

Technical Textiles
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Lecture No- 34
Automotive Textiles

Hello everyone, our today's topic is automotive textiles. Today we will discuss how textiles are used in automotive industries, what are the different types of fibers used in automotive textiles. There are various areas where we can use textile materials in automotive applications. So each application will require specific fiber and fabric characteristics. All these things will discuss here.

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- **Technical textiles that are used in this automotive or transport sector are called "MOBILTECH".**
- **Mobiltech today covers not only isolation and safety aspect but also focuses on comfort and style.**
- **Customers Attraction-Aesthetically pleasing interiors, Great comfort, Fuel economy.**
- **Today vehicles are not a vehicles but, has become the living room and office as people invest most of their time in it.**
- **Textiles contributes to about 25-30 kg per car.**

So automotive textiles are technical textiles that are basically used automotive or transport sector and these are classified as MOBILTECH. So MOBILTECH today covers, not only the isolation and safety aspects but also focus on the comfort and style. So, although for comfort and style we do not require any technical qualities but as these are used in automotive, so we can use we can target this fabrics as the technical textiles.


So here basically aesthetically pleasing interiors are in the car or any automobile. Today's vehicles are not the vehicles, but some living room. So that is why the interiors are also important, if we see total usage of textile materials, it is typically around 25 to 30 kg's per car. In

one car, so total textile materials uses 25 to 30 kgs in different components. So here we will discuss what are the components? Where we can use this textile material and what are their special purpose applications.

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Growth of automobile textiles-

- **Improvement in the standard of living of people resulting in the greater demand for personal vehicles.**
- **A car interior has become more and more important as people are spending more time in cars.**
- **For better fuel economy, the trend is towards lightweight vehicles replacing metal by fiber composites in most of the applications.**



So as far as growth of automobiles textile is concerned. Because due to the improvement in the standard of living of people, people are trying to buy their personal vehicle, a car interior has become more and more important as people are spending more time in the car, so interior is very important; like the carpet, the seat covers and for better fuel economy, we have to use lighter weight, so if we reduce the weight of the car, so it will be fuel economy will be there.

So the heavier metal parts are replaced by fiber reinforced composite to reduce the total weight of the vehicle.

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Growth of automobile textiles-

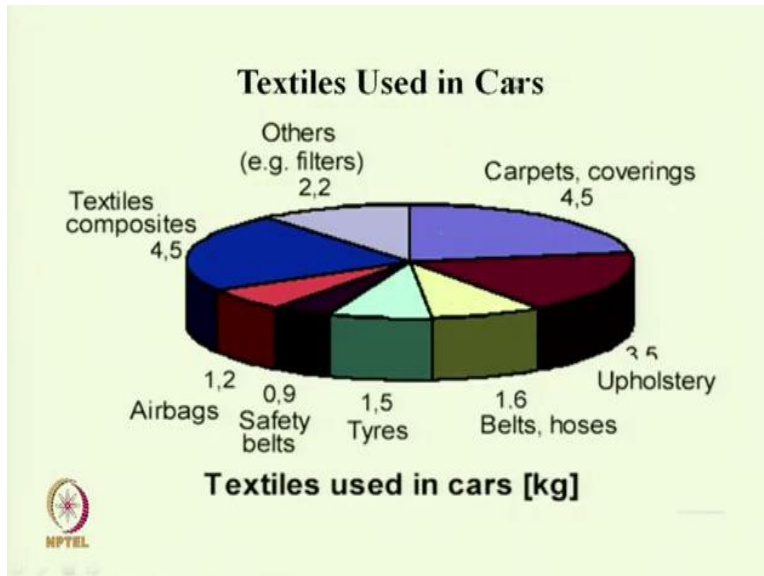
- **More safety devices in the vehicles in the form of air bags and seat belts.**
- **Ecological reforms for recycling of used cars have increased the amount of textiles in an automobile.**
- **Apart from interiors and safety, textiles have also come up with the solution to engineering problems such as Tyre reinforcement, acoustics protection, gas and air filtration.**



More safety devices in the vehicle are there in the form of say air bags and seat belts, they are the examples of technical textiles, automotive textiles. So air bags are nowadays, very common for the private cars and seat belts are typically required to protect ourselves and it is a statutory requirement to have seat belts, so ecological reforms for recycling of used car have increased, that is why the textile based composites are used particularly thermoplastic matrix.

