Computer Methods of Analysis of Offshore Structures
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Module - 01
Lecture - 24
Analysis of Space Frame Example - 1 (Part - 2)

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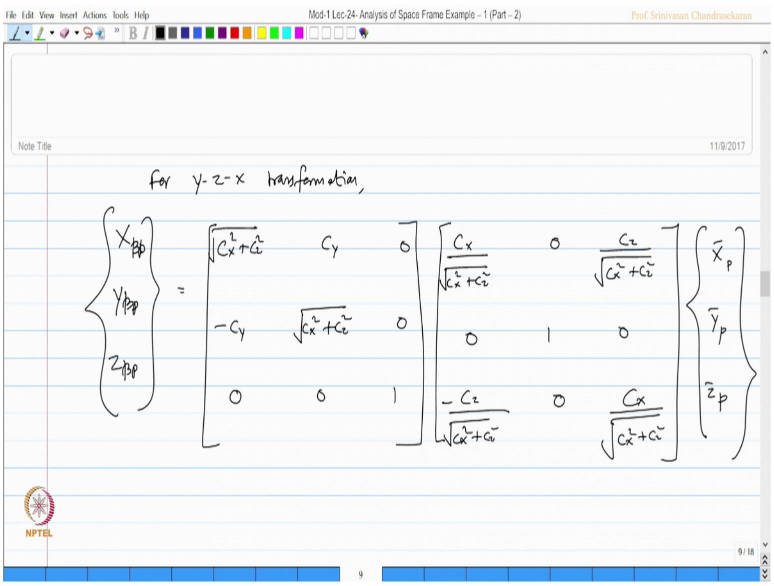

So, for y-z-x transformation, we already derived yesterday that x beta P y beta P and z beta p; P is transfer the point P and beta is the transformation is actually given by C x square plus C z square root C y 0 minus C y C x square plus C z square root 0 0 0 1 multiplied by C x by root of C x square z square 0 C z by root of C x square plus C z square 0 1 0 minus C z by root of C x square C z square 0 C x by root of C x square C z square.

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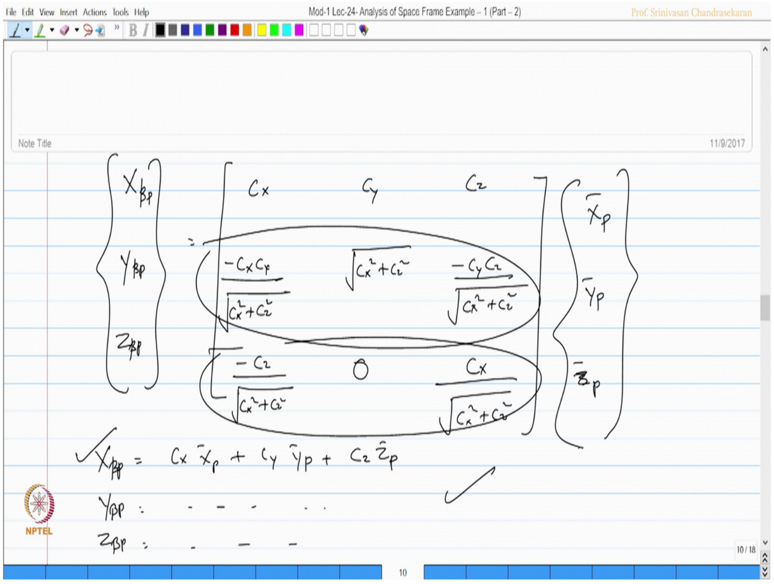

We derive this matrix yesterday multiplied by x bar P y bar P z bar P when you do this multiplication, I will find a relationship between x beta P y beta P z beta P as C x, C y, C z minus C x, C y by root of C x square plus C z square root of C x square plus C z square minus C y, C z by root of C x square plus C z square minus C z by root of C x square C z square 0 C x y root of C x square plus C z square multiplied by x bar P y bar P z bar p.

So, if we expand this, I can straight away write x beta P C x x bar P plus C y y bar P plus C z z bar P and so on y beta P and z beta P can be written; simply I can write this.

