Computer Methods of Analysis of Offshore Structures
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Module – 02
Lecture – 06
New generation platforms

So, few studies have been also conducted by Shaver et al in 2001 and Capanoglu et al in 2002.

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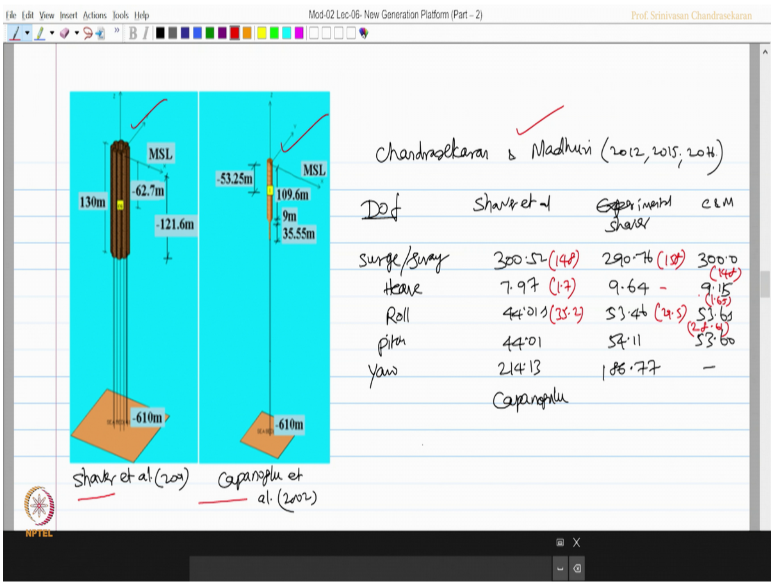

Based on which Chandrashekaran and Madhuri in 2012, 15, 16 etcetera as conceptualized as a preliminary research and studies very clearly showed for various degrees of freedom in surge and sway, Shaver et al showed a period of 300.52 seconds.

Shaver et al also did experimental study and that showed 290.76 seconds and Chandrashekar and Madhuri showed results which came to be 300.0 seconds. In heave degree of freedom this value was 7.97, this value was 9.64 and this came to 9.15. In roll degree of freedom this was 44.01 seconds, this was 53.46 seconds where as this was 53.6 seconds.

In pitch degree of freedom this value was found to be 44.01 and 54.11 and this again showed to be 53.60. In yaw degree of freedom which is a flexible degree, this was

214.13 seconds Shaver showed 186.77 experimentally and of course, they did not report anything of this order.

Similarly, when we compare this with Capanoglu, they showed this value as 148 and this 158 and based on the same model Madhuri showed it is 148, because the model taken by Capanoglu and that of Shaver et al are different it is a group of buoyant leg where as Capanoglu they were only single buoyant leg. In heave degree this was 1.7 and no experimental value by Capanoglu and this value became 1.65.

In role degree of freedom this value was 35.2, this is 29.5 and Chandrashekar et al showed 28.61. So, one can see very clearly here the conceptual model of triceratops generated experimentally and analytically tested by Chandrashekhar and et al compares well with Shaver et al and Capanoglu et al in the preliminary studies where as please note Shaver et al and Capanoglu studied this only on buoyant legs whereas, study of this was extended further to form a new generation platform which triceratops.

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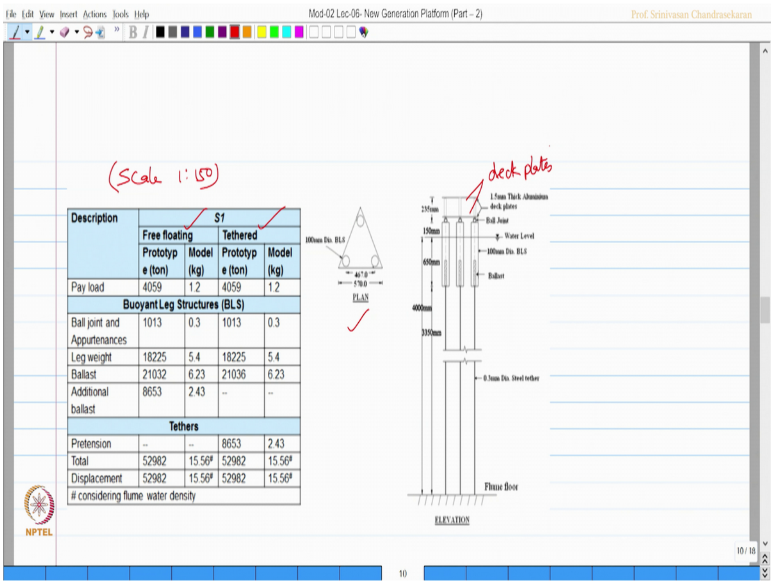

So, your full model was developed you can see here the details of the model. And an experimental and model testing were done on both free floating and tethered triceratops by Chandrashekhar et al for a pay load of 4059 tons on a scale of 1 is to 150. So, this was the triangular deck plan, which was proposed with two deck plates upper and lower deck plates. Ball joints isolated the deck partially, buoyant legs they are ballasted to maintain stability and floatation characteristics desired for a buoyant leg.

