



### **SUMCON User's Manual**

### Mechanical suspension modeling tool in Mathematica

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Installation / start program / load / save

# Model Construction

- Step 1. Registrate Rigid Bobies
- Step 2. Set Connection
- Step 3. Start calculation

0

# Calculation Result





### Preparation / Installation

#### 1) Install the Modeling tools from the below URL ; http://gwdoc.icrr.u-tokyo.ac.jp/cgi-bin/private/DocDB/ShowDocument?docid=3729

ICCRR Institute for Cosmic Ray Researcy University of Tokyo	JGW-T1503729-v1 [DocDB Home] [Upload Document] [Reserve Number] [Search] [Recent Changes] [Public Site] [Help] Suspension rigid-body modeling tool in Mathematica Abstract: This is a suspension modeling tool built in Wolfram Mathematica. You will need Mathematica later than version 7. To start the program uppin	Viewable by:
Document type: I Submitted by: <u>Takanori Sekiguchi</u> Updated by: <u>Takanori Sekiguchi</u> Document Created: 24 Jun 2015, 09:30 Contents Revised: 24 Jun 2015, 09:30 DB Jofo Revised:	<ul> <li>the attached file and execute 'startSUMCON.nb' in the top directory. The user manual is to be added soon.</li> <li>Files in Document: <ul> <li><u>sumcon 1 3 2 zip</u> (62 MB)</li> </ul> </li> <li>Get all files as <u>tar.gz</u>, <u>zip</u>.</li> </ul>	<ul> <li>Public document JGW-T1503729-v1</li> <li>Modifiable by:         <ul> <li>admin</li> <li>upload</li> </ul> </li> </ul>
24 Jun 2015, 09:30 Create a new version Change DB Info Username: Password:	Detector:Seismic Isolation     Activity:KAGRA     Detector:Suspensions  Authors:     Takanori Sekiguchi	
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# Preparation / Starting program



### Preparation / Load a model file

#### 2) Load previous file



### Preparation / Save a model file



### Model construction

#### 1) You should registrate suspension parameters as follows.

*		SUI	MCON Versi	on:1.32			- • ×
SUMCON spension odel structor in Mathematica	<b>Q</b> • ,	SUMCON V About SUM	ersion:1.32 CON <mark>Ver</mark>	sion Info	eflesh		^
New Model     Load Model     Sa       Model Construction     Calculation       Step 1. Registrate Rigid Bodies	ave Model typ n Result   Export	peAproto_160 t <b>Model</b>	324_TMspr_w	oIMeddy.m			
1-1Set Body Names1-2Set Mass & MoI1-3Set Body Shapes1-4Set Initial Position	Body: GND Name O g F0 MD SF1 SF2 SF3 BF PF	<ul> <li>M [kg]</li> <li>0</li> <li>474</li> <li>18</li> <li>104</li> <li>90</li> <li>87</li> <li>84</li> <li>61.5</li> </ul>	Ixx [kgm2] 0 60 0.72 4.4 4.1 4. 4. 4. 2.4	Iyy [kgm2] 0 120 1.49 7.3 6.4 6.4 6.4 3.8	Izz [kgm2] 0 60 0.72 4.4 4.1 4. 4. 2.4	Shape Doughnut[y] Cylinder[y] Doughnut[y] TruncatedCone[y] TruncatedCone[y] TruncatedCone[y] TruncatedCone[y]	*
Step 2. Set Connection Set Material Properties 2–1 Set Wires 2–2 Set Vertical Springe	Wire: Name F0-MD-1 F0-MD-2 F0-MD-3	Body1 F0 F0 F0	Body2 I MD I MD I MD I	Material Maraging Steel Maraging Steel Maraging Steel	L [m] 1.9398 1.9398 1.9398	D [mm] 2. 2. 2.	

