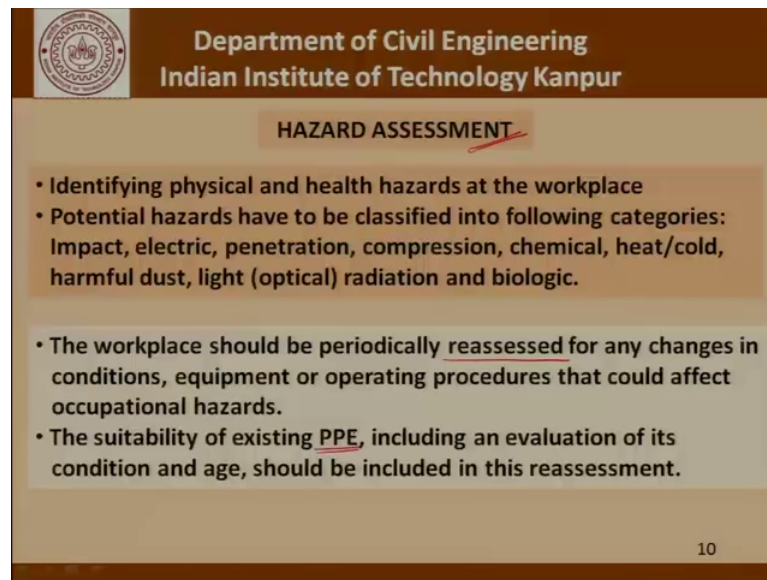
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Now, coming to what the employee's responsibilities are; the first responsibility is to properly wear the PPE. The second responsibility is attend training sessions on PPE, those of us who have travelled in air would know that there is always a standard exercise which tells the passengers as to how to handle safety belt, how to handle a life jacket and so on. So, it is the responsibility of all workers to make sure that they attend training sessions involving the use of PPE. In certain cases it is trivial and therefore, it may be done once in a year or maybe once in two years or at the time of induction alone, but in certain cases when specialized equipments are involved, this kind of training is required to be imparted periodically and the workers must take it seriously clean and maintain the PPE.

Most of the time what is done in sites is that the employer issues the PPE to the workers and it is their possibility to basically maintain it. So, it is their look out that the take care of the equipment issued to them clean it and maintain it and if it requires replacement or repair they should inform the supervisor about it. And then its employer's responsibility to make sure that it is appropriately either repaired or replaced.

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**HAZARD ASSESSMENT**

- Identifying physical and health hazards at the workplace
- Potential hazards have to be classified into following categories: Impact, electric, penetration, compression, chemical, heat/cold, harmful dust, light (optical) radiation and biologic.
- The workplace should be periodically reassessed for any changes in conditions, equipment or operating procedures that could affect occupational hazards.
- The suitability of existing PPE, including an evaluation of its condition and age, should be included in this reassessment.

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Now coming to hazard assessment, what we have to do is to identify the physical and health hazards at the workplace and potential hazards have to be classified into the following categories. Of course, these are perhaps not exhaustive, but at least it is indicative, impact, electric, penetration, compression, chemical heat or cold harmful dust, light or optical radiation and biological and so on.

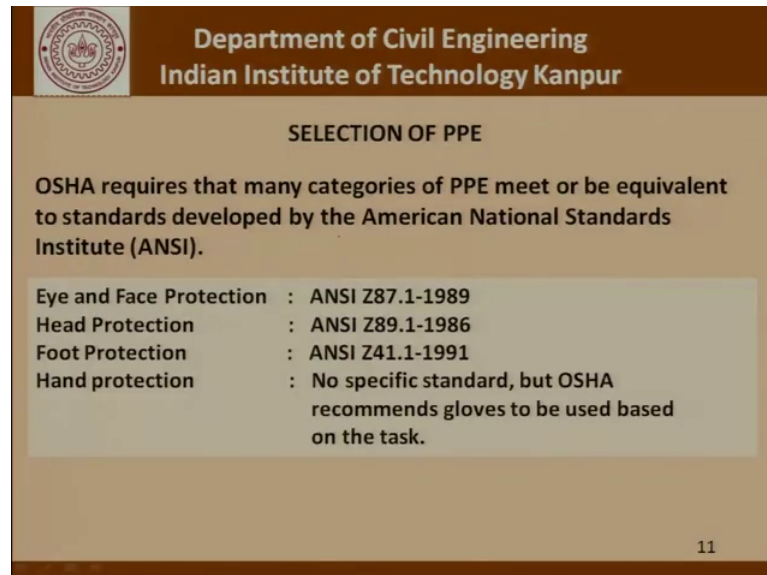
So, depending on the different phases of construction different types of construction, there could be different hazards that will come into play as far as a construction site is concerned. We must keep in mind that construction sites need not always be new construction sites. There can always be work taken up in an existing refinery or an existing atomic power plant and in that case the construction itself though it could be civil engineering, but the work should be protected against any possible radiation and all that. We have to carry out the hazard assessment very carefully taking into account the particular construction site or the particular job that we are executing.

