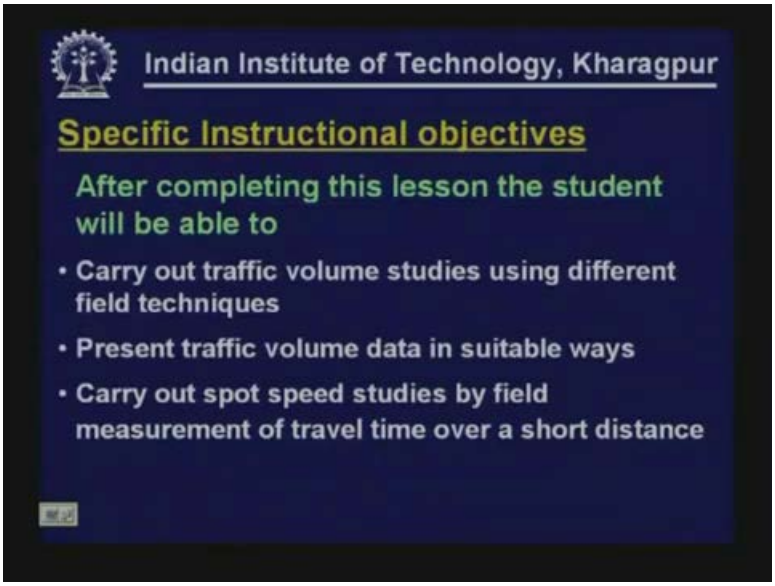
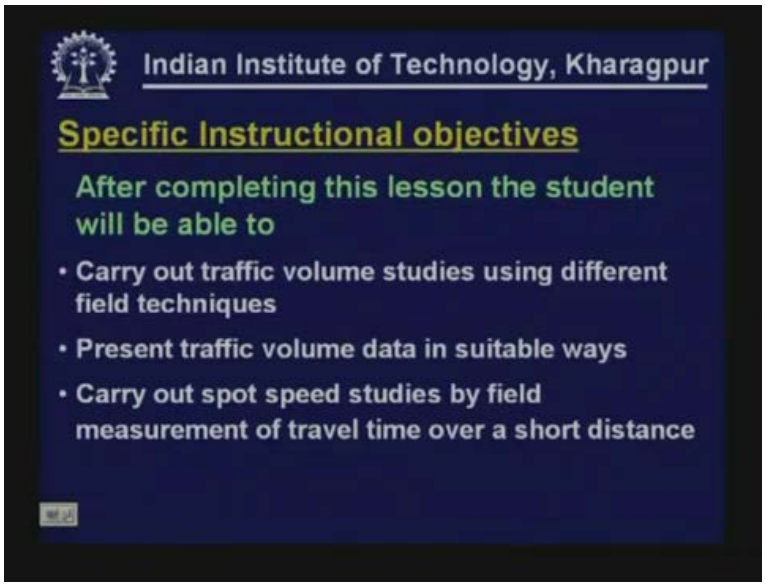
Introduction to Transportation Engineering
Dr. Bhargab Maitra
Department of Civil Engineering
Indian Institute of Technology, Kharagpur
Lecture - 4
Traffic Studies: Part - 1

(Refer Slide Time: 00:58)



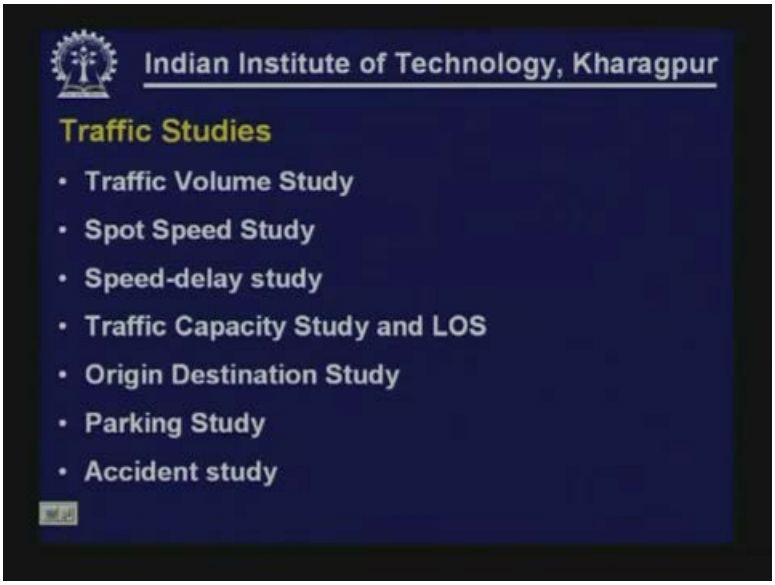
Lesson 2.3 Traffic Studies part I. After completing this lesson the student will be able to carry out traffic volume studies using different field techniques so they will expose to different field techniques and they will be able to carry out traffic volume studies. The student will be able to present traffic volume data in suitable ways there are different ways traffic data are presented for meaningful interpretation and analysis so they will be able to present traffic data and also carry out spot speed studies by field measurement of travel time over a short distance.

(Refer Slide Time: 01:02)



There are different ways for carrying out spot speed studies so after covering this part they will be able to carry out spot speed studies by field measurement of travel time over a short distance. For various reasons it is necessary to carry out traffic studies.

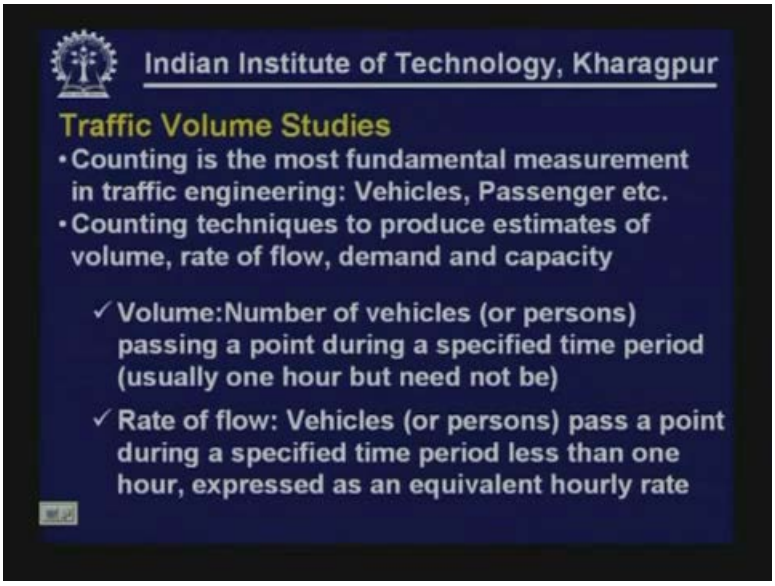
(Refer Slide Time: 02:15)



There are several types of traffic studies that are carried out including traffic volume study, speed study and within the speed study also spot speed study, speed and delay study, traffic capacity study and level of service, origin destination study, parking study, accident study and there are so many other kinds of specialized traffic studies. They are all different types of studies which are required to be carried out for specific purposes.

In this lesson we are not going to discuss about all the traffic studies but we will cover the most commonly used traffic studies like traffic volume study, spot speed study, speed and delay study are the three major and commonly used traffic studies.

(Refer Slide Time: 03:20)

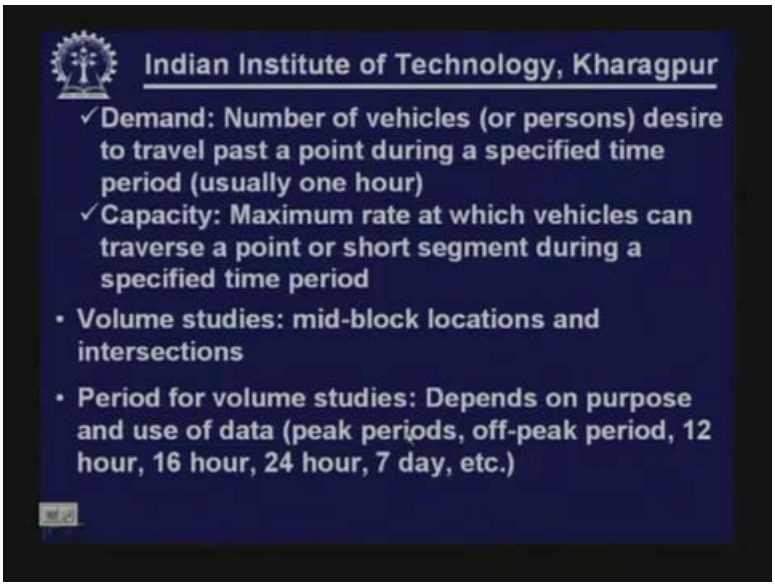


Coming to traffic volume studies counting is the most fundamental measurement in traffic engineering, counting of vehicles, counting of persons so for various reasons we are required to go for counting. so it may be person, it may be vehicle but counting is the elemental requirement as to how many people, how many cars or what would be the traffic vehicular traffic in general so counting techniques are used to produce estimates of traffic volume, rate of flow, demand and capacity. These are the related terms so let us try to understand them. First is:

Volume: what is volume? Volume is basically number of vehicles or persons as I indicated, it may be vehicle or person passing a point during a specified time period which is usually one hour but need not be. that means during a period of time it may be fifteen minutes, it may be half an hour, it may be even sixty minutes or one hour and how many vehicles or persons are passing a point during that particular time period is known as volume.

Rate of flow: Rate of flow is the number of vehicles or persons passing a point during a specified time period less than one hour expressed as an equivalent hourly rate, that's what is the difference. Here may be if I carry out a study for thirty minute duration I may say what will be the volume in thirty minutes, I can express it. But when the same thirty minute volume when I expressed it as an equivalent hourly volume that means if in thirty minute if there are X vehicles then in one hour then it is 2X so I say rate of flow is 2X vehicles per hour, that's the difference. One is the actual number during the specified time another is the number expressed as an equivalent hourly rate.

(Refer Slide Time: 05:43)



Demand: In traffic volume studies we also measure the demand not always but in many cases we measure the demand actually. It is number of vehicles or persons who desire to travel past a point. Carefully observe this point desire to travel. What we are actually measuring in the field we have to be really careful whether we are really capturing all those who desire or we are capturing only a part of that. So number of vehicles or persons decide to travel past a point during a specified time period, again usually it is one hour. And capacity is maximum rate, carefully observe this part, it is rate at what can be observed again and again, it is not the maximum volume that once in a life time is achieved it is not that but what can be achieved again and again.

