Structural Health Monitoring (SHM)
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Lecture - 76
Part – 2: SHM design by experimental investigations for lab scale model of TLP - I

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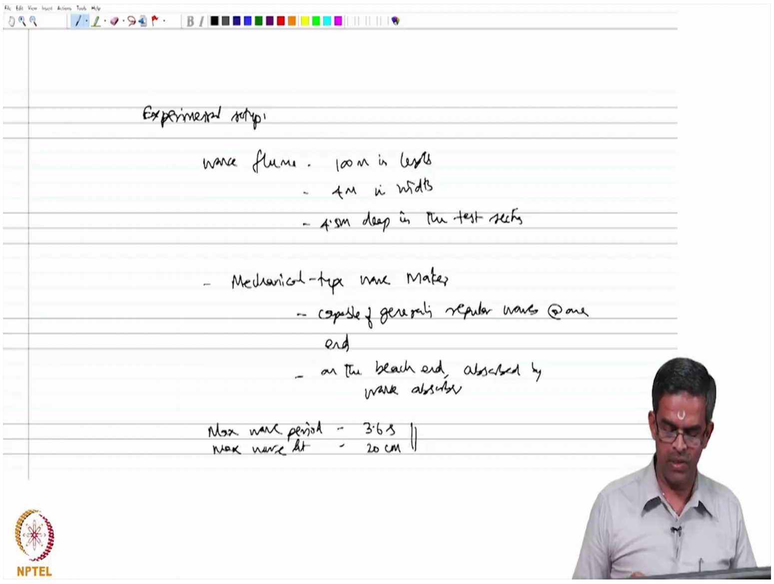

Shows that there is a wave flume of about 100 meter in length, 4.5 meter deep in the test section; it is equipped with mechanical type wave maker, which is capable of generating regular waves at one end.

And on the beach end these waves are absorbed by wave absorber, which can be generated in this system in the test setup is about 3.6 seconds and the maximum wave height, which can be generated is about 20 centimetres in the lab scale that is the constraint or limitation of the test setup what we presently have at this moment.

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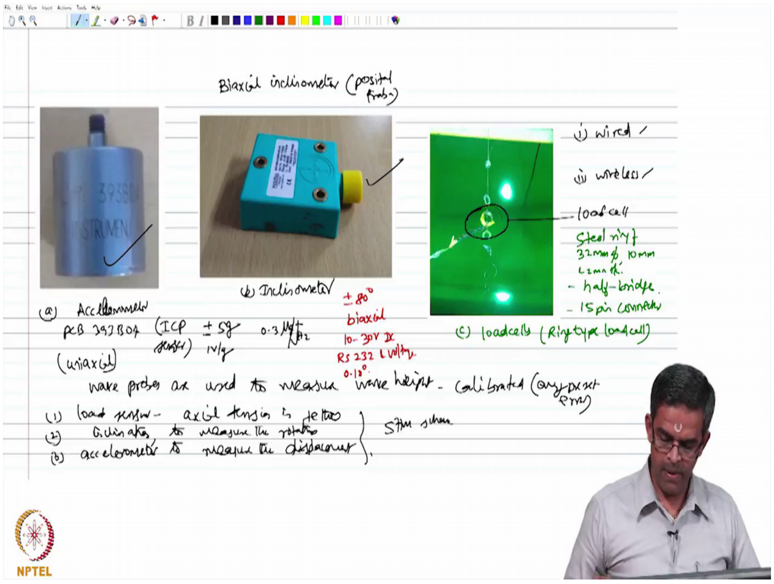

Wave probes are used for measuring the wave height, during the test run of the experiment, they are calibrated to know the error if at all any preset error. The structural health monitoring system consists of different equipments in this case, we need to have the load sensors to measure the axial tension in tethers, we need to also measure the inclination because as you look at TLP in general.

