A case study of construction safety
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Module No # 04
Lecture No # 17
Safety Talk

Hello everyone my name is Rudra Mishra. I am a civil engineer working with L & T construction. I have done my B Tech in civil engineering from VIT chennai in 2018. So today I will be sharing my experience on one of the most important aspects in construction that is safety. So, some of you might be wondering why it is not a profit margin which is important and safety is important.

This is because I do not think any of you might have heard that some XYZ project become successful even though more than 100 people died. Have you ever heard about that? I do not think so. So, projects do not become successful only because it has attained a quite a good profit margin, but it become successful when there is minimum fatality and minimum injuries throughout the project work. So today I will be sharing my experience on ports and harbor construction. So, I will take you to the presentation.

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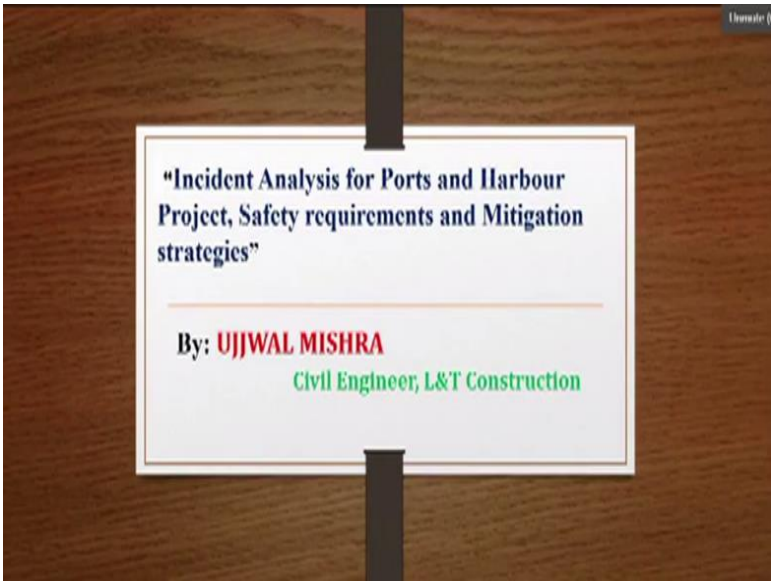

So, we will be seeing incident analysis for ports and harbour project what are the safety requirements and mitigation strategies.

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OUTLINE

Sr No	Description	Slide Number
1.	Project Background	5
2.	Objective of the Work	7
3.	Introduction	8
4.	Risk Analysis	9
4.1.	Risk Severity VS Probability	10
4.2.	Risk Matrix	11
5.	Factors Responsible for Incidents	12
6.	Safety in Barge Operation	13
7.	Risk Mitigation	19

This is the outline of the presentation it will have project background objective of the work, introduction, risk analysis. Risk analysis will be divided into 2 parts, risk severity and probability and risk matrix. Followed by factors responsible for incidence; safety in barge operations and risk mitigation.

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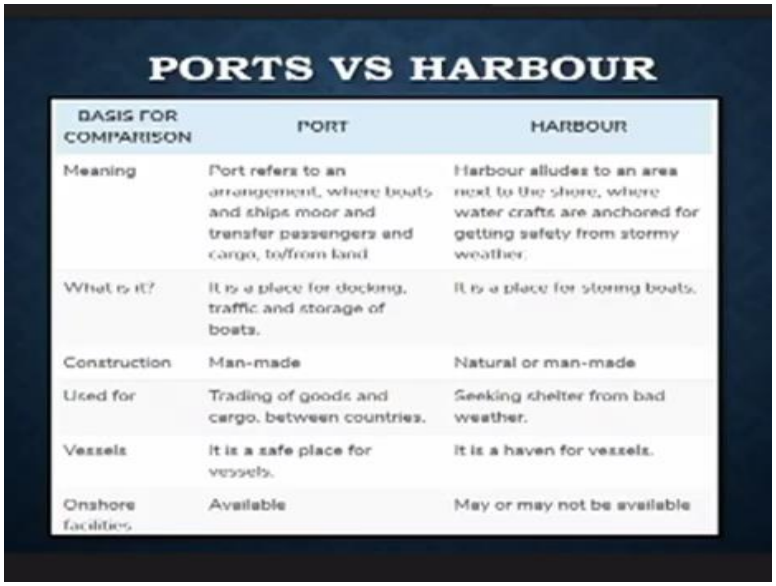

PORTS VS HARBOUR

BASIS FOR COMPARISON	PORT	HARBOUR
Meaning	Port refers to an arrangement, where boats and ships moor and transfer passengers and cargo, to/from land	Harbour alludes to an area next to the shore, where water crafts are anchored for getting safety from stormy weather.
What is it?	It is a place for docking, traffic and storage of boats.	It is a place for storing boats.
Construction	Man-made	Natural or man-made
Used for	Trading of goods and cargo, between countries.	Seeking shelter from bad weather.
Vessels	It is a safe place for vessels.	It is a haven for vessels.
Onshore facilities	Available	May or may not be available

So many of us have a confusion regarding what is a port? And what is a harbor? So, I have shown a basic difference here as you can see in the presentation. So, there are various comparison matrix, that I have taken and I have compared what is a port? And what is a harbor? So that it becomes easy for normal person or a public to understand the differences. So, if you

take the meaning port refers to an arrangement with boats and ships moor and transfer passengers and cargo to and from land but harbour alludes to an area.

