Ocean Structures and Materials
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Module - 3
Lecture - 1
Introduction to Design

In the previous modules, that is module 1 and module 2, we have discussed about different types of ocean structures, coastal structures, a structural form, structural action for different environmental loads, the different types of environmental loads, different wave theories, how to compute these forces etcetera in detail.

In module 2, we discussed about the construction methodologies, construction practices, techniques involved in various types of construction of offshore and coastal structures, and also we discussed about the dredging and dredging requirements and various equipments used for dredging. In this module 3, we will discuss about materials which are used for marine environment for the benefit of the viewers. We will quickly show you the outline of the third module which we will discuss in the sequence of lectures now.

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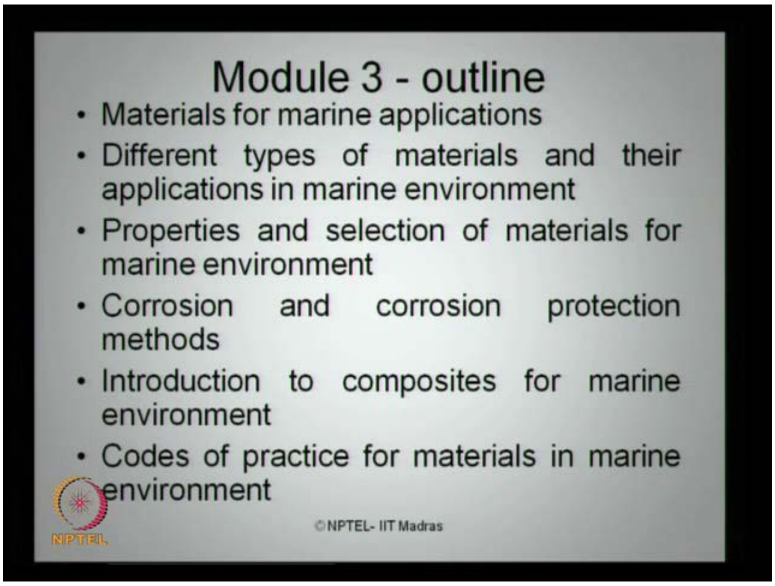

We will talk about materials for marine applications, we will have to discuss on different types of materials and their applications to marine environment, properties and selection of materials for marine environment, corrosion and corrosion protection methods for different materials, introduction to composites for marine environment. We will also discuss about various codes of practice for selection of material in marine environment.

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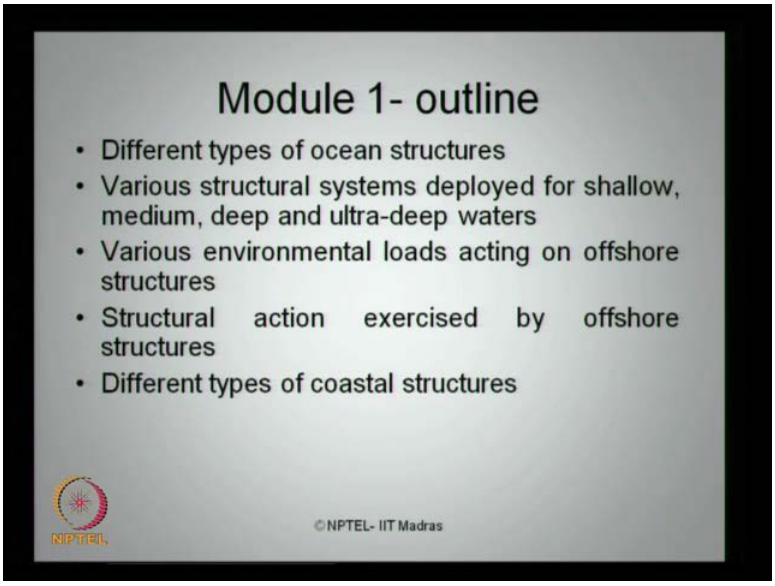

For the benefit of viewers let us quickly, briefly review what we have discussed in module 1. We discussed about different types of ocean structures, we also discussed in detail various types of structural systems that are deployed for shallow water, medium, deep water, and ultra- deep waters. We discussed various environmental loads that are acting on offshore structures, how to compute them, what are the different wave theories which are relevant to be used for computing these forces acting on different members of offshore structures.

We also discussed about structural action exercised by various types of ocean structures to encounter these applied loads on these members. We also discussed in detail about different types of coastal structures, their structural form, geometric shape, size, dimension, and cross section, and their applicability in terms of benefits, merits and demerits of coastal structures.

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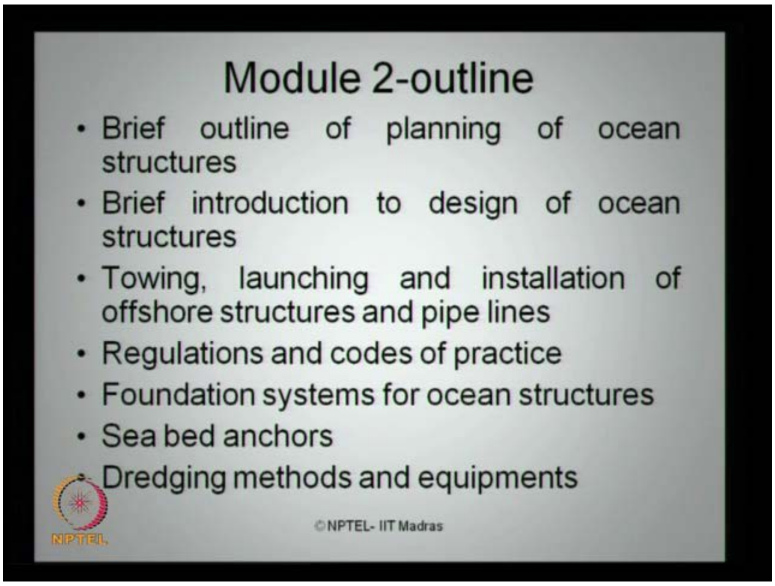

In module 2, we discussed about brief outline of planning ocean structures, brief introduction to design of ocean structures, towing, launching, and installation of offshore structures and pipe lines. We discussed about regulations and codes of practice. We also had discussions on foundation systems of ocean structures. We also discussed sea bed anchors and dredging methods and equipments, different equipments used for dredging at different locations.

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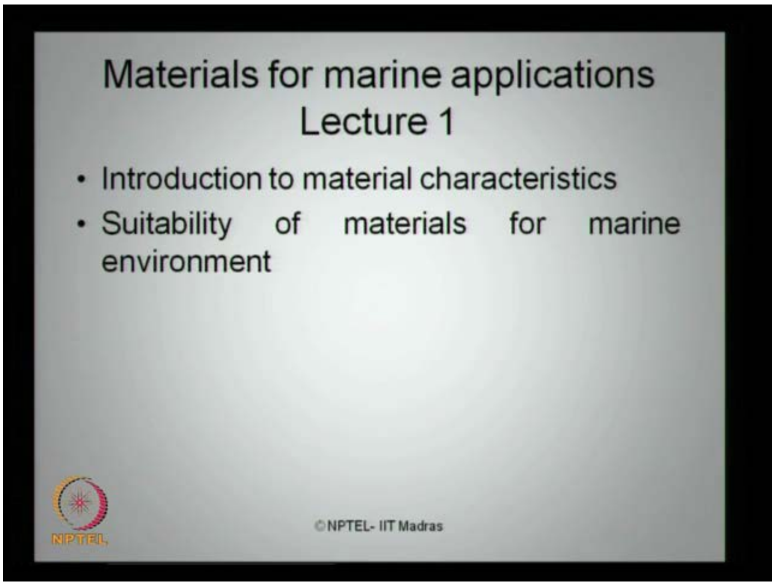

Ladies and gentlemen, in the third module, we are going to discuss about materials for marine applications. This is the first lecture on module number 3, the outline of this lecture will be as follows; we will talk about introduction to material characteristics because to understand how to select materials for marine application, I must first understand what are those special material characteristics that are important to be looked up on before I select the variety of material that can be used for marine applications. Then we will also quickly summarize the suitability of materials for marine environment, it means what are those special characteristics physical, structural, to be looked up on so that I can select a material based on these requirements.