So that they can be recycled again. Apart from the interiors and safety textiles have also come up with the solution of engineering problem; like tyre reinforcement, acoustics problem and gas and air filtration. So for tyre reinforcement the textile materials are used, gas and air filters, so textile based gas filter and air filters are used. Even the liquid filters made up the textile based nonwoven based materials are used.

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Now different areas where textiles are used in a car in terms of mass the weight in terms of kg. The upholstery around 3.5 kg it is a rough estimation. Belts and hoses its 1.6 kg tyre; in the tyre 1.5 kg is used, safety belt 0.9 kg, airbags 1.2 kg, textile composite 4.5 kg that can always be increased when we try to replace the body of car total entire body of the car with the textile composites. So other material like filters 2.2 kg carpets 4.5 kg.

If we take together this will become around 25 to 30 kg, so this is the total, average actually approximate mass, o why do we need textiles in automobiles? This is due to a high strength and light weight.

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Why Textile?

- High Strength & light Weight
- Finding new filtration system
- Safer than metallic parts
- Attractive
- Improving cost effectiveness



Durability

So that is the unique characteristics of textile the specific strength is very high so in automobiles some applications, we need high strength and lighter weight is required for fuel efficiency. Textile based filters will have high filtration efficiency with low pressure drop and safer than metallic parts. We can make the interior more attractive, cost effective and durability, so the due to all these reasons we use textile materials in automobiles.

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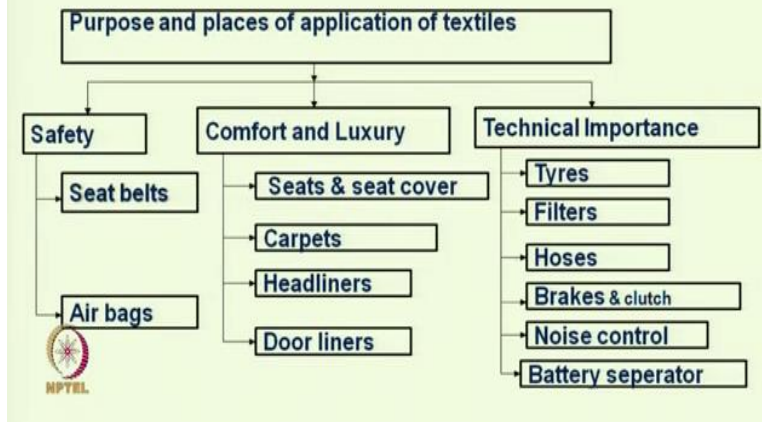


The basic requirements in textile materials particularly in fibers for automobile applications it is to be lighter in weight, should not be very heavy. High breaking strength is required, puncture resistance should be high, adhesion with the particularly for tire chord. Adhesion with rubber is important for rubber reinforcement. Optimum porosity is required for filtration application. Or acoustic applications, dimensional stability is required where water resistance.

For some application; UV resistance, water proof, color fastness these are the requirements and also thermal protection should be there. Flame retardant finish should be there, good mechanical characteristics, good color fastness to light, waterproofing abrasion resistance these are the requirements of textile materials for automotive applications.

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Categories :



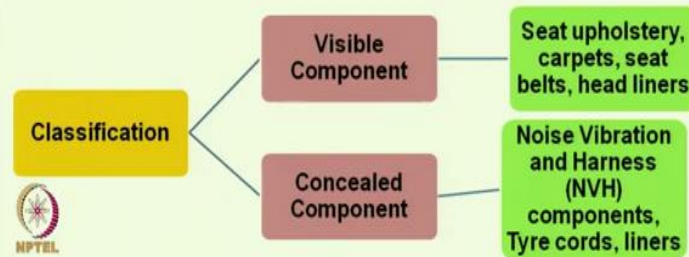
And if we see the category wise, particularly the specific requirement wise we can divide into three different categories. Based on the purposes; the purpose, if the purpose is safety then we think of seat belts and airbags and both seat belts and air bags are the examples of technical textiles, automotive textiles. If we want comfort and luxury then; seats and seat covers, carpets headliners, door liners are there.

And technical importance it is a tyre cord, filters hoses, textile hoses, textile brakes and textile reinforced composite breaks and clutches are there, acoustic control, noise control, so that noise from outside or noise from inside can go out or from outside it should not come inside so noise absorption and in battery separator we can use textile material.