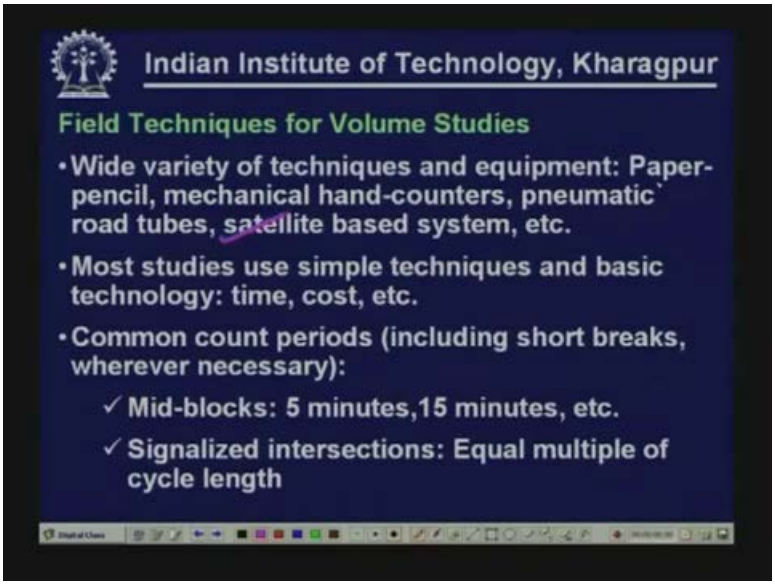
The maximum rate at which vehicles can traverse a point or short segment during a specified time period is also again expressed as rate that means hourly flow rate. We shall elaborate more on this capacity definition. We are just introducing the capacity terminology here. It is the maximum rate but there are other aspects which are also essential to define capacity in a complete form so we will come back to that part.

The traffic volume studies are our focus here for this lesson. Volume studies are carried out primarily at mid block locations and at intersections. These are the two places where normally carry away traffic volume studies. if you take up a road there are mid block sections and intersections so within that intersection area within the intersection influence area we normally call that location as intersection block and away from intersections that is the area which are free from the influence of intersections are called mid block locations. So we carryout traffic volume studies for mid block locations and as well as for intersections.

Next point is what should be period of volume studies, for how much period we must carry out the traffic volume studies. This again it all depends on the purpose and use of the data. What is the reason or why we are carrying out traffic volume studies? It may be like peak hour or peak period, morning peak, evening peak or may be twelve hour volume count, it may be sixteen hour

volume count, it may be twenty four hour volume count, it may be seven day volume count so it is possible to have different traffic volume studies covering only peak hours may be seven days and may even be three sixty five days a year, permanent count stations. So basically all depends on the purpose. So we have to understand why we are carrying out traffic volume study what is the possible use of the data and accordingly we have to decide what should be the duration for carrying out studies.

(Refer Slide Time: 09:25)



Field Techniques for Volume Studies:
Wide variety of techniques and equipment are available starting from the very crude or very simple way of doing that to using very sophisticated equipment or advanced technologies. wide variety of techniques are available starting from paper pencil, mechanical hand counters, pneumatic road tubes up to even satellite based system etc. So I have mentioned it in the order of the simplest to most advanced or technology supported ways and means for doing or instance. There are wide varieties of techniques that are used but most studies use simple techniques and basic technology. The question is why, the answer is time and cost.

As I have told you can even use satellite based system but we have to look at the need for the project, need for the data what you want, what level of accuracy is really necessary for the project and so on and if we are talking about very sophisticated technologies even that may be too expensive and it may not be possible to set up that equipment or system within a very short duration or period of time.

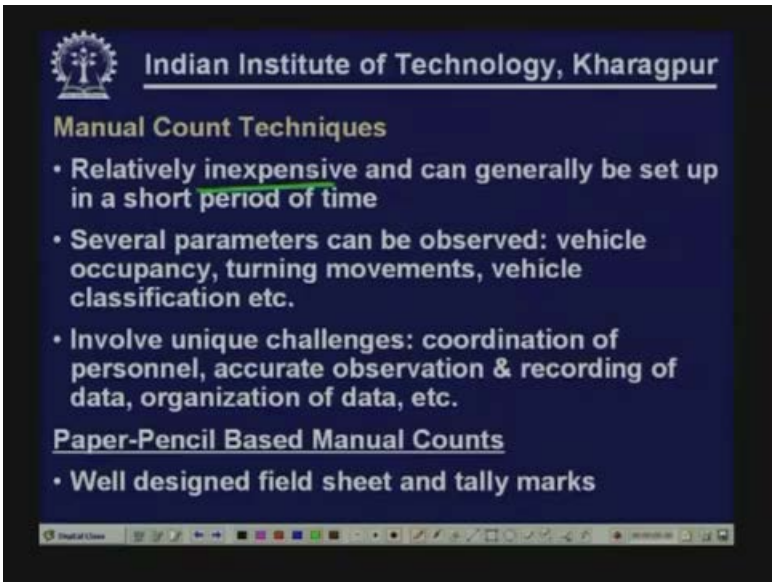
On the other hand if you are using manual based count techniques accuracy may be little but limited in some cases. Of course you can improve the performance there are so many ways and methods to do that but in some cases or almost in all the cases it is very simple, very simple you can quickly set up and it is not expensive. So mainly considering the time requirement and considering the cost requirement more studies are carried out using simple techniques and basic technology, these are the two things.

Now, common counting period as I told it may vary widely depending on the need but still trying to give you little bit idea about mid block counts. Normally that is the duration of studies and this we are talking about the count period. Now these two are different. Duration of studies means for how much period should I carry out traffic volume studies, is it for one day or peak hour or twelve hours, sixteen hours that is the counting period, but then what is the actual period of studies known, what should be the duration of counting, should I make fifteen minute count, should I record fifteen minute traffic volume data, five minute traffic volume data or every minute traffic volume data so that's the question we are trying to answer.

Now for mid block studies normally five minutes or fifteen minutes count is used. that means we record the total data that's the most disaggregate level we collect the data so we will have fifteen minute data and then we may add fifteen minute data and then try to get hourly flow and then and want to see the variations and all sorts of things. But common count period for mid block volume studies are five minute or fifteen minute.

Now remember that we normally do not use very small period of counting because you may get very instant fluctuations in traffic volume which are not steady traffic volume. So, if we try to calculate the rate of flow by multiplying proper duration of counting or time then we may get unusual high values which are not practical which are not of steady flow. So normal duration of counting is five minute, fifteen minute for mid blocks and for signalized intersection it is equal multiple of cycle length because we cannot say whether it is five minute or fifteen minute or three minute but it should be equal multiple of cycle length. It is because signalized cycle means cycle length is the unit so it should be multiple of the cycle length.

(Refer Slide Time: 14:02)



First coming to manual count techniques: manual count techniques as I mentioned they are relatively inexpensive, it can generally be set up in a short period of time, you can quickly set up count techniques. These are the major two advantages for which we go for manual counts. There are other advantages also like several parameters can be observed which for automatic or

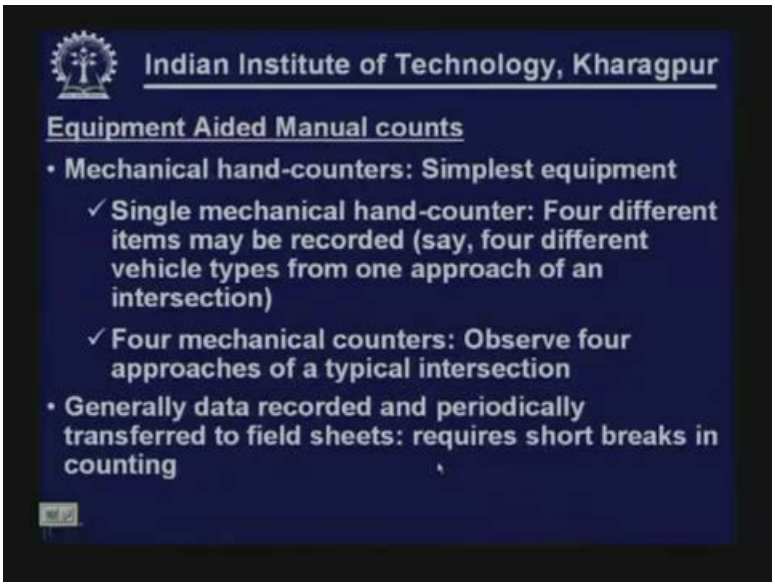
machine based recording system it is difficult or impossible to observe practically like vehicle occupancy and the turning movements like how many are turning left, how many are turning right, how many are going straight in an intersection and so on.

So this kind of data occupancy data, turning traffic data, vehicle classification data like how many are cars say we are using sophisticated equipment may be we will be able to classify car and bus but within cars suppose if we want private current taxis are to be recorded separately because taxis generally have fixed color so by looking at the vehicle itself you can understand that this is a taxi and the other vehicle may be a private vehicle. But in automatic count it is very difficult to classify them as which one is taxi and which one is a private car. So in some cases manual count techniques are extremely useful because a large number of parameters can be observed like vehicle occupancy, turning movement, vehicle classification etc.

But manual count techniques involve unique challenges to be understood very clearly. Challenges are in terms of coordination of personnel. So many people are working may be if you are carrying out traffic volume study at a mid block location or at an intersection may be some ten, fifteen, twenty thirty people might be working, coordinating the work coordination is a major challenge so that part is to be ensured, then accurate observations and recording of data this is again a challenging task because manual component is involved, sometimes all the people may not be equally serious when they are in the field so you have to ensure that they are really doing the work, they are really looking at the vehicle and recording it either using pencil and putting tally marks or using some kind of counters. Hence this is a manual process so you have to make sure that they are serious and they are really doing the work, recording the data is correct, accuracy of observation and recording, organization of data are all done properly. These are some of the unique challenges involved in manual counting.

We carry out paper and pencil based manual count where we use well designed field sheets and tally marks. there will be a fixed format where required vehicle classification will be given, time period will be given and enumerators normally we call them enumerators we collect the data in the field particularly for traffic volume studies so they will actually use paper and pencil based noting down or recording of data so they will simply put tally marks and then try to do that. Normally we put tally marks like 1, 2, 3, 4 and 5 and then again 1, 2, 3 which means 8 vehicles have been counted. So well designed field sheet and tally marks we use. This is paper and pencil based manual count.

