CML Formatted File

Nov 28, 2005. Kazumi Matsui

(Yokohama National University)

1. Introduction

This document describes the structure of CML formatted files. This format must be the most basic format of FORTRAN programs for the finite element analysis in our research group. All of the FORTRAN programs for the FE analysis need to use this format for our conveniences.

We can separate this format into the 3 kinds of data statements, INPUT, OUTPUT and OPTIONAL. The INPUT file contains some properties of the FE model made by "FEMAP", and is translated from the "FEMAP NEUtral formatted file" to the CML format by the program "NEU2CML". The OUTPUT file has several results gotten through your FE analysis. So, if your FE codes output some results by CML format, you can get "FEMAP NEUtral formatted file" through the program "CML2NEU".

The OPTIONAL data block statements are not necessary for the usual FE analysis and used in some programs to control the analysis. Though the program "NEU2CML" does not create these special statements, you must add these statements by your hand or execute some special program for this purpose. If you need another kind of data block statements, you may create the new data blocks. However in such a case, **you MUST announce the format of your new data blocks to the member of this working group and NEVER use the same data block statements**.

2. Outline of the format

A CML formatted file has several data blocks (coordinates of nodes, properties of elements, deformation data, etc). Each data block starts with the data block's header "**/*****/**" with 5 characters, and continue to the next header. The total number of data described at the next line of the header and the data statements begin after that.

The INPUT and the OUTPUT data are separated by the header "**/LASTD/**". The INPUT data of your CML formatted file must be described until the header "**/LASTD/**" is stated, and the OUTPUT data must be described after this header. You may place the OPTIONAL data in wherever you want. But note that the OPTIONAL data in the output section in CML formatted file is never translated into the "FEMAP NEUtral formatted file".

Document of the CML-formatted file

3. Headers of data blocks

INPUT Data Statements	
/TITLE/	Title of the model
/COORD/	Coordinates of nodes
/TRIA3/	Properties of elements (Constant Strain Triangle element, 2D)
/TRIA6/	Properties of elements (6 nodes quadratic triangular element, 2D)
/QUAD4/	Properties of elements (4 nodes linear rectangular element, 2D)
/QUAD8/	Properties of elements (8 nodes quadratic rectangular element, 2D)
/TTRA4/	Properties of elements (6 nodes linear tetrahedral element, 3D)
/TTR10/	Properties of elements (10 nodes quadratic tetrahedral element, 3D)
/HEXA8/	Properties of elements (8 nodes linear hexahedral element, 3D)
/HEX20/	Properties of elements (20 nodes quadratic tetrahedral element, 3D)
/MATER/	Material properties
/EULER/	Euler angles
/LOCRD/	Local coordinates
/CONST/	Loading conditions
/LOADC/	Constraint conditions
OUTPUT Data Statements	
/NODAL/	Nodal output (ex. displacement)
/ELMTL/	Elemental output (ex. stress, strain, density)
OPTIONAL Data Statements	
/SOLUT/	Control parameters for the computation (Kazumi)
/PSTEP/	Define the loading step at which some results should be outputted (Kazumi)
/PELEM/	Define the macroscopic ID of element and its integration point where the microscopic deformations should be outputted (Especially in program "GNGLAN") (Kazumi)
/CTRLV/	Control values and general settings (Yamakawa)
/PDISP/	Define ID of node where the nodal displacements should be outputted (Yamakawa)
/PFOCE/	Define ID of node where the nodal forces should be outputted (Yamakawa)
/OPTIM/	Data block for Topology optimization (Kazumi)
/OPTMZ/	New data block for Topology optimization (kzm)
General statements	
/LASTD/	Header to describe the last of INPUT data
/ENDOF/	Header to describe the END OF FILE

4. INPUT Data Block Statement

The data blocks listed below are the most basic data for FE analysis, so all the FORTRAN programs may need to have them. If some programs need other data statements (Lames's constants for example), you can use "dummy value" statements in this format for your new statements.