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Classification of Automotive Textiles-

Automobile segment of Technical Textile products includes applications in automotive and automotive components (Including aircrafts and railways).



In another way we can classify the automotive textiles based on whether it is a visible component and if it is concealed component; like the automotive textiles the visible components are which we can see easily like; seat, upholstery, carpets, seat belts, headliners. So these are visible components and concealed components are noise vibration and harnesses components, tyre chords, liners, so these are concealed component which are inside the car for different purposes.

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Approximate Textiles used in a modern car

Textile Component	Percentage
Carpets	30-35
Upholstery	15-20
Pre-assembled interior components	12-15
Tyres	10-15
Safety Belts	5-10
Airbags	2-5
Others	5-10

So approximate textile usage in terms of percent; so carpet is 30 to 35%, upholstery 15 to 20%, so different percentages are there air bag 2 to 5%.

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APPLICATION AREAS & PROPERTIES OF AUTOMOTIVE TEXTILES-			
Sl. No.	Application areas	Main performance properties	Fibres used
1	Upholstery	Abrasion & UV resistance, attractive design & texture	Polyester, wool, nylon, acrylic
2.	Tyre cords & fabrics	Tensile strength, adhesion to rubber, fatigue resistance	Polyester, Nylon, HT rayon, steel & aramid
3.	Composite	Stiffness, strength, light weight, energy absorbing, thermal stability	Glass, carbon, aramid, HT polyester & polyethylene
4.	Hoses, belts etc.	Heat resistance, tensile strength, dimensional stability, adhesion to rubber, chemical resistance	HT polyester, aramid

Now let us see at different application areas; what are the main performances required and accordingly what are the different fibers recommended for those applications? In upholstery the main the characteristics requirements are abrasion and UV resistance, attractive design and textures are required. So for this reason polyester, wool, nylon, acrylics are used. Tire cord and tire cord fabrics.

It is tensile strength addition with rubber and fatigue resistances are important for that polyester, nylon, high tenacity rayon are used. Sometime aramids are also used. For composite applications for the body parts, we need stiffness, strength lighter in weight, so energy absorption, so any sock absorption thermal stability, these are the requirements, so for that we use glass carbon, high tenacity polyester, aramid, polyethylene this type of fibers are used. For hoses and belts the main requirements are heat resistant.

For hose we require heat resistant fiber for build tensile strength, dimensional stability, adhesion to rubber chemical resistance, these are the requirements. So for hose adhesion to rubber should be there because rubber reinforced hoses are used sorry the fiber reinforced rubber hoses are used, so high tenacity polyester and aramids are used in this area.

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APPLICATION AREAS & PROPERTIES OF AUTOMOTIVE TEXTILES-

Sl. No.	Application areas	Main performance properties	Fibres used
5.	Seat belts	Tensile strength, abrasion and UV resistance	HT polyester
6.	Airbags	Ability to withstand high temperature inflation gases, durability to storage in compacted state long time	Nylon - 6,6, nylon - 4,6
7.	Carpets	Light fastness, mouldability	Nylon, polyester,



For seat belts the main important characteristics is that the tensile strength, abrasion resistance is very important because it constantly it is getting abraded and UV resistance. So it is exposed in the light always so that is why UV resistance is important, so for this high tenacity polyester used for seat belts. In airbag the main characteristics requirements are ability to withstand high temperature inflation gas, durability to storage in compact stage for long time.

That is very important because airbags are normally not in use most of the time only in extreme crash condition where accidents take place that time airbags come out from their store place. So due to storage there should not be any degradation. So for that the nylon 6, 6 and nylon 4,6 are used. Another important quality requirement is that, it is impact resistant, so because sudden inflation suddenly that the airbag gets inflated.

So it should withstand that type of impact strength impact stress. The carpet, the light fastness and mold ability should be there nylon and polyester are used. Here nylon is used basically for higher abrasion resistance.

