# HEAT TRANSFER AND THERMOSTRUCTURAL ANALYSIS OF A CYLINDER



An aluminium cylinder of 4m height, 5mm thickness and 1m radius is considered for this tutorial. The outer surface of the cylinder is adiabatically sealed and a portion of the cylinder 26 cm at a height 2.8 m is exposed to the sorrounding which has a convective coefficient of  $100 \text{ W/m}^2$  K at 300 K. A constant heat flux 10 kW/m<sup>2</sup> is acting at the bottom, whereas the top edge of the cylinder is maintained at 373 K.

A structural load of 1000 kN is acting at the top edge of the cylinder and the bottom of the cylinder is assumed to be fixed. The objective of this analysis is to find the maximum stress due to the thermal environment along with the mechanical loads.

#### PROCEDURE

# 1. Create Keypoints

Command: POINT, ADD					
Menu	: Geometry $\rightarrow$ Keypoint $\rightarrow$ Create $\rightarrow$ ADD				
	POINT, ADD				
	Point Data 0:0:0 📘				
Parameters:					

Similarly create key points at (0:4:0) and (1:0:0)

At the end of the operation your screen should look like this.

] 🛃	🕼 Eile Edit View Geometry Mesh Load/BC Property Analysis Post Others Windows Help						
	茵耆耆 🕹 ◀ ▶   ♡ ♀ ♡ ひ / 彡 図   ℡ ヰ ⊿ 🖓 🖬 🖬 🚔 🔺 🔺						
IIIII • < < II III III • 20 4 1	Model Main Show Log Objects Labels Background Paint Mode Shading Colour List Axis L	Colour Settings	FEAST2025 VSSC / ISRO		ê		
	Load., Store., Point Data 30:0:0	NT, ADD	×.		v av u	a	

# 2. Create Cylindrical Surface

Command: SURFACE, CYLAXIS

Menu : Geometry  $\rightarrow$  Surface  $\rightarrow$  Create  $\rightarrow$  Cylaxis

	SURFACE, CYLAXIS		
	Axis	P1/P2	$\mathbb{R}$
Doromotora	Radius	P3	ß
Farameters.			

At the end of the operation your screen should look like this.

F	<u>File Edit View</u> Geometry Mesh Load/BC Pro	perty Analysis Post Others <u>Wi</u> ndows <u>H</u> elp
Ċ	ן מי י% ב פע וויי יי וויי א וויי מי א מי מי מי מי	/ 🔟   🖽 斗 🥢 🖸   🗳 🧱 齢   🗻 🗜
	Model   Main   Show   Log Colour   Settings   Objects Labels   Background     Background 2   Paint Mode Shading   Colour List   Axis Labels	FEAST2025 VSSC/ISRO
Ma X 1 W4	Load., Store., SURFACE, CYLAXIS Axis P1/P2 by Radius P3 by	y www.u

# 3. Generate mesh

Command: MESH, QUAD

Menu : Mesh→MeshGen→Quad

	mesh, QOAD	
Surface	1[0]	
Element size	0.130908	
Method	Mapped	-
Туре	4-Node	•
Divisions		
Bias		

Parameters:

F

Element size can be entered manually or by clicking two points on the geometry edge. Then click on the 'Divisions' command box, so that node divisions will be displayed on the geometry. The element subdivisions can be increased or decreased by left clicking or right clicking respectively.

At the end of the operation your screen should look like this.

]] 🛃	<u>F</u> ile <u>E</u> dit	View Geometry Mesh Load/BC Pro	erty Analysis Post Others <u>W</u> indows <u>H</u> elp	
lt	n 🖻 🏝 🖂	।▶ ∽ ≃ <u>]</u> ፼ዾଶฃ ∢	🔟 🕮 🕰 🖓 🖸 🗮 齡 👗 !	
· ~ · ~ · · · · · · · · · · · · · · · ·	Model Main Objects Labels Background Paint Mode Shading Colour List	Show   Log Colour   Settings   Background   Background 2 Highlight    Global Axis    Axis Labels	FLAST2025 VSSC/ISRO	
*		MESH, QUAD		
74	Surface Element size Method Type Divisions Bias	1(0) by 2.3791 by 4-Node by by by by by by by by by by by by by b	yx	