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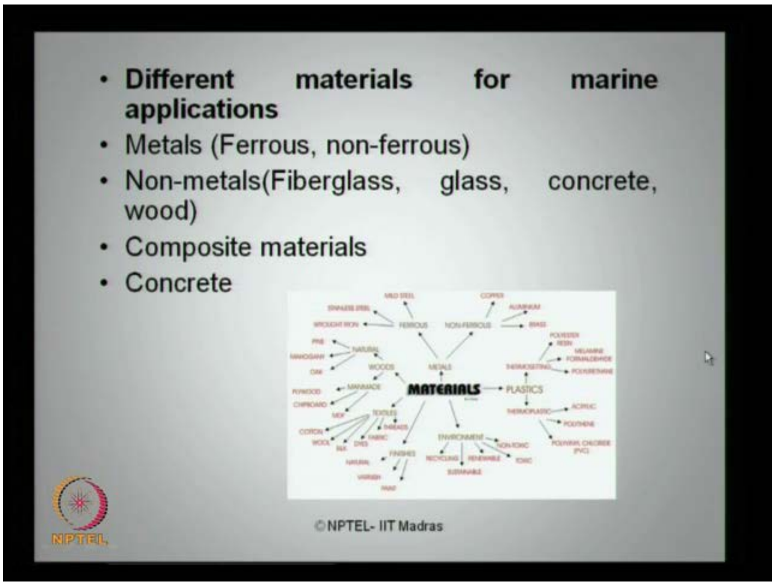

The different materials have chances of getting applied for marine application; there can be ferrous and non-ferrous metals. We can have non-metals; like fiberglass, glass, concrete and wood which fine application in marine environment. We can also have composites which are frequently being used in marine application. Of course, concrete can never be ignored as one of the primary material for construction of ocean structures, if you look at the flow diagram which is being given here, if you look at material as the core area of my interest I have got metals, metals can be ferrous and non-ferrous, which can be for example, mild steel for example, copper, aluminum and brass. I can also have plastics which can be thermosetting and thermoplastics resins, which can be acrylic polythene and polyvinailcloride, which you called PVC which also has application in marine environment.

If you look at the environmental issues related to selection of a material, then recycling, sustainability, renewable, toxic and non- toxic, are some important domains of interest which people focus on environmental issues related to materials being used in environmental practices. If you look at different kinds of other material than metals say for example, wood, there can be natural and manmade, varieties of wood- naturalwood can be pine magonianope, whereas manmade can be plywood, chipboard, mdf etc. Sometimes people use geomembrains and textains also as material for marine application cotton, wool, silk, dices, naturals etc because they can also be used as type of protection in chemical coatings which has been used. People also use chemicals for finishers of members and marine environment.

So, marine environment has a very complex level of application and why varieties of material have been used in practice in the marine environment. So, our interest is to look at those fundamental characteristics which have very important for select the material for marine environment.

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What are the mechanical properties of metals which are very important and which will guide as to select material for ocean environment? The mechanical properties are generally considered as an important index to study the behavior of metals under loads. For example, strength, hardness, toughness, elasticity, plasticity, brittleness, ductility, malleability, are some of the very important properties of mechanical index properties which can be useful to understand the behavior of metal under different loads.

Now, these properties are described in terms of the types of forces or stress, that the metal must withstand and how these forces are resisted, so depending upon the pattern they resists, the methodology they resists, and of course depending upon the type of action of the forces on these material, then these properties are redefined, slightly and intrinsically.

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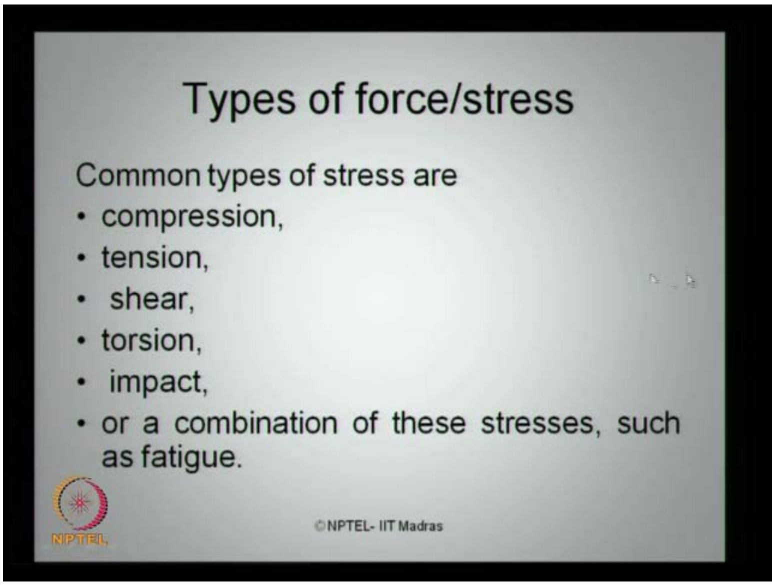

Let us then understand what are the different type of forces or stresses that act on members in offshore structures. There are common types of stresses which can be classified as follows; We can have a compressive stress or a compressive force acting on a member, we can have a tensile force or tensile stress generated on members. We can have shear force coming on the members, we can also have torsional effect on members and impact forces which can be caused by the vessels or tuck board on the members during impact and interestingly a combination of the stresses is the most critical way we must look at them.

So, if they act independently or they act in the absence of others then the problems are lesser, but if they combine together then I may encounter different kinds of problems like one example is a fatigue problem, which is a reversal of forces in terms of let say tension and axial compression.

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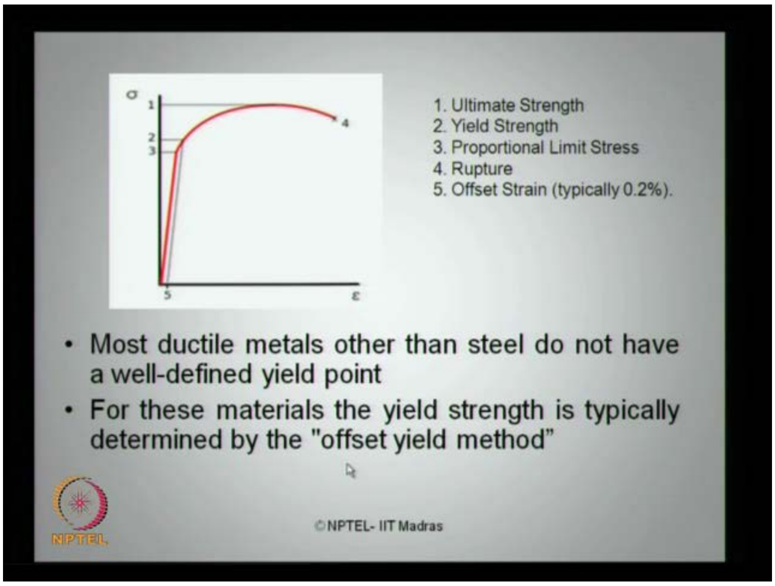

This is a very interesting figure showinga stress strain curve which all the engineering students must know. Let as quickly understand what is the importance of this in selection a material for marine environment is a classical stress strain curve for a ductile material which I am showing here. There are different points which I am indicating here 1, 2, 3 and 4, whereas one stands for the ultimate strength of the member which in index shown in the stress axis. Yield strain is the point from which the yield level can be estimated which again a strength value shown on the stress axis, of course limit a proportionality or proportional limit stress is up to which a stress strain curve remains linear which we all understand, and 4 can be the point of rupture where the materials actually forms nap can ruptures.

In case when you are not able to define the yield point very clearly because most ductile material other than steel do not pronouncedly show a well -defined yield point, in such cases what we do is we plot a point two percent typical strain offset and draw a parallel line which is parallel to the initial slope of this line; where ever this line is intersecting my so called stress strain curve I obtained that as my yield point, this method is what we called as offset yield method.

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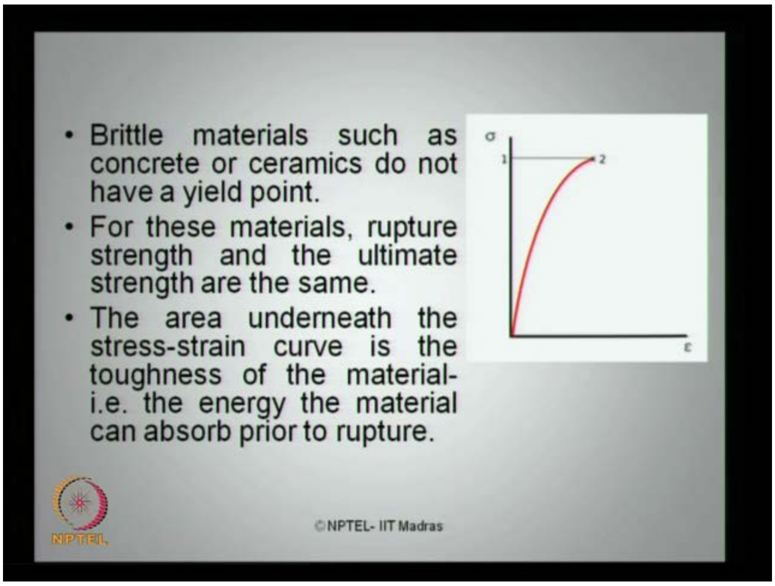

In case of the brittle material the story is slightly different; brittle material such as concrete, or ceramics do not have a designated yield point. In such cases rupture strength and ultimate strength are exactly the same for these members. The area underneath the stress- strain curve is an index of the toughness of the material. So, toughness is on the other hand energy of the material which can absorb prior to the rupturing of the material.

