Technical Textiles
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Lecture - 02
Introduction to Technical Textiles (Contd.,)

Hello everyone, so we will continue with the technical textiles understanding, basic understanding part. Now, what you are discussing in last class was that the fibre properties, what are the basic fibre properties for technical textiles.

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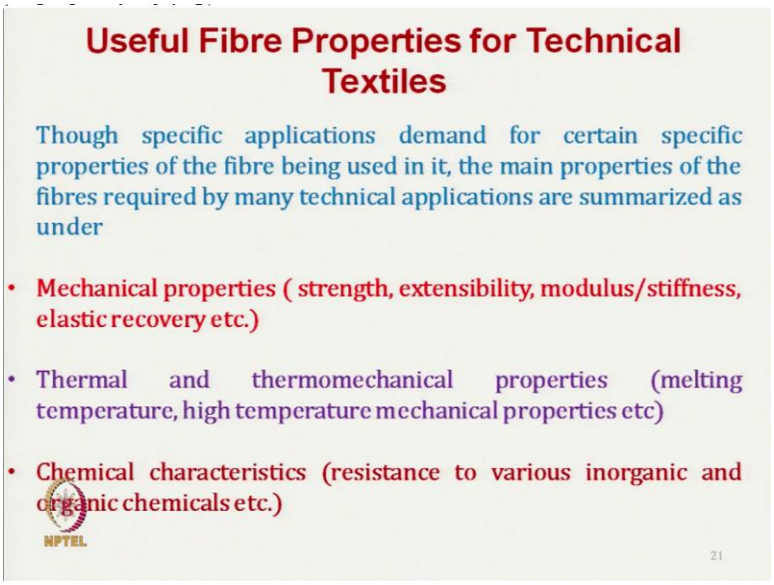

So, although specific technical textiles for the specific application requires certain specific property, but in general the main properties of fibres required by many textile application for the technical uses are mechanical properties. This is the basic property where we need to have better strength; we need to understand the extensibility, modulus and elastic recovery. These are the basic mechanical properties of any technical textile fibres.

We may not require that high strength for apparel textiles, but for technical textiles, we need strength, at least for some specific areas. Then comes thermal and thermo-mechanical properties. In conventional textile, the melting point is not that important but for technical application, particularly high temperature application or composite application, we must know the melting point of fibre.

Depending on that, we should select the areas of application and also most important characteristic is the mechanical property at high temperature. At normal temperatures, some fibres will have higher strength, but at higher temperature, if the mechanical properties deteriorate, we should not use that fibre for the particular application. Next is chemical characteristics, which is very important. Whether the polymer is chemically reactive or chemically inert that decides the areas of application.

So, chemical characteristics, the resistance to various inorganic and organic chemicals are important. Particularly, say for geotextiles, we must use such fibre which are relatively chemically inert like polypropylene, we use for geotextile application where the fibre does not degrade by chemical reaction.

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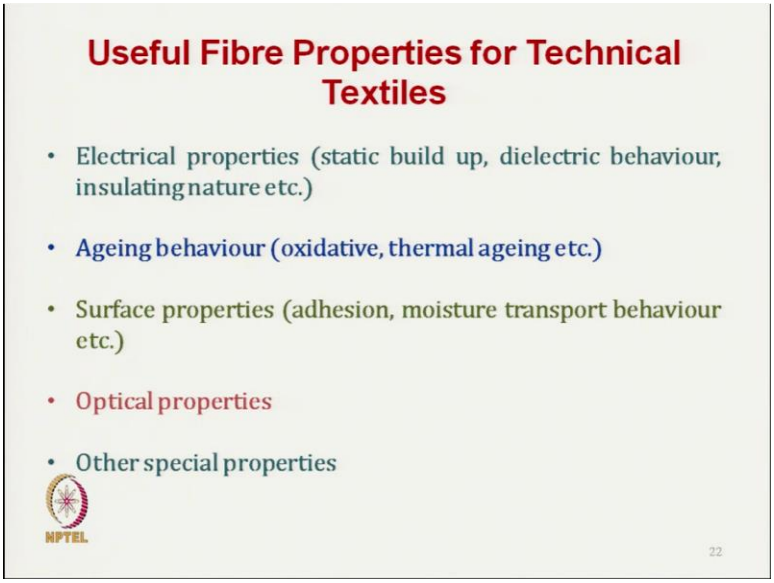

Electrical properties are also very important, like static build up, dielectric behavior. So, the fibre should have insulating nature. Ageing behavior, oxidative or thermal ageing, that we must take into consideration. Surface properties, adhesion, moisture transport behavior, optical properties and there are various special properties which are required for the fibres to be used for technical textiles. So, we must understand, we must characterize the fibre before we select the particular fibre for a specific application.

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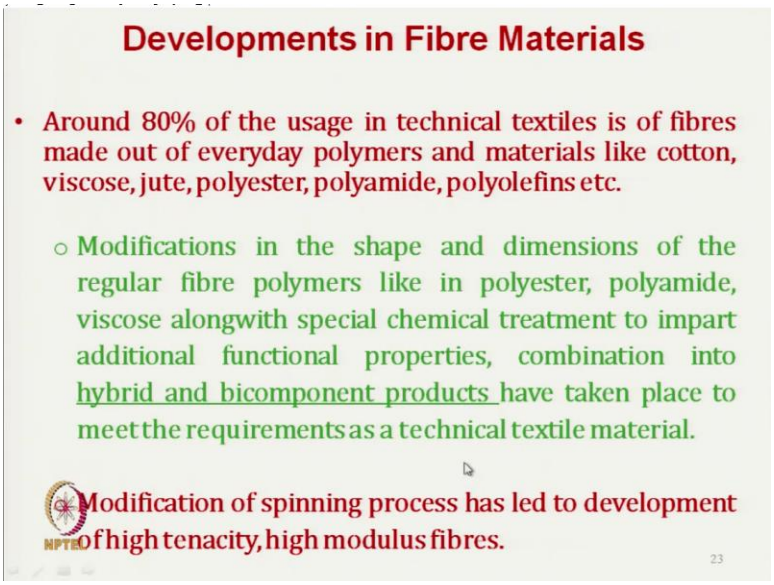

So, if we see at present around 80% of the technical textiles are being used for the normal application where we use everyday polymer and materials, like cotton, viscose, jute, polyester, polyamide, polyolefins. These are used typically around 80% of technical textile application. Rest 20% we use high performance textiles fibre.