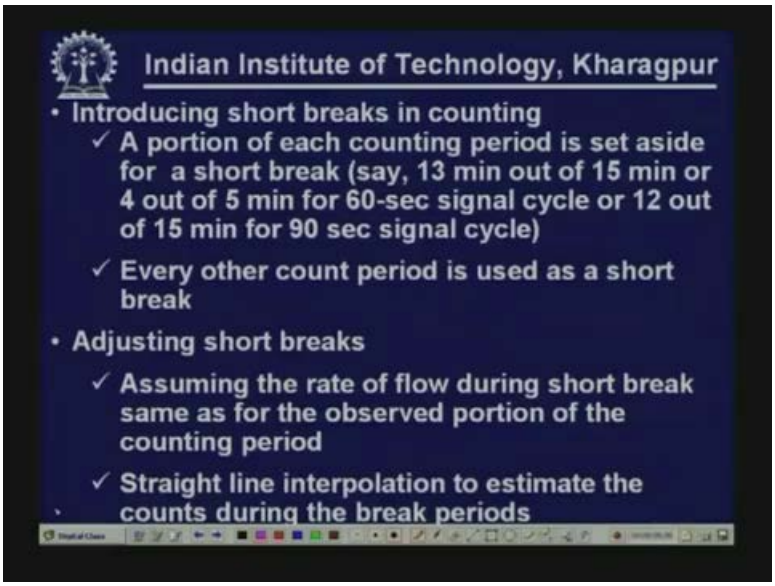
(Refer Slide Time: 18:30)



Equipment Aided Manual counts: is also common. Here most of the times the commonly used thing is mechanical hand counters. So mechanical hand counters are used they are simplest equipment. A single mechanical hand counter normally can record four different items. Normally a single mechanical hand counter can record four different items may be four different vehicle types from one approach. So may be one person using a mechanical hand counter to observe traffic volume from an intersection approach can record four different vehicle types for example, one may be a car and another is a two wheeler, another may be a bus, another may be commercial vehicles. Therefore four different items may be recorded by one hand counter.

Suppose we need to record four different vehicle types for all four approaches simultaneously then maybe we require four mechanical counters to observe approaches of a typical intersection. In mechanical hand counters generally data is recorded and periodically transferred to field shield. Automatically once you observe a vehicle you press the button, again you observe the vehicle you press the button then periodically this data is to be transferred to the field sheet. So when you are transferring it you are essentially giving a break. Therefore in this process it is required to give short breaks in counting. Why these short breaks are necessary? Let us again try to understand it clearly. It is because we need to transfer the data from mechanical hand counter to field sheet periodically. So when you are transferring it then at that time exactly it is not possible to really count and record the vehicle volume so during the process of transferring the data there is a break that is necessary so it requires short breaks in counting.

(Refer Slide Time: 20:35)



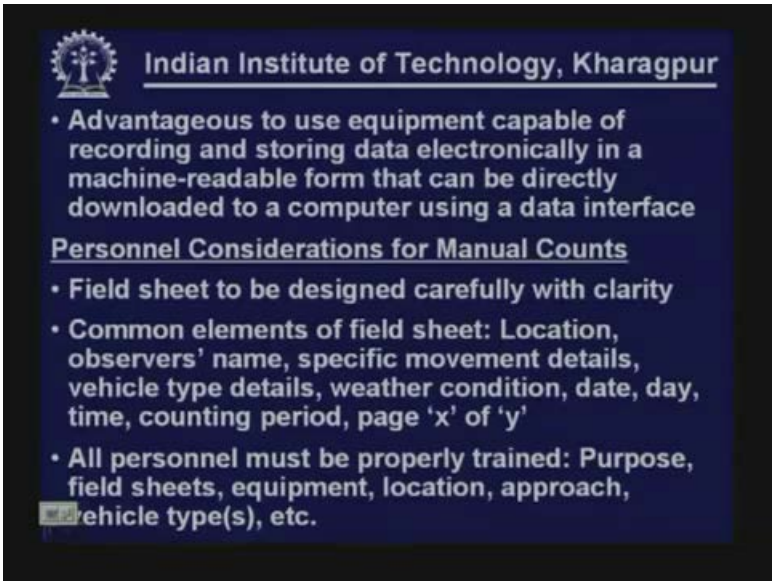
In two different ways the short breaks can be introduced. One is a portion of each counting period is set aside for a short break. Again let us try to understand that. Suppose if it is a fifteen minute counting so every fifteen minute we are trying to record the traffic data. That means from six to six fifteen what is the traffic volume, six fifteen to six thirty how many traffic volume and so on. So it is actually for fifteen minute but we may record traffic volume data for thirteen minute in every fifteen minute and two minute time we can use for transferring the data. So it is thirteen minute out of fifteen minute or may be four minute out of five minute and if it is sixty second signal cycle it has to be multiple of the signal cycle length or maybe it is twelve out of fifteen minute if it is a ninety second signal cycle.

Now why I have mentioned it here twelve out of fifteen, four out of five is because look at this thing these are all multiple of the signal cycle that's why I have mentioned it in this way. The other alternative is don't take two minute or one minute from the counting period but do the counting alternatively. That means every other count period is used as a short break.

So, suppose if it is fifteen minute duration counting we will do counting for fifteen minutes, next fifteen minutes we don't count and again next fifteen minutes we count, next fifteen minutes we don't count and like that we proceed. Obvious question is yes now we have understood how we introduce short breaks but then the question comes how we will adjust short breaks. Yes, there are simple ways one can adjust this breaks. If we are following the first method like thirteen minute out of fifteen minute we are doing the counting and we want to know the traffic volume for fifteen minute what we do is we assume the rate of flow during short break same as for the observed portion of the count period. That means suppose if I have work observed X1 number of vehicle in thirteen minutes then this may be the traffic volume x1 by 13 into 15. I will assume that it will be the traffic volume during the fifteen minute period. That means I am assuming that rate of flow during short breaks of two minutes is same as for the observed portion whatever you have observed in thirty minute during the counting period, whatever rate of flow served it is the same.

If you are following the second method like every other count period you are using then a straight line interpolation may be done to estimate the counts during the break points like if I plot it like say time wise if you do here I have the worst, here again second I have not observed, third I have observed, fifth I have observed so I may now interpolate it whatever is the in between traffic so here it is this volume and here it is this volume so a straight line interpolation may be done to estimate the counts during the break periods. From this discussion it is obvious that introducing breaks means yes. There are the alternative ways we can introduce breaks. There are ways also we can adjust this traffic volume to take into consideration the effect of breaks. But it is obvious from this discussion that it is advantageous to use equipment which is capable of recording and storing data electronically in a machine readable form that can be directly downloaded to a computer using a data interface which is a more advanced technology.

(Refer Slide Time: 24:54)



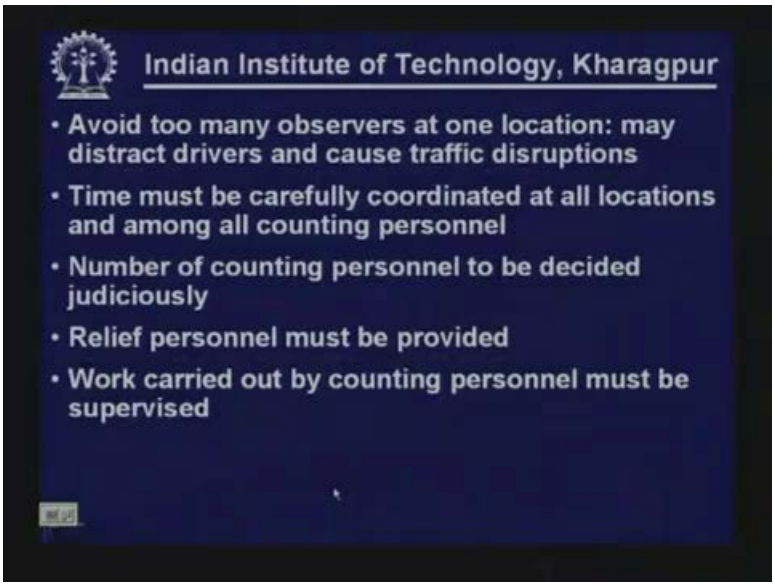
So logically I need not elaborate much on this point because it is understood that such kind of equipment will definitely be advantageous. There are equipments capable of doing this kind of a thing. Now as I mentioned earlier that manual counts are simple, economical, can be set up quickly but there are certain unique challenges particularly personal consideration for manual counts. Let us try to understand those points. It is necessary to design field sheets with clarity, every field sheet should be very clear as to where the volume count is happening, for which direction, what are the vehicle types, what is the duration of counting, what is the day, what is the time, what is the climatic condition and where to record the data, whether to use tally marks or some other way to do the entry and so on. So field sheets are to be designed carefully with clarity, that's the first point.

Therefore as a continuation of first point the second point is I have tried to indicate some of the common elements which are included in the field sheet like location, observer name, specific movement details whether left turning movement is taking place or right turning or the straight movement, what are the vehicle types that are getting recorded in a field sheet, what is the weather condition, date, day, time, what is the counting period that is used and normally suppose

if you are taking fifteen minute count and the period of the volume study is eight hours say for example then so many sheets will be required so it is normally helpful to put like this page X(Y) so page 1(10), 2(10), 3(10) like that so those ten pages are the traffic volume data for a particular location, for particular vehicle types and for particular directions.

Then the second important part is all personnel must be properly trained because it is enumerated or field people who are going to record the data so they must be trained properly. They should understand each and every column or information which is there in the field sheet and which is to be recorded in the field. So a total clarity is necessary in terms of understanding the field data, understanding the survey, what to be recorded, where to be stored, how it is to be retained, what are the other places that enumerator should fill up, and all this equipment, all these things must be known to the key personnel or field people. They should know the purpose as to why they are carrying out this thing, what field sheet they are using, what equipment to be used, where the survey is to be carried out, which approach of an intersection for example is to be taken, what are the vehicle types a person will record, all these should be known and that's possible only when enumerators are well trained well in advance. So before you go the field you have to go to the enumerators, sit with them explain them may be carry out a pilot survey if necessary to make sure that they have understood the requirements.

(Refer Slide Time: 28:48)



Avoid too many observers at one location may distract drivers and cause traffic disruptions. We want to record the natural condition. We want to record the activities that take place in a natural condition. So, if too many people are making a crowd in one place then drivers may think what is happening here so their natural movement may get disturbed we don't want that so that is to be avoided. Time must be carefully coordinated at all locations or all counting personnel. May be at a time three intersections are covered for traffic volume studies. Now, at all the three intersections for all the people the watch should be or the clock should be coordinated, they should start at the same time. If it is 9 O' clock at all intersections people should write 9 O' clock otherwise in one place people will write 9 O' clock and the other will write nine five and other

nine ten so that will give problem that will give difficulties in terms of interpretation and analysis so time must be carefully coordinated at all locations and among all counting personnel.