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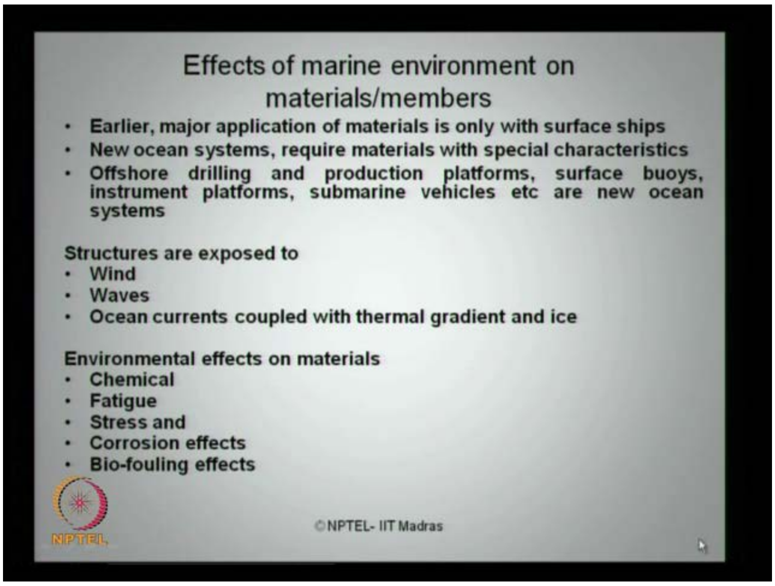

Now, let as quickly look at the effects of marine environment on members or materials used for ocean structures. Earlier the major application material is only surface ships, now the ocean systems require material with special characteristics. Offshore drilling and production platforms, surface buoys, instrumentation platforms, submarine vehicles, are new kinds of ocean systems which demand special characteristics material which can be used or applied on them.

Now, interestingly let as quickly look at what are the exposure which are meant for ocean structures. Ocean structures are exposed to different environmental weather as wind, waves, ocean currents, coupled with thermal gradients and ice. Of course, environmental effects which can be caused by these materials are the following; it can have the chemical effect on the material, it can have a fatigue failure on the material, and of course the stress and corrosion effects are also equally important, which are after effects of these environmental effects on the materials. Interestingly, in the recent times because of the environmental impact assessment being becoming very important for offshore structures, of course the structures bio-fouling effects are also considered to be an important parameter to estimate the deterioration characteristics of the material, and the effect of the material after deterioration on the environment.

So, bio-fouling effects also form a very important effect which is caused by on the material by these environmental forces. Now, let as ask a fundamental question under the given complex system of different kinds of forces acting on the member, different combination of forces acting on the members of the offshore structures or ocean structures, what characteristics the material should possess; because I must understand what material actually need tobe qualified to be used for ocean structures and systems.

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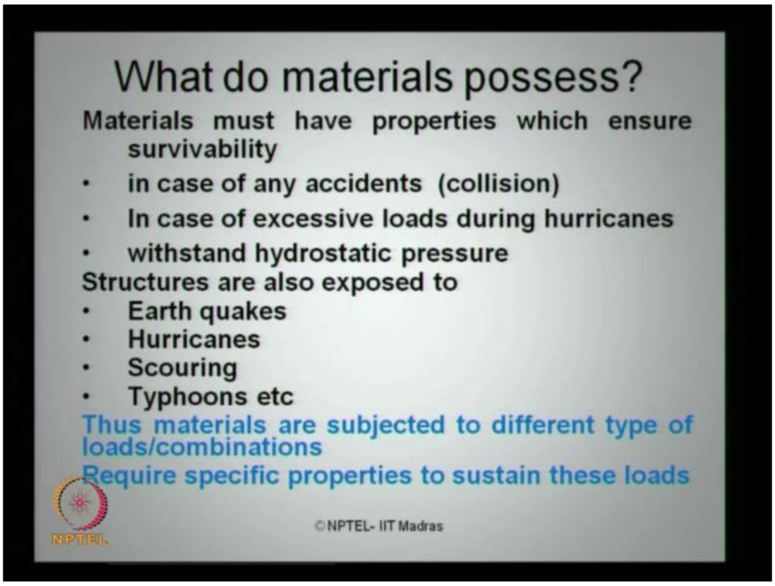

Materials must have properties which ensure fundamentally, survivability under this environment. The moment is survivability, then it should survive in case of collision, it should survive in case of excessive loading which can occur during hurricanes or special kinds of environmental forces. It should withstand a severe hydrostatic pressure, ladies and gentlemen, interestingly can only name very few situations where these kinds of conditions are imposed on material to withstand which are highly uncertain.

For example, land based structures may not have to undergo the forces which are relating from accidents very often, where as in ocean structures or offshore structures collision is considered to be one of the day to day life load which happens because duckboards keep on offloading the fuel from the platform, or the crude oil from the production system will always have tendency or they is a high probability that these vessels may touch or may rub upon members of structural system.

So, in case of accidents, in case of excessive loads which is caused by uncertainty during hurricanes, and in case of excessive hydrostatic pressure materials must remain in tag which we called they should have very high degree of survivability. In addition structures are also exposed to earth quakes, hurricanes, scouring effects, typhoons, etc.

Now, look at an offshore structural system and the present environmental loading. There is a very good combination or rather there is a very serious combination of different kinds of force systems, different combination these forces acting on the members, different effect caused by the environmental nature on the member material and material also have specific physical and structural characteristics.

Now, the algorithm of selection a material of offshore structural system is growing complex in nature and therefore, we must clearly understand a guideline how to select these materials for ocean applications. Therefore, material is subject to different kinds or different types of loads and their combinations which is very critical for us to understand before we go for selection a material. Therefore, it requires specific properties to sustain these loads. What are those specific properties which are demanded from the material if they have got to qualify for ocean structures or ocean systems?

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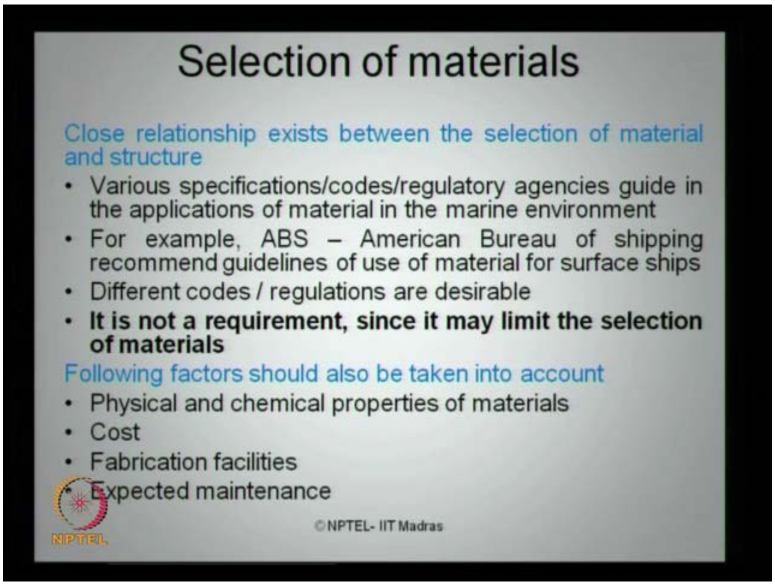

Now, selection of material is a very important phenomenon; which we must understand thoroughly before we study important characteristics of material that is to be used in offshore structural systems. We must understand, ladies and gentlemen, there exists a very close relationship between selection a material and the type of structure; various specifications, codes, regulatory agencies guide in the applications of material in the marine environment, there is no doubt about it you got different varieties of codes which will govern some suggestions or recommend some idea and certain methodologies based on which you can select the material for marine environment.

