

Ocean Structures and Materials
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Module - 2
Lecture - 9
Dredging equipments' specifications

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In lecture on module two, in the course of ocean structure and materials, we will talk about dredging equipments and specifications. At the later part of this lecture, I will talk about some specific characteristics of concrete as a construction material for offshore platforms. This lecture has got many material and specifications of equipments, which has been borrowed and used from Dredging Corporation of India. So, we sincerely thank DCI for the support in terms of sharing the specification of equipments manufacture and used by DCI India.

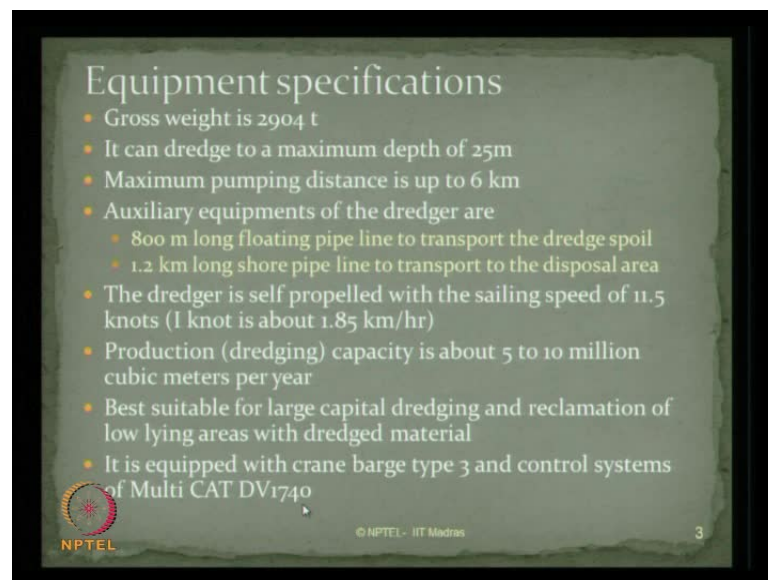
The picture what you see here is famous Aquarius, the cutter suction dredger. Aquarius, shown in the photograph is actually high powered cutter suction dredger. Now, by this time we all understand what are the different varieties and cutters of dredgers available in the market. So, this lecture is dedicated to the real use of different kinds of dredging equipments, which are used for practical applications.

Aquarius is very common and versatile equipment used by Dredging Corporation of India,

which has high power cutter suction dredger. It is a self-propelled ocean going cutter suction dredger, which is built by DCI in the year 1977. The overall dimension as a dredger is about 107 meters for width of about 19.7 meter for depth about 7.6 meter. Its operational draft is about 4.85 meter.

You can see here, this is the A frame, which we were talking about which supports the dredger and this the cutter edge, which gets into and keep on cutting and loosening the material, then which is being sucked by the dredger.

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Let us look at the equipment specification of this gross weight of this, about 2904 tones. It can dredge to maximum depth of 25 meters; the maximum pumping distance is about 6 kilometer. So, the material, which is dredged, can also be pump off the coast to a maximum distance of about 6000 meters. It has also many auxiliary types of equipment by name, 800 meter long floating pipe, which can be used to transport the dredge spoil from the vessel to the offshore side; 1.2 kilometer long shore pipe line to transport it further to the any disposable area, which they have identified.

The dredger is the self-propelled vessel with sailing speed of above 11.5 knots. Ladies and gentleman, 1 knot is about 1.85 kilometers per hour, so approximately it is about 24 kilometers per hour speed the vessel can travel. The production capacity, which is otherwise addressed as the dredging capacity, is varying from 5 to 10 million cubic meters per year. It is best suitable for large capital dredging and reclamation of low lying areas

with dredged material. I think you understand now what do I mean by capital dredging. This equipment is also fitted with the crane barge type 3 and it has got control systems, which is multi CAT DV1740 specifications.

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We can look at the arrangement what this dredger has for loosening of material.

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This picture shows the dredger has been used for side line dredging, which is directly operating from the pontoon. This is side line dredging, what they have been doing along the course of any specific river.

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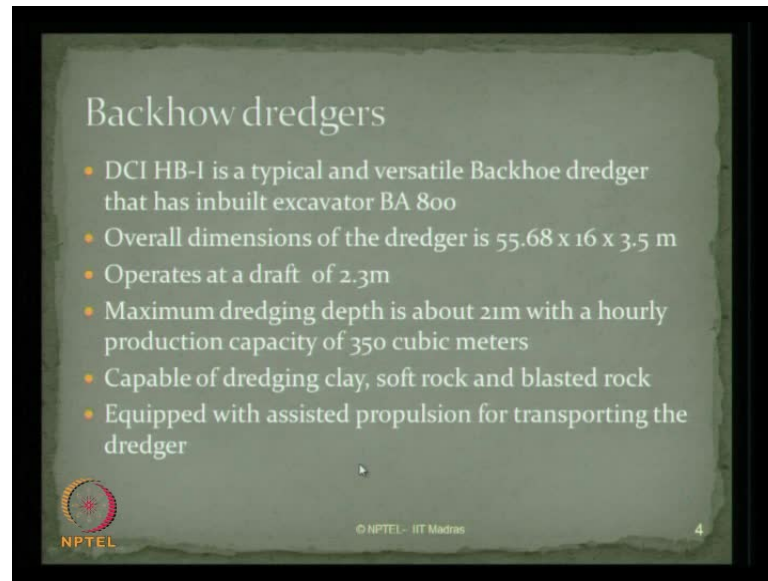
This is a closer view of the rotary cutting edge, which Aquarius uses for cutting and loosening of the dredged material.

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This is front view of the Aquarius showing the cutting edge and of course, the A frame what you see here.

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Backhoe dredgers

- DCI HB-1 is a typical and versatile Backhoe dredger that has inbuilt excavator BA 800
- Overall dimensions of the dredger is 55.68 x 16 x 3.5 m
- Operates at a draft of 2.3m
- Maximum dredging depth is about 21m with a hourly production capacity of 350 cubic meters
- Capable of dredging clay, soft rock and blasted rock
- Equipped with assisted propulsion for transporting the dredger

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The other kind of dredger, which I want to show you in the lecture, is backhoe dredger. Dredging Corporation of India has a specific backhoe dredger, which is HB-1 type, which is typical and versatile model of backhoe dredger, which has been inbuilt excavator with BA 800.

