Application of Soil Mechanics
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Lecture – 23

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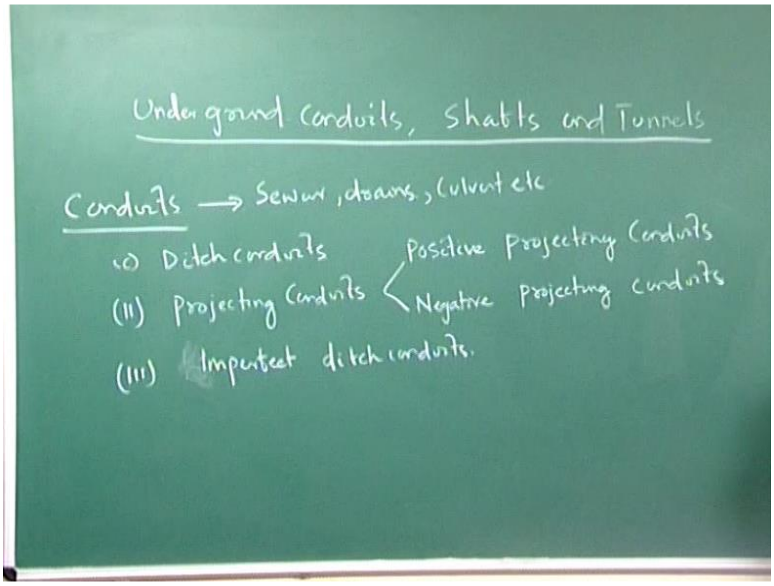

Next part of your application of soil mechanics is your underground conduits shafts, and tunnels basically how this stress variations in conduits shafts, and tunnels. We are going to discuss. So,, then first part will start with this conduits now conduits it may be classified as it may be classified as number one ditch conduits number two projecting conduits; that means, positive positive projecting conduits, then negative projecting conduits third is your third one is your special one it is called imperfect ditch conduits imperfect specially.

Where you are using this conduits what is the conduits why we say that it is conduits conduits basically used for it can say that sewer pipes drains culverts conduits basically used in case of kind of sewer pipelines sewer pipes or sewer lines or drains culverts e t c. So, it has been classified into three parts. If I classify what are the different types of conduits first one is your ditch conduits second one is your projecting conduits, and this projecting conduits as two parts; one is your positive projecting conduits, second is your negative projecting conduits a projecting conduits, third one is your imperfect ditch conduits. Now if I draw the line draw the show this.

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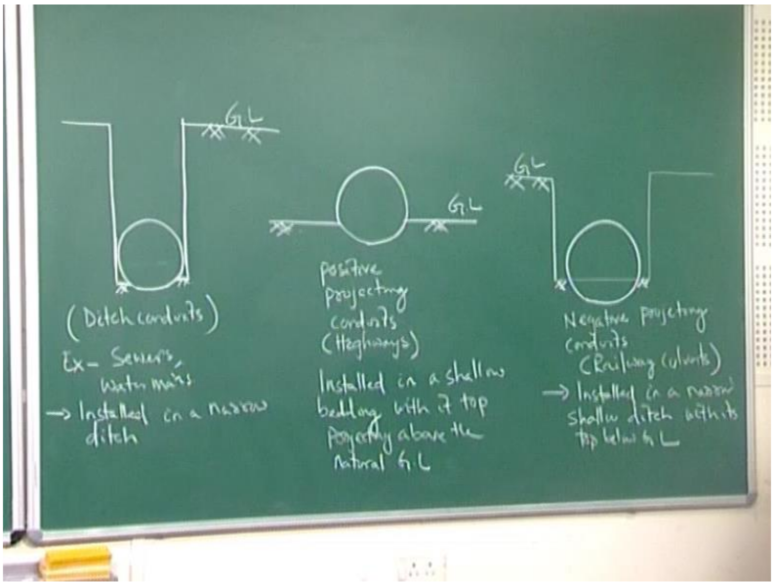

What is ditch conduits, and the projecting conduits, and imperfect ditch conduits graphically or figure wise I am just showing it this is your ground level ground level, and this called these called ditch conduits second one. If I draw it these kind of figure if this is my ground level. So, this is your positive projecting conduits this has been particularly used highways or roads, then third one is your, if I draw negative projecting conduits it has been used particularly in case of railway culverts.

