Farm Machinery
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Lecture – 29
Estimation of Draft in Farm Machines – II

Well, students, now let us welcome to the Estimation of Draft in Farm Machines lecture II. Here, in fact, total lecture number 29, but this farm machines that the draft number – II, because see if we had just discussed about in the previous lecture about a strain which is being used and I also said that now the advanced way by which we are in a position to take care of those so much of wire etcetera by putting into load cells.

So, these strain gauge based load cells are available and those load cells are compact and easy to handle etcetera and can be used into the locations where you want to measure the different types of forces become the tensile forces the compressive forces and so on. Now, in this case here we would like to show you what sort of instrumentation which we have developed at IIT, Kharagpur with the load cells.

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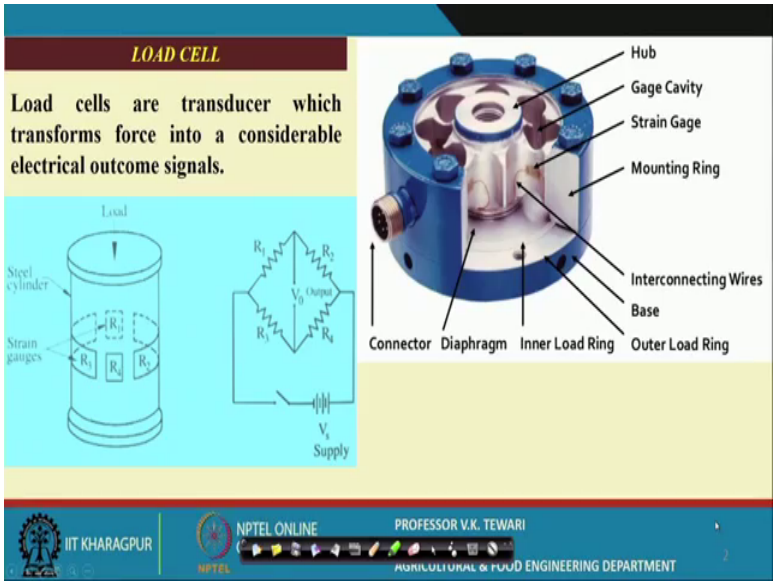

It is very essential as well to also know about what is this load cell and all that just this information we have gathered from literature, so that you can you can appreciate this point of what this load cell is in fact. So, this load cell load cells are transducers which transforms force into a considerable electrical output signal. Now, this is what, it is what

was done in the strain gauges as well. Now, this is a load onto this and this is a cylinder steel cylinder on which where we have put the strain gauges you can see that this strain gauges are put and these strain gauges again go back to your same strain same with stone bridge and you will be in a position to find out this load.

So, it load cells are transducers; that means, indirectly you are getting electrical signal and that signal will be calibrated, so that you are in a position to get the actual value. How does it look like in a compact form? This is how it looks like. So, you can have a look at this see the, this is the connector where you can connect the equipment connect the details, then the this is a diaphragm over here, then the inner loading this is a inner loading.

Then the outer loading, then the you can say this is the base of this, then interconnecting wires, will be over here, then mounting rings; well, the mounting rings are here, then strain gauges which are kept here you can see that a strain gauges here and there then the gauge cavity, well this is cavity and this is the total hub in which you have. So, this is the whole construction of a load cell, where it has very in a very compact way it has taken the strain gauges and you do not have so much of then the electrical wires which were there in the earlier case.

So, this is one which is very compact and very handy to use and it is available in various capacities of 10 k, 20 k, 50 k and so on and so forth. So, these can be used. Now, we will see how we have utilized this for developing a three-point leakage dynamometer at IIT, Kharagpur.

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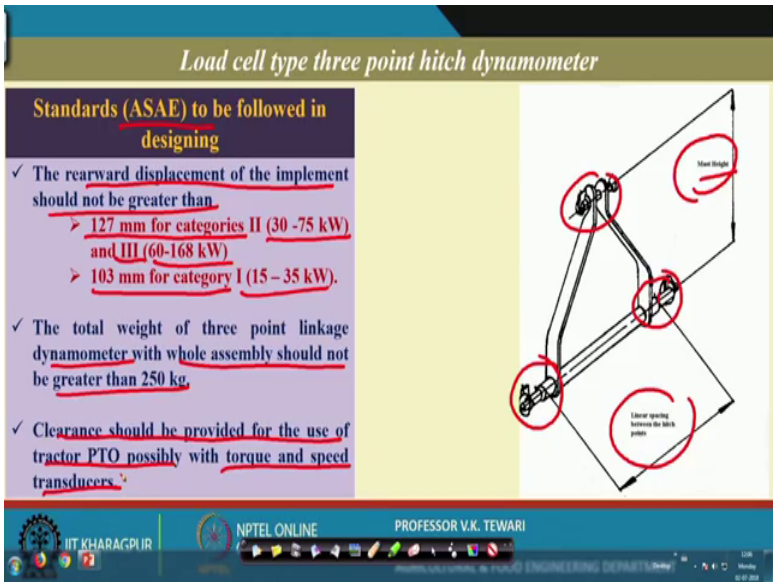

