

Traffic Engineering
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Lecture - 59
Introduction to Road Safety

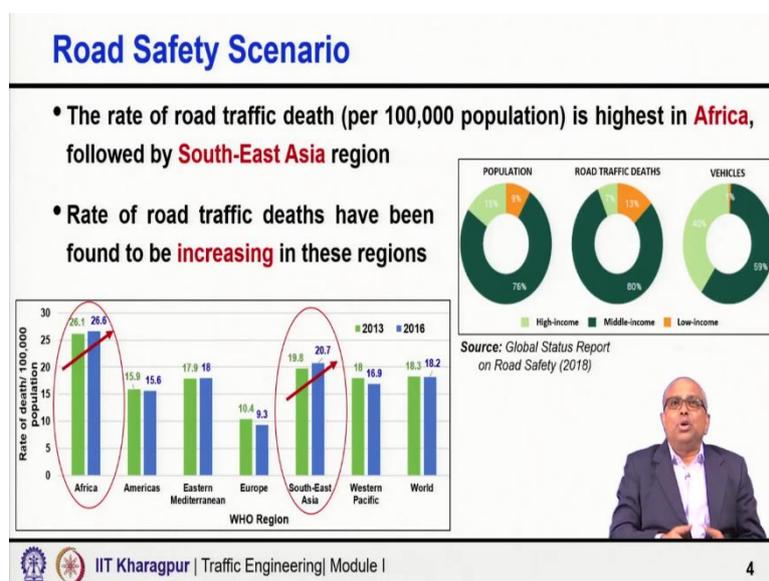
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Welcome to module I which is on traffic safety. And this is the first lecture on this module, Introduction to Road Safety. First, let us look at the road safety scenario, globally and then in India. Globally, every year 1.3 million deaths are happening and 50 million people are suffering injury due to road crashes. Road crashes is the eighth in the leading cause of deaths quite in the top and most importantly it is the first leading cause of death for children and young adult. The most important age group for any country considering the future, 5 to 29 years, for that age group, this is the first leading cause of death.

If you look at the death rates expressed in this case may be per 100,000 population, then the death rates in low-income countries are 3 times higher approximately than in high income countries. So, that shows that more rates are much higher in low-income countries as compared to the high-income countries. And in overall sense, 90 percent of the deaths are actually in LMIC what we call as Low and Medium Income Countries. So, who is taking the burn it is basically the LMIC, Low and Medium Income Countries, who have multiple other program problems, economic issues and they are suffering maximum because of the road traffic crashes and the resulting fatalities?

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The rate of road traffic deaths as I said per 100,000 population, in that sense is the highest in Africa followed by Southeast Asia region. If you look at this figure, Africa here, southeast Asia, the highest bar you can see in Africa followed by southeast Asia and alarmingly, rate of road traffic deaths have been found to be increasing in this region, I have just tried to indicate the and trying to show you the upward trend in both regions, Africa and Southeast Asia. The present rates are highest in Africa followed by southeast Asia and in both these regions, there is an increasing trend of the rate of death per say, number of deaths per 100,000 population.

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Road Safety Scenario

Vulnerable Road Users (VRUs) and Road Safety

- **Pedestrians, Bicyclists and Motorcyclists** are easily injured and killed in crashes, due to **lack of any protective shells** around them
- **More than half** of all road traffic deaths are among vulnerable road users

Global Death Share Proportion

Category	Percentage
Pedestrians & Cyclists	26%
Motorized Two-Wheelers	28%
Car Occupants	17%
Others / Unspecified	29%

VRUs ~ 54%

Source: Global Status Report on Road Safety (2018)



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Now, if you look at the vulnerable road users, their involvement in road safety globally, you will see that pedestrians, bicyclists, and motorcycles are cyclists are easily insured and killed in road crashes, the simple reason they do not have any protective shells around them, so they are, if they are killed, their chance of or probability of fatality is very high.

And the biggest concern is more than half of the road traffic deaths are among vulnerable road users. If you look at this global representation global death share, the motorized two wheelers and pedestrians and bicyclists together contribute nearly 54 percent. So, nearly more than half of the all-road traffic deaths include vulnerable road user. These are all to be noted because this have clear indications what and how we should proceed further to mitigate the number of road accidents and mitigate the number of fatalities bringing down the number of fatalities.

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Road Safety Scenario

Global Plan: Decade of Action for Road Safety 2021-2030

- **Target:** To reduce road traffic deaths & injuries **BY AT LEAST 50%** during this period
- **Requirement to achieve the target:** Governments & partners to implement integrated **SAFE SYSTEM APPROACH**

✓ Requires calls for action on the following components:

- Multimodal transport & land-use planning
- Safe road infrastructure
- Safe vehicles
- Safe road use
- Post-crash response

World Health Organization
DECADE OF ACTION FOR ROAD SAFETY
2021 - 2030

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In the global plan or as per global plan, during this decade of action for road safety, 2021 to 2023, the target is to reduce road traffic death and injury by at least 50 percent, during this decade. And if we have to do, that if we have to achieve that then the governments and partners need to implement, an integrated safe system approach focusing on all the important elements or components, namely multimodal transportation and land use planning. It is very important, multimodal context and the land use is the root cause of majority of the traffic issues or traffic problems.