/TITLE/ - Title of the Model

Record	Column	Description	Format	etc
1	1-7	Header of data block (**/TITLE/**)	A7	
2	1-80	Title of the model	A80	

/COORD/ - Coordinates of nodes

Record	Column	Description	Format	etc
1	1-7	Header of data block (**/COORD/**)	A7	
2	1-8	Total number of nodes	I8	
3 – (1 record per node)	1-8	ID of node	I8	
	9-23	Coordinate of X-direction	E15.5	
	24-38	Coordinate of Y-direction	E15.5	
	39-53	Coordinate of Z-direction	E15.5	

Document of the CML-formatted file

/TRIA3/ - Properties of Elements (2D, Constant Strain Triangle element)

Record	Column	Description	Format	etc
1	1-7	Header of data block (**/TRIA3/**)	A7	
2	1-8	Total number of elements	I8	
	9-13	Dummy Value	I5	
3 – (1 record per element)	1-8	ID of element	I8	
	9-13	Material ID of this element	I5	
	14-18	ID of Euler angle	I5	
	19-23	Integration method 1: = normal integration (fully) 2: = selective reduced integration 5: = single point integration (special scheme for "GNGLAN")	I5	
	24-28	Dummy value	I5	
	29-60	Connectivity of element (1-3) (follow the right-hand rule)	3I8	

/TRIA6/ - Properties of Elements (2D, 6-nodes quadratic triangle)

Record	Column	Description	Format	etc
1	1-7	Header of data block (/TRIA6/)	A7	
2	1-8	Total number of elements	I8	
	9-13	Switch for incompressibility 0: Usual displacement-based formulation 3: P1-iso-P2/P0 element	I5	2012/11
3 – (1 record per element)	1-8	ID of element	I8	
	9-13	Material ID of this element	I5	
	14-18	ID of Euler angle	I5	
	19-23	Integration method 1: = normal integration (fully) 2: = selective reduced integration 5: = single point integration (special scheme for "GNGLAN")	I5	
	24-28	Dummy value	I5	
	29-60	Connectivity of element (1-6) (follow the right-hand rule)	4I8	
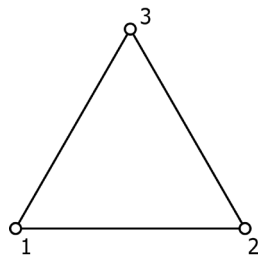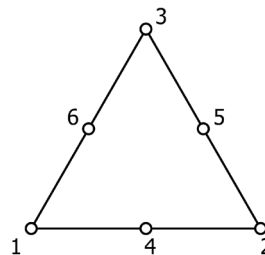
TRIA3   TRIA6

/QUAD4/ - Properties of Elements (2D, 4-nodes linear rectangular)

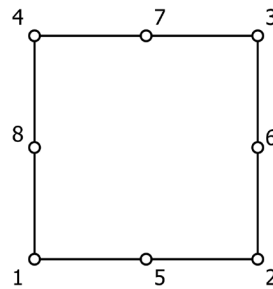| Record	Column	Description	Format	etc
1	1-7	Header of data block (**/QUAD4/**)	A7	
2	1-8	Total number of elements	I8	

	9-13	Switch for incompressibility
		   0: Usual displacement-based formulation
		   3: Mean dilatation method
			I5	2012/11

3 – (1 record per element)	1-8	ID of element	I8	
	9-13	Material ID of this element	I5	
	14-18	ID of Euler angle	I5	

	19-23	Integration method
		   1: = normal integration (fully)
		   2: = selective reduced integration
		   5: = single point integration
		       (special scheme for "GNGLAN")
			I5	

	24-28	Dummy value	I5	
	29-60	Connectivity of element (1-4) (follow the right-hand rule)	4I8	

/QUAD8/ - Properties of Elements (2D, 8-nodes quadratic rectangular)

Record	Column	Description	Format	etc
1	1-7	Header of data block (**/QUAD8/**)	A7	
2	1-8	Total number of elements	I8	
	9-13	Dummy Value	I5	
3 – (1 record per element)	1-8	ID of element	I8	
	9-13	Material ID of this element	I5	
	14-18	ID of Euler angle	I5	

	19-23	Integration method
		   1: = normal integration (fully)
		   2: = selective reduced integration
		   5: = single point integration
		       (special scheme for "GNGLAN")
			I5	

	24-28	Dummy Value	I5	
	29-92	Connectivity of element (1-8) (follow the right-hand rule)	8I8	
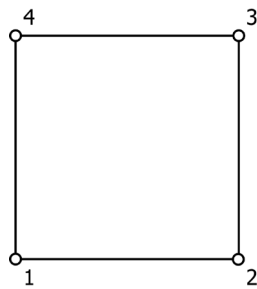
QUAD4

QUAD8

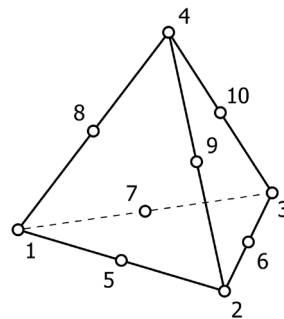## /TTRA4/ - Properties of Elements (3D, 4-nodes linear tetrahedral element)