And this fibres we some time required to modify, the shape and dimension, like we change the crosss ction of polyester from circular to different shaped polyester fibre for high absorbent application, sports textile, active sports textile we use polyester but not normally circular cross section, various special cross sections are used. Also the same normal polymers, we convert it to hybrid and bicomponent product to be used for technical textile applications. Also the normal polymer if we modify the spinning process, we can achieve high tenacity, high modulus fibre which may be used for technical textile application.

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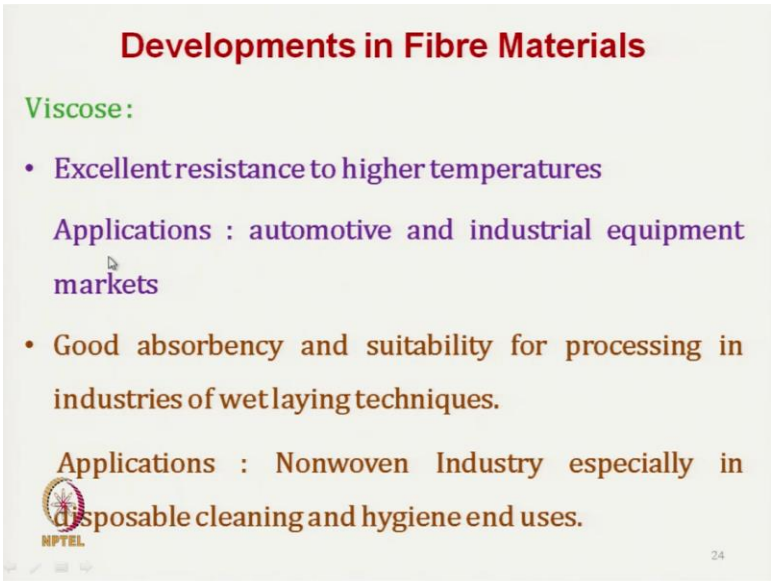

So, if we talk about the normal fibres like viscose, it is used for technical textile application due to its excellent resistance to high temperature. So, where we require this high temperature resistance characteristic we may select viscose. Like in automotive and industrial equipment market, we use viscose fibre, it has good absorbency, suitability for processing in industries of wet laying technique. So, viscose fibre is used for wet laying nonwovens due to its good absorbency characteristics. The applications are nonwoven industry, especially in disposable cleaning and hygiene end uses where we need absorbency characteristics.

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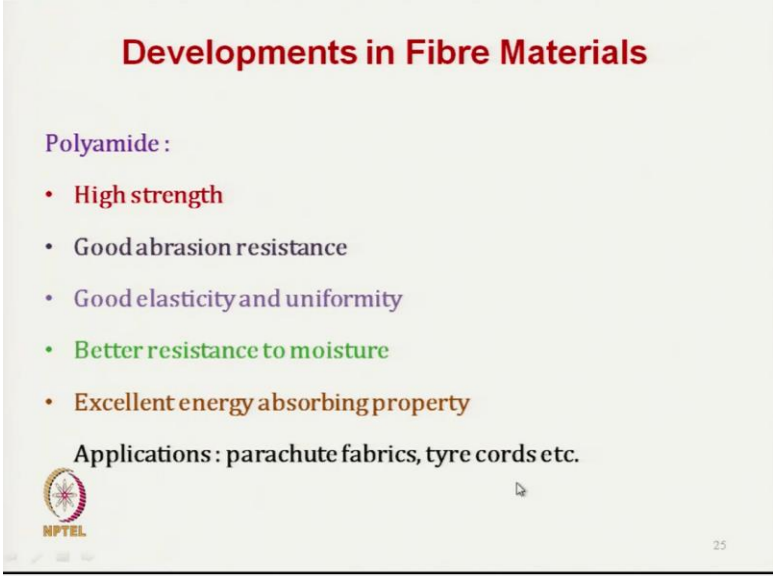

Then polyamide fibres, polyamide has high strength, very good abrasion resistance. So, the applications where good abrasion resistance is required the polyamide fibres are being used. It

has good elastic recovery, elasticity and uniformity is good, better resistance to moisture, excellent energy absorbing property, that is higher work of rupture. So, this characteristic, higher work of rupture, due to these characteristics the polyamide fibres are used for rope. The applications are parachute fabric, tyre cords fabric.

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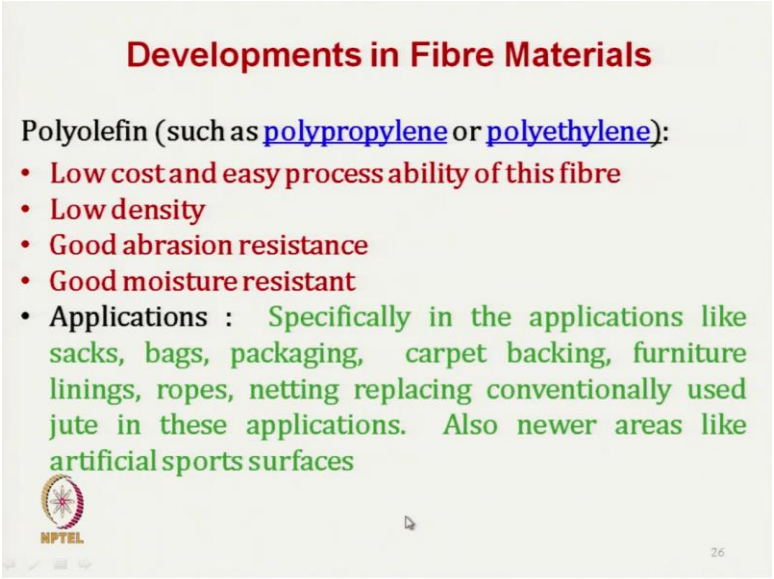

Polyolefin like polypropylene, polyethylene, these fibres, they have low cost, easy process ability, lighter in weight due to lower density, good abrasion resistance, good moisture resistant. So, their moisture absorption properties good that means they have almost 0 moisture absorption property. Polypropylene has got almost 0 moisture absorption property. These characteristics we use for technical textile application.

