Crashworthiness

Computational Design Laboratory Department of Automotive Engineering Hanyang University, Seoul, Korea



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- 예제 문제
 - Non-linear joint moment analysis
 - Mid rail analysis
- 해석 프로세스
 - ▶ 기하형상 생성
 ▶ 재료 물성 및 특성 입력
 ▶ 요소망 생성
 ▶ 구속조건 설정
 ▶ 하중조건 설정
 ▶ 해석케이스 정의 및 해석 실행
 ▶ 후처리

FIRST ORDER ANALYSIS: CRASHWORTHINESS

2004-01-1660

First Order Analysis for Automotive Body Structure Design - Part 3: Crashworthiness Analysis Using Beam Elements

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Toyota Central R&D Labs., Inc.

Noboru Kikuchi

The University of Michigan

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JOINT MOMENT ANALYSIS

예제: JOINT MOMENT ANALYSIS

• Shell 모델의 등가 강성 계산





HYPERCRASH 실행



유한요소해석 모델 불러오기





재료 물성 입력 (1)

616	Review	۶I			
6	Create New	▶ Airb	ag material		>
	Create Template	▶ Com	nposite and Fabric		>
×	Delete	Con	nection		>
	Clone	Elas	tic and Hyperelasti	ic	• I
l	Cross Reference	Elas	to-plastic		Johnson-Cook (2)
	Lock	Hon	eycomb		 Zerilli-Armstrong (2)
	UnLock	Hyd	Irodynamic		 Hyd. Elasto-plastic (3)
	Move entity(s) to	Roc	k and Concrete		Hyd. Johnson-Cook (4)
	See in Browser	Viso	co-elastic		Ductile damage (22)
	Group Selected Row	_s Fluid	d		Ductile damage (23)
		- Non	turbulent flow	Ĩ	Plastic brittle for shell (27)
		Turb	bulent flow	1	Hill orthotropic (32)
		Othe	er	\backslash	Piecewise linear (36)
		Use	r Material		Hill ortho. tab. (43)
		_		_	Cowper-Symonds (44)
					Zhao (48)

PLAS_TAB	
<u>6</u>	
D	2
Title	New MAT 2
Local Unit System	None
[RHO_] Initial density*	7.85E-6 2
[RHO_0] Reference density	0
[E] Young's modulus*	206
[Nu] Poisson's ratio*	.3
[Eps_p_max] Failure plastic strain	0
[Eps_t] Tensile failure strain	0
[Eps_m] Tensile failure strain	0
[C_hard] Hardening coefficient	0
[F_smooth] Strain rate smoothing	
[F_cut] Cutoff frequency for strain rate filtering	0
[Eps_f] Maximum tensile failure strain	0
[VP] Strain rate choice flag	0: Strain rate are total strain rate
[fct_IDp] Pressure vs. yield factor function	None
[Fscale] Y-Scale factor for yield factor function	1
[Fct_IDE] Function identifier for the scale factor of You	None
[Elnf] Saturated Young's modulus for infinitive plastic s	0
[CE] Parameter for Young's modulus evolution	0
Heat	

Piecewise linear(36) 재료 생성 2 재료 물성치 입력 [RHO_I]: 7.85e-6 [E]: 240 [Nu]: 0.3

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재료 물성 입력 (2)



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SHELL				
D		2		
Title		New PROP 2		
Local Unit System		None		
[Ismstr] Flag for shell small strain form	ulation	0: Use value in /DE	EF_SHELL	
[Ishell] Flag for 4 node shell element for	ormulation	0: Use value in /DE	EF_SHELL	
[Ish3n] Flag for 3 node shell element f	ormulation	0: use value in /DE	F_SHELL	
[Idrill] Flag for drilling degree of freedo	m stiffness	0: No		
[P_thick_fail] Percentage of through the	ickness integration	0		
[hm] Shell membrane hourglass coeffi	cient	0		
[hf] Shell out of plane hourglass		0		
[hr] Shell rotation hourglass coefficien	ıt	0		
[dm] Shell membrane damping		0		
[dn] Shell numerical damping		0		
[N] Number of integration points through the thickness		0		
[Istrain] Flag to compute strains for po	st-processing	0: Use val	EF_SHELL	
[Thick] Shell thickness*		1.6		
[Ashear] Shear factor		0		
[Ithick] Flag for shell resultant stresse	s calculation	0: Default set to va	alue defined with /DEF_SHELL	
[lplas] Flag for shell plane stress plast	licity	0: Default 🕎 v	alue defined with /DEF_SHELL	
Support*		1 items 2		
Close	Sa	ve	Cancel	