Load cell type three ok, where there are as I told you that we have designed at IIT, Kharagpur and where they are needed to be fitted. In fact, they need to be fitted at the locations where we have where we have the where we are of fitting the linkages so, and the top link here and in the lower links here. So, these are the positions where you need to put the load cells. Now, it is not so simple that we can just put the load cells over there because the implements portion has to be attached over there, there is a pin which will be attached over there. So, some arrangement has to be made.

Well, and now there are certain standard values which need to be maintained with respect to the attachment which is there on the tractor side and the attachment, which is there on the implement side. So, you can see here that this is the mast height the mast height of the implement over here when we are talking with respect to the three point linkage and the linear spacing between the hitch points this is linear spacing which we get into the hitch points.

Now, how much these need to be maintained with respect to ASAB? Now, it is very essential that we follow while we are designing this and we are measuring the values, we need to follow these standards and the world standards or international standards, which is given by ASAE or ASABE. In fact, ASABE is the one which has is the name of the body, but then all standards are ASAE standards here.

So, you can see that the rearward displacement of the implement should not be greater than see what will happen is the implement will be displaced rearward the moment you have another attachment in between. So, that cannot be more than you can see a 127 millimeter for categories II and III. Now, these categories II and III in fact, represent 30 to 30 75 kilowatt and 60 to 168 kilowatt tractor sizes.

So, of these tractors for these tractors if you have the three-point linkage then they will be called as category II and category III and a not more than 103 millimeter for category one which is 15 to 35 kilowatt tractors for which we have the three-point linkage the total weight of the three point linkage dynamometer with whole assembly should not be greater than 250 kg.

Now, these are also standardized because then this is the weight which is already has to be borne by the tractor and it will add to the weight of the implement as well. So, we need to have some information about how much is the total weight of the three point the linkage dynamometer which we are having it should not be more than this great the highest value which has been given.

Then, the clearance should be provided for the use of the tractor PTO. Yes, when while you are doing this you see that the tractor PTO you might have seen the tractor PTO. So, that tractor PTO should be clearly left otherwise then it will be very difficult to attach an implement say if you are trying to measure a for you use PTO for a rotary type of implement like a root of 8 or so. So in that case you must give clear space for clearance enough clearance for the PTO to be used for torque and speed transducers.

This, is very important because once we use a instrumented tractor well, I must tell what is this instrument tractor at this point of time, but we mean by instrumented tractor is that in the in the tractor we have fitted these gadgets for measurement of sleep, measurement of speed, measurement of fuel consumption, measurement of the speed of the engine which is running and then the measurement of the draft and different angles which I have just explained.

So, all these are fitted and just you have to attach the implement to the tractor and then take it to the field and all the details will be recorded. So, this is a tractor which is a instrument tractor, tractor and this has been developed at IIT, Kharagpur using which we are in a position to find out all details of the power being utilized by any equipment

whether it is a trailed equipment or whether it is a tractor on three point linkage mounted in equipment or implement.

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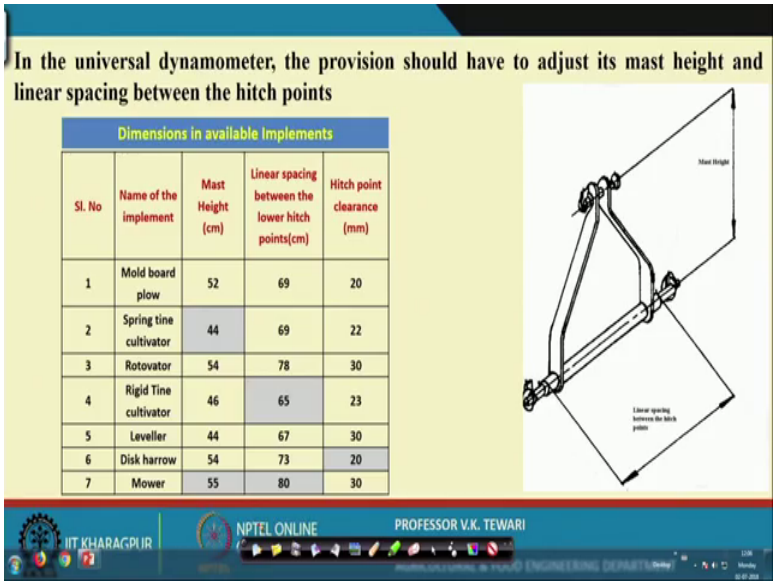

