FrontISTR Analysis Flow Manual

FrontISTR Commons

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Contents

1 FrontISTR Analysis Flow Manual

This software is the outcome of “Research and Development of Innovative Simulation Software” project supported by Research and Development for Next-generation Information Technology of Ministry of Education, Culture, Sports, Science and Technology.

Item	Content
Name of Software	FrontISTR
Version	5.6
License	MIT License
Correnponding Clerks	FrontISTR Commons2-11-16 Yayoi, Bunkyo-ku, Tokyoc/o Institute of Engineering Innovation, School of EngineeringE-mail : support@frontistr.org

1.1 Manuals

- Introduction

- How to install
- Theory
- User's manual
- Tutorial
- FAQ

This manual describes the analysis method by the finite element method (FEM) used in FrontISTR.

Regarding the stress analysis method of solids, the infinitesimal deformation linear elasticity static analyais method is described first, and geometric nonlinear analysis method and elastoplasticity analysis method which are required when handling finite deformation problems are described next. Furthermore, a summarized evaluation method of the facture mechanics parameters which can be acquired using the results of the stress analysis by FEM is described. Finally, th eigenvalue analysis and heat conduction analysis method is described.

1.2 List of description on this manual

- Analysis Flow, Input File, Output File (new manual)
- User Subroutines (new manual) ## Overall Control Data

Individual header descriptions have been moved to the new manual. Only overviews and data definition examples are provided here.

1.2.1 Outline of Overall Control Data

The overall control data is for defining the file name of the input/output files for FrontISTR. The features of the overall control data file are as follows.

- This is an ASCII format file based on a free format.
- This file consists of a header which starts with "!" and the data following this.
- The order of description of the header is basically free.
- A "," is used as a punctuation mark of the data.

1.2.2 Input Rules

The overall control data file consists of a header line, data line and a comment line. One header is always included in the header line.

Header The meaning of the data and data block is specified in the overall control data file.
When the head of the term starts with a "!", it is considered to be a header.

Header Line The header and the parameter accompanying this are described in this line.
The header line must start with a header.
When a parameter is required, a "," must be used to continue after that.
When the parameter takes on a value, use an "=" after the parameter and describe the value after that.

Data Line The data line starts from the next line of the header line, and the necessary data is described.
The data lines may be in multiple lines; however, this is determined according to the rules of the data description defined by each header.
There are cases where data lines are not required.

Punctuation A comma "," is used as a punctuation of the data.

Handling of Blanks Blanks are disregarded.

Name Regarding the characters which can be used for the name, there is the underscore "_", hyphen "−", and alphanumeric characters "a − z, A − Z, 0 − 9"; however, the first letter of the name must start with "_", or an alphabetic character "a − z, A − Z".
There is no distinction between uppercase and lowercase letters, and all letters are internally handled as uppercase letters.
The maximum length of the name is 63 characters.

File Name Regarding the characters which can be used for the file name, there are the underscore "_", hyphen "−", period ".", slash "/", and the alphanumeric characters "a − z, A − Z, 0 − 9".
As long as there is no specific description, a path can be included in the file name. Both the relative path and the absolute path can be specified.
The maximum length of the file name is 1,023 characters.

Floating Point Data Exponents are optional. An "E" or "e" character must be added before the exponent.
The selection of "E" or "e" is optional. "D" or "d" can not be used.

!!, # Comment Line Lines starting with "!!" or "#" are considered to be comment lines, and are disregarded. A comment line can be inserted in any position in the file, and there are no restrictions on the number of lines.

1.2.3 Header List

The overall control data consists of the following headers.

Header Name	Contents
!CONTROL	Analysis control data definition
!MESH	Mesh data definition
!RESTART	Restart data definition
!RESULT	Analysis results data definition
!SUBDIR	Dividing to sub directories

1.3 Single Domain Mesh Data

Individual header descriptions have been moved to the new manual. Only overviews and data definition examples are provided here.

1.3.1 Outline of Single Mesh Data

In order to acquire the mesh data of FrontISTR, there are two methods, such as the method to input the single domain mesh data file, and the method to input the distributed mesh data file to perform parallel processing. Single domain mesh data is described in this section.

The features of single domain mesh data are as follows.

- This is an ASCII format file based on a free format.
- This file consists of a header which starts with "!" and the data following this.
- The order of description of the header is basically free.
- A "," is used as a punctuation mark of the data.

1.3.2 Input Rules

The single domain mesh data file consists of a header line, data line and a comment line. One header is always included in the header line.

Header The meaning of the data and data block is specified in the single domain mesh data file.
When the head of the term starts with a "!", it is considered to be a header.

Header Line The contents of the header and the parameter accompanying this are described in this line.
The header line must start with a header. When a parameter is required, a "," must be used to continue after that.
When the parameter takes on a value, use an "=" after the parameter and describe the value after that. The header line can not be described in more than two lines.

Data Line The data line starts after the header line, and the necessary data is described.
The data lines may be in multiple lines; however, this is determined according to the rules of the data description defined by each header.
There are cases where data lines are not required.

Punctuation A comma "," is used as a punctuation of the data.

Handling of Blanks Blanks are disregarded.

Name Regarding the characters which can be used for the name, there is the underscore "_", hyphen "−", and alphanumeric characters "a − z, A − Z, 0 − 9"; however, the first letter of the name must start with "_", or an alphabetic character "a − z, A − Z". There is no distinction between uppercase and lowercase letters, and all letters are internally handled as uppercase letters.
The maximum length of the name is 63 characters.

File Name Regarding the characters which can be used for the file name, there are the underscore "_", hyphen "−", period ".", slash "/", and the alphanumeric characters "a − z, A − Z, 0 − 9".
As long as there is no specific description, a path can be included in the file name. Both the relative path and the absolute path can be specified.
The maximum length of the file name is 1,023 characters.

Floating Point Data Exponents are optional. An “E” or “e” character must be added before the exponent. The selection of “E” or “e” is optional. “D” or “d” can not be used.