Record	Column	Description	Format	etc
1	1-7	Header of data block (**/TTRA4/**)	A7	
2	1-8	Total number of elements	I8	
	9-13	Dummy Value	I5	
3 – (1 record per element)	1-8	ID of element	I8	
	9-13	Material ID of this element	I5	
	14-18	ID of Euler angle	I5	

	19-23	Integration method
		  1: = normal integration (fully)
		  2: = selective reduced integration
		  5: = single point integration
		     (special scheme for "GNGLAN")
			I5	

	24-55	Connectivity of element (1-4) (follow the right-hand rule)	4I8	

/TTR10/ - Properties of Elements (3D, 10-nodes tetrahedral element)

Record	Column	Description	Format	etc
1	1-7	Header of data block (**/TTR10/**)	A7	
2	1-8	Total number of elements	I8	
	9-13	Dummy Value	I5	
3 – (1 record per element)	1-8	ID of element	I8	
	9-13	Material ID of this element	I5	
	14-18	ID of Euler angle	I5	

	19-23	Integration method
		  1: = normal integration (fully)
		  2: = selective reduced integration
		  5: = single point integration
		     (special scheme for "GNGLAN")
			I5	

	24-103	Connectivity of element (1-10) (follow the right-hand rule)	10I8	
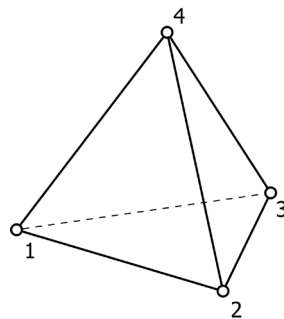
TRIA4

TRIA10

/HEXA8/ - Properties of Elements (3D, 8-nodes linear hexahedral element)

Record	Column	Description	Format	etc
1	1-7	Header of data block (**/HEXA8/**)	A7	
2	1-8	Total number of elements	I8	

	9-13	Additional element type
		   0: = normal
		   2: = mean dilatation (hex8m)
			I5	

3 – (1 record per element)	1-8	ID of element	I8	
	9-13	Material ID of this element	I5	
	14-18	ID of Euler angle	I5	

	19-23	Integration method
		   1: = normal integration (fully)
		   2: = selective reduced integration
		   5: = single point integration
		      (special scheme for "GNGLAN")
			I5	

	24-87	Connectivity of element (1-8) (follow the right-hand rule)	8I8	

/HEX20/ - Properties of Elements (3D, 20-nodes hexahedral element)

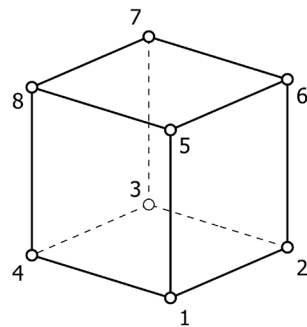| Record	Column	Description	Format	etc
1	1-7	Header of data block (**/HEX20/**)	A7	
2	1-8	Total number of elements	I8	
	9-13	Dummy Value	I5	
3 – (1 record per element)	1-8	ID of element	I8	
	9-13	Material ID of this element	I5	
	14-18	ID of Euler angle	I5	

	19-23	Integration method
		   1: = normal integration (fully)
		   2: = selective reduced integration
		   5: = single point integration
		      (special scheme for "GNGLAN")
			I5	

	24-183	Connectivity of element (1-20) (follow the right-hand rule)	20I8	

HEXA8   HEX20

Document of the CML-formatted file
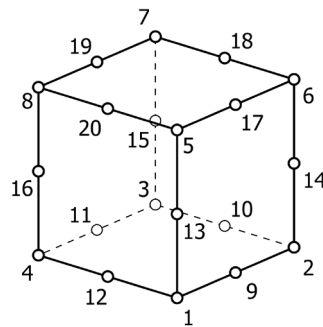
/MATER/ - Material Properties

Record	Column	Description	Format	etc
1	1-7	Header of data block (**/MATER/**)	A7	
2	1-5	Total number of materials	I5	
3 – (5 records per material)	1-5	ID of material	I5	