Then creating safe road infrastructure, not just creating road infrastructure as we have been doing in majority of the LMICs, just building road, but building road and building safe road infrastructure are two different things, giving new consideration to requirements of all road users not only the requirements of motorists. Then safe vehicle which is also ah to some extent compromised in LMICs, the same brand, when it is in European market and when it is in other African region or in southeast Asia, the safety features are not the same.

Safe road use and users and also the post-crash response, you know the golden hour. If the victims are transferred to hospital where proper care can be taken, then the fatality rate can come down drastically. So, the post-crash response is again very very important.

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Road Safety Scenario

Scenario in India

- **150 thousand** people are killed from **450 thousand** of road traffic crashes every year
- **National Highways (NHs)** comprise of less than **2%** of the entire road network, but account for **more than 35%** of total traffic fatalities



Year	Crashes	Deaths	Injuries
2017	4,64,910	1,47,913	4,70,975
2018	4,67,044	1,51,417	4,69,418
2019	4,49,002	1,51,113	4,51,361



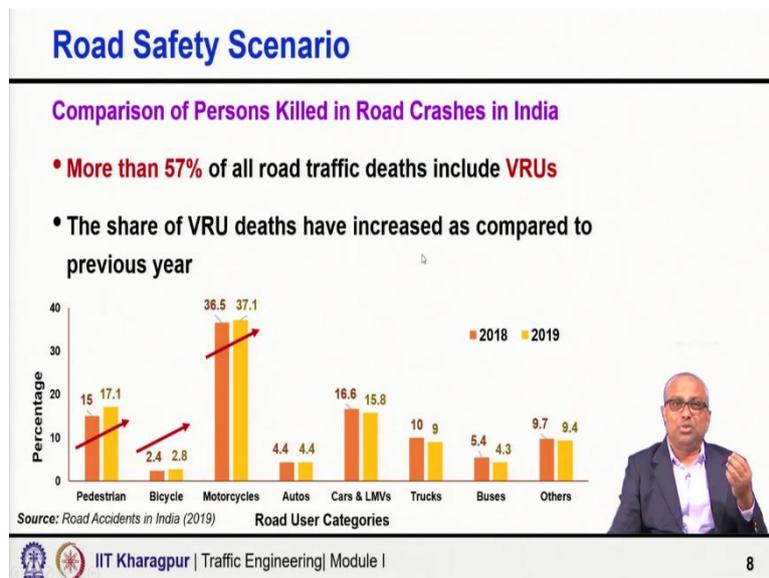
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Coming to the scenario in India, that was the global scenario, now coming to the scenery of India. In our country, every year, 150,000 deaths happen from 450,000 of road crashes, not a good thing, very high. And here most importantly, the national highways which actually include only 2 percent of our entire road network in the country, account for 35 percent of the total traffic fatalities, very disproportionate figure, so the national highways and also the state highways they are to be handled in a much better way.

And if we look is necessary, the way we are building our national highways and state highways, it is important, no doubt, we need to develop our roads, widening road to 4 lane, 6 lane, dual carriageway, standards they are the necessity, the economy road on transport and road transport has a very big role to play in the overall economic growth of the country, so we need it. But much more focus is required on the road safety aspects, something definitely wrong with the way we are developing our infrastructure.

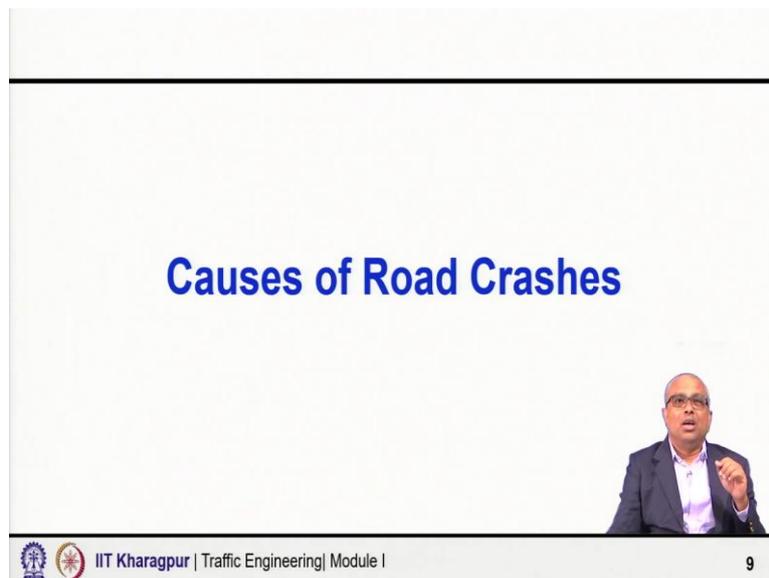
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Here, also if you compare that what is the involvement of various in Indian context it is more than 57 percent, not much different and because if you see what we said that globally that share is around 54 percent various and here in Indian case, it is around 57 percent. And the share of VRU's deaths have increased as compared to previous years especially if you compare 2018 and 2019 data, 2020 data because of the impact of Covid, somehow the number may be very different.