Due to its surface characteristics it wicks liquid particularly water at very faster rate. The applications of polyolefin fibres are sacks, packages, bags due to the high abrasion resistance, carpet backing, furniture lining, ropes, netting. So, the all these applications are there and the newer application areas like artificial sports surface.

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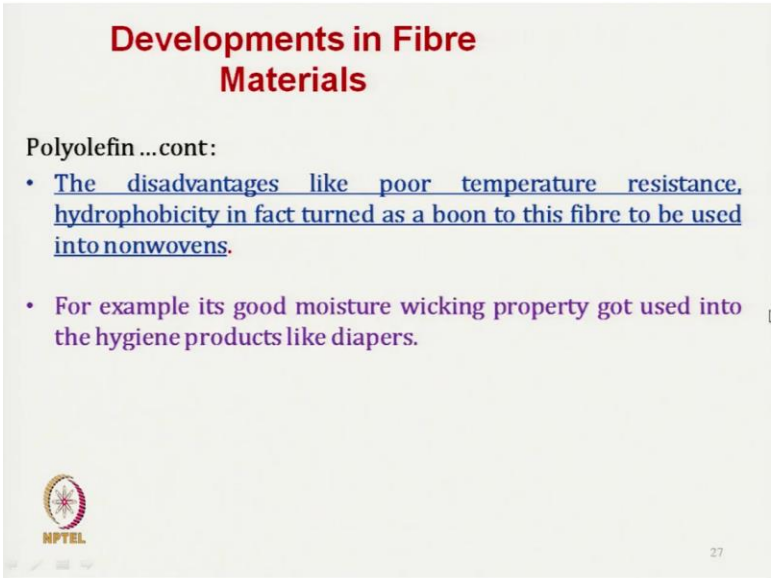

The disadvantage of polyolefin fibres were basically earlier it was thought that they have poor temperature resistance because of their lower melting point, and they are hydrophobic in nature. But these disadvantages, apparent disadvantages are being used as positive point in technical textile manufacturing like nonwovens. Melt blown or spunbonded nonwovens are easily manufactured from due to its lower melting point.

It has good moisture wicking properties which help it is use in the hygiene products. Like diapers and napkins where we need very fast moisture transport characteristics, keeping the skin dry as it does not absorb moisture. It is hydrophobic in nature, but at the same time it wicks very quickly. Now, let us see this polypropylene, suppose this is the fabric made of polypropylene and here it is a human skin and for diaper application.

So, inner layer which is in contact with the human body where liquid is generated due to its very high wicking characteristics, this liquid is being transported to inner core, there are inner layers leaving this skin entirely dry, so this skin become dry, at the same time as this fibre does not absorb moisture, so there would not be any water accumulation in this surface though, so the person will feel comfortable. So, this characteristic is very important for hygiene product. As I mentioned, that lower extrusion temperature made it suitable material for technologies like spunbonding and melt blowing, so to reduce the energy cost.

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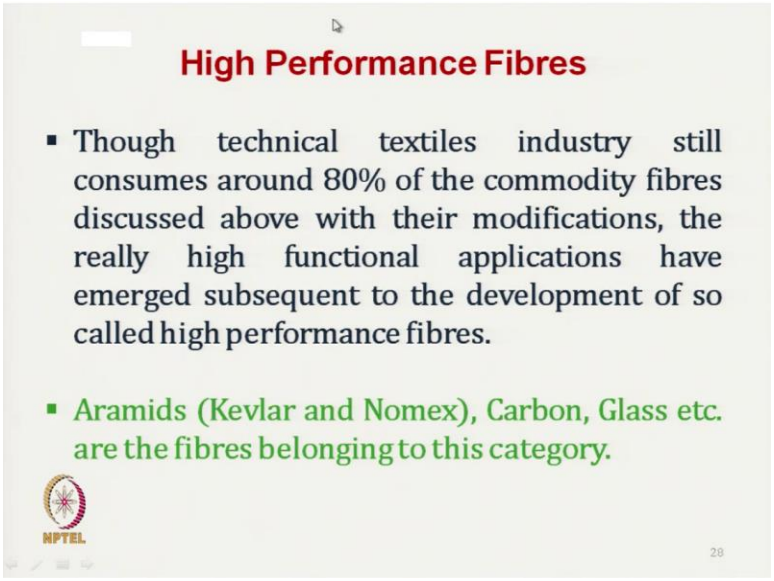

Apart from the normal fibre, high performance fibres are also being used. So, though technical textiles industry still consume 80% of commodity fibres that I have already mentioned. The really high functional application requires high performance fibre, there we cannot use commodity fibres. So, some of the fibres are like Aramid fibres, Meta or Para aramid fibres, Carbon, Glass fibres, these are coming under high performance fibres, used for technical textiles for very specific application where we cannot use commodity fibres.

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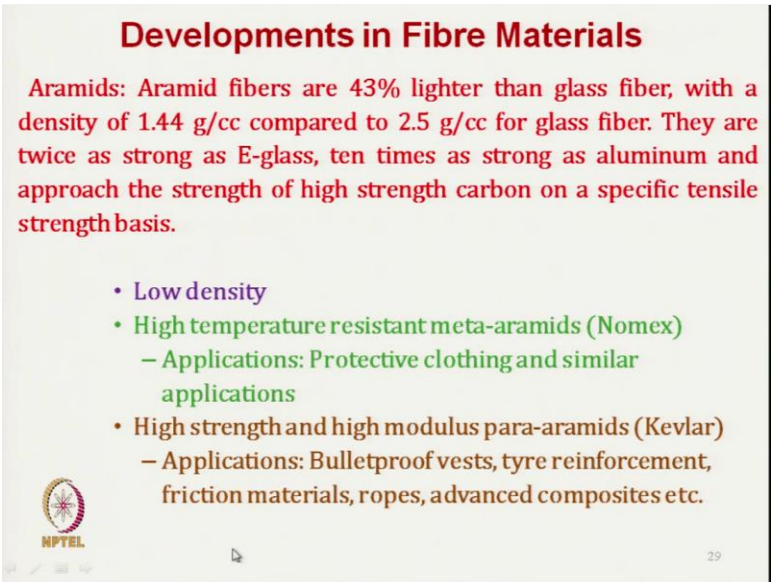