RBE2 생성 (1)



RBE2 생성 (2)



구속조건 설정



			₩ Boundary condition 생성
	BCS		
DADIOSS Taola - Data History		1	
RADIOSS TOOIS Data history		New BCS 1	
	ALE formul.		· · · · · · · · · · · · · · · · · · ·
ass	Lagrange mult. formul.		┃
/ Condition	✓ Translation		
			l l
			<u> </u>
	V Rotation		▲ 💽 구속할 절점 선택
	[RT] 7 rotation		
			- i
	[Skew_id] Skew	None	
	[Gnod_id] Support*	26 items	
*			

변위조건 설정



접촉조건 설정

LoadCase RADIOSS Tools Data History Added Mass Boundary Condition F Concentrated Load Contact Interface	 Review Create N Create T Delete Data Hist Clone Change S 	ew ALE/Lagrange with sliding (Type 1) emplate Kinematic condition (Type 2) Surface/Surface(Type 3) Nodes/Surface (Type 5) Rigid body/Rigid body (Type 6) Mutti usage (Type 7)		LoadCase > Contact Interface클릭, 마우스 우클릭 후 "Multi usage (Type 7) 클릭 Self Impact 체크
·				[Stfac]: 1
TYPE7	4			[Commin]: 0.0
	Net	w INTED 1	ĺ	[Gapmin]. 0.9
				[Fric]: 0.2
Local Unit System	Nor	le		
Formulation	0: 0	Classical		Mast_id]: 모넬 선택
[Istf] Stiffness definition	0: 0	efault, set to value defined in /DEFAULT/INTER/TYPE	1	
[Ithe] Heat contact			·	
[Igap] Gap/element option	0: 0	efault, set to value defined in /DEFAULT/INTER/TYPE		
[Fpenmax] Maximum fraction of initial pe	enetration 0			
[Ibag] Vent hole closure when contact	0: [efault, set to value defined in /DEFAULT/INTER/TYPE		
[Idel] Node and segment deletion	0: [efault, set to value defined in /DEFAULT/INTER/TYPE		
[Icurv] Slave gap with curvature	0:1	lo curvature		
(ladm) Local curvature tiag	1	lot activated	I	
[dtmin] Limiting nodal time step	0		1	
[irem_gap] Flag for deactivating slave n	odes if element s 0: L	lefault, set to value defined in /DEFAULT/INTER/TYPE		
[[rem_⊥2] rag for deactivating the slave [Gapmin] Min. gap for impact activ. ► 1150 Bound cond deactivation	.9	eraur, set to the value defined in JUEFAUL I /IVI EKVI		
[Inacti] Stiffness deactiv. (init, penetratio	on) 0: [efault, set to value defined in /DEFAULT/INTER/TYPE		
[VisS] Critical damping coeff. on interfa	ce stiffness 0			
[VisF] Critical damping coeff. on interfa-	ce friction 0		i	
[Tstart] Start time	0			
[Tstop] Stop time	0			
[Bumult] Sorting factor	0			
[[ffric] Friction formulation [Fric] Coulomb friction	0: 9 0.2	tatic Coulomb		
[Iform] Friction penalty formulation	0: 0	efault, set to value defined in /DEFAULT/INTER/TYPE		
[Ifiltr] Friction filtering	0:1	lo filtering		
[sens_ID] Sensor to Activate/Deactivate	e the interface Nor	ie	İ	
[fct_IDf] Friction coefficient with temper	ature function id Nor	ie	I	
[AscaleF] Abscissa scale factor on FC				
Ilitric, ULFriction Identifier for friction de	Inition for select(Not	NTED group & of DADT		
■ [mast_id] Master surface (Advanced	l selector)	NER GROUP 5 OF PART		

해석 케이스 설정



0: Reduced
0: Default
0: Default
0: Default
0: Default
1: Force computation of rotational DOF
1
100
: Default
0
1
FREAC: Reaction forces for imposed velocities, displace
DPOT: Potations

<mark>1</mark> Model > Control Card클릭

2 파라미터 설정

³ 모델 export (RADIOSS 선택)



해석 실행 (RADIOSS)

