The Advanced Topics in the Science and Technology of Concrete
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Tension Test of 7-wire Steel Strand

Welcome to the material testing laboratory, I am Prabha Mohandas, Ph.D. scholar in BTCM division, civil engineering Department at IIT Madras, today I am going to talk, explain about how to do tension test for prestressing stands, typically prestressing strands are widely use in which structures, slide way sleepers and high-rise buildings and these stands are high-capacity strands of about angle to 200 kN depending on different sides of the bus.

So it is very important to characterise those strands to meet the acceptance criteria, to be used in the structures, so what are those acceptance criteria? So in tension test will be getting the different parameters like yield strength of the materials, elastic models of the strand and ultimate load of strand and ductility of the strand.

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Typically three types of strands are being used in pretension or prestressed concrete systems, those are 3wires trends which has 6 MM diameter and next one 7 wires strands with 12.7 MM diameter which is typically used in pretension concrete systems and the next one of 15.2 MM diameter stands again this was also 7wire stands which is typically which is typically used in post-tension concrete structures.

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So today I am going to do testing on these 12.7 MM diameter strand, so to make those specific criteria to for the acceptance think, core has specified minimum requirements for each panel meters, for example the 12.7 MM strand should have the nominal diameter of 12.7 plus or minus, so we have standard specifications which gives the minimum criteria for the acceptance purpose, so in India we have IS 14262 that is the specification used for prestressing strands and we have ASTM A1061 again that is also being used for prestressing strands 7wire.

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So now we can start doing the testing for 7wire stands, before starting the testing we need to do the specimen preparation and certain measurements for the calculation purpose later, so we need to have vernier apparatus to measure the nominal diameter of this strand and we have dial gauge to measure the elongation of the strand during the testing and we have the skill to measure the length of the strand before replace the strand in the testing machine.

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So basically strand is at of 7wires, 6 outer helical wires and 1 centre king wire, so to get the correct area of the strand, you need to measure the individual outer diameter of the strand and then king wire and some of that to get the actual area of the strand, so you have to measure the nominal diameter of the strand using vernier caliper, then we can measure the pitch length

of the strand, so we need to measure the gauge length for placing this dial gauge on the strand to measure the elongation during the testing.

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So once the gauge length is fixed we can prepare the gripping portion of the strand, so we need to, so for any tension test gripping is very important because we need to avoid stress concentration near the wedges, so basically when we apply lateral pressure while gripping that will induce test concentration and that may affect the result.

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So once we get the dimensions of the strand we will next prepared the end region of the strand for gripping the strand in the machine, so we need to be careful while gripping because

we need to avoid stress concentration which will affect the results, ASTM specification gives we need to use special cushioning devise to avoid stress concentration near the ends, so for that purpose we have prepared this hardened aluminium plate which can be placed at the end of this stands for gripping purpose.

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So you can see the groups made on the plate on which strands will be placed and during testing we may face some slipping, so to avoid that ASTM specifications as given to, suggested to use aluminium oxide oil slurry made using glycerine and we have placed the clamp at both ends make sure that the, this strand is not slipping or rotating during the testing.

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Now we have prepared the specimen for the tension test, once the specimen is ready we have to mount this specimen on the machine for the tension testing, so before getting into the testing I will just brief about tension machine that we are going to use.

