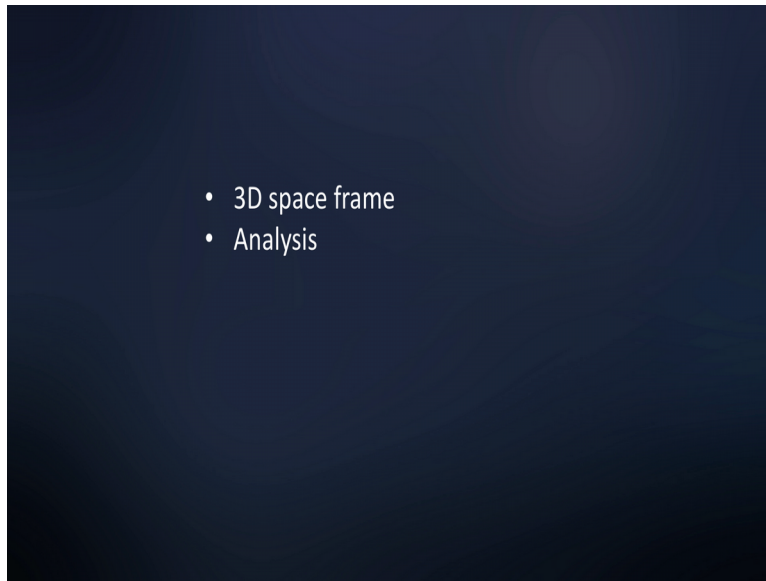


Computer Methods of Analysis of Offshore Structures
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Module - 01
Lecture – 26
3d Analysis of Space Frame Example – 1 (Part – 2)

(Refer Slide Time: 00:16)



(Refer Slide Time: 00:23)

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3D analysis of space frame - Example 1

MATLAB program:

```

%% input
clear;
%% 3D analysis of space frame
clc;
n = 3; % number of members
E1 = [1 1 1]; %Elemental rigidity
E1y = E1;
E1z = E1;
E1x = [0.25 0.25 0.25].*E1; %Flexural constant
E1y = [0.25 0.25 0.25].*E1; %Axial rigidity
L = [3 3 3]; % length in m
nj = n+1; % Number of Joints
coord = [0 0 0; 3 0 0; 3 3 3]; %Coordinate wrt X,Y,Z; size=nj,3
dc = [1 0 0 0 0 1; 0 1 0 0 0 1]; % direction cosines for each member
tytr = [1 1 2]; % Type of transformation for each member
psi = [0 0 90]; % Psi angle in degree for each member
% C matrix
c1 = [1 0 0 0 1 0; 0 0 1 0 0 0]; % C matrix for member 1
c2 = [0 0 1 0 0 1; 0 1 0 0 0 0]; % C matrix for member 2
c3 = [0 1 0 0 0 1; 1 0 0 0 0 0]; % C matrix for member 3
uu = 12; % Number of unrestrained degree of freedom
ur = 12; % Number of restrained degree of freedom
u1 = [1 2 3 4 5 6 7 8 9 10 11 12]; % global labels of unrestrained dof
u2 = [13 14 15 16 17 18 19 20 21 22 23 24]; % global labels of restrained dof
l1 = [13 14 15 16 17 18 1 2 3 4 5 6]; % Global labels for member 1
l2 = [1 2 3 4 5 6 7 8 9 10 11 12]; % Global labels for member 2
l3 = [19 20 21 22 23 24 7 8 9 10 11 12]; % Global labels for member 3
l = [l1; l2; l3];
dof = uu + ur; % Degrees of freedom
ktotal = zeros(dof);
fem1 = [0 30 0 0 0 0; 0 0 15 0 0 0; 0 0 0 0 0 0]; % Local fixed end moments of member 1
fem2 = [0 0 0 0 0 0; 0 0 0 0 0 0; 0 0 0 0 0 0]; % Local fixed end moments of member 2
fem3 = [0 0 0 0 0 0; 0 0 0 0 0 0; 0 0 0 0 0 0]; % Local fixed end moments of member 3

```

Handwritten notes:

- $\frac{wL^2}{16} = \frac{20 \times 3^2}{16}$
- A vertical list of values: 0, +30, 0, 0, 0, +15, 0, 0, 0, 0, -15. The values +30, +15, and -15 are marked with checkmarks.
- A bracket on the right groups the values from +30 to -15, with the label $(FEM)_{K3}$ written next to it.
- Each value in the list is enclosed in a small circle.