### **Axes definition**



### Model construction / Step 1. / Set Body Names

#### 2) Set suspension names

*	S	UMCON Ver	rsion:1.32				×				
SUMCON in Mathematica	*				1-1 Se	t Body Nar	nes				×
New Model Load Model Save Model	Registr	ate Body	Names								
Model Construction Calculation Result	GND	Name	GND	Name	GND	Name	GND	Name	GND	Name	
Step 1. Registrate Rigid Bodies	<ul><li>✓</li></ul>	g		F0		MD		SF1		SF2	
1–1 Body:		SF3		BF		PF		RMario		Mario	
Set Body Names		IRM		IM		RM		TM			
Set Mass & MoI											
1–3 Set Body Shapes											
1-4						Objec	cts_to	uched	on gr	ound	
Set Initial Position	Save	Cancel				shoul	d be	checke	d hei	re.	
Step 2. Set Connection											
Set Material Properties     Wire:       2-1     Name       Set Wires     F0-MD-       2-2     F0-MD-       Set Vertical Springs     F0-MD-	Body1 1 F0 2 F0 3 F0	Body2 MD MD MD	Material Maraging Steel Maraging Steel Maraging Steel	L [m] 1.9398 1.9398 1.9398	D [mm] 2. 2. 2.		, ,				
						100	» •				

# **Model construction / Step 1. / Set Mass** Please click the "Off-diag".

#### 3) Set Masses and Moment of inertia

Registration page is open. <a href="https://www.selicitation.com"></a>

<b>\$</b>	*				1-2 Set M	1ass & MoI				×
SUMCON in Mathematica	Set Ma	ss and M	loment o	f Inertia						î î
spension odel structor		Сору	Paste	Mass	Ixx	Іуу	Izz		I Matrix	
New Model Load Model Save Model typeApr	g	Сору	Paste	0	0	0	0	•	Off-Diag	
Model Construction Calculation Result Export Mode	F0	Сору	Paste	474	60	120	60	*	Off-Diag	
Step 1. Registrate Rigid Bodies	MD	Copy	Paste	18	0.7199-	1.49	0.7199-	*	Off-Diag	
	SF1	Copy	Paste	104	4.4	7.3	4.4	*	Off-Diag	
1–1 Body:	SF2	Copy	Paste	90	4.1	6.4	4.1	*	Off-Diag	
Set Body Names GND Name N	SF3	Copy	Paste	87	4.	6.4	4.	*	Off-Diag	
1-2 F0 4	BF	Copy	Paste	84	4.	6.4	4.	*	Off-Diag	
1-3 MD 1 SF1 1	PF	Copy	Paste	61.5	2.4	3.8	2.4	*	Off-Diag	
Set Body Shapes SF2 9	RMario	Copy	Paste	20.54	0.5022-	0.8413-	0.5127-	*	Off-Diag	
1–4 Set Initial Position BF 8	Mario	Copy	Paste	21.07	0.1593-	0.3015-	0.1631-	*	Off-Diag	
PF 6	IRM	Copy	Paste	20.82	0.3353-	0.6379-	0.3279-	*	Off-Diag	
<	IM	Copy	Paste	20.67	0.0933-	0.1653-	0.1053-	*	Off-Diag	
Sten 2 Set Connection	RM	Copy	Paste	22.91	0.3961-	0.3611-	0.4355-	•	Off-Diag	
Step 2. See connection	ТМ	Copy	Paste	22.88	0.1115-	0.1135-	0.1399-	*	Off-Diag	
Set Material Properties Wire:			1							
2-1 Name Bo	Save	Cancel		Kegis	terea c	odies				
Set wires F0-MD-2 F0										~
Sat Vertical Springs									100	% 🔺
	_					100%	▲			

2 0	ст на	55 & MOI		
		I Matrix		
	*	Off-Diag		
		×	У	z
_		x 60	0	0
-	^	у 0	120	0
		z 0	0	60
	•	Off-Diag		
		Off-Diag		
	*	Off-Diag		
	*	Off-Diag		