So, 18 to 19 you know they are very high, motorcyclist and this is the pedestrian, and so the vulnerable road user again more than 50 percent in this case also and showing an upward trend very alarming. And altogether, we are number one in deaths due to road accident, we must be very very careful and we need scientific, systematic approach looking or accepting the reality, that is what are really important, we have to bring down the fatalities.

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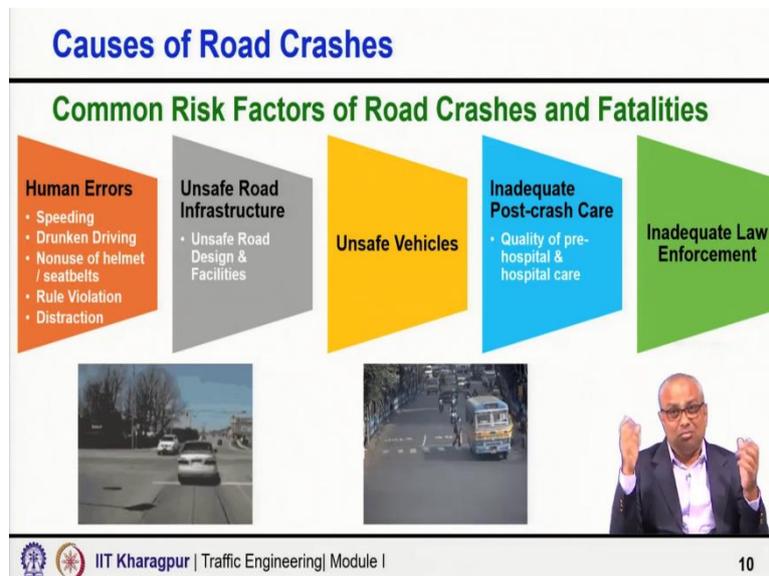


Causes of Road Crashes

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Causes of Road Crashes

Common Risk Factors of Road Crashes and Fatalities

- Human Errors**
 - Speeding
 - Drunken Driving
 - Nonuse of helmet / seatbelts
 - Rule Violation
 - Distraction
- Unsafe Road Infrastructure**
 - Unsafe Road Design & Facilities
- Unsafe Vehicles**
- Inadequate Post-crash Care**
 - Quality of pre-hospital & hospital care
- Inadequate Law Enforcement**

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This slide features a white background with the title "Causes of Road Crashes" in blue and "Common Risk Factors of Road Crashes and Fatalities" in green. It displays five colored trapezoidal boxes representing risk factors: Human Errors (orange), Unsafe Road Infrastructure (grey), Unsafe Vehicles (yellow), Inadequate Post-crash Care (blue), and Inadequate Law Enforcement (green). Below the boxes are two small images of road scenes and a small inset video of a speaker. The footer contains the IIT Kharagpur logo and the text "IIT Kharagpur | Traffic Engineering | Module I" and the number "10".

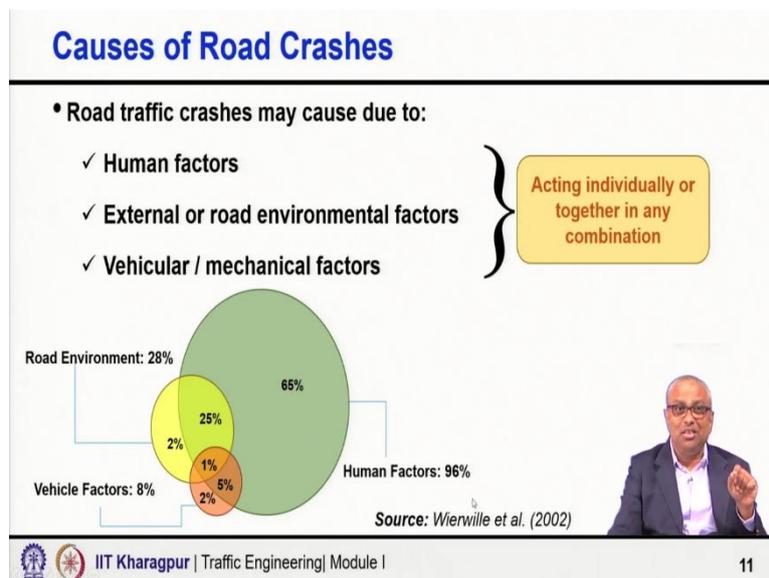
Let us look at the causes of road crashes, why the road crashes happen? Global research indicates that there are 5 broad risk factors, human factors for example, speeding, drunken driving, no use of helmet or seat belt, violation of rule, distraction, talking in over mobile or texting somebody while driving, this kind of things, all together human error that is one major area.

The other area is unsafe road infrastructure, as I said creating road and creating safe road is very very different. So, many cases we have created infrastructure but they are not safe infrastructure, so unsafe design and lack of facilities, unsafe facilities they are the cause, so that is the road infrastructure, road engineering aspects, I should say.