Now, the workplace should be periodically reassessed for any changes in the conditions equipment or operating procedures that could affect occupational hazards. So, this assessment is not a onetime exercise, but as I have also said earlier that it is a periodic assessment is carried out. Continuing the suitability of existing PPE including an evaluation of its condition and age should be included in this reassessment. So, it is important to ensure that the PPE is adequate and is of a certain standard that affords the



right kind of protection. And that is something which you will come to when we discuss the details of the different PPE.

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**SELECTION OF PPE**

OSHA requires that many categories of PPE meet or be equivalent to standards developed by the American National Standards Institute (ANSI).

Eye and Face Protection	: ANSI Z87.1-1989
Head Protection	: ANSI Z89.1-1986
Foot Protection	: ANSI Z41.1-1991
Hand protection	: No specific standard, but OSHA recommends gloves to be used based on the task.


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Now coming to the election of PPE, the occupational safety and health administration that is OSHA requires that the PPE should be meeting or be equivalent to standards developed by the American National Standards Institute, some of those standards are given here for eye and face protection, head protection, food protection, hand protection and so on.

There is nothing sacrosanct about the American National Standards Institute, but what is being said is that, once a PPE is being procured and is being used is being issued it should confirm to certain standards whether its American or Australian or Indian that does not matter. It depends on the client, it depends on the contractor what is part of the contract. This has to be laid down and defined before the job is in fact, awarded. So, this has to be part of the contract document that well as far as this particular job is concerned the contractor shall provide to its workers PPE conforming to such and such standards.



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**HEAD PROTECTION**

A head injury can impair an employee for life or it can be fatal. Wearing a safety helmet or hard hat is one of the easiest ways to protect an employee's head from injury.

- Resist penetration by objects
- Absorb the shock of a blow
- Be water-resistant and slow burning
- Have clear instructions explaining proper adjustment, and, replacement of the suspension and headband.

**Hard Hats**

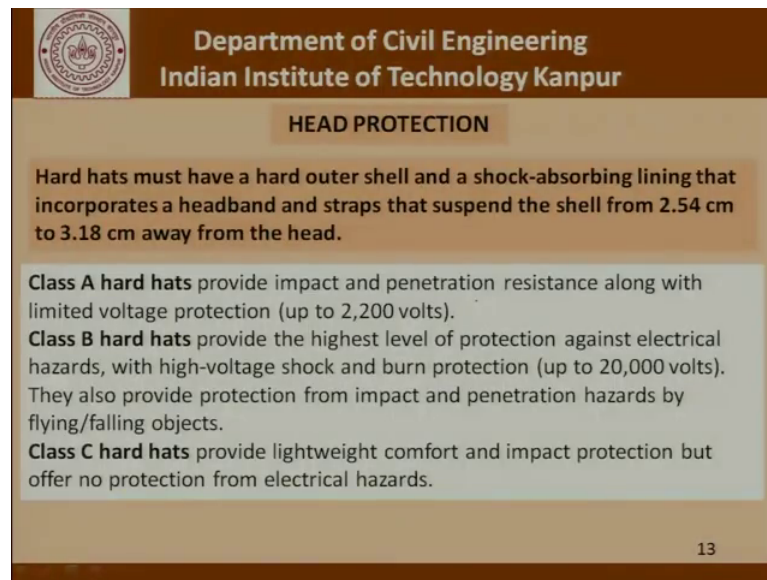


Source: <https://www.thesun.co.uk>

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So, now coming to a specific types of PPE or the specific equipment that protect different parts of a body; let us first talk of head protection. We must remember that a head injury is a very very serious injury and can impair an employee for life or it can even be fatal. Therefore, wearing a safety helmet or a hard hat is one of the easiest ways to protect an employee from a head injury. What should be the functional requirements of a hard hat? It should resist penetration by objects. So, if there is a falling object that hits the helmet it should resist penetration from that. It should absorb the shock of a blow, it should be water resistant and slow burning and there should be clear instructions explaining proper adjustments and replacement of the suspension and headband. We will talk about these qualities once again a little later.

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**HEAD PROTECTION**

Hard hats must have a hard outer shell and a shock-absorbing lining that incorporates a headband and straps that suspend the shell from 2.54 cm to 3.18 cm away from the head.

**Class A hard hats** provide impact and penetration resistance along with limited voltage protection (up to 2,200 volts).

**Class B hard hats** provide the highest level of protection against electrical hazards, with high-voltage shock and burn protection (up to 20,000 volts). They also provide protection from impact and penetration hazards by flying/falling objects.