# 4. Apply Material Property

Command: MATERIAL, HTISOTROPIC

Menu : Property→Material →Thermal →Isotropic

MATERIAL, EDIT					
Elements	1T1410[0]	$\mathbf{k}$			
Thermal Conductivity	237	•••			
Density	2800				
Specific Heat	900				
Label					

Parameters:

5. Apply Thickness

Command: THICKNESS, ADD

Menu : Property→Physical →Thickness

	THICKNESS, EDIT	
Elements	1T1410[0]	Þ
Thickness	0.005	•••
Label		-

Parameters:

Parameters:

# 6. Apply Convective Boundary Condition

Command: HTCONVEC, ADD

Menu : Load/BC $\rightarrow$ Thermal $\rightarrow$ Convection

нтсс			
e F	ntity Type	Face 💌	
.e 8	ntity Face	8(F1)9(F1)38(F1)39(F1)68(F1	$\triangleright$
ficient 1	ilm Coefficient	100	•••
Temperature 3	mbient Temperature	300	•••
	abel		
	abel	300	-

The selected face is look like below

]]	<u>File Edit View</u> Geometry	Mesh Load/BC Pro	perty Analysis Post Others <u>W</u> indows <u>H</u> elp	
]] t	ት 🚰 🏝 🔺 🕨 🗠	DP P 🖑 U 🖣	/ 🔟   🖽 🗠 🖄 🖸 🔛 👬   🖄	M.
■。 < ■ ■ 筆 ¥ 23 会 🖕 ■ 🖬 🖬 ⊘ 🔗 🕺 🙀	Model     Main     Show     Log     Colou       ⊕     Geometry       ⊕     Main     Show     Log     Colou       ⊕     Geometry       ⊕     ANTYPE       ⊕     HTCONVEC       □     SET#1       ⊕     HTTEMP       ⊕     HTTEMP       ⊕     THICKNESS       □     SET#1	EDIT	FEAST2025 VSSC/ISRO	

# 7. Apply Heat Flux Boundary Condition

Command: HTFLUIX, ADD

Menu : Load/BC $\rightarrow$ Thermal $\rightarrow$ Heat flux

HTFLUX, EDIT			
Entity Type	Edge 💌		
Entity Edge	30T1410B30(D2)[0]	$\mathbb{R}$	
Flux Rate	10	•••	
LCS	0	ß	
Label			

Parameters:

The defined edge is look like this,

]] 🛃	<u>File Edit View</u> Geometry Mesh Load/BC Pro	perty Analysis Post Others Windows Help	
j t	n 🗗 🏝 🔺 🕨 🗠 🛄 🖾 🖉 🕲 🧃	/ 🔟   🖽 斗 🖉 🦄 🖸   🖬 🧱 齢   🚣 🥂	
	Model Main Show Leg Colour Settings ⊕ Geometry ⊕ Antrope ⊕ Antrope ⊕ HTFLUX ↓ SETE 1 ⊕ MATERIAL ⊕ MATERIAL ⊕ SET# 1	FTAST2025 VSSC/ISRO	
94	HTFLUX, EDIT		
	Entity Edge  The second		
	Flux Rate         10         E3           LCS         0         b           Label	y	N
		<b></b> x	

# 8. Apply Temperature Boundary Condition

Command: HTTEMP, ADD

Menu : Load/BC→Thermal→Temperature

	HTTEMP, EDIT		
	Nodes 1T1427B31[0]		$\mathbf{k}$
	Temperature	373	•••
Parameters:	Label		

The defined nodes is look like this,





9. Set Analysis Type

Command: ANTYPE, SET

Menu : Analysis→Analysis Type

ANTYPE, ADD Analysis Types HT Steadystate

**10.** Save the project

Menu: File →Save



#### 12. Perform Post Processing

# i) Graph plots for displacement/ velocity/ acceleration

# Command: POST, CONTOUR

#### Menu : Post→Contour

Item	Temperature	-
	remperatore	
Restrict To		
Contour Type	Band	•
No of contours		9 👤
Decimal Places		2 🚔
Element Outline		
🗍 Draw Border		
🔲 Highlight Maximum		
🔲 Highlight Minimum		
Colour-Label		

Parameters:

At the end of the operation your screen should look like this.