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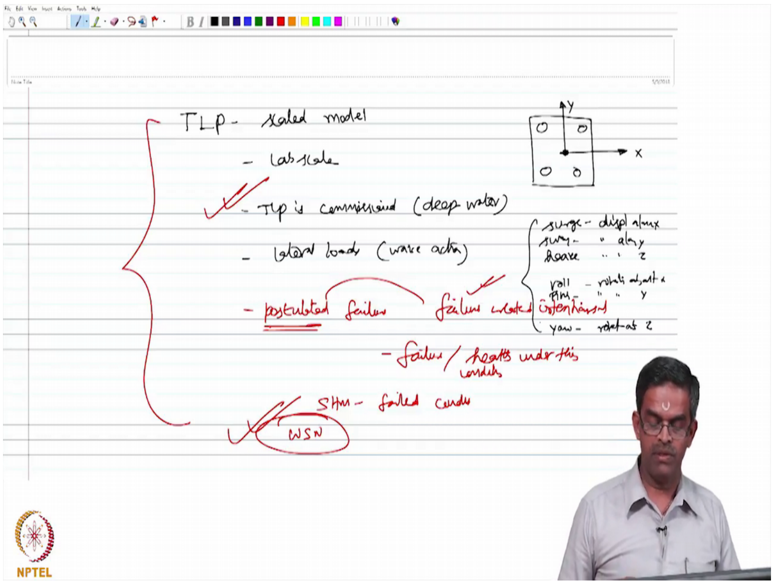

The rigid body motion of TLP in plan which has got let us say 4 legs if this is my x axis, this is my y axis and the z axis is normal to the board here this is my x axis. So, it has got surge which is the displacement along x, sway which is displacement along y, heave which is displacement along z axis then roll which is rotation about x axis, then pitch which is rotation about y axis and yaw which is rotation about z axis. So, it is what 6 degrees of freedom. So, surge sway heave roll pitch and yaw.

So, now it is going to move in all 6 degrees of freedom therefore, roll pitch and yaw being rotation I need in kilometre to measure the rotations the third one could be I also need accelerometers, to measure the displacements ok. That is the wave measurements or that is the measurements which we need to measure during the health monitoring scheme let us quickly look at what are the two types of systems we are proposing.

We are proposing two systems, one is your wired system other is wireless system as we compared them in the previous lecture using buoyantly storage regasification platform, similarly in TLP we did the same thing by actually employing. Two types of health monitoring systems, one is wire and the other is wireless, data acquisition is done on scaled model using both the systems. The accelerometer what we have used is PCB 393 B04 which you see here is accelerometer, which is piezoelectric I CP sensor integrated circuit piezoelectric sensor it is an ICP sensor integrated circuit piezoelectric sensor, which is used to measure the acceleration time history over a definite period of time T.

This can also measure the dynamic pressure force and strain values. In the present study this is used to measure surge sway and heave displacements of the platform on a scaled model. Output of the acceleration model will be connected to the signal conditioner before it is connected to the data equation channel on excitation, the force is exerted by the mass and piezoelectric material generates electric output through the electrodes. For a constant mass force exerted by the piezoelectric material will be proportional to the external vibration and the how the acceleration of the body on which the accelerometer is placed will be able to give us an indication of the displacement response of the body in any specific axis to which it is connected.

So, we are talking about the specification of accelerometer., this is 393 B04 ICP sensor it is uniaxial sensor, the range is plus minus 5 g, the sensitivity is 1 volt per gram and the noise performance is about 0.3 mu g per root hertz. The next one what we used is inclinometer, this is the inclinometer what we have used.

This is posital fraba biaxial inclinometer the make is posital fraba, which can measure inclination in two perpendicular axis. Now, the range of this is plus minus 80 degrees, it has got biaxial inclination measurements. It operates between 10 to 30 volts DC, the interface is using receptor RS 232 cable and voltage, accuracy is about 0.1 degrees that is the accuracy of the inclinometer, then kilometre is calibrated for using the instrument or the experiment before it is being conducted.

To measure the axial strain or to measure the axial forces in the tethers, we also have the load cells. The current experiment uses ring type load cell as shown in the screen now, this can measure the dynamic tension variation in the tethers they are fabricated using this is the load cell I can mark it here we can see this is the load cell, this consists of steel ring you can see here the steel ring of 32 mm diameter, 10 mm wide and 2 mm thick. The strain gauge is used or foil tape half bridge epoxy resins are applied to protect them from waterproofing.

It has got a acquisition connected to the DAQ using fifteen pin connector to which it is connected through the data acquisition system. The load cells are calibrated before they are being used in the experiment.