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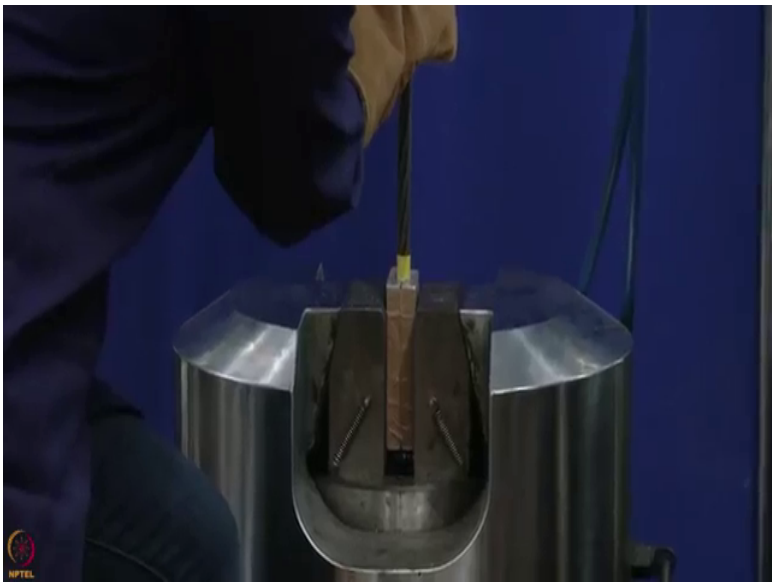

We had this universal testing machine from MTS, the machine capacity is 1000 kN which is fully servohydraulic control and this is the hydraulic control system which will be used to apply the lateral pressure for gripping the strands and this controls we have to moves this upper portions to place the strands, now we have place the strand under the machine for the testing, once the strand is fixed preloaded is applied to give the strands straight.

Typically 10% of its breaking strength will be applied as a preload as per the standard specifications, once the dial gauges fixed you need to measure the gauge length, that is the distance between the two knife edges of the dial gauge, then you need to measure the gap length that is the distance between the upper and lower grip to get the total deformation or total elongation of the strand at the end of the testing.

So during the test you need to monitor the dial gauge reading to get the elongation at different intervals of loading, typically we will be taking the dial gauge reading at every 10 kg Newton interval till it reaches its yield strength, ones it has reach the yield strength, we need to remove this dial gauge from the strand to avoid the damage, when the strand is rupturing or breaking at the later stage.

Once the dial gauge is removed we will continue the test till the strand breaks or till strand reaches its ultimate strength, once the dial gauge is fixed, to capture the post peak behaviour, we are using displacement control method, basically we are applying to amember minute loading rate, so now we will start the testing.

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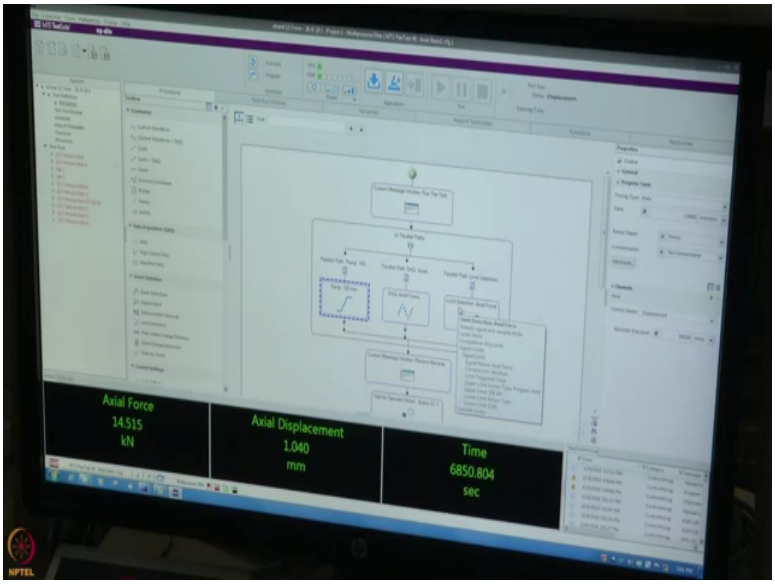