Then unsafe vehicles as I have said, in many cases the safety features are missing, and we are cutting down the cost, bringing down the vehicle price to make it competitive, to remain competitive in the market, but we are cutting, where cutting, the corners, where we are cutting in the safety features, that is again is one of the reasons. Inadequate post cash care, quality of pre-hospital and hospital cares is not really so good, there are deficiencies.

And last but very important, inadequate law enforcement. Whatever you do, if we are we may create law but that has to be those laws are to be implemented those road laws are to be enforced properly. So, in many cases, especially in LMICs, there is glaring deficiency or in a positive sense, we can say there is a lot of scope for improvement in terms of law enforcement. So, these are the 5 different pillars.

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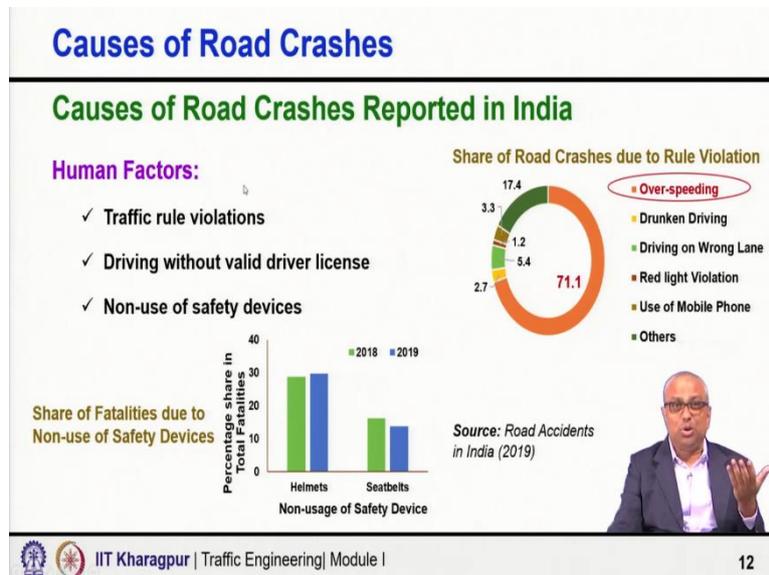


In a simple format, who are on roads, people, road, road environment, and vehicles, so in a very simple way, another way of looking at it, if we look at it that road crashes may occur due to human factors, external or road environment factors, and vehicular or mechanical factors. Somewhat a different way of regrouping these verticals. Human factors, external or road environment factors and vehicle or mechanical factors and these factors sometimes act individually sometimes together in any combinations to contribute to road accidents or road crashes.

Look at these shares, so there are quite overlaps and if you see human factors solely or combinedly contributing to 96 percent. Road environment or road engineering, directly alone or in combination with others contributing to 28 percent, so better road engineering also is really an issue and the vehicle factors all together alone or in combination with road

environment factors and human factors contributing to about 8 percent. Obviously, this 28 plus 8 plus 96 will be more than 100 because there are overlaps.

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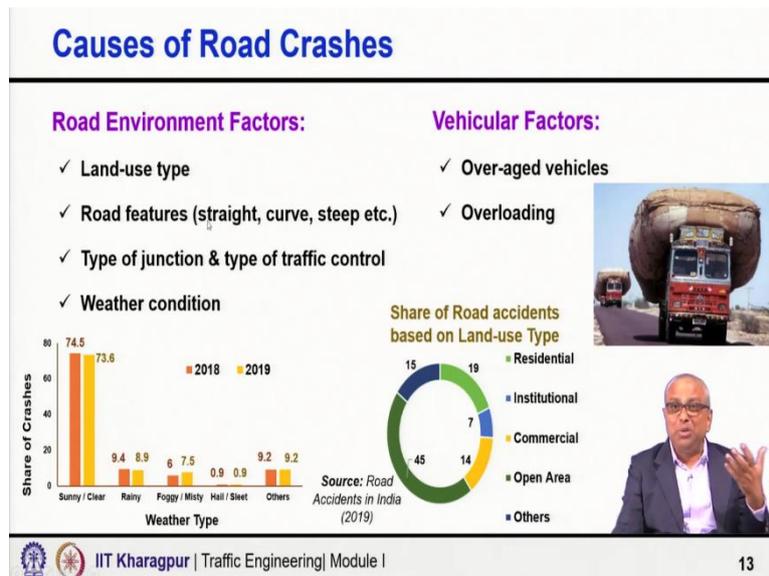
Now, coming to the causes of road crashes reported in India, specific Indian context, what is happening. The human factors may include traffic rule violations, drivers driving without a valid driving license, non-use of safety devices for say 2-wheeler noise of helmet or for motor vehicle, 4-wheeler users not using the seat belt.

So, if you look at it, that traffic rule violations, these are the different shares, what are kinds of violation, the major share you can see it is speeding or over speeding, so speeding is a major issue the infrastructure, the road environment traffic compared to those or overall road traffic environment, and the kind of speed that is happening is not they are not compatible, the speeding is not compatible, over speeding is happening.

So, over speeding may happen because somewhere the posted speed limit itself may be higher than what it should be and the other way, there are plenty of cases where the postage speed limits are actually violated by the motor vehicle users, so that is what is actually the reality. So, share of road crashes due to rule violation over speeding or speeding, contributes to more than 70 percent, very very important, all these are some very quick look at the kind of information that are available and to understand the implications, and what they indicate regarding the requirements or what interventions to be done, in which area to improve the overall scenario or road safety in India.