The overall dimension of the dredger is about 56 meter by 16 meter by 3.5 meters. It operates at a draft of about 2.3 meters. The maximum dredging depth, this dredge can operate is about 21 meter with an hourly production capacity of about 350 cubic meters. It is capable of dredging clay, soft rock and blasted rock from the site. It is equipped with assisted propulsion for transporting the dredger from one location to another location.

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This is the picture showing you the backhoe dredger owned by Dredging Corporation of India, BH-1. This is the (()), which lifts the dredge spoil. This is backhoe dredger hose from the vessel, which can be transported from one location to another location because it is self-propelled as well.

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Dredging is one of the major activity in ports and harbours

- Maintenance dredging is done to ensure continuous availability of the desired depth in the shipping channels
- Common and almost continuous process in major and non major ports, Navy, Fishing harbours and other maritime organizations
- The Indian coastline of about 5700 km is being active towards
 - Creation of new harbours
 - Deepening of existing harbours
 - To maintain required depths at various ports

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Dredging is one of the major activity in many ports and harbours in India. Maintenance dredging is done to ensure continuous availability of the desired depth in the shipping channels; common and almost continuous process in major and non major ports, Navy,

fishing harbours and other maritime organizations.

The Indian coastline, which is about 5700 kilometer long, is being active towards, as we all understand, creation of new harbours, deepening of existing harbors and of course, to maintain the required depths at various ports for all which dredging is one of the major and continuous nonstop activity, which is carried out along the coastline of the country.

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The DCI Dredge 16 is an active dredger, which is operating along the Indian coastline. It has got a trailer suction dredger with hopper capacity of 7400 cubic meters. I already told you, dredger capacity is rated respect to the hopper capacity. The maximum dredging depth of this specific dredger is about 25 meters; this also has shore pumping facility.

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You can see here, in the center part, which is a closer view, I will show you, this is place where the sediments or the dredge spoil is being collected and they are drain hose, which drains off water from the vessel, only the sediments is being transported. The dredger is heading towards the dumping ground where sediments will be collected and the water will be further drained off.

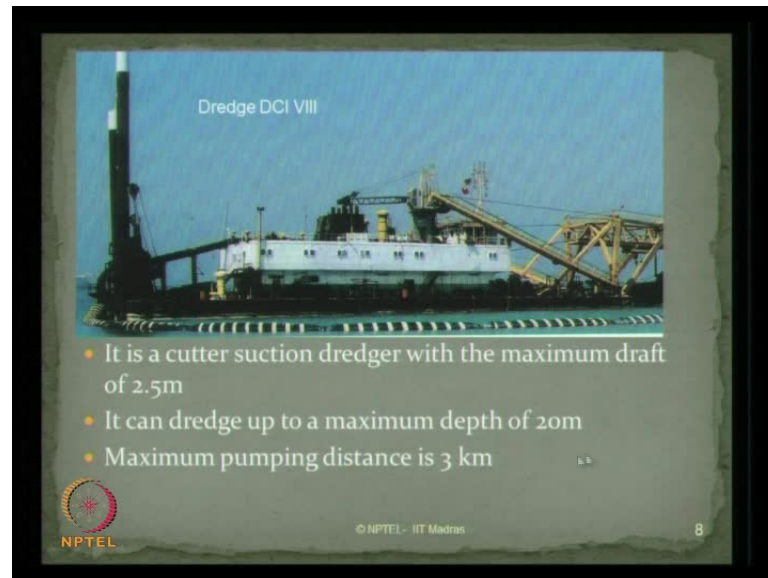
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If you look at the dredging applications in the modern era, apart from an essential project for safe navigation, dredging has also other important applications. If you want to do for

environmental protection, improve tourism, doing flood control operations, controlled and improved irrigation, power generation projects, port development projects, reclamation projects and laying of shore pipelines, etcetera, in many of these projects dredging is considered to be one of the vital activities. These activities, which are vital also important for national progress, keep dredging a continuous process in the (()).

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Dredging DCI-8 is the picture, which you see here, this is a cutter suction dredger with the maximum draft of about 2.5 meters, it can dredge up to a maximum depth of about 20 meters. The maximum pumping distance of the dredge spoil is about 3 kilometers.

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The other view, what you see here, is Dredge DCI-18, which is another view of the same dredge facility, which you saw in the last line.

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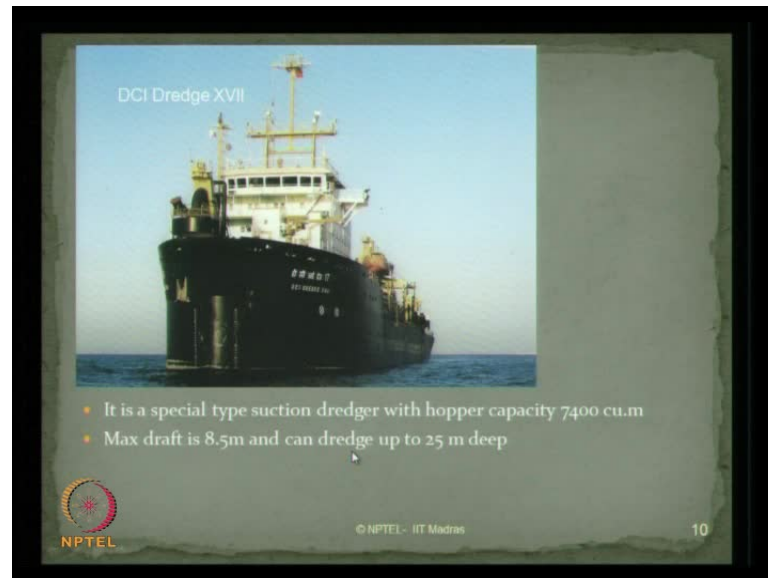


Now, the fundamental question comes in mind, however, the vitality is important of dredging work?