	6-10	Definition of material model
		--- for small strain problems ---
		    1: Isotropic linear elastic - plastic material
		        (Plane Strain or 3D)
		    2: Isotropic linear elastic - plastic material
		        (Plane Stress)
		    3: Anisotropic linear elasticity (P. Strain / 3D)
		    4: Anisotropic linear elasticity (P. Stress)
		    or GTN model
		    5: GTN model (Hutchinson & Nahshon)
		    6: Lemaitre model
		--- for large deformation problems ---
		    1: Neo-Hookean material
		    2: Hencky type material
		    3: Hencky based elastic – plastic material
			I5	2012/11

	1-12	Young modulus	E12.5	E
	13-24	Poisson's ratio	E12.5	ν
	25-36	Density	E12.5	ρ
	37-48	Thermal expansion coefficient	E12.5	
	49-60	Heat Conductivity	E12.5	
	1-12	Specific Heat	E12.5	
	13-24	Initial void fraction (GTN)	E12.5	frac_i
	25-36	Damage parameter (GTN)	E12.5	q_1
	37-48	Damage parameter (GTN)	E12.5	q_2
	49-60	Initial yield stress (uniaxial)	E12.5	σ_Y
	1-12	Hardening parameter 1	E12.5	H
	13-24	Hardening parameter 2	E12.5	σ_Y^∞
	25-36	Hardening parameter 3	E12.5	δ
	37-48	Hardening parameter 4 Damage parameter (GTN)	E12.5	n f_c
	49-60	Hardening parameter 5 Damage parameter (GTN)	E12.5	θ f_F
	1-12	Pressure yield parameter (Drucker–Prager) Damage parameter 1 (Lemaitre)	E12.5	k S
	13-24	Damage parameter 2 (Lemaitre) Damage-parameter(GTN)	E12.5	r f_N
	25-36	Damage-parameter(GTN)	E12.5	S_N
	37-48	Damage-parameter(GTN)	E12.5	ε_N

	49-60	Definition of hyperelastic material model (negative value means "INCOMPRESSIBLE")
		   0: Hencky's material model
		   1: Neo-Hookean Material
		   2: Mooney-Rivlin model
		   3: Ogden's model
		   4: St. Venant-Kirchhoff material
			E12.5	obsoleted 2012/11

		(continued for anisotropic materials)		
(+6 records per an-isotropic material)		Anisotropic elastic material properties in D-matrix form $$\begin{bmatrix} D11 & D12 & D13 & D14 & D15 & D16 \\ & D22 & D23 & D24 & D25 & D26 \\ & & D33 & D34 & D35 & D36 \\ & & & D44 & D45 & D46 \\ & & & & D55 & D56 \\ & & & & & D66 \end{bmatrix}$$		2012/11
		for piezo-electric materials		
3 – (5 records per material)	1-5	ID of material	I5	
	6-10	Dummy Value	I5	2012/11
	1-12	Dummy Value	E12.5	
	13-24	Dummy Value	E12.5	
	25-36	Dummy Value	E12.5	
	37-48	Dummy Value	E12.5	
	49-60	Dummy Value	E12.5	
	1-12	Elastic property C_11	E12.5	
	13-24	Elastic property C_12	E12.5	
	25-36	Elastic property C_13	E12.5	
	37-48	Elastic property C_33	E12.5	
	49-60	Elastic property C_44	E12.5	
	1-12	Elastic property C_66	E12.5	
	13-24	Electric property e_31	E12.5	
	25-36	Electric property e_33	E12.5	
	37-48	Electric property e_15	E12.5	
	49-60	Piezo electric property x_11	E12.5	
	1-12	Piezo electric property x_33	E12.5	
	13-24	Dummy Value	E12.5	
	25-36	Dummy Value	E12.5	
	37-48	Dummy Value	E12.5	
	49-60	Dummy Value	E12.5	

J$_2$ Flow Theory with nonlinear Isotropic Hardening

$$f(\boldsymbol{\sigma}, \alpha) = \|\mathrm{dev}(\boldsymbol{\sigma})\| - \sqrt{\frac{2}{3}} K(\alpha), \quad K(\alpha) = \theta\{\sigma_Y + H\alpha + (\sigma_Y^\infty - \sigma_Y)(1 - exp[-\delta\alpha])\}$$

/EULER/ - Euler Angles

Record	Column	Description	Format	etc
1	1-7	Header of data block (**/EULER/**)	A7	
2	1-5	Total number of Euler angles	I5	
3 – (1 record per angle)	1-5	ID No. of Euler angle	I5	
	6-18	Euler angle around Z-axis (degree)	E13.5	
	19-31	Euler angle around X-axis (degree)	E13.5	
	25-36	Euler angle around Y-axis (degree)	E13.5	

These statements describe the angles between the macroscopic coordinate system and the microscopic one in the macroscopic model for the program "GNGLAN".