Look at this, the helmets and seat belts, what I say no non-use of safety devices, how they are contributing and the shares are quite significant, so it tells that we should focus. Till now, we could not convince the two wheelers that helmet is necessary. Majority of the people use helmet because wherever police will be there, so they are afraid of police, police will catch them, they will find, so they use helmet. The basic understanding that helmet is essential for my own safety if I am driving two-wheeler that very essence is missing, not for everybody but to a large extent.

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Road environment factors may include land use type, what is the type of land use, you will find that national highway is passing through areas which are like semi urban development, markets are there, activities are there, schools, colleges, offices are located very close to roadway and there is no protection to vulnerable road users, no facilities provided they are just simply crossing the road looking at the gaps in the traffic and no segregation, no protection to vulnerable producers.

Land use type, road infrastructure, say straight segment, curve segment, sharp curves, steep, slope, type of junction, and type of control, I have taught you already, weather condition, all these are contributing to road accidents and fatalities, which we can call as road environment factors. Regular factors may include overaged vehicle the edge of the vehicle, vehicle fitness is a major issue and also the overloading of vehicles.

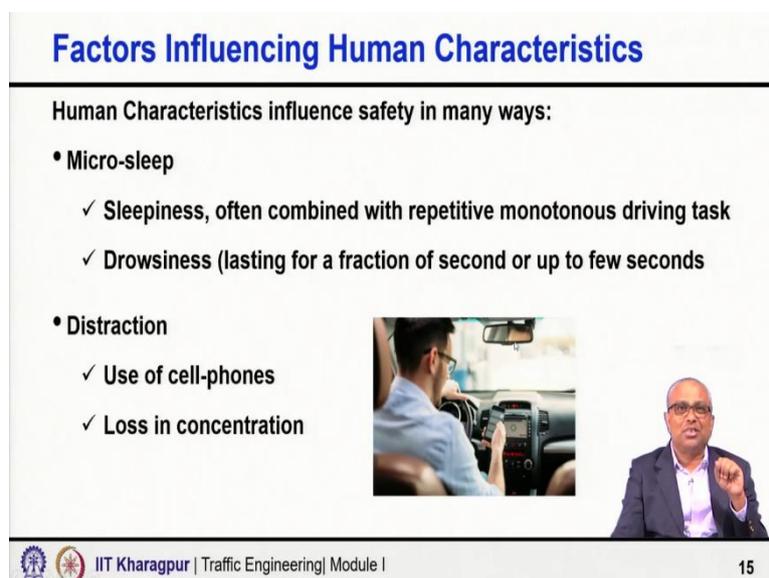
Yes, we cannot say that there is no action, no enforcement, but with the same focus, continuous, every day, 24/7, 365 days in a year, same level of enforcement against overloading is missing. The vehicle fitness, there are plenty of lacunas, if I start talking, the several hours can probably go on this topic that what are the real problems, with the vehicle fitness aspect the way the

certification is obtained, maybe afterwards many of the things are very different, I mean tried to everything is changed actually. So, at the time of taking the fitness vehicle is made very nice but once the fitness is taken and then they are on road that vehicle condition may be very different.

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Slide 14 features the title "Factors Influencing Human Characteristics" in blue text. A small inset image shows a man in a suit and glasses speaking. The footer includes the IIT Kharagpur logo, the text "IIT Kharagpur | Traffic Engineering| Module I", and the slide number "14".



Slide 15 features the title "Factors Influencing Human Characteristics" in blue text. Below the title, it states "Human Characteristics influence safety in many ways:" followed by two main categories: "Micro-sleep" and "Distraction". Under "Micro-sleep", there are two bullet points: "✓ Sleepiness, often combined with repetitive monotonous driving task" and "✓ Drowsiness (lasting for a fraction of second or up to few seconds)". Under "Distraction", there are two bullet points: "✓ Use of cell-phones" and "✓ Loss in concentration". An inset image shows a driver using a cell phone while driving. Another inset image shows the same man in a suit and glasses speaking. The footer includes the IIT Kharagpur logo, the text "IIT Kharagpur | Traffic Engineering| Module I", and the slide number "15".