Dredging was important because it is essential to maintain the navigable path; to promote national and international maritime trade; to improve water resources, for example, dredging is done at locations where desalination plants are installed; to ensure

environmental protection for shipping, both international and national depths; at ports, harbours, and approach channels, need to be maintained to keep nation's waterways and channels deep and safe for shipping dredging becomes very important and vital. And of course, dredging has acquired major importance in land reclamation projects, beach nourishment projects in India, as well as, around the world.

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DCI dredge-17 is again an active dredger, which is very commonly deployed. So, special type of suction dredger, which has got huge hopper capacity of 7400 cubic meters; the maximum draft at which vessel can operate is about 8.5 meter. It can maximum dredge to the depth of 25 meters.

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The dredge spoil, you can see here, is a line, which disposes off the dredge spoil from the dredger to that of offline coastline area. This is considered as one of the major hindrance and interference with public and traffic during the dredging process.

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If you look at the commercial value of dredging projects, because one is amazed to know what is commercial value of this kind of project. In India, interestingly, dredging projects are not cheap. They are one of the most expensive projects being executed in the country. To give an idea to you, following figures can be considered within India. Projects ranging

from 10 corers to 1700 corers are the estimated buckets and cost of dredging projects in India. The period of execution of projects, which is normally between 1 year to 9 years.

The recent advancements in dredgers make them a state-of-art technology. They are equipped with microchip technology and remote sensing satellites to control dredging, projects of dredging. They are also custom built to withstand sea roughness. They are also equipped with latest communication device, instrumentation and computerized dredge control systems, so that more accuracy in dredging can be achieved.

Ladies and gentleman, we saw the first part of the lecture, where we spoke about different equipments in practices, which has been deployed by Dredging Corporation of India for variety of projects in India, as well as in abroad. So,alongwith the lecture we will give a practical idea about what are the specification types of dredgers being used, how are they being deployed, what is the water depth they are operating and what are the draft at which they can work and what are size and what is the commercial value of these kinds of projects, which are being used in India.

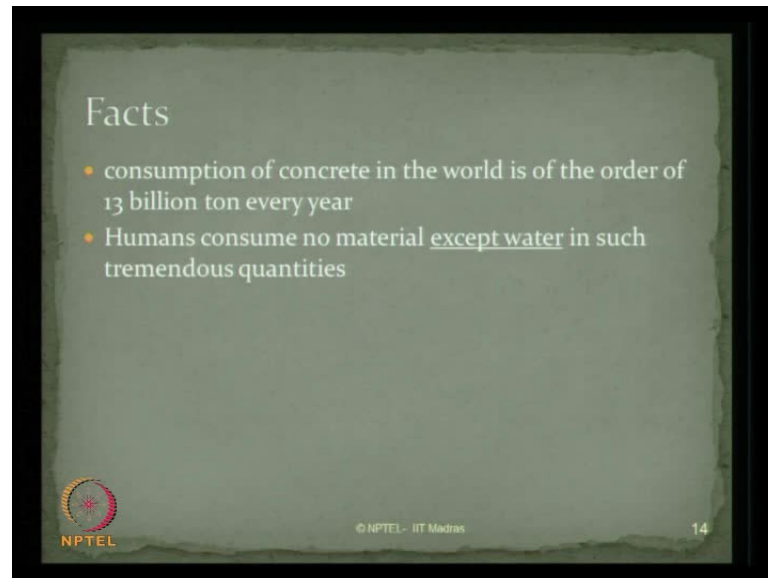
Now, the second part of lecture focuses on, interestingly, concrete as the special material. So, we already see, in the first module, different material being used for offshore construction. We also saw the third module, different material, which will be used for offshore construction. Concrete is understood and accepted as one of the interesting important and vital construction material for offshore platforms.

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If you look at this figure, it is amazing to know, it is one of the largest dam being constructed in concrete. So, let us talk about concrete and deterioration process in concrete.

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There are few facts in concrete, which is amazing. Consumption of concrete in the world for major infrastructure development is in the order of 13 billion ton every year. Ladies and gentleman, it is interesting to know, that humans consume no other material except water in such tremendous quantities. It means, concrete has becomes next to water in its vitality and importance in human life.

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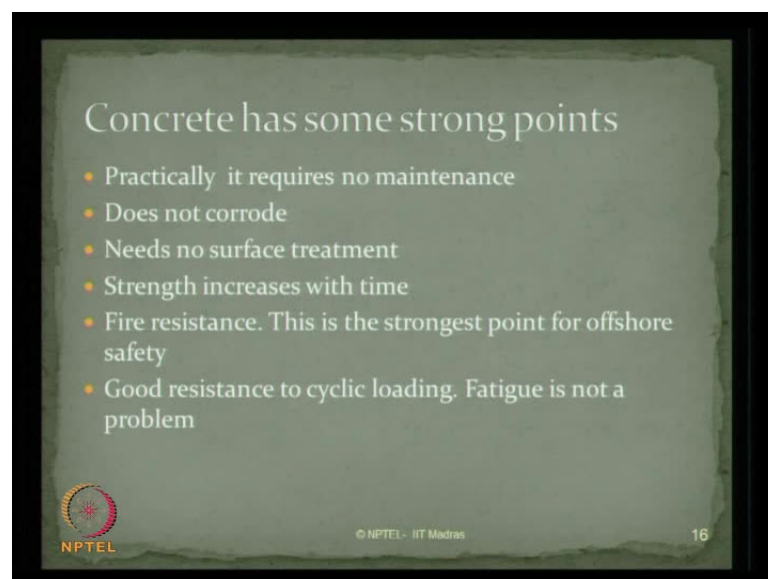
WHY is this material so common?

- Ability to withstand action of water without serious deterioration makes it an ideal material
- Concrete members can be cast to any desired shape and size easily
 - Freshly made concrete is of a plastic consistency
 - permits it to flow into formwork.
- Usually the cheapest and most readily available

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Why is this material so common? What is specialty about the material? This material has an ability to withstand action of water without serious deterioration, which makes it an ideal material for construction of offshore platforms. Concrete members can be cast to any desired shape and size depending upon the formation and formability. Freshly made concrete is of a very high plastic consistency, it permits it to flow into formwork of any shape and size as you desired. Usually, it is the cheapest material and most readily available construction material in the market.