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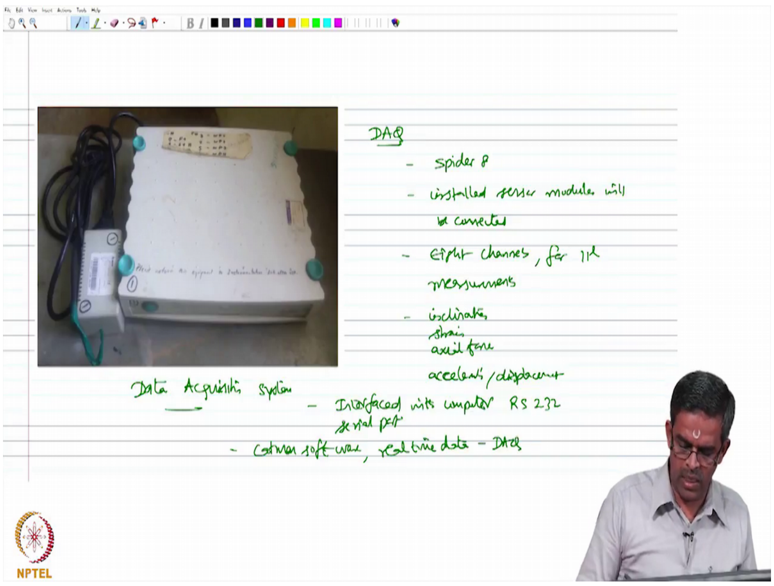

The next one is the data acquisition system, which we briefly call DAQ this experiment uses spider 8 DAQ as seen in the figure here, the data acquisition system DAQ, which is spider 8 in which all installed sensor modules will be connected. This has got 8 channels for parallel measurements which can be used to record non electrical quantities for example, in our case inclination strain axial force variation and acceleration or let us say displacement.

So, all can be measured using DAQ, the data acquisition system is interfaced with digital computer using RS 232 serial port, Catman software is used which is pre installed in the computer can read the real time data which is acquired in the DAQ that is a setup we have.

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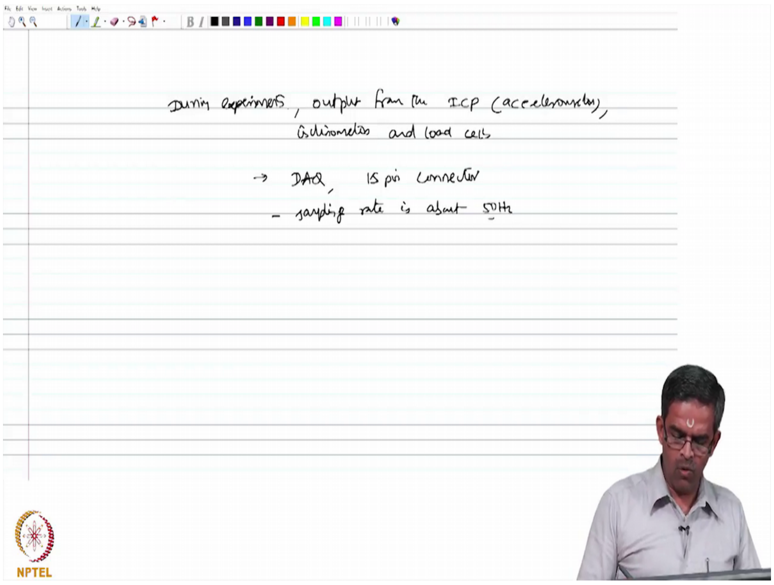

During experiments output from the ICP, that is piezoelectric sensors of accelerometers in the kilometres and load cells will be connected to the DAQ, using 15 pin connector in case of wired sensors and the sampling rate is fixed is about 50 hertz.

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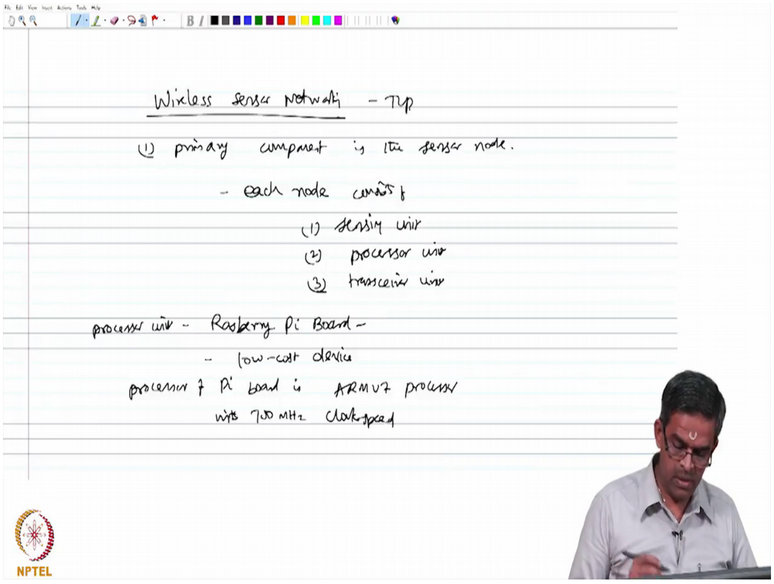

Now, let us move on to the discussion of wireless sensor networking, which is used in the TLP model. The primary component of the wireless sensor networking is a sensor node, each sensor node consists of a sensing unit, processing unit and a transceiver unit. The process unit is raspberry P i board, which has been discussed in detail in the last lecture.