They were all initially tethered with pre tension, similar to that of a tlp using 0.3 mm diameter steel tether in an experimental set up. So, for this the structural details in terms of pre tension, displacement, ball joint and appurtenances low etcetera are available on the screen now for your reference.

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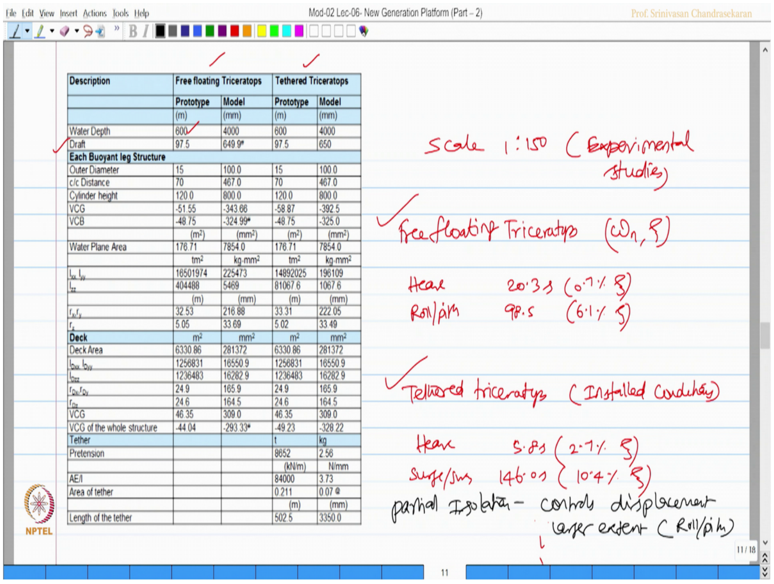

Description	Free floating Triceratops		Tethered Triceratops	
	Prototype	Model	Prototype	Model
	(m)	(mm)	(m)	(mm)
Water Depth	600	4000	600	4000
Draft	97.5	649.9*	97.5	650
Each Buoyant leg Structure				
Outer Diameter	15	100.0	15	100.0
c/c Distance	70	467.0	70	467.0
Cylinder height	120.0	800.0	120.0	800.0
VCG	-51.55	-343.66	-58.87	-392.5
VCB	-48.75	-324.99*	-48.75	-325.0
	(m^2)	(mm^2)	(m^2)	(mm^2)
Water Plane Area	176.71	7854.0	176.71	7854.0
	tm^2	$kg\text{-}mm^2$	tm^2	$kg\text{-}mm^2$
I_{xx}, I_{yy}	16501974	225473	14892025	196109
I_{zz}	404488	5469	81067.6	1067.6
	(m)	(mm)	(m)	(mm)
r_x, r_y	32.53	216.88	33.31	222.05
r_z	5.05	33.69	5.02	33.49
Deck	m^2	mm^2	m^2	mm^2
Deck Area	6330.86	281372	6330.86	281372
I_{Dxx}, I_{Dyy}	1256831	16550.9	1256831	16550.9
I_{Dzz}	1236483	16282.9	1236483	16282.9
r_{Dx}, r_{Dy}	24.9	165.9	24.9	165.9
r_{Dz}	24.6	164.5	24.6	164.5
VCG	46.35	309.0	46.35	309.0
VCG of the whole structure	-44.04	-293.33*	-49.23	-328.22
Tether			t	kg
Pretension			8652	2.56
			(kN/m)	N/mm
AE/l			84000	3.73
Area of tether			0.211	0.07 @
			(m)	(mm)
Length of the tether			502.5	3350.0

Your further studies then extended to a water depth of 600 meters for a scale of 1 is to 150 and experimental studies were performed to understand the response behavior.