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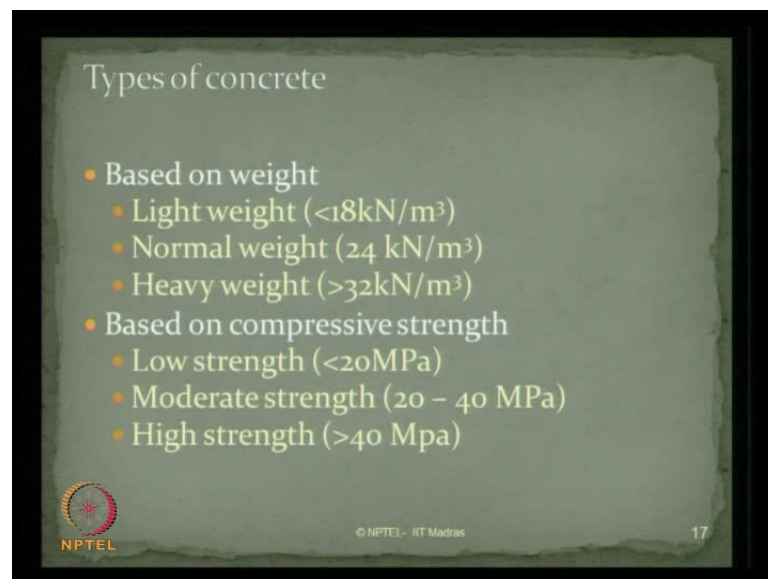
Concrete has some strong points

- Practically it requires no maintenance
- Does not corrode
- Needs no surface treatment
- Strength increases with time
- Fire resistance. This is the strongest point for offshore safety
- Good resistance to cyclic loading. Fatigue is not a problem

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Concrete has very few strong points. Remember, practically it requires no maintenance at all; it does not corrode by on its own; it needs no surface treatment if properly constructed, the strength increases with time. It has got very high fire resistance; this is one of the strongest points, which can be recommended for using concrete as a material for offshore structures because looking at fire safety point of view, concrete is considered one of the attractive materials for offshore structures. It has got very high resistance to cyclic loading. Fatigue, as far as concrete is considered, is not a problem at all.

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There are different types of concrete available in the literature, let us put up a brief summary on them. Based on weight, I have got light weight concrete, normal weight and heavy weight. Light weight is the, weight is less than 18 kilometer per cubic meter, heavy weight is more than 32 kilometer per cubic meter.

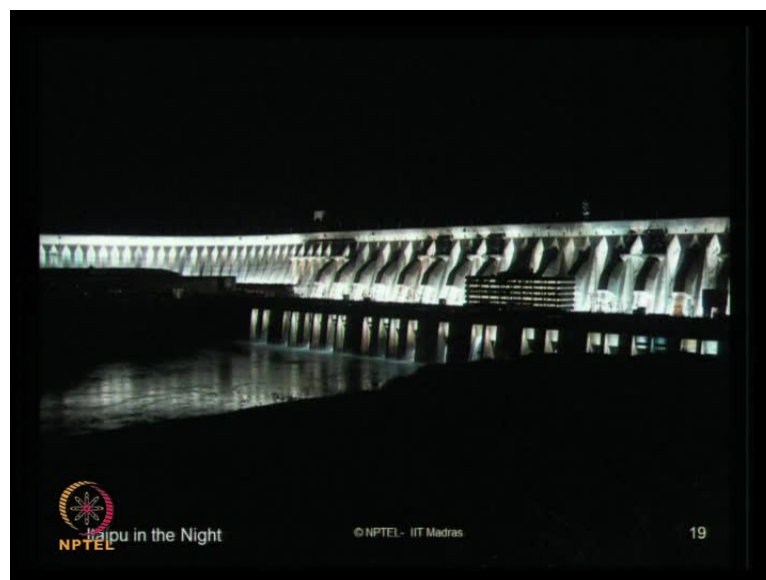
Now, based on compressive strength also concrete can be classified as low strength, moderate strength and high strength. Low strength is anything less than 20 mega-Pascal, whereas high strength, more than 40 mega-Pascal.

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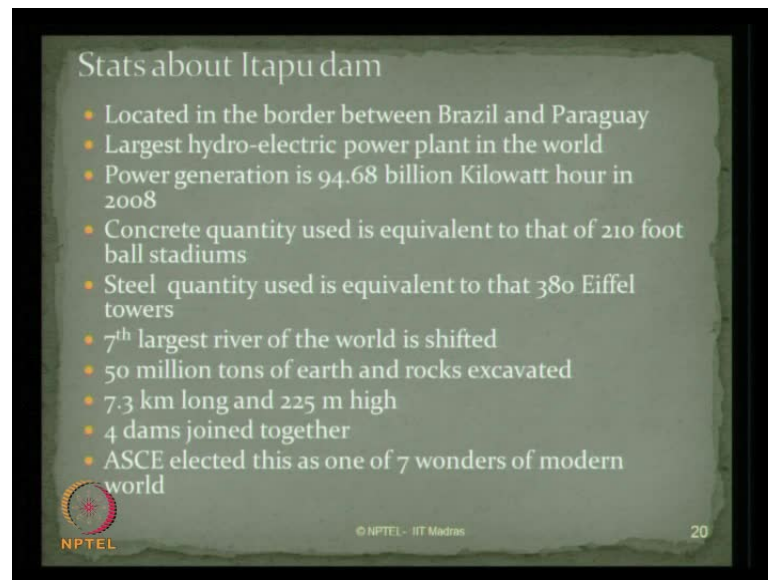
Some classical concrete structures will make you to attract this material as construction material for offshore platforms as well. Look at the Itaipu dam spill way, which is one of the vital and interesting structures, which is made out of concrete.

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If you look at the photograph with Itaipu in the night, it is very attractive and there are some vital statistics of the Itaipu dam, which makes it one of the world wonders.