🗍 🚰 Eile Edit View Geometry Mesh Load/BC Pro	operty Analysis Post Others <u>W</u> indows <u>H</u> elp	_ <i>B</i> ×
12 🖆 🏝 🔺 ▶   ∽ ≃   12 ♀ < ℃ 🕹 🧹	🍼 🔟   🕮 斗 🚈   🎭 🖸   🖬 🏫   🍝 🎢	
Model Main Show Log Colour Settings	FAST2025 VSSC/ISRO	3.73E+02 3.65E+02 3.67E+02 3.47E+02 3.41E+02 3.33E+02 3.32E+02 3.17E+02 3.09E+02 3.01E+02
Post, Contour           Item         Temperature         Image: Contour Type           Restrict To         Image: Contour Type         Image: Contour Type           No of contours         Image: Contour Type         Image: Contour Type           Decimal Places         Image: Contour Type         Image: Contour Type           Image: Contour Type         Image: Contour Type         Image: Contour Type           Image: Contour Type         Image: Contour Type         Image: Contour Type           Image: Contour Type         Image: Contour Type         Image: Contour Type           Image: Contour Type         Image: Contour Type         Image: Contour Type           Image: Contour Type         Image: Contour Type         Image: Contour Type           Image: Contour Type         Image: Contour Type         Image: Contour Type           Image: Contour Type         Image: Contour Type         Image: Contour Type           Image: Contour Type         Image: Contour Type         Image: Contour Type           Image: Contour Type         Image: Contour Type         Image: Contour Type           Image: Contour Type         Image: Contour Type         Image: Contour Type           Image: Contour Type         Image: Contour Type         Image: Contour Type           Image: Contour Type         Image: Contour Type		

To perform thermo-structural analysis, the same model with load of 1000 kN at top edge of the cylinder and the procedure for this analysis is detailed below.

]	<u>Eile E</u> dit	View Geometry Mesh Load/BC Pro	perty Analysis Post Others <u>W</u> indows <u>H</u> elp	
	🖻 🏝 🕓	● ♥ ♥ ♥ ■ ₽ ₽ ♥ ♥	/ 🔟 💷 🚈 🖉 🗖 🔲 🗰 齢 🖾 🚦	
	Model Main Objects Labels Background Paint Mode Shading Colour List	Show Log Color Settings Background1 Background2 Highlight Global Axis Axis Axis Labels	PLATENDS VSSC/JSRO	
*				
ŶÅ		MESH, QUAD		
	Surface	1[0]		
	Element size	2.3791		
	Mathead	Manual		
	metriod			
	Туре	4-Node	Y WILLIAM STATE	
	Divisions	4		
	Rine			
	0103	<u></u>		



After meshing follow below steps,

1. Apply Boundary Condition

Command: DISPBC, ADD

Menu : Load/BC→Structural→Displacement

	DISPBC, ADD	
Nodes	43T2838B43[0]	${\bf k}$
DispBC	0/0/0/0/0	
LCS	0	$\searrow$
Label		

Parameter:

At the end of the operation your screen look like this,



# 2. Apply Material Property

Command: MATERIAL, ISOTROPIC

Menu : Property→Material →Structural →Isotropic



	MATERIAL, ISOTROPIC		
	Elements	ALL	$\triangleright$
	Young's Modulus	70E09	•••
	Nu	0.3	•••
	Density	2800	•••
	Alpha		•••
	Label		
Parameter:			

Thickness is same as applied in heat transfer analysis

#### 3. Apply Point load

Command: POINTLOAD, ADD

Menu : LoadBC  $\rightarrow$  Structural  $\rightarrow$  Point load

		POINTLOAD, EDIT	
	Nodes	1T1427B31[0]	$\triangleright$
	Magnitude	-1000e+3	•••
	Component	FY 💌	
	LCS		$\triangleright$
Parameter:	Label		