9/23

So, the program says it is for 3 dimensional analysis input will be the number of members 3 EI is taken as one for the time being we said, EI y and EI z are EI we also said the torsional constant GI x is one fourth of EI; EA x is also one fourth of EI length of the member is 3, we have input number of joints will be number of members plus 1. Let us also work out the coordinate matrix of all the member; we already have it here.

(Refer Slide Time: 01:00)

Material Properties:

$$EI_x = EI_y = EI$$

$$GI_x = EI/4$$

$$EA_x = EI/4$$

Coordinate Matrix:

Joint	x	y	z
A	0	0	0
B	+3	0	0
C	+3	0	-3
D	+3	-3	-3

You can see here 0, 0, 0, 3, 0, 0, 3, 0, 3 minus 3 and 3 minus 3, 3 we input that here.

(Refer Slide Time: 01:16)

Transformation Input

Member	L_i (m)	J_i (m^2)	direction cosine	$\{T_{ij}\}$ Transformation	angle
			C_x, C_y, C_z		
AB	3.0	(A) (B)	$\begin{bmatrix} +1.0 & 0 & 0 \end{bmatrix}$	$\checkmark y-z-x$	$\left. \begin{matrix} \psi_1 = 0^\circ \\ \psi_2 = 0^\circ \end{matrix} \right\}$
BC	3.0	(B) (C)	$\begin{bmatrix} 0 & 0 & -1 \end{bmatrix}$	$\checkmark y-z-x$	$\left. \begin{matrix} \psi_1 = 0^\circ \\ \psi_2 = 90^\circ \end{matrix} \right\}$
DC	3.0	(D) (C)	$\begin{bmatrix} 0 & +1 & 0 \end{bmatrix}$	$\checkmark z-y-x$	$\left. \begin{matrix} \psi_1 = 0^\circ \\ \psi_2 = 90^\circ \end{matrix} \right\}$

We can see; here we can input this, then direction cosines; we just now worked out; we already have it here; see here 1, 0, 0, 0, 0, 1, 0, 0 minus 1, 0, 1, 0, let us look at here 1, 0, 0, 0, 0 minus 1 and 0, 1, 0. So, no issue; then let us try to find out the type of transformation one correspond to in this; one corresponds to y-z-x transformation and 2 corresponds to z-y-x transformation.

We know for members 1 and 2; it is y-z-x for the member 3 it z-y-x. So, we said 1, 1, 2 psi angle we computed 0, 0, 1, 90, you can see here 0, 0 and 90, we input that 0 0 and 90. Now we know from the C matrix for member 1, 2 and 3; just now we derived this, I will show you for C 1, 1, 0, 0, 0, 1, 0, 0, 0, 1; you can see that here just now we did that C 1.

(Refer Slide Time: 02:17)

The slide displays a 3D coordinate system with three members (1, 2, 3) and their respective direction cosine matrices (C1, C2, C3). The global coordinate system is labeled with axes X, Y, Z. The local coordinate systems for each member are labeled with axes x, y, z. The direction cosine matrices are given as:

$$[C] = \begin{bmatrix} c_{11} & c_{12} & c_{13} \\ c_{21} & c_{22} & c_{23} \\ c_{31} & c_{32} & c_{33} \end{bmatrix} \quad C_{ij}$$

The matrices are:

$$C_1 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$C_2 = \begin{bmatrix} 0 & 0 & -1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{bmatrix}$$

$$C_3 = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 0 & 0 \end{bmatrix}$$

The slide also shows a table of global labels for each member:

Member	Global Labels
Member 1	13, 14, 15, 16, 17, 18
Member 2	1, 2, 3, 4, 5, 6
Member 3	19, 20, 21, 22, 23, 24

Similarly, C 2 and C 3 the input that here C 1, C 2, C 3.