Well, certain other informations also important. Universal dynamometer see, what we say what are the distance what are the values which are important here? Because of the universal dynamometer the provision should have a should have to adjust the mast height and the linear spacing between the hitch points. We talked of this linear spacing and the mast height now these essence these are essential with regard to what are the standards given by ASAE as I said.

So, for mold board plow this is the arrangement here, for a springtime cultivator this is the amount here in centimeters, then for a rotavator this is 54. Similarly, for rigid tine cultivator it is this and disc harrow, mower all these values are given. Linear spacing between the lower hitch points are also given for the respective ones for mold board plow it is 69, for a springtime cultivator it is again 69, rotavator it is 78 because compared to this.

Then the hitch point clearance, this is very important. How much clearance must be also provided for the hitch point 20 millimeter, 22 millimeter and 33 millimeter. Kindly mark these units these are very important while you are talking with respect to the dimensions in the available implements. These very important when you are facing fitting these to the universal dynamometers, when you are talking of a dynamometer which can be fitted

to the tractor and can be attached for measurement of forces in any implement for that matter on equipment, which is connected to the three point linkage of a tractor.

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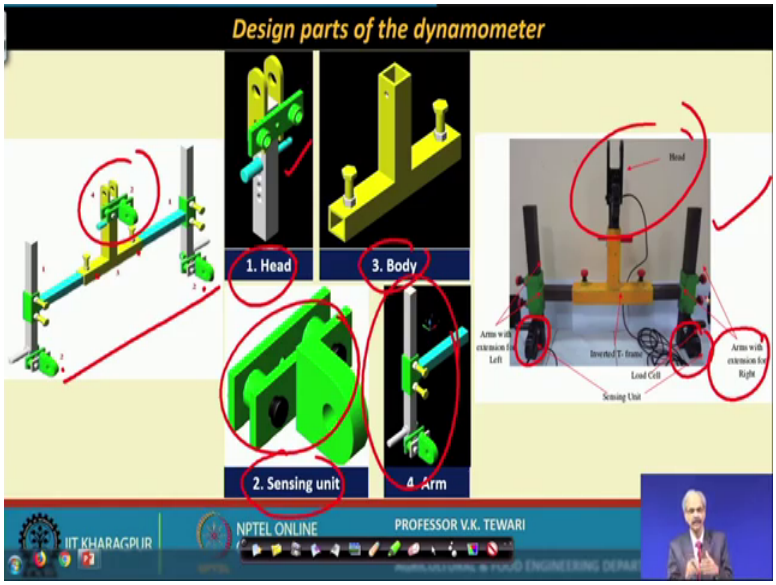

The what are the different parts of the dynamometer? Well, it is very important we see as I told you that we have you developed this at IIT, Kharagpur. I would I would I would like to show you where what are the different components of this. The different components you can see here 1 is the head. Now, this is the body of the, that particular one which is connected here, the 2 is the sensing unit now where is the sensing unit, ok. I I told you earlier that is simply not possible to put that load cell anywhere there has to be housing there has to be a arrangement a frame which has to be created this is the one where which is created here for the sensing unit.

Now, you can see the third is the body. Now, this is the body of this. So, you can see these parts and components which are essential and then fourth is the arm. Now this is the arm over here. So, these are the ones which are connected. So, of the head the sensing unit, the body and the arm, now these are the different parts of the dynamometer which we have done at IIT, Kharagpur and this is the connection if you can see this is for the two lower links, this is for the top link here and these are the arrangements which are connected.

And, the actual unit here you is shown to you which is, which was also shown in the earlier slide. Now, this is the unit which is shown here you can see the head is kept over

here you can see, the sensing units at these two locations here and the load cells which are there and the arms with extension for right and left, these are the arms which are extension for right and left and depending upon where it is to be added.

So, the if we were talking of the details of the distances of this where which is connected to the tracker three point linkage and what are the values which need to be maintained with respect to the different categories of the three point linkages for different sizes of tractors.