The node for point load is at the top end

### 4. Apply Thermal load

Command: THERMAL, ADD

Menu : LoadBC  $\rightarrow$  Structural  $\rightarrow$  Thermal load

	THERMAL, ADD	
Nodes	ALL	ß
Temperature Source	File 💌	
File name	E:\Thermostructural\cylinder-HT_1m_4m.OUT	•••
Reference temperature	0	
Label		

Parameter:

Select the \*.out file from heat transfer analysis file location.

# 5. Set Analysis type

Command: ANTYPE, SET

Menu : Analysis→Analysis Type

		ANTYPE, ADD	
	Analysis Types	Static	•
Parameter :			

#### After that follow steps from 10 and 11 from heat transfer analysis

1. Perform Post processing

Command: POST, CONTOUR

Menu : Post→Contour

	Post, Contour		
	ltem	Displacement	<b>–</b>
	Component:Disp	TY	•
Parameter:	🗌 On Deformed		

At the end of the operation your screen should look like this.



#### To find stress contour in y direction,



F

# FREE VIBRATION ANALYSIS OF A CYLINDER



An aluminium cylinder of radius 2m and height 4m is constrained at the bottom through 24 bolted joints. The thickness of the cylinder is 3mm. A mass of 500 kg is lumped at a height of 5m from the cylinder top surface. The mass is connected with the top of the cylinder through 24 bolted joints. Initially a free vibration analysis is performed to estimate the natural frequencies and mode shapes of the system.

A 1g steady state lateral base excitation is applied at the bottom of the cylinder and the response at the mass is estimated. This is done by performing a frequency response base excitation analysis. The lateral base excitation is applied to the cylinder through a heavy inertial mass 50 times greater than the system mass. The inertial mass is connected to the cylinder bottom portion through 24 number of rigid links. 2% critical damping is assumed for all the modes.

#### **PROCEDURE**

#### 2. Create Key points

Command: POINT, ADD

: Geometry  $\rightarrow$  Keypoint  $\rightarrow$  Create  $\rightarrow$  ADD Menu

	POINT, ADD	
Point Data	0:0:0	ß
	·	

Parameters:

Similarly create key points at (0:4:0) and (2:0:0)

At the end of the operation your screen should look like this.



#### 3. Create Cylindrical Surface

Command :SURFACE, CYLAXIS

: Geometry  $\rightarrow$ Surface $\rightarrow$  Create  $\rightarrow$ Cylaxis Menu

		SURFACE, CYLAXIS		
	Axis	P1/P3	3	
	Radius	P2	₽.	
meters :				

Paran

At the end of the operation your screen should look like this.



]] 🛃	Eile Edit View Geometry Mesh Load/BC P	roperty Analysis Post Others <u>W</u> indows <u>H</u> elp
lt	೭ 🛃 🏝 🔺 🕨 🗠 🗍 🖾 ೭ 🔍 🕲	🛷 🔟   🖽 🛶   🎭 🖸   💵 📸   🖂 🖉
	Model   Main Show   Log   Colour   Settings   Free Edge Point Curve Volume Volume Note Curve Volume Volume	FEAST2025 VSSC/ISRO
±23 <b>4</b> 12 m 12 <i>0</i>	□ I Node □ □ □ Element □ LCS □ DISPBC □ RLINK □ TNING □ GAP	
С М ж 74	GUPLINS   □ HTLINK SURFACE, CYLAXIS Axis   P1(0)/P23(0)   ] Radius   P2(0)   ]   ]	y w u

#### 4. Generate mesh

Command :MESH, QUAD

Menu : Mesh→MeshGen→Quad

	MESH, QUAD				
Surface 1[0]					
Element size	0.237685	L,			
Method	Mapped	•			
Туре	4-Node	-			
Divisions	S1(D2)[0]*72/S1(D4)[0]*72	L,			
Bias		L.			