Number of unrestrained degrees are 12; restrained degrees are again 12, the global label for unrestrained degree you can see here, it varies from unrestrained degrees 1 to 12 restrained degrees; 30 into 24; sorry. So, 30 in to 24; I am going to 12. Now the global labels for member 1; 13, 14, 15 to 18, then 1 to 6, see here global labels 30 to 18, then 1 to 6, we did the same thing exactly here, then for member 2 1 to 12 continuous the member 2; 1 to 12 continuous, then for member 3; 19 to 24, then 7 to 12 for member 3; 19 to 24, then 7 to 12.

We enter that then we form the degrees of freedom, then we found out the fixed end moments you know the fixed end moments are going to be computed based on the loading the loading on the member is only on the member A B. So, the member A B will have moments and the fixed end moments can be simply said as only at the member A B member A B the member has 13 to 6 as the degrees of freedom. So, I can write down here is there fixed end moments of the member A B on labels 13, 14, 15, 16, 17, 18, then 1, 2, 3, 4, 5, 6.

The 13 is along x. So, now, force. So, now, force 14 is along y, there will be reaction the total load applied is 20 into 3; 60. So, 30 this way and 30 up way. So, plus 30 along z no force about x, no force about y no force, but about z; there is going to be reaction moment n, moment w l square by 12. So, w l square by 12 which will be 20 into 3 square by 12 which amounts to 15. So, plus 15 along 1 along x, 0 along y, again plus 30 along z, 0 about x, 0 about y, 0 and this is going to be minus 15.

The members B C and C D; see there are no loads in B C and C D; therefore, the fixed end moments along B C and C D will be 0. Now I assemble this and get the joint load vector. So, we have entered 0, 30, 0, 0, 0, you can check here 0, 30, 0, then 3 0s have to 30, then plus 15 1 0 plus 30, 2 0s, 3 are the 3 0s and minus 15 remaining other members are 0 and 0, then continue with the coding we then form the transformation matrix.

(Refer Slide Time: 05:50)

```

%% transformation matrix
T1 = zeros(12);
T2 = zeros(12);
T3 = zeros(12);
for i = 1:n
    for j = 1:n
        T1(i,j)=c1(i,j);
        T1(i+3,j+3)=c1(i,j);
        T1(i+6,j+6)=c1(i,j);
        T1(i+9,j+9)=c1(i,j);
        T2(i,j)=c2(i,j);
        T2(i+3,j+3)=c2(i,j);
        T2(i+6,j+6)=c2(i,j);
        T2(i+9,j+9)=c2(i,j);
        T3(i,j)=c3(i,j);
        T3(i+3,j+3)=c3(i,j);
        T3(i+6,j+6)=c3(i,j);
        T3(i+9,j+9)=c3(i,j);
    end
end
  
```

The screenshot shows a MATLAB script editor window with the following content:

- File Edit View Insert Actions Tools Help
- Mod 1 Lec 26- 3d Analysis of Space Frame Example - 1 (Part - 2)
- Prof. Srinivasan Chandrasekaran
- %% transformation matrix
- T1 = zeros(12);
- T2 = zeros(12);
- T3 = zeros(12);
- for i = 1:n
- for j = 1:n
- T1(i,j)=c1(i,j);
- T1(i+3,j+3)=c1(i,j);
- T1(i+6,j+6)=c1(i,j);
- T1(i+9,j+9)=c1(i,j);
- T2(i,j)=c2(i,j);
- T2(i+3,j+3)=c2(i,j);
- T2(i+6,j+6)=c2(i,j);
- T2(i+9,j+9)=c2(i,j);
- T3(i,j)=c3(i,j);
- T3(i+3,j+3)=c3(i,j);
- T3(i+6,j+6)=c3(i,j);
- T3(i+9,j+9)=c3(i,j);
- end
- end
- NPTEL logo
- 10/23