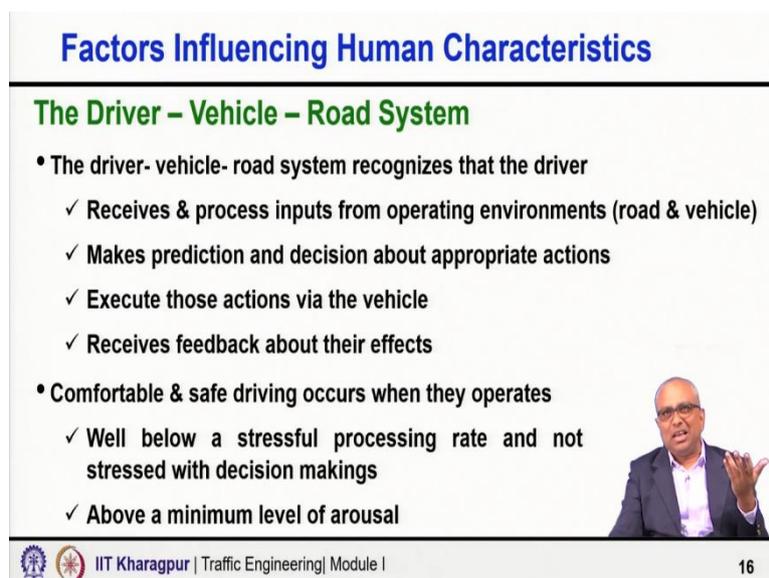
Let us look at the factors influencing human characteristics, because major you have seen a very large error is human error or human characteristics that are playing a big role. So, let us look at the factors which influence human characteristics, but I wanted to say you, why we need to be so careful. One is the kind of data that itself shows that human characteristics are very important and we need to focus on that. They in a way contribute, they have a big role and

if we, because of the issues related to human characteristics, you may find problems such as micro-sleep, such as distraction, and which may lead into road crashes and fatalities.

Micro-sleep, as you know is the sleepiness often combined with repetitive monotonous driving task long time driving, especially the commercial vehicle drivers or the travel agencies, tour and travel agencies those drivers they drive continuously, so it may be a monotonous thing for them and the drowsiness that is the lasting for a fraction of seconds or up to a few seconds.

Now, all these may lead to actually may contribute to microsleep. Similarly, distraction may happen because of you are using cell phone or somehow loss of concentration happens due to several other reasons it is possible, so distraction micro-sleep this kind of things are closely related to human characteristics and all these kinds of things may lead to root crashes and cause even fatalities.

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Factors Influencing Human Characteristics

The Driver – Vehicle – Road System

- The driver- vehicle- road system recognizes that the driver
 - ✓ Receives & process inputs from operating environments (road & vehicle)
 - ✓ Makes prediction and decision about appropriate actions
 - ✓ Execute those actions via the vehicle
 - ✓ Receives feedback about their effects
- Comfortable & safe driving occurs when they operates
 - ✓ Well below a stressful processing rate and not stressed with decision makings
 - ✓ Above a minimum level of arousal

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So, what are the human characteristics? What are the factors that are ah influencing human characteristics? Not the human characteristics but which are the factors that are influencing human characteristics. Even though there is the driver vehicle and road system, it is all together, where the driver vehicle road system, we recognize in in this system, we recognize that the driver receives and process inputs from the operating environment, road and vehicle and then makes prediction assessment and take decision, what is the appropriate action, then execute those actions via the vehicle may be pressing the brake pedal, and pedal and then you know trying to stop or trying to decelerate or trying to change lane, steering action, brake action, acceleration, deceleration, all these happen and receives feedback about their effects from the environment.

Now, comfortable and safe driving occurs only when they operate they operate well below a stressful processing rate and not stressed with decision makings and above a minimum level of arousal. So, minimum level of awareness, consciousness, alertness, and not doing, not doing any manoeuvre or any processing which is stressful and taking decision under stressed condition, these are very very important, so these are directly coming from the human characteristics.

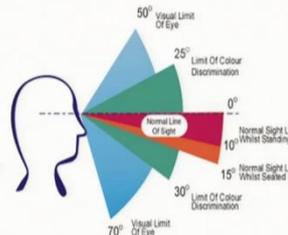
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Factors Influencing Human Characteristics

Physical Characteristics

Vision Characteristics

- **Ability to see:** In adverse weather conditions
- **Visual acuity & Field of vision:** Key criteria in determining **placement of traffic signs**
- **Colour vision:** Key criteria in determining the **colour of traffic signs**
- **Impact of Aging on Vision**
 - ✓ Experience low light level, face trouble in judging gaps (**Depth perception**)
 - ✓ Poor contrast sensitivity & discrimination of colour



The diagram illustrates the visual field and color discrimination capabilities of the human eye. It shows a profile of a head with a dashed line for the 'Normal Line Of Sight'. The visual limits are marked at 50° (top), 70° (bottom), and 0° (center). Color discrimination limits are shown as colored wedges: 25° (green), 15° (red), and 30° (blue). A note indicates 'Normal Sight Line (Whist Standing)' and 'Normal Sight Line (Whist Seated)'. A small inset photo of a man in a suit is visible in the bottom right corner of the slide.

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Physical characteristics, which also influence the overall safety scenario very important. Say, vision characteristics I have taught you these characteristics for example ability to see, then visual acuity and field of visions I have mentioned all those in the in the beginning module A, so I am only touching upon those to show you the linkage between though among those characteristics and the road safety issues. So, placement of sign that is getting decided is very important and thereby influence safety as well. Colour vision, whether I am able to recognize the sign properly, signals properly, impact of aging on vision, very very important.