So, for a water depth of this, we are designed draft was established and dimensions and initial pre tension values and all structural characteristics of the platform for a scaled model comparative prototype in terms of tethered triceratops and free floating are available on the screen now for our discussion. The free floatation characteristics showed that the free floating triceratops had heaved degree roll and pitch degree of freedom frequencies as 20.3 seconds in terms of period with 0.7 percent damping.

In roll it was 98.5 with 6.1 percent damping. The tether triceratops showed better vertical stiffness, therefore; heaved area freedom it showed 5.8 seconds with 2.7 percent structural damping of course, in surge and sway it showed 146 seconds with about 10.4 percent structural damping. So, details of the model are shown on the screen now; and these are the natural periods and damping of the platform, concede for free floating and tethered triceratops under installed conditions.

More details of this study can be also seen from the reference papers of Chandrashekhar et al which has been given in the NPTEL website of this particular course. Interestingly, we understood that partial isolation controls displacement to a larger extent; especially in roll and pitch. To verify this statement, I request you to please go through the experimental and numerical papers published by Chandrashekhar and et al which reference are given in the NPTEL website of this course; you will verify this statement by reading those papers.

But I have a different observation. The observation is though the deck response is partially isolated, but still buoyant leg showed large displacement around a rotation. Can we control that? Can we integrate the motion of all the buoyant legs together? So, that was also examined by interconnecting the buoyant legs with three legs together and each leg has got three groups of buoyant legs and each one of them are connected; however, each buoyant leg remain independent.

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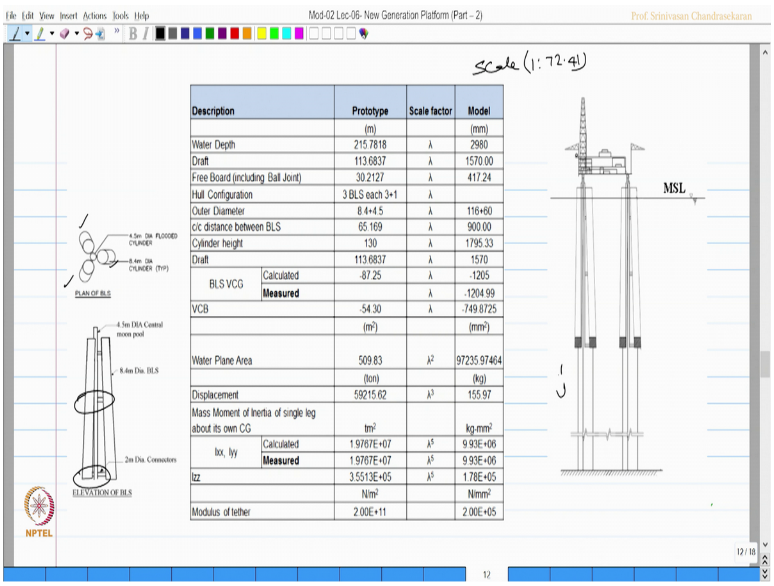

Description		Prototype	Scale factor	Model
		(m)		(mm)
Water Depth		215.7818	λ	2980
Draft		113.6837	λ	1570.00
Free Board (including Ball Joint)		30.2127	λ	417.24
Hull Configuration		3 BLS each 3+1	λ	
Outer Diameter		8.4+4.5	λ	116+60
c/c distance between BLS		65.169	λ	900.00
Cylinder height		130	λ	1795.33
Draft		113.6837	λ	1570
BLS VCG	Calculated	-87.25	λ	-1205
	Measured		λ	-1204.99
VCB		-54.30	λ	-749.8725
		(m^2)		(mm^2)
Water Plane Area		509.83	λ^2	97235.97464
		(ton)		(kg)
Displacement		59215.62	λ^3	155.97
Mass Moment of Inertia of single leg about its own CG		tm^2		$kg\text{-}mm^2$
Ixx, Iyy	Calculated	1.9767E+07	λ^5	9.93E+06
	Measured	1.9767E+07	λ^5	9.93E+06
Izz		3.5513E+05	λ^5	1.78E+05
		N/m^2		N/mm^2
Modulus of tether		2.00E+11		2.00E+05

So, the structural characteristics of this model at the scale of 1 is to 72.41 to be very specific is given on the screen. So, the structural characteristics and geometric characteristics of the platform, which are attempted new, are also shown in the screen at this moment. And this study showed a very interesting phenomenon of advantageous features.