## Model construction / Step 1. / Body shape

#### 4) Set suspension body shapes

	拳			1-3 Set	Body Shapes	×
	Set Ap	pearance	of Bodie	25		^
spension odel structor in Mathematica		Сору	Paste	Select Shape	Dimension	
New Model Load Model Save Model type	g	Сору	Paste	Doughnut[y] -	Outer D Inner D 1.5 0.8 0.2 0.2 0.2	
Model Construction Calculation Result Event	F0	Сору	Paste	Cylinder[y] -	Diameter Height 1.4 0.2 0.2 0.2 0.2 0.2	-
Step 1. Registrate Rigid Bodies	MD	Сору	Paste	Doughnut[y] -	Outer D         Inner D           0.7         0.5         0.2         0.2         0.2	5
Set Body Names  I-2  Set Body Names  GND Name  GND  GND  Name  GND  Set Body	SF1	Сору	Paste	TruncatedCone[y] 🔻	Upper D Lower D Height 0.6 0.8 0.2 0.2 0.2	5
Set Mass & MoI         F0           1-3         SF1	SF2	Сору	Paste	TruncatedCone[X] -	Upper D Lower D Height 0.6 0.8 0.2 0.2 0.2	5
Set Body Shapes SF2 1-4 SF3 BF	SF3	Сору	Paste	TruncatedCone[y]	Upper D Lower D Height 0.6 0.8 0.2 0.2 0.2	
PF	BF	Сору	Paste	TruncatedCone[y] -	Upper D Lower D Height 0.5 0.7 0.2 0.2 0.2	-
Step 2. Set Connection	PF	Сору	Paste	TruncatedCone[y] -	Upper D Lower D Height 0.4 0.6 0.2 0.2 0.2	
Set Material Properties Wire:	RMario	Сору	Paste	OpenCuboid[y] -	x-size Choose the shap	e
2–1 Set Wires F0–MD–1 F0–MD–2	<			- • • •	x-size From options	<b>`</b> ~
2-2 F0-MD-3					10	0% 🔺
					100% 🔺 🔡	

### Model construction / Step 1.

#### 5) Set suspension initial positions

# The shape, you chose in the step 1-3, should be reflected to this screen.

<b>*</b>	*		1-4	4 Set Initial Position	
SUMCON in Mathematica	Set Init	ial Position of F	igid Bodies		
New Model Load Model Save Model typeA	Name	x [mm]	y [mm]	z [mm]	
Model Construction Calculation Result Event M	g	0.	0.	0.	
Step 1. Registrate Rigid Bodies	F0	0.	500.	0.	
1-1 Body:	MD	0.	-1621.1	0.	
Set Body Names GND Name	SF1	0.	-1771.1	0.	
1–2 F0 Set Mass & MoI MD	SF2	0.	-4042.1	0.	
1-3 SF1	SF3	0.	-6313.1	0.	
1-4 SF2	BF	0.	-8686.1	0.	
Set Initial Position BF	PF	0.	-11967.1	0.	
<	RMario	0.	-12386.1	0.	
Step 2. Set Connection	Mario	0.	-12386.1	0.	
Wire-	IRM	0.	-12654.503	0.	
2-1 Name	IM	0.	-12654.403	0.	
Set Wires F0-MD-1 F0-MD-2	RM	0.	-13004.503	0.	
Set Vertical Springs	тм	0.	-13004.503	0.	ō
	Save	Cancel			