!!, # Comment Line Lines starting with “!!” or “#” are considered to be comment lines, and are disregarded. A comment line can be inserted in any position in the file, and there are no restrictions on the number of lines.

1.3.3 Header List of Single Domain Mesh Data

The single domain mesh data consists of the following headers.

Header Name	Contents	Description No.
!AMPLITUDE	Unsteady load	M1-1
!EGROUP	Element group	M1-2
!ELEMENT	Element information	M1-3
!EQUATION	Restricted point data	M1-4
!HEADER	Title of mesh data	M1-5
!MATERIAL	Material information	M1-6
!NGROUP	Node group	M1-7
!NODE	Node information	M1-8
!SECTION	Section information	M1-9
!SGROUP	Surface group	M1-10
!ZERO	Absolute zero-point	M1-11
!CONTACT PAIR	Contact surface pair	M1-12
!END	Read end	M1-13

In each header, there are data items which are compatible to the parameter and each header.

Each of the above headers is briefly described in the following with examples of data creation. The number indicated on the right end of the data creation is the description number of the above Table.

1.3.3.1 Example of Mesh Data

```
!HEADER                                                    M1–5
  TEST MODEL CTLR10

!NODE                                                      M1–8
  1, 0.00000E+00, 0.00000E+00, 0.00000E+00
  2, 0.50000E+01, 0.00000E+00, 0.00000E+00
  3, 0.10000E+02, 0.00000E+00, 0.00000E+00
  .. ...          ...          ...

!ELEMENT,TYPE=351                                          M1–3
  1, 1, 2, 4, 34, 35, 37
  2, 2, 5, 4, 35, 38, 37
  3, 2, 3, 5, 35, 36, 38

!SECTION, TYPE=SOLID, EGRP=ALL, MATERIAL=M1                M1–9
  1.0

!MATERIAL, NAME=M1, ITEM=2                                 M1–6
!ITEM=1, SUBITEM=2
  2.1E5, 0.3
!ITEM=2, SUBITEM=1
7.8e–6

!NGROUP, NGRP=FIX, GENERATE                                M1–7
  2 , 2 , 1
  3 , 3 , 1
  1 , 1 , 1
```

```
  69  , 69  , 1
  67  , 67  , 1

!NGROUP, NGRP=CL1                                    M1-8
  50

!END                                                 M1-13
```

1.4 Analysis Control Data

Individual header descriptions have been moved to the new manual. Only overviews and data definition examples are provided here.

1.4.1 Outline of Analysis Control Data

In FrontISTR, an analysis control data file is input to acquire the computing control data, solver control data and post process (visualization) control data as shown in the following figure, in order to implement the analytical calculations.

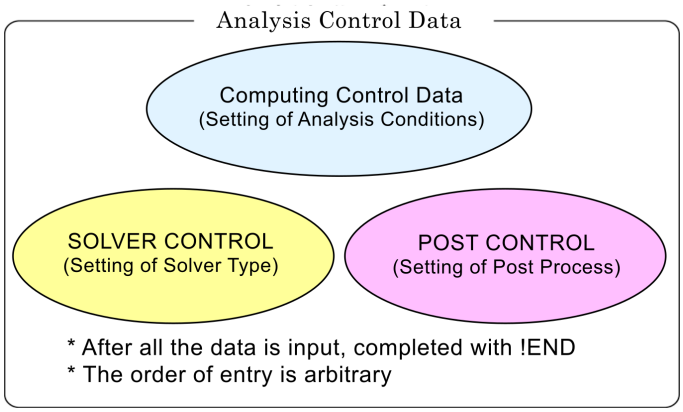

Figure 1: Analysis Control Data

The features of the analysis control data file are as follows.

- This is an ASCII format file based on a free format.
- This file consists of a header which starts with "!" and the data following this.
- The order of description of the header is basically free.
- A "," is used as a punctuation mark of the data.
- The inside of the file is briefly divided into three zones.
- "!END" is input at the end of the file for completion.

Example of Analysis Control Data

```
##################################################################
##### (1) Computing control data portion #####################
##################################################################
### Control File for HEAT solver
!SOLUTION,TYPE=HEAT
!FIXTEMP
 XMIN, 0.0
 XMAX, 500.0

##################################################################
##### (2) Solver control data portion ########################
##################################################################
### Solver Control
!SOLVER,METHOD=1,PRECOND=1,ITERLOG=NO,TIMELOG=NO
100, 1
1.0e-8,1.0,0.0
```

```
#####################################################################
##### (3) Post control (visualization) data portion #########
#####################################################################
### Post Control
!WRITE,RESULT
!WRITE,VISUAL
!VISUAL, method=PSR
!surface_num = 1
!surface 1
!surface_style = 1
!display_method 1
!color_comp_name = TEMPERATURE
!color_subcomp = 1
!output_type = BMP
!x_resolution = 500
!y_resolution = 500
!num_of_lights = 1
!position_of_lights =
-20.0, 5.8, 80.0
!viewpoint = -20.0 10.0 8.0
!up_direction = 0.0 0.0 1.0
!ambient_coef= 0.3
!diffuse_coef= 0.7
!specular_coef= 0.5
!color_mapping_style= 1
!!interval_mapping= -0.01, 0.02
!color_mapping_bar_on = 1
!scale_marking_on = 1
!num_of_scale = 5
!font_size = 1.5
!font_color = 1.0 1.0 1.0
!END
```

1.4.2 Input Rules

The analysis control data consists of a header line, data line and a comment line.

One header is always included in the header line.

Header The header specifies the meaning of the data and the data block in the analysis control data. When the head of the term starts with a "!", it is considered to be a header.

Header Line The header and the parameter accompanying this are described in this line.
The header line must start with a header. When a parameter is required, a "," must be used to continue after that. When the parameter takes on a value, use an "=" after the parameter and describe the value after that.
The header line can not be described in more than two lines.