Parameters :

Element size can be entered manually or by clicking two points on the geometry edge. Then click on the 'Divisions' command box, so that node divisions will be displayed on the geometry. The element subdivisions can be increased or decreased by left clicking or right clicking respectively.

At the end of the operation your screen should look like this.

📝 <u>F</u> ile	e <u>E</u> dit <u>V</u> iew Geometry Mesh Load/BC	roperty Analysis Post Others <u>W</u> indows <u>H</u> elp	
🗅 🖻	। 🐣 🔺 🕨 🗠 🔟 🖉 🖉 🖉 🖉	an a	
Mod Mod Lat Bac Pai Sha Co Y	del Main Show Log Colour Settings ojects bels ckground ading slour List Colour Settings C Default C Property C Dimension C Component	FEAST2025 VSSC/ISRO	
23 ▲			
K Load	d Store		
Vi Vi Eler Met Typ Divi Bias	MESH, QUAD face 1[0]  http://www.second.com/		

# 5. Apply Material Property

Command: MATERIAL, ISOTROPIC

Menu : Property→Material →Structural →Isotropic

MATERIAL, ISOTROPIC					
Elements	ALL	$\bigtriangledown$			
Young's Modulus	70e09	•••			
Nu	0.3	•••			
Density	2800	•••			
Alpha		•••			
Label					

Parameters:

#### 6. Apply Thickness

Command: THICKNESS, ADD

Menu : Property→Physical →Thickness

THICKNESS, ADD							
Elements	Elements 18T34/52T68/86T102/120T136/154T170/1						
Thickness	0.003	•••					
Label							

Parameters:

# 7. Create Rigid link

Command: RLINK, ADD

Menu : Load/BC→Structural→Rigid link



	RLINK, ADD	
Master Node	2522[0]	$\searrow$
Slave Nodes	18T2433B105[0]	$\triangleright$
Master DOF	Any 💌	
Slave DOFs	123456	•••
LCS		$\triangleright$
Label		

i. Parameters :

Create node at 0:9:0 by (Mesh  $\rightarrow$ Node  $\rightarrow$ Create $\rightarrow$  Add) and it is taken as Master node remaining nodes at top edge is taken as slave nodes (Slave nodes should be 24. equally spaced between 72 nodes at bottom).

At the end of the operation your screen should look like this,



#### 8. Apply Boundary Condition

Command: DISPBC, ADD

Menu : Load/BC→Structural→Displacement

				Displacement BC	×
				Translation	Apply
		DISPBC, ADD			☐ Select all
	Nodes	2523[0]	$\mathbf{b}$	, v 02 [0	
	DispBC	/0/0/0/0/0			
	LCS	0	$\mathbf{b}$	I Ry 0	
Parameters:	Label			I▼ Rz 0	

Apply DISPBC at bottom edge nodes corresponding to 24 rigid links

#### 9. Set Mass Data

Command: ELEMENT, ADD i.

Menu :	$Mesh \rightarrow Element \rightarrow Create \rightarrow Add$						
					💽 Element Type	×	
	Nodes	ELEMENT, ADD		R	Spring Mass		
Parameters:	Dimension Type	0	•	•	Accept	<u>C</u> ancel	

Node id at location 0:9:0.

Menu

Command: MASS, ADD ii.

	MASS, ADD	
Elements	2449[0]	ß
MX	500	
MY	500	
MZ	500	
IXX	0	
IYY	0	
IZZ	0	
IXY	0	
IXZ	0	
IYZ	0	

Parameters:

Mass of 500 is defined at top node id 0:9:0

#### 10. Set Analysis Type

Command :ANTYPE,SET

: Analysis → Analysis Type Menu



	ANTYPE, EDIT				
Parameters ·	Analysis Types	Free vibration 💌			

# 11. Save the project

Menu: File →Save

Click Here **12.** Activate solver ∬ 🗗 Eile Edit View Geometry Mesh Load/BC Property Analysis Post Others Windows Help | "L 🚰 🏝 | ◀ ▶ | ∾ ལ || ഈ ᄵ (♡ (♡ | ☞ 🗠 / 🖉 🖾 👘 ) 🍝 🏄 Model Main Show Log Colour Settings F Geometry
 Model Data -۰ FEAST2025 VSSC/ISRO 0 **ANTYPE** BASEEXCITATION SET# 1 6 SET# 1 Ŷ DISPBC SET# 1 23 복 (습 SET# 1 • вя 'nt BASEEXCITATION, ADD Nodes 2523[0] Ø  $\mathbf{k}$ 0 Magnitude 9.81 ••• **м** Ж Component UX ▼ LCS ß Ŷ4 Label