1) Set suspension wire information, by clinking here

Step 2. Set Connection		🌣 Set Wir	es			2-1 Set W	ires				×
Set Material Properties	Wire:	Create N Edit Ea	ew Wire	Set Material Prop	erties						
2-1 Eat Wires	F0-MD-1	Del	Сору	Name	U Body	U Clamp Pos	[mm]		L Body	L Clamp	Pos [m
Set wires	F0-MD-2	Delete	Copy	F0-MD-1	F0 -	290.	-80.	0.	MD 🔹	290.	17
2-2 Set Mention I Continent	F0-MD-3	Delete	Сору	F0-MD-2	F0 -	-145.	-80.	-251	MD 👻	-145.	17
set vertical springs	F0-SF1-1	Delete	Сору	F0-MD-3	F0 •	-145	-80.	251.1-	MD 👻	-145	17
2–3 Set Towerted Dendulum	SF1-SF2- SF2_SF3-	Delete	Copy	F0-SF1-1	F0 -	0.	120.	0.	SF1 🔻	0.	-1
et Inverted Pendulum	SF3-BF-1	Delete	Copy	SF1-SF2-1	SF1 -	0.	-25.	0.	SF2 🔻	0.	5.
2-4	BF-PF-1	Delete	Сору	SF2-SF3-1	SF2 👻	0.	-5.	0.	SF3 🔻	0.	5.
et Heat Links	PF-Mario-	Delete	Copy	SF3-BF-1	SF3 🔻	0.	-5.	0.	BF 👻	0.	5.
-5	PF-RMario	Delete	Conv	BF-PF-1	BF 👻	0	-5	0.	PF 🔻	0	5
set Damper	PF-RMario	Delete	Conv	PE-Mario-1	PF v	0	-5	0	Mario 💌	0	5
	Mario-IM-	Delete	Capy	DE-PMario_1	DE -	175.5	-J.	0.	PMario -	175 5	5.
	Mario-IM-	Delete	Сору	PF-RMaria 2		1/5.5	-5.	0.		1/5.5	5. 
	<	<									> 100% ▲
Step 3. Start Calculation											
	•										
Construct Model											

In more detail, please See p. 12 ~ p. 15

#### 2 - i) Set suspension wire information



#### The number of the wires

Upper & lower body name

Suspension position of the upper & lower body (From body's Center of Mas)

Wire material (They are registered already. mostly.)

1)Length, 2) diameter, 3) Neck length, 4) Neck dimeter

#### Wire stiffness

#### 2 - ii) Set suspension wire information



#### The number of the wires

Upper & lower body name

Suspension position of the upper & lower body (From body's Center of Mas)

Wire material (They are registered already. mostly.)

1)Length, 2) diameter, 3) Neck length, 4) Neck dimeter

#### Wire stiffness

#### 2 - iii) Set suspension wire information



#### The number of the wires

Upper & lower body name

Suspension position of the upper & lower body (From body's Center of Mas)

Wire material (They are registered already. mostly.)

1)Length, 2) diameter, 3) Neck length, 4) Neck dimeter

#### Wire stiffness

#### 2 - iv) Set suspension wire information



#### The number of the wires

Upper & lower body name

Suspension position of the upper & lower body (From body's Center of Mas)

Wire material (They are registered already. mostly.)