**Class C hard hats** provide lightweight comfort and impact protection but offer no protection from electrical hazards.

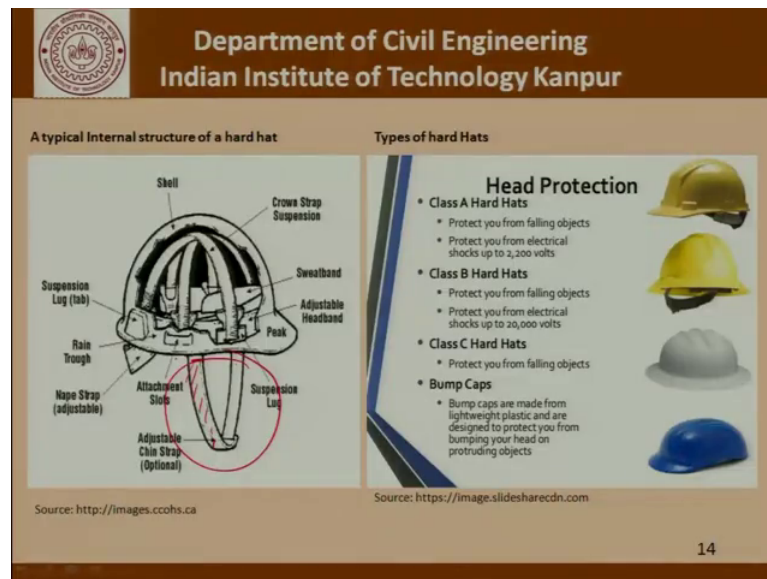
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Now, hard hats must have a hard outer shell and a shock absorbing lining that incorporates a headband in straps that suspend the shell from 2.54 centimeters to 3.18 centimeters away from the head. That is an inch to an inch and a quarter from the head. There can be obviously, classifications of these hard hats and one classification is A, B and C; where class A hard hats provide an impact and penetration resistance along with limited voltage protection up to 2,200 volts. In certain cases which is called class B; hard hats they provide the highest level of protection against electrical hazards with high voltage shock and burn protection up to 20,000 volts and they also provide protection for impact and penetration hazards by flying or falling objects. A class C hard hats provide lightweight comfort and impact protection, but offer no protection from the electrical hazards.

What we have to keep in mind that even though as far as this set of lectures or series of lectures is concerned is largely concentrated on civil engineering examples and the civil engineering background a construction site is not a civil engineering site alone. There are several examples where there is very very serious electrical engineering operation in progress, equipment erection, equipment operations and so on and so forth. And therefore, as a construction manager one has to be aware of certain things which are not necessarily in the domain of one engineering or the other. So, I would leave it to you to find out whether safety engineering is a subject itself or not and how many universities offer degrees or diplomas in something called safety engineering.

Now, continuing our discussion with head protection.

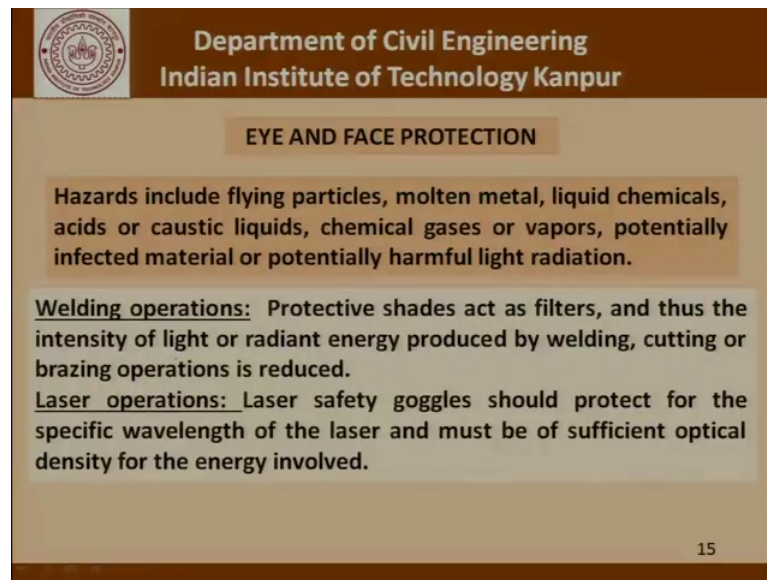
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This pictures here show the typical internal structure of a hard hat and the different types of hard hat. And this is the suspension that we are talking about the adjustable chin strap and worker should know how to handle it. So, it should not happen that for some reason the worker was wearing the helmet, but it gets blown away and the worker is head by a falling object. These are the kind of possibilities which have to be prevented. It has also to be ensured that this strap does not wear out over a period of time or a somehow cut at some place or the other. So, then the helmet does not afford any protection and that is something which we need to educate the workers about and they have to be careful about it when maintaining this helmet.

Now, coming to the eye and face protection.

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**EYE AND FACE PROTECTION**

Hazards include flying particles, molten metal, liquid chemicals, acids or caustic liquids, chemical gases or vapors, potentially infected material or potentially harmful light radiation.

Welding operations: Protective shades act as filters, and thus the intensity of light or radiant energy produced by welding, cutting or brazing operations is reduced.


Laser operations: Laser safety goggles should protect for the specific wavelength of the laser and must be of sufficient optical density for the energy involved.

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The hazard includes flying particles, molten metal, liquid chemicals, acids of caustic liquids, chemical gases of vapors, potentially infected material or potentially harmful light radiation, what is specific examples of this could be welding operations where protective shades act as filters and thus the intensity of light or radiant energy produced by welding cutting or brazing operations is reduced. So, this is how we try to protect the eyes in a welding operation.