# 13. Perform Post Processing

# I. To check natural frequencies

Command: POST, VIEWRESULT

Menu : Post  $\rightarrow$  Table View



requency	
Mode	Frequency(Hz)
1	23.4446
2	23.4446
3	23.8027
4	23.8027
5	25.203
6	25.203
7	25.7919
8	25.7919
9	28.1618
10	28.9817
11	28.9817
12	29.5078
13	29.5117
14	30.4276
•	•
Сору	Close



# FREQUENCY RESPONSE ANALYSIS OF A BASE EXCITED CYLINDER



An aluminium cylinder of radius 2m and height 4m is constrained at the bottom through 24 bolted joints. The thickness of the cylinder is 3mm. A mass of 500 kg is lumped at a height of 5m from the cylinder top surface. The mass is connected with the top of the cylinder through 24 bolted joints. Initially a free vibration analysis is performed to estimate the natural frequencies and mode shapes of the system.

A 1g steady state lateral base excitation is applied at the bottom of the cylinder and the response at the mass is estimated. This is done by performing a frequency response base excitation analysis. The lateral base excitation is applied to the cylinder through a heavy inertial mass 50 times greater than the system mass. The inertial mass is connected to the cylinder bottom portion through 24 number of rigid links. 2% critical damping is assumed for all the modes.

#### PROCEDURE

# 14. Create Key points

Command: POINT, ADD

Menu : Geometry  $\rightarrow$  Keypoint  $\rightarrow$  Create  $\rightarrow$  ADD

			POINT, ADD	
	Point Data	0:0:0		$\mathbf{k}$
Parameters:				

Similarly create key points at (0:4:0) and (2:0:0)

At the end of the operation your screen should look like this.



# **15. Create Cylindrical Surface**

Command :SURFACE, CYLAXIS

Menu : Geometry →Surface→ Create →Cylaxis

		SURFACE, CYLAXIS	
	Axis	P1/P3	[k]
	Radius	P2	$\mathbf{b}$
Parameters :			



At the end of the operation your screen should look like this.

]] 🖸	Eile Edit View Geometry Mesh Load/BC	Property Analysis Post Others <u>W</u> indows <u>H</u> elp
]  t	🗅 🛃 🎽 🔺 🕨 🗠 👋 🛄 🖻 ዶ 🖑 🕻	P 🛷 🔟   🕮 斗 🚈   🏡 💟   🗖 🧱 🆍   👗 🔏
	Model   Main Show   Log   Colour   Settings            Free Edge             Point                  Curve                 Surface <th>FEAST2025 VSSC/ISRO</th>	FEAST2025 VSSC/ISRO
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	⊤ TING   ⊂ GAP   ⊂ COUPLING   ⊂ HTLINK SURFACE, CYLAXIS Axis P1(0)/P29(0) Radius P2(0)  }	y w u

#### 16. Generate mesh

Command :MESH, QUAD

Menu : Mesh→MeshGen→Quad

	MESH, QUAD	
Surface	1[0]	L3
Element size	0.237685	L3
Method	Mapped	-
Туре	4-Node	-
Divisions	S1(D2)[0]*72/S1(D4)[0]*72	L3
Bias		L3

Parameters :

Element size can be entered manually or by clicking two points on the geometry edge. Then click on the 'Divisions' command box, so that node divisions will be displayed on the geometry. The element subdivisions can be increased or decreased by left clicking or right clicking respectively.

At the end of the operation your screen should look like this.