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Areas of Application

○ Car body Covers	○ Sun blinds
○ Seat Cover Fabric	○ Helmets
○ Nylon Tyre Cord Fabric	○ Space Suits
○ Seat belt webbing	○ Data wear
○ Air bag	○ Heavy Goods Vehicles (HGV)
○ Interior Carpets	○ Tarpaulins
○ Interior design	○ Spray Guards
○ Headliners	○ Flexible intermediate Bulk containers
○ Insulation felts	○ Filters
	○ Battery separators
	○ hoses



These are the various areas where we can use textile material; so car body cover is there will discuss all these areas one by one. Seat cover fabric, nylon tyre cord, seat belt webbing, air bag, interior carpets, interior design, headliners, insulation, felts, sun blind, helmets, space suit, data wear. So these are all related to the automobile textiles. Filters battery separators, hoses, tarpaulins are also used. So we will discuss one by one first the car body cover.

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Car body covers

- Car body covers are used to cover the car if no cover space for parking is available.

Product Characteristics

- The car body cover is a 100% technical textile product and are made of a variety of fabrics including canvas, PVC , reinforced cotton material and Nylon.




Car body covers are required where sufficient parking space covered parking space are not there. So you should cover the car with the car body covers. The requirement of the products are car body is a 100% technical textile product and made of variety of fabrics, including canvas, PVC, reinforced cotton material and nylon to protect the car from the environment like light, dust.

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Carpets

- The carpets used in car are mainly three types
 - ✓ Tufted carpet
 - ✓ Tufted loop pile
 - ✓ Needle felt
- Manufactured by nylon, PP and polyester is used as backing fabric.
- It plays significant role in vibration and noise control.
- Carpets protect from thermal and acoustic problems.




In the carpet used was of three main types of carpets; tufted carpet, tufted loop pile and needle felt. Now a day's needle felt carpets are widely used. These are manufactured from nylon polypropylene, polyester used as backing fabric. It plays a significant role in vibration and noise control, so proper selection of carpet structure is required with a proper cushioning effect and carpet also protect from thermal and acoustic problem.

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PRODUCT CHARACTERISTICS

- The automotive interior carpets are nonwoven, made primarily from polypropylene fibers.
- The carpet is laid on the vehicle floor above which rubber mats are placed.
- The desired characteristics of automobile interior carpets are:
 - ✓ High durability
 - ✓ High abrasion resistance
 - ✓ Tensile strength
 - ✓ Low flammability
 - ✓ Good compression recovery




The automotive interior carpets are nonwoven made of mainly polypropylene fibers. The carpet is laid on the vehicle floor which rubber mats are placed. So that it does not get soiled quickly. The main characteristics requirement are high durability, high abrasion resistance, tensile

strength, low flammability good compressional recovery. So compression recovery is important the resilience characteristics is important.

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Nylon tyre cord fabric

- The nylon (6 and 6,6) tyre cord is prepared from high tenacity continuous filament yarn by twisting and plying.
- Nylon tyre cord fabric provides strength to a tyre.
- The tyre industry consumes nearly 98% of the total nylon tyre consumption.
- Nylon tyre cord fabric gradually replaced the usage of rayon and polyester cords in the tyre industry.




So now the nylon tyre cord fabric mainly nylon 6 and nylon 6, 6 are used. Tyre cord is prepared from high tenacity continuous filament yarn by twisting and plying. Nylon tyre cord fabric provides strength to a tyre. The tyre industry consumes nearly 98% of total nylon tyre consumption, so nylon tyres basically are gradually replacing the rayon and polyester chord in the tyre industry. So majority of the tyre cords are used that nylons are used.

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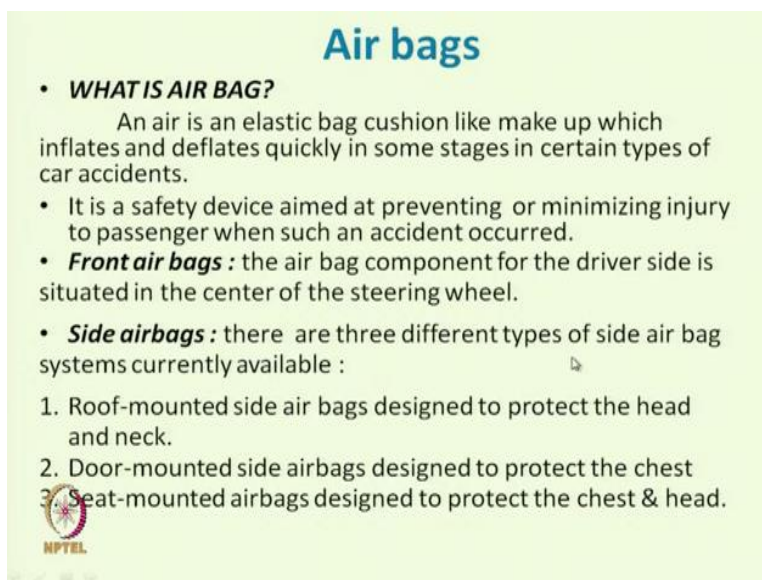
- Nylon 6 tyre cord fabrics having
 - ✓ High strength
 - ✓ Fatigue resistance
 - ✓ Impact resistance
 - ✓ High adhesion
- The tyre cords are generally available with linear density of 930 dtex, 1400 dtex, 1870 dtex, 2100 dtex.
- The critical specifications drive the characteristics such as breaking strength, elongation, adhesion, ply twists and hot air shrinkage.