As far as laser operations are concern, laser safety goggles should protect these specific wavelength of the laser and must be of sufficient optical density for the energy involved. So, before the procurement of the protective equipment is made, one has to drop their specifications depending upon the actual hazards and their details. Those hazards and details need to be provided to the safety inspector by the competent engineers and then together they decide what should be the specification of the PPE to be procured and used at a particular site.

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### EYE AND FACE PROTECTION

**Common eye and face protection include:**  
Safety spectacles, goggles, welding shields, laser safety goggles, face shields

Operations	Plate thickness inches	Plate thickness mm	Minimum* protective shade
Gas welding: Light	< 1/8	< 3.2	4
Gas welding: Medium	1/8 - 1/2	3.2 - 12.7	5
Gas welding: Heavy	> 1/2	> 12.7	6
Oxygen cutting: Light	< 1	< 25	3
Oxygen cutting: Medium	1 - 6	25 - 150	4
Oxygen cutting: Heavy	> 6	> 150	5


Intensity, CW maximum power density (watts/cm <sup>2</sup> )	Attenuation	
	Optical density (O.D.)	Attenuation factor
10 <sup>-2</sup>	5	10 <sup>5</sup>
10 <sup>-1</sup>	6	10 <sup>6</sup>
1.0	7	10 <sup>7</sup>
10.0	8	10 <sup>8</sup>

Source: 29 CFR 1910.133(a)(5)

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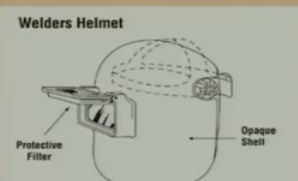
Continuing with our eye and face protection measures, this is basically just a chart which says filter lenses for protection against radiant energy depending on the kind of operations that are involved there are different thicknesses and protective shades. We select the laser safety glasses in a similar manner depending on the intensity involved.

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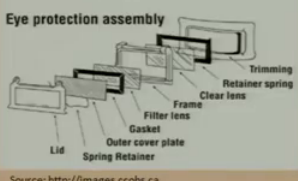
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#### Welders Helmet




Labels: Protective Filter, Opaque Shell

#### Eye protection assembly




Source: <http://images.ccohs.ca>

#### Laser Safety Goggles



Source: <http://lasersafetygoggles.com>

#### Face Shield



Source: <https://www.osha.gov>

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So, this here are pictures about the laser safety goggles of the face shield and the welders helmet with all the details and these websites and the internet will help you get more

information about the technical details involved. So, please remember that design of these PPE is also an important subject that needs to be studied.

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**HEARING PROTECTION**

The louder the noise, the shorter the exposure time before hearing protection is required.

**Permissible Noise Exposures**

Duration per day, in hours	Sound level in dB*
8	90
6	92
4	95
3	97
2	100
1 1/2	102
1	105
1/2	110
1/4 or less	115

Hearing protectors worn by employees must reduce an employee's noise exposure to within the acceptable limits provided in the adjoining Table.

\*When measured on the A scale of a standard sound level meter at slow response.


Source: 29 CFR 1910.95

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Coming to hearing protection that is your ears; obviously, the louder the noise the shorter the exposure time before hearing protection is required. So, for a certain amount of noise which we are all exposed to and we tolerate in our daily lives. Beyond the threshold is when we require the hearing protection and depending on the level of that noise, the duration for which we may be permitted to be exposed that noise is also different. Here is the permissible noise exposure and durations in hours and the sound level in decibels. As the sound level in decibels increases the duration per day in hours which you can be exposed to reduces. So, that is something which we need to keep in mind and beyond this point we need to provide appropriate hearing protection. And hearing protectors worn by employees must reduce an employee's noise exposure to within acceptable limits provided in this table.

So, that is how we evaluate functional performance of hearing protection.

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**HEARING PROTECTION**

Appendix B of 29 CFR 1910.95, details the information on methods to estimate the attenuation effectiveness of hearing protectors based on the device's noise reduction rating (NRR).  
Manufacturers of hearing protection devices must display the device's NRR on the product packaging.

Some types of hearing protection include:

- Single-use earplugs** are made of waxed cotton, foam, silicone rubber or fiberglass wool.
- Pre-formed or molded earplugs**
- Earmuffs**, which require a perfect seal around the ear.