<u></u>	<mark>꺹</mark> Radioss2020 실행
Radioss 2020 Provide the second seco	오 앞서 제작한 모델 불러온 뒤 Run 클릭
Input file(s): Model_01_Analysis_0000.rad Options:	
□ Use SMP: -nt 2 □ Use MPI options ☑ Use solver control □ Schedule delay Image: State of the state of	
Contour Pick Deplacement(R) 2 2345-101 2 2325-101 1 3352-100 1 3325-101 1 3355-101 1 3355-10000000000000000000000000000000000	









후처리 (3)



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Rotational DOF 선택,
 548번 절점 선택,
 Y 방향으로의 그래프 확인
 → 그래프 csv파일로 저장
 M로운 그래프 추가 후
 Displacement 선택,
 548번 절점 선택,
 X 방향으로의 그래프 확인
 → 그래프 csv파일로 저장

새로운 그래프 추가 후











FIRST ORDER ANALYSIS 빔 요소

예제: JOINT MOMENT ANALYSIS





기하형상 생성 (1)

I Untitled - HyperWorks 2020 - RadiossBlock (Radioss2020 Format) File Edit View Collectors Georgen Vesh Connectors Materials Pro	operties <u>B</u> Cs <u>S</u> etup <u>T</u> ools Morphing P <u>o</u> st <u>X</u> YPlots	Preferences Applications Help				- 0 X	🖁 User Profiles (🤦) 클릭
Sonsing Mask Madely Sales	🔣 User Profiles	>	< ¹ 6 "d" "d" "d" "d" "d" "d" "d" "d" "d" "d			- 1 of 1	
	Customize user interface:						
¶u - ¶ ¶ % % · • ¶u - №	Application: HyperMesh	•					
Name ID 🕥 Include	· · · · · · · · · · · · · · · · · · ·						· · · <u>- · ·</u>
	C Default (HyperMesh)		2				2 RADIOSS 선택
	RADIOSS	Radioss2020) <mark> </mark>				
	C OptiStruct						
	C AcuSolve						
	C Abaqus	Standard3D 🔹]				
	C Actran	, _					
	C Ansys						
	C Exodus	Sierra SD *	1				
	C FEKO						
	C LaDama		7				
	C Lisbyria	Keyword971_R11.1					
	Madymo	Madymo70 🔹					
	C Marc	Marc3D 🔹					i
	C Nastran	NastranMSC *	1				Ì
Name Value	C Pamorash	Pamcrash2G2019	i la				
	C Permas	, –					
	C Samcef		De 🔿 🔒 Balance – Rose 🔗				
				· · · · · · · · · · · · · · · · · · ·		- W -	
	✓ Always show at start-up		surfaces	solids	quick edit	Geom	
			defeature	ribs	point edit	C 2D	
		OK Cancel	midsurface		autocleanup	C 3D	
						C Tool	
A suble may defeed				r	here [C Post	
AND PETITING ANNUELED AND AND AND AND AND AND AND AND AND AN					IMODEL I		







Na	ame	Value
	Solver Keyword	/MAT/ELAST/
	ID	1
	Name	material1
	Color	
	Include	[Master Model]
Ĩ	Defined	
1	User Comments	Hide In Menu/Export
	Card Image	M1_ELAST
	Regular_OR_encrypted_flag	Regular
	RefRho_Option	
	Rho_Initial	7,85e-09
	E	206000, 0
	Nu	0,3

선형 재료 생성 Card Image: M1_ELAST Rho_Initial: 7.85e-9 E: 206 GPa Nu: 0.3

2 1차원 특성 생성 (사각 단면 구조 적용)

요소망 생성 (1)

<u> </u>			
1	ID Name Include Collector Config Section Type Standard angle Parameter Definitions Dimension a Dimension b Thickness t	1 beamsection1 [Master Model] (1) beamsectcol1 Standard HMBOX 0,0 50,0 80,0 1,6	
S	2 Solver Keyword ID Name Color Include Defined User Comments Card Image Hyperbeamsection Regular_OR_encrypted_flag	Value /PROP/BEAM/ 1 property1 Master Model] V Hide In Menu/Export P3_BEAM (1) beamsection1 Regular	
	3 Name Solver Keyword ID Name Color Include Defined User Comment Card Image	Value J /PART/ 1 auto1 [Master Model] V s Hide In Menu/Export Part (1) property1 (1) material1	