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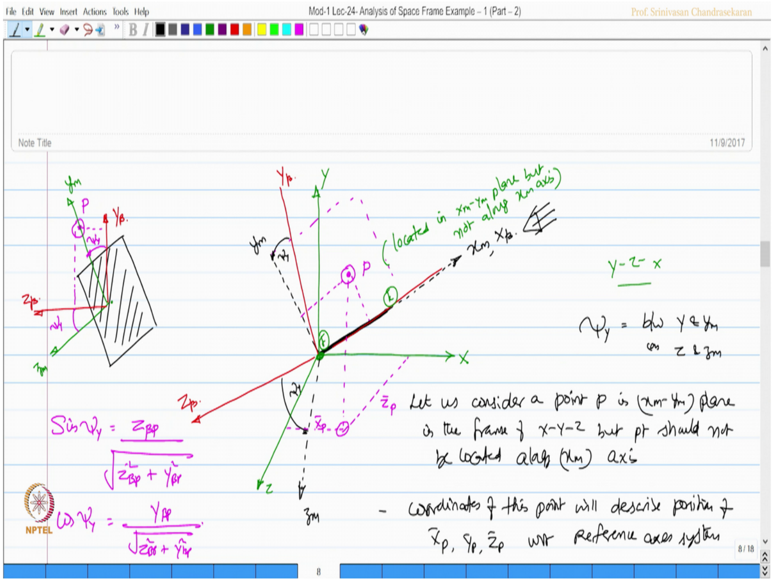

Now, very interestingly looking at this figure coordinates of the point P on x m y m plane is now given by y beta P and z beta P is it not; how can I say that? Let us say I view this from here and draw a section; let us say my y m is vertical and my z m is to the left of that and my y beta is to the right of y m, so this y beta and z beta. Obviously, will be the left of z m is it not z beta.

And if you take this point P somewhere on y m this is y m; is it not; this is y m; let us say I rub this arrow, this is y m, if you take this point P and I call this is point P; now this distance and this distance will be simply known to us and this value is what we call as psi y is also equal to this. So, now, the coordinates of this point will be given.

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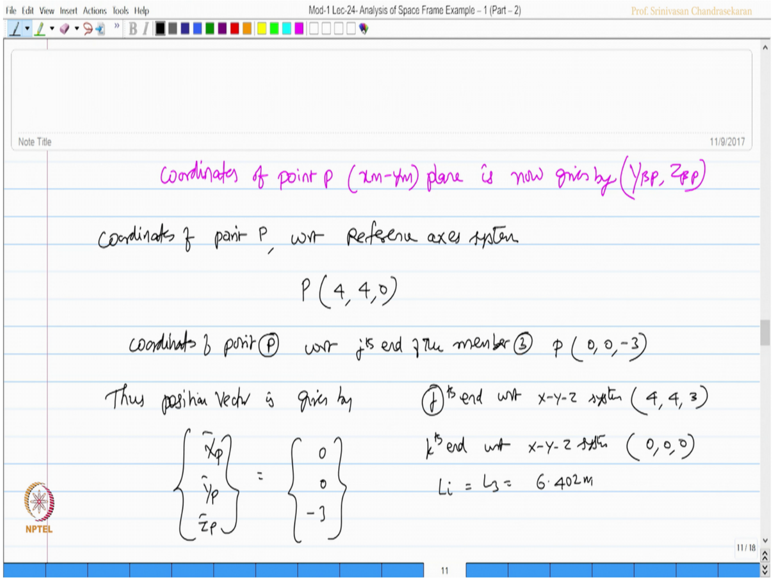

Coordinates of point P on the x m, y m plane is now given by y beta P and z beta P; is it not; look at this figure.

Y beta P and z beta P correct. So, I can now find sin psi y as simply z beta P by root of z beta P square plus y beta P square. Similarly cos psi y can be simply y beta P by root of z beta P square plus y beta P square, I will use this relationship now. So, the coordinates of point P with reference to the reference axes system; let us see; what is that coordinates of point P with reference to reference system should be of the point P; let us say this figure of the point P.

