Computer Methods of Analysis of Offshore Structures

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Module – 01
Lecture – 24
Analysis of space frame: Example – 1 (Part - 3)

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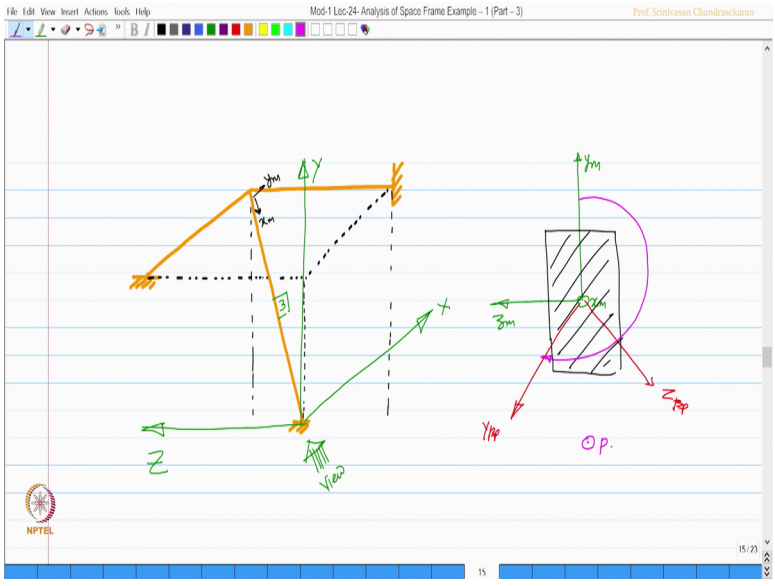

Is presented like this; so, this is another member. So, my axes are marked this way which is X axes, this is Z axes and this is Y axes, we are worried about this member; let us look at the view from here because this is my X m end of this member and this is my Y m end of this member; is it not.

So, I look towards the X m end in the negative direction that is the view when I draw the view. So, this is my cross section let say this is my Y m X m of course, here dot Y m is vertical and Z m is to my left this is my Y m right. So, let us mark the other 2 angles; the z beta P and y beta P; let us take any point P on the plane; let say this is my point P you know the psi way angle is actually is angle between Y m and Y beta is it not.

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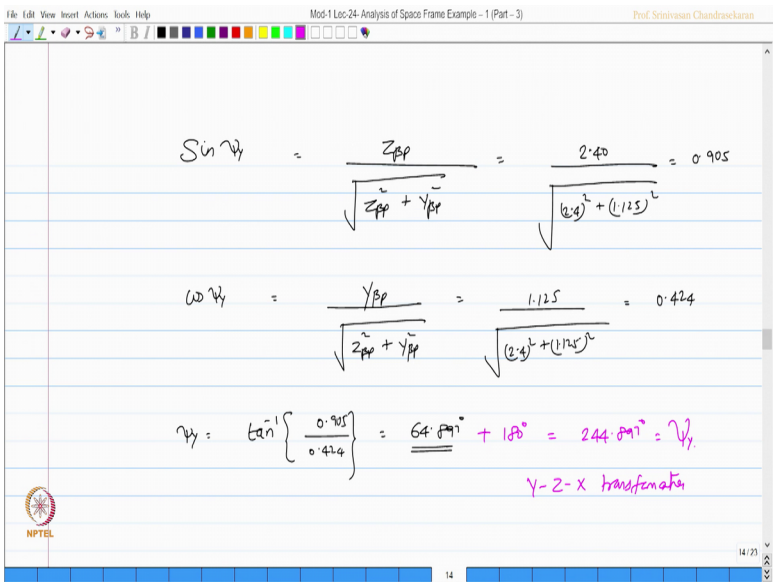

So, what I should do is whatever value I got I should add 180 degree to this 180 degree is to be added to this; is it not. So, I am actually getting this angle, but I am adding 180 to that if I do that it becomes 244.897 degrees which is my psi Y angle for doing Y, Z, X transformation. So, by this form; friends one can easily find out the directions cosines and sin angle psi angle which is inclination of the local axes with that of the reference set of axes.