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Stats about Itapu dam

- Located in the border between Brazil and Paraguay
- Largest hydro-electric power plant in the world
- Power generation is 94.68 billion Kilowatt hour in 2008
- Concrete quantity used is equivalent to that of 210 foot ball stadiums
- Steel quantity used is equivalent to that 380 Eiffel towers
- 7th largest river of the world is shifted
- 50 million tons of earth and rocks excavated
- 7.3 km long and 225 m high
- 4 dams joined together
- ASCE elected this as one of 7 wonders of modern world

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The Itapu dam is located in the border between Brazil and Paraguay. It is the largest hydro-electro project in the world power generation, is above 95, million, billion kilowatt hour in 2008. The concrete quantity used is equivalent to that of 210 football stadiums. The steel quantity used in this project is equivalent to about 380 similar Eiffel towers.

It is one of the wonders of the world, is 7th largest river of the world is shifted from this dam, 50 million tons of earth and rocks excavated during this project. It is above 7.3 kilometer long and 225 meter high. There are four dams joined together to make the Itaipu dam, is a single wonder of concrete structure. Therefore, American society of civil engineers elected this as one of seven wonders of modern world.

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Another interesting wonder, which concrete created in construction industry is sports stadium in Rome, very interesting geometric configuration.

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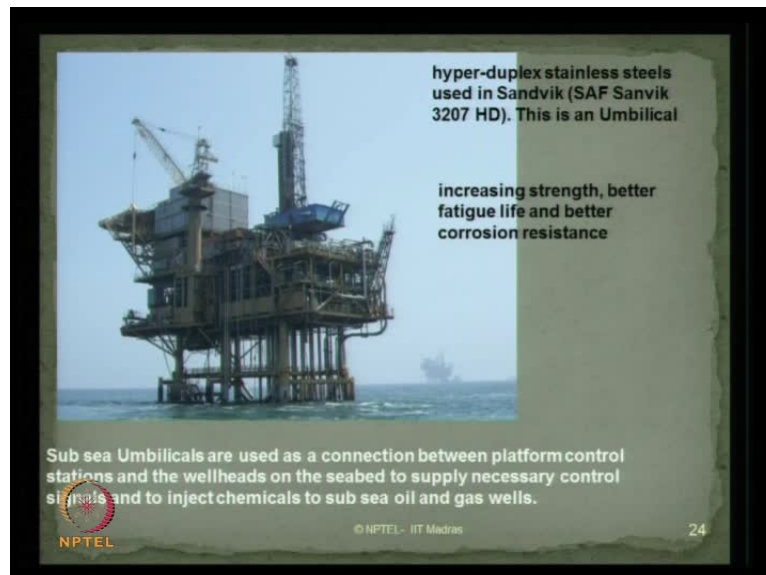
The other wonder, as we all know, it is the tallest tower PETRONAS in Malaysia.

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Now, let us see what is advantage of concrete being used as a material in offshore platforms? Interestingly, ladies and gentleman, Heidrun TLP, constructed in 1995 at 345 meter water depth is one of the largest concrete TLP ever constructed in the world, is located in the North sea, it carries the largest deck load ever a TLP can carry.

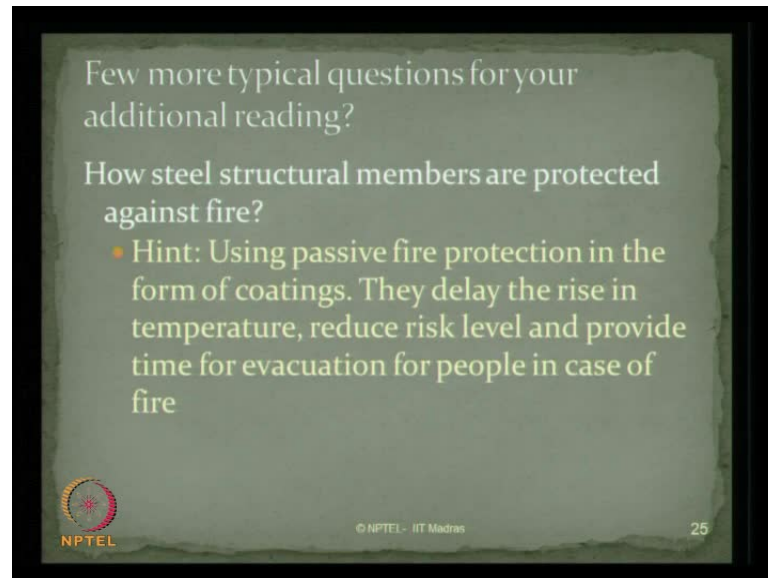
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In this specific module, hyper-duplex stainless steel is being used in Sandvik, is an umbilical. Actually, this increase in strength, better fatigue life and better corrosion resistance has made the steel very useful for construction material. The subsea umbilicals

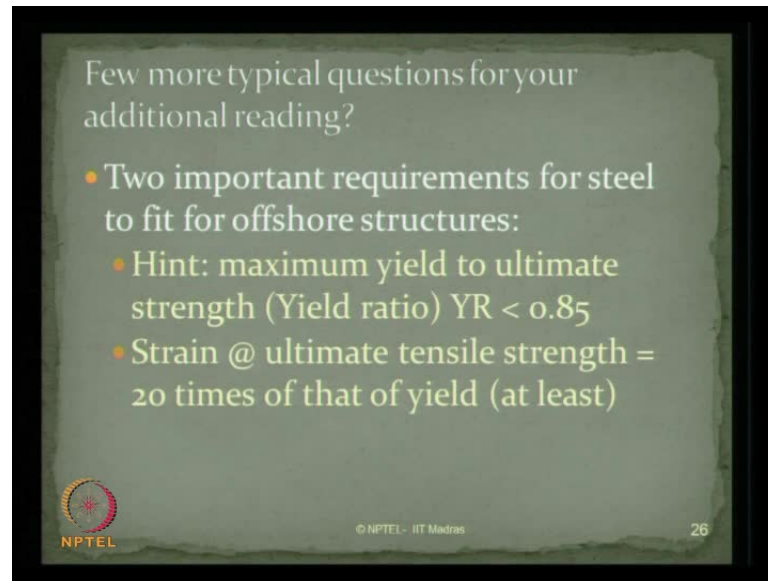
are used as a connection between platform control stations and the wellheads on the seabed to supply necessary control signals and to inject chemicals to sub sea oil, as well as, gas wells.