(Refer Slide Time: 05:56)

```

%% Getting type of transformation and psi angle
for i = 1:n
    if txyz(i) == 1
        fprintf('Member Number -%d\n', i);
        disp(i);
        fprintf('Type of transformation is Y-Z-X\n');
    else
        fprintf('Member Number -%d\n', i);
        disp(i);
        fprintf('Type of transformation is X-Y-X\n');
    end
    fprintf('psi angle -%d\n', i);
    disp(psi(i));
end
%% stiffness coefficients for each member
scl = EA./L;
sc2 = 6*EIz./(L.^2);
sc3 = 6*EIy./(L.^2);
sc4 = GI./L;
sc5 = 2*EIy./L;
sc6 = 12*EIz./(L.^3);
sc7 = 12*EIy./(L.^3);
sc8 = 2*EIz./L;

```

Handwritten notes:

$$[K]_{AB}, K_{BC}, K_{CD}$$

$$\bar{K}_{AB} = T^T K T$$

$$\bar{K}_{BC} =$$

$$\bar{K}_{CD} =$$

$$K_{uu}$$

Diagram: A frame element with nodes U, V, W and restraints r, r, r.

Then we find the stiffness coefficients which we derived in the previous lecture for the entire matrix, we get now the stiffness coefficients and stiffness matrix for the member A B, for the member B C, for the member C D, then we find K global of the member A B which can be T transpose K T of the member.

K bar B C, then K bar C D. Now can be computed we assemble this to get K total in that we partition unrestrained degrees and restrained degrees separately and I can get K u u that is what we have doing here.

(Refer Slide Time: 06:39)

```

%% stiffness matrix 6 by 6
for i = 1:n
    %dof = zeros(dof);
    K1 = [sc1(i); 0; 0; 0; 0; -sc1(i); 0; 0; 0; 0; 0; 0];
    K2 = [0; sc6(i); 0; 0; 0; sc2(i); 0; -sc6(i); 0; 0; 0; sc2(i)];
    K3 = [0; 0; sc7(i); 0; -sc3(i); 0; 0; 0; -sc7(i); 0; sc3(i); 0];
    K4 = [0; 0; 0; sc4(i); 0; 0; 0; 0; 0; sc4(i); 0; 0];
    K5 = [0; 0; -sc3(i); 0; (2*sc5(i)); 0; 0; 0; sc3(i); 0; sc5(i); 0];
    K6 = [0; sc2(i); 0; 0; 0; (2*sc8(i)); 0; -sc2(i); 0; 0; 0; sc8(i)];
    K7 = -K1;
    K8 = -K2;
    K9 = -K3;
    K10 = -K4;
    K11 = [0; 0; -sc3(i); 0; sc5(i); 0; 0; 0; sc3(i); 0; (2*sc5(i)); 0];
    K12 = [0; sc2(i); 0; 0; 0; -sc8(i); 0; -sc2(i); 0; 0; 0; (2*sc8(i))];
    K = [K1 K2 K3 K4 K5 K6 K7 K8 K9 K10 K11 K12];
    fprintf('Member Number -%d\n', i);
    disp(i);
    fprintf('Local Stiffness matrix of member, [K] = \n');
    disp(K);
    if i == 1
        T = T1;
    elseif i == 2
        T = T2;
    else
        T = T3;
    end
    Ttr = T';
    Kg = Ttr * K * T;
end