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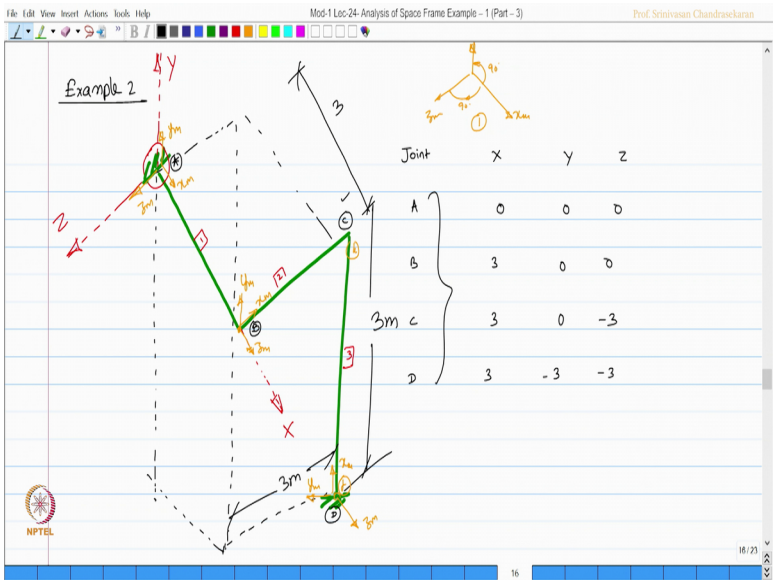

Let us do quickly one more problem and understand this further in detail. So, I have a structure system like this. So, I should now say example 2 one member this way one member this way another member vertical I have frame like this let us mark the reference axes this is my extension of this is my X axes, this is my Y axes, Z axes.

So, this becomes my origin from my reference axes system now got 3 members let us say member number one member number 2 and member number 3 let us mark the dimensions of these members let say; let us complete this. So, let say dimension is 3 meters this dimension is also 3 meters and this dimension is also 3 meters.

One is interested to compute the direction cosines and psi angle of all the 3 members that is the requirement to do that let us mark the local axes of each member the global axes is known to us the local axes I am marking this as X m Y m is anticlockwise ninety to that. So, this is Y m and Z m is going to be this way if we look at this carefully this is X m and this is Y m 90 anticlockwise, then clockwise to the right Z m, this is the 90 again that is how for member one it is marked.

For member 2, I take this as my origin for member 2. So, this is my X m. So, the left Y m to the right, Z m of the member for the third member I take this as my jth node; this is my kth node. So, in that case this becomes my X m anticlockwise; this becomes my Y m and to the right this becomes my Z m correct that is how they are marked let us make a

simple table to understand; this let say the joint what are the global X, Y, Z coordinates of the joint let us name the joints.

This is A, this is B, this is C and this is D, then let us say joint A, joint B and joint C and joint D with reference to the global axes joint A, you know A is exactly matching with the reference axes origin. So, it 0 0 0; if we look at the point B, you know you have travelled 3 meters in X, but along y and z you are not travelled anything. So, 3 0 0 0 if you look at C that is this joint you have travelled 3 meters along X along; we now travel, but along Z it is minus 3 meters is it not; if you look at D you have travelled 3 meters along X you have travelled 3 along Y, then you are travelled minus 3 along Y and you are travelled minus 3 along Z as well.

So, now the coordinates X, Y, Z are been established for all the joints A, B, C, D; let us now try to estimate the psi angle of that.