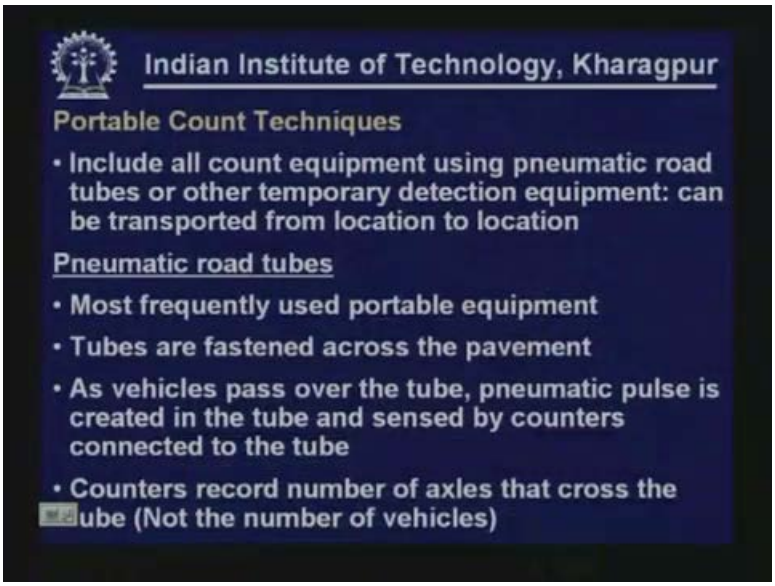
Number of counting personnel is to be decided judicially. By this way it is very difficult to give a rule as how many persons will be required. one should basically go to the field and see at what level he wants to collect the data or is it really necessary to collect the data, how many vehicle types, how many approaches, how many traffic lines are there, what is the traffic volume, what are the different shears the average shears of different vehicle types in the total traffic volume and then one can decide how many personnel or how many persons will be really required to do the survey or to do the studies in a proper manner with desired level of accuracy.

(Refer Slide Time: 30:37) Suppose there are two vehicle types we give to one person and both vehicle types there are a lot of vehicles then you may not be able to count that so one should judge may be give one traffic vehicle type which is generally predominant in the traffic stream and may be with that one more vehicle type which you know occasionally is coming in the traffic stream that may be possible. So you have to decide the number of counting personnel judiciously.

Relief personnel must be provided because we need the enumerators to count the traffic continuously so it is eight hours a person cannot work continuously you will require may be a cup of tea or need to go outside for drinking water, taking rest for five ten minutes so you must provide adequate relief personnel. So in rotation everybody gets paid and otherwise if you don't provide then they will not count they will probably go away and there will be no counting during that period.

Finally the most important thing I believe is the work carried out by counting personnel must be supervised, there should be adequate number of supervisors to supervise whether really the coordination is there in the overall work, to see if everybody is working properly, everybody is recruiting the number correctly in a systematic manner so the whole system of data collection is working in a smooth manner that is to be ensured by a proper supervision so that supervision is very necessary.

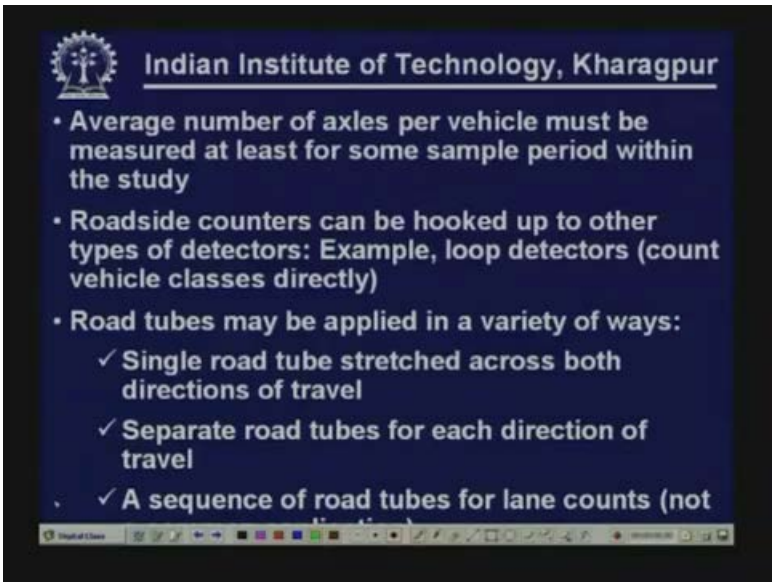
(Refer Slide Time: 32:15)



Portable Count Techniques: This is another kind of count technique. It includes all count equipments which are used in pneumatic road tubes or may be other temporary detection equipments. We are calling this as portable count technique because this pneumatic road tubes or temporary detection equipment can be transported from one location to another location. you have carried out traffic volume studies at location A, you can take the whole set up and go to location B so we are calling them portable count technique, that's why we call this as portable count technique.

The pneumatic road tube is the most frequently used portable equipment. Tubes are fastened across the pavement, you just place them across the pavement and as vehicles pass over the tube pneumatic pulse is created in the tube and is sensed by counters which are connected to the tube so that way it can understand yes one axle has crossed this tube because the pulse goes and counters can sense that. Remember that counters record number of axles that cross the tube and not the number because the pulse is generated every time an axle crosses the tube. Hence the number of pulse getting generated will be an indication of how many axles have crossed but it will not give the vehicle number directly. So it is necessary to carry out studies at least for some sample period to estimate the average number of axles per vehicle.

(Refer Slide Time: 34:09)

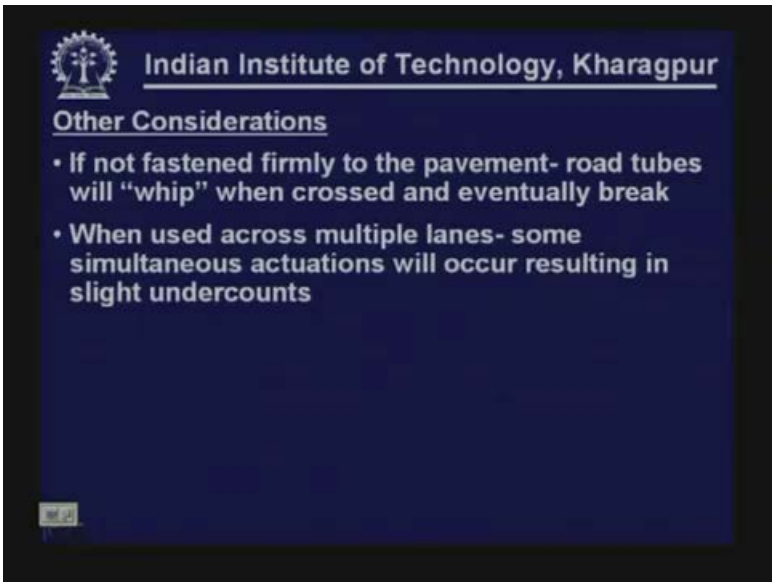


Normally I am sure many of you might be thinking it's a two axle but it is not really so. If you do traffic volume studies on highways there are so many commercial vehicles which are having axles more than two. So, if we observe the number of axles on a sample basis then we can calculate the average number of axles which are applicable for the given location and accordingly from the recorded pulse pneumatic pulse or number of axles we can divide it by the average number of axles per vehicle to get an estimate of number of vehicles.

Road side counters can be hooked up to other types of detectors. Say for example loop detectors which can count the vehicle number of classes directly. Road type tubes may be applied in a variety of variety of ways. There are so many ways the road tubes can be applied may be a single road tube stretched across both directions of travel. May be this is one direction; this is another direction you put one road tube and that is recording both directions of movement.

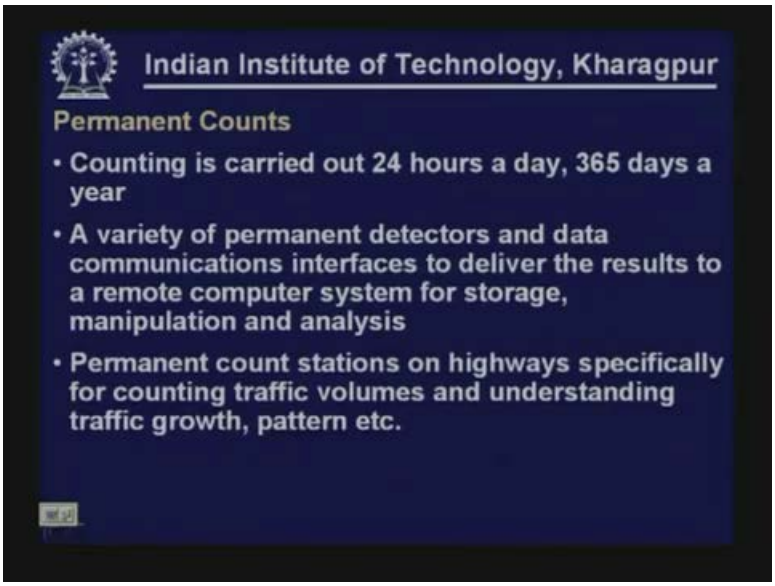
Separate road tube for each direction of travel: If it is a divided road may be with divider that is with a median in between then one road tube will be here and another road tube there so there are separate road tubes for each direction of travel or a sequence of road tubes for lane counts. Even in one direction there could be some three or four lanes so it may be necessary to record the traffic volume data lane-wise. So if one pneumatic tube is placed across all the lanes then we know the total volume but we do not know the lane-wise distribution. So if necessary a sequence of tubes may be used for lane counts but it is not a very common practice, it is not done commonly. In most of the cases we use separate road tubes for each direction of travel.