요소망 생성 (2)



1D > line mesh

lines 선택 element size : 500 입력 element config: bar2 선택 property 설정 Orientation: z-axis 설정

조인트 요소 생성 (1)

Jame	Value
Solver Keyword	/PROP/SPR_GENE/
ID	2
Name	property2
Color	
Include	[Master Model]
Defined	
User Comments	Hide In Menu/Export
Card Image	P8_SPR_GENE
Regular_OR_encrypted_flag	Regular
MASS	0,0001
Inertia	0,0001







조인트 요소 생성 (2)



조인트 요소 생성 (3)



2 양 끝단에는 temp node를 생성하여 joint를 생성함

네 군데 joint 요소 생성

Temp node: (0,0,1), (150, 1000, 1)



a 6	Brou	wsers	Ы	vperWorks	×	: 👍 👷	
(🙈 T 🛚	a Tcl	Console	Н	vperMesh	Þ	✓ Mask	
ession	HW	/C Console	Н	vperView	•	✔ Model	- L i
1 🕰	Exp	and Window	Н	vperGraph 2D	÷.	Utility	
	Pag	1e	• н	yperGraph 3D	•	Assembly	- L i
	🗸 Pan	nels	м	otionView		Comparison	Li
6 - - 9	🖌 🖌 Stat	tus Bar	м	ediaView		Aeroelasticity	
	🗄 Tab	Area	•		_	Contact	
lame 1	Too	olbars	▶ lude	🗊 🔒 👘		Part	
- 💼 M/	AT (1)					✓ Solver	
💼 PF	IOP (2)					Verification	
🖷 💼 PA	RT (2)					List	
- 💼 FU	NCT (1))				Entity State	
📰 BE	AM (3)					NVHAssembl	y 📕
📆 SF	'RING (4	l)				Connector	
						Subsystem	

Value

/BCS

BCS

Loads

All DOF

~

V

~

V

~

~

[Master Model]

<Unspecified>

Hide In Menu/E

<Unspecified>

Non Weighted Constraint

Create

Edit

Review

Show

Hide

Isolate Only

References

Filter entities

Warn upon entity type change

Create/Edit

lame

ID.

Include Engineering type

Туре

Title

DOF1

DOF2

DOF3

DOF4

DOF5

DOF6

skew_ID

grnd_ID

Solver Keyword

User Comments

Constraint Type





Name

ID.

구속조건 설정 (2)

Name	Value
Solver Keyword	/BCS
ID	2
Include	[Master Model]
Engineering type	Non Weighted Constraint
Туре	BCS
grnd_ID	<unspecified></unspecified>
Title	SPC
User Comments	Hide In Menu/Export
Constraint Type	All DOF
DOF1	
DOF2	
DOF3	
DOF4	
DOF5	
DOF6	



같은 방법으로 반대편 절점은 DOF2 제외하고 모두 구속

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변위 조건 설정 (1)

Name

Title User Comments fct_ID(T) Dir

Solver Keyword ID Include Engineering type Type grnd_ID

System Input Type skew_ID sens_ID icoor

0,0

Ascale(X)

Fscale(Y)

Tstart

Tstop

s Mate	eria <u>ls P</u> roperties E	▲ Include File	Post XYPlots Preferen	cet		S	olver MPDI	탭 우 [.] SP 생	클릭전 성	하여	
•	· · · · · · · · · · · · · · · · · · ·	BOUNDARY CONDITIONS	BCS LAGMUL CLOAD (Force) CLOAD (Moment) CONVEC GRAV IMPACC IMPDISP ECEO	1			fct_ID 간-번	(T) 우 변위 혐	.클릭 밝수 (하여 생성	
	eate kpand All bilapse All bilapse All bilapse r bilapse Plot bilaps	AMS BOX CNODE CLUSTER DAMP DEFENSE EBCS FAIL FRAME FRICTION	IMPFLUX IMPTEMP IMPVEL_FGEO INITEMP INIVEL INIVEL_AXIS PLOAD RADIATION								
/alue /IMPDISP			Curve editor								
s [Master Model] Weighted Constraint MPDISP (Unspecified> _oads Hide In Menu/Export			Curre List: Curve J curve 2	1 2	-50-						c
<pre></pre> Skew System	Create Create/Edit Edit Plot Curve		X 0.0 0.1	¥ *	-100-						
): Cartesian coordina	Review										-