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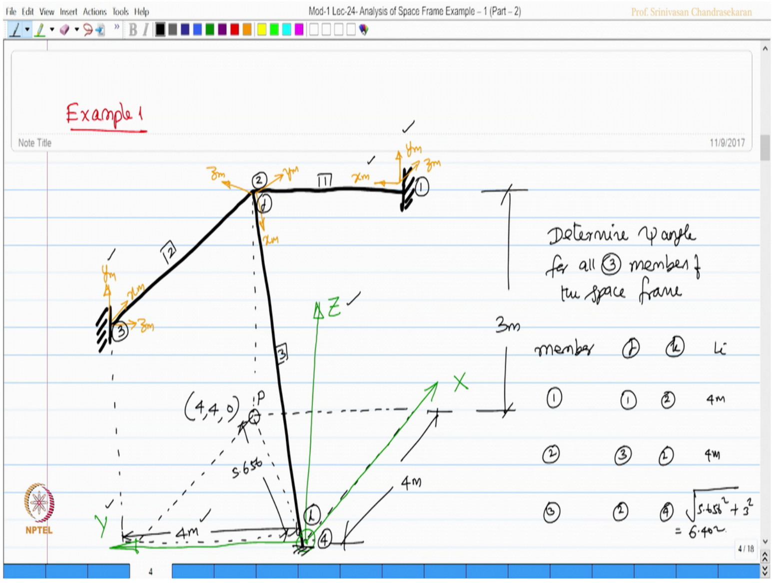

Now, I call this as my point P, I am choosing this point on x y m plane, I call this as my point P for the problem. So, the coordinates of this point with the reference axes system will be 4 comma, I can write it here 4 comma 4 comma 0 with reference to j-th end, it will be 0 comma 0 comma minus 3, correct; this end will be I write down that here coordinates of point P will be 4 comma 4 comma 0.

Similarly, the coordinates of point P with reference to the j-th end of the member 3 that is measured from the j-th end will be 0 comma 0 comma minus 3, you can see here with reference to j-th end, this is j-th end of this member, this is the j-th end of this member. So, 0 comma 0 comma minus 3 because z is positive; so, thus the position vectors is given by x p, y p and z p, simply 0 0 and minus 3.

Now, what are the coordinates of the j-th end with respect to x-y-z axes system; we can see here coordinates of the j-th end with respect to this will be 4 comma 4 comma 3; 4 comma 4 comma 3. Similarly coordinates of the j-th end with respect to x-y-z system, you can see here; this will be the origin. So, it is 0; is it not; this is the j-th end. So, it is 0, now the length of the member which is 3 is also known to us which is 6.402 meters; we already computed that we can see here we already computed that.

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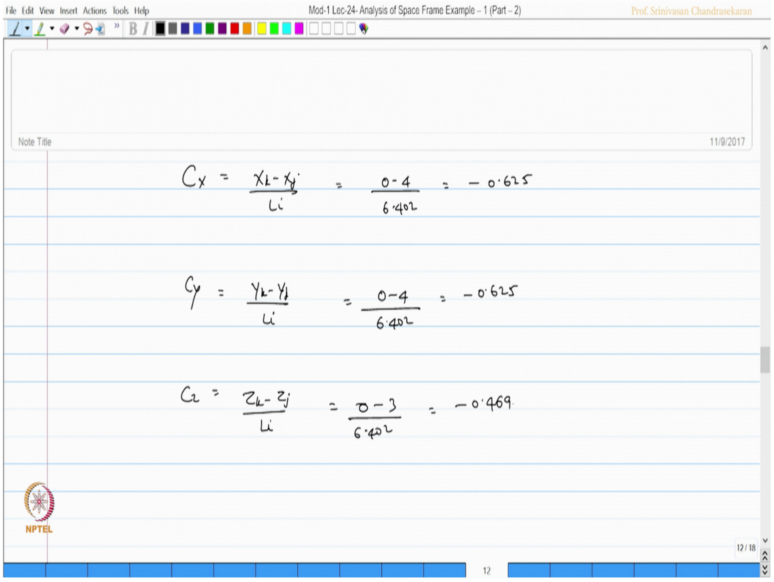

Now, let us compute C x, C y and C z; the direction cosines which will be simply x k minus x j by L i y k y j L i z k z j L i; let us do that 0 comma minus 4 by 6.402, 0 minus 4 by 6.402, 0 minus 3 by 6.402 which will give me minus 0.625 minus 0.625 minus 0.469; these are my directions cosines; once I get this, I can use this relationship X B P will be equal to this C x, C y, C z by this Y B P will be equal to this row by column and Z B P will be this row multiplied by the column.

So, let us do this relationship. So, I say x beta P which is given by C x x bar P plus C y y bar P plus C z z bar p.