This is my ground level, and this is called this type of things is called negative projecting conduits, this is for railway culverts. Now if I say ditch conduits this is example is your ditch conduits is your sewers water main pipes water mains in this case example is your highways, and this case railway culverts at these conduit is installed it is particularly it is installed. In a narrow ditch in a narrow ditch exhibited in a on dist of soil below the ground level. If you look at here in a narrow ditch exhibited in a on dist of soil example soil below the ground level which is, then cover with earth back field in case of positive projecting conduits install in installed in a shallow bedding with its top projecting above the natural ground level top projecting above the natural ground level. Similarly in case of negative projecting conduits conduits installed installed in a narrow shallow shallow ditch with its top bellow the ground level with its top below ground level which is, then covered with an embankment look at here the classification of this conduits I am taking into three parts basically this classification of this conduits is three parts.

So, if I classify this conduits into three parts basically conduits has been used sewer lines drainage culverts. So, classification is your ditch conduits, and projecting conduits these two conduits has been widely used ditch conduits, and projecting conduits the projecting conduits has two parts two again; one is your positive projecting conduits, second one is your negative projecting conduits third one is specially conduits, it is called imperfect ditch conduits. So, will discuss later on now you are concentrating with this part two ditch conduits as well as projecting conduits. If you look at this figure if you look at the figure what you mean by ditch conduits, if a narrow ditch below the ground surface has been made in narrow ditch above the narrow ditch below the below the narrow ditch a conduits has been installed. So, this is called ditch conduits.

So, installed in a narrow ditch, and best example is your sewer lines or water main pipe lines it go far below the ground surface below the ground surface that case it is these are called ditch conduits, then positive projecting conduits. If you look at here the ground surface g l is your ground level ground level is at somewhere else above your ditch conduits in case of projecting conduits, if you look at positive projecting conduits the ground level is there above ground level if this is my ground surface above ground surface the conduit will be distingly distinguishly visible; that means, above the ground surface the conduit will be some part will be there.

So, it generally where it is generally provided in case of highways or road if this is my ground surface, if a road has to be con constructed above this ground surface generally above the ground level this conduit has been installed, and above these the construction road construction has been made. So, installed in a shallow bedding this is a shallow bedding with its top projection above the natural ground level with its top this part is you top projecting above the natural ground level this g l is nothing but is your natural natural ground level natural ground level. Now come back to negative projecting conduits this has been highly used particularly in case of railway culverts railway culverts, because the railway line has to pass railway culvert what will happen installed in a narrow shallow ditch if you look at this two, if I take this two.

This is a long ditch, and this is a very small or narrow ditch in these case this part has been installed. So, that ground level is slightly higher slightly higher. So, in this case it is called it is called negative projecting conduits; that means, whole conduits it has been dividing into two parts on e is you ditch conduits other is your projecting conduits, and projecting conduits has two parts; that means, projecting has two parts; one is your positive projecting conduits, second one is your negative projecting conduits now will start one by one how this stress variations stress formation they are first let us start with these ditch conduits.

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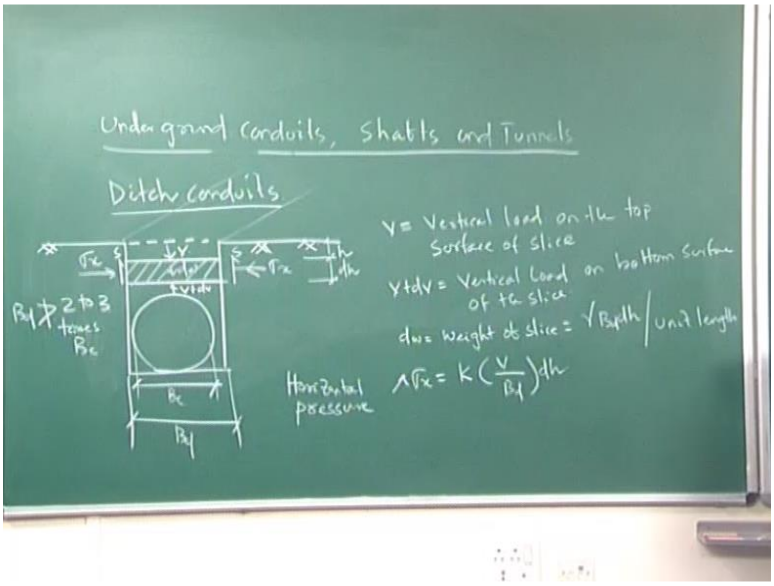