So, the design of parts of the dynamometer are given like this. These are in fact, you need to understand here, that they have been thought of a very properly over a period of time. It is not that we have decided just in six months time, we have taken enough time and other enough experimentation has been has been done over a period of time and then we have come to this very simple parts, which look very simple as here and then they are connected in this case here.

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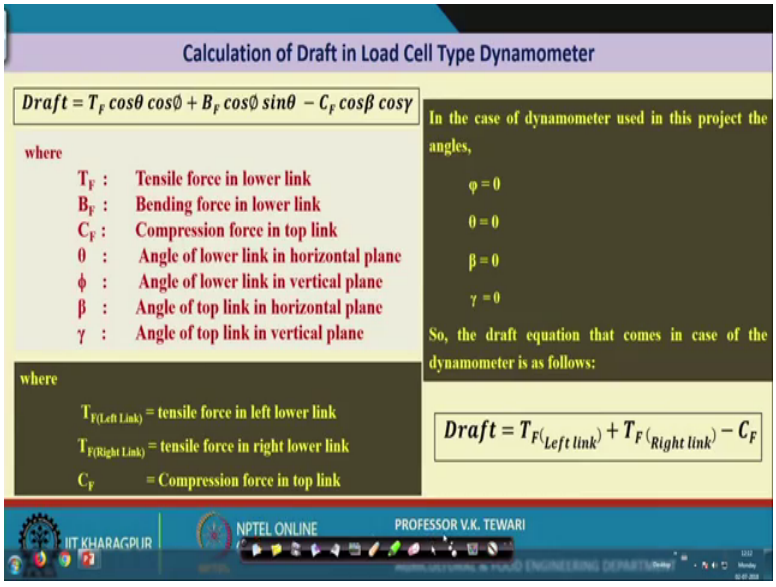

Well, calculation of draft in load cell type dynamometer. So, what are the calculations? You we require I would draw your attention see the previous lecture which we found out, we were in a position to find out the tensile force, then the bending force and the compressive forces and the different angles etcetera, which we had discussed and by using the strain gauges we are in a position to get the draft like this.

Now, in the case of the dynamometer which we have developed here these things are not there, the these angles are not there at all. So, the draft equation that comes in this case is a very simple one and it just talks of the left link the force, then the tensile force in the right link and minus the compressive force in the top link. Now, we by these we are in a position to simplify this, one at the same time we are in a position to simplify the different wires etcetera which were there when we had the strain gauges.

And, then whether the how far they are accurate, it is very essential to see also how far they are accurate? Let us have a look at this.

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Draft sensing unit is tested with mold board plough, cultivator and disc harrow. Now, you can see here that the draft sensing unit which we had we have tested them with respect to the different tillage equipment. It is very essential to test them with the equipment which are which require larger forces.

So, these are the equipment which require see the mold board plough which is requiring mold board plough here. So, mold board plow is fitted here, you can see the operation of this mold board plough in this case here, then the cultivator which is here and then the disc harrow which is here. So, these are the locations where at these draft sensing units are tested on their actual field conditions and you can see here the various wires and the so many of wires are there. You can have a look at these wires that so much of wires come into picture and one need to have a careful about these wires. If they snatch

somewhere then the whole system will be disabled and you will not be in a position to get the actual values.

But, then with these we have tested them in actual field conditions and we have got these values and compared I will show you how.

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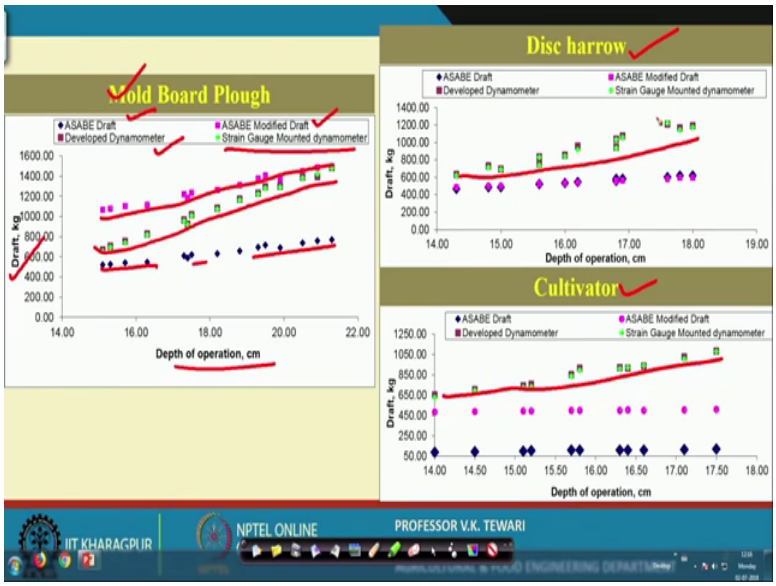

With moldboard plow, with disc harrow and cultivator; now, you can see here the, what we did? How do we compare this? We have you can see that the developed dynamometer is here and then ASABE draft equation, then ASABE modified draft equation. At IIT, Kharagpur we did a lot of studies and we just wanted to check how far is the ASABE equation, which was developed under outside conditions is suitable for Indian soils.