The aramid fibres, they have special characteristics, they are lighter like 43% lighter than glass fibre with a density of 1.44 gram per cc, as compared to 2.5 gram per cc for glass fibre, with very high strength. They are twice as strong as E-glass, 10 times as strong as aluminum and

approaches the strength of high strength carbon on a specific tensile strength basis. So, these fibres are very strong fibre, they have low density, high temperature resistant particularly meta aramid fibres are high temperature resistant.

Nomex is a fibre, produced by DuPont, their applications are protective clothing and similar high temperature application. High strength and high modulus para-aramids like for example Kevlar these are used for bulletproof vests, tyre reinforcement, ropes. So, the high strength and high modulus fibres are used in this area. So, these specific requirements, specific characteristics are not present in commodity fibres.

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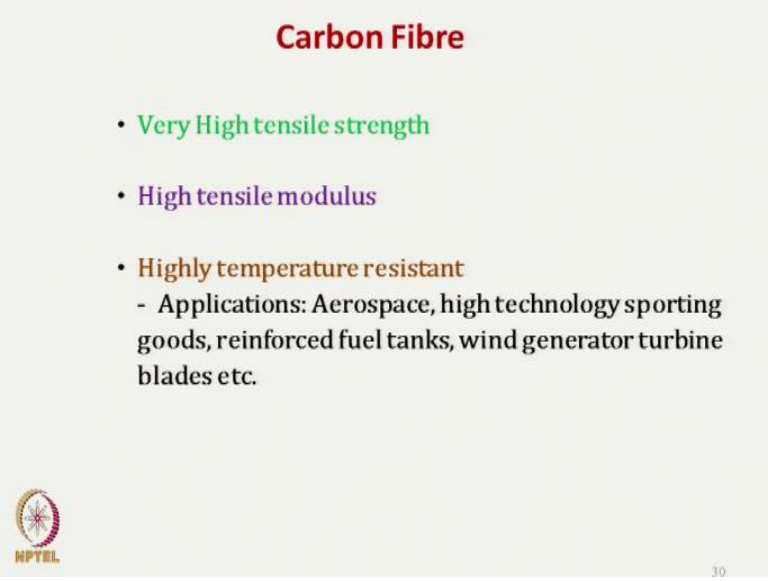

Next fibre is that carbon fibre. It has very high tensile strength, very high tensile modulus, high temperature resistance. Due to all these characteristics they are used in aerospace, high technology sports goods, reinforcement in fuel tank, wind generator, wind turbine, so, turbine blades. So, they are reinforced by carbon fibre.

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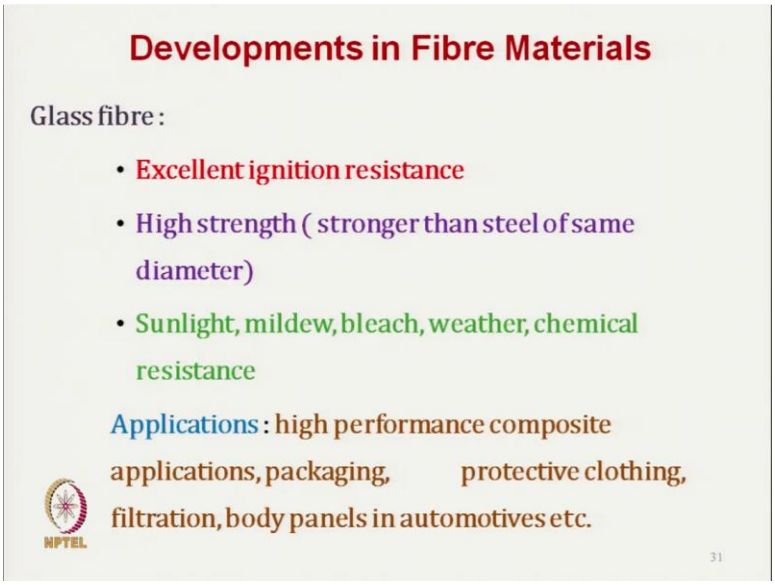

So, the developments in fibre materials are to continue with then it is a glass fibre. It has got excellent ignition resistance. So, we can use in high temperature application, very high strength stronger than steel with the same diameter, it is sunlight, mildew, bleach, weather, chemical resistance. So, we can use all in all these applications where sunlight degradation, degradation due to mildew, bleaching, weathering, chemical. So, are there the applications areas are high performance composite, packaging, protective clothing, filtration, mainly high temperature filtration, so, body panels in automotive. So, all these area we can use glass fibres.

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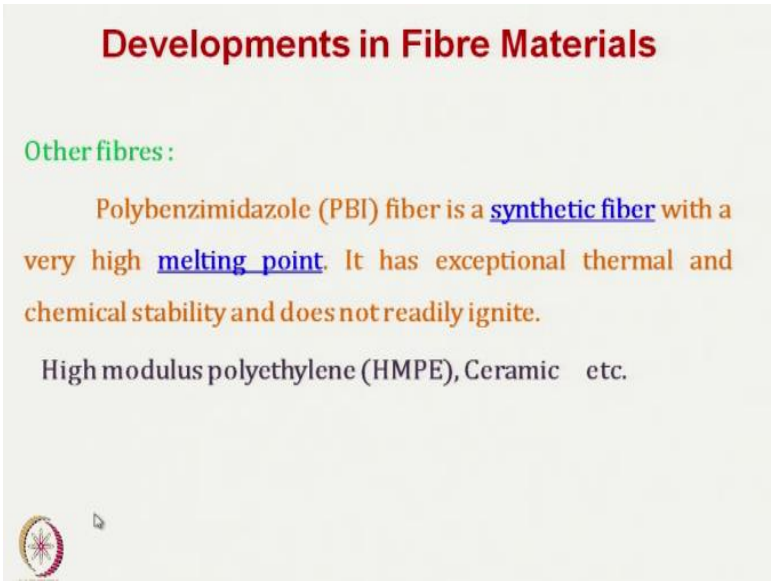

The other fibres are, PBI fibre which is a synthetic fibre with very high melting point, it has exceptional thermal and chemical stability and it does not really ignite. So, these are the fibres which are used for very specific technical textile application. So, PBI is used for firefighter clothing, it has got the other fibre is that ceramic fibre, high modulus polyethylene fibres.