Earmuffs



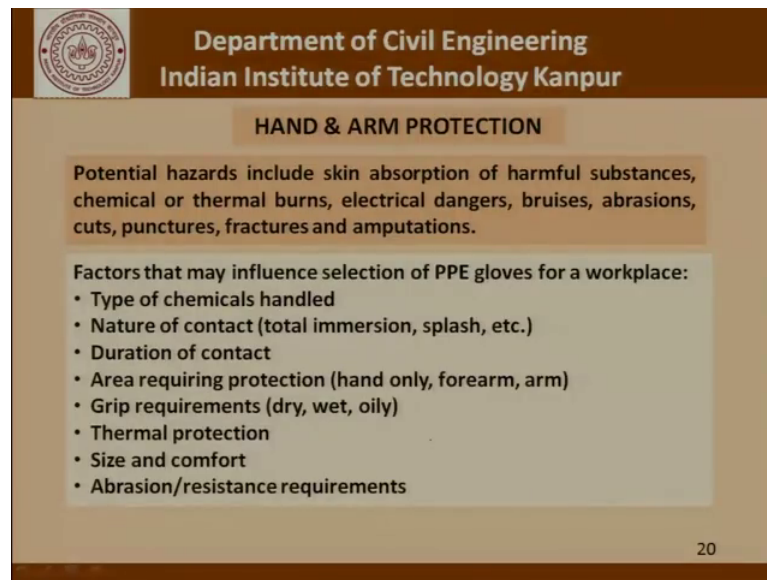
Source: <http://www.prochoice.com.au>

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Now this is the ear muffs for hearing protection and appendix B of 29 CFR 1910.95 details the information on methods to estimate the attenuation effective of hearing protectors based in devices noise reduction ratio or the noise reduction rating. Manufacturers of hearing protection devices must display the devices NRR on their product packaging. So, these are the kind of stipulations that are made out when we are manufacturing the PPE and somebody is buying them. Some types of hearing protection includes single use earplugs made of waxed cotton, foam, silicone rubber or fiberglass wool pre formed or molded ear plugs or ear muffs which require a perfect seal around the hear. So, when it comes to periodic maintenance somebody has to ensure that the ears of the worker or indeed being sealed.



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**HAND & ARM PROTECTION**

Potential hazards include skin absorption of harmful substances, chemical or thermal burns, electrical dangers, bruises, abrasions, cuts, punctures, fractures and amputations.

Factors that may influence selection of PPE gloves for a workplace:

- Type of chemicals handled
- Nature of contact (total immersion, splash, etc.)
- Duration of contact
- Area requiring protection (hand only, forearm, arm)
- Grip requirements (dry, wet, oily)
- Thermal protection
- Size and comfort
- Abrasion/resistance requirements

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So, coming to the handed arm protection; potential hazards could include skin absorption of harmful substances, chemicals or thermal burns, electrical dangerous, bruises, abrasions, cuts, punctures, fractures and amputations in the extreme case. The factors that may influence the selection of PPE gloves for this work place would be the type of chemicals handled, nature of contact, total immersion, splash etcetera. Duration of contract area requiring protection whether it is only the fingers or the hands or the forearm or the entire arm; grip requirement in terms of dry wet and oily. Thermal protection size and comfort, abrasion and resistance requirements; so this is how we try to quantify the performance of a PPE which is suppose to afford protection to the hands and arms.



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**HAND & ARM PROTECTION**

**Types of protective gloves**

- **Leather, canvas or metal mesh gloves:** Leather gloves, Aluminized gloves, Synthetic gloves, Aramid fiber gloves
- **Fabric and coated fabric gloves**
- **Chemical and liquid resistant gloves:** Butyl gloves, latex rubber gloves, Neoprene gloves, Nitrile gloves
- **Insulating rubber gloves**


<p><b>Metal Mesh Gloves</b></p>  <p>Source: <a href="http://mpbs.com/">http://mpbs.com/</a></p>	<p><b>Chemical Resistant Gloves</b></p>  <p>Source: <a href="http://www.ror.com.au">http://www.ror.com.au</a></p>	<p><b>Insulating Rubber Gloves</b></p>  <p>Source: <a href="https://www.fierck.es">https://www.fierck.es</a></p>
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So, coming to more details of this gloves leather, canvas or metal mesh gloves, fabric or coated fabric gloves, chemical or liquid resistant gloves, insulating rubber gloves are some of the gloves that are commonly used in construction sites.

These are pictures of some of these gloves the metal mesh gloves or the chemical resistant gloves or the insulating rubber gloves and I would encourage you to look at the internet and try to get a better idea and an understanding of the different kinds of protective equipment that are available not only for the gloves, not only as gloves or hand protection, but also goggles and all that.

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**BODY PROTECTION**

In addition to cuts and radiation, some examples of workplace hazards that could cause bodily injury:

- Temperature extremes
- Hot splashes from molten metals and other hot liquids
- Potential impacts from tools, machinery and materials
- Hazardous chemicals

Examples of body protection include laboratory coats, coveralls, vests, jackets, aprons, surgical gowns and full body suits.

**Safety Vests**




Source: <https://aw01.alicdn.com>

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Now, coming to body protection. In addition to cuts and radiations some examples of workplace hazards that could cause bodily injury could be temperature extremes, hot splashes from molten metals or other liquids, potential impacts from tools, machinery and materials and hazardous chemicals. And examples of the protection could include laboratory coats, coveralls, vests, jackets, aprons, surgical gowns and full body suits.

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**BODY PROTECTION**

**Paper-like fiber** used for disposable suits provide protection against dust and splashes.

**Treated wool and cotton** adapts well to changing temperatures, is comfortable, and fire-resistant and protects against dust, abrasions and rough and irritating surfaces.

**Duck** is a closely woven cotton fabric that protects against cuts and bruises when handling heavy, sharp or rough materials.