The main requirements are high strength, fatigue strength because fatigue strength is very important because always this tyres are under stress. Impact resistance is important, high adhesion with the rubber is important typically 930 decitex, 1400 decitex, 1870 decitex, 2100 decitex. These are the standard linear density of nylons are used, the linear density of tyre cords are there.


So the critical characteristics are breaking strength, elongation, adhesion, ply twist and hot air shrinkage. So hot air shrinkage should be as low as possible because during the long running the tyre gets heated, so at that time that the tyre cord should not shrink.

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Air bags

- **WHAT IS AIR BAG?**
An air is an elastic bag cushion like make up which inflates and deflates quickly in some stages in certain types of car accidents.
- It is a safety device aimed at preventing or minimizing injury to passenger when such an accident occurred.
- **Front air bags** : the air bag component for the driver side is situated in the center of the steering wheel.
- **Side airbags** : there are three different types of side air bag systems currently available :
 1. Roof-mounted side air bags designed to protect the head and neck.
 2. Door-mounted side airbags designed to protect the chest
 3. Seat-mounted airbags designed to protect the chest & head.

 NPTEL

Now, another technical product in the area of automotive textile is the air bag which is extremely important for the safety. Now let us try to see what is airbag; it is an elastic bag cushion it is like make up with the inflates and deflates quickly. In some stage to certain type of car accident. During the car accident with a fraction of second we need to inflate the airbag.


So that the accident impact is not there in that on the driver or passengers, so it is a safety device. There are two types of airbags one is front airbag, these are the airbags, the airbag component for the driver side situated at the center of steering wheel and side airbags are the roof mounted airbag so roof mounted side airbag designed to protect the head and neck, door mounted airbags are there to protect the chest.

And also seat mounted air bags are designed to protect the chest and head. So there are air bags at different location of the car to protect our body.

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- ✓ The yarn or fabric primarily nylon 66, lighter denier and silicon coated.
- ✓ Approximately 2 square meter of fabric is used per air bag module



At the time of any accident. The yarn and fabric primarily used nylon 66, nylon 66 filaments are used and lighter denier and it is a silicon coated, approximately 2 square meters of fabric are used per airbag one airbag we require 2 square meter of fabric.


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Working Principle of Airbag

- Airbags inflate quickly -faster than the blink of an eye.
- In the first 15 to 20 milliseconds, air bag sensors detect the crash and then send an electrical signal to fire the airbags.
- A small explosive device ignites a Sodium azide burns with tremendous speed, generating nitrogen, which inflates the airbags.

Chemical Reaction:
$$2 \text{NaN}_3 \longrightarrow 2 \text{Na} + 3 \text{N}_2 \text{ (gas)}$$
sodium azide



Now if we see the principles of airbag; airbag inflates quickly at very fast rate in the first 15 to 20 milliseconds the airbag sensor detects the crash. First, it detects the crash, then it sends electrical signal to fire the airbag and one small explosive device ignites the sodium azide, this is


sodium azide which burns at tremendous speed, this after ignition the chemical reaction takes place it burns at tremendous speed and generates nitrogen gas. This nitrogen gas is used to inflate the airbag quickly and protect the passengers and drivers also.

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Characteristics

- Manufactured from nylon 6, nylon 66 yarn of 315, 420, 630 and 840 denier.
- Tear resistance of the air bag must be good.
- Fabric must withstand forces of hot gases and gas must not penetrate through it.