For example, American bureau of shipping recommend guidelines of use of material for surface ships; different codes and regulations are desirable instead of following a new color single code we must go for different codes and regulations available. It is not a requirement following different kinds of codes because since it may limit the selection of material, if you go for one specific code then the material recommended by these code because mandatory for us to use in the marine environment, so this not always mandatory you must follow only one exclusive code, but of course, different varieties of codes suggest different methodologies by which you can select the material for marine environment.

Following factors should also be considered while selecting a material for marine environment. Let see what they are; you must understand thoroughly the physical and chemical properties of the materials. We must also look in to the cost factor because offshore structures are latex cost of very high index. the fabrication facilities is one important governing guideline, if you want to select a material for offshore structural fabrication systems because the material should be constructible and fabricate able because it is very important for us to make it easy and comfortable for the manufacturer, or for the contractor to fabricate the system which design in the shop floor. And interestingly, the expected maintenance must be there for putting the survivability of these kinds of structural systems and the complex ocean environment.

So, selection of material is closely governed by advice or recommendations given by various international codes, this gives as variety to select material depending upon different guidelines and recommendations. Secondly, various factors we must focus to select the material for marine applications, physical and chemical properties of the material, the cost factor, the fabrication facilities and expected maintenance are important guidelines for us to understand how to select the material for ocean systems.

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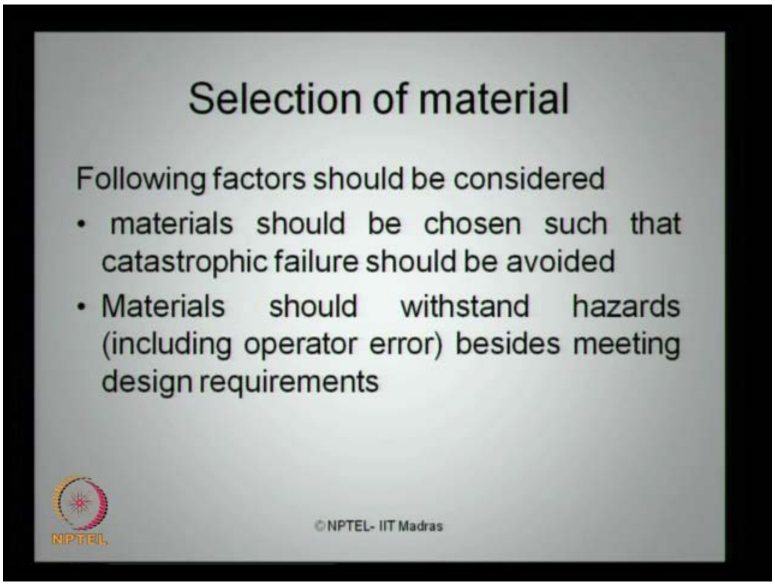

Following factors should also be considered; materials should be chosen such that catastrophic failure should be avoided, it means that failure, if at all occurs, even at a lower probability, should not be sudden or immediate, because the lot amount of qualitative and quantitative assets are invested on offshore platforms. So, the platform or the material or the design or the geometry should give me an interesting warning before it starts ending up in catastrophic failure. So, materials should be chosen carefully, so that catastrophic failure should not occur. Materials must also withstand hazards, what you understand by hazards, where did they arrive from.

There can be hazards which can be arising from operational errors. Ladies and gentlemen, remember offshore process or oil production process is a complex system. It involves lot of electro, mechanical, electrical instrumentation equipments, which have got to be synchronized in a specific format to actually successfully do drilling or a production of crude oil or any fossil fuel from the sea belt. So, because of the integration of different kinds of equipment system which we must always see that the material selected should be capable of withstanding the foreseen hazards besides these meeting the design requirement.

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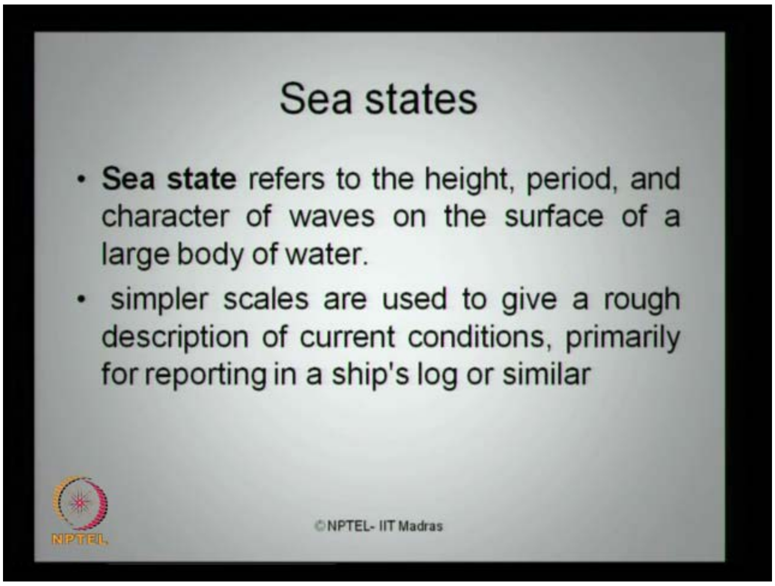

Let as look at different kinds of sea states for which the offshore structural system is subjected. Sea state refers to height, period, and character of waves on the surface of a large body of water. Essentially they are simple scales which are used to give a rough description of the current conditions, primarily for reporting a ship's log or similar.

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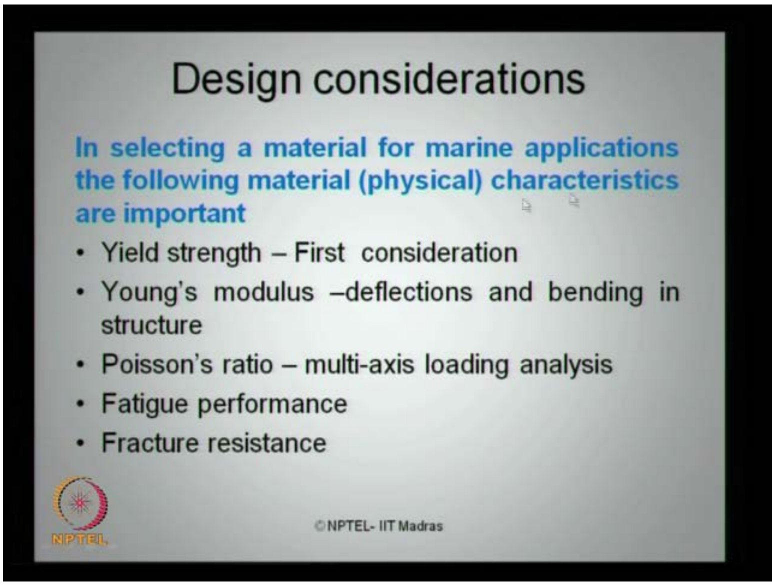

Let us quickly look at, very briefly, the design considerations based on which material must be selected. In selecting a material for marine application the following physical characteristics of the material are very important. Foremost, is of course the yield strength of the material because based on the yield strength it gives me a guideline, how to design the member. The second characteristics is very important and of course please do understand that they are all in the same ascending order, I am not putting them in a specific order, I am only listing them; young's modulus is an important characteristic which will govern deflections and bending of structural members.

Poisson's ratio is also important, because we are dealing with multi-axis loading analysis in offshore structural members. Fatigue performance is very important, because reversal of forces is in inherent characteristics of environmental loads which encounter these kinds of ocean structural systems. And of course fracture resistance is very important phenomena, which demanded from the material in offshore structural system.

So, in the design point of view yield strength young's modulus Poisson's ratio are very important. Sometimes, in design considerations fatigue and fracture resistance are also equally necessary to be focus before we select the material for marine environment. So, I put all of them as physical characteristics for selection a material.