So, this is basically an area which is next to the shore where water crafts are anchored for getting safety from stormy weathers. So, what is it exactly? So port is a place for docking traffic and storage of boats. So, what about harbour? It is a place for storing boats. So, when we come to construction part ports are always manmade but harbor can be a manmade structure or a natural harbor.

So, what is this used for? Ports are used for trading of goods and cargos between countries and what about harbor? Harbor is used for seeking shelter from bad weather. Vessels, so this is a place for vessels. So that it can be safely stored harbour. It is also used for storing vessels. Onshore facilities so in ports construction onshore facilities are available but in harbour it may or may not be available.

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So, this is an example of a Visakhapatnam port as you can see in the picture. So, as I have told you about port and a harbour thing so the land area which you can see here where these ships or boats re stored this particular place here and here. This is basically a port and this water area you can see this entire area this is a harbor and this is a natural harbor as you can see here. So, I hope now the difference between port and harbor is clear now moving on with the presentation. So, the project background, we will start the presentation with the project background.

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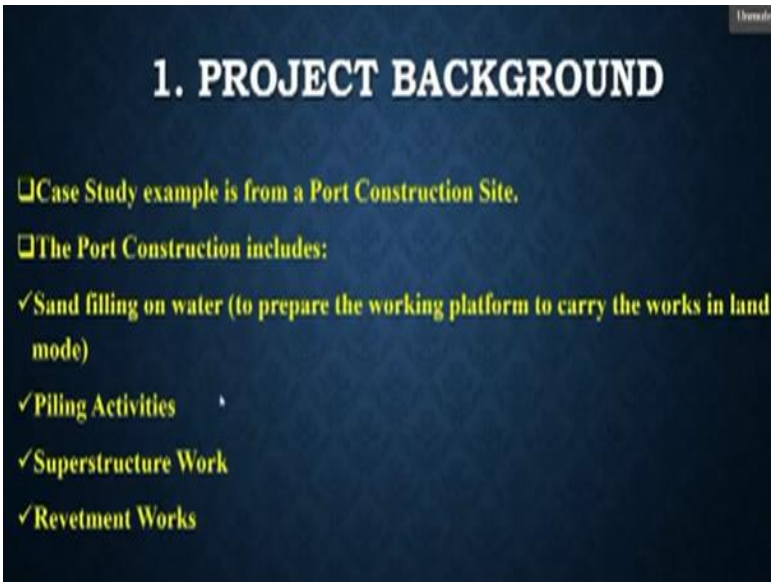

So, the case study that I have taken is from a port construction site. So, port construction basically includes following things done. One is sand filling on water, pilling activities, superstructure work, revetment works. So, what is sand filling on water? So, this is basically done to prepare the working platform so that most of the works can be done on a land mode of construction. And it becomes easy to construct anything on a land as compared to water.

Pilling activities you might have read or heard about it superstructure work also you might have heard so what is a revetment work? So, this is something which is not very common.

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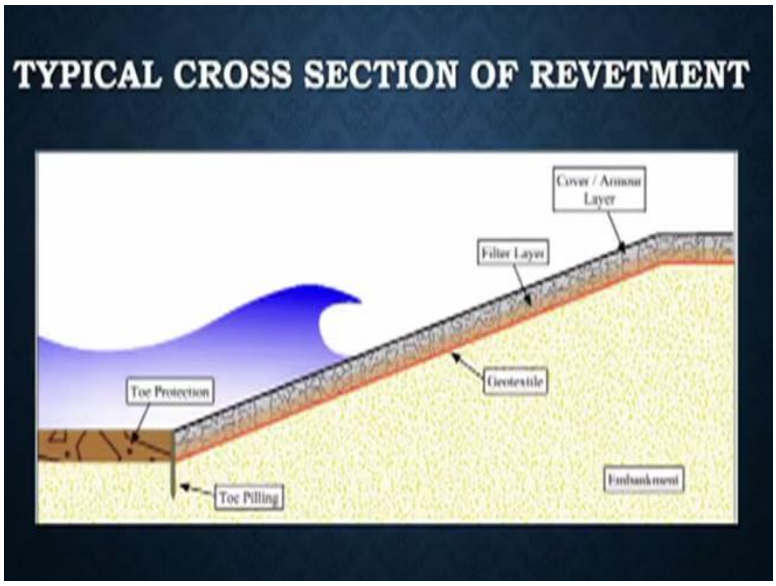

So, this is a basic cross section of a revetment work. So, this particular structure as you can see this one is a revetment. So, what is basically a revetment? So, this is a sloping structure this particular thing you can see here is a sloping structure. So, this, sill protect your shore side that is a land side from crushing waves. These are the waves this is the water side or the sea side. So, this particular sloping structure will protect the land from shoring and erosions.