1)Length, 2) diameter, 3) Neck length, 4) Neck dimeter

#### Wire stiffness

#### This sheet is output automatically.

*					2-1 Set	Wires	٠				2-1 Se	et Wires				\$				2-1 Set	Wires				×
Edi	t Each	Wire	Edit Wire Connect	ion																					
Del		Сору	Name	U Body	U Clamp P	os [mm]		L Body	L Clamp Pos	s [mm]		Mat	E [GPa]	Poission R	Los	[rad]	L	.[m] D [mn	i] NL [mm]	ND [mm]	T [N]	Upper Cl	amp Direction		Low
Del	te	Copy	F0-MD-1	F0 •	290.	-80.	0.	MD 🔻	290.	17.	0.	C-70 Steel 🔹	200	0.3	3.	E -	-4 1	1.6211 4.500	0- 26.5	2.	294.3	0	-1	0	0
Del	te	Сору	F0-MD-2	F0 -	-145.	-80.	-251	MD 👻	-145.	17.	-251	C-70 Steel 🔹	200	0.3	3.	E ·	-4 1	1.6211 4.500	0- 26.5	2.	294.3	0	-1	0	0
Del	te	Copy	F0-MD-3	F0 •	-145	-80.	251.1-	MD 🔹	-145	17.	251.1-	C–70 Steel 🔹	200	0.3	3.	E ·	-4 1	1.6211 4.500	0- 26.5	2.	294.3	0	-1	0	0
Del	te	Copy	F0-SF1-1	F0 •	0.	120.	0.	SF1 🔹	0.	2.5	0.	Maraging Steel 🔹 👻	184	0.32	1.	E ·	-4 2	2.2711 4.500	0- 30.5	3.	6652.16	0	-1	0	0
Del	te	Сору	SF1-SF2-1	SF1 •	0.	-44.	0.	SF2 🔻	0.	2.5	0.	Maraging Steel 🔹 👻	184	0.32	1.	E ·	-4 2	2.271 4.500	0- 30.5	3.	5546.5-	0	-1	0	0
Del	te	Сору	SF2-SF3-1	SF2 🔹	0.	-44.	0.	SF3 🔹	0.	2.5	0.	Maraging Steel 🔹 👻	184	0.32	1.	E ·	-4 2	2.271 4.500	0- 30.5	3.	4440.99	0	-1	0	0
Del	te	Сору	SF3-BF-1	SF3 -	0.	-44.	0.	BF 👻	0.	2.5	0.	Maraging Steel 🔹 👻	184	0.32	1.	E ·	-4 2	2.373 4.500	0- 30.5	3.	3335.4	0	-1	0	0
Del	te	Сору	BF-PF-1	BF 💌	0.	-54.5	0.	PF 🔻	0.	1.5	0.	Maraging Steel 🔹 👻	184	0.32	1.	E -	-4 3	3.281 4.500	0- 30.5	3.	2354.4	0	-1	0	0
Del	te	Сору	PF-Mario-1	PF 🔹	0.	-79.0-	0.	Mario 👻	0.	1.5	0.	Maraging Steel 🔹	184	0.32	1.	E ·	-4 0	0.169 4.500	40.5	2.	712.206	0	-1	0	0
Del	te	Copy	PF-RMario-1	PF 💌	0.	20.	-175.5	RMario 💌	0.	17.	-175.5	Copper Beryllium 🔹	134	0.3	5.	E ·	-6 0	0.287 4.500	0- 40.5	2.	857.394	0	-1	0	0
Del	te	Copy	PF-RMario-2	PF 🔹	151.9-	20.	87.75	RMario 🔻	151.9-	17.	87.75	Copper Beryllium 🔻	134	0.3	5.	E ·	-6 0	0.287 4.500	40.5	2.	857.394	0	-1	0	0
Del	te	Copy	PF-RMario-3	PF 🔹	-151	20.	87.75	RMario 💌	-151	17.	87.75	Copper Beryllium 🔻	134	0.3	5.	E ·	-6 0	0.287 4.500	0- 40.5	2.	857.394	0	-1	0	0
Del	te	Сору	Mario-IM-1	Mario 🔹	94.	-5.	110.	IM 👻	94.	5.	110.	Copper Beryllium 🔻	134	0.3	5.	E ·	-6 0	0.2684-	0.	0.6	464.994	0	-1	0	0
*					2-1 Set \	Wires	*				2-1 Set	Wires			1	\$				2-1 Set	Wires				×
Dele	e	Сору	Mario-IM-3	Mario 🔻	-94.	-5.	110.	IM 👻	-94.	5.	110.	Copper Beryllium 👻	134	0.3	5.	E -	6 0	.2684- 0.6	0.	0.6	464.994	0	-1	0	0 ^
Dele	e	Copy	Mario-IM-4	Mario 🝷	-94.	-5.	-110.	IM 👻	-94.	5.	-110.	Copper Beryllium 👻	134	0.3	5.	E –	6 0.	.2684- 0.6	0.	0.6	464.994	0	-1	0	0
Dele	e	Copy	RMario-IRM-1	RMario 🔻	171.7	5.	161.	IRM 👻	171.7	30.	161.	Copper Beryllium 👻	134	0.3	5.	E –	6 0.	.2425- 0.6	0.	0.6	610.182	0	-1	0	0
Dele	e	Copy	RMario-IRM-2	RMario 👻	171.7	5.	-161.	IRM 👻	171.7	30.	-161.	Copper Beryllium 🔻	134	0.3	5.	E –	6 0.	.2425- 0.6	0.	0.6	610.182	0	-1	0	0
Dele	e	Copy	RMario-IRM-3	RMario 👻	-171.7	5.	161.	IRM 👻	-171.7	30.	161.	Copper Beryllium 👻	134	0.3	5.	E –	6 0.	.2425- 0.6	0.	0.6	610.182	0.	-1.	0.	0.
Dele	e	Copy	RMario-IRM-4	RMario 💌	-171.7	5.	-161.	IRM 🔹	-171.7	30.	-161.	Copper Beryllium 👻	134	0.3	5.	E –	6 0.	.2425- 0.6	0.	0.6	610.182	0.	-1.	0.	0.
Dele	e	Сору	IM-TM-1	IM 👻	114.2	-40.	29.2	TM 👻	114.2	-30.	29.2	Sapphire 👻	345	0.3	2.	E -	7 0.	.33 1.6	0.	1.6	221.706	0	-1	0	0
Dele	e	Copy	IM-TM-2	IM 👻	114.2	-40.	-29.2	TM 🔹	114.2	-30.	-29.2	Sapphire 👻	345	0.3	2.	E -	7 0.	.33 1.6	0.	1.6	221.706	0	-1	0	0
Dele	e	Copy	IM-TM-3	IM 👻	-114.2	-40.	29.2	TM 👻	-114.2	-30.	29.2	Sapphire 👻	345	0.3	2.	E –	7 0.	.33 1.6	0.	1.6	221.706	0	-1	0	0
Dele	e	Copy	IM-TM-4	IM 👻	-114.2	-40.	-29.2	TM 👻	-114.2	-30.	-29.2	Sapphire 👻	345	0.3	2.	E -	7 0.	.33 1.6	0.	1.6	221.706	0	-1	0	0
Dele	e	Сору	IRM-RM-1	IRM 👻	153.1-	50.	44.70-	RM 👻	153.1-	50.	44.70-	Copper Beryllium 🝷	134	0.3	5.	E –	6 0.	.3308- 0.6	0.	1.	362.97-	0	-1	0	0
Dele	e	Copy	IRM-RM-2	IRM 🔹	153.1-	50.	-44.7-	RM 🔹	153.1-	50.	-44.7-	Copper Beryllium 🝷	134	0.3	5.	E –	6 0.3	.3308- 0.6	0.	1.	362.97-	0	-1	0	0
Dele	e	Сору	IRM-RM-3	IRM 👻	-153	50.	44.70-	RM 👻	-153	50.	44.70-	Copper Beryllium 👻	134	0.3	5.	E –	6 0.	.3308- 0.6	0.	1.	362.97-	0	-1	0	0
Dele	e	Copy	IRM-RM-4	IRM 🔹	-153	50.	-44.7-	RM 🔹	-153	50.	-44.7-	Copper Beryllium 🔻	134	0.3	5.	E –	6 0.	.3308- 0.6	0.	1.	362.97-	0	-1	0	0
Sa	<b>e</b>	Cancel	]																						
<							<									<									>
															100										100% 🔺