The characteristic is that manufactured from nylon 6, the nylon 66 of 315, 420, 630, 840 denier. The tear resistance of air bag must be good, it should not burst even bursting strain should be good and fabric must withstand force of hot gas and gas must not permeate through it, so permeability should be very low.

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Seating fabrics

Raw materials for seat textiles:

Polyester, Nylon (6 & 6,6) and Polypropylene.

The fabric formation methods include weaving, knitting and nonwoven.

- ✓ The fabric is further laminated to provide desired protection characteristics.
- ✓ The fabric is further finished as per the desired specifications of automobile.




And next coming the seating fabrics. So raw materials are polyester, nylon, polypropylene, they are used and woven, knitted and nonwoven fabrics are used for seating fabrics. Fabric can be laminated to provide desired protective characteristics.

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- ✓ The cotton or synthetic yarn is woven on power looms to produce fabric which is further stentered on stentering machine to smoothen out the fabric (remove bumps).



Cartoon and synthetic yarns are used for seating fabrics. For interior design the color textured and overall appearance is important.

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Seat belt webbing

- ✓ Seat belts minimize injuries during accidents.
- ✓ Seat belts are fabric made from nylon filament yarns or high tensile polyester filament yarn (500-3000 dtex)
- ✓ The load specification is an important criterion for usage vehicles.
- ✓ The seat belt is energy absorbing material which functions safety harnesses to prevent harmful movements of passenger during collision.

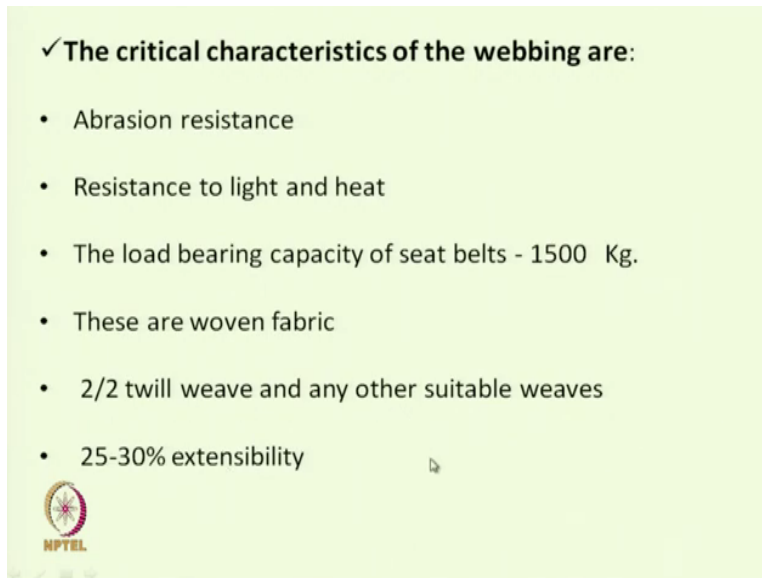


Next is seatbelt webbing, seat belt is used to minimize the injuries during accident seat belts are fabrics made from nylon filament or high tenacity polyester filament, typically 500 to 3,000 decitex filaments are used. The total loads specification is an important criteria. The seat belt is

energy absorbing material which functions safety harness to prevent harmful movement of passenger during collision.


So it should protect it should protect it should prevent the sudden movement of passengers, for that we need high impact strength and as well as high tensile strength.

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✓ The critical characteristics of the webbing are:

- Abrasion resistance
- Resistance to light and heat
- The load bearing capacity of seat belts - 1500 Kg.
- These are woven fabric
- 2/2 twill weave and any other suitable weaves
- 25-30% extensibility



So critical criteria are that is abrasion resistance must be very good, resistance to light and heat should be high. The load bearing capacity of seat belt is should be around 1500 kg, these are woven fabric because otherwise if we use other type of structure the extensibility will be very high. We use woven fabric 2 by 2 twill normally use or any suitable weaves can use and typical breaking elongation should be around 25 to 30%

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Headliners

- Headliners are used in passenger cars and multi/sports utility vehicles as nonwoven light weight roofing material.
- The cars were earlier fitted with knitted/woven fabric with hard cardboard type of backing.
- The trend has changed and increasingly nonwoven headliners are being used in vehicles.
- Usually the headliners are polyester or PP needle punched nonwoven



In headliners these are used in passenger cars, where? Nonwovens are used for lightweight roofing. So headliners are used in most of the cars. The cars were earlier fitted with knitted and woven fabrics, the trend now has changed to nonwoven fabric made of polyester and polypropylene needle punched fabric. So this nonwoven fabric help in absorbing the shock as well as, it absorbs the sound so it is it acts as sound insulator also.