**Leather** is often used to protect against dry heat and flames.

**Rubber, rubberized fabrics, neoprene and plastics** protect against certain chemicals and physical hazards. When chemical or physical hazards are present, check with the clothing manufacturer to ensure that the material selected will provide protection against the specific hazard.


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Coming to some of the specific types of body protection available; it could be paper like fiber used for disposable suits that provides protection against dust and splashes, it could

be treated wool or cotton which adapts well to changing temperatures is comfortable and fire resistant and protects against dust abrasions and rough and irritating surfaces, it could be duck which is a closely woven cotton fabric that protects against cuts and bruises when handling heavy sharp or rough materials. Leather is often used to protect against dry heat and flames, rubber and rubberized fabrics, neoprene and plastics protect against certain chemicals and physical hazards.

When chemical and physical hazards are present check with the clothing manufacturer to ensure that the material selected will provide adequate protection against this specific hazard. What we must emphasize once again even though I have talked about it when we are talking about safety in the initial stages. A construction site is definitely hazardous place that does not mean that construction will not take place. It is important that we understand the hazards involved, take appropriate measures to ensure that even though it is hazardous place no injury happens. Of course, the best thing to happen is no accident happens, but the least we can try to do is to ensure that the injuries are minimized.

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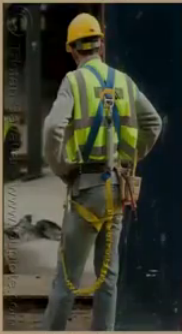


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**SAFETY BELTS, LIFELINES, LANYARDS**

- Lifelines, safety belts, and lanyards shall be used only for employee safeguarding.
- Any lifeline, safety belt, or lanyard actually subjected to in-service loading, as distinguished from static load testing, shall be immediately removed from service and shall not be used again for employee safeguarding.
- Lifelines shall be secured above the point of operation to an anchorage or structural member capable of supporting a minimum dead weight of 5,400 pounds.
- Lifelines used on rock-scaling operations, or in areas where the lifeline may be subjected to cutting or abrasion, shall be a minimum of 7/8-inch wire core manila rope. For all other lifeline applications, a minimum of 3/4-inch manila or equivalent, with a minimum breaking strength of 5,400 pounds, shall be used.

Safety belt



Source: <http://www.logosoft.com>

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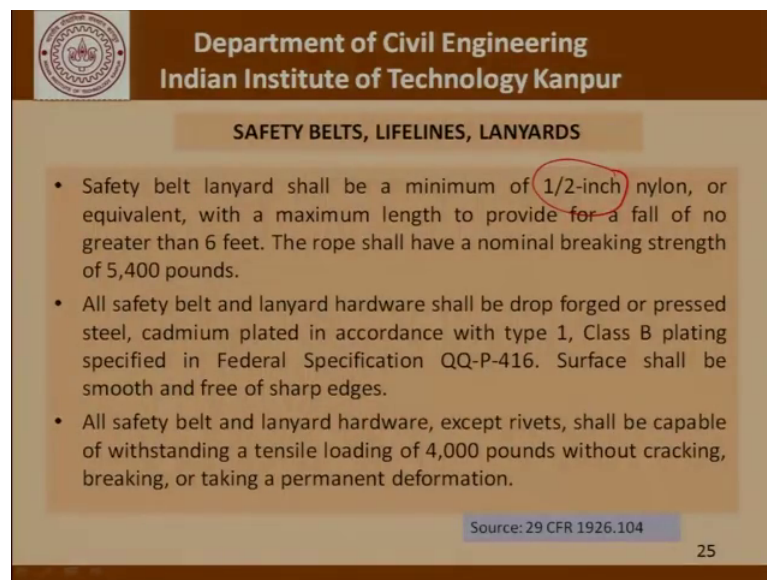
Now coming to safety belts, lifelines and lanyards, this is what the picture looks like for a safety belt and the text that is given here. I will just quickly read it; lifeline, safety belts and lanyards shall be used only for employees safe guarding. They should not be used for any other purpose. Any life line safety belt or lanyard actually subjected to in service

loading as distinguished from static load testing shall be immediately removed from service and shall not be used again for employees safe guarding.

So, if this particular PPE has been actually subjected to some loads that should be replaced, it should not continue to be used. Life line shall be secured above the point of operation to an anchorage or a structural member capable of supporting a minimum dead weight of 5,400 pounds. And life line used on rocks scaling operations or in areas where life line may be subjected to cutting or abrasion shall be minimum of seven-sixth of an inch wire core, manila rope. For all of the lifeline applications a minimum of three-fourth of an inch manila or equivalent with a minimum breaking strength of 5,400 pounds shall be used. So, the language used here is shall be used or it shall have certain specifications, shall be immediately removed.

So, this is how the specification are returned and it is important or it is imperative on the contractor to follow it letter and spirit. Continuing with our discussion on safety belts and life lines.