### Model construction / Step 2. / Set Vertical springs (GAS)

1) Set GAS filter, by	*				2-2 Set Vertical Springs
	Set Ve	rtical Sp	rings		* New Vertical Springs
Step 2. Set Connection	Create	New Spri	ngs 🔍	News	Registrate New Vertical Springs
	Delete	Сору	Edit	GAS0	Spring Name
Set Material Properties	Delete	Сору	Edit	GAS1	GAS0 Namo
Set Wires	Delete	Сору	Edit	GAS2 GAS3	Choose wire suspension point where spring is inserted
2-2 Set Vertical Springs	Delete	Сору	Edit	GAS4	Desition of the CAC
2-3	Delete	Сору	Edit	GAS5	F0-SF1-1 • Upper SP • • • • • • • • • • • • • • • • • •
Set Inverted Pendulum	Delete	Сору	Edit	TMspring1	Stiffness & Prestress
2–4 Set Heat Links	Delete	Сору	Edit	TMspring3	Calculate from wire tension & resonant frequency Stiffness
2–5 Set Demonstra	Delete	Сору	Edit	TMspring4	Stiffness: 2409.3- N/m Prestress: 6652.16 N
Set Damper	Save <	Cance	1		
	Mario <	-IM-2		Mario	50. Q factor
Stan 2 Start Calculation					Center of Percussion Effect
Construct Model					