]] 🛃	<u>F</u> ile <u>E</u> dit	<u>V</u> iew Geometry Mesh Load/BC P	roperty Analysis Post Oth	ers <u>W</u> indows	<u>H</u> elp											
🗅	n 🔁 🔁 🔹	(▶  ∽ ≃ <u> </u> ፼ዖ ∜ ଅ	🛷 🗵   🖽 斗 🖄		🏫 🛛 者 🎽	<b>1</b>										
· ~ · ·	Model Main Objects Labels Background Paint Mode Shading	Show  Log Colour  Settings  © Default © Material © Property © Dimension	FEAST2025 VSSC / ISRO													
8	Colour List	C Component											11		1111	
Υ								+++	$\left  \right $				11	111	1111	
23									$\left  \right $					$\left  \right $		
4							+++		+++	_						
<b>e</b>									+++	_			++-	+++		-
BH							+++	++++					₩	$\left  \right $		
1													++			
Ø													Ħ			
0													++			
8	Load Store												Ħ			1
*													Ħ			
Ŷ4		MESH, QUAD											T			
	Surface	1[0]														
	Element size	0.237685	Y							N	7					
	Method	Mapped 💌														
	Туре	4-Node	<u> </u>								v	υ				
	Divisions	k														
	Bias	R														

# **17. Apply Boundary Condition**

Command: DISPBC, ADD

Menu : Load/BC→Structural→Displacement

				Displacement BC	>
				Translation	Apply Cancel
		DISPBC, ADD		I Uy 0	Select all
	Nodes	2523[0]	$\mathbf{b}$		
	DispBC	/0/0/0/0/0	•		
	LCS	0	$\searrow$	Ry 0	
:	Label			Rz 0	

Parameters:

Apply DISPBC at location 0:0:0

# **18. Apply Material Property**

Command: MATERIAL, ISOTROPIC

Menu : Property→Material →Structural →Isotropic

	MATERIAL, ISOTROPIC	
Elements	ALL	ß
Young's Modulus	70e09	•••
Nu	0.3	•••
Density	2800	•••
Alpha		•••
Label		

Parameters:

#### **19. Apply Thickness**

Command: THICKNESS, ADD

Menu : Property $\rightarrow$ Physical  $\rightarrow$ Thickness

	THICKNESS, ADD	
Elements	18T34/52T68/86T102/120T136/154T170/1	$\searrow$
Thickness	0.003	•••
Label		

Parameters:

# 20. Create Rigidlink

Command :RLINK,ADD

Menu : Load/BC→Structural→Rigidlink

			RLINK, ADD	
		Master Node	2522[0]	ß
		Slave Nodes	18T2433B105[0]	Q
		Master DOF	Any	
		Slave DOFs	123456	•••
		LCS		R
::	Davage at any	Label		
11.	Parameters :			
			RLINK, ADD	
		Master Node	2523[0]	ß
		Slave Nodes	35T2450B105[0]	b
		Master DOF	Any 💌	
		Slave DOFs	123456	
		LCS		ß
		Label		
iii.	Parameters :			

Create node at 0:0:0 by (Mesh  $\rightarrow$ Node  $\rightarrow$ Create $\rightarrow$  Add) and it is taken as Master node remaining nodes at bottom edge is taken as slave nodes (Slave nodes should be 24. equally spaced between 72 nodes at bottom). Similarly create node at a height of 0:9:0 and create rigid links similar to the bottom edge.

At the end of the operation your screen should look like this.



Model Main e Geometry B Model Data B ANTYPE B ASSEC D DAMPIN B DISPACE B MASS B MATERJ C STR C STR C THICKN	Show Log Colour Setting:	VALUE AL
	RLINK, ADD	
Master Node	2523[0]	
Slave Nodes	35T2450B105[0]	
Master DOF	Any	
	123456	
Slave DOFs		
Slave DOFs LCS	k	z X

#### 21. Set Mass Data

- iii. Command: ELEMENT, ADD
  - Menu : Mesh $\rightarrow$  Element  $\rightarrow$  Create  $\rightarrow$  Add