```

Handwritten notes:

$$K1 = [sc1(i); 0; 0; 0; 0; -sc1(i); 0; 0; 0; 0; 0; 0]$$

$$K2 = [0; sc6(i); 0; 0; 0; sc2(i); 0; -sc6(i); 0; 0; 0; sc2(i)]$$

$$K3 = [0; 0; sc7(i); 0; -sc3(i); 0; 0; 0; -sc7(i); 0; sc3(i); 0]$$

$$K4 = [0; 0; 0; sc4(i); 0; 0; 0; 0; 0; sc4(i); 0; 0]$$

$$K5 = [0; 0; -sc3(i); 0; (2*sc5(i)); 0; 0; 0; sc3(i); 0; sc5(i); 0]$$

$$K6 = [0; sc2(i); 0; 0; 0; (2*sc8(i)); 0; -sc2(i); 0; 0; 0; sc8(i)]$$

$$K7 = -K1$$

$$K8 = -K2$$

$$K9 = -K3$$

$$K10 = -K4$$

$$K11 = [0; 0; -sc3(i); 0; sc5(i); 0; 0; 0; sc3(i); 0; (2*sc5(i)); 0]$$

$$K12 = [0; sc2(i); 0; 0; 0; -sc8(i); 0; -sc2(i); 0; 0; 0; (2*sc8(i))]$$

$$K = [K1 K2 K3 K4 K5 K6 K7 K8 K9 K10 K11 K12]$$

$$Kg = Ttr * K * T$$

So, K local stiffness matrix, then B said K global that is T transpose K T, then global stiffness matrix for all the 3 members, then complete stiffness matrix.

(Refer Slide Time: 06:50)

```

file Edit View Insert Actions Tools Help Mod-1 Loc-26-3d Analysis of Space Frame Example - 1 (Part - 2) Prof. Srinivasan Chandrasekaran
fprintf ('Global Matrix, [K global] = \n'):
disp (Kg);
for p = 1:12
for q = 1:12
Knew(1(i,p),1(i,q)) =Kg(p,q);
end
end
Ktotal = Ktotal + Knew;
if i == 1
T1 = T;
K1 = Kg;
fembar1 = T1'*fem1;
elseif i == 2
T2 = T;
K2 = Kg;
fembar2 = T2'*fem2;
else
T3 = T;
K3 = Kg;
fembar3 = T3'*fem3;
end
end
fprintf ('Stiffness Matrix of complete structure, [Ktotal] = \n');
disp (Ktotal);
Kunr = zeros(12);
for x=1:uu
for y=1:uu
Kunr(x,y) = Ktotal(x,y);
end
end
fprintf ('Unrestrained Stiffness sub-matrix, [Kunr] = \n');
disp (Kunr);
KunInv = inv(Kunr);
fprintf ('Inverse of Unrestrained Stiffness sub-matrix, [KunInverse] = \n');
disp (KunInv);

```

Then from that unrestrained stiffness matrix and inverse of that; so, we get $K u u$ and $K u u$ inverse from these 2 steps.

(Refer Slide Time: 07:07)

```

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%% Creation of joint load vector
j1 = [0; 30; 0; 0; 0; 15; 0; 0; 0; 0; 0; 0]; % values given in kN or kNm
j1u = j1(1:12,1); % load vector in unrestrained dof
delu = KunInv*j1u;
fprintf ('Joint Load vector, [J1] = \n');
disp (j1);
fprintf ('Unrestrained displacements, [delu] = \n');
disp (delu);
del = [0; 0; 0; 0; 0; 0; 0; 0; 0; 0; 0; 0];
del = zeros (dof,1);
del = [delu; delr];
deli = zeros (12,1);
for i = 1:12
for p = 1:12
deli(p,i) = del(1(i,p),1);
end
if i == 1
delbar1 = deli;
mbar1 = (K1)' * delbar1;
fprintf ('Member Number = ');
disp (i);
fprintf ('Global displacement matrix [Delibar] = \n');
disp (delbar1);
fprintf ('Global End moment matrix [Mbar] = \n');
disp (mbar1);

```

After that we create the joint load vector joint load vector is nothing, but reversal of FEM vector, we crate that vector then we found solved for del u del u is nothing, but $K u u$ inverse of J L u or are in reference axes system I get delta u bar once I get that I get the

member forces in global displacements let us look at the 3 members, then ultimately the joint forces you check for this that is the program.