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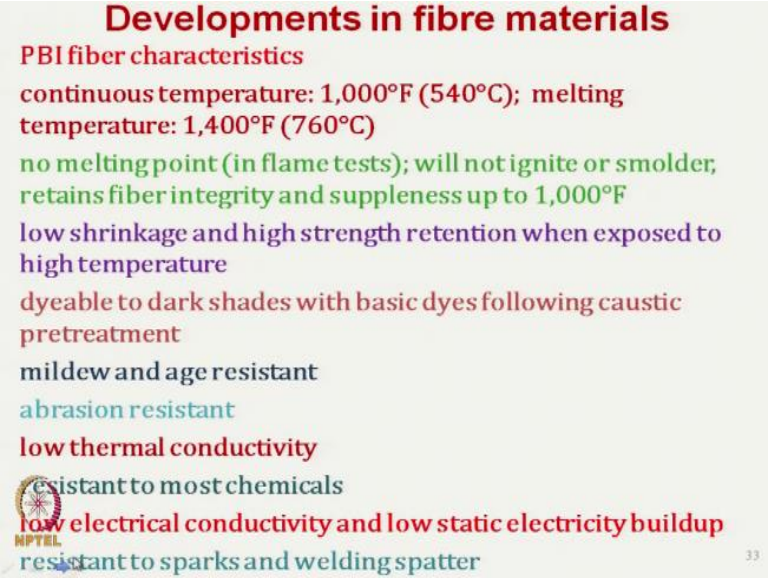

So, PBI fibres, their basic characteristics are it is stable at very high temperature like around 1000 degree Fahrenheit continuous temperature exposure, it is stable and it is melting temperature is around 1400 degrees Fahrenheit. No specific melting point up to 1000 degrees Fahrenheit, will not ignite, retain fibre integrity. It has low shrinkage, high strength tension when exposed to high temperature. It is dyeable. So, we can dye the fibre easily with the basic dye. Mildew and age resistant, abrasion resistant, low thermal conductivity.

And it is resistant to most of the chemicals and it has low electrical conductivity, low static electricity buildup and resistant to sparks and welding spatter. So this fabric that is why this PBI fibres are used for welders clothing.

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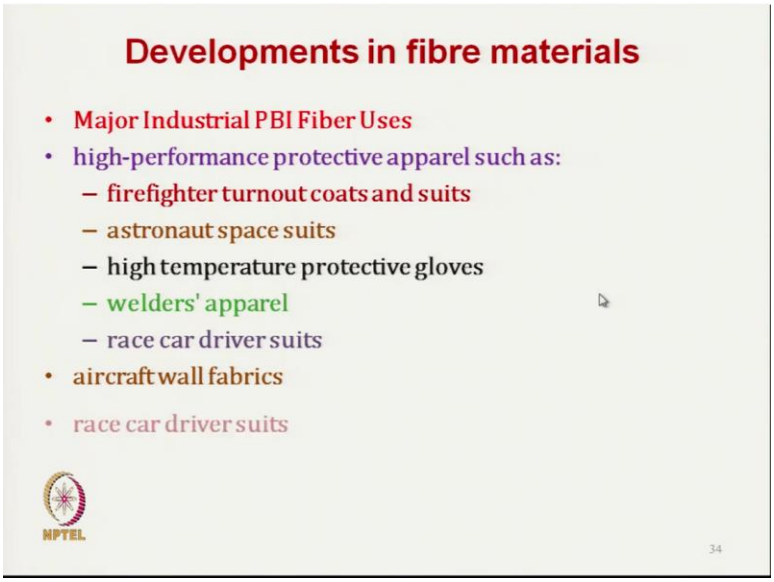

So the major industrial applications are high performance protective apparel such as firefighter cloth, astronaut suit, high temperature protective gloves, welders apparel as I mentioned, race car driver suit, aircraft wall fabrics. So, these are the applications of the PBI fibres.

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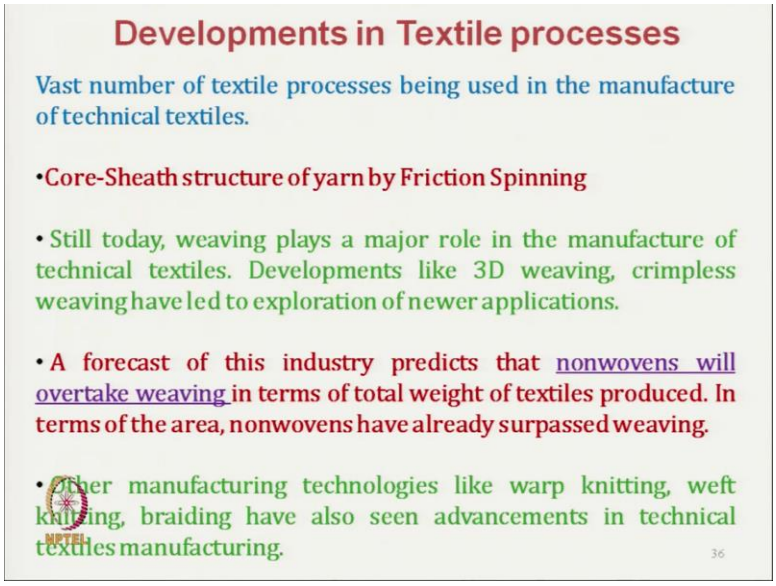

Now, we will discuss the textile processes. So, after fibre, we have to now modify the textile processes for technical textiles, we have to reorient the conventional textile process towards the technical textile manufacturing processes. There are different processes being applied for yarn manufacturing, core-sheath structure of yarn, which is by friction spinning is widely used for technical applications.

So, core-sheath yarns are not normally used for apparel application where these are used for technical applications. As far as fabrics are concerned, weaving still plays a major role in manufacturing of technical textiles with modification also. So, 3D weaving, crimpless weaving. So, they have been modified normal weaving has been modified to these areas for newer applications.

It has been forecasted that nonwoven will overtake weaving in terms of total weight, because nonwoven has got their versatile characteristics apart from weaving and nonwoven, other applications are manufacturing techniques are knitting, both warp and weft knitting although warp knittings are majorly usually used for technical application. Braiding is also one area which is used for technical textile manufacturing.

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Now, I will discuss the applications of technical textiles. The areas where applications are the transportation textiles these are the textiles where they are used for cars, lorries, buses, trains, ships, aerospace. So any transportation where these textiles are used are termed as transportation textiles. It is the largest end use applications of technical textiles. Around 20% of technical textiles are used in transportation industry.

Where the carpets of cars, buses, trains, aerospace, carpets, seat covers, tyres, belts, safety belts, airbags, filters, composite reinforcement. So all these areas it is for composite body where

technical textiles are used. So advantage of using such technical textiles in automobiles are mainly it is reduction in weight, which actually in terms enhance the fuel efficiency, longer life of protect this technical textiles used in transportation industries.

Flexibility in design, we can change the design easily, which is not possible for other products, like the inner lining of car, for sound insulation. We can easily mold depending on the dimension or design of the car or carpet. So, flexibility in designing is there and we can produce quickly. So, due to all these advantages technical textiles are largely used in transportation area.

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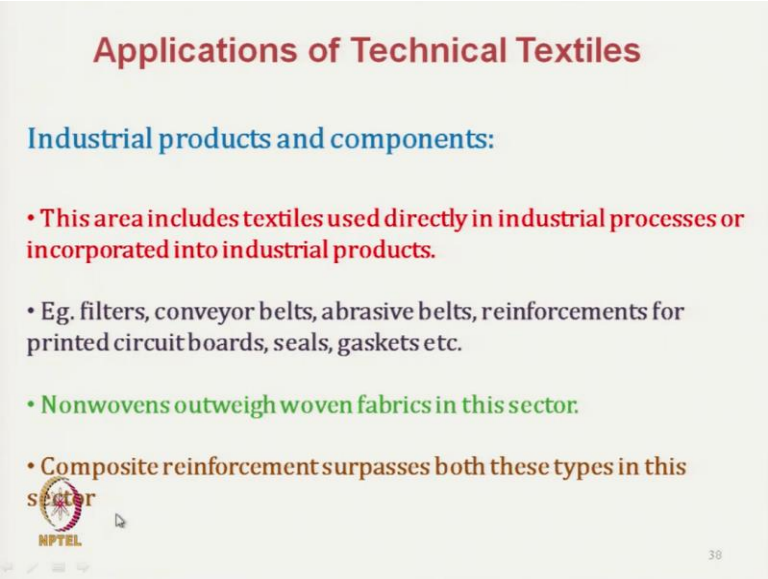

Next area is that industrial products and components. These technical textiles are used for basically industry like filter, conveyor belts, abrasive belts, reinforcement for printed circuit board, seal gaskets, these are all textile products used in industry. Nonwovens normally it is actually taking over the woven fabrics in these areas. Composite reinforcement surpasses both the types of sectors like composites are used now a days industrial application.

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In medical and hygiene textiles, these are the high volume but low cost product. There are 2 types of application one is a high volume, low cost product and other is very specific very high, very expensive product. As far as hygiene textiles are concerned they are high volume, but low value product like wipes, baby diapers, adult sanitary and incontinence, these are nonwovens are dominated.

And on the other hand, there are technical textile product we used in medical and hygiene application which are very expensive, high value but used in small quantity. These are basically medical and surgical products like operating gowns, drapes, sterilization packs, dressings, sutures, orthopedic pads; these are actually used in small quantity. There is another area where the products are highly specialized and very expensive of highest value products are artificial ligaments, veins, arteries, skin replacement. So these are the areas where technical textile products are used for this specific application.

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In home textiles also use technical products. So, main application of technical textile in home textile area is wadding and fibrefill application. Hollow fibres with excellent insulating properties in bedding and sleeping bags are being used. Foams are being replaced by technical textile product due to the health concern. Woven and nonwoven fabrics are used for carpet and furniture backing. Dry-laid and hydro-entangled products are used for household cleaning application. So, these are the technical textile products used for home textiles.

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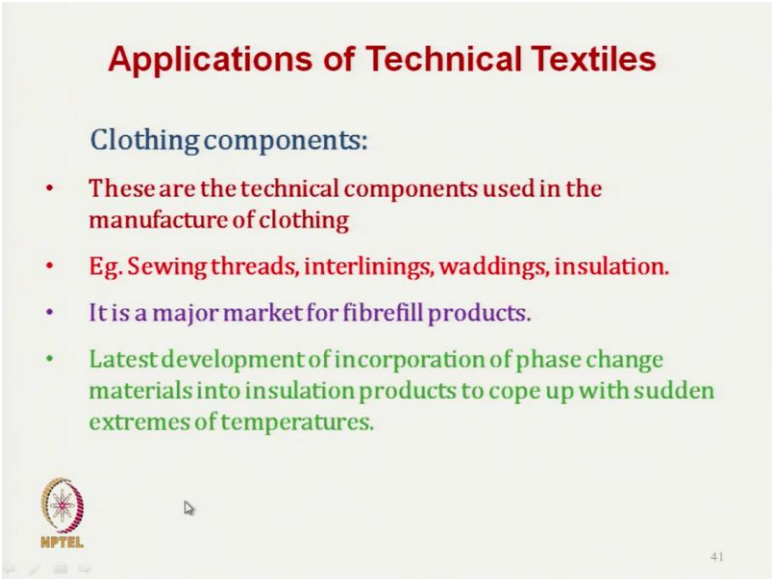

Clothing components in clothing components apart for normal from normal textile, we use technical textile products like sewing threads, interlinings, insulation, waddings, these are technical textile products used in clothing components. Fibre fill products. And latest

development of incorporation of phase change materials into insulation product to cope up with sudden extreme change in temperature. So, the phase change materials which are technical textile products are being used as clothing component.

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In fishing industry, we use technical textiles like nets, ropes and lines, we use technical textiles. High modulus polyethylene being used for lightweight, ultra strong. So the polyethylene being used for nets due to its lightweight and low absorption. In agriculture and horticulture we use technical textiles in wide areas, like covering and protection and containment application.

Like conventionally we use heavy weight textile like jute, sisal are replaced with the lightweight materials like polyethylene, polypropylene. Lightweight spunbonded fleece used for shedding, thermal insulation and weed suppression. Basically, where weeds are coming along with the actual plants, if we cover the area with this type of fabric shedding, keeping the other zone ready for the plants, so, weed will get suppressed and effectively this will die.

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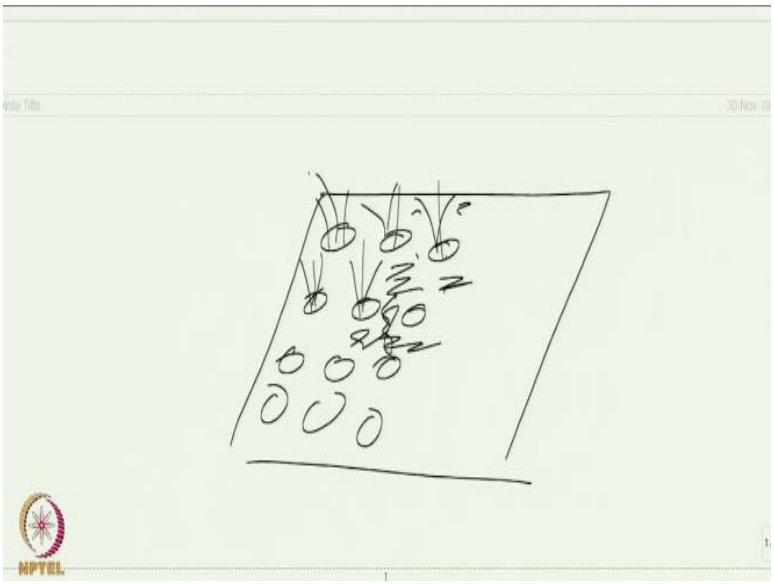

Like if we see, this is the field and if we cover the field with weed suppression technical textile the fabric will have holes, with specific area where we want the plants to grow these are the required area where plants are growing but, remaining all these areas we do not want any weed to grow. So if we covered this area with this type of cloth, so weed will automatically die. So this area is being used. And heavier nonwoven, woven and knitted structures are used for wind and hail protection.

Another area where nonwoven technical textiles are used in agriculture it is called, pre-seeded nonwoven where nonwoven fabric within the structure already it is pre-seeded, seed has been actually incorporated within the structure. Now, that total nonwoven mat is laid on the surface and this nonwoven fabrics are generally it is a biodegradable natural fibres like jute nonwoven being used and with the time from the seed plants will grow and the fabric will get degraded. So, that is one area of technical textile. Capillary nonwoven mats which are used to distribute moisture to the growing plant.

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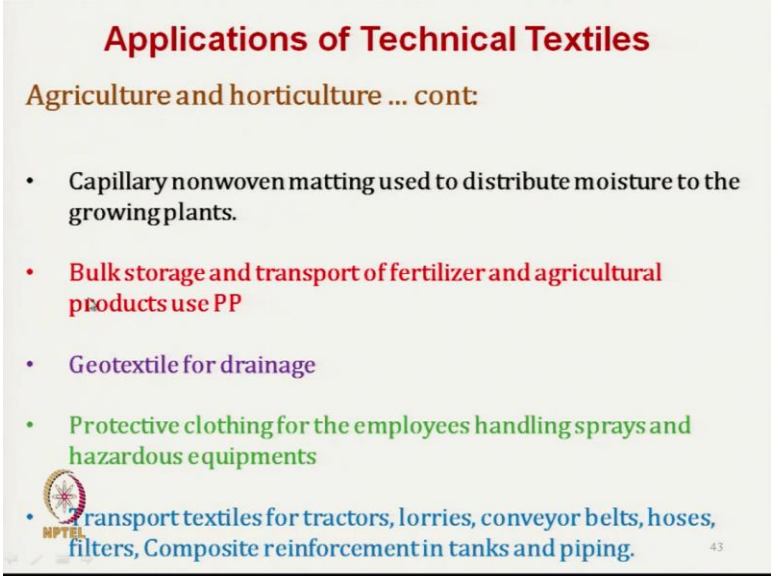

So, nonwoven mats, capillary mats are used to moisten the plants. Bulk storage and transport of fertilizer and agricultural product where polypropylene are used like bags, sacks where polypropylene are used for transportation and storage of fertilizer. Geotextile for drainage so we use for drainage. Protective clothing for employees handling the spraying and hazardous equipment so that protective textiles are being used where the employees are being protected from the harmful chemicals.

Maybe mask, maybe gowns we use. Transport textiles for tractors, lorries, conveyors, belts, hoses, composite reinforcement these are actually comes under transport textiles but used in agricultural applications.

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Next application is construction of building and roofing. The application areas are permanent construction like dam, tunnels, bridges where we use geotextiles or fibre reinforced concrete. Temporary structures like tents, awnings are used where textile structures are used for this building on and the roofing. In architectural area, the architectural membranes are being used, predominantly it is mainly used in sports stadia, exhibition centre, modern buildings.

Nonwoven glass and polyester fabrics widely used in roofing. So glass nonwovens and polyester they are widely used in roofing mainly for insulation purpose. Some breathable membranes are also used for moisture penetration of wall. These acts as building and equipment insulation. So all this nonwovens and this membranes they act as insulation materials. So double wall spacer fabrics filled with suitable material provide thermal and sound insulation. So, this spacer fabrics are used for sound insulation of a building.

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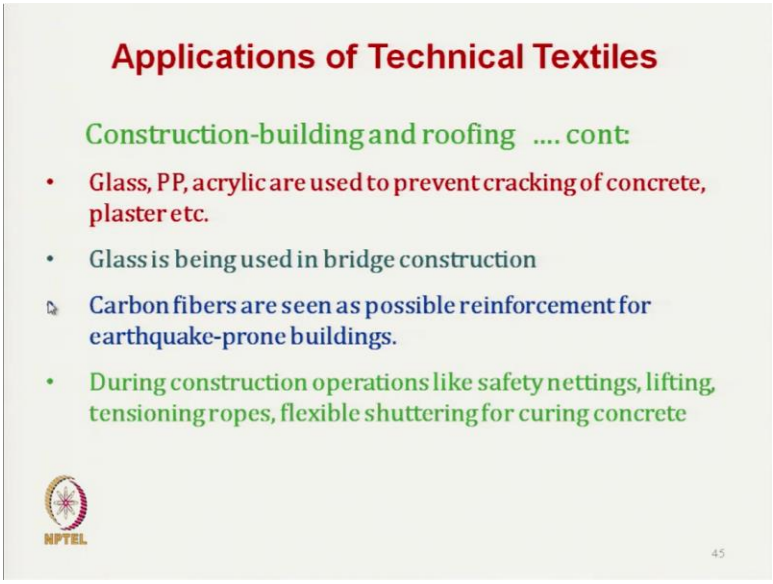

Glass, polypropylene, acrylic, they are used for preventing the cracks in concrete or plasters. So, that is a fibre reinforced concrete are being used to prevent the cracks. Glass is being used for bridge construction. Carbon fibres are used for earthquake prone building due to its very high strength it gives reinforcement with lightweight. And during construction, we use technical textiles in the area of safety nettings, lifting, tensioning ropes, flexible structure. So, for curing the concrete so these are the areas where technical textiles are used.

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In packaging and containment area, so it is bags of cotton, jute, flax and gradually this cotton, jute, flax, this packaging materials are being replaced by polypropylene due to its higher strength, lower moisture regain and relatively inert chemical nature. Lightweight nonwoven and

knitted structures are being used for wrapping and protecting products, mainly in food industry. Wet laid nonwoven fabrics are used for tea and coffee bags.

Meats, vegetable, fruits are packed with a nonwoven insert, to absorb liquid present in the product. Strong light weight spunbonded nonwovens are used for courier envelopes. So for envelopes used in courier purpose, we will see that we use spunbonded nonwovens because it is strong and lightweight. So, woven straps are now a days is being used and it is replacing the steel bands due to the environmental concern and due to its flexibility.

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In sports and leisure area the performance clothing and footwears are being used due to their lighter weight, higher stretchability. Artificial turfs in sports surface, like many sports will see that artificial turfs are being used. Carbon fibre reinforced composites are used for racket frames, golf clubs, fishing rods, cycle frames these are the areas. Balloon fabrics, parachute, paraglider fabrics, sailcloth are used for sports. These are the very specific area of technical textiles.

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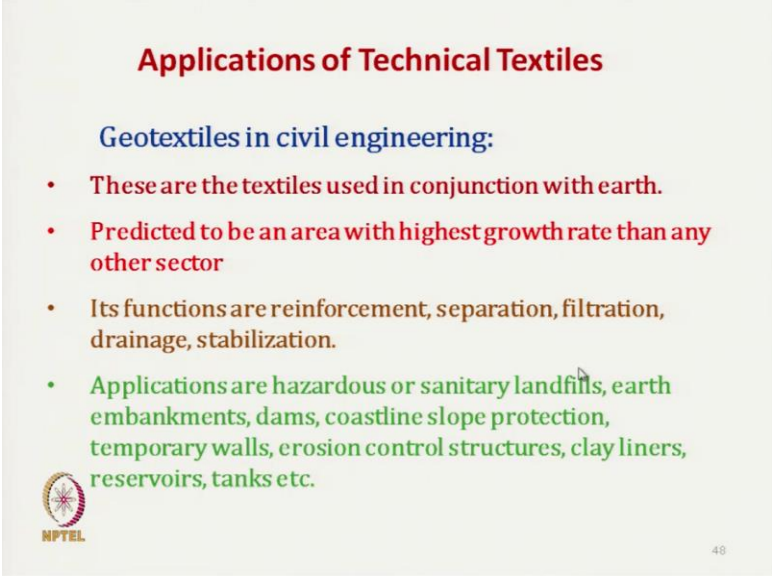

Geotextiles are used in civil engineering construction for their different applications. These textiles are used in conjunction with the earth for reinforcement or drainage or different other applications, we will discuss in that segment. So, this area is predicted to be at most promising. So, the main use is the functions are reinforcement, separation, filtration, drainage, stabilization of earth. These are the different applications dams, temporary wall, erosion control. So, these are different application.

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Protective and safety clothing area, new generation high performance fibres like aramid are used in this sector. So, they have various specific applications depending on the requirement. So, that I have already mentioned like fire protection, ballistic protection, chemical protection. So, these

are the different application areas and sensitive instruments are protected. For that we need electromagnetic shielding clothing to protect instruments, electronic gadgets.

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Ecological protection is also one area where technical textiles are important. These are used for protection of environment and ecology. In fact, this area overlaps many other areas like industry, industrial textile, geotextiles, agricultural textiles. So if we see these industrial textiles like your filter fabric, it is coming under ecological protection. Geotextiles, if we protect the soil, we are actually protecting the ecology. So like that it is overlapping.

So, we can say the textile can contribute in every sphere of their use like by reducing weight in transport and construction, thereby saving materials and energy. So, as far as ecology is concerned, if we use textile product, we are reducing the mass. At the same time we are reducing the energy. So, indirectly we are protecting the ecology. So, that is all about basic introduction of technical textile. We have understood the application areas, different types of fibres and from next class; we will start the specific area, we will start with the fibre reinforced composite. Till then thank you.