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Factors Influencing Human Characteristics

- **Visual Reception: Glare Recovery**
 - ✓ Ability to recover from the effects of glare
 - ✓ For example, need to provide light transitions at entry/ exit of tunnels



Hearing Perception

- Receiving Sound stimuli -important to detect warning sounds



Mental Make-up

- Knowledge, Skill, Intelligence, Experience of the road users



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Visual reception or say for example glare recovery. Hearing perception to detect warning sounds. Mental makeup, knowledge, skill, intelligence, experience of the overall road users, so the linkage, you know now, how the human characteristics? What are the factors influence human characteristics? And how the linkages happen with the road safety?

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Factors Influencing Human Characteristics

Psychological Characteristics

- Attentiveness
- Anger
- Fear
- Anxiety
- Perception-Reaction process
 - ✓ Used for **Signal Design and Braking Distance**
- Phobias
- Superstition
- Impatience



SUPERSTITIONS



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Psychological characteristics again very important in the context of road safety, they are also human characteristics. For example, attentiveness, anger, fear, anxiety, impatience, superstitions, phobias, perception-reaction process, all these actualities the, for example, say perception-reaction process is very important for signal design and breaking distance, that is getting influence and other characteristics also.

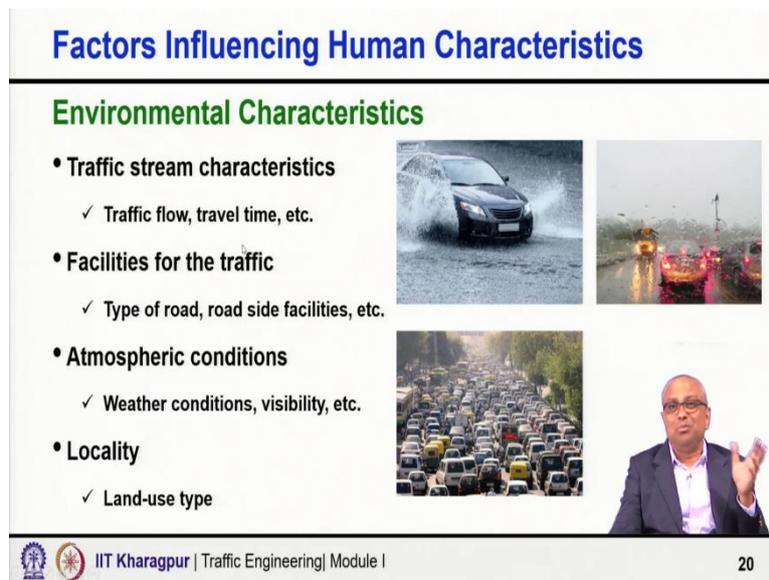
If you are angry, when you are driving and you behave in a crazy manner. Congestion is there, just become and cool, calm and quiet, except that there is a congestion, it will take little longer time, you become crazy and then try start doing manoeuvres in a very unsafe manner and then eventually that will lead to a road crash. So, every aspect is very very important psychological characteristic.

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Factors Influencing Human Characteristics

Environmental Characteristics

- **Traffic stream characteristics**
 - ✓ Traffic flow, travel time, etc.
- **Facilities for the traffic**
 - ✓ Type of road, road side facilities, etc.
- **Atmospheric conditions**
 - ✓ Weather conditions, visibility, etc.
- **Locality**
 - ✓ Land-use type



Environmental characteristic, directly linked with the safety traffic system characteristics, traffic flow, how much travel time, slow moving, fast moving, motorized, non-motorized, all those. Facilities for the traffic, what is the type of road? What is the roadside facilities? atmospheric condition, for the example, the weather condition, the visibility, the during, fog during rainy season it is when it is raining, when or when there is a fog, it influences, it impacts, so you have to be careful. Locality, the type of land use, very very important, very very important in Indian context as well.

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Factors Influencing Human Characteristics

Other Factors Influencing Human Characteristics

Pavement Marking

- Importance of pavement markings and their **influence on safe driving** is well known, especially for
 - ✓ Night time driving
 - ✓ Driving in difficult weather conditions (rain, fog, snow, etc.)
 - ✓ Old age drivers
- **Edge lines** have a significant impact on roadway departure crashes
- **Raised pavement markers** have an impact on night-time crashes, depending upon AADT and degree of curvature



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There are several other factors which influence human characteristics for example, Pavement Marking. Now, you know that importance of pavement markings and their influence on safe driving is well known especially, if you are doing night time driving the road and the outside carriageway portion all are, all look black because most cases the roads are between us, roads between espionage.

So, which look black, so the painting, road marking is really extremely important, it tells you clearly that is the road portion. Especially during night-time and also during driving in difficult weather condition, when it is raining, fog or snow, the visibility is low, then this marking really is very important, and also for old age drivers who probably otherwise have some issues related to the vision.

Edge lines especially have very significant impact on roadway departure crashes. And one thing, let me tell you, the lane markings are also very important, you cannot drive, you cannot have a high-speed facility without lane marking, so that way the longitudinal markings or lane markings, edge markings, they are very important.