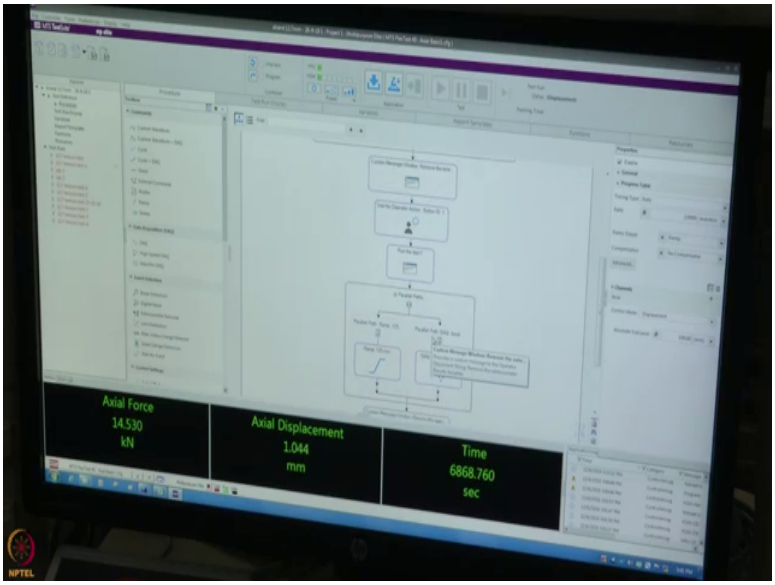

So now we have the computer program to run the test and capture the load and displacement data, we used 2 MM per minute displacement rate to apply the load, so typically displacement control test or preferred to capture the post peak behaviour of the materials, then once it has reached its yield strength there will be a deduction, indication to remove the dial gauge and the dial gauge will be removed once reaches its yield strength, then we will continue the test till the specimen fails, then the load end displacement will be recorded.

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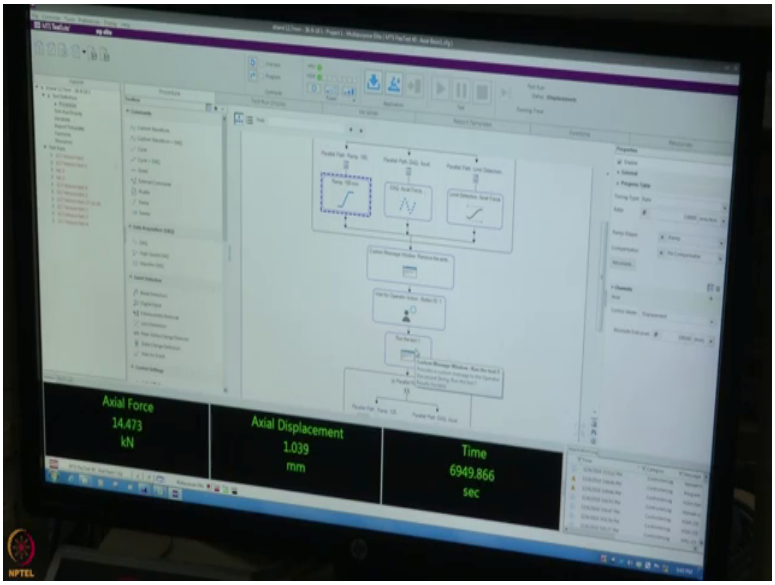