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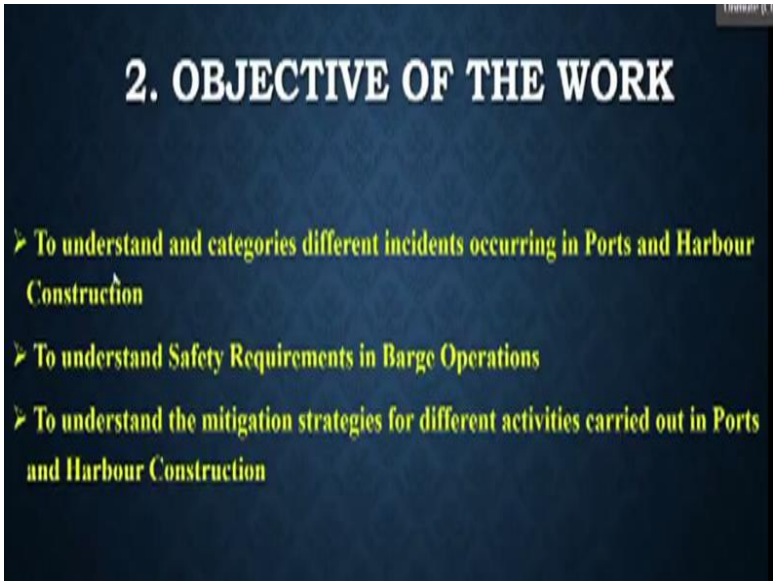

So, what is the main objective of the work is to understand and categories different incidents occurring in ports band harbour construction. To understand safety requirements in barge operationsto understand the mitigation strategies for different activities carried out in ports and harbour construction.

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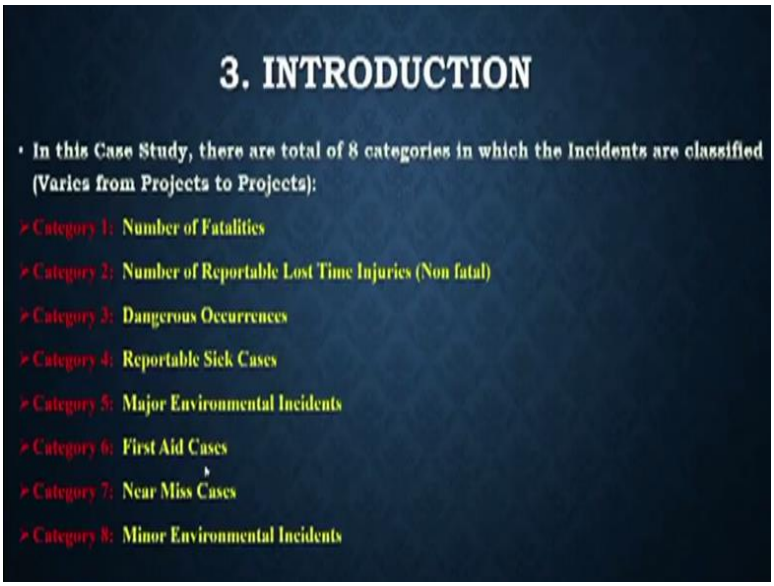

So, starting with the introduction part. So, in any project what is initially done is incidence, are classified into various categories. So that example that I have taken is in have classified it into 8 categories. So, these are nothing new you might have already read about these categories. So, it is only the difference between how you number or name the categories. So, for this particular example I have given from category 1 to category 8.

So, category 1 is number of fatalitiescategory 2 is number of reportable lost time injuries which is non-fatal. Category 3 is dangerous occurrences category 4 is reportablesick cases category 5 is major environmental incidents. Category 6 is first aid cases category 7 is near miss cases category 8 is minor environmental incidents and these may vary from projects to projects.

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So now coming on to risk analysis for various activities for ports and harbour project. So before starting any work all the activities are listed out and potential hazards for that particular activity are prepared their impacts and mitigation. Strategies have to be prepared before that particular work has started. So, what are the activities in the port and harbor construction? That needs special emphasis for risk and its, mitigation.