(Refer Slide Time: 36:53)



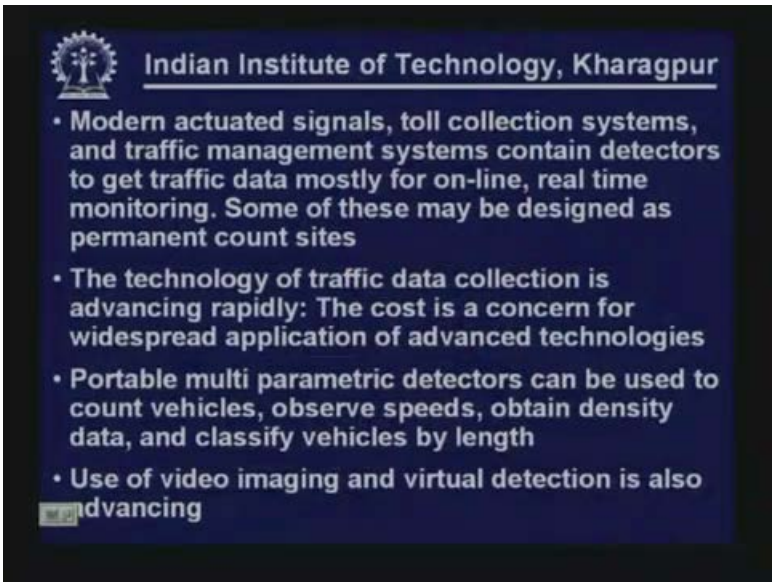
Remember that if not fastened firmly to the pavement if we are not fastening the tube properly on the pavement then road tapes may get damaged because a large number of vehicles will cross the tube and the tube will eventually break. So you have to make sure that tube is fastened firmly to the pavement and when used across multiple lengths there may be some simultaneous actuations which will occur therefore you may get slight undercounts. Why it is happening? Every time a vehicle crosses the tube the pulse will go. So if there are multiple lanes and at a time may be two vehicles are crossing the tube it may not happen all the time but it is possible that occasionally two vehicles may cross the tube at the same time so a single pulse will go and it could be recorded like a single axle has crossed the tube which may eventually result in slight undercounts.

(Refer Slide Time: 37:41)



There are permanent counts with stations where the counting is carried out twenty four hours a day and three sixty five days a year. A variety of permanent detectors and data communication interfaces are used to deliver the results to a remote computer system for storage manipulation and analysis. So 24 hours 365 days this permanent set up is available and is counting traffic volume data. We have permanent count station on highway specifically for counting traffic volumes and understanding traffic growth, pattern etc. now with this development part it is very much necessary for us to understand the traffic growth as how the traffic volume is growing, what is the seasonal variation of traffic not that monsoon, winter, summer etc the traffic volume is not same so how the traffic volume changes from rainy season to winter to summer and so on. Therefore permanent count station traffic data is a very, very valuable source for estimating signal variation, for understanding traffic growth factors and all sorts of other traffic data requirements.

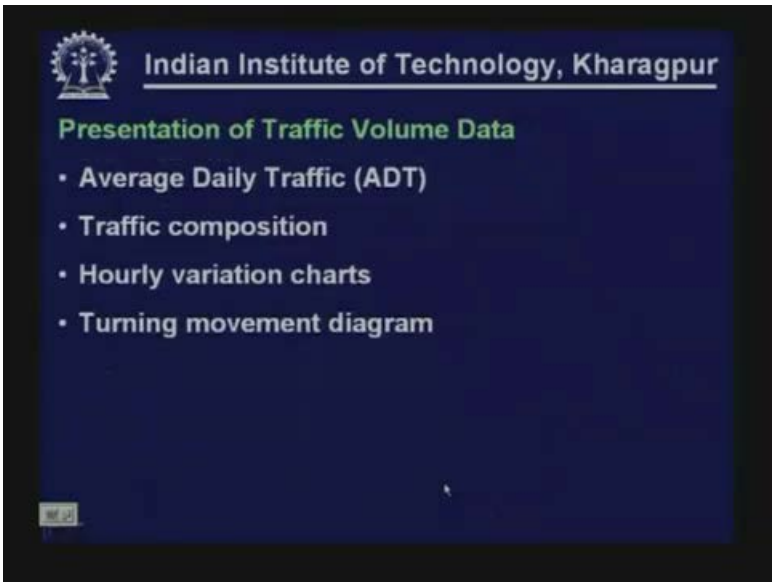
(Refer Slide Time: 39:00)



Modern actuated signals, toll collection systems and traffic management system contain detectors to get traffic data mostly for online real time monitoring. Some of these may be designed as permanent counters. So the idea is they are doing the traffic counting but this is for online monitoring. It is not really working like a permanent count station, it is recording the data but the purpose is different, the purpose is online monitoring. So some of these places may be converted with additional little bit accessories and equipment to work as permanent count station data.

Finally remember that the technology of traffic data collection is advancing rapidly. The major concern is the cost for wide spread application of advanced technologies. I indicated in the beginning itself, you have the technologies available there is no problem. But is it economical to use those technologies for a common purpose, the probable answer is no, so the cost is a major concern for widespread application of these advanced technologies. And even use of video imaging and virtual detection is also advancing rapidly. Already in some places it is available also. At research level it is successful that the video imaging or the virtual detecting system does the traffic volume count and collect so many other related data.

(Refer Slide Time: 40:45)

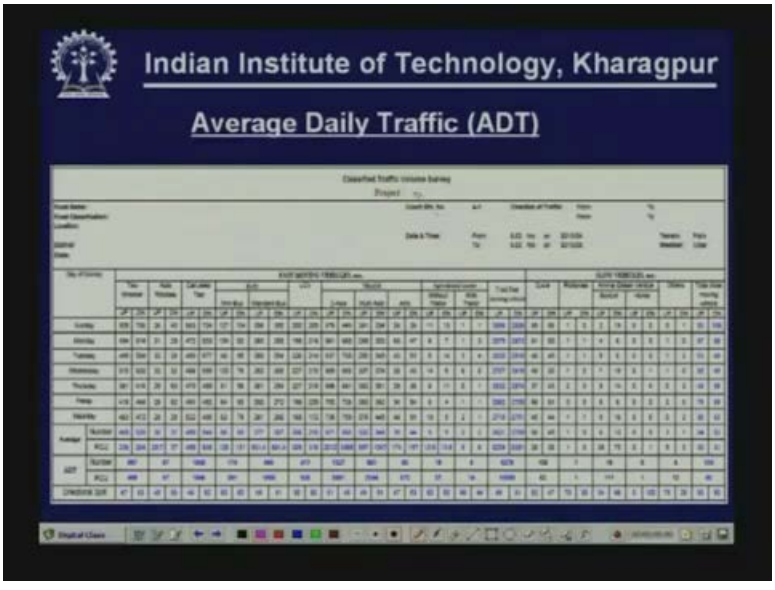


How to present the traffic data? There are so many ways the traffic data may be presented;

- Average daily traffic
- Traffic composition
- Hourly variation chart
- Turning moment diagram this is applicable for intersections

So there are so many ways in which these traffic volume data may be presented. Let me quickly show you some of those things.

(Refer Slide Time: 41:10)

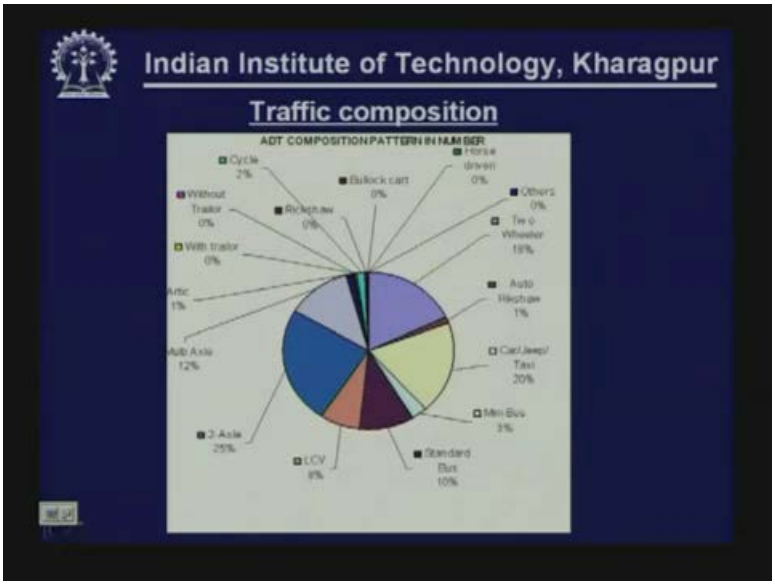


This is the average daily traffic data. I know it is difficult to read anything from that, you may not read the number really but what is the information we are trying to put in a concise form is what one should observe carefully. This I have given the projects, you give the project name, this is the count station number, data and time, direction of number, what is the terrain condition, what is the weather condition, what is the district, it belongs to which state or which part, this is the road name, location and everything. Now here what we are trying to show is a typical example of representing seven day traffic volume data. So this is Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, and Saturday and so on.

Then there are two broad classes; fast moving vehicle and slow moving vehicle. Under fast moving vehicle there are other different vehicle classifications like two wheelers, three wheelers and all sorts of thing. Further there are two columns; one for up direction traffic and other for down direction traffic everywhere. You take another thing this is for up direction and this is for down direction traffic and here we are presenting the seven day average as what we have observed. First row is number so this is representing the number and the second is the equivalent volume in Passenger Car Unit or PCU so you know the concept of PCU also.

Then with that we are estimating ADT because it is a seven day traffic volume count. What is ADT? It is considering up, down and vehicle-wise separately and then totaling it up. Here this is the one where we are showing the directional speed as what is the speed at directions up and down. So you can see that in a very concise form you can present many related information. I have shown the seven day variation, have shown vehicle-wise what is the number and then in vehicle number, in PCU, in up direction, down direction and then slow moving, fast moving, doing the ADT calculation everything in a fully concise form. There are innovative ways to design your own average daily traffic representation chart but this is just an example.