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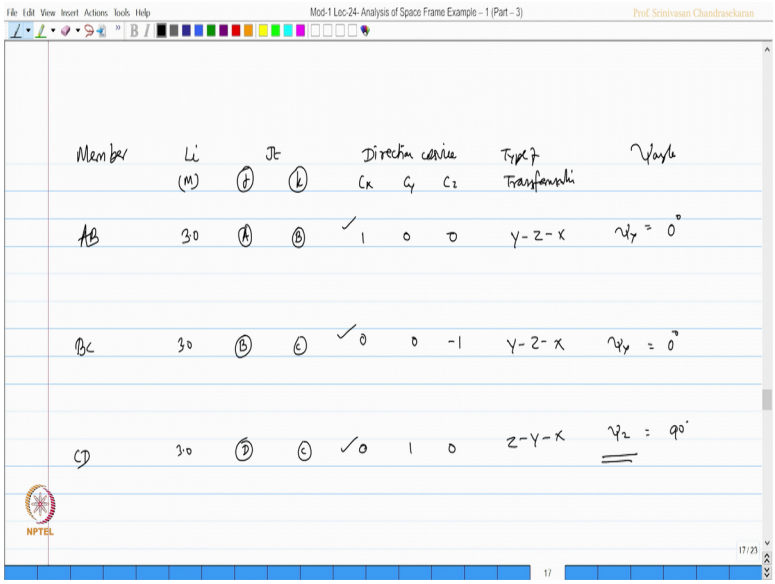

Let us make another table let say member the length of the member L i, but say in meters let say the joint system what is the ordinate of jth joint and k joint let us now mark the directions cosines which are C x, C y and C z, then let us decide about the type of transformation we want.

Then we take about the psi angle let us see what are the members let say A B, B C and C D there are 3 members lets mark them here A B, B C and C D let see the length of all the

members A B is 3 meter B C is again 3 meters C D is also 3 meters let us say 3.0, 3.0 and 3.0; let see what is the j end k end of A B this is j and this is k that is origin here.

So, its j is at A; is it not and k is at B, similarly for this, this is at B and this at T C where as for C D origin is here. So, it is D and C correct let us talk about direction cosines.

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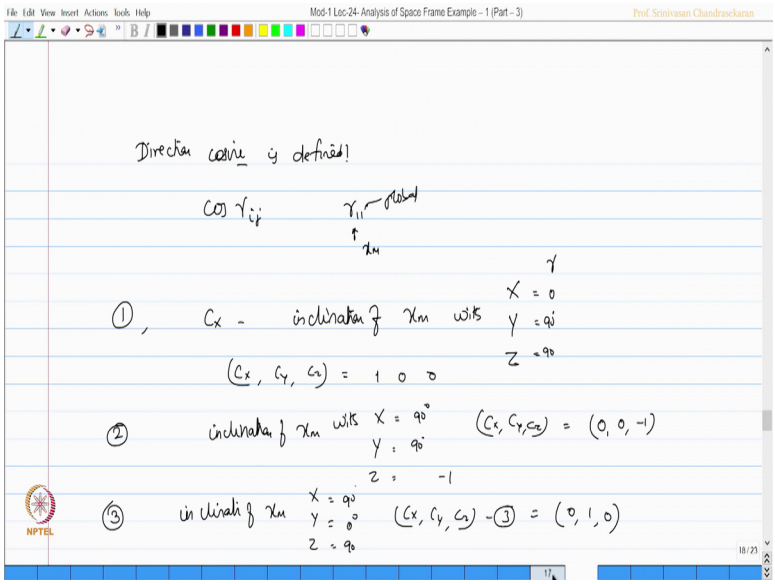

Let us ask a question how a direction cosine is define now direction cosine is cos gamma i j that is what is called direction cosine where if I say gamma 1 1, it is actually the first one is the X m axes the second one is the global axes. So, I want to know for the member one what would be the C x values that is inclination of X m axes with X axes, Y axes, Z axes and that angle I have derive the cos of that angle.