변위 조건 설정 (2)

Na	ime	Value			
	Solver Keyword	/IMPDISP			
	ID	3			
	Include	[Master Model]			
	Engineering type	Weighted Constraint			
)_	Туре	IMPDISP			
	grnd_ID	<unspecified></unspecified>			
	Title	Loads			
	User Comments	Hide In Menu/Export			
s mg	fct_ID(T)	(2) curve2			
)2/_	Dir	Υ			
	System Input Type	Skew System			
	skew_ID	<unspecified></unspecified>			
	sens_ID	<unspecified></unspecified>			
	icoor	0: Cartesian coordinates			
	Ascale(X)				
	Fscale(Y)				
	Tstart	0,0			
	Tstop				



해석 케이스 설정





<u>m</u>	
	\$ 1 1
File selection	
File type:	RADIOSS
Template:	Radioss2020 💌
File:	C:\Users\Namhee\Desktop\week12_1D_Beam\Week12_1D_Beam_0000.rad
🖙 Export optic	ons
Export:	Custom Select Entities
🗖 Export n	nodified onlySelect Includes
Solver option	s: Select Options

$\widehat{\mathbf{m}}$	<u>}</u>										
)2	HyperWorks	Solver Run I	Manager (@	DESKTOP	-J07RQSL)				- (×
4	ile <u>E</u> dit <u>V</u> iew	<u>L</u> ogs <u>S</u> o	olver Co-s	i <u>m</u> ulation	Hyper <u>W</u> orks	<u>H</u> elp					
ł	Input file(s):	Week12_1D	_Beam_000	0.rad							1
(Options:										
0	Use SMP: -nt	2 🗌 (Use MPI opt	tions [☑ Use solver c	ontrol	Schedule delay	r			
	8							Run	(Close	

모델 export

2 Radioss에서 해석 실행





MID RAIL ANALYSIS 쉘 요소

모델 불러오기



재료 물성 입력 (1)

616	Review) I		
6	Create New	Airbag material		▶
	Create Template	Composite and Fabric		▶
X	Delete	Connection		▶
	Clone	Elastic and Hyperelast	tic	•
l	Cross Reference	Elasto-plastic		Johnson-Cook (2)
	Lock	Honeycomb		 Zerilli-Armstrong (2)
	UnLock	Hydrodynamic		 Hyd. Elasto-plastic (3)
	Move entity(s) to	Rock and Concrete		Hyd. Johnson-Cook (4)
	See in Browser	Visco-elastic		 Ductile damage (22)
	Group Selected Rows	s Fluid		 Ductile damage (23)
-		Non turbulent flow	Ĩ	Plastic brittle for shell (27)
		Turbulent flow	۲.,	Hill orthotropic (32)
		Other		Piecewise linear (36)
		User Material		Hill ortho. tab. (43)
			_	Cowper-Symonds (44)
				Zhao (48)

PLAS TAB	
8	
D	2
Title	New MAT 2
Local Unit System	None
[RHO_] Initial density*	7.85E-6 2
[RHO_0] Reference density	0
[E] Young's modulus*	206
[Nu] Poisson's ratio*	.3
[Eps_p_max] Failure plastic strain	0
[Eps_t] Tensile failure strain	0
[Eps_m] Tensile failure strain	0
[C_hard] Hardening coefficient	0
[F_smooth] Strain rate smoothing	
[F_cut] Cutoff frequency for strain rate filtering	0
[Eps_f] Maximum tensile failure strain	0
[VP] Strain rate choice flag	0: Strain rate are total strain rate
[fct_IDp] Pressure vs. yield factor function	None
[Fscale] Y-Scale factor for yield factor function	1
[Fct_IDE] Function identifier for the scale factor of You	None
[EInf] Saturated Young's modulus for infinitive plastic s	0
[CE] Parameter for Young's modulus evolution	0
Heat	

Piecewise linear(36) 재료 생성 2 재료 물성치 입력 [RHO_I]: 7.85e-6 [E]: 240 [Nu]: 0.3 3

재료 물성 입력 (2)