(Refer Slide Time: 07:39)

```

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elseif i == 2
    delbar2 = deli;
    mbar2 = (Eg2 * delbar2) + fbar2;
    fprintf('Member Number = %d\n', i);
    disp(i);
    fprintf('Global displacement matrix [DeltaBar] = \n');
    disp(delbar2);
    fprintf('Global End moment matrix [MBar] = \n');
    disp(mbar2);
else
    delbar3 = deli;
    mbar3 = (Eg3 * delbar3) + fbar3;
    fprintf('Member Number = %d\n', i);
    disp(i);
    fprintf('Global displacement matrix [DeltaBar] = \n');
    disp(delbar3);
    fprintf('Global End moment matrix [MBar] = \n');
    disp(mbar3);
end
end

%% check
mbar = [mbar1'; mbar2'; mbar3'];
jf = zeros(dof,1);
for a=1:n
    for b=1:n2 & size of k matrix
        d = 1(a,b);
        jfnew = zeros(dof,1);
        jfnew(d,1) = mbar(a,b);
        jf = jf + jfnew;
    end
end
fprintf('Joint forces = \n');
disp(jf);

```

(Refer Slide Time: 07:45)

```

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OUTPUT:
Member Number = 1
Type of transformation is T-2-X
Psi angle = 0
Member Number = 2
Type of transformation is T-2-X
Psi angle = 0
Member Number = 3
Type of transformation is T-2-X
Psi angle = 90

Global stiffness matrix of member, (E) =
[ 0.0000 0 0 0 0 0 -0.0033 0 0 0 0 0
  0 0.4444 0 0 0 0 0.6667 0 -0.4444 0 0 0 0.6667
  0 0 0.8889 0 0 0 0 0 0 0 0 0 -0.8889 0
  0 0 -0.6667 0 0 0 1.3333 0 0 0 0.6667 0 0 0.6667
  0 0.6667 0 0 0 0 1.3333 0 -0.6667 0 0 0 0 0.6667
 -0.0033 0 0 0 0 0 0 0.0033 0 0 0 0 0 0
  0 -0.4444 0 0 0 0 -0.6667 0 0.4444 0 0 0 0 -0.6667
  0 0 -0.8889 0 0 0 0 0 0 0 0.4444 0 0.6667 0
  0 0 0 -0.6667 0 0 0 0 0 0 0 0.8889 0 0
  0 0 -0.6667 0 0 0 0.6667 0 0 0 0.6667 0 1.3333 0
  0 0.6667 0 0 0 0 0.6667 0 -0.6667 0 0 0 1.3333 0 ]

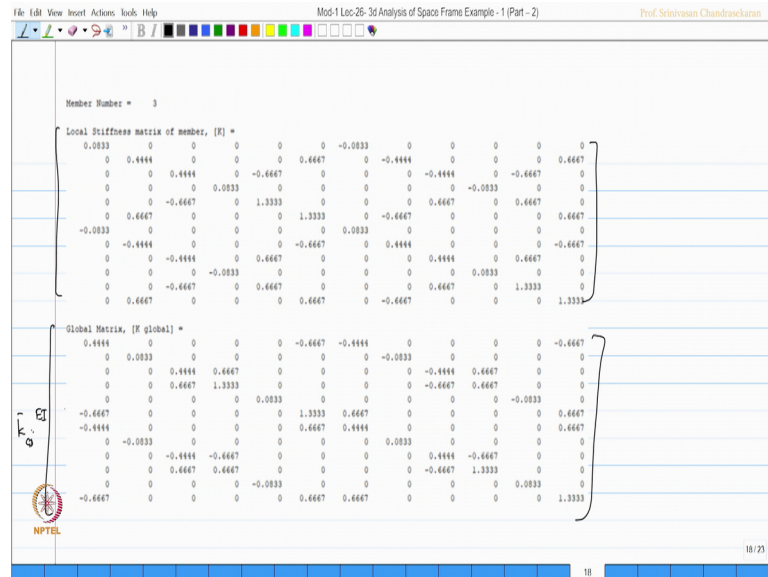
Global matrix, (K global) =
[ 0.0033 0 0 0 0 0 0 -0.0033 0 0 0 0 0
  0 0.4444 0 0 0 0 0.6667 0 -0.4444 0 0 0 0.6667
  0 0 0.8889 0 0 0 0 0 0 -0.4444 0 -0.6667 0
  0 0 0 0.8889 0 0 0 0 0 0 0 -0.8889 0
  0 0 -0.6667 0 1.3333 0 0 0 0.6667 0 0.6667 0
  0 0.6667 0 0 1.3333 0 -0.6667 0 0 0 0.6667
 -0.0033 0 0 0 0 0 0 0.0033 0 0 0 0 0
  0 -0.4444 0 0 0 0 -0.6667 0 0.4444 0 0 0 -0.6667
  0 0 -0.8889 0 0 0 0 0 0.4444 0 0.6667 0
  0 0 -0.6667 0 0 0 -0.6667 0 0.8889 0 0 0.6667 0
  0 0 0.6667 0 0.6667 0 0 0.6667 0 -0.6667 0 1.3333 0
  0 0.6667 0 0 0 0.6667 0 -0.6667 0 0 1.3333 0 ]

KAB = E1