So, these activities are working at height, vehicles tools plant and equipment, excavation works temporary works and formworks cranes and lifting. Piling activities, hot work and fire working in confined space, working in and around underground and overhead services, working over or adjacent to water, climate and environment.

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4.1 Risk Severity Vs Probability

Severity: It signifies the intensity of the risk.
Probability: It signifies the chances of occurrence of a particular risk.

Severity	Probability	Value	Significance
Fatality	The event is almost certain to occur and has occurred repeatedly	4	Very Likely
Reportable injury/illness resulting in more than 2 days off work	The event will probably occur in most circumstances	3	Likely
Non Reportable Lost time injury/illness resulting in less than 2 days off work	The event may occur only in exceptional circumstances	2	Unlikely
Injury/illness requiring First Aid	Very unlikely but remotely possible	1	Very Unlikely

So now this particular risk analysis will be divided into 2 parts one is severity and other is probability. So, what is severity and what is probability? So, severity is how intensive that particular risk is. So, it signifies the intensity of the risk and probability is as you might have already heard it signifies the chances of occurrences of that particular kind of risk. So, what we have done here is? We have analyzed a particular kind of activity on a probability and severity scale so which is from 1 to 4.

As you can see here 4 is the maximum value and if a particular activity has a maximum value of 4 in severity and probability this means the impact will be very likely to happen and it is very severe as you can see here. The probability says that event is almost certain to occur and has occurred reputedly. So, this particular activity will be given of value 4 and best safety practices will have to be followed for this particular kind of activity having value 4.

Similarly, we have value 3 which is likely to happen, value 2 gives unlikely possibility and value 1 says very unlikely. So, I will also show how this particular kind of table is used in subsequent slides.

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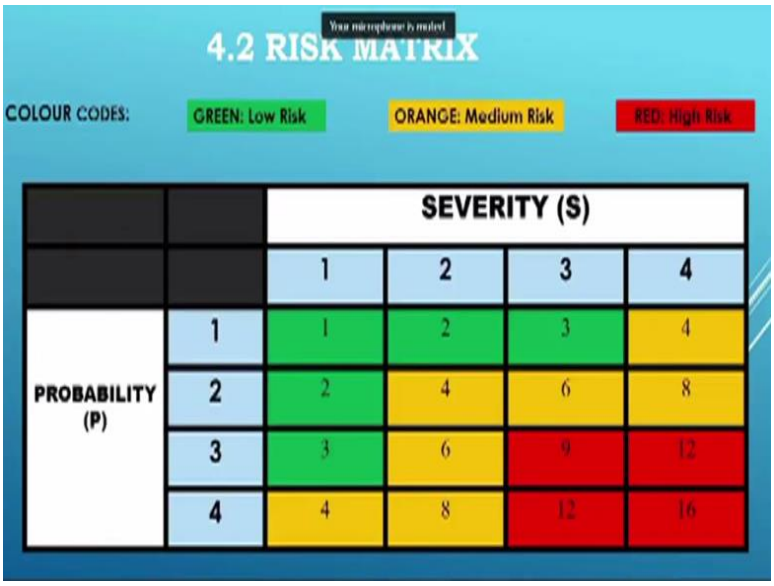

Another important thing we have is a risk matrix as you can say this is a particular matrix, we have severity values on the X axis and probability values on the Y axis. So maximum value is 4, minimum is 1. So, as you can see this is a table that has been generated and these numbers as you can see inside are the multiple of these 2 values. For example, this one you can see is multiple of 1 into 1 this 4 you can see is multiple of 2 into 2 this 6 is a multiple of 2 into 3.

Similarly, 12 is a multiple of 4 into 3. So why there are different colors given here? So, for any activity, this matrix are prepared and these colorsare given this means it becomes easy for any viewer to understand that the numbers in green have very low risk. So, if these activities have to performed minimum safety standards are enough to mitigate all the risk in this particular kind of activities. Similarly orange colour says that the activity that you are going to do has the medium risk.

And the red color says the kind of activity that you are going to do has very high risk. So best safety practices have to be involved for doing these kinds of activities which have red colour or high-risk factor. So what are the factors responsible for incidence?