/LOCRD/ - Local Coordinate

Record	Column	Description	Format	etc
1	1-7	Header of data block (**/LOCRD/**)	A7	
2	1-5	Total number of Local coordinate	I5	
3 (3 record per system)	1-5	ID No. of Local coordinate	I5	
	6-18	Coordinate of origin (X-coordinate)	E13.5	
	19-31	Coordinate of origin (Y-coordinate)	E13.5	
	25-36	Coordinate of origin (Z-coordinate)	E13.5	
	6-18	Coordinate of local Z-axis (X-coordinate)	E13.5	
	19-31	Coordinate of local Z-axis (Y-coordinate)	E13.5	
	25-36	Coordinate of local Z-axis (Z-coordinate)	E13.5	
	6-18	Coordinate of local X-axis (X-coordinate)	E13.5	
	19-31	Coordinate of local X-axis (Y-coordinate)	E13.5	
	25-36	Coordinate of local X-axis (Z-coordinate)	E13.5	

These statements describe the position of the microscopic coordinate system relative to the macroscopic one in the macroscopic model of the program "GNGLAN".

Document of the CML-formatted file

/CONST/ - Conditions for Constraint

Record	Column	Description	Format	etc
1	1-7	Header of data block (**/CONST/**)	A7	
2	1-5	No. of the Multiple Constraints	I5	
	6-10	No. of the Single Point Constraints	I5	
	11-15	No. of the Periodic Conditions	I5	
In the case of the Multiple constraint (arranged by Oide, K.)				
3— (2 records per pair)	1-8	ID of the master node	I8	
	9-16	ID of DOF that be constrained	I8	
	17-24	No. of the slave nodes	I8	
	1-8	ID of the slave node	I8	
	9-16	ID of DOF that be constrained	I8	
In the case of the Single Point Constraint				
3 – (1 record per point)	1-8	ID of node being constrained	I8	
	9-13	Dummy Value	I5	
	14	EMPTY	X	

	15-20	Flags of constraint (for each component)
		  0: = OFF
		  1: = ON
		(translation for x,y,z, rotation around x,y,z-axis)
			6I1	

	21-32	Constrained displacement (X-direction)	E12.5	
	33-44	Constrained displacement (Y-direction)	E12.5	
	45- 56	Constrained displacement (Z-direction)	E12.5	
	57-68	Constrained angle (around X-axis)	E12.5	
	69-80	Constrained angle (around Y-axis)	E12.5	
	81-92	Constrained angle (around Z-axis)	E12.5	
In the case of the Periodic Condition				
3 – (2 records per pair)	1-8	ID of Node which has periodicity (base)	I8	
	9-13	Number of DOF (default = 7)	I5	
	14-18	Dummy Value (default = 1)	I5	
	1-8	ID of node corresponding to base one	I8	
	9-13	Number of DOF (default = 7)	I5	
	14-25	Weight apply to node (default = 1.0)	F12.5	

/LOADC/ - Loading Conditions

Record	Column	Description	Format	etc
1	1-7	Header of data block (**/LOADC/**)	A7	
2	1-5	No. of the loading sets	I5	
3	1-5	No. of the Nodal Loading	I5	npoin
	6-10	No. of the Distributed Loading	I5	npres
	11-15	No. of the Body Force	I5	nbody
	16-27	Factor of Total Loads	E12.5	2012/11
In the case of The Nodal Loading				
4 – (1 record per node)	1-8	ID of node on where the load is applying	I8	
	9-20	Traction force component for X-direction	E12.5	
	21-32	Traction force component for Y-direction	E12.5	
	33-44	Traction force component for Z-direction	E12.5	
	45-56	Moment around X-axis	E12.5	
	57-68	Moment around Y-axis	E12.5	
	69-80	Moment around Z-axis	E12.5	
In the case of The Distributed Loading (for 2D)				
4 – (1 record per element)	1-8	ID of element on where the load is applying	I8	
	9-16	ID's of 2-nodes which define the line where the load is distributing (follow the right-hand rule)	I8	
	17-24		I8	
	25-36	Magnitude of pressure	E12.5	
	37-48	Traction force component X-direction per length	E12.5	
	49-60	Traction force component Y-direction per length	E12.5	
	61-71	Dummy Value	E12.5	
In the case of The Distributed Loading (for 3D)				
4 – (1 record per element)	1-8	ID of element on where the load is applying	I8	
	9-16		I8	
	17-24	ID's of 4-nodes which define the surface where the load is distributing (follow the right-hand rule)	I8	
	25-32		I8	
	33-40		I8	
	41-52	Magnitude of pressure	E12.5	
	53-64	Traction force component for X-direction per area	E12.5	
	65-76	Traction force component for Y-direction per area	E12.5	
	77-88	Traction force component for Z-direction per area	E12.5	
In the case of The Body Force				
4 – (1 record per element)	1-8	ID of element on where the load is applying	I8	
	9-20	Dummy Value	E12.5	
	21-32	Body force component X-direction per volume	E12.5	
	33-44	Body force component Y-direction per volume	E12.5	
	45-56	Body force component Z-direction per volume	E12.5	