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The slide is titled "Department of Civil Engineering Indian Institute of Technology Kanpur" and "SAFETY BELTS, LIFELINES, LANYARDS". It contains three bullet points detailing safety requirements. The first bullet point specifies a minimum of 1/2-inch nylon for safety belt lanyards. The second and third bullet points specify requirements for safety belt and lanyard hardware, including drop forged or pressed steel, cadmium plating, and tensile loading resistance.

**Department of Civil Engineering  
Indian Institute of Technology Kanpur**

**SAFETY BELTS, LIFELINES, LANYARDS**

- Safety belt lanyard shall be a minimum of 1/2-inch nylon, or equivalent, with a maximum length to provide for a fall of no greater than 6 feet. The rope shall have a nominal breaking strength of 5,400 pounds.
- All safety belt and lanyard hardware shall be drop forged or pressed steel, cadmium plated in accordance with type 1, Class B plating specified in Federal Specification QQ-P-416. Surface shall be smooth and free of sharp edges.
- All safety belt and lanyard hardware, except rivets, shall be capable of withstanding a tensile loading of 4,000 pounds without cracking, breaking, or taking a permanent deformation.

Source: 29 CFR 1926.104

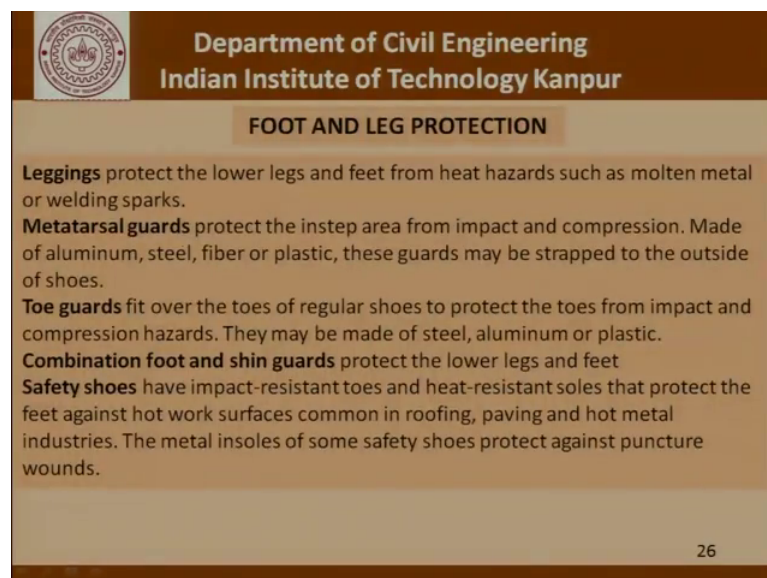
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Safety belt lanyards shall be a minimum of half inch nylon or equivalent with a maximum length to provide for a fall of no greater than 6 feet and the rope shall have a nominal breaking strength of 5,400 pounds. All safety belts and lanyard hardware shall be drop forged or pressed steel cadmium plated in accordance with type 1, class B plating is specified in the federal specifications such, as such and surface shall be smooth

and free of sharp edges. All safety belts and lanyard hardware except rivets shall be capable of withstanding a tensile loading of 4,000 pounds without cracking, breaking or taking a permanent deformation.

So obviously, we are using in this discussion today the FPS system. We are talking of inches, we are talking of pounds and I am leaving it to you to do a small exercise of converting these to the standard SI units and of course, the fact that they have been borrowed largely from American standards is the reason why these have been retained in inches and pounds.

(Refer Slide Time: 26:26)



**Department of Civil Engineering**  
**Indian Institute of Technology Kanpur**

**FOOT AND LEG PROTECTION**

**Leggings** protect the lower legs and feet from heat hazards such as molten metal or welding sparks.

**Metatarsal guards** protect the instep area from impact and compression. Made of aluminum, steel, fiber or plastic, these guards may be strapped to the outside of shoes.

**Toe guards** fit over the toes of regular shoes to protect the toes from impact and compression hazards. They may be made of steel, aluminum or plastic.

**Combination foot and shin guards** protect the lower legs and feet


**Safety shoes** have impact-resistant toes and heat-resistant soles that protect the feet against hot work surfaces common in roofing, paving and hot metal industries. The metal insoles of some safety shoes protect against puncture wounds.

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Now coming to the foot and leg protection, leggings protect the lower legs and feet from heat hazard such as molten metals of welding sparks. Metatarsal guards protect the instep area from impact and compression made of aluminum steel fiber or plastic. These guards may be strapped to the outside of shoes. Toe guards fit over the toes of regular shoes to protect the toes form impact and compression hazards. They may be made of steel, aluminum or plastic combinations of foot and shin guards protect the lower legs and feet. Safety shoes have impact resistance toes and heat resistance soles that protects the feet against hot work surfaces common in roofing, paving and hot metal industries. The metal in soles of some safety shoes also protect against puncture wounds.



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**Department of Civil Engineering**  
**Indian Institute of Technology Kanpur**

**FOOT AND LEG PROTECTION**

**Special purpose shoes**

Electrically conductive shoes provide protection against the buildup of static electricity.


Electrical hazard, safety-toe shoes are nonconductive and will prevent the wearer's feet from completing an electrical circuit to the ground.