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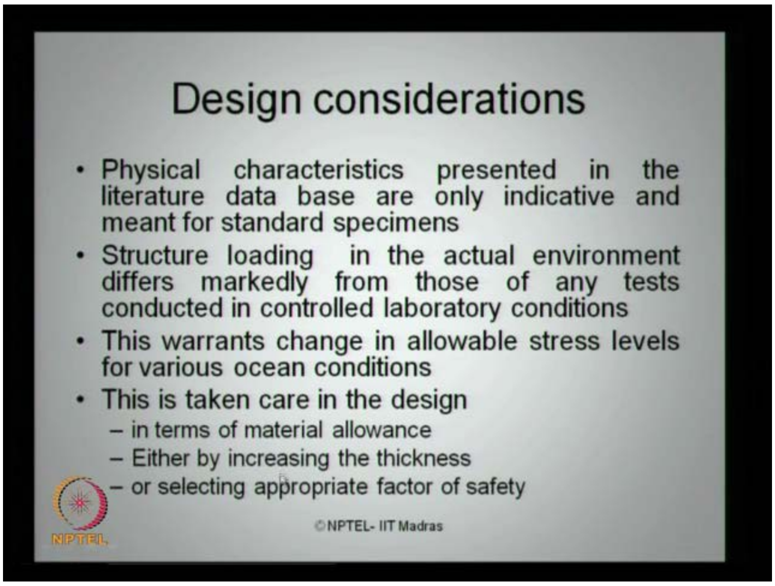

In addition physical characteristics present in the literature are very important to understand that they are only indicative. For example, if the material has the yield value of lecture 250 mega pascal, it is only indicative value which is for a standard specific, but in reality depending upon the material what we are trying to use, the structural loading in natural environment may vary this kind of properties in reality. So, there is the market difference which exists between the data which you have based on the laboratory test and incept to conditions because the material or the member will you subjected to different combination of forces which can alter the properties, which has we studied in the strict laboratory conditions.

Therefore, this warrants a change in allowable stress levels for various ocean conditions, it means in short the physical characteristics of a given material which have indicative, which are available from the laboratory experiments are only guidelines. You cannot use them directly; you need to alter them or appropriately modify them to suite different stress levels which are actually encountering the members in ocean systems, or ocean environment. So, how this is taken care of in the design in terms of what we called material allowance. You cannot say the increase in the thickness of member than, that is actually merely required based on design consideration because that allowance increases in thickness take of care of uncertainties which is caused by change in the conditions in the ocean environment.

There also usedfor what we called appropriate factor of safety. So, these are some of the method by which one accounts form the variations in the stress values of the material under marine environment.

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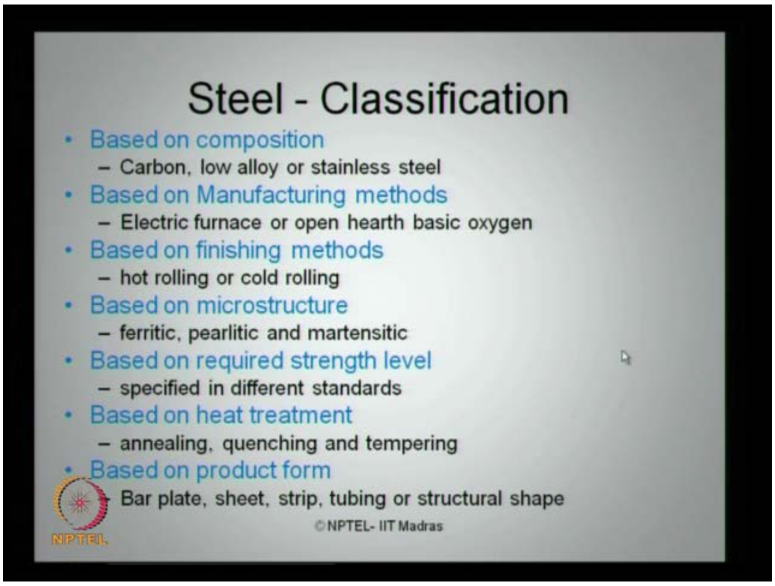

Let us now look at one specific material in this lecture and try to classify this as applicable to selection of these materials for ocean structural systems. Let say for example, steel is a fundamental material which is very popularly and widely and largely being used for ocean structures. So, steel are classified by a variety what I am going to snow here, steel is classified based on composition may be it called as carbon, low alloy or stainless steel. We can also classify steel based on manufacturing methods as electric furnace or open hearth basic oxygen, can also classify steel based on the finishing methods it can be either called as either hot rolling or cold rolling, can also classify steel based on its microstructure as ferritic, pearlitic, or martensitic. It can also classify based on required strength level which is specified different standard.

Ladies and gentlemen, please understand that the strength requirement of material for example, steel is also variedly different in different international codes and regulations. It is not uniform everywhere, depending upon where you are going to apply this material, on which component of the member you going to apply the yield strength or the strength recommendations given by the codes vary. We must sturdily understand the steel can also be classified based on these strength level requirements.

Based on heat treatment we can also classify steel as annealing, quenching and tempering, by based on product form, the final geometric form of course we understand as structural engineers steel can also be classified as bars, plates, sheets, stripes, tubes, or of any other structural shapes which is have been given a name depending upon its manufacturing cross sectional dimensions. So, steel classification has got a wide verity so it is very important for us to understand how we are going to classify steel for my application in ocean structural system.

Am I going to classify based on its composition? Am I going to look at the strength requirements of this material? Am I going to look at the finishing methodologies based on which I am going to classify? Am I going look at the product form? So, ladies and gentlemen, please do not recognize classification of steel as simply cross sectional shapes like bars, members, plates, etc. Steel classification especially has separate offshore structural system is having a very wide variety and they also differ in different kinds of international codes.

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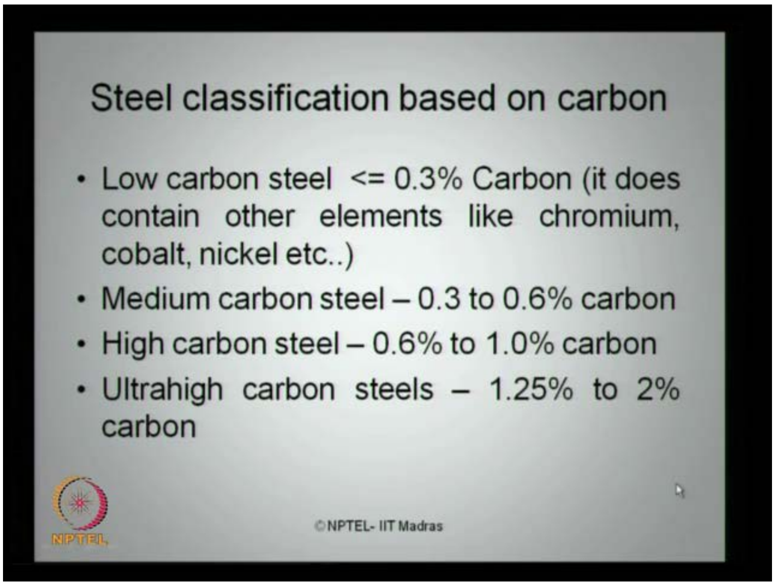

Now, if you look at steel classification based on carbon alone, you can further classify this as low carbon steel, medium carbon steel and high carbon steel. So, low carbon steel is the one which has got less than or equal to 0.3 percent carbon, it does not contain other elements like chromium, cobalt and nickel whereas, medium carbon steel as the percentage of carbon varying from 0.3 to 0.6 percent and high carbon steel has content varying from 0.6 to 1 percent of carbon.

So, carbon plays a very important role in altering physical and structural characteristics of steel. We also have ultra- high carbon steel which is having percentage as highest 2 in its chemical composition.

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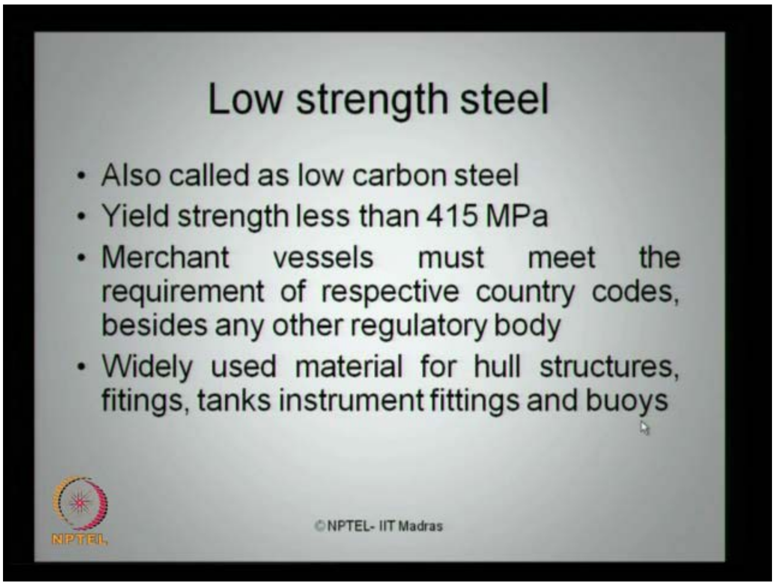

We can also classify steel further based on its strength as I said, low strength steel, medium strength and high strength steel. Now, let us quickly look at what do we understand by a low strength steel, it is also called as low carbon steel, yield strength is lesser than 415 mega pascal. The merchant vessels must meet these requirements of course, of different respective country codes, besides any other regulatory body.