Data Line The data line starts after the header line, and the necessary data is described.
The data lines may be in multiple lines; however, this is determined according to the rules of the data description defined by each header.
There are cases where data lines are not required.

Punctuation A comma "," is used as a punctuation of the data.

Handling of Blanks Blanks are disregarded.

Name Regarding the characters which can be used for the name, there is the underscore "_", hyphen "−", and alphanumeric characters "a − z, A − Z, 0 − 9"; however, the first letter of the name must start with "_", or an alphabetic character "a − z, A − Z". There is no distinction between uppercase and lowercase letters, and all letters are internally handled as uppercase letters.
The maximum length of the name is 63 characters.

File Name Regarding the characters which can be used for the file name, there are the underscore "_", hyphen "−", period ".", slash "/", and the alphanumeric characters "a − z, A − Z, 0 − 9".

As long as there is no specific description, a path can be included in the file name. Both the relative path and the absolute path can be specified.
The maximum length of the file name is 1,023 characters.

Floating Point Data Exponents are optional. An "E" or "e" character must be added before the exponent. The selection of "E" or "e" is optional.

!!, #, Comment Line Lines starting with "!!" or "#" are considered to be comment lines, and are disregarded. A comment line can be inserted in any position in the file, and there are no restrictions on the number of lines.

!END End of mesh data
When this header is displayed, the reading of the mesh data is completed.

1.4.3 Analysis Control Data

1.4.3.1 Header List of Computing Control Data

In FrontISTR, the following items can be mentioned as the boundary conditions which can be used for the computing control data.

- Distributed load conditions (body force, pressure loading, gravity, centrifugal force)
- Concentrated load conditions
- Heat load
- Single point restriction conditions (SPC conditions)
- Spring boundary conditions
- Contact
- Concentrated heat flux
- Distributed heat flux
- Convective heat transfer boundary
- Radiant heat transfer boundary
- Specified temperature boundary

The same as the mesh data, the !HEADER format is used as the definition method of the above boundary conditions.

The header list of the common control data is shown in the following Table 7.3.1, and the header list for each analysis type is shown in Table 7.3.2.

Table 7.3.1: Control Data Common to All Analysis

Header	Meaning	Remarks	Description No.
!VERSION	Solver version number		1-1
!SOLUTION	Specification of analysis type	Mandatory	1-2
!WRITE,VISUAL	Specification of visualization output		1-3
!WRITE,RESULT	Specification of results output		1-4
!WRITE,LOG	Specification of results output		1-5
!OUTPUT_VIS	Control of visualization output items		1-6
!OUTPUT_RES	Control of results output items		1-7
!RESTART	Control of restarting		1-8
!ECHO	Echo output		1-9
!ORIENTATION	Definition of local coordinate system		1-10
!SECTION	Definition of local coordinate system the sction correspondent to		1-11
!INITIAL_CONDITION	Definition of initial condition		1-12
!END	Ending specification of control data		1-13

Table 7.3.2: Control Data for Static Analysis

Header	Meaning	Remarks	Description No.
!STATIC	Static analysis control		2-1
!MATERIAL	Material name		2-2
!ELASTIC	Elastic material physical properties		2-2-1

Header	Meaning	Remarks	Description No.
!PLASTIC	Plastic material physical properties		2-2-2
!HYPERELASTIC	Hyperelastic material physical properties		2-2-3
!VISCOELASTIC	Viscoelastic material physical properties		2-2-4
!CREEP	Creep material physical properties		2-2-5
!DENSITY	Mass density		2-2-6
!EXPANSION_COEFF	Coefficient of linear expansion		2-2-7
!TRS	Tempearture dependent behaviour of viscoelastic material		2-2-8
!FLUID	Flow Condition		2-2-9
!USER_MATERIAL	User defined material		2-2-10
!BOUNDARY	Displacement boundary conditions		2-3
!SPRING	Spring boundary conditions		2-3-1
!CLOAD	Concentrated load		2-4
!DLOAD	Distributed load		2-5
!ULOAD	User defined external load		2-6
!CONTACT_ALGO	Contact analytic algorithm		2-7
!CONTACT	Contact		2-8
!TEMPERATURE	Nodal temperature in thermal stress analysis		2-9
!REFTEMP	Reference temperature in thermal stress analysis		2-10
!STEP	Analysis step control		2-11
!AUTOINC_PARAM	Auto increment control		2-12
!TIME_POINTS	Output time point control		2-13
!CONTACT_PARAM	Contact scan control		2-14

Table 7.3.3: Control Data for Eigenvalue Analysis

Header	Meaning	Remarks	Description No.
!EIGEN	Eigenvalue analysis control	Mandatory in eigenvalue analysis	3-1

Table 7.3.4: Control Data for Heat Conduction Analysis

Header	Meaning	Remarks	Description No.
!HEAT	Heat conduction analysis control	Mandatory in heat conduction analysis	4-1
!FIXTEMP	Nodal temperature		4-2
!CFLUX	Concentrated heat flux given to node		4-3
!DFLUX	Distributed heat flux / internal heat generation given to element surface		4-4
!SFLUX	Distributed heat flux by surface group		4-5
!FILM	Heat transfer coefficient given to boundary plain		4-6
!SFILM	Heat transfer coefficient by surface group		4-7
!RADIATE	Radiation factor given to boundary plane		4-8
!SRADIATE	Radiation factor by surface group		4-9
!WELD_LINE	Weld line		4-10

Table 7.3.5: Control Data for Dynamic Analysis

Header	Meaning	Remarks	Description No.
!DYNAMIC	Dynamic analysis control	Mandatory in dynamic analysis	5-1
!VELOCITY	Velocity boundary conditions		5-2
!ACCELERATION	Acceleration boundary conditions		5-3
!COUPLE	Coupled surface definition Required in coupled analysis		5-4
!EIGENREAD	Specification of eigenvalues and eigenvectors	Mandatory in frequency response analysis	5-5
!FLOAD	Definition of concentrated load for frequency response analysis		5-6

In each header, there are data items which comply with the parameter and each header.