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Insulation Felts

- Insulation felts often known as NVH products (Noise, vibration and harshness parts) are used as for acoustic and thermal insulation in the automobiles.
- These parts are not only provides noise protection inside the car but also reduction in the noise emission outside.




So these insulating felts are applied so insulating felts often known as NVH products, noise vibration and harshness parts. So they are used to protect us from noise and vibration, so these are used for acoustic and thermal insulation of automobiles that is why nonwovens are used. So

these are this parts are not only provide noise protection inside the car, but also reduce the noise emission outside. So noise, it should not go outside.

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Sun blinds


- The sun blinds are located in the interiors of a four wheeler just above the windshield.
- These are used to block the light from the sun from entering through the windshield.
- There are two sun blinds in a car,
 - One for driver; and
 - The other for co-passenger
- However, the high end car models have up to four sun visors.



Sun blind is another technical product the sun blinds are located in the interior of a four-wheeler just above the wind shield. These are used to block the sunlight, here also we can use textile materials.

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- The blinds are primarily made of three parts
 1. The synthetic backbone made of polypropylene
 2. Scrim – coarse woven reinforcement fabric; and
 3. Upholstery – typically artificial leather



So blinds are typically made of three parts. The synthetic backbone made of polypropylene and scrims are coarse woven reinforced fabric and upholstery typically artificial leathers are used. So here textile components are also used.

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Tarpaulins

- ✓ Heavy Goods Vehicles are a major user of tarpaulins, which are made of **PVC coated nylon and polyester plain woven fabrics from high tenacity yarns.**
- ✓ Tarpaulins must have resistance to cold cracking, reduced flammability, coating adhesion, water proofness, UV resistant and high tear and tensile strengths.
- ✓ These must be dimensionally stable over a wide range of temperatures and relative humidities and be resistant to common chemicals, oils and engine fuels.



So tarpaulin is another technical textile product used basically for heavy goods vehicle, which are made of PVC coated nylon and polyester plain woven fabric from high tenacity yarns, because here strength and tearing strength, tensile strengths, abrasion resistance are important. So and PVC coating is important because here it should be water impermeable. Tarpaulin is used to protect the goods from getting wet. So tarpaulins must have resistance to cold cracking.

So this PVC cracking should not be there. So coating adhesion should be good. It should be waterproof, UV resistant and high tear strength and tensile strength, because it is always used in exterior, so there are chances of getting damaged. So they must be dimensional stable at different temperature and relative humidity and should be resistant to common chemicals, oils, engine oils. So this should not get affected, that is why nylon and polyesters are used.

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Flexible Intermediate Bulk Containers

- ✓ Flexible Intermediate Bulk Containers are used for transporting materials such as powders.
- ✓ These are woven with polypropylene tape yarns with a specially Silicone coating.



Another technical textile product is flexible intermediate bulk container, this type of containers are used in the automobile to carry a bulk product like powder type products. So woven fabrics basically polypropylenes are used. So woven fabrics here, it is a nylon and polyester are used silicon coated and with the polypropylene tapes. This is very important to carry the powder like materials. Filters are also important.

So I am not going to discuss the filter again here, this filter design we have already covered in filtration section.

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Types of Filters

1. Air filter
2. Oil filter
3. Fuel filter
4. Cabin Air Filter




So air filter, oil filter, fuel filter, cabin air filter, so these are the different types of filtration requirement like air conditioner filter so and we have seen that different types of filter structures
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Upholstery

Upholstery Fabrics are generally:

1. Flat woven fabrics
2. Pile woven fabrics
3. Warp knits
4. Circular knits

- Now a days air jet textured and spun polyester are used.
- Seat cover fabrics are yarn dyed or piece dyed.




In upholstery fabric mainly woven fabric, pile fabric, warp knitted, circular knitted fabrics are used and yarns air jet textured and spun polyester yarns are used. Air jet textured textiles yarns are used basically to have some softness.