These are widely used materials essentially for hull structures, fittings, tank instrument fittings, and buoys. Low strength steel has got specific applications in ocean structural systems. It can be used for manufacturing or fabricating. Hull systems can be used for fittings and appurtenances; it canbe used for tanks; it can be used for manufacturing buoys.

Ladies and gentlemen, it is very interesting that for the first time probably you may be hearing that steel is classified depending upon, or a material is classified depending upon where you going to use this material specifically. So, ladies and gentlemen, international codes apply in offshore structural system or very intrinsic and very clear the categorically design and say, what can be the material should be used and what location of the member. For example, you can see here very clearly the hull structure systems, fittings and appurtenances and tanks and buoys can have low strength steel as a preferable material. For example, AXTN A2 42 A 41 are widely used for pressure vessels.

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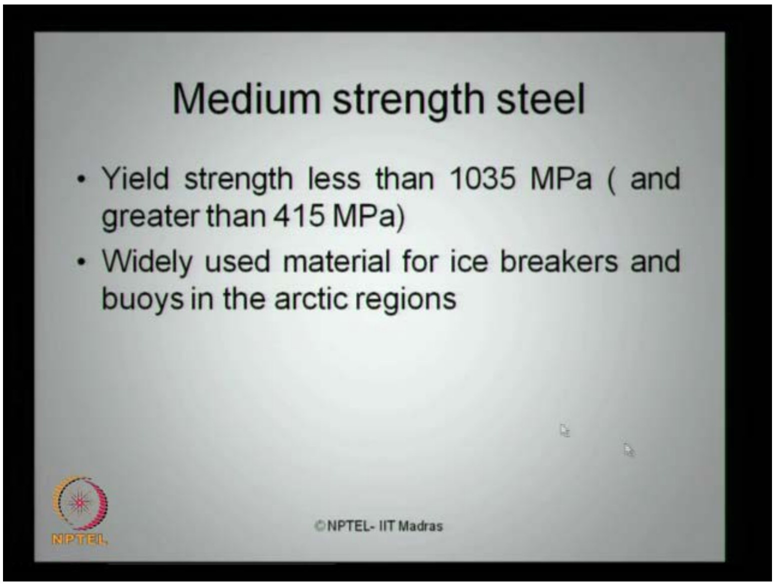

If you look at the medium strength steel, the yield strength varies from 1035 mega Pascal that varies from 415 mega Pascal and goes till 1035 mega Pascal. It is widely used as the material for ice breakers and buoys in arctic regions. Remember, again I am insisting that material are classified for example, steel in the specific example is classify international codes not only depends upon strength, but also they recommending their applicability for different kinds of members used in different region as well as arctic region etc. It very interesting and very detailedand therefore, these detailed guidelines which are available international codes helps us to select material very comfortably and very easily.

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If you look at high strength steel, yield strength is greater than 1035 mega Pascal, is one of the very high value probably in design of onshore structural systems, like buildings etc. You must have never encountered steel whose yield strength is higher than 1000 mega Pascal. In rain force concrete structural system they have been using steel is about 550 mega Pascal or may be 415, whereas we have an yield strength here which as high as 1035 mega Pascal. We also have a special kind of steel which is called maraging steel, which has yield strength varying from 1 Giga Pascal to 2 Giga Pascal approximately is very surprising and very categorically recommended steel, this having relatively very highly ductile and heat treated to improve these kind of properties it is, what we called as maraging steel.

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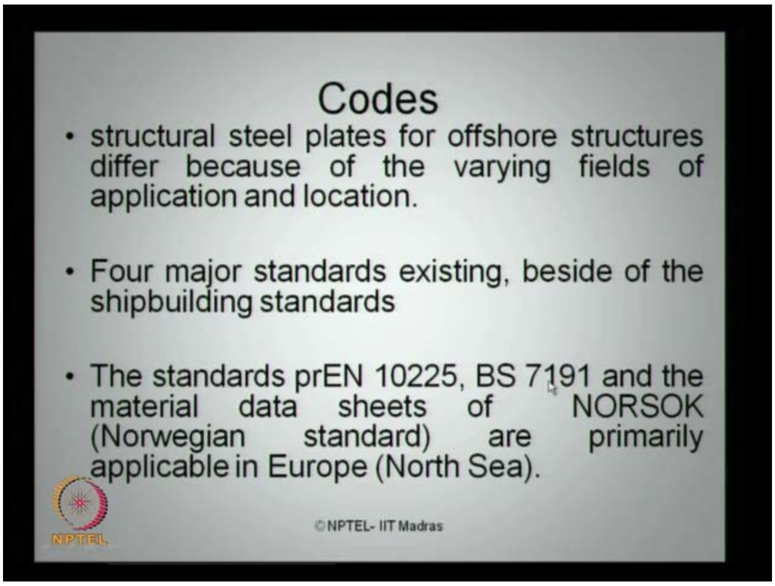

Now, let as quickly look at what are the different kinds of codes and what are the recommendations given by the codes. I am not giving the name of the codes their availing the reference already given to you in the webpage of NPTEL IIT madras for these codes. I am not looking at the names of the codes, am going to suggest how these codes guide me to select material for offshore structural systems.

Structural steel plates for offshore structures differ because of the varying fields of application and location where they have been used. Four major standard is existing besides shipbuilding standards. Let us quickly see what are they the standards are prEN

10225, BS 7191 and the material data sheets based on Norwegian standards and primarily which are applicable in North Sea India.

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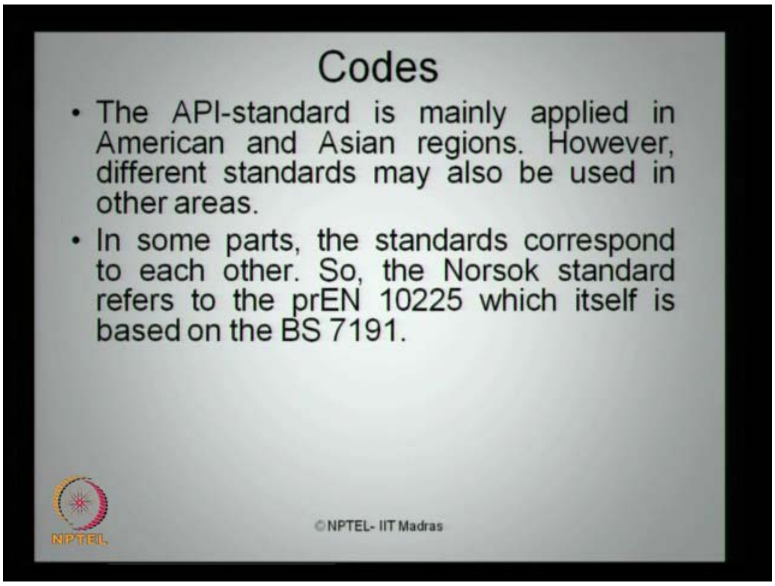

The API- standards is mainly applied in American and Asian regions, however there is no bar that the standards cannot be used in other areas. In some parts the standard corresponds to each other. In some class some specific codal application these standard also match the yield values exactly with each other. So, the Norsok standard refers to prEN 10225 from derivation BS, 7191.

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So, codes can also be used for different regions. Now, how codes actually classifies steel for offshore applications. Remember, I am now looking at classification of steel from the codes for offshore applications, where I am going to apply and the applicability of the member location within a specific structural system.

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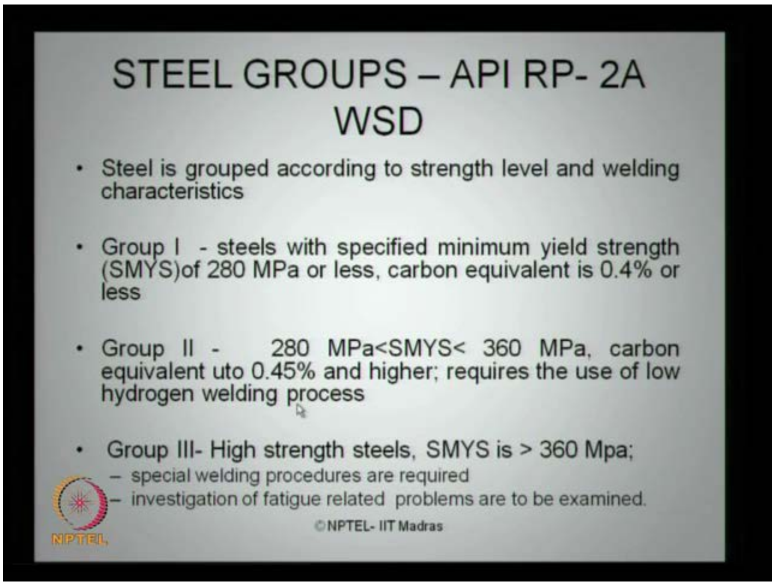

So, if you look at steel group based on API RP- 2A working stage design code, how API RP 2A groups steel. Steel is grouped according to the strength level and welding characteristics, very interestingly not only based on strength, but also weld ability is also seen as one of the important element to group steel for structural application as per American Petroleum Institute recommended practice 2A working state design. If group says group 1, group 2 and group 3; group 1 are steels with minimum yield strength what I called SMYS, specific minimum yield strength of 280 mega Pascal or lesser and carbon equivalency 0.4 percent or lesser because carbon equivalency will guide weld able characteristics of any steel.