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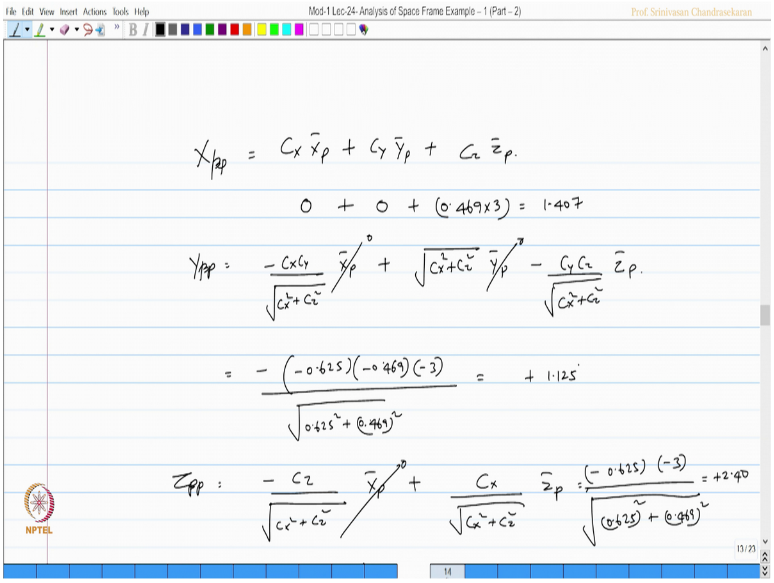

So, C x and C y are anyway 0 because the x P and y P bar are 0 plus C z is 0.469 into 3. So, that gives me this values as 1.407 y beta P; if you look at the equation, this will be minus C x, C y by root of C x square plus C z square of x bar P plus root of C x square plus C z square of y bar P minus C y C root of C x square C z square of z bar p.

We know these values are 0. Therefore, this term will not be there let us substitute directly for the last term which will be minus of minus 0.625 minus 0.469 minus 3 divided by root of 0.625 square plus 0.469 square which will be plus 1.125 z beta P is given by minus C z of C x square plus C z square of x bar of P plus C x by root of square of C x and C z of z power of P.

We know that this value is further 0; let us substitute only for this value which will be minus 0.625 into minus 3 divided by root of 0.625 square plus 0.469 square which gives me this value as plus 2.4.

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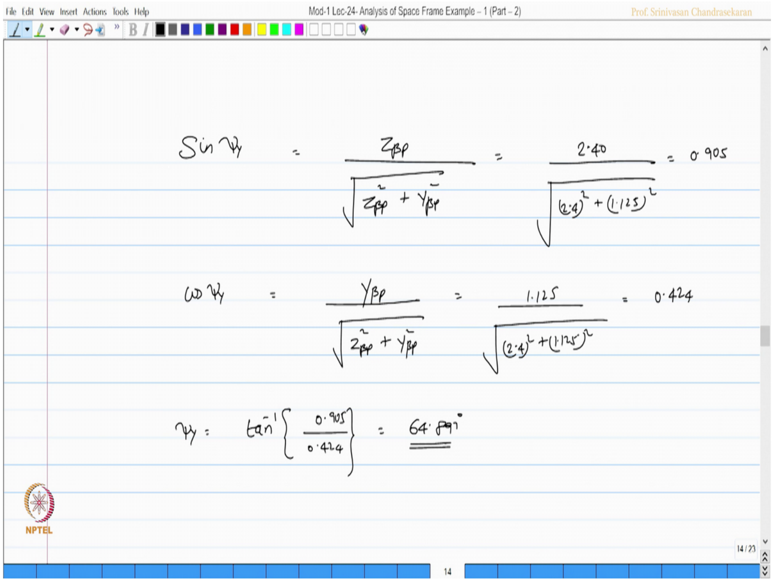

Let us now compute sin psi y which is given by Z beta P by root of z beta P square plus Y beta P square we already derive this expression.

Let us substitute that now 2.40 by square root of 2.40 square plus 1.125 square which becomes 0.905 cos psi y which has been also derived as y beta P by z beta P square plus y beta P square which will be 1.125 by 2.4 square plus 1.125 square which gives me 0.424.

So, now psi y can be said as tan inverse of 0.905 by 0.424, because sin by cos will give you tan and the angle is tan inverse of that which gives me 64.897 degrees, but let us carefully mark psi y depending upon the figure. Let us take the member.