Let us draw a ditch conduits, and we see how much is your stress variations let us say width b d of the trench b d is your width of the trench this. If you look at here these distance with these distance is your b d width of the trench, and b c is your diameter of the your conduits generally width of the trench generally b d generally b d width of the trench, so not greater than. So, not greater than two to three times times b c; that means, diameter of your conduits diameter of your trench should not be greater than two to three time of diameter of your conduits the loading imposed on the buried conduits can be obtained by considering equilibrium of an elements slice of thickness d h elements slice of an thickness d h. So, what is the load come in to this particularly in this conduits. Now if I consider a very small slice of thickness of d h at a distance h below the ground surface now what are the forces acting on itself weight of these ditch is your d w v is your total particle force b plus d b is your after a infinite small element d h, this is other direction this is you sewer force this is a sigma s lateral stress this is a sewer stress or this is a sigma s lateral stress. Now let say v is equal to vertical load vertical load on top surface on the top surface of slice slice v plus d v is equal to vertical load on bottom surface of the slice d w is equal to.

If you look at here this is a d w, this is a slice, and this is your d w d w is your width means d w is your weight weight of the slice this comes out to be gamma times b into d into d h per unit length gamma is your unit weight gamma is equal to unit weight, and b d b d is your width of your width, and d h is your thickness; that means, this into this area into gamma, and per unit length, if I take it in this direction; that means, per unit length per meter length this is your weight of your slice.

So, horizontal pressure sigma x sigma x is equal to k times k is your coefficient of lateral earth pressure into v by b t into d h b by b d vertical force by your b d over your d d h sigma x is your k times of lateral stress is equal to k times vertical stress vertical stress is your force for area that is your b d per unit length into d x times this is your lateral stress or horizontal pressure you can say that sigma h x is equal to horizontal pressure.

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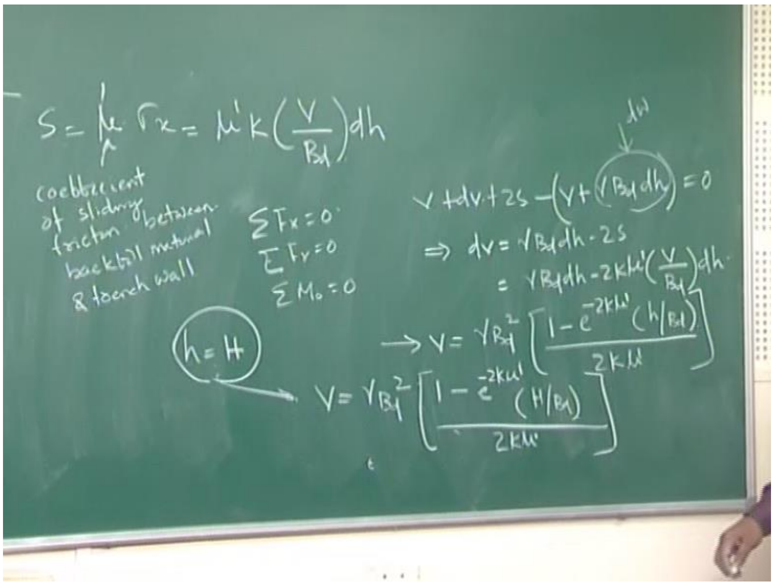