So, we have done that and that modified draft is in fact, we are talking of that equation which we have developed at IIT, Kharagpur. Then we have done by the developed dynamometer and the strain gauge mounted dynamometer. So, we have in fact, as I showed you earlier we had talked of the values which were there for strain gauges and then the load cells.

And, using these strain gauges and load cells, we just want to compare as far how far we are accurate because then there is a difference between these two we at one location the strain gauges are compact into it and in another location we have all the strain gauges and angles given.

Here the angles have been removed in the case of the draft for this because in this case you got only the two or the lower links and the one at the top link is subtracted as compared to the one which is there in the other diagram other equation, where the draft is compared with all and you get all the angles, forces and loads etcetera. So, when we compare we see that there is hardly any difference. In fact, the difference is not significant you can say here that ASABE draft is this is the one for ASABE draft you can see this value then ASAE the modified is this one here. And, then the strain gage mounted once or you can see here and the developed one is in fact, onto that only.

So, we I can tell you that very high accuracy level we have got with the developed dynamometer as compared to the strain gauges. So, we claim this that the draft which has been measured with the different depths operation of the implements in case of a mold board plow, similarly, in case of a disc harrow and also in case of cultivator. We got the similar effect you can just have a look that, this you can see here that strain gauges and this the difference is not there in fact.

Virtually the difference is not there for all the three implements that we had taken and the various depth of operations operation which we have done the field actual field condition. So, we can we were very much happy that we are in a position to develop an equipment which is compact which is simple and easy to handle and easy to carry anywhere and all that with minimum of wires etcetera.

So, we call the three point leakage diameter developed at IIT, Kharagpur. Now, we will see what else we have with us.

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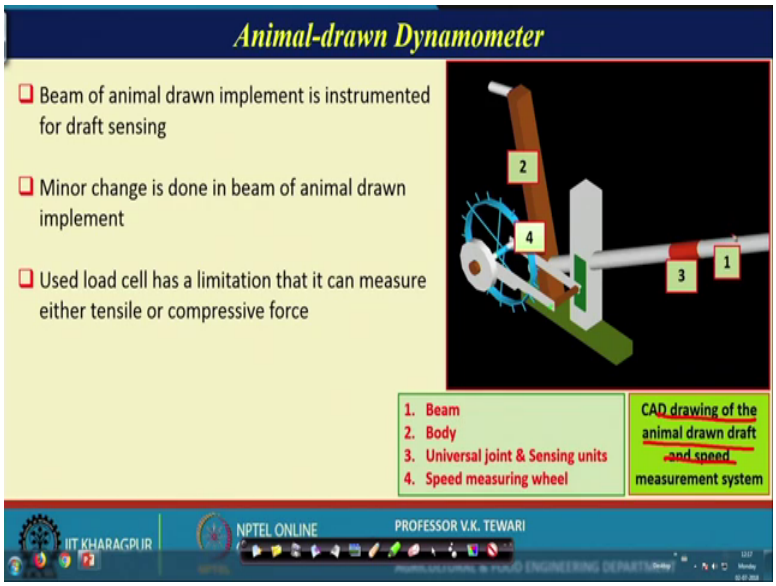

See, the while we developed this we also wanted that how do you measure these draft for animal drawn equipment. It is worth knowing animal drawn equipment and even the one which we are talking with respect to the manual drawn as well. So, in animal drawn equipment where do we keep these dynamometer and for that also we have used a similar concept. This is the CAD, CAD drawing of the animal drawn draft and a speed equipment here.

You can see that a is the beam here first one is the beam, then the this is the body of this, then universal joint and sensing unit. This is the location where we have the universal joint and sensing location and a speed measuring wheel the that we have a 4 wheel kept here which will measure the speed actual speed of operation while the this particular equipment or the animal drawn device is under operation in the field. So, low yes, then beam of animal drawn implement is instrumented for draft sensing.