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SHELL						
D		2				
Title		New PROP 2				
Local Unit System		None				
[Ismstr] Flag for shell small strain form	ulation	0: Use value in /DE	EF_SHELL			
[Ishell] Flag for 4 node shell element for	ormulation	0: Use value in /DE	EF_SHELL			
[Ish3n] Flag for 3 node shell element for	ormulation	0: use value in /DE	F_SHELL			
[Idrill] Flag for drilling degree of freedo	m stiffness	0: No				
[P_thick_fail] Percentage of through th	ickness integration	0				
[hm] Shell membrane hourglass coeffi	cient	0				
[hf] Shell out of plane hourglass		0				
[hr] Shell rotation hourglass coefficien	t	0				
[dm] Shell membrane damping		0				
[dn] Shell numerical damping		0				
[N] Number of integration points throug	gh the thickness	0				
[Istrain] Flag to compute strains for po	st-processing	0: Use val				
[Thick] Shell thickness*		1.6 1				
[Ashear] Shear factor		0				
[Ithick] Flag for shell resultant stresses	s calculation	0: Default set to value defined with /DEF_SHELL				
[lplas] Flag for shell plane stress plast	icity	0: Default mix value defined with /DEF_SHELL				
Support*		1 items 2				
Close	Sa	ve	Cancel			



RBE2 생성



구속조건 설정 (1)



구속조건 설정 (2)

B	CS	
ID)	2
Т	tle	New BCS 2
A	LE formul.	
	agrange mult. formul.	
$\left\{ \cdot \right\}$	Translation	
	[TX] X translation	
Y	[TY] Y translation	
	[TZ] Z translation	
~	Rotation	
	[RX] X rotation	
- i.	[RY] Y rotation	
	[RZ] Z rotation	
[5	Skew_id] Skew	None
[C	Gnod_id] Support*	1 items
		\mathbf{X}
		\mathbf{X}

강체 중심 절점은 Y 방향 구 속조건을 제외한 모든 자유 도 구속 (Tx,Tz,Rx,Ry,Rz 구속)



변위조건 설정



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접촉조건 설정

LoadCase RADIOSS Tools Data History Added Mass Boundary Condition F Concentrated Load Contact Interface	 Review Create New Create Template Delete Data History Clone 	 ALE/Lagrange with sliding (Type 1) Kinematic condition (Type 2) Surface/Surface(Type 3) Nodes/Surface (Type 5) Rigid body/Rigid body (Type 6) 	LoadCase > Contact Interface클릭, 나마우스 우클릭 후 "Multi usage (Type 7) 클릭
Prez D Title Self Impact Local Unit System Formulation [Istf] Stiffness definition [Ithe] Heat contact [Igap] Gap/element option [Fpenmax] Maximum fraction of initial [Ibag] Vent hole closure when contact [Ide]] Node and segment deletion [Icury] Slave gap with curvature [Ide]] Local curvature flag [Stfac] Scale factor for stiffness [Ithm] Dccal curvature flag [Stfac] Scale factor for stiffness [Ithm] Dccal curvature flag [Ithm] Scale for deactivating the slaw [Gapmin] Min. gap for impact activ. > [I_GC] Bound cond. deactivation [Inact] Stiffness deactiv. (init. penetrin [VisS] Critical damping coeff. on inter [VisS] Critical damping coeff. on the inter [VisS] Critical damping coeff. on inter [VisS] Critical damping coeff. o		e defined in /DEFAULT/INTER/TYPE e defined in /DEFAULT/INTER/TYPE e defined in /DEFAULT/INTER/TYPE e defined in /DEFAULT/INTER/TYPE e defined in /DEFAULT/INTER/TYPE raiwe defined in /DEFAULT/INTER/TYPE e defined in /DEFAULT/INTER/TYPE	Sen Impact 세그 [Stfac] : 1 [Gapmin]: 0.9 [Fric]: 0.2 [Mast_id]: 모델 선택

해석 케이스 설정

Model LoadCase RADIOSS Tools Dat	2		i 🎬 Model > Control Card클릭
t∰ Browser ◆ Part ✓ Material	RUN_NAME_NUMBER_LETTER RUN_NAME_NUMBER_LETTER Run Number [DT_STOP] Final time for run Restart letter	1 100 : Default	2 파라미터 설정
Add to Material Friction Function Function 2D Function Scale and Shift	ANIM_DT ANIM_DT [TSTART] Start time [TFREQ] Time frequency	0 1	<mark>∛</mark> 모델 export (RADIOSS 선택)
🚭 Control Card	ANIM_VECT ANIM_VECT_RESTYPE_SUPPORT Variable name to be saved in animation file*	FREAC: Reaction forces for imposed velocities, displace	