Each of the above headers is described in the following with examples of data creation for each analysis type. The description number in the above Table is the number indicated on the right end of the example of the data creation.

1.4.3.2 (1) Control data common to all analyses

1.4.3.2.1 Example of Analysis Control Data

```
### Control File for FISTR
!VERSION                                    1-1
  5
!SOLUTION, TYPE=STATIC                      1-2
!WRITE, VISUAL                              1-3
!WRITE, RESULT                              1-4
!ECHO                                       1-9
!BOUNDARY                                   2-3
  FIX, 1, 3, 0.0
!CLOAD                                      2-4
  CL1, 3, -1.0
!END                                        1-12
```

1.4.3.2.2 Description of Header

1-1 `!VERSION`

Refer to the solver version.

1-2 `!SOLUTION, TYPE=STATIC`

TYPE=analysis type

1-3 `!WRITE, VISUAL`

Output of data by visualizer via memory

Outputs the file just by entering

1-4 `!WRITE, RESULT`

Output of analysis results file

Outputs the file just by entering

1-6 `!ECHO`

Output of node data, element data and material data to log file

Outputs to the file just by entering

1-8 `!END`

Indicates the end of control data

1.4.3.3 (2) Static analysis control data

1.4.3.3.1 Example of Static Analysis Control data

```
### Control File for FISTR
!SOLUTION, TYPE=STATIC                          1-2
!WRITE, VISUAL                                  1-3
!WRITE, RESULT                                  1-4
!ECHO                                           1-9
!MATERIAL, NAME=M1                              2-2
!ELASTIC, TYPE=ISOTROPIC                        2-2-1
  210000.0, 0.3
!BOUNDARY                                       2-3
  FIX, 1, 3, 0.0
!SPRING 2-3-1
  200, 1, 0.03
!CLOAD 2-4
  CL1, 3, -1.0
!DLOAD 2-5
  1, P1, 1.0
!TEMPERATURE                                    2-9
  1, 10.0
!REFTEMP                                        2-10
!STEP, CONVERG=1.E-5, MAXITER=30                2-11
!END                                            1-12
```

1.4.3.3.2 Description of Header

- Red figures are the values indicated in the example.
- Alphabetic characters in the 2nd line of the table express the parameter name.

2-1 `!STATIC`

Setting of static analysis method

2-2 `!MATERIAL`

Definition of material physical properties

NAME = name of material physical properties

2-2-1 `!ELASTIC, TYPE=ISOTROPIC`

Definition of elastic substance

TYPE = elastic type

Young's Modulus	Poisson's Ratio
YOUNG_MODULUS	POISSON_RATIO
210000.0	0.3

2-3 `!BOUNDARY`

Definition of displacement boundary conditions

Node ID or Node Group Name	Start No. of Restricted Degree of Freedom	End No. of Restricted Degree of Freedom	Restricted Value
NODE_ID FIX,	DOF_idS 1,	DOF_idE 3,	Value 0.0

2-3-1 `!SPRING`

Definition of spring boundary conditions

Node ID or Node Group Name	Restricted Degree of Freedom	Spring Constant
NODE_ID 200,	DOF_id 1,	Value 0.03

2-4 `!CLOAD`

Definition of concentrated load

Node ID or Node Group Name	Degree of Freedom No.	Load Value
NODE_ID CL1,	DOF_id 3,	Value -1.0

2-5 `!DLOAD`

Definition of distributed load

Element ID or Element Group Name	Load Type No.	Load Parameter
ELEMENT_ID 1,	LOAD_type P1,	param 1.0

2-9 `!TEMPERATURE`

Specification of nodal temperature used for thermal stress analysis

Node ID or Node Group Name	Temperature
NODE_ID 1,	Temp_Value 10

2-10 `!REFTEMP`

Definition of reference temperature in thermal stress analysis

2-11 `!STEP`

Control of nonlinear static analysis (Omissible in the case of linear analysis)

Convergence Value Judgment Threshold	No. of Sub Steps (When AMP exists, AMP has priority)	Max No. of Iterative Calculations	Time Function Name (Specified in !AMPLITUDE)
CONVERG 1.0E-05	SUBSTEPS 10	MAXITER 30	AMP

1.4.3.4 (3) Eigenvalue analysis control data

1.4.3.4.1 Example of Eigenvalue Analysis Control Data

```
### Control File for FISTR
!SOLUTION, TYPE=EIGEN                    1-2
!WRITE, VISUAL                           1-3
!WRITE, RESULT                           1-4
!ECHO                                    1-9
!EIGEN                                   3-1
  3, 1.0E-8, 60
!BOUNDARY                                2-3
 FIX, 1, 2, 0.0
!END
```

1.4.3.4.2 Description of Header

Red figures are the values indicated in the example.

3-1 `!EIGEN`

Parameter settings of eigenvalue analysis

No. of Eigenvalue	Allowance	Max No. of Iterations
NSET	LCZTOL	LCZMAX
3,	1.0E-8,	60

2-3 `!BOUNDARY` (Same items an in Static Analysis)

Definition of displacement boundary conditions

Node ID or Node Group Name	Start No. of Restricted Degree of Freedom	End No. of Restricted Degree of Freedom	Restricted Value
NODE_ID	DOF_idS	DOF_idE	Value
FIX,	1,	3,	0.0

1.4.3.5 (4) Heat conduction analysis control data

1.4.3.5.1 Example of Heat Conduction Analysis Control Data

```
### Control File for FISTR
!SOLUTION, TYPE=HEAT                     1-2
!WRITE, VISUAL                           1-3
!WRITE, RESULT                           1-4
!ECHO                                    1-9
!HEAT                                    4-1
!FIXTEMP                                 4-2
  XMIN, 0.0
  XMAX, 500.0
!CFLUX                                   4-3
  ALL, 1.0E-3
!DFLUX                                   4-4
  ALL, S1, 1.0
!SFLUX                                   4-5
  SURF, 1.0
!FILM                                    4-6
  FSURF, F1, 1.0, 800
!SFILM                                   4-7
```

```
  SFSURF, 1.0, 800.0
!RADIATE                                    4−8
  RSURF, R1, 1.0E−9, 800.0
!SRADIATE                                   4−9
  RSURF, R1, 1.0E−9, 800.0
!END                                        1−12
```

1.4.3.5.2 Description of Header

Red figures are the values indicated in the example.

4-1 `!HEAT`

Definition of control data for calculation

```
!HEAT
  (No data)                    ——— Steady calculation
!HEAT
  0.0                          ——— Steady calculation
!HEAT
  10.0, 3600.0                 ——— Fixed time increment unsteady calculation
!HEAT
  10.0, 3600.0, 1.0            ——— Automatic time increment unsteady calculation
!HEAT
  10.0, 3600.0, 1.0, 20.0      ——— Automatic time increment unsteady calculation
```

4-2 `!FIXTEMP`

Node group name, or node ID and fixed temperature

4-3 `!CFLUX`

Definition of concentrated heat flux given to node

Node Group Name or Node ID	Heat Flux Value
NODE_GRP_NAME	Value
ALL,	1.0E-3

4-4 `!DFLUX`

Definition of distributed heat flux and internal heat generation given to surface of element

Element Group Name or Element ID	Load Type No.	Heat Flux Value
ALL,	S1,	1.0

Load Parameter

Load Type No.	Applied Surface	Parameter
BF	Element Overall	Calorific value
S1	Surface No. 1	Heat flux value
S2	Surface No. 2	Heat flux value
S3	Surface No. 3	Heat flux value
S4	Surface No. 4	Heat flux value
S5	Surface No. 5	Heat flux value
S6	Surface No. 6	Heat flux value
S0	Shell surface	Heat flux value

4-5 `!SFLUX`

Definition of distributed heat flux by surface group

Surface Group Name	Heat Flux Value
SURFACE_GRP_NAME SURF,	Value 1.0

4-6 `!FILM`

Definition of heat transfer coefficient given to boundary plane

Element Group Name or Element ID	Load Type No.	Heat Transfer Coefficient	Ambient Temperature
ELEMENT_GRP_NAME FSURF,	LOAD_type F1,	Value 1.0,	Sink 800.0

Load Parameter

Load Type No.	Applied Surface	Parameter
F1	Surface No. 1	Heat transfer coefficient and ambient temperature
F2	Surface No. 2	Heat transfer coefficient and ambient temperature
F3	Surface No. 3	Heat transfer coefficient and ambient temperature
F4	Surface No. 4	Heat transfer coefficient and ambient temperature
F5	Surface No. 5	Heat transfer coefficient and ambient temperature
F6	Surface No. 6	Heat transfer coefficient and ambient temperature
F0	Shell surface	Heat transfer coefficient and ambient temperature

4-7 `!SFILM`

Definition of heat transfer coefficient by surface group

Surface Group Name	Heat Transfer Rate	Ambient Temperature
SURFACE_GRP_NAME SFSURF,	Value 1.0,	Sink 800.0

4-8 `!RADIATE`

Definition of radiation factor given to boundary plane

Element Group Name or Element ID	Load Type No.	Radiation Factor	Ambient Temperature
ELEMENT_GRP_NAME RSURF,	LOAD_type R1,	Value 1.0E-9,	Sink 800.0

Load Parameter

Load Type No.	Applied Surface	Parameter
R1	Surface No. 1	Radiation factor and ambient temperature
R2	Surface No. 2	Radiation factor and ambient temperature
R3	Surface No. 3	Radiation factor and ambient temperature
R4	Surface No. 4	Radiation factor and ambient temperature
R5	Surface No. 5	Radiation factor and ambient temperature
R6	Surface No. 6	Radiation factor and ambient temperature

Load Type No.	Applied Surface	Parameter
R0	Shell surface	Radiation factor and ambient temperature

4-9 `!SRADIATE`

Definition of radiation factor by surface group

Surface Group Name	Radiation Factor	Ambient Temperature
SURFACE_GRP_NAME	Value	Sink
SRSURF,	1.0E-9,	800.0

1.4.3.6 (5) Dynamic analysis control data

1.4.3.6.1 Example of Dynamic Analysis Control Data

```
### Control File for FISTR
!SOLUTION, TYPE=DYNAMIC                          1-2
!DYNAMIC, TYPE=NONLINEAR                         5-1
  1 , 1
  0.0, 1.0, 500, 1.0000e-5
  0.5, 0.25
  1, 1, 0.0, 0.0
  100, 5, 1
  0, 0, 0, 0, 0, 0
!BOUNDARY, AMP=AMP1                              2-3
  FIX, 1, 3, 0.0
!CLOAD, AMP=AMP1                                 2-4
  CL1, 3, -1.0
!COUPLE, TYPE=1                                  5-4
  SCOUPLE
!STEP, CONVERG=1.E-6, ITMAX=20                   2-11
!END                                             1-12
```

1.4.3.6.2 Description Header

- Red figures are the values indicated in the example.
- Alphabetic characters in the 2nd line of the table express the parameter name.

5-1 `!DYNAMIC`

Controlling the linear dynamic analysis

Solution of Equation of Motion	Analysis Types
idx_eqa	idx_resp
11	1

Analysis Start Time	Analysis End Time	Overall No. of STEPS	Time Increment
t_start	t_end	n_step	t_delta
0.0	1.0	500	1.0000e-5

Parameter γ of Newmark-β Method	Parameter β of Newmark-β Method
gamma	beta
0.5	0.25

Type of Mass Matrix	Type of Damping	Parameter R_m of Rayleigh Damping	Parameter of R_k of Rayleigh Damping
idx_mass 1	idx_dmp 1	ray_m 0.0	ray_k 0.0

Resules Output Interval	Monitoring Node ID or Node Group Name	Results Output Interval of Displacement Monitoring
nout 100	node_monit_1 55	nout_monit nout_monit

Output Control Displacement	Output Control Velocity	Output Control Acceleration	Output Control Reaction Force	Output Control Strain	Output Control Stress
iout_list(1) 0	iout_list(2) 0	iout_list(3) 0	iout_list(4) 0	iout_list(5) 0	iout_list(6) 0

2-3 `!BOUNDARY` (Same items as in Static Analysis)

Definition of displacement boundary conditions

Node ID or Node Group Name	Start No. of Restricted Degree of Freedom	End No. of Restricted Degree of Freedom	Restricted Value
NODE_ID FIX,	DOF_idS 1,	DOF_idE 3,	Value 0.0

2-4 `!CLOAD` (Same items as in Static Analysis)

Definition of concentrated load

Node ID or Node Group Name	Degree of Freedom No.	Load Value
CL1,	3,	-1.0

5-4 `!COUPLE, TYPE=1`

Definition of coupled surface

Coupling Surface Group Name
SCOUPLE

2-11 `!STEP, CONVERG=1.E-10, ITMAX=20`

Control of nonlinear static analysis

(Omissible in the case of linear analysis, and unnecessary for explicit method)

Convergence Value Judgment Threshold (Default: 1.0E-06)	No. of Sub Steps (When AMP exists, AMP has priority)	Max No. of Iterative Calculations
CONVERG 1.0E-10	SUBSTEPS	ITMAX 20

1.4.3.7 (6) Dynamic analysis (Frequency Response Analysis) Control Data

1.4.3.7.1 Example of Dynamic analysis (Frequency Response Analysis)

```
!SOLUTION, TYPE=DYNAMIC                                  1−2
!DYNAMIC                                                 5−1
  11 , 2
  14000, 16000, 20, 15000.0
  0.0, 6.6e−5
  1, 1, 0.0, 7.2E−7
  10, 2, 1
  1, 1, 1, 1, 1, 1
!EIGENREAD                                               5−5
  eigen0.log
  1, 5
!FLOAD, LOAD CASE=2                                      5−6
  _PickedSet5, 2, 1.0
!FLOAD, LOAD CASE=2
  _PickedSet6, 2, 1.0
```

1.4.3.7.2 Description of Header

- Red figures are the values indicated in the example.
- Alphabetic characters in the 2nd line of the table express the parameter name.

5-1 `!DYNAMIC`

Controlling the frequency response analysis

Solution of Equation of Motion	Analysis Types
idx_eqa 11	idx_resp 2

Minimum Frequency	Maximum Frequency	Number of divisions for the frequency range	Frequency to obtain displacement
f_start 14000	f_end 16000	n_freq 20	f_disp 15000.0

Analysis Start Time	Analysis End Time
0.0	6.6e-5

Type of Mass Matrix	Type of Damping	Parameter R_m of Rayleigh Damping	Parameter R_k of Rayleigh Damping
idx_mass 1	idx_dmp 1	ray_m 0.0	ray_k 7.2E-7

Results Output Interval in Time Domain	Visualization Type(1-Mode shapes,2-Time history result at f_disp)	Monitoring Node ID in Frequency Domain
nout 10	vistype 2	nodeout 1

Output ControlDisplacement	Output ControlVelocity	Output ControlAcceleration	Output Controlignored	Output Controlignored	Output Controlignored
iout_list(1) 1	iout_list(2) 1	iout_list(3) 1	iout_list(4) 1	iout_list(5) 1	iout_list(6) 1

5-5 `!EIGENREAD`

Controlling the input file for frequency response analysis

The name of eigenvalue analysis log
eigenlog_filename eigen0.log

lowest mode to be used in frequency response analysis	highest mode to be used frequency response analysis
start_mode 1	end_mode 5

5-6 `!FLOAD`

Defining external forces applied in frequency response analysis

Node ID, Node Group Name or Surface Group Name	Degree of Freedom No.	Load Value
_PickedSet5	2	1.0

1.4.4 Solver Control Data

1.4.4.1 Example of Solver Control Data

```
### SOLVER CONTROL
!SOLVER, METHOD=CG, PRECOND=1, ITERLOG=YES, TIMELOG=YES          6-1
  10000, 1                                                       6-2
  1.0e-8, 1.0, 0.0
```

1.4.4.2 Description of Header

- Red figures are the values indicated in the example.

1.4.4.2.1 6-1 `!SOLVER`

```
METHOD     = method
             (CG, BiCGSTAB, GMRES, GPBiCG, etc.)
TIMELOG    = whether solver computation time is output
MPCMETHOD = method for multipoint constraints
             (1: Penalty method,
              2: MPC-CG method (Deprecated),
              3: Explicit master-slave elimination)
DUMPTYPE   = type of matrix dumping
DUMPEXIT   = whether program exits right after dumping matrix
```

The following parameters will be disregarded when a direct solver is selected in the method.

```
PRECOND    = preconditioner
ITERLOG    = whether solver convergence history is output
SCALING    = whether matrix is scaled so that each diagonal element becomes 1
```

USEJAD = whether matrix ordering optimized for vector processors is performed
ESTCOND = frequency for estimating condition number
(Estimation performed at every specified number of iterations and
at the last iteration. No estimation when 0 is specified.)

6-2

No. of Iterations	Iteration Count of Preconditioning	No. of Krylov Subspaces	No. of Colors for Multi-Color ordering	No. of Recycling Set-Up Info for Preconditioning
NITER	iterPREMAX	NREST	NCOLOR_IN	RECYCLEPRE
10000	1			

6-3

Truncation Error	Scale Factor for Diagonal Elementswhen computing Preconditioning Matrix	Not Used
1.0e-8,	1.0,	0.0

1.4.5 Post Process (Visualization) Control Data

An example of the post process (visualization) control data and the contents are shown in the following.

1.4.5.1 Example of Visualization Control Data

Each description number (P1-0, P1-1, etc.) is linked to the number of the detailed descriptions in the following.

- P1- expresses the common data, and P2- expresses the parameter for the purpose of the rendering.In addition, the rendering will become valid only when the output_type=BMP.
- When the surface_style is !surface_style = 2 (isosurface) !surface_style = 3 (user specified curved surface), a separate setting is required. The data is indicated collectively after the common data.(P3- is a description of the isosurface in !surface_style = 2. P4- is a description of the user specified curved surface in !surface_style = 3.)
- The items indicated with two ! like "!!", will be recognized as a comment and will not affect the analysis.

### Post Control	Description No.
!VISUAL, method=PSR	P1−0
!surface_num = 1	P1−1
!surface 1	P1−2
!surface_style = 1	P1−3
!display_method = 1	P1−4
!color_comp_name = STRESS	P1−5
!colorsubcomp_name	P1−6
!color_comp 7	P1−7
!!color_subcomp = 1	P1−8
!iso_number	P1−9
!specified_color	P1−10
!deform_display_on = 1	P1−11
!deform_comp_name	P1−12
!deform_comp	P1−13
!deform_scale = 9.9e−1	P1−14
!initial_style = 1	P1−15
!deform_style = 3	P1−16
!initial_line_color	P1−17
!deform_line_color	P1−18
!output_type = BMP	P1−19
!x_resolution = 500	P2−1
!y_resolution = 500	P2−2
!num_of_lights = 1	P2−3
!position_of_lights = −20.0, 5.8, 80.0	P2−4

```
!viewpoint = -20.0 -10.0 5.0                P2-5
!look_at_point                              P2-6
!up_direction = 0.0 0.0 1.0                 P2-7
!ambient_coef= 0.3                          P2-8
!diffuse_coef= 0.7                          P2-9
!specular_coef= 0.5                         P2-10
!color_mapping_style= 1                     P2-11
!!interval_mapping_num                      P2-12
!interval_mapping= -0.01, 0.02              P2-13
!rotate_style = 2                           P2-14
!rotate_num_of_frames                       P2-15
!color_mapping_bar_on = 1                   P2-16
!scale_marking_on = 1                       P2-17
!num_of_scale = 5                           P2-18
!font_size = 1.5                            P2-19
!font_color = 1.0 1.0 1.0                   P2-20
!background_color                           P2-21
!isoline_color                              P2-22
!boundary_line_on                           P2-23
!color_system_type                          P2-24
!fixed_range_on = 1                         P2-25
!range_value = -1.E-2, 1.E-2                P2-26
```

1.4.5.1.1 Common Data List<P1-1 - P1-19>

No.	Keywords	Types	Contents
P1-0	!VISUAL		Specification of the visualization method
P1-1	surface_num		No. of surfaces in one surface rendering
P1-2	surface		Setting of the contents of surface
P1-3	surface_style	integer	Specification of the surface type (Default: 1)1: Boundary surface2: Isosurface3: Curved surface defined by user based on the equation
P1-4	display_method	integer	Display method (Default: 1)1. Color code display2. Boundary line display3. Color code and boundary line display4. Display of 1 specified color5. Isopleth line display by classification of color

No.	Keywords	Types	Contents
P1-5	color_comp_name	character(100)	Compatible with parameter name and colormap(Default: 1st parameter name)
P1-6	color_subcomp_name	character(4)	When the parameter is a vector, specifies the component to be displayed. (Default: x)norm: Norm of the vectorx: x componenty: y componentz: z component
P1-7	color_comp	integer	Provides an ID number to the parameter name(Default: 0)
P1-8	color_subcomp	integer	When the degree of freedom of the parameter is 1 or more, specifies the degree of freedom number to be displayed.0: Norm(Default: 1)
P1-9	iso_number	integer	Specifies the number of isopleth lines.(Default:5)
P1-10	specified_color	real	Specified the color when the display_method = 40.0 < specified_color < 1.0
P1-11	!deform_display_on	integer	Specifies the existence of deformation.1: On, 0: Off (Default: 0)
P1-12	!deform_comp_name	character(100)	Specifies the attribution to be adopted when specifying deformation.(Default: Parameter called DISPLCEMENT)
P1-13	!deform_ comp	integer	ID number of the parameter when specifying deformation.(Default: 0)

No.	Keywords	Types	Contents
P1-14	!deform_scale	real	Specifies the displacement scale when displaying deformation.Default:Autostandard_scale = 0.1 * sqrt(x_range2 + y_range2 + z_range2) / max_deformuser_defined: real_scale = standard_scale * deform_scale
P1-15	! initial_style	integer	Specifies the type of deformation display.(Default: 1)0: Not specified1: Solid line mesh(Displayed in blue if not specified)2: Gray filled pattern3: Shading (Let the physical attributions respond to the color)4: Dotted line mesh (Displayed in blue if not specified)
P1-16	!deform_style	integer	Specifies the shape display style after the initial deformation.(Default: 4)0: Not specified1: Solid line mesh (Displayed in blue if not specified)2: Gray filled pattern3: Shading (Let the physical attributions respond to the color)4: Dotted line mesh (Displayed in blue if not specified)
P1-17	! initial_line_color	real (3)	Specifies the color when displaying the initial mesh. This includes both the solid lines and dotted lines.(Default: Blue(0.0, 0.0, 1.0))

No.	Keywords	Types	Contents
P1-18	!deform_line_color	real (3)	Specifies the color when displaying the deformed mesh. This includes both the solid lines and dotted lines.(Yellow(1.0, 1.0, 0.0))
P1-19	output_type	character(3)	Specifies the type of output file. (Default: AVS)AVS: UCD Data for AVS(only on object surface)BMP: Image data (BMP for- mat)COMPLETE_AVS: UCD data for AVSCOMPLETE_REORDER_ Rearranges the node and element IDSEPARATE_COMPLETE_ For each decomposed do- mainCOMPLETE_MICROAVS Outputs the physical value scalarFSTR_FEMAP_NEUTR Neutral file for FEMAP

1.4.5.1.2 Rendering Data List <P2-1 - P2-26>

(Valid only when the output_type=BMP)

	Keywords	Types	Contents
P2-1	x_resolution	integer	Specifies the width of final figure. (Default: 512)
P2-2	y_resolution	integer	Specifies the height of final figure. (Default: 512)
P2-3	num_of_lights	integer	Specifies the number of lights. (Default: 1)
P2-4	position_of_lights	real(:)	Specifies the position of the lights by coordi- nates.(Default: Directly above front)Specification method !position_of_lights= x, y, z, x !position_of_lights=100.0, 200.

	Keywords	Types	Contents
P2-5	viewpoint	real(3)	Specifies the viewpoint position by coordinates.(Default: x = (xmin + xmax)/2.0) y = ymin + 1.5 *(ymax - ymin)z = zmin + 1.5 *(zmax - zmin))
P2-6	look_at_point	real(3)	Specifies the look at point position.(Default: Center of data)
P2-7	up_direction	real(3)	Defines the view frame at Viewpoint, look_at_point and up_direction(Default: 0.0, 0.0, 1.0)
P2-8	ambient_coef	real	Specifies the peripheral brightness. (Default: 0.3)
P2-9	diffuse_coef	real	Specifies the intensity of the diffused reflection light by coefficient.(Default: 0.7)
P2-10	specular_coef	real	Specifies the intensity of specular reflection by coefficient.(Default: 0.6)

	Keywords	Types	Contents
P2-11	color_mapping_style	integer	Specifies the color mapping style.(Default: 1)1: Complete linear mapping (Maps overall color in RGB linear)2: Clip linear mapping (Maps from mincolor to maxcolor in the RGB color space)3: Nonlinear color mapping (Patitions all domains into multiple sections, and performs linear mapping for each section)4: Optimum auto adjustment (Performs a statistical process of the data distribution to determine the color mapping)
P2-12	interval_mapping_num	integer	Specifies the number of sections when the color_mapping_style = 3
P2-13	interval_mapping	real(:)	Specifies the section position and color number when the color_mapping_style = 2 or 3.if the color_mapping_style=2;!interva the color_mapping_style=3;!interva Must be describe in one line.
P2-14	rotate_style	integer	Specifies the rotating axis of animation.1: Rotates at x-axis.2: Rotates at y-axis.3: Rotates at z axis.4: Particularly, specifies the viewpoint to perform animation. (8 frames)
P2-15	rotate_num_of_frames	integer	Specifies the cycle of anima-tion.(rotate_style = 1, 2, 3)(Default: 8)

	Keywords	Types	Contents
P2-16	color_mapping_bar_on	integer	Specifies the existence of color mapping bar.0: off; 1: on; Default: 0
P2-17	scale_marking_on	integer	Specifies whether to display the value on the color mapping bar.0: off; 1: on; Default: 0
P2-18	num_of_scale	integer	Specifies the number of memories of the color bar. (Default: 3)
P2-19	font_size	real	Specifies the font size when displaying the value of the color mapping bar.Range: 1.0-4.0 (Default: 1.0)
P2-20	font_color	real(3)	Specifies the display color when displaying the value of the color mapping bar.(Default: 1.0, 1.0, 1.0 (White))
P2-21	background_color	real(3)	Specifies the background color. (Default: 0.0, 0.0, 0.0 (Black))
P2-22	isoline_color	real(3)	Specifies the color of the isopleth line. (Default: Same color as the value)
P2-23	boundary_line_on	integer	Specifies whether to display the zone of the data.0: off; 1: on; Default: 0
P2-24	color_system_type	integer	Specifies the color mapping style.(Default: 1)1: (Blue - Red)(in ascending order)2: Rainbow mapping (Ascending order from red to purple)3: (Black - White)(in ascending order)
P2-25	fixed_range_on	integer	Specifies whether to maintain the color mapping style for other time steps.0: off; 1: on; (Default: 0)

	Keywords	Types	Contents
P2-26	range_value	real(2)	Specifies the section.

1.4.5.1.3 Data List by Setting Values of `surface_style`

In the case of isosurface (`surface_style=2`)

	Keywords	Types	Contents
P3-1	data_comp_name	character(100)	Provides the name to the attribution of the isosurface.
P3-2	data_subcomp_name	character(4)	When the parameter is a vector, specifies the component to be displayed. (Default: x)norm: Norm of the vectorx: x componenty: y componentz: z component
P3-3	data_comp	integer	Provides an ID number to the parameter name(Default: 0)
P3-4	data_subcomp	integer	When the degree of freedom of the parameter is 1 or more, specifies the degree of freedom number to be displayed.0: Norm(Default: 1)
P3-5	iso_value	real	Specifies the value of the isosurface.

In the case of a curved surface (surface_sytle = 3) specified by the equation of the user

	Keywords	Types	Contents
P4-1	method	integer	Specifies the attribution of the curved surface. (Default: 5)1: Spherical surface2: Ellipse curved surface3: Hyperboloid4: Paraboloid5: General quadric surface
P4-2	point	real(3)	Specifies the coordinates of the center when method = 1, 2, 3, or 4(Default: 0.0, 0.0, 0.0)
P4-3	radius	real	Specifies the radius when method = 1(Default: 1.0)
P4-4	length	real	Specifies the length of the diameter when method = 2, 3, or 4.Note: The length of one diameter in the case the ellipse curved surface is 1.0.
P4-5	coef	real	Specifies the coefficient of a quadric surface when method=5.coef[1]x2 + coef[2]y2 + coef[3]z2 + coef[4]xy + coef[5]xz + coef[6]yz + coef[7]x + coef[8]y + coef[9]z + coef[10]=0Ex: coef=0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 1.0, 0.0, -10.0This means the plain surface of y=10.0