Document of the CML-formatted file

5. OPTIONAL Data Block Statement

/SOLUT/ - Control Block for loading (GNGLAN /PLAST)

Record	Column	Description	Format	etc
1	1-7	Header of data block (**/SOLUT/**)	A7	
2	1-5	Total number of the loading step	I5	nstep
	6-10	Defined Area of Pressure Loads The pressure loads are defined in; 0 = Initial Configuration (Kirchhoff Stress) 1 = Deformed Configuration (Cauchy Stress)	I5	ifoc

	11-15	Contact condition
		   0:= Ignore contact or release
		   1:= Opened fissure (contact problem)
		   2:= Release the connection
		      when the criterion has been violated
		   3:= Perfectly constrained
			I5	idum

	16-20	Initial condition for the analysis
		   0:= Start from initial state
		   1:= Resume with historical data
		      (Ext. forces are additional ones)
		   2:= Resume with historical data
		      (Ext. forces are the objective loading level)
			I5	istart

	21-25	Controlling method
		   0:= Load & Disp. Are directly controlled
		   1:= Standard arc-length method
		      (Final load levels are unknown)
		   2:= Arc-length method for objective load level
		      (Final load levels are guaranteed)
			I5	iarc

3	1-5	The loading step from which the analysis starts	I5	iamax

	6-10	Number of the increment defined explicitly
		   0: = Constant increment
		   1~: = Follow the explicit definition
		      (see; below definitions for details)
		Objective # of iterations for arc-length method
		   default value = 3
		(in the case "iarc" = 1 or 2)
			I5	minc

	11-15	Dummy Value	I5	itrobj
	16-20	Dummy Value	I5	itrmax
	21-25	Dummy Value	I5	mtol
In the case the loading increments are defined explicitly				
4 – (minc-1)	1-5	Beginning loading step with this increment	I5	
	6-10	End of loading step with this increment	I5	
	11-22	Loading increment	F12.5	
In the case of "arc-length" control (iarc = 1 or 2)				
4	1-12	Initial length of "arc"	F12.5	arcini

Combinations of "istart" and "iarc" (initial condition and controlling method)

Istart = 1, iarc = 2:   defined increments are guaranteed

Istart = 2, iarc = 2:   defined final load levels are guaranteed

Document of the CML-formatted file

/PSTEP/ - Loading Step for Output (GNGLAN / PLAST)

Record	Column	Description	Format	etc
1	1-7	Header of data block (**/PSTEP/**)	A7	
2	1-5	Total number of steps for output (negative value "-n" means output per "n" steps without the following explicit definitions)	I5	lstp
3 – (lstp –1)	1-5	Numbering for convenience	I5	
	6-10	ID of loading step for output	I5	

/PELEM/ - Microscopic Output (GNGLAN)

Record	Column	Description	Format	etc
1	1-7	Header of data block (**/PELEM/**)	A7	
2	1-5	Number of the points for microscopic output	I5	lpel
3 – (lpel –1)	1-5	Numbering for convenience	I5	
	6-13	ID of Macroscopic element	I8	
	11-18	ID of Gaussian point of the element (see Fig. 1)	I5	

/PDISP/ - Output the displacement

Record	Column	Description	Format	etc
1	1-7	Header of data block (**/PDISP/**)	A7	
2	1-5	Total number of node at which the nodal displacements should be outputted	I5	
3 – (1 record per node)	1-5	ID	I5	
	6-13	ID of the Node	I8	
	14-18	ID of DOF to be printed 1: x-dir displacement 2: y-dir displacement 3: z-dir displacement 4: Nodal potential value (temp. ele. potential)	I5	2012/11

Natural Coordinate for Integration

Physical Coordinate for FE Model

Natural Coordinate for 3D Integration
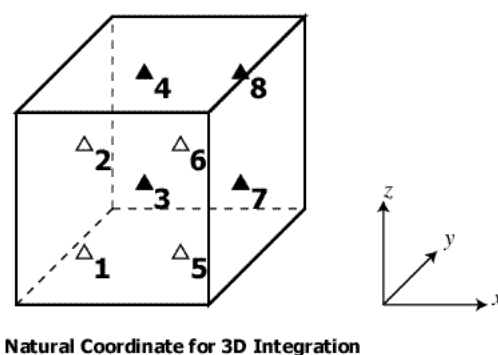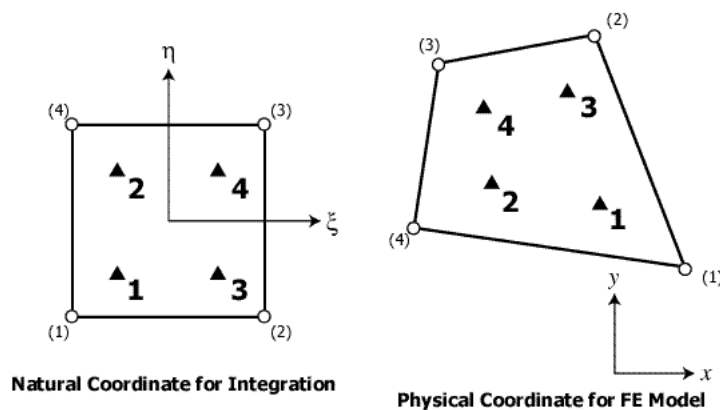
/PFOCE/ - Output the equivalent nodal force

Record	Column	Description	Format	etc
1	1-7	Header of data block (**/PFOCE/**)	A7	
2	1-5	Total number of node at which the equivalent	I5	

		nodal forces should be outputted		
3 – (1 record per node)	1-5	ID	I5	
	6-13	ID of the Node	I8	
	14-18	ID of DOF to be printed 1: x-dir displacement 2: y-dir displacement 3: z-dir displacement 4: Nodal potential value (heat. /charge)	I5	2012/11

/PSTRS/ /PSTRN/- Output the Stresses

Record	Column	Description	Format	etc
1	1-7	Header of data block (**/PSTRS/, /PSTRN/**)	A7	
2	1-5	Total number of records, at which elemental stresses/strrains should be outputted	I5	
3 – (1 record per node)	1-5	ID	I5	
	6-13	ID of the Element	I8	
	14-18	ID of component to be printed 1: xx , 2: yy, 3: zz (stress / strain) 4: xy, 5: yz, 6: zx (stress / strain) 7: x, 8: y, 9: z (thermal gradient /electric field)	I5	2012/11

/CTRLV/ - Control values for general setting for the analysis

Record	Column	Description	Format	etc
1	1-7	Header of data block (**/CTRLV/**)	A7	
2	1-12	Tolerance	E12.4	
	13-17	Max number of iteration	I5	
3	1-12	Tolerance of Pin-point for bifurcation point	E12.4	
	13-17	Max number of iteration for Pin-Point	I5	
4	1-12	Step size for arc-length method	E12.4	
	13-17	Number of loading steps	I5	
5	1-12	Initial data of force parameter	E12.4	
6	1-5	ID of the bifurcation point that is analyzed	I5	
7	1-12	Scale of bifurcation mode	E12.4	
	13-17	Direction of bifurcation mode (+1 or –1)	I5	
8	1-5	Type of analysis 0=: Axial symmetry 2=: Plain strain 3=: 3-dimension	I5	iswdim
9	1-5	Switch for the initial condition 0=: start the analysis from zero 1=: start the analysis from non-zero	I5	iswstr
10	1-5	Switch for Tangential stiffness 0=: Use the "continuum" elastoplastic tangent 1=: Use the "Consistent" tangent moduli	I5	iswtgt

		Switch for the integration method		
11	1-5	0=: perfect integration 1=: selective integration	I5	iswsri

/OPTIM/ - Data block for Topology Optimization

Record	Column	Description	Format	etc
1	1-7	Header of data block (**/OPTIM/**)	A7	
2	1-10	Volume constraint (%)	F10.5	
	11-22	Initial value of Lagrange Multiplier	E12.5	
	23-27	Beginning of iteration (default = 1)	I5	
	28-32	Maximum iteration number	I5	
	33-44	Tolerance for the Volume Constraint	E12.5	
	45-56	Tolerance for the Objective Function	E12.5	
3	1-8	Number of Design variables (Element or Node)	I8	
	9-13	Dummy value	I5	
	14-18	Dummy value	I5	
4— (1 record per 1 design variable)	1-8	ID of the design variable (Element or Node)	E12.4	