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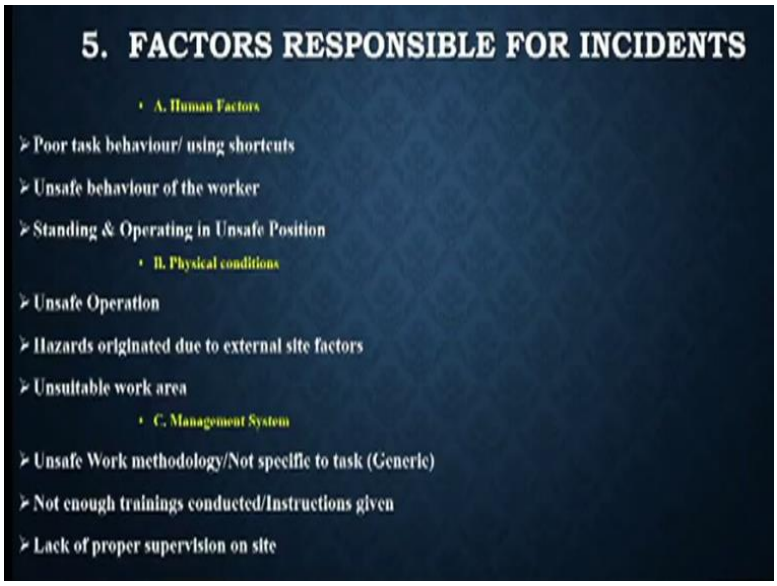

So, we have basically classified 3 important factors such as human factors, physical factors and management factors has the most important factor responsible for any incidence to occur on any side. So, what are human factors? So human factors are basically subdivided into few other parts which says poor task behavior using shortcuts unsafe behavior of the worker standing and operating in unsafe position.

So, this is the thing; that are not properly done by the worker working on a site. Physical conditions this belongs to the site conditions which is unsafe operations, hazard originated due to external site factors, unsuitable walk area. It may or may not be belonging to a human error but mostly it belongs to physical conditions of the site factors. Third, we have is management systems this belongs to the superior or the project managers or the management that is working in that particular kind of project.

So, what is the sub division? It is the unsafe work methodology or not specific to task that is they follow some generic work method. Not enough trainings conducted and instructions given lack of proper supervision on site. So, these are the things that lead to incidence in most of the site situations.

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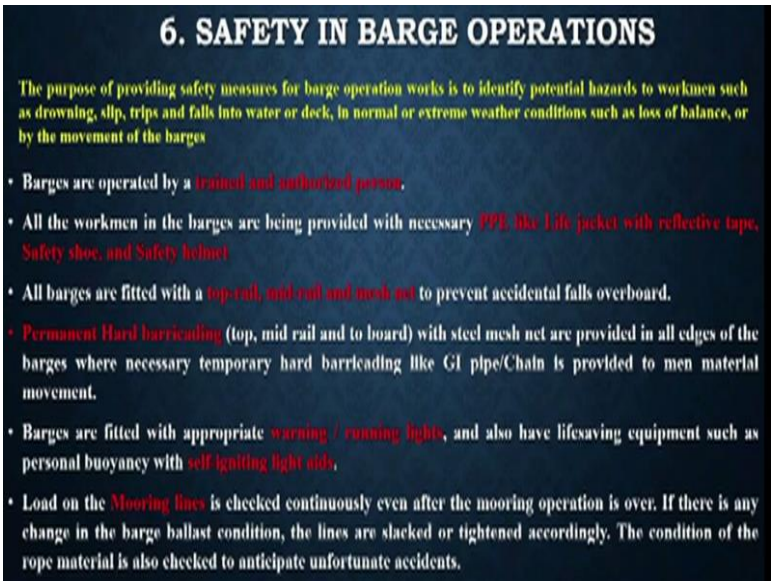

Since this is talking about ports and harbor work. So, one of the most important things we have in any port or harbor construction is a barge. So, what is basically a barge? As you can see in this particular picture this this is a barge and this is a crane which is mounted on a barge. So, all the activities that needs to be done on the sea part or the water area has to be done using this. Because you cannot do all the work on a land mode now so this is arrangement that is used for walking on a water mode.

So, what are the safety things that we have to follow here barges are operated by a trained and authorized person it has to be operated by trained and authorized persons only. PPEs, that is personal protect equipment like life jacket with reflective tape safety shoes and safety helmet shall be owned by all the people working on the barge. Barges are fitted with top rail, mid rail and mesh net.

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So, I will show you in the picture as you have seen here this is the mesh and rails provided here you can see on all the edges. So basically, a top rail, this is a mid-rail and this is a bottom rail or toe board it is called. This will prevent any person from falling permanent hard barricading shall be provided warning lights and running lights should be provided. Self igniting light aids shall be provided and mooring lines shall be checked all the time for the operations. So, I will show you what are mooring lines and other things here?