The advantage of this is a low cost device, which can be used for local data acquisition. The processor of P i board is ARMV 7 processor with 700 megahertz clock speed which is quite reasonably fast to acquire the data and transfer the data quickly.

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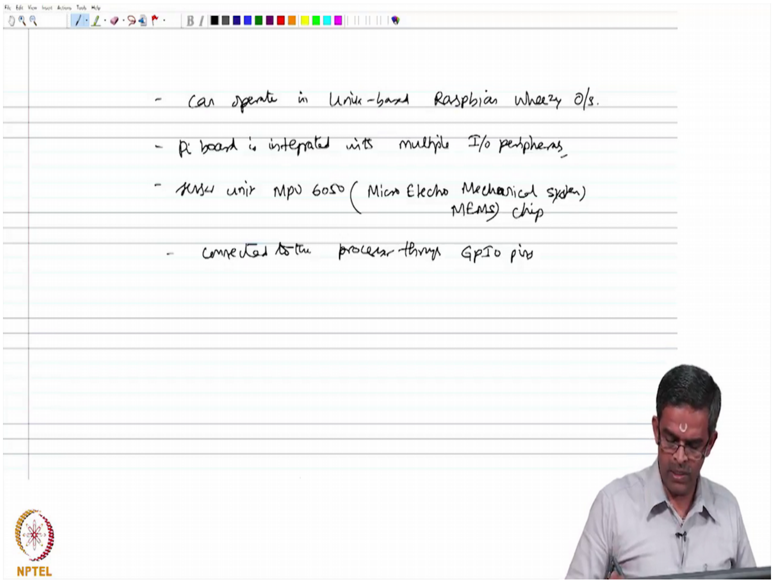

This can operate this can operate in Linux mode or Linux based Raspbian wheezy operating system. The P i board is integrated with multiple input output peripherals.

The sensor unit that is MPU 6050 whose detail have been discussed in the last lecture as well which is micro electro mechanical systems, which we call MEMS sensors. So, MEMS chip MPU 6050 this is connected to the processor through GPIO pins that is General Purpose Input Output pins.

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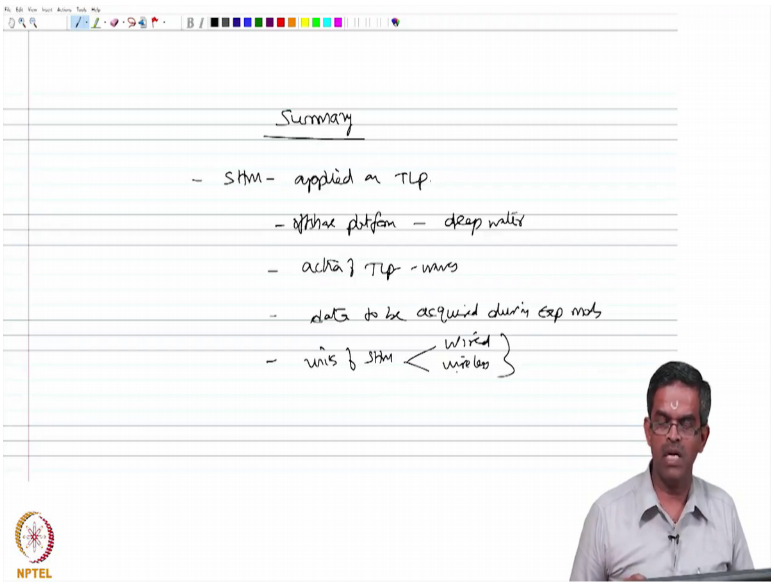

So, friends let us look at the summary of this lecture quickly. In this lecture we are talking about structural health monitoring applied on tension like platform and offshore platform used for oil exploration in deep waters. We discussed about the action of TLP under waves as an introduction, we then understood what data to be acquired during experimental modelling.

We discussed about the various units of structural health monitoring, both wired and wireless, we continue to discuss them in detail before we discuss about the results, and the health monitoring observations what we made on a lab scale of a TLP using the SHM design, which is indigenously developed at our department at IIT Madras.

Thank you very much and look for you in the next lecture bye.