If you look at group 2 it varies from 280 to 360, the carbon equivalency is up to 0.45 or higher, it requires the use of low hydrogen welding process. Even the welding process is also guided specifically by this code. If you look at group 3 the high strength steel is having yield value more than 360 mega Pascal special welding procedures for the steel are recommended by the code investigation of failure related problems are mandatory, if you use the steel for design.

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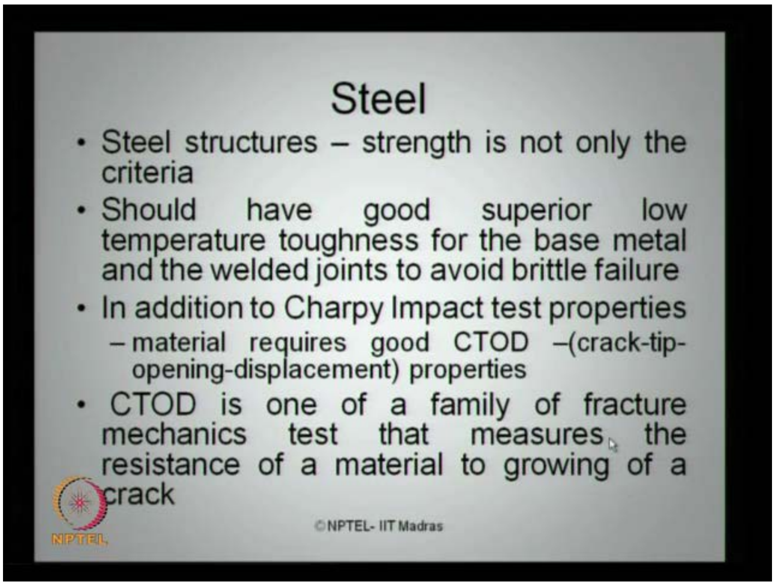

If you look at steel again further, steel structures for designing offshore structural system, strength is not the only criteria remember that, should have a good superior low temperature toughness for the base metal and the welded joins, because this kind of combination with better strength and low temperature toughness will improve its weld ability as well as it avoid brittle failure. In addition to Charpy's impact test properties which are mandatory for steel if you selected on strength basis, material also requires good CTOD, CTOD stands for crack tip opening displacement characteristics they also important for selecting. CTOD is the one of the important family of fracture mechanics test that measure the resistance of the material to growing of a crack.

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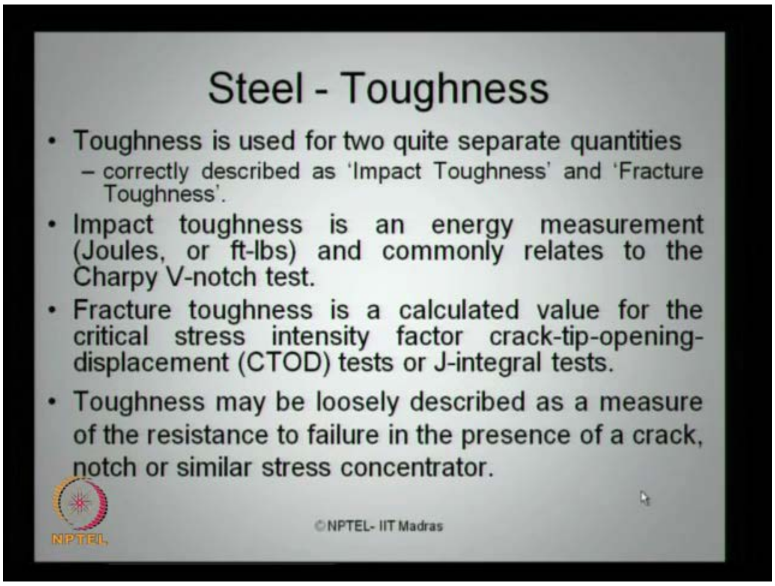

Look at steel toughness; toughness is used to two quite separate quantities; one is what we called impact toughness, other is fracture toughness. Impact toughness is an energy measure in joules and commonly related to Charpy's V-notch test fracture toughness is a calculated value for a critical stress intensity factor crack tip opening displacement test, or J-integral test will qualify this kind of values. So, toughness may be loosely described as a measure of resistance to failure in the presence of crack, notch or similar stress concentrator. So, we must understand that is one of the important requirements for selecting a material for offshore structural systems because we always have a probability of stress concentration occurring at the joins of the members in a given structural system in offshore structural systems.

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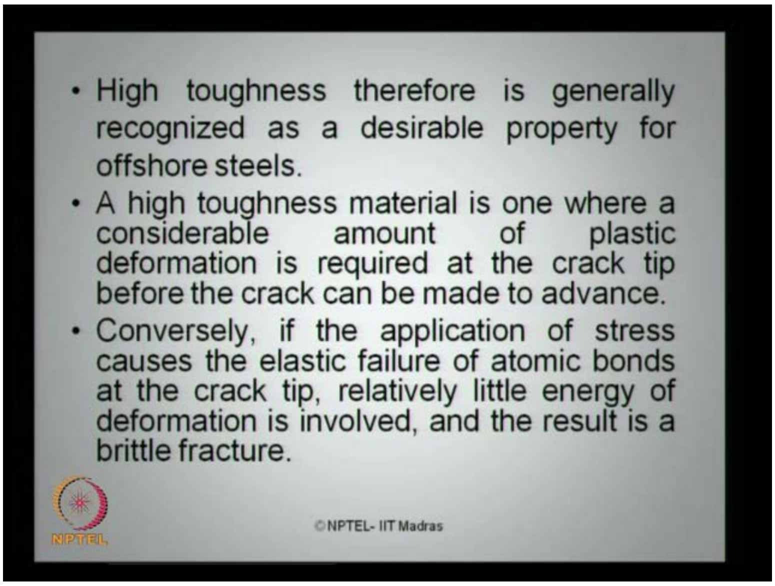

High toughness therefore, is generally recognized as desirable characteristics of offshore steel. High toughness material is one where a considerable amount of plastic deformation is required at the crack tip, before the crack can be made to advance. Conversely, if the application of stress causes an elastic failure of atomic bonds of the crack tip, relatively little energy of deformation is involved and the results in a brittle failure. So, it is very important to understand the CTOD characteristics also as one of the consideration for the selecting material is recommended by API RP.

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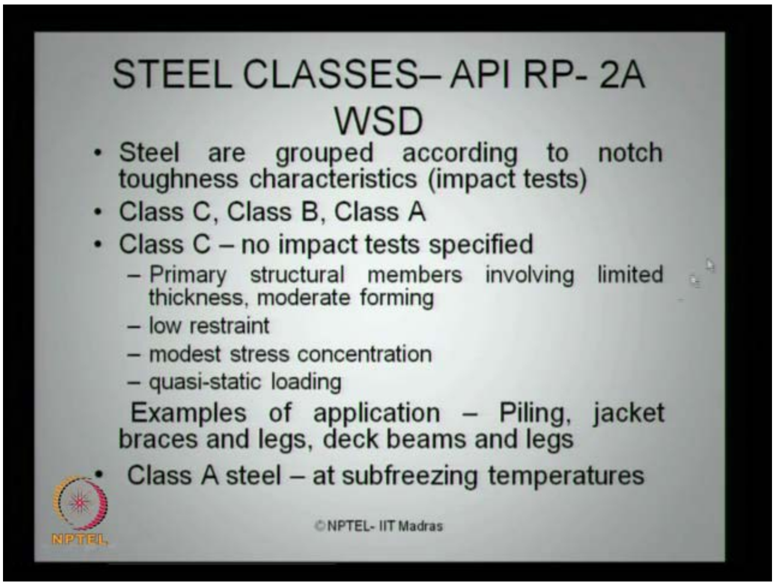

Steel classification based on API RP -2A WSD further says, steel can be grouped based on the notch toughness characteristics from impact test; class C, class B and class A. Class C, no impact test specified primarily structural members involved in limited thickness and moderate forming can use class C, its low restraint, modest stress concentration and quasi static loading are the specific probable areas where these kind of steel can be recommended for offshore application. Examples can be piling, jacket braces, jacket legs, deck beams, and legs of offshore platforms. When you got subfreezing requirement temperature then you must look for class A steel which is recommended for these kind of regional applications.