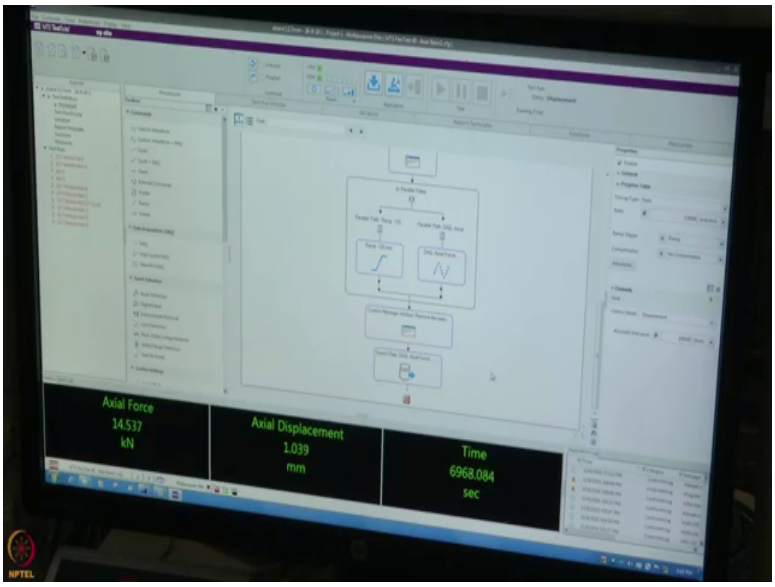

So here we have the computer program to run the test, so which is initially displacement rate of 2 MM per minute is used to apply the load, displacement control rate is preferred because we need to capture the post peak behaviour also, then the load will be increased gradually to reach its yield strength, once it has reached its yield strength there will be indication to remove the dial gauge from the strand and dial gauge will be removed, then the test will be continued to reach its ultimate strength or the specimen fails. Then the load and displacement will be recorded (())(10:02)

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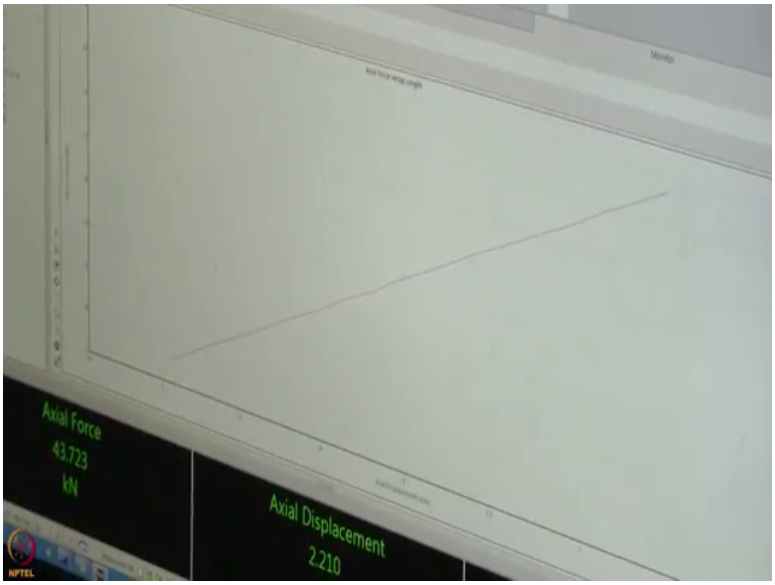

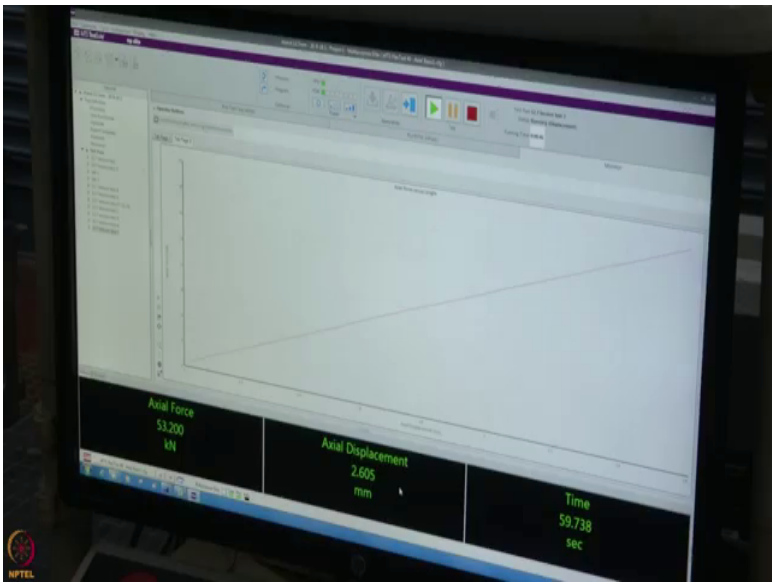

So while test is running here you can see the load displacement behaviour of the strand and now you can see the load is linearly increasing and the force and the displacement are showed at the bottom of the screen, meanwhile reading will be taken, dial gauge reading will be taken

at every 10 kg Newton interval, now this indicates that is the specimen has reached close to its yield strength and now we can remove the dial gauge from the strand.