					💽 Element Type	$\times$
		ELEMENT, ADD			Spring	
	Nodes	2522[0]		$\mathbf{k}$	Mass	
	Dimension	0	-			
Parameters:	Туре	1			Accept	<u>C</u> ancel

Node id at location 0:9:0. Similarly create mass element at 0:0:0

iv. Command: MASS, ADD

Menu

: Property  $\rightarrow$  Physical  $\rightarrow$  Mass

	MASS, ADD			MASS, ADD	
Elements	2449[0]	R	Elements	2450[0]	$\square$
MX	500		MX	50000	
MY	500	•••	MY	50000	
MZ	500	•••	MZ	50000	•••
IXX	0	•••	IXX	0	•••
IYY	0	•••	IYY	0	•••
IZZ	0	•••	IZZ	0	
IXY	0	•••	IXY	0	
IXZ	0		IXZ	0	
IYZ	0		IYZ	0	
Label			Label	-	

Parameters:

Mass of 500 is defined at top node and mass of 50000 is defined at bottom mass location.

#### 22. Set Base Excitation Data

Command: BASEEXCITATION, ADD

Menu : Load/BC $\rightarrow$ Structural $\rightarrow$ Base Excitation

		BASEEXCITATION, ADD	
	Nodes	2523[0]	$\mathbf{b}$
	Magnitude	9.81	•••
	Component	UX 💌	
	LCS		$\mathbf{k}$
Parameters:	Label		

At the end of the operation your screen should look like this.

]] 🛃	<u>File E</u> dit	View Geometry Mesh Load/BC	Prop	perty Analysis Post Others <u>W</u> indows <u>H</u> elp
t	י 📥 🔁 נ	< ▶ ∽ ≃ <u>∥</u> थ २ ११ ७	1	/ 🔟 📴 🖳 🚈 🖄 🗳 🗳 🛤 🏫 🎽 🍝 🔏
	Model Main Geometry Model Data ANTYPE BASEEX SET# DJSPBC SET# FREQRE SET# MASS	Show Log Colour Settings	•	FEAST2025 VSSC/ISRO
ø	Nodes	2523[0]	6	
0	Magnitude	9.81 E		
e¥4a ⊻	Component	UX 💌		
30 194	LCS Label		4	

# 23. Create Damping Data

Command: DAMPING, ADD

Menu : Analysis →Damping



#### 24. Set Analysis Type

Command :ANTYPE,SET

Menu : Analysis→Analysis Type

Parameters : ANTYPE,SET
Analysis Type Frequency Response ---

# 25. Set Frequency Response General Data

# Command: FREQRESGEN, ADD

Menu : Analysis  $\rightarrow$  Frequency Response  $\rightarrow$  General

	FRE	QRESPGEN, ADD	
	Response Extraction	Auto	
	Start Frequency	5	
	End Frequency	40	
	Finer Increment	0.1	
	Coarser Increment	1	
	Number of modes	20	
	Mass type	Lumped 💌	
	Stress Output	NO 💌	
	Nodes	ALL	
ameters:			

Parameter

Note :

In the node list the node IDs of the nodes at which the response to be extracted is specified

26. Save the project

Menu: File →Save



### 28. Perform Post Processing

#### I. Graph plots for displacement/ velocity/ acceleration

Command: POST, HISTORYPLOT

Menu : Post→History Plot

Post, HistoryPlot	
Acceleration	•
TX	•
2522[0]	Þ
Modulus	•
	Acceleration TX 2522[0] Modulus

Parameters:

Select the top mass lumping node. At the end of the operation your screen should look like this.



# II. To check natural frequencies

Command: POST, VIEWRESULT

Menu : Post  $\rightarrow$  Table View

			Post, TableView	
	ltem	Frequency		•
ere.				

Mode	Frequency(Hz)
1	23.427
2	23.427
3	23.7916
4	23.7916
5	25.1774
6	25.1774
7	25.7859
8	25.7859
9	28.1617
10	28.9362 -
11	28.9362
12	29.4729
13	29.473
14	30.4186
۱ <u> </u>	<b> </b> • [
Сору	Close

Parameters: