Frequency Response 해석

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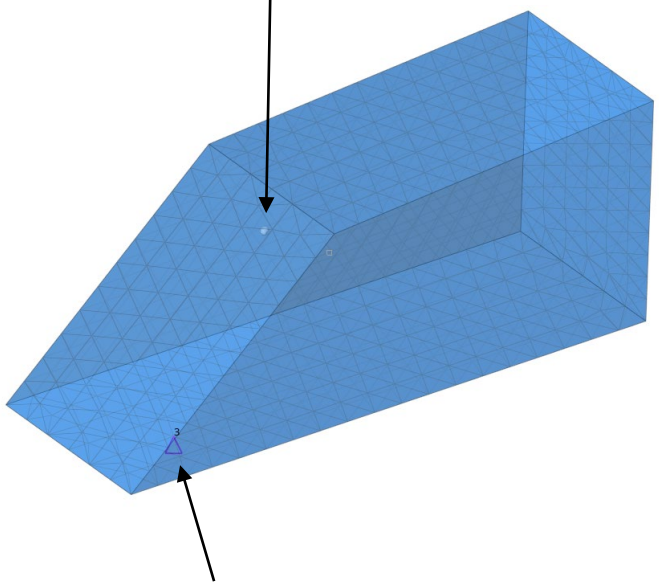
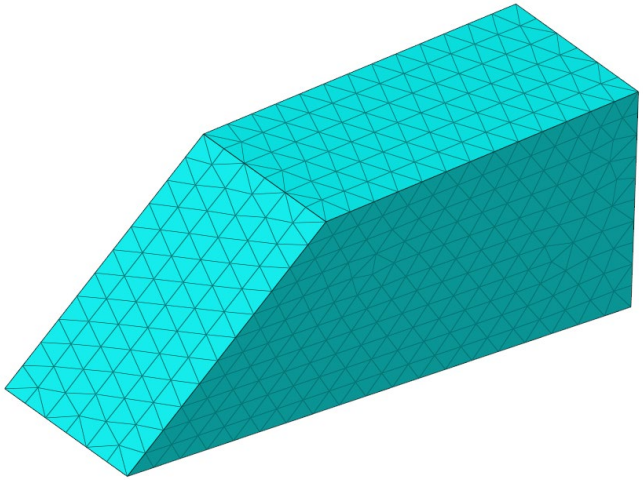
ACOUSTIC ANALYSIS OF A HALF CAR MODEL

Location near the ear of driver

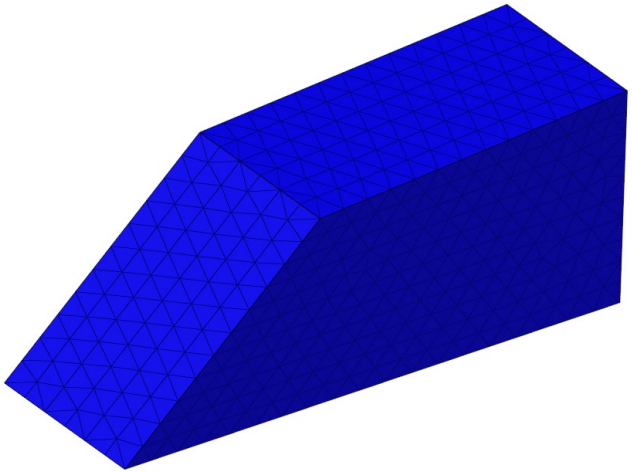


Force

Outside: Solid
(2D shell elements)



Inside: Air
(3D elements)



COUPLED FREQUENCY RESPONSE ANALYSIS

$\frac{1}{\rho}\nabla p + \ddot{\mathbf{u}} = 0$ Inviscid flow (linear pressure-density relation)

$p + \beta(\nabla \cdot \mathbf{u}) = 0$ Continuity equation

Governing equation of the fluid domain

$$\frac{\ddot{p}}{\beta} - \frac{1}{\rho}\nabla^2 p = 0$$

p : Pressure of fluid domain

β : Compressibility of fluid domain

$\mathbf{u}$: Displacement of structural domain

ρ : Density of structural domain

Effect of structure on the fluid domain

$$\mathbf{M}_F\ddot{p} + \mathbf{C}_F\dot{p} + \mathbf{K}_F p - \mathbf{A}_{int}\ddot{\mathbf{u}} = \mathbf{s}_F$$