	New Horizontal Flexure
Model construction / Step 2. / Set IP	Edit Inverted Pendulum
• • •	IP Name
Name	
Desition of the ID	Choose Base and Top Bodies
FOSICION OF CHE IF	Position of IPs in Horizontal Plane
	Calculate IP Position
Position of the IP leas	x [mm] z [mm]
Fosition of the IF legs	Leg2 -304.99528.27-
	Length of IP Legs
Length of the IP leg	
	Load Mass
	Calculate from Suspended Bodies
Load mass on the IP	849.9 kg
	Effective Stiffness and Quality Factor
	Calculate stiffness from Resonant Frequency
Effective bending stiffness	Leg1         71.579-         10
of bottom flexure	Leg2 71.579- 10 Leg3 71.579- 10
of bottom nexure	Additional yaw stiffness due to Rigidity of flexures
Additional tarsion stiffnass	Stiffness [Nm/rad]         Q-factor           Torsion         35.         1000.
Additional torsion stimess	Center of Percussion Level
	✓ -80 dB
COP level	✓ Overcompensated
	Finish 100% A

### Model construction / Step 2. / Damper

Set Eddy	2-5 Set Damper	
Set Damper		
tep 2. Set Connec Create New Damper		
Del Copy Edit	Name Body1 Body2 Damping Point in Body1 [mm] Damping P	
Material Properties		^
1 Save Cance	* New Heat Links	x
) whes	New Damper	
z t Vertical Spring	Name	
3		
Inverted Pendu	Damping Between:	
4	Body1: MD - Body2: F1 Position	n of the Eddy current dan
t Heat Links	Position of Damper	
5 t Damper	Body1: 010. 0 Pushing point	
•	Damping Strength Matrix	
ep 3. Start Calculation	x     y     z     Pitch     Yaw     Roll       x     50     0     0     0     0       y     0     125     0     0     0       z     0     0     50     0     0       Pitch     0     0     0     2       Pitch     0     0     0     2       Yaw     0     0     0     2	strength matrix
Construct Model	Finish 75%	%

### Model construction / Step 3.

#### 1) Start the calculation, by clinking here

Set Material Properties 2–1 Set Wires 2–2 Set Vertical Springs 2–3 Set Inverted Pendulum 2–4 Set Heat Links 2–5 Set Damper	Wire: Name F0-MD-1 F0-MD-2 F0-MD-3 F0-SF1-1 SF1-SF2-1 SF2-SF3-1 SF3-BF-1 BF-PF-1 PF-Mario-1 PF-RMario-2 PF-RMario-3 Mario-IM-1 Mario-IM-2	Body1 F0 F0 F0 SF1 SF2 SF3 BF PF PF PF PF PF Mario Mario	Body2 MD MD SF1 SF2 SF3 BF PF Mario RMario RMario RMario IM IM	Material Maraging Steel Maraging Steel	L [m] 1.9398 1.9398 2.26566 2.26644 2.26711 2.36766 3.3877 0.406237 0.227468 0.227468 0.227468 0.227468 0.227468 0.227468 0.227468	D [mm] 2. 2. 4.5 4.5 4.5 4.5 4.5 4.5 4.5 4.5 4.5 4.	~
Step 3. Start Calculation Construct Model	Start ca	alcula	tion, l	oy pushing	here!		

### Model construction / Step 3.

1) In the end, you can get the frequency response, and its eigen mode shapes!