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Battery Separator

- ✓ Separates anode from cathode of battery preventing short circuit.
- ✓ Glass fiber is replaced by polyester.



And battery separators; in the battery separators, we can use the textile material where to prevent the short circuiting between anode and cathode we use the glass fiber battery separators.

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Hoses

- It acts as a transmission media
- Automotive hose pipe products include fuel, oil, radiator, hydraulic brakes, power steering and air conditioning pipes.
- Kevlar and Nomex are best preferred but nylon and rayon reinforcements are also used.



In hoses the automotive automobile hoses, we can use the textile product, so Kevlar and Nomex where with high melting point we can use.

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COATING

DIRECT COATING-

➤ Two Techniques involves-

- **Knife over roller technique**
- **Floating knife or knife over air technique**

➤ As the fabric moves forward, it is scraped by the knife and the polymer resin compound is spread evenly over the surface

➤ Direct coating uniformity depend upon Shape of knife, Angle of knife to fabric and Position of knife.

➤ Applications area-

- **Automotive car seat fabrics ,Tarpaulins and light weight material**

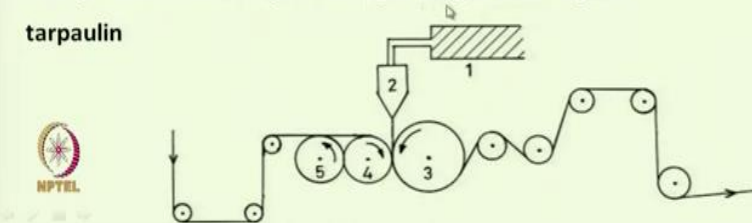


So in many applications, in automobile we use textile material with the coating so particularly in seating fabric, tarpaulins, lightweight materials so different application area we use the coating of fabrics. There are different types of coatings.

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HOT MELT EXTRUSION COATING-

- For thermoplastic polymers such as polyurethane, polyolefins and PVC, which are applied by feeding granules of the material into the nip between moving heated rollers.
- Apply resin to fabric at a faster rate than that can be achieved by transfer coating or direct coating.
- This process is used to produce light weight coverings or tarpaulin



We can use the hot melt extrusion coating, this is the fabric okay here and through the hot melt extrusion this fabric is being coated here, this is a fabric is coming here hot melt extrusion, extruded the coating material is actually it is coming from this place and then the coating is taking place and the coated fabric is then roll in. So this process is used to produce light weight covering or tarpaulin. So for production of tarpaulin we can use this hot extrusion coating.

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ROTARY SCREEN COATING-

- The rotary screen technique applies to a fabric by forcing it through a cylindrical screen, it is used mainly for textile printing.
- Add-ons in between 5 and 500 g/m².
- The add-on is controlled by :Resin viscosity, Mesh of the cylindrical screen, Speed ,and Pressure of the squeegee bar inside Screen.
- This technique allows some stretchy fabrics to be coated
- Require less fabric tension

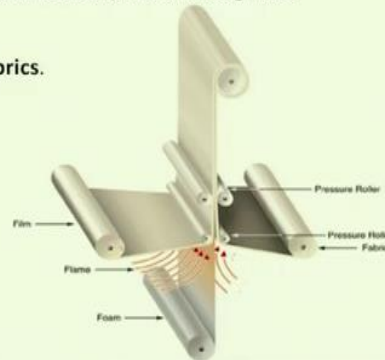


Rotary screen coating is also there, where similar to the rotary screen printing we can use instead of a pigment we can use resin or any other coating material to coat the textile material.

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Flame Lamination

- Use to adhere **polyurethane foam** to a textile material.
- A web of Polyurethane foam is passed over a gas flame at around **950°C** and combined with textile.
- The foam-laminated textile material is then passed through the second nip and wound up .
- Mainly used for **automotive fabrics**.



For automotive applications, flame lamination is also there where this foam is placed in between the fabrics. So here polyurethane foam is used, the polyurethane foam is passed over a gas flame, this is a gas flame. Around 950 degree Celsius and combined with textile material here and these are mainly used in automotive textiles. So these are different coating techniques, so or and lamination technique, we have many other coating and lamination techniques which are used in the automotive industry.

So what we have discussed the different areas of applications and different fiber materials characteristics, and if we can select the fiber material and fabric, so we can improve the performance in automotive textiles. So we will end here the next class we will discuss another topic, till then thank you.