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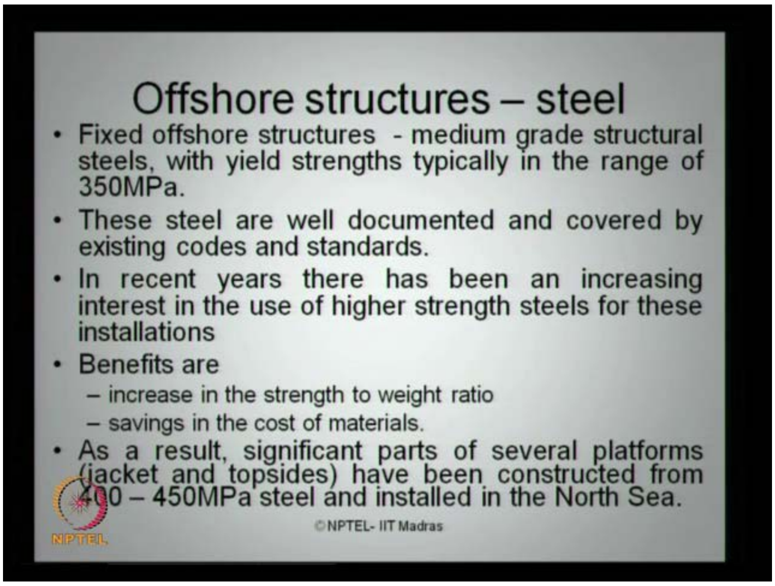

Offshore structural steel can also be recommended based for example, fixed offshore structure, you can use medium grade structural steel with yield strength typically in the range of 350 mega Pascal these steel structures are these steel are well documented and covered by existing standards and codes very well. In recent years there has been an increasing interest of using high strength steels for these installations. The benefits are increased in the strength to weight ratio and saving in cost of material. As a result, significant parts of several platforms for example, jackets and topsides have been constructed using 400 to 450 mega Pascal steel of yield strength which are installed in North Sea.

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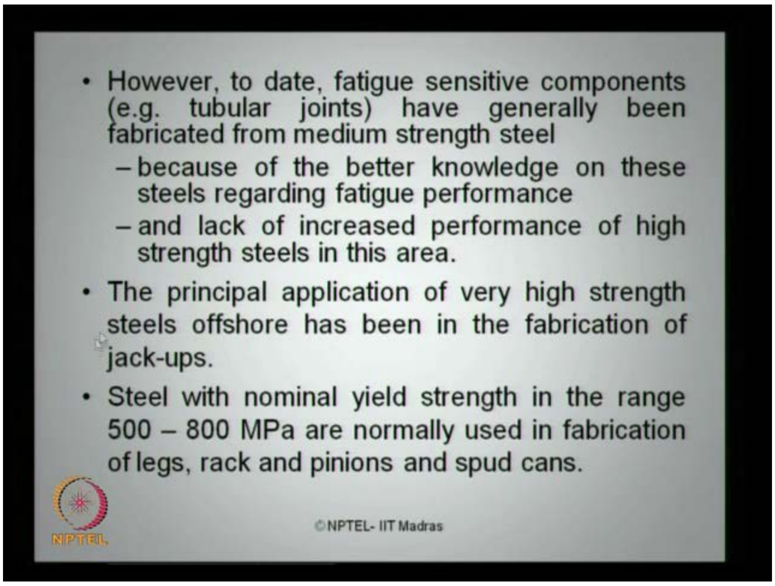

However, to date, fatigue sensitive component example tubular joints have generally been fabricated from medium strength steel because of the better knowledge on these steels, regarding fatigue performance, and lack of increased performance of high strength steels in this area. The principle application of very high strength steels has been in the fabrication of jack ups bricks, steel with nominal yield strength in the range 500-800 mega Pascal have been used in fabrication of legs, rack and pinions and spud cans of jack-up brick.

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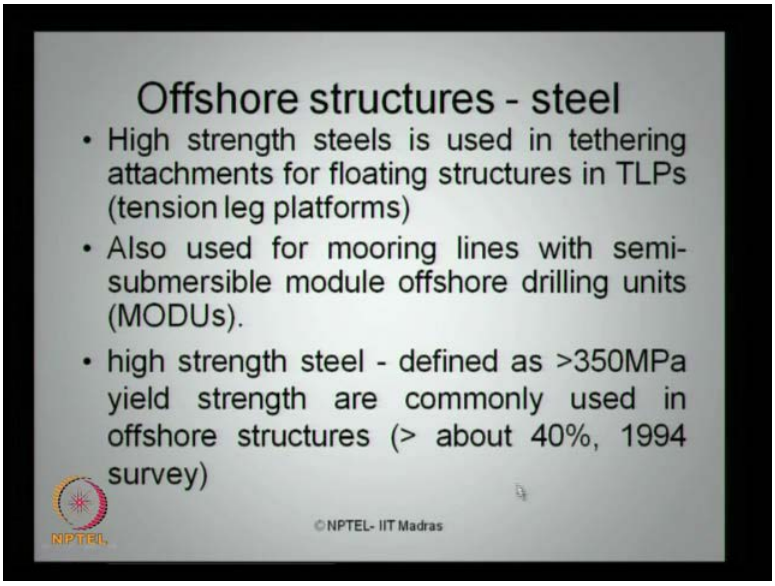

If you look down further high strength steels are used in tethering attachment for floating structures in TLPs, also used for mooring lines with semi-submersible in case of mobile offshore drilling units. High strength steel defined as yield strength more than three fifty mega Pascal are commonly used about 40 percent of offshore structural system use this as per survey shown in 1994.

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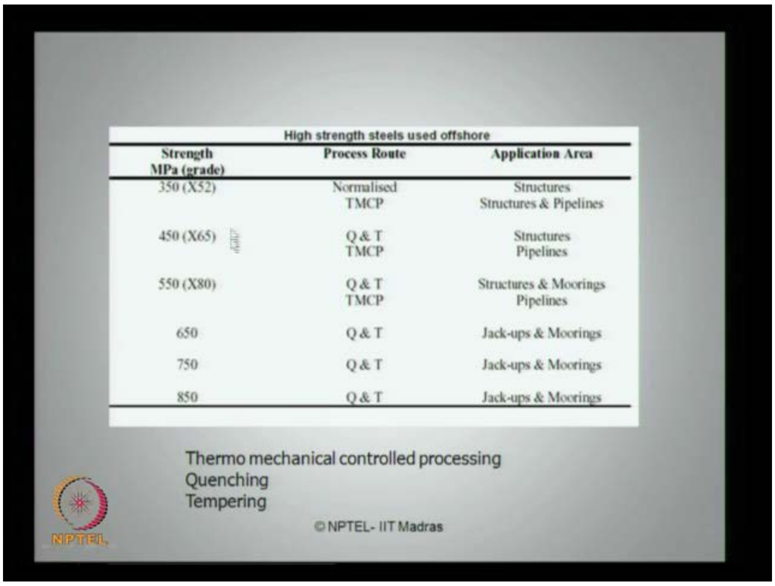

High strength steels used offshore

Strength MPa (grade)	Process Route	Application Area
350 (X52)	Normalised TMCP	Structures Structures & Pipelines
450 (X65)	Q & T TMCP	Structures Pipelines
550 (X80)	Q & T TMCP	Structures & Moorings Pipelines
650	Q & T	Jack-ups & Moorings
750	Q & T	Jack-ups & Moorings
850	Q & T	Jack-ups & Moorings

So, it is a very interesting table which gives me the strength of steel, the process routing, and the application areas. For example, 350 x 52 is a normalized TMCP steel, which is used for structures and pipelines. TMCP stands for thermo, mechanical, controlled processing, Q stands for quenching and T stands for tempering. So, different strength of steel as per the grades is depending upon the process routes, depending upon the application area are shown in the summary here for the benefit of the reader.

Thank you very much.