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There are few more typical questions for your additional reading, which you would like to know. How steel structural members are protected against fire? It is one of the important areas of interest for offshore structures. The hint is using passive fire protection in the form of coatings. People protect steel structures and make them as fire resistant. These passive fire protection coatings delay the rise in temperature, reduce risk level and also provide time for evacuation for people in, actually in case of fire.

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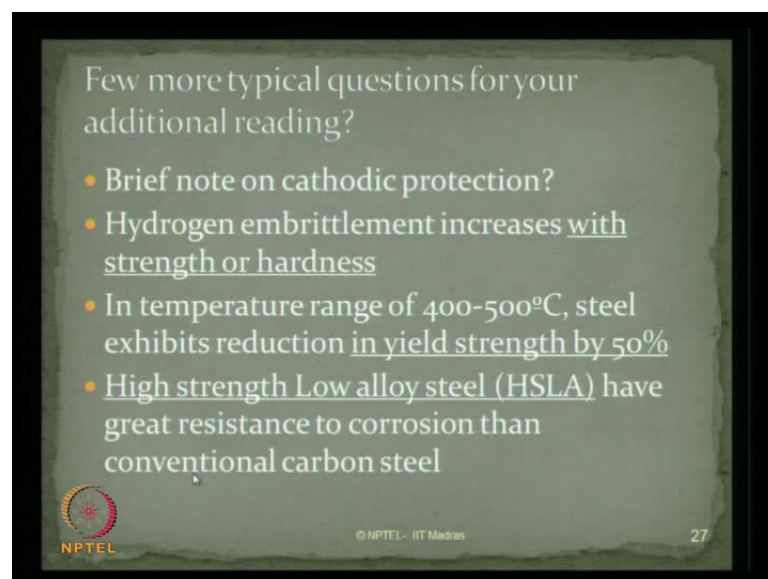
Few more typical questions for your additional reading?

- Two important requirements for steel to fit for offshore structures:
 - Hint: maximum yield to ultimate strength (Yield ratio) $YR < 0.85$
 - Strain @ ultimate tensile strength = 20 times of that of yield (at least)

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Two important requirements for steel to fit for offshore structures, if you ask me a question, then I would ask you to remember the maximum yield to ultimate strength ratio, what we call yield ratio. Yield ratio to be used steel as an offshore material should be less than 0.85. The strain at ultimate tensile strength should be at least 20 times as that of strain at yield. So, if these two qualities are satisfied, then that steel is fit enough to be used for offshore structure.

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Few more typical questions for your additional reading?

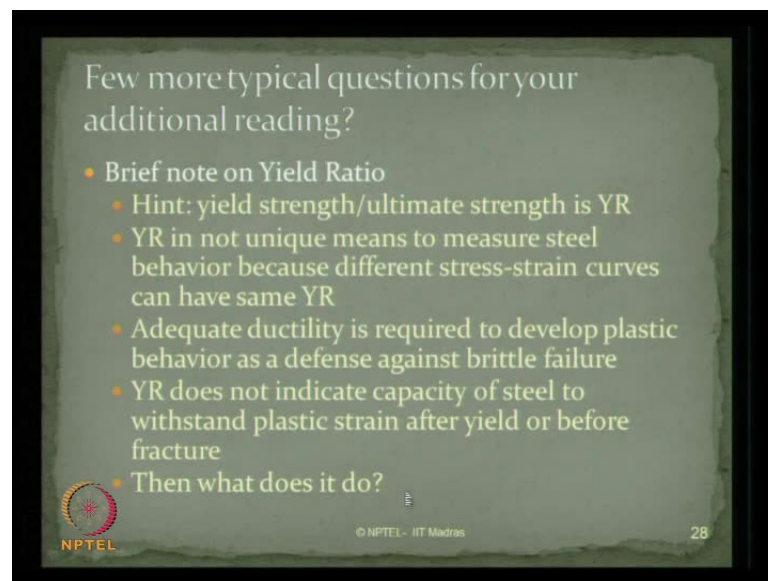
- Brief note on cathodic protection?
- Hydrogen embrittlement increases with strength or hardness
- In temperature range of 400-500°C, steel exhibits reduction in yield strength by 50%
- High strength Low alloy steel (HSLA) have great resistance to corrosion than conventional carbon steel

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There are few more questions, which I want to leave you for your additional reading. Make


a brief note on cathodic protection; hydrogen embrittlement increase with strength or hardness. In temperature range of 400 to 500 degree Celsius, steel exhibits reduction in yield strength, which is as high as 50 percent, is very important fact, which you must remember by using steel at a higher temperature, especially in offshore platforms. The high strength low alloy steel, which we call as HSLA, have great resistance to corrosion than that of conventional carbon steel, therefore they can be used for offshore construction.

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Few more typical questions for your additional reading?

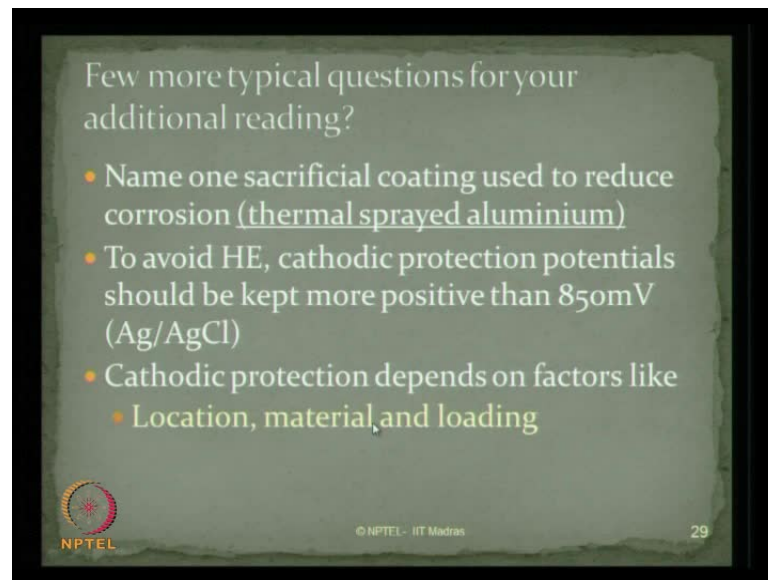
- Brief note on Yield Ratio
 - Hint: yield strength/ultimate strength is YR
 - YR is not unique means to measure steel behavior because different stress-strain curves can have same YR
 - Adequate ductility is required to develop plastic behavior as a defense against brittle failure
 - YR does not indicate capacity of steel to withstand plastic strain after yield or before fracture
 - Then what does it do?