Now, this sewering resistance developed along the site of the vertical direction is equal to mu times your horizontal pressure; that means, sewering resistance of the site s is equal to mu times your horizontal pressure sigma x mu is equal to nothing, but is your coefficient of sliding friction between backfill material, and trench wall. So, these comes out to be. If you look at here k is equal to coefficient of lateral earth pressure Mu is equal to of sliding friction between backfill material, and trench wall. If you look at here coefficient of friction is this is your trench wall; that means, friction between these trench wall end is your backfill material this is your backfill material. So, this is your coefficient of friction mu is equal to coefficient of sliding friction, and this comes out to be sometimes people say mu sometimes some somebody say mu dash both are fine. So, I will be mu dash k into v by b d into d h the sigma x whatever I got it from here has been replace to here in case of sewering resistance to find it out. Now you consider the equilibrium of this element equilibrium of this element equilibrium means whatever the forces force in x direction force is equal to zero force in y direction is equal to zero you moment is equal to zero by taking considering the equilibrium now it will be vertical forces v plus d v plus two s b plus d v is your vertical load on the bottom surface of this slice b plus d b, if you look at here it is acting upward sewer force also acting upward I am taking in upward as a positive v plus d v plus two s minus v plus gamma b d into d h minus what do you a minus, because if I am taking this force in this direction is positive upward direction.

So, downward direction is your beep. So, this is negative and what is this also vertical stress vertical stress how much v by b d into d h. So, v by v by b d into d h. So, it will be gamma gamma terms of gamma times of sorry unit weight of slide unit weight of slide d w is also downward if you look at unit weight of slide is equal to slice gamma b d into d h. So, this is your vertical force at the top of the slice this is your unit weight. So, this will be your negative, because this is downward, and this will be vertical upward this force is vertical upward this force is vertical upward this force is vertical upward. So, in equilibrium these plus these plus these is equal to these plus this now solving these d v is equal to gamma b d d h minus two s. So, which is equal to gamma b d d h minus two k mu prime v by b d into d h now solution of the above differential equation. Now if I find it on solution of the above differential equation it is a differential equation it comes out to be comes out to be v is equal to gamma b d square into one minus e to the power minus two k mu prime h by b d by two k mu prime at the top of the conduits at the top of the conduits at the top of the conduits you take as h is equal to h, because h you can consider some times universal h is equal to we can take it capital h this comes out to be v is equal to gamma b d square into one minus e to the power minus two k mu prime into h by b d by two k mu prime.

Now, this is your by solving this. Now let me summarize how I have proceed I have consider a very small element very small element below the ground surface I have consider a very small element below the ground surface which is ever be your conduits ditch why I am consider, because I want to know what are the forces or stress coming ever be your ditch. So, this small element is, let us say this small element is d h width of d h it is at a distance of the h from the ground surface now let us say b is your let us say b is your vertical forces of the slice of the slice vertical forces at the top, and v plus d b is your vertical load on the bottom surface of the slice s is your sewer resistance sigma x is your horizontal pressure. So, now, again if I am taking this slice this weight is you d w, because this slice why it is d w people will ask.

Because this slice have taken a infinitely small d h that is why this weight coming to it is your d w now the weight of the slice is equal to gamma gamma is your unit weight unit weight. So, the soil into b d b d is your width of the trench if you look at this b d your width of the trench into d h d h is your the slice; that means, b d into d h this is your area into per meter per meter length unit lengthy can consider this length this length in these direction particularly in these directions. Now what is the value of horizontal pressure the value of horizontal pressure sigma x is equal to k times k times I can write it in terms of k times into sigma v.

So, k is equal to lateral earth pressure coefficient sigma v is equal to vertical stress how the vertical stress will come into picture this will come into picture v by b d v is your vertical load on the top of the surface by b d into d h, because this is your small width of your slice small thickness of your slice d h. So, horizontal pressure I get it, then sewering resistance s is equal to mu prime times of sigma x, because mu is your coefficient of sliding friction between backfill material, and trench wall with these s is equal to mu times of mu prime times of sigma x you can take the value of sigma x from here at put it the value of sigma x here after getting all the value of d w sigma x, and sigma your prime of s sewering resistance now consider the whole slice into equilibrium conditions once it is in a equilibrium conditions what will happen forces in x direction forces in y direction, and moment is would be zero I have consider the forces. So, what will happen this forces in vertical forces.