Minor changes done in the beam for animal drawn implement here. This say, there need to be because you would need to do some changes as compared to what you have done over there because of the construction of this and because of the way it is connected to the animal which are the actually the source of draft power. So, the used load cells has a limitation that it can measure either tensile or compressive forces.

Yeah, well this is very essential and this is very one of the limitation, you can say that yes, your load cells either they can measure tensile or compressive forces. So, well, then

we have to deal with it because we are interested to find out what accurately and how is the value, when we are using an animal drawn equipment in the field.

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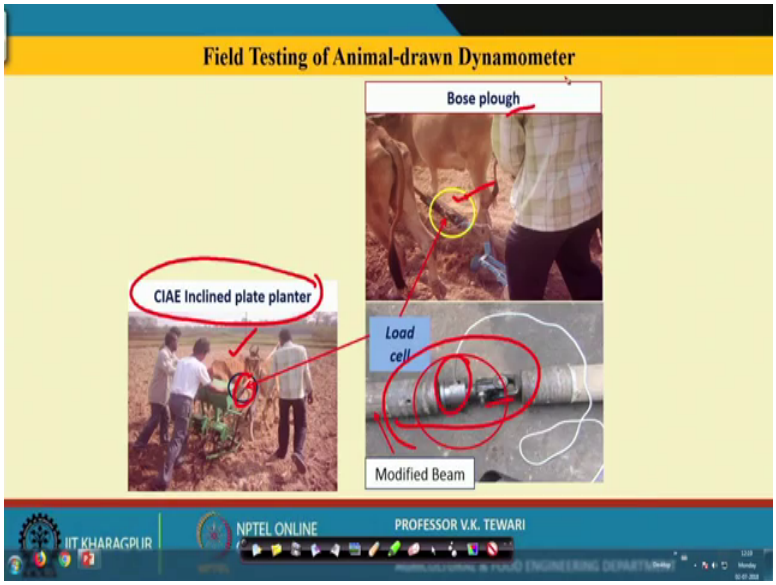

Well, fields testing also. We did field testing because then until and unless you see the actual thing into the field condition you may not appreciate. So, it was we wanted that people should see at how they are being used what we where we have used, you can have a look at this.

Now, you see that CIAE inclined plate planter. So, in this inclined plate planter we have used at this location, you can see the power shows the block here and this is the modified beam. The beam has been modified and this is where this is the universal joint hook and this is the location of our the load cell here. And, this is shown over here as well this is one Bose plough I in fact, this is a simple plough, but in somebody name of Bose is the one who developed this plough which is very much prevalent in West Bengal and that is why we have used that name as the plough.

So, but it is a plough is not very different, but has a small molded slightly twisted board and a small one for the capacity of the blocks of a West Bengal you can consider that part and that is why we have shown that a planter being used and for a Bose plough which is used.

So, the these two in the field condition we have measured and we have seen that yes it is in a position to measure the values of the tensile loads, which are coming onto the equipment and which is in fact, being taken by the animal.

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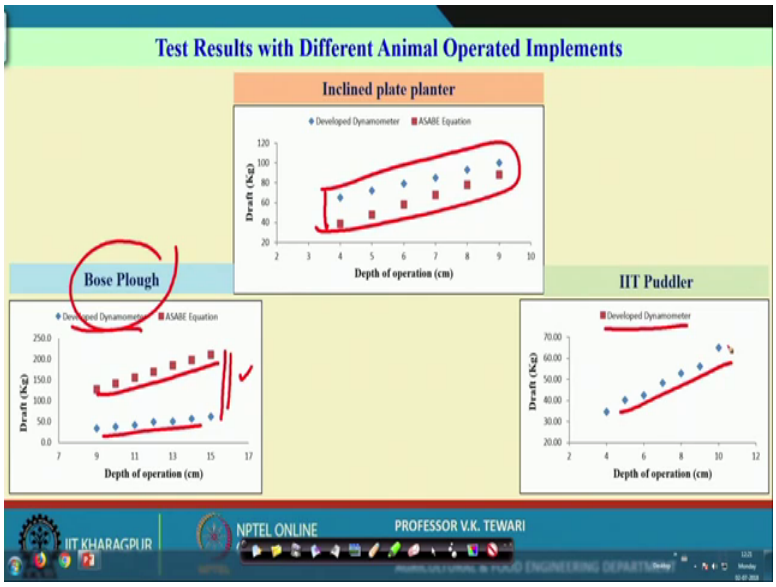

Different animal operated equipment. Yes, we wanted to compare this and here is the data which will you will appreciate from this data that yes, it is possible and we have done this particular equipment and compared the values.