Because the distance between two vehicles you can assess but the lateral placement where exactly you are located laterally, that it is very difficult to access, so the lane marking, edge marking, they are longitudinal markings in all forms they are very very useful and they are important not a decoration, it is not that road, yes, road also will look very different, very nice, once you have a proper road marking, the visibility and glaring, retro deflection characteristics will be very different, but that is not the only thing, it has got a scientific role to play, there is a scientific reason and it has a role to play in terms of the safety and efficiency of vehicular

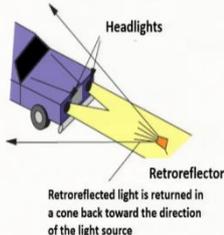
movement. Raised pavement markers have an impact on night-time crashes depending on the AADT and also degree of curvature.

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Factors Influencing Human Characteristics

Retroreflectivity in Marking and Signage

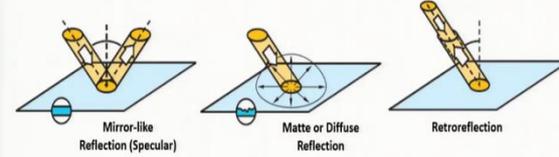
- A measurement of efficiency of a pavement marking to return light in the general direction from which it came
- Generally achieved either by 'glass beads' or 'prismatic cube corners' on the marking material



Headlights

Retroreflector

Retroreflected light is returned in a cone back toward the direction of the light source



Mirror-like Reflection (Specular)

Matte or Diffuse Reflection

Retroreflection



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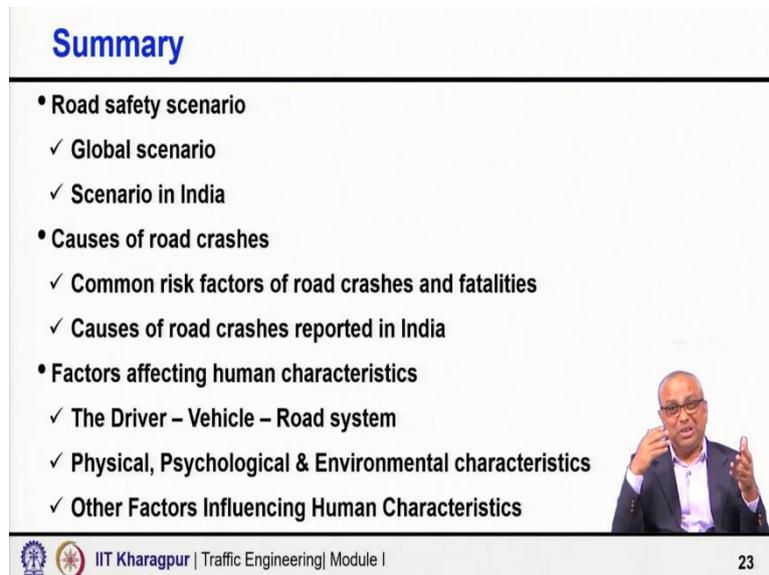
Retro reflectivity in markings and signage, again a very important factor, I am only, you know all these things, you know what is the road marking, different types of marking, you know driver's characteristics, you know vehicle characteristics, you have studied all those, I am only touching upon this thing again to show you the linkage with the safety, for safety everything is important. So, do not they think it is a requirement just like that, it is requirement for the safety, there is a direct link.

So, retro reflectivity as you know is a measurement of the efficiency of a pavement marking to return light in the general direction from which it came. Generally, in terms of road payment, this is achieved by putting glass beads or prismatic cube corners on the marking material. So, that way it is achieved and more and more innovation is happening and you know these days very high-quality retro reflective sheets are available which you can use as road sign very good retro reflection it gives, even the paint also, the road painting or road marking also can give you very good reflection, provided you use actually a very good quality material.

And codes are there, you refer to Indian codes, the relevant code for road marking, the relevant code for road signage, installation, what characteristics, what property, I mentioned all those look at my lectures in module A, try to link, so there are codal provisions, it is not that bad that we do not know anything, there are things which are quite known, quite established, scientifically proved also and accordingly included, what all we need, to follow those and

follow those not that because the road will look nice, follow those if we really want to address the concerns related to road safety and fatalities.

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Summary

- **Road safety scenario**
 - ✓ Global scenario
 - ✓ Scenario in India
- **Causes of road crashes**
 - ✓ Common risk factors of road crashes and fatalities
 - ✓ Causes of road crashes reported in India
- **Factors affecting human characteristics**
 - ✓ The Driver – Vehicle – Road system
 - ✓ Physical, Psychological & Environmental characteristics
 - ✓ Other Factors Influencing Human Characteristics

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So, all together what we discussed in this lecture is about the road safety scenario, the global scenario, the scenario in India, how the road fatalities are happening, at what rate it is happening, how the vulnerable road users are involved, how the trends are changing and to tell you some of the very important findings from the data that will tell you in which direction why road shift is important, why we need to focus on various aspects, where more focus is necessary and to really move forward in a scientific and systematic manner.

Then we discussed about the causes of road crashes what are the common risk factors of road crashes and fatalities, what are the road causes of road crashes as per the road crisis reported in India? What are the factors affecting the human characteristic, because human characters have a big role. And then, I discussed about the driver vehicle and the road system how the feedbacks and everything happen and why the human characteristics are important then various physical psychological and environmental characteristics which impact or influence the human characteristics and behaviour and also the other factors which may have an impact on human characteristic. With this, I close this lecture, thank you so much.