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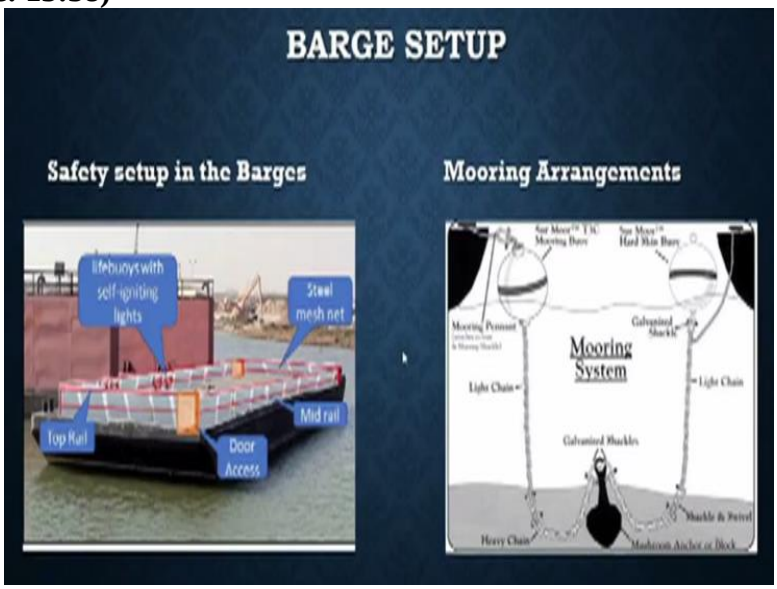

In this particular picture, this is for a barge and how safety set up is provided in this, barges. So, as you saw about rails, top rail, mid rail and bottom rail is a door access steel mesh are provided. And lifebuoys with self igniting also provided thee you can see here this is a mooring

arrangement. So, this will help to hanker that particular barge at a place where some kind of activities going on.

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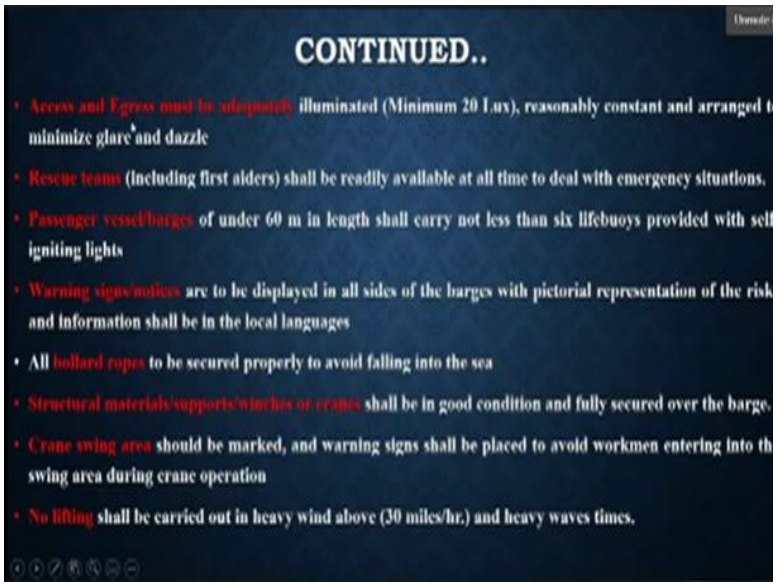

Continuing now, access and egress must be adequately eliminated.

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So, in this particular picture you can see this is the access and egress on barge. So, it has to be secured properly using structural steel material rescue teams shall be readily available at all the time to deal with emergency situations. Passenger vessel barges of under, 60 meters in length shall carry not less than 6 lifebuoys. Warning signs and notices shall be displayed all bollard ropes to be secured properly to avoid falling into the sea. So, what is the bollard ropes?

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This is the bollard arrangement as you can see so it has to be tied in a particular pattern. So that hankering can be done properly structural materials supports winches or cranes shall be in a good condition and fully secured over the barge. As you can see in this particular picture, we have crane mounted on a barge and how it is secured properly using structural steel material. Crane swing area should be marked and warning signs shall be placed.

No lifting shall be carried out in heavy winds above 30 miles per hour so these are some of the important things that has to be taken care of. As you see in this particular picture in the left, we have a night shit operation going on the barge. So minimum of hundred lux of visibility has to be provided as you can see here.

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7. MITIGATION STRATEGIES

Sr No	Activity	Hazard	Risk Involved	Potential risk	Assessement • Probability (P) • Severity (S)			Control Measures	Re-Assessement		
					P	S	Index		P	S	I
1	**Work at Height**	Unprotected leading edges and impact of falling objects Damage due to falling objects and production	Fatal/serious injury due to falls and impact of falling objects	General site workers General site staff Site visitors	4	4	16	•Install edge protection (ideally guardrails at 1m with mid-rail and toe-boards). •Ensure fall protection is provided for those installing guardrails •Install signage and illumination / lighting where necessary to highlight and warn of hazard of floor opening or leading edge	2	4	8

Now moving on with the mitigation strategies so what are mitigation strategies basically? Mitigation strategies are the control measures established for each and every activity that is going to be conducted and why do we have to do this? We have to do this so that people or the worker who is working on that, particular activities knows that what is the probability? What is the severity of that particular kind of risk?