Effect of fluid on the structural domain

$$\mathbf{M}_S\ddot{\mathbf{u}} + \mathbf{C}_S\dot{\mathbf{u}} + \mathbf{K}_S\mathbf{u} - \mathbf{A}_{int}^T p = \mathbf{s}_S$$

$$\begin{bmatrix} \mathbf{M}_S & 0 \\ -\mathbf{A}_{int} & \mathbf{M}_F \end{bmatrix}\begin{bmatrix} \ddot{\mathbf{u}} \\ \ddot{p} \end{bmatrix} + \begin{bmatrix} \mathbf{C}_S & 0 \\ 0 & \mathbf{C}_F \end{bmatrix}\begin{bmatrix} \dot{\mathbf{u}} \\ \dot{p} \end{bmatrix} + \begin{bmatrix} \mathbf{K}_S & \mathbf{A}_{int}^T \\ 0 & \mathbf{K}_F \end{bmatrix}\begin{bmatrix} \mathbf{u} \\ p \end{bmatrix} = \begin{bmatrix} \mathbf{s}_S \\ \mathbf{s}_F \end{bmatrix}$$

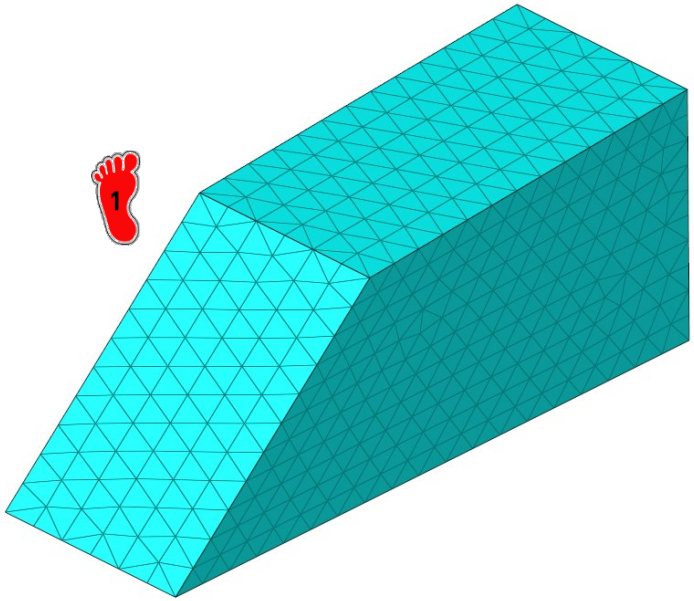
	Fluid	Structure
Mass matrix	$\mathbf{M}_F$	$\mathbf{M}_S$
Damping matrix	$\mathbf{C}_F$	$\mathbf{C}_S$
Stiffness matrix	$\mathbf{K}_F$	$\mathbf{K}_S$
Source vector	$\mathbf{s}_F$	$\mathbf{s}_S$

$\mathbf{A}_{int}$: Interface matrix

$\ddot{\mathbf{u}}$: Acceleration of the structural grids at the fluid-structure interface

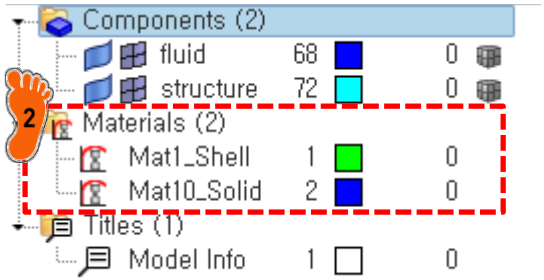
p : Pressure of the fluid grids at the fluid-structure interface

정적하중조건 설정 (1)



1 "Half_Car.hm" 불러오기

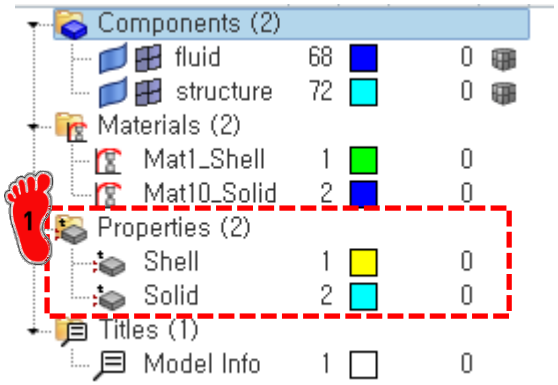
2 재료 생성 후 물성치 입력



Name	Value
Solver Keyword	MAT1
Name	Mat1_Shell
ID	1
Color	
Include	[Master Model]
Defined	☑
Card Image	MAT1
User Comments	Hide In Menu/Export
E	210000,0
G	
NU	0,3
RHO	7,85e-09

Name	Value
Solver Keyword	MAT10
Name	Mat10_Solid
ID	2
Color	
Include	[Master Model]
Defined	☑
Card Image	MAT10
User Comments	Hide In Menu/Export
BULK	
RHO	1,2e-12
C	343000,0

정적하중조건 설정 (2)



Name	Value
Solver Keyword	PSHELL
Name	Shell
ID	1
Color	
Include	[Master Model]
Defined	☑
Card Image	PSHELL
⊞ Material	(1) Mat1_Shell
User Comments	Hide In Menu/Export
T	2.0
MID2	1
MID2_opts	☐
I12_T3	

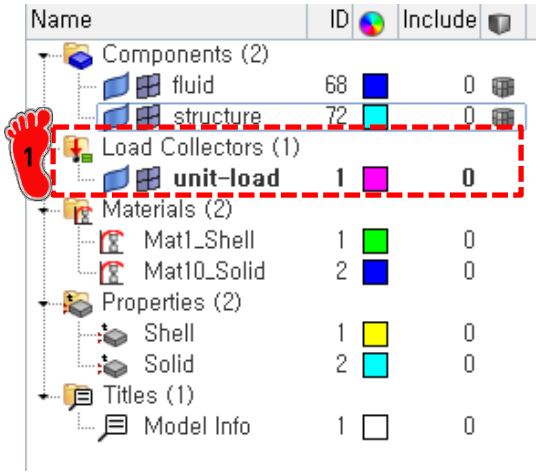
Name	Value
Solver Keyword	PSOLID
Name	Solid
ID	2
Color	
Include	[Master Model]
Defined	☑
Card Image	PSOLID
⊞ Material	(2) Mat10_Solid
User Comments	Hide In Menu/Export
CORDM options	BLANK
ISOP	
FCTN	PFLUID
HOURGLS_OPT	☐
PSOLIDX	☐

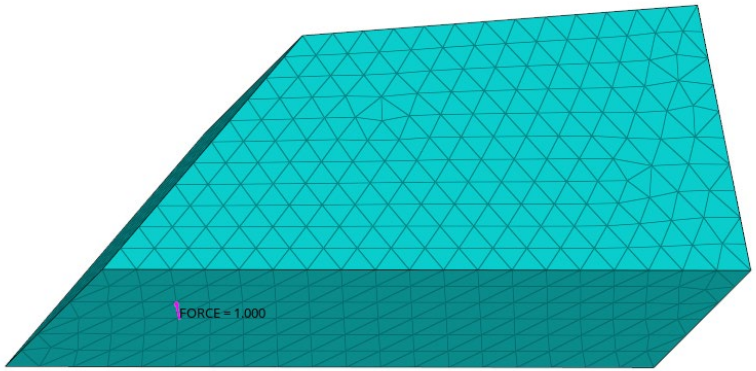
1 Property 생성 후 재료 반영
(1) PSHELL
→ T=2.0 입력

(2) PSOLID
→ FCTN: PFLUID 선택

각 components에 생성한 property 부여

주파수 의존함수 입력

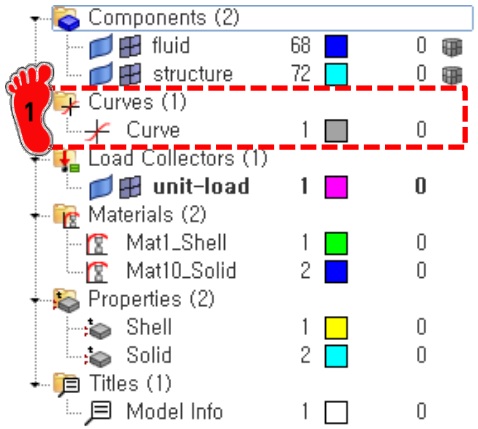


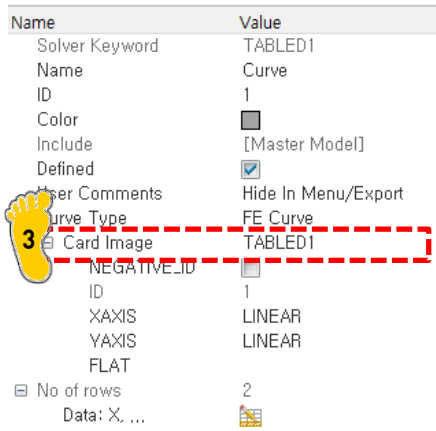


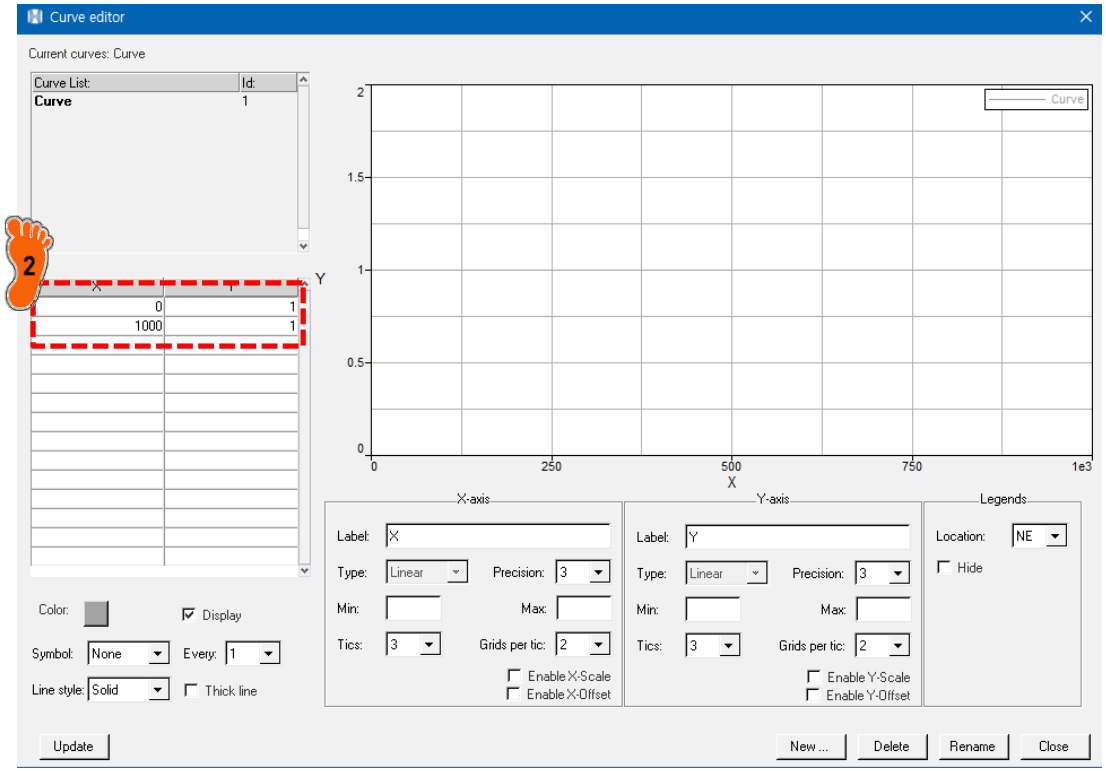
1 Load collector 생성

2 Node id: 10972
Z 방향 1N 하중 부여

동적하중조건으로 변환





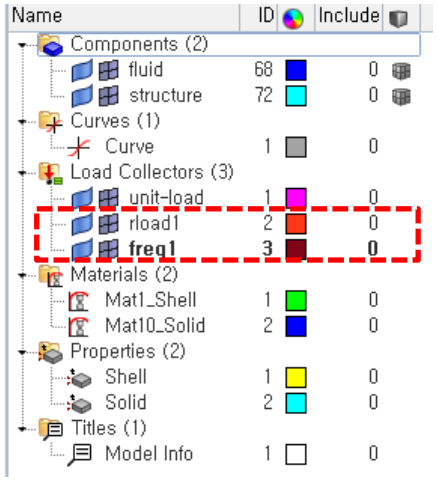


1 Curve 생성

2 (X,Y): (0,1), (1000,1) 입력

3 Card image: TABLED1 선택

해석 케이스 설정 (1)



Name	Value
Solver Keyword	RLOAD1
Name	rload1
ID	2
Color	
Include	[Master Model]
Card Image	RLOAD1
User Comments	Hide In Menu/Export
⊞ EXCITEID	(1) unit-load
⊟ DELAY_OPTION	
DELAY	
⊟ DPHASE_OPTION	
DPHASE	
⊞ TC	(1) Curve
TD	<Unspecified>
TYPE	

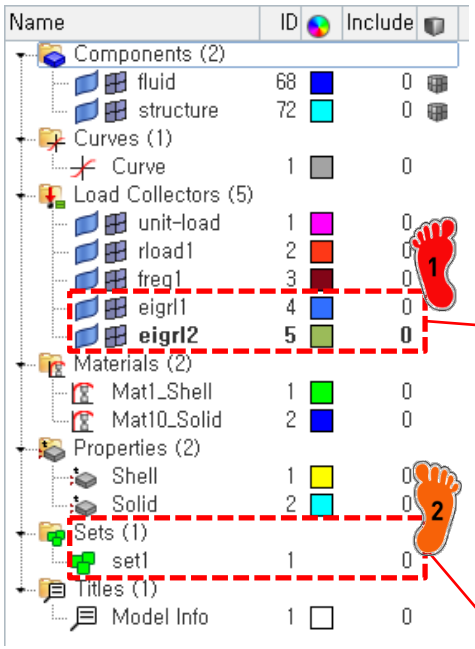
Name	Value
Name	freq1
ID	3
Color	
Include	[Master Model]
Card Image	FREQi
User Comments	Hide In Menu/Export
FREQ	☐
⊟ FREQ1	☑
⊟ NUMBER_OF_FREQ1 =	1
ID	3
F1	0.0
DF	1.0
NDF	200
FREQ2	☐
FREQ3	☐
FREQ4	☐
FREQ5	☐

1 Load collectors 생성

2 (1) RLOAD1
→ EXCITED: unit-load 선택
TC: Curve 선택

(2) FREQi
→ FREQ1 체크
F1:0, DF:1, NDF:200 입력

해석 케이스 설정 (2)



Name	Value
Solver Keyword	EIGRL
Name	eigrl1
ID	4
Color	
Include	[Master Model]
Card Image	EIGRL
User Comments	Hide In Menu/Export
V1	
V2	600.0
ND	50
MSGLVL	
MAXSET	
SHFSCL	
NORM	MASS

Name	Value
Solver Keyword	SET
Name	set1
ID	1
Include	[Master Model]
Defined	☑
Card Image	SET_GRID
Set Type	non-ordered
Entity IDs	1 Nodes
User Comments	Hide In Menu/Export
TYPE	GRID
SUBTYPE	LIST
No of rows	1
ID	18881

1 Load collectors 두 개 생성

→ Card image: EIGRL
V1: 600, ND: 50 입력

2 Set 생성

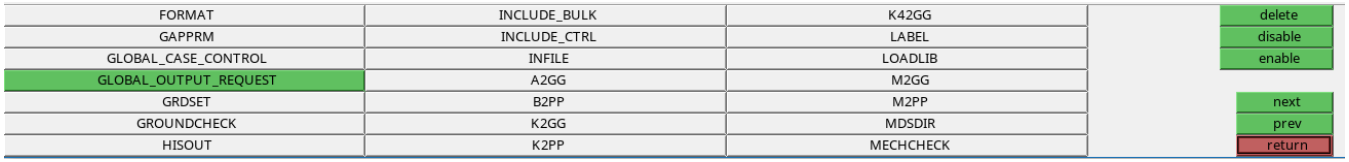
→ Card image: SET_GRID
Entity IDs: Node id
18881 추가