Foundry shoes insulating the feet from the extreme heat of molten metal, foundry shoes keep hot metal from lodging in shoe eyelets, tongues or other shoe parts. These snug-fitting leather or leather-substitute shoes have leather or rubber soles and rubber heels.


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There are a special purpose shoes, electrically conductive shoes provide protection against the buildup of static electricity, electric hazard, safety toe shoes are non conductive and will prevent the various feet from various completing an electrical circuit, to the ground foundry shoes insulating the feet from extreme heat of molten metal. Keep the hot metal from lodging in the shoe eyelets, tongues and other parts these snug fitting leather or leather substitute shoes have leather or rubber soles and rubber heels.


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**Metatarsal Guards**  
  
Source: <https://cdn3.volusion.com>

**Foot and Shin Guards**  
  
Source: <http://www.ellwoodsafety.com>

**Toe Guards**  
  
Source: <http://www.westernsafety.com>

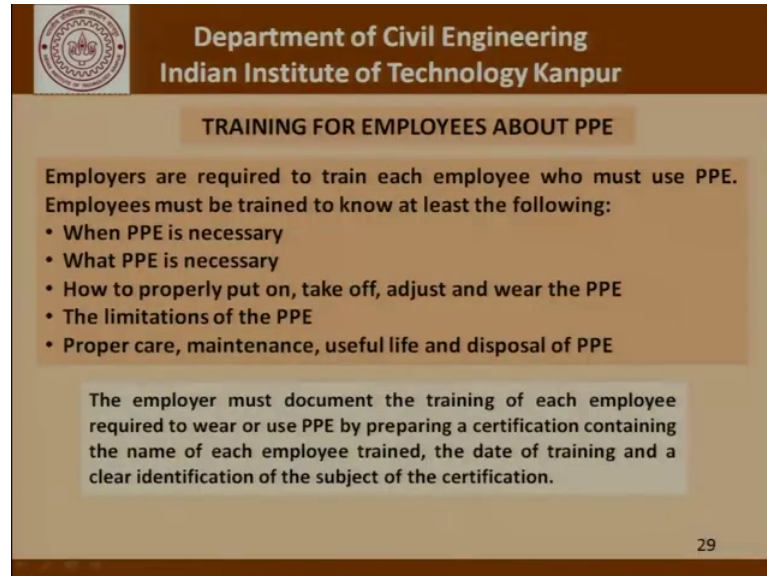
**Anatomy Diagram of Safety Shoes**  
  
Source: <https://sc01.alicdn.com>

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And these are pictures of some of the shoes and foot protection equipment which are often used in the industry.

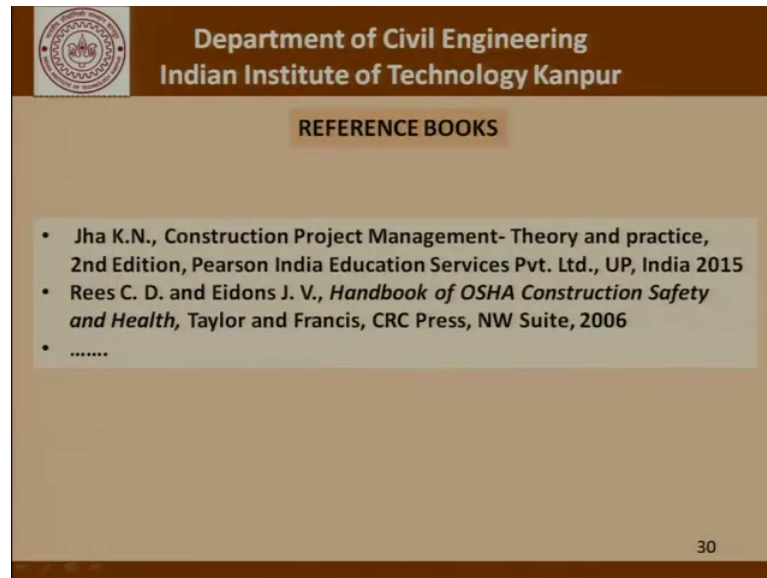
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Now coming to the training of employees about PPE; the employers are required to train each employee who must use PPE and the employees must be trained to know at least the following. When PPE is necessary? What PPE is necessary? How to properly put on, takeoff, adjust and wear the PPE and the limitations of the PPE? The employees have to be told and educated that wearing the PPE does not protect them from all hazards. There are limitations depending on the type of PPE being used. Proper care, maintenance, useful life and disposal of the equipment that has to be a part of the employee training. The employer must document the training of each employee required to wear or use the PPE by preparing a certification program and the name of each employee trained, the date of training, a clear identification of the subject of the certification. So, this is more like record keeping for that is something which is very important for a construction site which may have a thousand people working.

So, it is important that as part of the induction program before the workers are allowed to go to the actual construction site, they go through a basic induction program which may cover just the fundamentals of protection and then have more specialized programs and training sessions depending on the actual environment where different workers are working.

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With this we come to an end of our discussion today and you might find some of these references useful in understanding the subject matter cover today better and I look forward to seeing you again in this course.

Thank you.