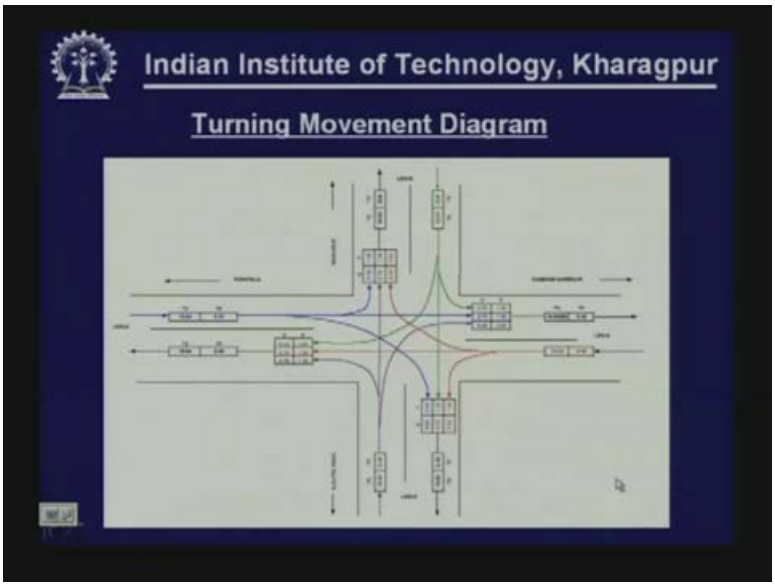
(Refer Slide Time: 43:33)



This is an example of how you represent traffic composition over a given period of time. With the help of a pi chart you can easily present the shear of different vehicle types in the total traffic

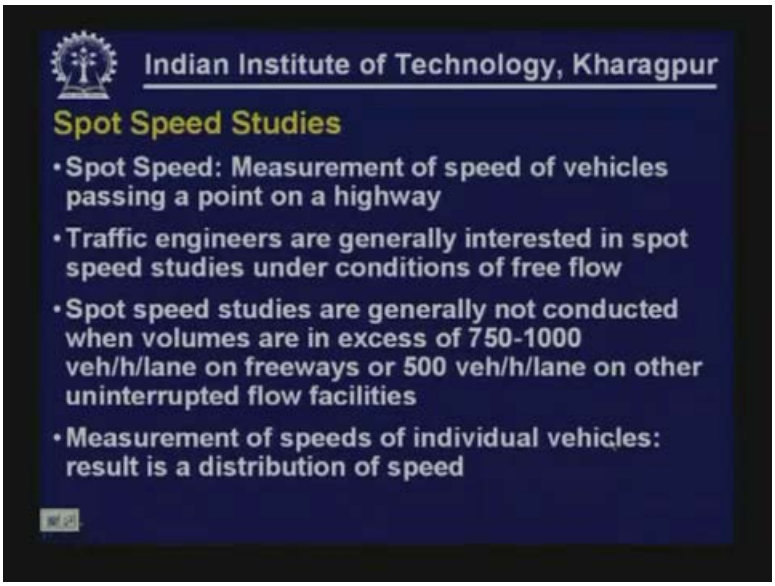
stream. Then this is showing the hourly variation chart, it starts from 7 O'clock in the morning and goes up to 7 O'clock in the morning till the next day so it shows how the traffic volume is changing in 24 hours. One I am showing for fast moving vehicle, another for slow moving vehicle, this pink one here and this blue line is showing the total number of vehicles. It is basically that you can show the fast moving vehicle, you can show the slow moving vehicle separately, you can show the total vehicle, you can show in number, you can show in PCU but this is a form in which you can present this hourly variation where one can easily understand.

(Refer Slide Time: 44:28)



This is the way of representing turning traffic movement count. There are other ways of presenting that; what is the total traffic is coming here, then how much is talking left turn, how much is going straight, how much is taking right here etc. So, if you come here take another approach what is the total volume coming out of that how many is coming from this direction, how many is coming from this direction, how many is coming from this direction and so on. So in one figure itself you can show all the traffic volume, all the turning traffic, how many are coming, how many leaving each approach and how they are getting distributed, how many are entering into easy approach, where from they are entering etc and this may be for peak hour we represent it as what is the happening in the peak hour and accordingly this goes as an input for traffic signal system design or traffic signal design. This is about the traffic volume studies.

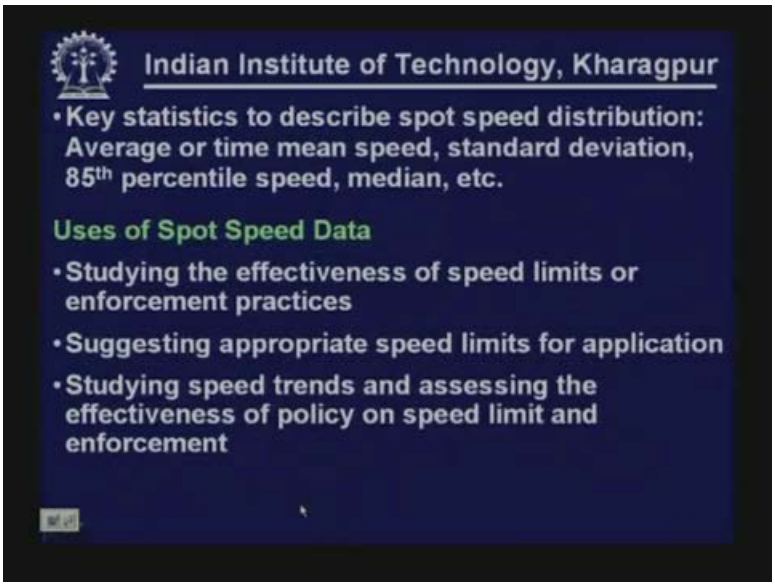
(Refer Slide Time: 43:52)



Spot Seed Studies: You know what spot speed is. It is the measurement of speed of vehicles passing a point on a highway, it is the point measurement, point measurement over a period of time. Now traffic engineers remember that they are generally interested in spot speed studies under condition of free flow because that's where we can use the spot speed data. If the road is under congestion, if the speed has already come down drastically then there is no point in carrying out spot speed study. So traffic engineers are normally interested for spot speed studies when the traffic volume is not heavy or rather the traffic is flowing nearly at a free flow condition. Remember that spot speed studies are generally not conducted when volumes are in excess of 75,000 vehicles for freeways and 500 vehicles per hour per lane on other uninterrupted flow facilities. Therefore if the traffic volume is more than the suggested range normally we do not carry spot speed study because this is an indication that traffic is no more at a free flow or near the free flow state and already congestion has started occurring.

If you measure the spot speed for a given situation, the road is fixed, the environmental speed, if you measure speed of different vehicle types you will find that the speed is not the same, not that you observe ten or twenty or hundred vehicles and not that they will give you the same speed. Therefore it is an indication that if you measure the speed of individual vehicles they cannot be the same or the result is distribution of speed, that's why we say speed follows certain distribution.

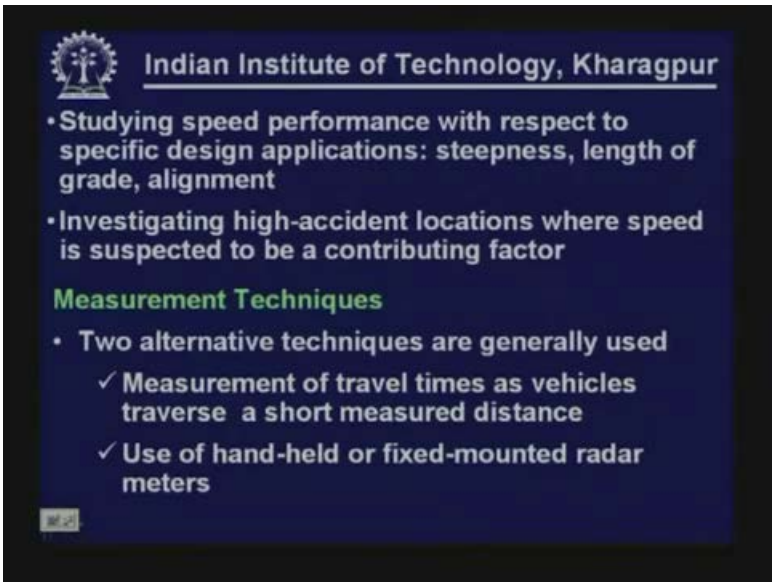
(Refer Slide Time: 47:58)



When it is the distribution speed is distributed following certain distribution. So when it is distribution some key statistics are required to describe spot speed distributions. What are the key statistics that are normally used? Average or time mean speed, average observations over time, standard deviation, eighty fifth percentile speed, median value etc are the key statistics which are used to describe spot speed distribution.

Now, what are the uses of spot speed data? Spot speed data is used for various reasons studying the effectiveness of speed limits or enforcement practice. You might have given a speed limit but whether people are really following it so you do the spot speed study and see what is the speed of vehicles. For suggesting appropriate speed limit it may be other way. You do the spot speed study and then you see whether it is necessary to study or to suggest the speed limit whether the vehicles are really speeding up. Then we have what is called as studying the speed trains and assessing the effectiveness of policy and enforcement. These things are expressed in different ways.

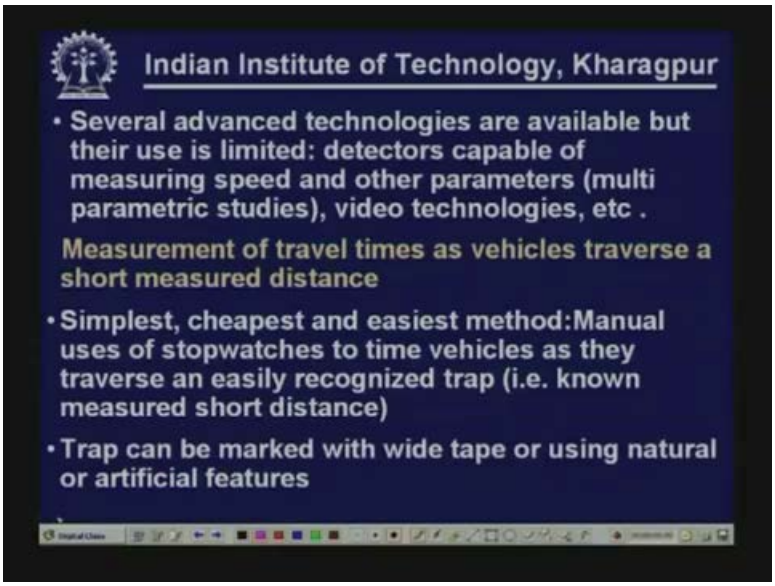
(Refer Slide Time: 49:16)



Studying speed performance with respect to specific design and applications like stiffness, what is the effect of stiffness on speed, what is the effect of length of grade on speed, what is the effect of alignment on speed etc so we want to study this performance with respect to specific design applications? Then we have investigating high accident location where speed is suspected to be a contributing factor. May be you are thinking over speeding is the cause for accident at certain locations so we want to investigate whether really over speeding is taking place so you may carryout spot speed studies. So there are various reasons why we need to carryout spot speed studies.

Coming to the measurement techniques there are two alternate techniques which are generally used. One is measurement of travel time as vehicle traverse a short measured distance. Basically it will be track length or known major measurement distance, short trap length, known distance so calculate how much time the vehicle takes to cross this distance take the time and accordingly calculate the speed. It is because the section or the stretch is very short we are considering it as a spot speed or speed at this particular point. The second approach is the use of hand held or fixed mounted radar meter. We call it radar gun, radar meters so this is another equipment which is also used for spot speed measurement. We will discuss about the first technique today and discuss about this radar gun and related aspect in the nest lesson.