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There is a brief note on yield ratio, which I want to share with you. The yield ratio is nothing but the ratio of yield strength to ultimate strength. Yield ratio is not unique means, to measure steel behavior because different stress-strain curves have different yield ratio. Adequate ductility is required to develop plastic behavior as a defense against brittle failure, which is more encouraging for offshore structure.

Yield ratio does not indicate capacity of steel. Please remember, this only indicate the with stand plastic strain after yield or before fracture. Then after fracture how does it behave, what does it do, I leave it to you for your self-reading.

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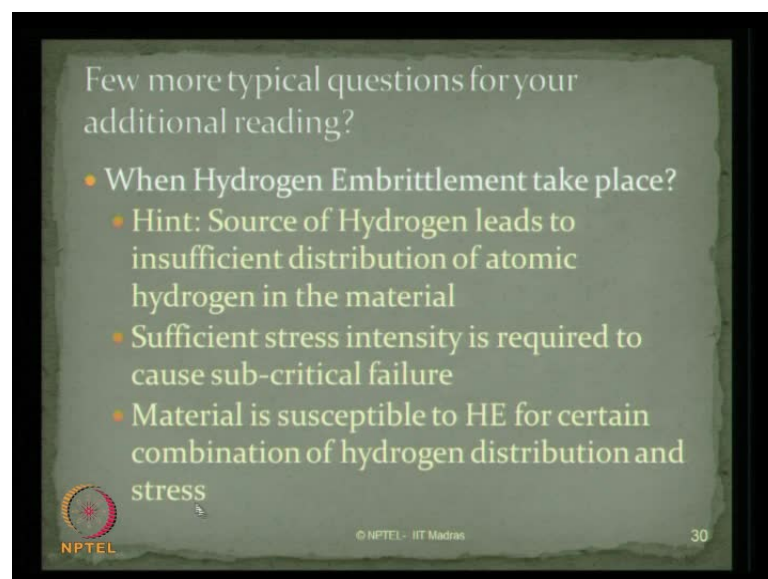
Few more typical questions for your additional reading?

- Name one sacrificial coating used to reduce corrosion (thermal sprayed aluminium)
- To avoid HE, cathodic protection potentials should be kept more positive than 850mV (Ag/AgCl)
- Cathodic protection depends on factors like
 - Location, material and loading

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Can you name any one sacrificial coating, which is used to reduce corrosion? Thermal sprayed aluminum is one interesting techniques, which is now used for making sacrificial coating to reduce corrosion. To avoid hydrogen embrittlement, cathodic production potentials should be kept more positive than 850 milli Volts in terms of silver and silver chloride solution. The cathodic protection depends on many factors; some of them are location, material and loading as well.

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Few more typical questions for your additional reading?

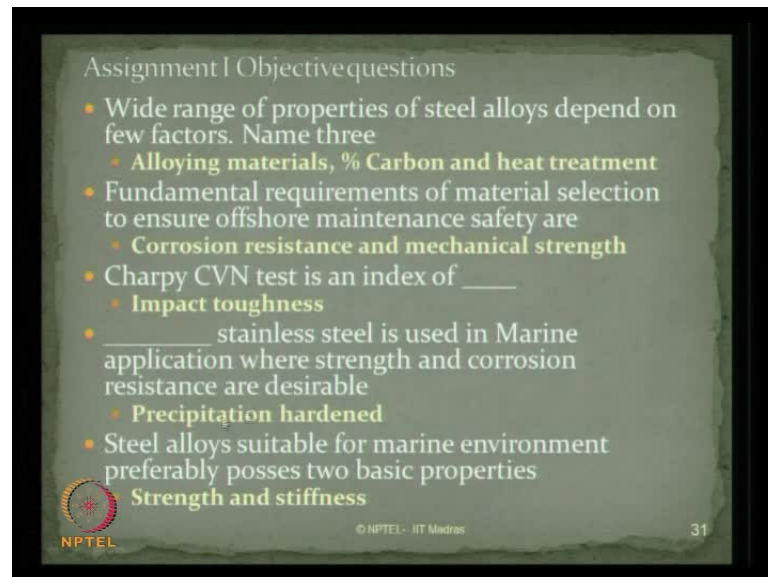
- When Hydrogen Embrittlement take place?
 - Hint: Source of Hydrogen leads to insufficient distribution of atomic hydrogen in the material
 - Sufficient stress intensity is required to cause sub-critical failure
 - Material is susceptible to HE for certain combination of hydrogen distribution and stress

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When hydrogen embrittlement take place, is a very interesting question, which one would

like to know, the source of hydrogen actually leads to insufficient distribution of atomic hydrogen in the material. Sufficient stress intensity is required to cause sub-critical failure. The material is susceptible to hydrogen embrittlement for certain combination of hydrogen distribution and stress concentration factors.

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Assignment I Objective questions

- Wide range of properties of steel alloys depend on few factors. Name three
 - Alloying materials, % Carbon and heat treatment
- Fundamental requirements of material selection to ensure offshore maintenance safety are
 - Corrosion resistance and mechanical strength
- Charpy CVN test is an index of ____
 - Impact toughness
- _____ stainless steel is used in Marine application where strength and corrosion resistance are desirable
 - Precipitation hardened
- Steel alloys suitable for marine environment preferably possess two basic properties
 - Strength and stiffness