Let us see this figure now what is inclination of X m axes with x. So, it 0; is it not because X m are aligned in that case this is the angle; this is the angle is 0; what is inclination of Y m axes, X m axes with Y 90 degree; X m axes with Z 90 degree. So, this is 90, this is 90 therefore, I should say C x, C y, C z will be C x, C y and C z; in this case will be cos of this cos 0 1 0 and 0 let us do this for member 2. So, I want to now find inclination of X m member X m of that member with x y and z let us see; what are these angles.

X m is align along with Z therefore; the angle of inclination of X m with x global is 90 is it not. Similarly Y m sorry X m with y is again 90, is it not; whereas, X m with z is

aligned, but minus. So, I should say minus 1. So, the C x, C y and C z for member 2 will be 0, 0 and minus 1. Similarly for member 3 let us see, what is inclination of X m axes with X, Y and Z global; let see the angles X m of this member is vertical. So, X m inclination with X is 90 degree; 90 degrees X m inclination with y is aligned. So, 0 degrees is it not. So, 0 degrees.

X m inclination with z is 90 degree again. So, my C x, C y, C z for member 3 will be actually 0 because cos 90 is 0 1 and 0; let us enter that value here is going to be 1 0 0 0 0 minus 1 and 0 1 0 is it not; that is what we have found it we can see 1 0 0 0 0 minus 1 0 1 0 1 0 0 0 0 minus 1 0 1 0; let us decide the type of transformation.

You know if we look at the X m axes it is inclined with x. So, one can go for any kind of transformation we can try Y-Z-X transformation for the member B C X m is aligned with Z. So, no issue X m is aligned with Z. So, no issue, one can go for Y-Z-X transformation if we look at third X m is aligned with Y. So, I cannot go for Y-Z-X, I should go for Z-Y-Z transformation. So, my angle will be psi Y, psi Y and psi Z, I would like to see this.

The moment you say psi Y, it is angle between the Y m and Z m and Y m and Y, is it not that is the angle, let see what is happening here Y m and Y. So, that is 0, similarly for the second member Y m and Y again 0 for the second member for the third member Y m is horizontal whereas, Y is vertical. So, 90 degree 90.

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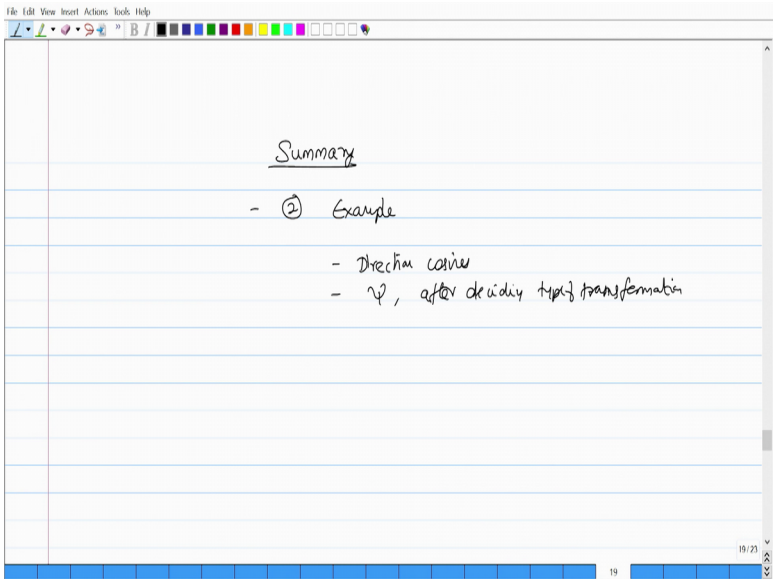

So, by this logic one can easily workout the psi angle by inspection. So, friends let us look at the summary of this lecture in this lecture we picked up 2 examples problems of phase frame V 4 out the direction cosines, we also found out the psi angle after deciding the type of transformation correct, we extend this algorithm to analyse 3 dimensional phase structure in the next class.

Thank you very much.