(Refer Slide Time: 51:00)

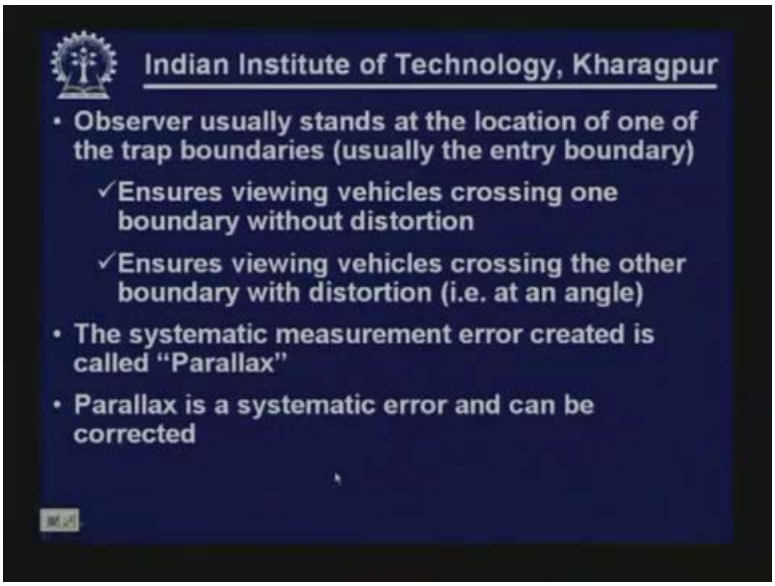


Several advanced techniques are available but remember that again their use is limited because of the cost considerations. Detectors capable of measuring speed and other parameters they are available which are normally used for multi parametric studies, video technologies are available which are used for volume counts, speed measurement and so many other things but again cost is a major consideration for wide spread applications of these advanced technologies for common type of statistics.

Coming to the measurement of travel time as vehicles traverse a short major distance it is simplest, cheapest and easiest method. Basically we use manual use of stop watches to time vehicles as they traverse an easily recognized trap. This is an easily recognized trap so we observe using stop watch when the vehicle enters here and when the same vehicle leaves this place how much time it has taken to travel this distance T so we press the stop watch here to start it again press the stop watch as it exceeds the section so we know what is the time required.

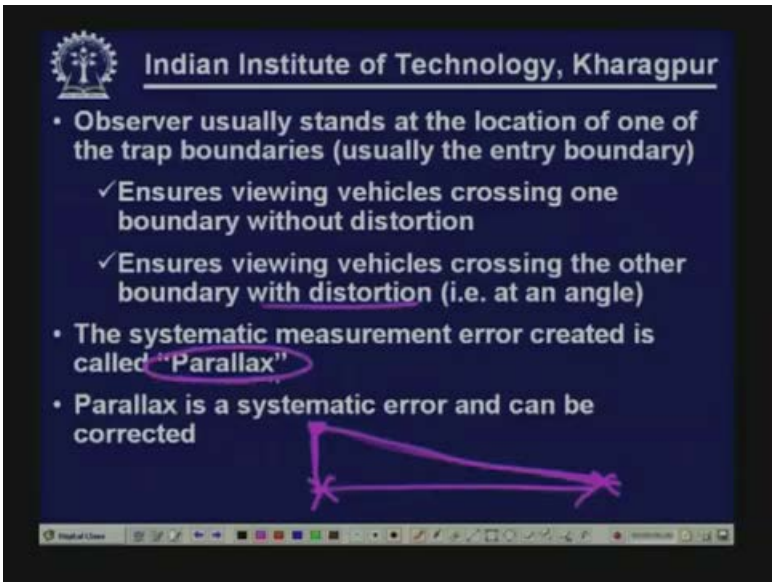
Then track can be marked with white tapes. On the road you just put may be two white tapes so we can easily say this is my trap line or sometimes some natural or artificial features also, you can put some cones or you can refer to an electric post or may be a tree which is there and so on.

(Refer Slide Time: 52:36)



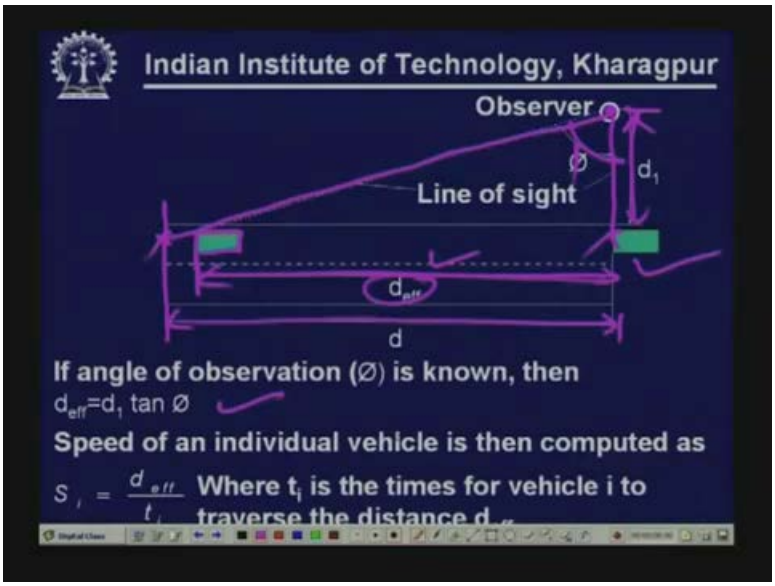
Observers usually stand at the location of one of the trap boundaries usually at the entry boundaries so suppose if it is there observer will stand here so this ensures viewing vehicles crossing one boundary without any distortion. So obviously the vehicle is crossing he is standing here perpendicularly, he can see that thing without distortion. But this automatically ensures viewing vehicles crossing the other boundary with distortion. He cannot see both the vehicles without distortion. If he is seeing one vehicle without distortion the other vehicle he is seen obviously with distortion. So this systematic measurement error is created and it is called parallax. So parallax is a systematic error that we are referring to and it is a systematic error and can be corrected.

(Refer slid Time: 53:25)



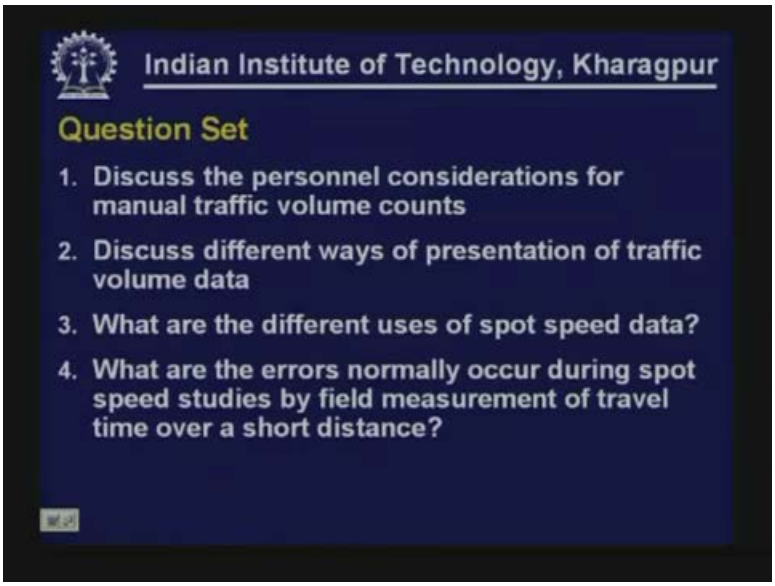
Let us see how we can correct it. Here I have explained the thing. The observer is standing here as the vehicle is crossing he is viewing the vehicle here so it is absolutely no problem. When this vehicle crosses this line this is the exit line and this is the observer's line of sight so the vehicle is actually here but the observer is getting an obstruction to this line so he is saying thinking that probably the vehicle has crossed. The vehicle has actually traveled this distance which is d effective rather than actual distance d. So a correction is necessary this correction can be applied easily if we know this angle phi. If you know this angle phi and if this distance is d1 then you can calculate this d effective which is nothing but d1 tan phi. So if you know the distance apply that, calculate the speed taking this d effective divided by time.

(Refer Slide Time: 54:37)



There could be errors due to early or late depressing of stop watch but this tends to be random so it can be minimized or it cancels out. Of course this error can be minimized using longer trap length because if the travel time is more the percentage error will be less. But obviously we cannot make it too longer then the meaning of spot speed will be lost.

(Refer Slide Time: 55:07)

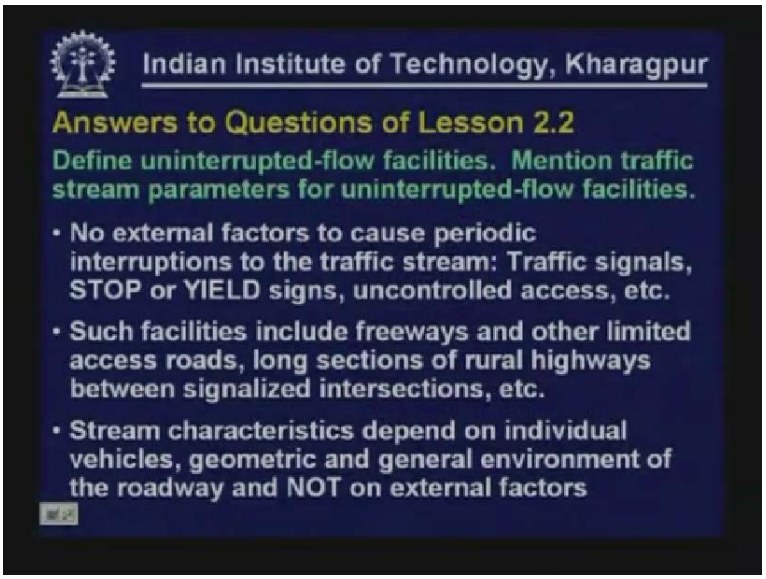


Question Set:

1) Discuss the personnel consideration for manual traffic volume counts
2) Discuss different ways of presentation of traffic volume data
3) What are the different uses of spot speed data?
4) What are the errors normally occur during spot speed studies by field measurement of travel time over short distance?