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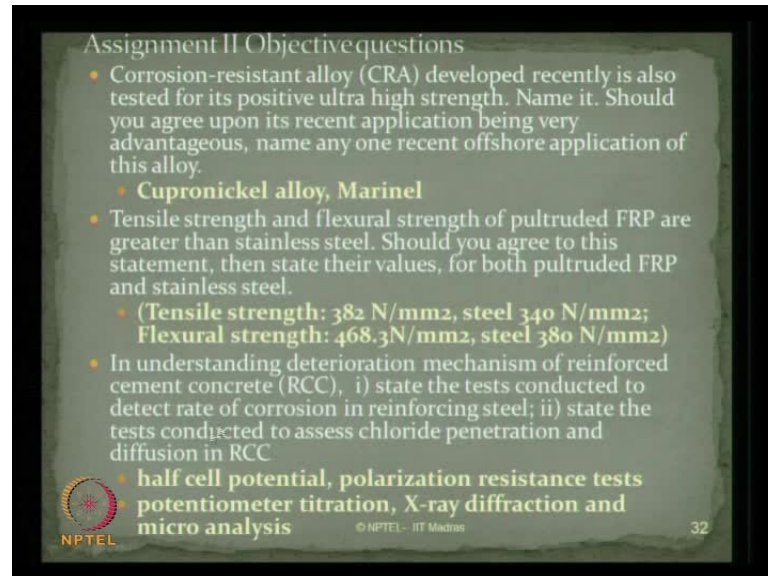
I have got few assignments for you in objective questions. I have the answers also here. Can you name wide range of properties of steel alloys, depends on few factors, what are they? Name at least three of them. The steel alloys depend on many factors, amongst all important, all the alloying materials the percentage carbon percent in the alloy and of course, the heat treatment process.

Fundamental requirements of material selection to ensure offshore maintenance safety, what are they? They are corrosion resistance and mechanical strength. These are two important parameters, which ensure selection of steel or any material for offshore construction in maintenance safety point of view.

If we look at Charpy's V notch test, can you tell me it is an index of what? It is an index of impact toughness. Austenitic stainless steel is used in marine application where strength and corrosion resistance are desirable. People use precipitation hardened stainless steel is a manufacturing process of the steel, which is generally recommended for a marine application where strength and corrosion resistance equally are important and desired.


Steel alloys, which are suitable for marine environment preferably possess or should possess two basic properties, can you name them? They are strength and stiffness.

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Assignment II Objective questions

- Corrosion-resistant alloy (CRA) developed recently is also tested for its positive ultra high strength. Name it. Should you agree upon its recent application being very advantageous, name any one recent offshore application of this alloy.
 - **Cupronickel alloy, Marinel**
- Tensile strength and flexural strength of pultruded FRP are greater than stainless steel. Should you agree to this statement, then state their values, for both pultruded FRP and stainless steel.
 - **(Tensile strength: 382 N/mm², steel 340 N/mm²; Flexural strength: 468.3N/mm², steel 380 N/mm²)**
- In understanding deterioration mechanism of reinforced cement concrete (RCC), i) state the tests conducted to detect rate of corrosion in reinforcing steel; ii) state the tests conducted to assess chloride penetration and diffusion in RCC.
 - **half cell potential, polarization resistance tests potentiometer titration, X-ray diffraction and micro analysis**

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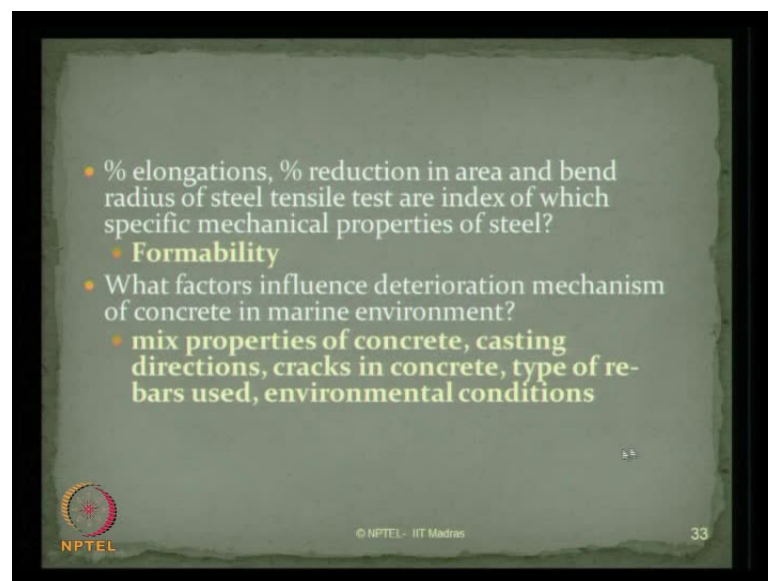
Corrosion resistant alloy, which we called as CRA in the literature, which are typically developed recently is also tested for its positive ultra high strength, name it. Should you agree upon recent application being very advantageous, name any one recent offshore application, which has used this alloy. The recent invention of corrosion resistant alloy is cupronickel alloy. This alloy has been used recently in one of the recent offshore application, which is marinel platform.

The tensile strength and flexural strength of a pultruded FRP are greater than stainless steel. It is a very important fact, which you must understand. If you agree on the fact, then state their values for both pultruded FRP and stainless steel. Let us look at both the properties, which are very important: one is tensile strength, other is flexural strength. The tensile strength for pultruded FRP is about 382 mega-Pascal, whereas for steel it is only 340. The flexural strength for pultruded FRP is about 468.3 mega-Pascal, whereas for steel is limited to only 380. So, pultruded FRP, which is interesting compensate has got more advantageous properties compared to that of conventional steel, which is being used for marine application.

In understanding the deterioration mechanism of reinforced concrete, state the tests conducted to detect rate of corrosion in reinforcing steel. Two, state the tests conducted to

assess chloride penetration and diffusion and reinforced cement concrete. The test, which is generally conducted to detect rate of corrosion is half cell potential or polarization resistance test. The test, which is conducted to assess chloride penetration and diffusion, is potentiometer titration or you can use X-ray diffraction and do micro analysis based on which you can estimate the chloride penetration and diffusion present in the existing reinforce concrete structures.

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So, ladies and gentlemen, let us look at some of them. Important properties are percentage elongations, percentage in reduction area and bend radius of steel tensile test. Can you tell me these are indices of which specific mechanical properties of steel? All of them belong to only one family, which is call formability.

What factors do influence deterioration mechanism of concrete in marine environment? Remember mix properties of concrete, casting directions, cracks in concrete, types of rebar are used and environmental conditions, all put together influence actually deterioration mechanism in concrete, especially in marine environment.

This lecture would have given you thorough overview of different applications, which has been used for dredging projects and of course, concrete is a special and attractive material for offshore platforms.

Thank you.