See the see with that plough which I talked of the equation is here and the developed dynamometer is here. Yes, there appears to be some gap in between, but then this is possibly you can think of some error somewhere, but we did not get in the case of the strain gauges and that when we talked of the tractor drawn equipment. But, here you can see in this case the inclined plate planter; we are very close you can see that this is the closer as compared to this.

The IIT Puddler in fact, we developed developed dynamometer, now here this is the developed dynamometer which is showing you the draft. We had a IIT Puddler, in fact, there is a Puddler which suits the capacity of the West Bengal blocks was developed at IIT, Kharagpur, with the less number of puddling blades inside and the size and that equipment was also tested under the lowland conditions and there we could find that the draft we were in a position to measure that draft.

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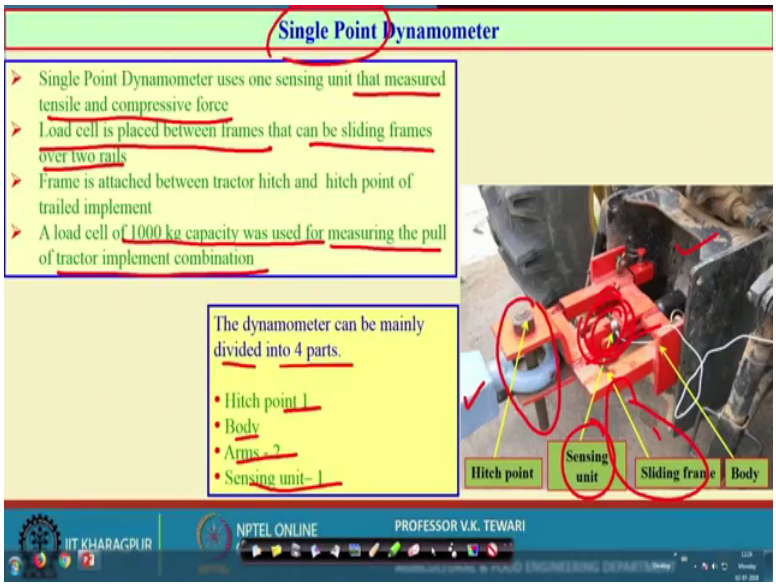

Single point dynamometer. Well, this is also important because some we test through the tractor not only the implements or equipment, but we attach also the haulage equipment which is mostly the trails the water bowsers or the trailers in which we carry lot of haulage material you can say you can think of either it is the and the bio-product oh or the actual material like paddy wheat grain or the straw etcetera, which are being carried.

So, many a times people you might have seen carrying human beings also on the trailers. So, we would also want to find out what is the actual force required there and that is why we have developed a on the same line we are doing a single point dynamometer or single point hitch. We had three point hitch and the single point hitch so; we wanted to develop this as well.

So, what are these? You can see the hitch point here this is the point, this is the pin which is used for hitching the buzzer or the trailer here and this is the part of the tractor. So, now you can see here that this is the location where in the sensing unit. This is the location we are sensing unit is there, this is the frame which can slide and which can be fitted properly and this is the body, body of this whole equipment. So, the hitch point is one the body arms and the sensing unit. So, the dynamometer can be mainly divided into four parts as I showed you over here.

Now, this is so far as the so far as this is the straight if it is straight we are in a very good position to find out using this sensing unit the accurate value. So, this will give even now

we had first talked of these the spring type then we talked of the hydraulic dynamometer, then we talked of the strain gauges and from this strain gauges then I said that using a strain gauges we have the load cells. And, using those load cells now, we are in a position to give even a single point also equipment which can be found out for haulage operations.

So, we have developed this. The tensile and compressive forces are measured with this, the load cell is placed between the frames that can be sliding frames for over two rails as it is explained over here and load cell of 1000 capacity was used for measuring the tractor implement combination. Here particularly this a 1000 kg was used because particularly for these what we have? We have only the load the total load which is coming on to the ground and the friction. So, that is f into nu.

So, the virtually the load if you are talking of the total force which is to be pulled is nothing, but roughly 0.04 times the total weight of which is carried over there and that is why if it is straight connection between this. So, we are getting a 1000 kg capacity one, is in a position to measure this values and we can tell that this has been very accurately and very comprehensively tested and used at IIT, Kharagpur. And, this unit in fact, has been given to other places for testing as well and then it was also shown to people who matter particularly with regard to how these things work in the actual field conditions.