And what are the safety practices that he has to follow for that particular kind of risk. So, as we saw various activities initially, we get a few examples of the activity and show you how assessment is done. So, first activity is working at height. So, what is a hazard here? Hazard is unprotected leading edges and impact of falling objects damage due to falling objects and protection.

So, what is the risk involved risk? Involved could be as severe as fatality or serious injuries due to falls and impact of falling objects. So, who are the people at potential risk? This is general side workers or general side staffs or side visitors anybody could be at risk. Now how do we access this particular activity? So, as I told you about probability and severity and also a risk matrix which provides that number for that particular kind of risk?

So, these kinds of activities have been rated as maximum of 4 as the probability factor and also maximum of 4 as the severity factor. So, the index becomes 16. So, as you remember the colors number 16 is the maximum from risk matrix table and this means the best safety practices have

to be followed or else any misleading could lead to fatality or serious injuries. Now what do we do here now? So, we have to establish control measures.

So that this particular incident if something happens could be mitigated so what are the control measures needed here? First is install edge protection as you all saw in the barge operations; we have guardrails similarly edge protection has to be established ensure fall protection and install signage. In all the places where work is happening and in the night shift proper lighting has to be provided so what is a reassessment now?

And you see here the value suddenly drops from 4, probability to the value of 2, probability and the index becomes 8 now this shows orange colour. Now what is a reassessment? This means that if these control measures are established correctly the risk index from 16 can be brought down to 8 with these control measures. This means now moderate level of safety practices are enough to perform these, activity when these control measures are established.

So, this is just the reassessment of these control measures that we have taken. This value 16 comes because there are no control measures established. And now this 16 has dropped to 8 because these control measures are established moving on so this is a safe practice.

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So, there are 2 excavators working adjacent to each other but the swing area of escalator does not cross the swing area of the other excavator. And hence this is a safe practice but it should be permanently remembered that these booms should never cross each other.

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On the left you can see this is a material loading activity going on at a location where the dumper or the truck you call is unloading the rocks into a split barge. This is also kind of a barge which is used for transporting a, materials from one place to another. So, you can see here as edge protection given here for this particular kind of activity. On the right-hand side, you can see a survey boat.

So, this is the surveyor and he is having a helmet, life jacket, safety shoes and he is also holding to a structural element. So that while this particular boat is moving, he does not fall into water. So, this is a safe practice.

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Sr No	Activity	Hazard	Risk Involved	Potential risk	Assessment • Probability (P) • Severity (S)			Control Measures	Re-Assessment		
					P	S	Index		P	S	I
2	**Excavation**	Excavation / Trench / Tunnel collapse due to inadequate / inappropriate excavation techniques or excavation support installation	Fatal/serious injury due to soil collapse	General site workers General site staff Site visitors	4	4	16	• Excavation shall include the method of shoring / supporting the excavation • All excavations shall be inspected by a competent person before start of day's work or after adverse weather conditions. • The competent excavation supervisor / Engineer shall prepare a method statement for excavation of underground services incorporating the requirements • Workers are not allowed to work near the soil fall zone area unless protected by shoring or other mean	1	4	4

Next activity we have is excavation. So here also hazards risks potential risk factors established to a little; severities are given and control measures are established. So, what are the control measures? Excavation shall include the method of shoring the excavation all the excavation shall be inspected by competent person before start of the day's work. So, you can see if these control measures are established the risk index can be brought from 16 to a 4 value.

So, when the value is 16 best safety practices have to be established but with 4 minimum safety standards are enough to complete that particular kind of work.

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Sr No	Activity	Hazard	Risk Involved	Potential risk	Assessment • Probability (P) • Severity (S)			Control Measures	Re-Assessment		
					P	S	Index		P	S	I
3	**Working over or Adjacent to Water**	Fall of person into water	Risk of drowning	General site workers General site staff Site visitors	4	3	12	• Edge protection will be provided. • Safety harnesses should be worn and secured to the lifeline, while working at heights and where edge protection cannot be provided • Suitable lighting (34 lux) will be provided at edges adjacent to water. • A rescue boat will be available when necessary. • Life jacket shall be provided. • Activities at edges shall not be performed on rough wind times / dark hours. • Caution board must be displayed with proper information. • Boat point shall have firm anchoring point with buoy indication	1	3	3

Now we have another activity the working over or adjacent to water, this is one of the most important things in any port and harbor construction. Because this is mostly done for over 50% of the project work so what is hazard? Hazard is fall of a person into water. Risk is risk of drowning. Potential risk everybody who is working on that particular area is potential risk. So, what is the severity and probability?