*					:	SUMCON \	/ersion	:1.32					×			
,	Frequency Doma	in Plot Tool													You can click anywhe	re!
	Frequency Resp	once to Ground	Motion	<b>•</b>	Set S	Geismic Spe	ctrum								Please play with this	tool!
	Frequency Resp Frequency Resp Seismic Noise F	once to Externa once to Ground lot	al Force Motion	/Torque	pitcł	ng 🗌	yawg	🗌 rollg	)						( Some stuffs are to b	e added. )
	Thermal Noise	Plot pitchMD pitchSF1 pitchSF2 pitchSF3		yawMD yawSF1 yawSF2 yawSF3		yawF0 rollMD rollSF1 rollSF2 rollSF3		xMD xSF1 xSF2 xSF3 xBF		yMD ySF1 ySF2 ySF3 yBF		zMD zSF1 zSF2 zSF3 zBE				
		pitchBF pitchPF pitchRMario pitchRMario		yawBF yawPF yawRMario yawMario		rollBF rollPF rollRMario rollMario		xPF xRMario xMario xIRM		yPF yRMario yMario yIRM		Mainly, yo * Force Tr	ou ans	Ci St	an plot(get) ; fer function	
		pitchIM pitchRM pitchTM		yawIM yawRM yawTM		rollIM rollRM rollTM		xRM xTM		уRM уTM		* Displace * Seismic * Thorma	no	e jis	nt Transfer function se	
	Frequency:	0.01 -	10	00.	Step:	1001		] Logarit	thmic dd Plot	Lin	ear Plot	* Eigen fr * Eigen m	equ od	u u le	ency shape	
<	0.1					TM/ve For			) Sh	ow Legend		100%	> ▲:			

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For	spension odel structo	or in Mathemat	ica 🥰	About	SUMCON Versi	on Info	Reflesh		
FOr	-								
example,	New Model	oad Model	Save Model	TypeB1¥150	0723_TypeB1_Proto.	m			
	Model Construct	tion Calculat	tion Result E	xport Model					
	Model Basic Inf								
	Degrees of Free	dom:							
	45 State Varia	ables							
	6 Input Varia	ables							
	3 Float Varia	bles							
	Course of Description								
	Ground Position		nitcha . 0		rolla . O				
	$xg \rightarrow 0$ . $yg \rightarrow 0$	. 2g → 0.	pitcing $\rightarrow$ 0.	yawg → 0.	rolig → 0.				
	Equilibrium Poir	nt:							
	xF0 → 0. z	zF0 → 0.	yawF0 → 0.	$\times MD \rightarrow 0.$	yMD → -0.572	$zMD \rightarrow 0.$			
	pitchMD $\rightarrow$ 0.	yawMD → 0.	rollMD $\rightarrow$ 0.	xF1 → 0.	yF1 → -0.665	$zF1 \rightarrow 0.$			
	pitchF1 $\rightarrow$ 0.	yawF1 → 0.	rollF1 $\rightarrow$ 0.	xF2 → 0.	yF2 → -1.1984	zF2 → 0.			
	pitchF2 $\rightarrow$ 0. y	yawF2 → 0.	rollF2 $\rightarrow$ 0.	$xIR \rightarrow 0.$	yIR → -1.6936	$zIR \rightarrow 0.$			
	pitchIR $\rightarrow 0$ . y	yawIR → 0.	rollIR $\rightarrow 0$ .	$\times IM \rightarrow 0.$	yIM → -1.7699	$zIM \rightarrow 0.$			
	pitchIM $\rightarrow 0$ . y	yawIM → 0.	rollIM $\rightarrow 0$ .	$\times RM \rightarrow 0.$	yRM → -2.3569	$zRM \rightarrow 0.$			
	pitchRM $\rightarrow 0$ . y	yawRM → 0.	rollRM $\rightarrow 0$ .	$XIM \rightarrow 0.$	y1M → -2.3569	$ZIM \rightarrow 0.$			
	pitch $I M \rightarrow 0$ .	yawım → 0.	$roll IM \rightarrow 0.$	$nGASU \rightarrow 0.$	$NGASI \rightarrow 0.$	$nGAS2 \rightarrow 0.$			