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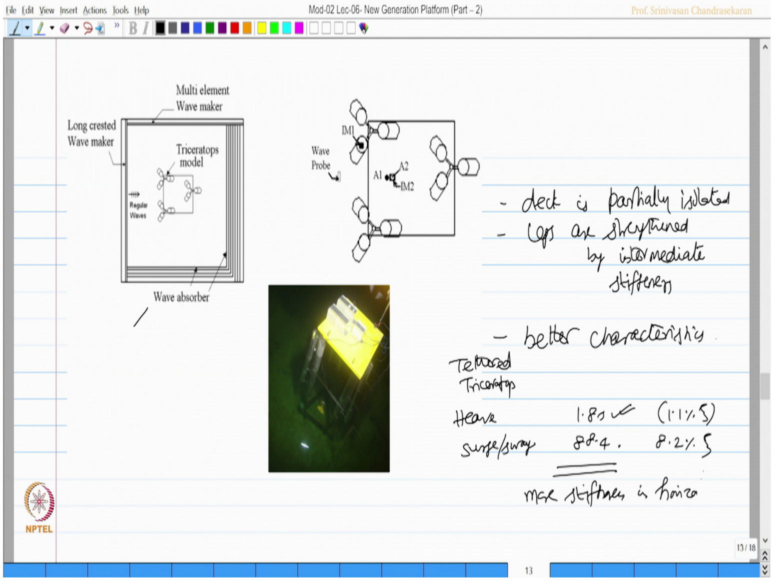

So, this is the plan of the triceratops model installed in the wave maker, in the wave basin. This is the instrumentation plan and this is the photograph of the experimental study for which now I will show you video. Please observe the video on the screen at this moment.

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So, triangular deck with the legs buoyant legs are connected to the deck using a ball joint, wave is hitting the legs; legs are rotating about this pivotal point.

But you can see here the deck remains almost horizontal. It means the role and pitch motion of the buoyant leg are isolated to get transferred to the deck which is the advantage of the whole system design. So, deck is partially isolated legs are strengthened by intermediate stiffeners, this showed better response characteristics.

So, if you compare the tether triceratops in heave motion surge and sway motion you see that the periods have come to 88.4 with 8.2 percent zeta, in heave its come to 1.8 seconds it is become more stiff with 1.1 percent structural damping. When you compare these values with a earlier periods what I gave you for an independent buoyant leg triceratops, they showed more stiffening in vertical plane and reduced frequency or time period in sense more stiffness in horizontal plane as well; which is a great advantage as for the structural form is concerned.

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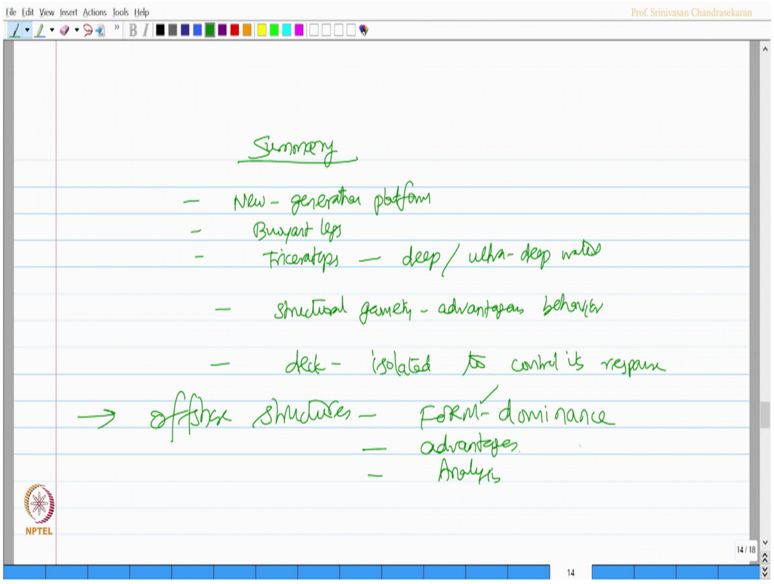

So, friends let us quickly write down the summary what we have learnt in this lecture. This lecture focused on new generation platform, the concept was concede from an idea called buoyant legs, which was assembled to form a triceratops which is suitable for deep and ultra deep waters. The structural geometry showed advantageous behavior. Now the deck can be isolated to control its response.

So, friends offshore structures have got form dominance in it are design, which shows advantages, which should be taken care of when we do the analysis. Unlike, conventional structures offshore structures should have a form uniqueness to do the analysis, this is the important concept what we wanted to establish from these set of lectures what we so far discussed in module 2. Next lecture we will move on to environmental loads will discuss about the programming how to work out environmental loads etcetera.

Thank you very much.