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Now we are done with the testing and our stand specimen has failed by breaking of single wire first followed by second wire, third wire and almost all the outer wires has broken, the first wire has broken at its centre, then the rest five wires has broken at the near the upper gripping point of the strand and you can see nice flower shape failure of the strand, if it is properly gripped from the test results, from the software we can get the load displacement data, using the data we can obtain the stress strain, profile of the prestressing strands, from the stress strain curve we can get the yield strength from the initial slope of the stress strain plot then the yield strength of the strand, then the ultimate strength where the first wire has failed, then finally the ductility or the total elongation of the strand.

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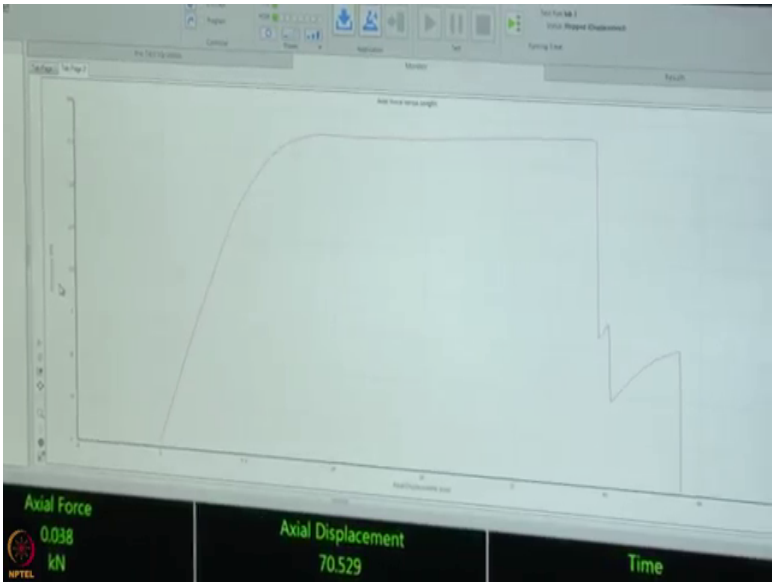