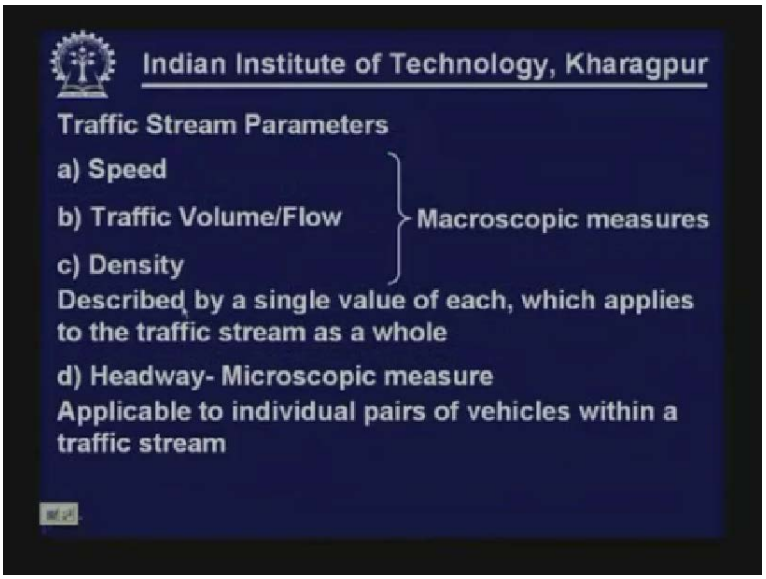
Try to answer these questions. The answers I will discuss during the next session.

(Refer Slide Time: 55:38)



Quickly trying to answer the questions of lesson two point two; uninterrupted flow facilities is basically where there is no external factor. This is what we call as uninterrupted flow facilities.

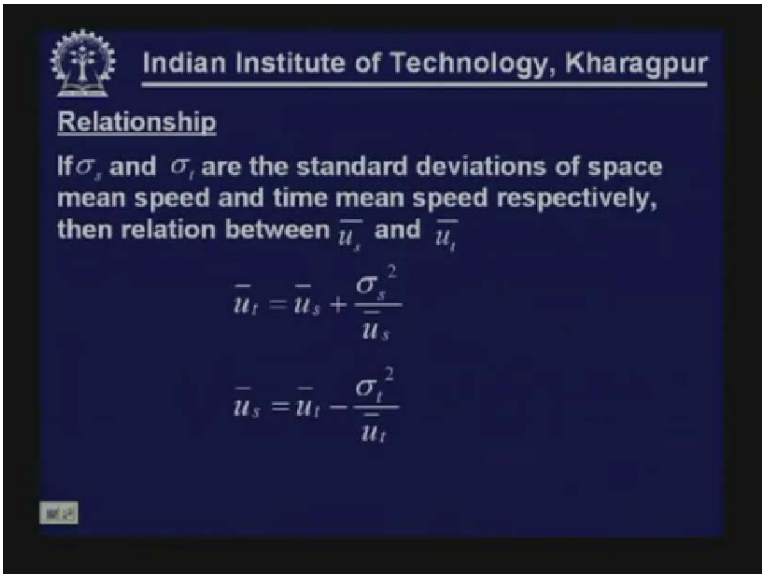
(Refer Slide Time: 55:46)



The stream parameters are macroscopic parameters and microscopic parameters both are used. Speed, traffic volume, flow and density are in the macroscopic parameter and headway is the microscopic parameter.

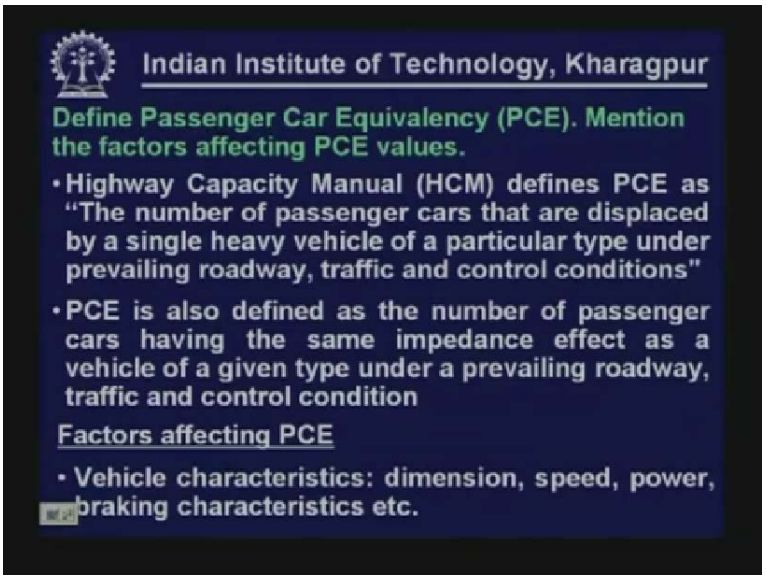
What is the difference between the time mean speed and space mean speed? State the relationship. You know that the time mean speed is the average speed at one point or location observed over a period of time. It is the arithmetic mean of the speed observed at a point and space mean speed is the average speed of vehicles over a certain road length at any time. It is harmonic mean of the speed observed at a point and normally always space mean speed is less than equal to time mean speed.

(Refer Slide Time: 56:28)



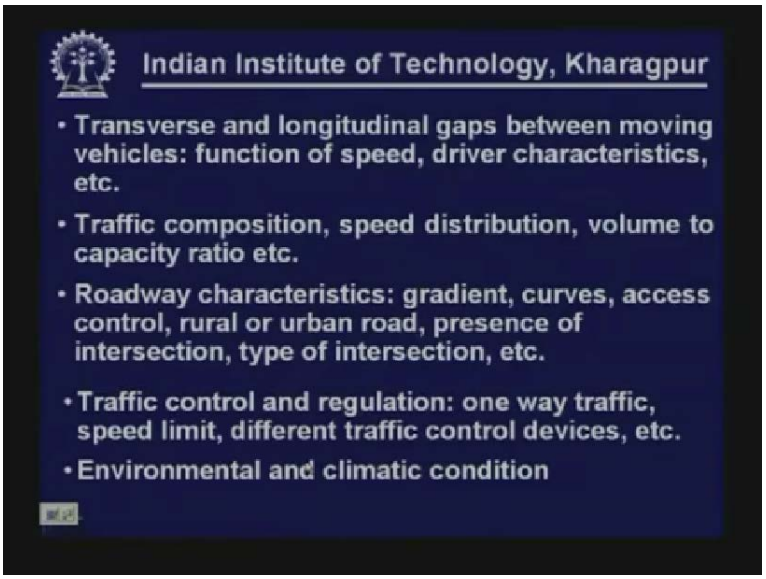
There is a relationship if you know either space mean speed or the time mean speed and the standard deviation or the variance so you can calculate the other thing using the well defined relationship.

(Refer Slide Time: 56:38)



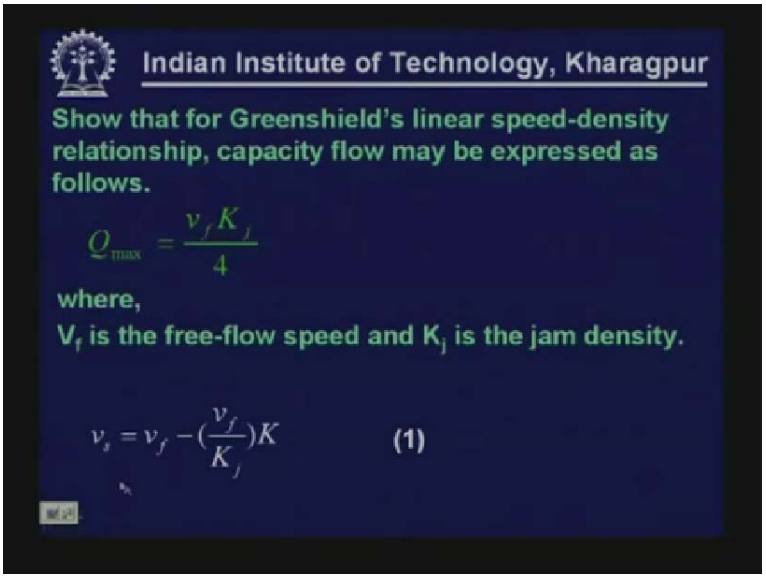
For PCE you can know that mixed vehicle we tried to express the simple vehicle type using the concept of PCU. It is the number of passenger cars having the same impedance effect as a vehicle of a given type under a prevailing road way traffic and control condition. There are factors which are affecting PCE vehicle characteristics as follows:

(Refer Slide Time: 56:57)



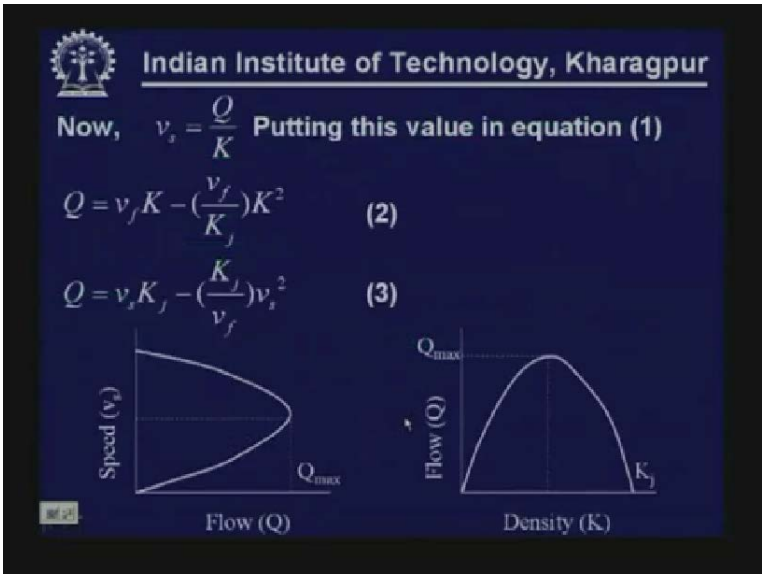
Transverse and longitudinal gaps, traffic composition, speed distribution, volume to capacity ratio, roadway characteristics, geometrics like gradient, curves, access control, etc, then we have traffic control and regulation and environmental and climatic condition.

(Refer Slide Time: 57:12)



Show that Greenshield's linear speed density relationship and prove that Qf = Vf into Kj by 4 so this is the linear relationship given by Greenshield.

(Refer Slide Time: 57:22)



If you use Vs = Q by K that is flow equal to speed into density then you can get equation 2 and 3, you can express Q in terms of K and Q in terms of speed. So take that derivative dQ dK = 0 which will give you the k value at capacity and make dQ dV = 0 that will give you V value at capacity so at maximum flow or capacity Vm into Km which is nothing but Vf into Kj by 4, thank you.

(Refer Slide Time: 57:36)