```

Let us look at the output member 1; y-z-x and psi angle 0 we can see here member 1.

(Refer Slide Time: 08:42)



So, I get $K \bar{C} D$, now we have EI multiplier in all the cases.

I have in EI multiplier in all the cases please understand that EI is taken as unity in this case EI multiplier, then we find the full stiffness matrix.

(Refer Slide Time: 09:03)

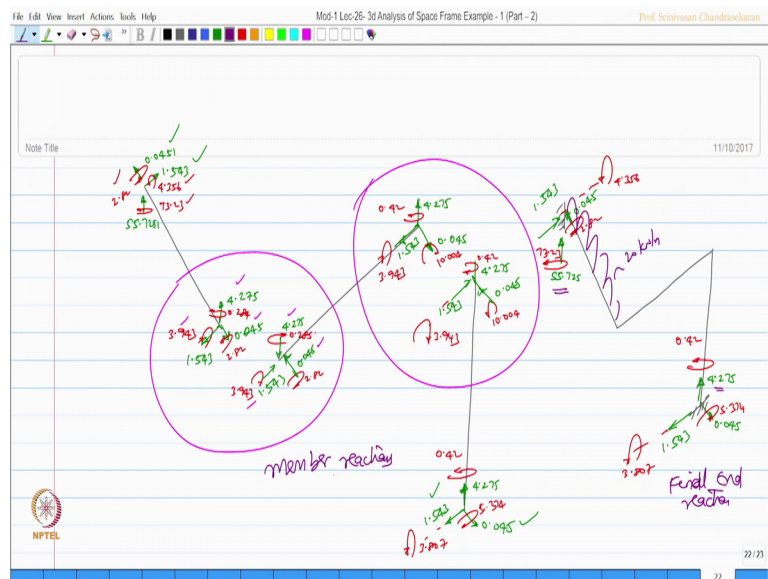


The full stiffness matrix which is going to be 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12 and 24 by 24 full stiffness matrix; we got out of which at 12 first, second, third, 4, 5, 6, 7, 8, 9, 10, 12. So, I have to will be partition here is or not to get $s u$ and 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12; another partition here correct.

I get my delta u bar as this value, then I substitute run the program get the global values of member 1, member 2 and the end redactions in the entire structure by assembling these 3 which I want to plot and show you. So, let us do it for member wise first member second member and let say third member.

If you look at the first member this is the first member minus 0 point 0 four. So, you can see here very clearly this is along this 3; these 3 will be translational along x-y-z at jth joint this is next 3 will be rotation about x-y-z at jth. So, this is about j th and this is about K th and this 3 will be translation, this 3 will be rotation along x y z respectively let us mark them. So, minus 0.051 means negative let us mark it here, let us mark that here 0.0451.