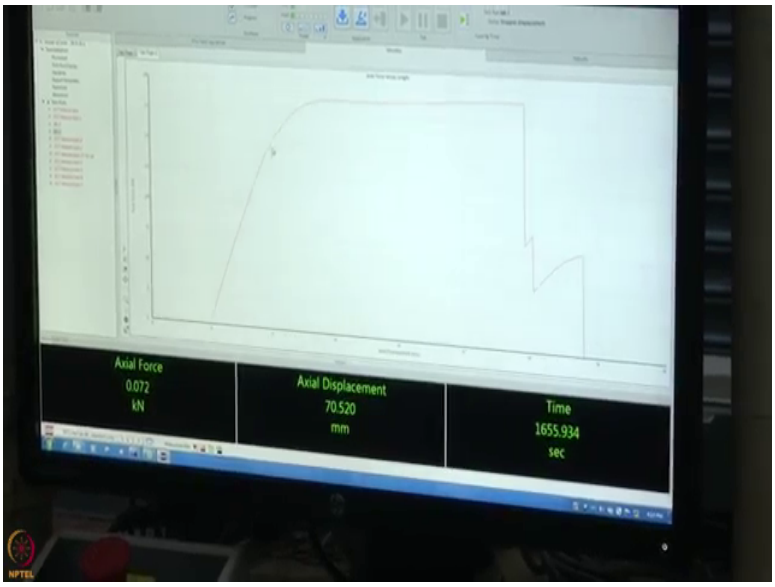

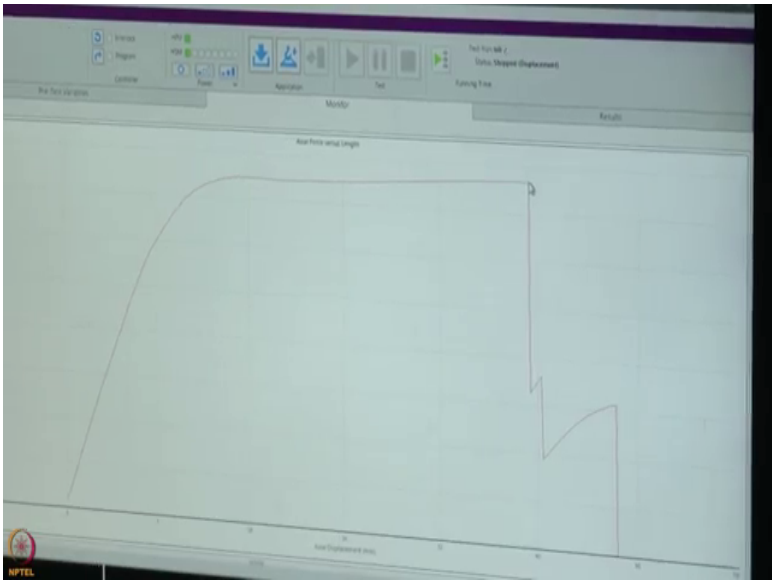

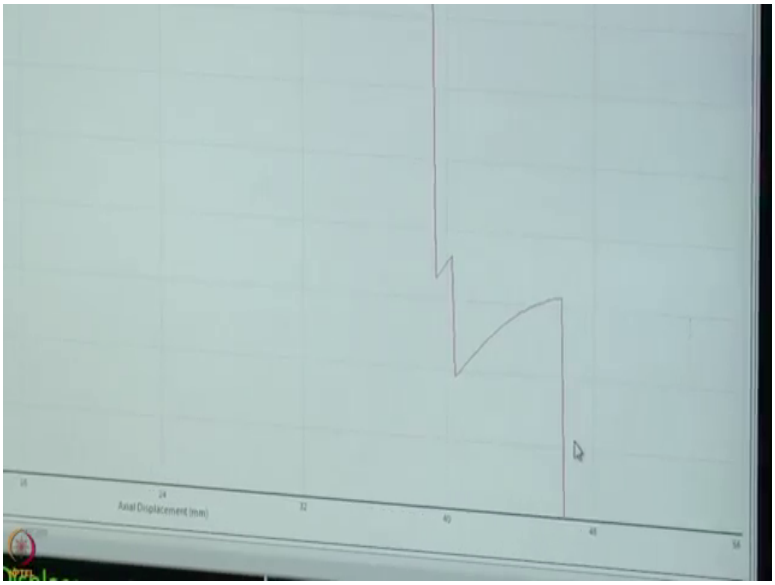
Axial Displacement (mm)

This plot shows the axial force and displacement behaviour for the prestressing strand based on this axial force you can get the, you can calculate the stress applied, dividing the axial force by area of the strand and strain can be calculated is appending the axial load and displacement from the software and this plot shows the axial force and displacement behaviour of the prestressing strand and from this data we can obtain the stress strain behaviour of the prestressing strand and this initial portion can be used to obtain the elastic models of the strand and this indicates where the yield strength of the strand and this indicates the ultimate strength of the strand where the first wire is broken and the load has dropped.

And subsequent breakage of the outer wires slow this for this dropped and finally this will indicate you total elongation of the strand which can be used to obtain the ductility of the material, in this session we have learned how to do tension test for DP prestressing strand, how do you need to prepare the strand specimens and the test procedure for tension test and procedure for obtaining the stress strain behaviour of the prestressing strand. Thank you.