If you look at here the vertical up this is called upward forces has positive, and the downward force I have taken negative. So, v plus d v plus this s minus v minus d w v plus d v it is two s why two s once you are considering the slice the s is this side d says is this side frictional resistance from the both the side. So, it will be v plus d v plus two s minus v plus gamma b d d h this is nothing, but your d w unit weight small weight of your slice with taking this it will come as a differential equation, and by solving this differential equation this term will come as a v is equal gamma this not r this is gamma b d square one minus e to the power minus two k mu prime k is your lateral earth pressure mu prime is your coefficient of sliding friction between backfill material, and trench wall h y b d h is your distance from ground level to your slice or you can say that h from distance from here to here now in general we take in general it has been taken as h is equal to h on the differential equation after solving v is equal to how much is your vertical load on top surface of slice, it is coming it is coming gamma b d square into one minus e to the power minus two k mu prime into h this is your capital h instead instead of small h I put it is a capital h by b d divided by two k mu prime this is your complete equation of your vertical load coming to your conduiter ditch conduits.

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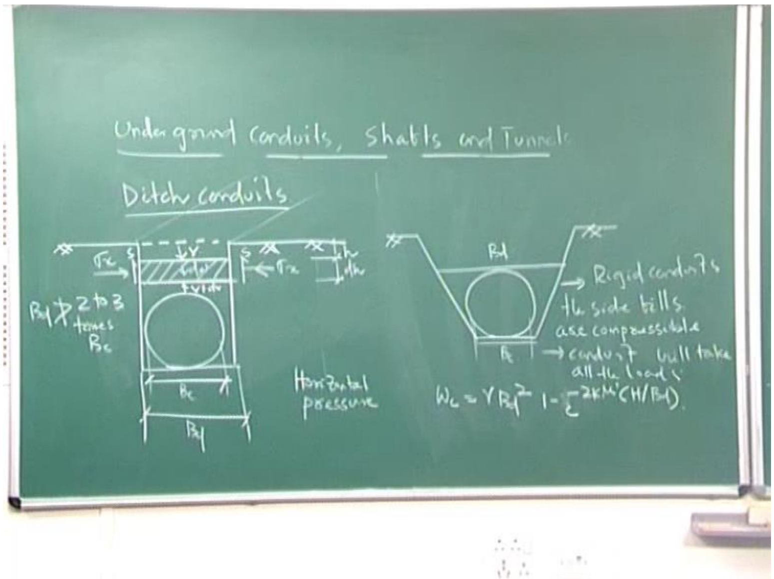

Now, in this case what will happen in this case what will happen this slope is a vertical slope it may possible it may possible this conduit ditch conduits may be placed may be placed with a side slow, if I consider this is my kind of this is the kind of b c, and this is your b d. If you look at here it is not always possible it is not always possible that you can go for a vertical kind of vertical kind of ditch now generally vertical kind of ditch is in stub. Not stubble. So, sometimes we provide the ditch conduits with a side slow these kind of consideration we give it in these case in case of very rigid conduits the side frills relatively compressible, and the conduit to it carrying practically all load. So, if I write it if it is a a rigid conduit the side frills are compressible, and conduit to it carry practically all the load conduit will take all the loads.

So, in this case what will happen? w c w c is equal to weight in the conduits w c is equal to weight in the conduits particularly w c is equal to gamma b d square one minus two one minus e to the power minus two k mu prime into h by b d this will be multiplied with our this your h by b d this will multiplied e to the power this is coming here h by b d, because it looks or if a it looks as if it is multiplication of e into h by b d know it is e to the power minus two k mu prime into h by b d by two k mu prime. So, now if I consider this as a, if I consider this as a whole term as a c d. So, now, weighten conduit total weight coming on the conduits is suppose to be I am taking at a c d gamma b d square now c d is known as load coefficient for ditch conduit this is known as load coefficient of ditch conduits load coefficient of ditch conduits. So, this load coefficient c d is equal to nothing but one minus e to the power two k mu prime h by b d divided by two k mu prime, and this is called load coefficient will discuss this graphical, and other parts may be tomorrow about your load coefficient, I will stop it here.

Thanks a lot.