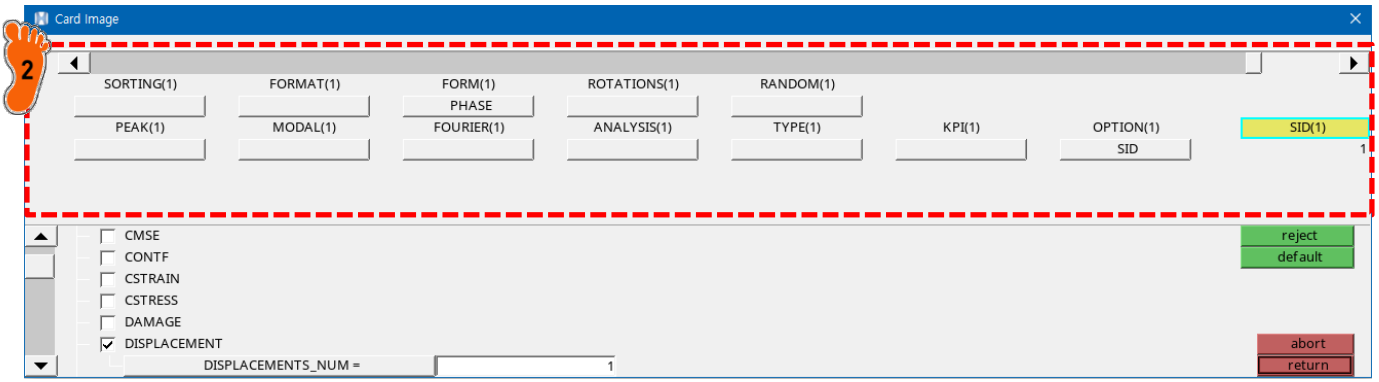
해석 케이스 설정 (4)

Name	Value
Solver Keyword	SUBCASE
Name	subcase1
ID	1
Include	[Master Model]
User Comments	Hide In Menu/Export
Subcase Definition	
Analysis type	Freq. resp (modal)
SPC	<Unspecified>
SUPORT1	<Unspecified>
DLOAD	(2) rload1
MPC	<Unspecified>
METHOD (STRUCT)	(4) eigrl1
METHOD (FLUID)	(5) eigrl2
FREQ	(3) freq1
SDAMPING (STRUCT)	<Unspecified>
SDAMPING (FLUID)	<Unspecified>
STATSUB (PRELOAD)	<Unspecified>

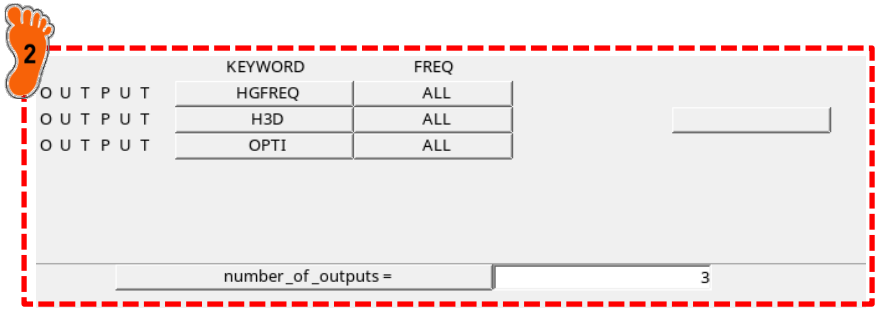
1 Load step 생성
Analysis type: Freq. resp (modal)
DLOAD: rload1
METHOD(STRUCT): eigrl1
METHOD(FLUID): eigrl2
FREQ: freq1

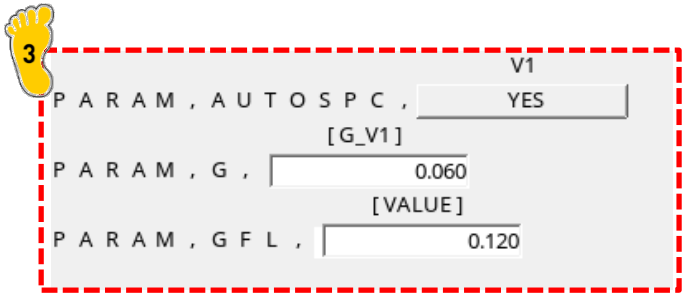
2 Control card → GLOBAL OUTPUT REQUEST 클릭
→ DISPLACEMENT 클릭
→ Form(1): PHASE 선택
OPTIONS(1): SID 선택
SID(1): SET 선택