(Refer Slide Time: 11:13)



And along y you can see here along y 55.7251. So, 55.7271 and along z. So, negative see here along z is negative minus 1.543. So, 1.543; let us about the translation; let us mark the rotations. So, the first 3 values are now done and next 3 values will be done then the next 3 then the next 3. So, this is for th j the end and this is for the K th end correct. So, minus 2.82. So, minus how do get that put your thumb towards this arrow the remaining 4 fingers we will give you the rotation minus means it is opposite; it should be opposite.

So, it should be clockwise 2.82; similarly, 73.23; similarly 4.356 look at this joint. Now, this is going to be 0.045 and this is going to be 1.543 and this is going to be 4.275 and

then the rotations clockwise is anticlockwise 2.82, 0.284, 0.284 and this is 3.943 for the member A B.

Let us do for the member B C this is 1.543 and this is down 4.275 and this is this way 0 0.045 and then the moments, this is 2.82, this is 0.285 and this is 3.943 and for this joint it is going to be 0 0.045, 4.275, 1.543, then 10.004, 0.42, 3.943.

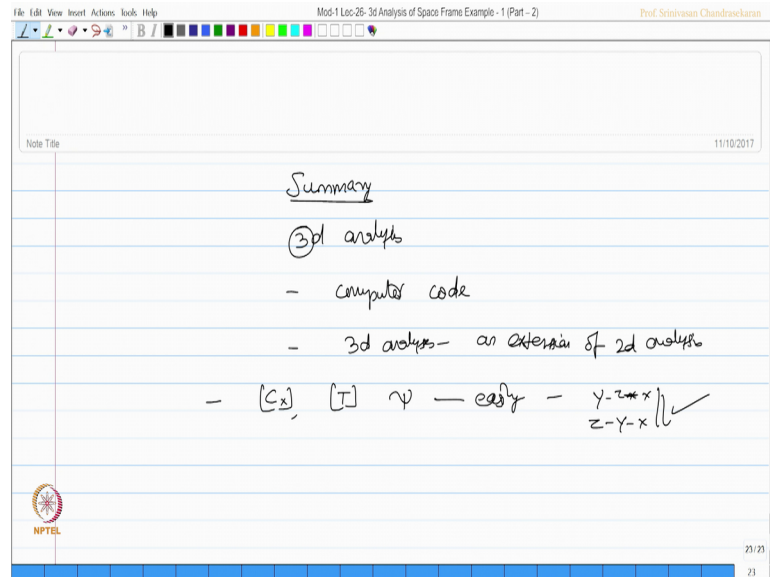
Let us come to this 0 0.045, 4.275 and 1.543, then 5.374, 0.423, 0.807, 4.275, 0.045, then 1.543, 0.42, 10, 0.004, 3.943 one can see here there is a perfect joint compatibility 4.275 4.275.

0 4 5; this way 0 4 5, this way 0.284, 0.285, 9 4 3 9 4 is a perfect joint compatibility in all the joints see here let us also try to plot the end reaction of the whole system which comes like this. So, we get the n values as 55.725 and 4.275, 0.045 and 0.045 which are exactly taken from here, then 1.543 which is here and 1.543 which is here, then 73.23 which is here.

4.356 which is here, then 2.82 which is here, similarly as for this comes in 0.425, 0.374 and 3.807; the total load applied is actually 20 kilo Newton per meter end for 3 meter 60. So, you can see here 55 and 4 makes it 60. So, reaction is balanced and the moments are balanced that is the final n reactions and moments these are members reactions and moments.

So, friends we have discussed in this lecture and interesting space frame problem of 3 D analysis.

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We also discuss the computer code to solve the problem we have understood; how the 3 D dimensional analysis becomes an extension of the concepts the 2 D analysis, we are able to arrive at the transformation matrix we are able to arrive at the rotation matrix we are able to arrive at the psi value easily for a given problem for any transformation chosen for the given problem friends, I want you to do more problems using this computer program and try to compare the results in enjoy how a 3 dimensional analysis using computer course and hand calculations can be very very simple and extended concept of 2 D analysis.

Thank you very much.