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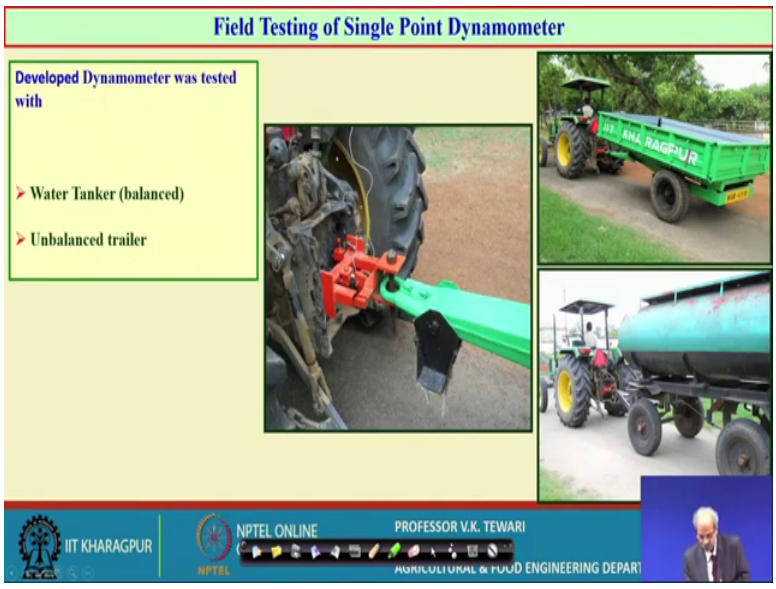

Now, this is the conditions where we are attaching the single point.

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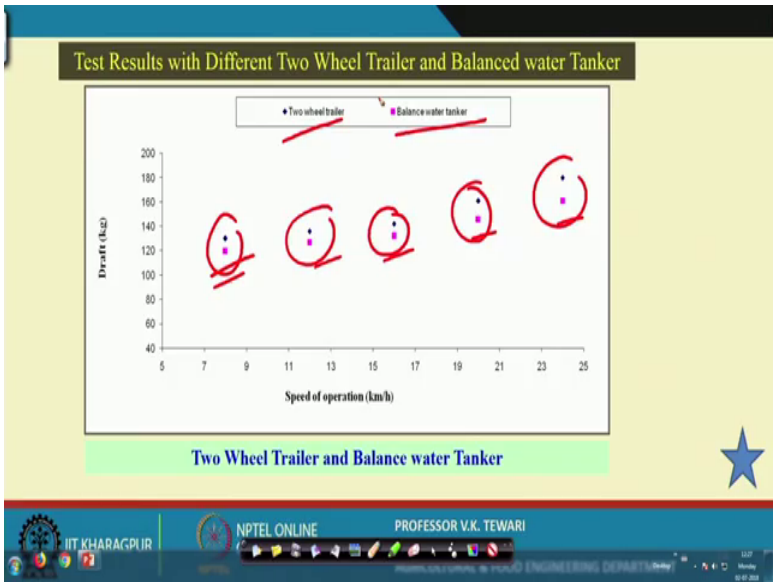

Well, here two results with two different two wheel trailers and balance will tankers. Now, this they result only to explain to you that the draft values which are two wheel trailer and balanced water tanker. You can see the differences are not much we. We can say here that we are very much accurate in both the wheels by which we have measured the two wheel trailer and balanced water tanker.

See we are talking of two wheel trailer here. So, the moment you talk of two wheel trailer here the you need to maintain the horizontal position of the hitch with respect to the trailer. So, this is important here, but then we found that if you are putting it a straight you the angle the distant the changes are not much when we are considering these because the balanced water tanker is a four wheel one and this is a two wheeled one. So, we are in a position to measure this.

So, by this way now you have seen what are the parameters which are to be measured for finding out the performance of an equipment with the tractor. We talked of the wheel sleep, then we talked of the draft then we talked of how to measure the sleep various speeds of operation and then we are in a position to measure for a animal drawn equipment, for a single point hitch and then for a three point hitch and we are in a position to measure even for the two wheel trailers and or a single excel trailers and four excel two excel trailers.

So, by this I can tell you that now, if you want to measure the performance of a machine under the field conditions, it is very essential for you to have the proper equipment or instrumentation which has been developed at IIT, Kharagpur and which are advanced and that can be used and we have used here and we are in a position to predict these values very well and I hope that you will be if you are interested you can take up these more details and then test this equipment and the these are available now for commercial utilization by the people and you can use it.

So, with this I think we will conclude the our testing parameters and the instrumentation which we have given over here.

Thank you.