해석 케이스 설정 (5)





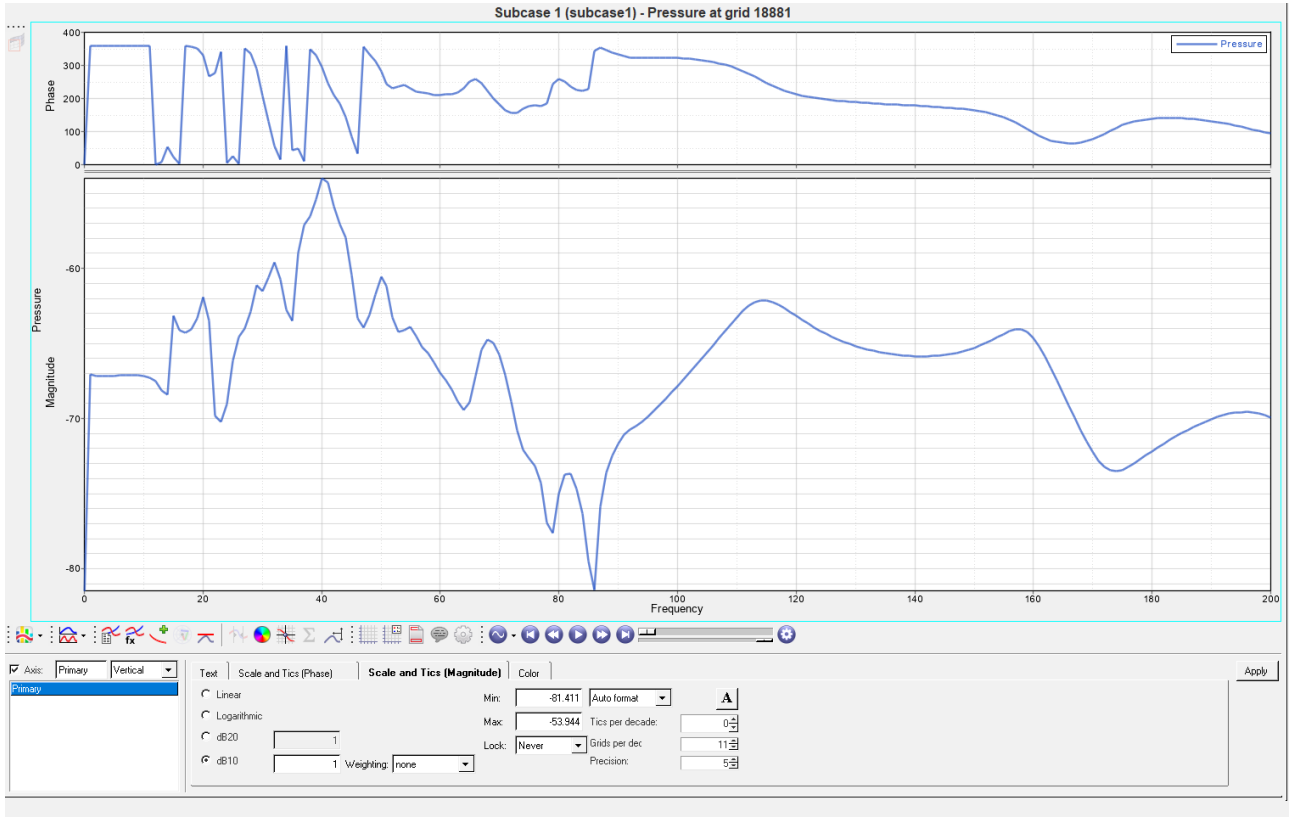
Control cards에서 다음과 같은 항목 선택

1 ACMDL 설정
→Inter: Diff 선택
INFOR: ALL 선택

2 OUTPUT 설정

3 PARAM 설정
→ AUTOSPC: YES 선택
G: 0.06 입력
GFL: 0.12 입력
(균일 감쇠 계수)

해석 케이스 설정 (6)



1 Nodes로 바꾼 후 한번 더 클릭

2 그림처럼 해석을 진행할 node 선택한 후 proceed