So, the index value here is 12 this means this is a red value. So, best safety practices have to be established for this particular kind of work. So, what are the control measures to bring this particular index to below than 12? So, when is edge protection as you saw in the barge operation safety harness should be warned and secured in the life time suitable lighting shall be provided? Rescue boats shall be made available life jackets shall be provided activities at edges shall not be performed on rough wind times or dark hours.

Caution boats must have proper information and boat points shall be properly secured so if these activities or measures are followed the reassessment value for that particular risk will give 3 which is in green color. This means minimum safety standards are enough to perform this kind of activities which is near to water.

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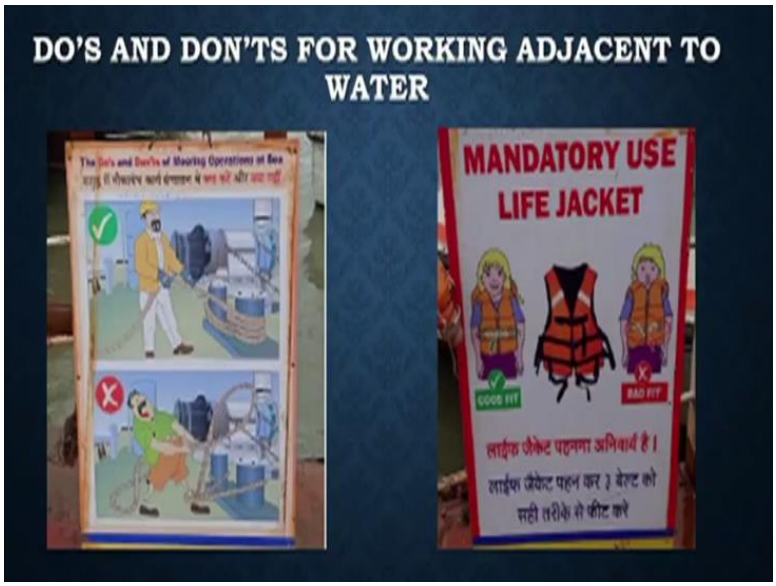

So, these are some do's and dont's for working adjacent to water on the left you can see this is how you tie a bollard. It has to be secured properly in a proper pattern and it should not be this unclean and untidy like this. This is about using a life jacket and it should be a proper fit jacket

and it should not be a loose jacket like this it should be a proper fit jacket. Now this is how you rescue a person who has fallen into the water.

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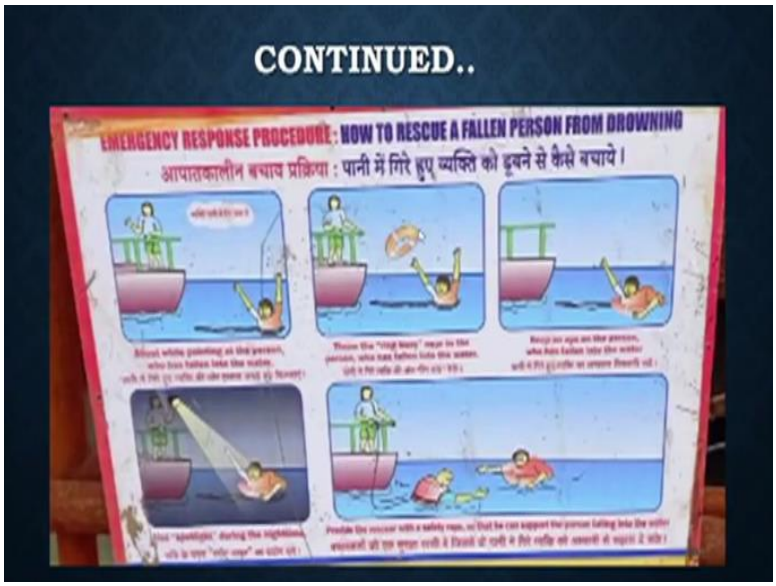

So, the first thing to do is throw a ring buoy so this particular thing is the ring buoy. So once the person receives the ring buoy he will be secured at a particular place and he will not drown at that particular time you can go and call for help till this person tries to survive here without drowning. This is for a day light activity what if that particular person falls in a night operation. So, first thing you do here all is also throwing a ring buoy first.

First you throw a ring buoy provide light so that the person knows that has is been looked after and does not drown. And you can also identify him get then go and call for help. So that is it from the presentation. I hope you are able to understand why safety plays an important role in any construction project. So, from the presentation I would like to summarize few key points which are most important. And I would also request everyone to remember those things.

Number 1 difference between port and a harbor, number 2 how to make a risk matrix? Number 3 what are the safety precautions that need to be followed in a barge operation? And the last and the most important one how to prepare a mitigation strategy for any kind of activity? So, thank you and happy learning.