	9-13	Switch for design
		    0=: OFF
		    1=: ON
			I5	

	14-25	Initial value of design variable 1	E12.5	a
	26-37	Initial value of design variable 2	E12.5	b
	38-49	Initial value of design variable 3	E12.5	ρ
	50-61	Initial value of design variable 4	E12.5	θ

/OPTMZ/ - New data block for Topology Optimization

Record	Column	Description	Format	etc
1	1-7	Header of data block (**/OPTMZ/**)	A7	
2	1-5	Beginning of iteration	I5	
	6-10	End of iteration (Not a number of step)	I5	
	11-15	Dummy value	I5	
	16-20	Dummy value	I5	

	21-25	Objective function for Optimization
		    1: End compliance
		    2: Stored potential energy
			I5	

3	1-5	Increment of iteration where to print	I5	
	6-10	1st threshold for modification of move limit	I5	
	11-15	2nd threshold for modification of move limit	I5	
	16-20	Dummy value	I5	
	16-20	Dummy value	I5	
4	1-12	Volume constraint (%)	E12.5	
	13-24	Tolerance for the Volume Constraint	E12.5	
	25-36	Tolerance for the Objective Function	E12.5	
	37-48	Minimum value for move limit	E12.5	
	49-60	Maximum value for move limit	E12.5	
4—— (1 record per 1 design variable)	1-8	ID of the design variable (Element or Node)	E12.4	

	9-13	Switch for design
		    0=: OFF
		    1=: ON
			I5	

	14-25	Initial value of design variable 1	E12.5	a
	26-37	Initial value of design variable 2	E12.5	b
	38-49	Initial value of design variable 3	E12.5	ρ
	50-61	Initial value of design variable 4	E12.5	θ

6. OUTPUT Data Block Statement

/NODAL/ - Nodal data of output

Record	Column	Description	Format	etc
1	1-7	Header of data block (**/NODAL/**)	A7	
2	1-5	ID of loading step now printing	I5	
	6-10	Dummy value	I5	
	11-15	Dummy value	I5	
3	1-8	Total number of nodes	I8	
4 – (1 record per node)	1-8	ID of node	I8	
	9-21	Displacement for X-direction	E13.5	
	22-34	Displacement for Y-direction	E13.5	
	35-47	Displacement for Z-direction	E13.5	
	48-60	Dummy value (Undefined Nodal Data A)	E13.5	
	61-73	Dummy value (Undefined Nodal Data B)	E13.5	
	74-86	Dummy value (Undefined Nodal Data C)	E13.5	

/ELMTL/ - Elemental data of output

Record	Column	Description	Format	etc
1	1-7	Header of data block (**/ELMTL/**)	A7	
2	1-5	ID of loading step now printing	I5	
	6-10	Dummy value	I5	
	11-15	Dummy value	I5	
3	1-8	Total number of elements	I8	
In the case of 2-dimensional analysis				
4 – (2 records per element)	1-8	ID of element	I8	
	9-21	Stress value of XX-component	E13.5	σ_{11}
	22-34	Stress value of YY-component	E13.5	σ_{22}
	35-47	Stress value of XY-component	E13.5	σ_{12}
	48-60	Strain value of XX-component	E13.5	E_{11}
	61-73	Strain value of YY-component	E13.5	E_{22}
	74-86	Strain value of XY-component	E13.5	E_{12}
	1-8	Empty	8X	
	9-21	von Mises stress	E13.5	$\bar{\sigma}$
	22-34	Effective plastic strain	E13.5	$\bar{\varepsilon}^{p}$
	35-47	Dummy value (Undefined Elemental Data A)	E13.5	
	48-60	Dummy value (Undefined Elemental Data B)	E13.5	
	61-73	Dummy value (Undefined Elemental Data C)	E13.5	
	74-86	Density	E13.5	

Document of the CML-formatted file

In the case of 3-dimensional analysis				
4 – (3 records per element)	1-8	ID of element	I8	
	9-21	Stress value of XX-component	E13.5	σ_{11}
	22-34	Stress value of YY-component	E13.5	σ_{22}
	35-47	Stress value of ZZ-component	E13.5	σ_{33}
	48-60	Stress value of YZ-component	E13.5	σ_{23}
	61-73	Stress value of ZX-component	E13.5	σ_{31}
	74-86	Stress value of XY-component	E13.5	σ_{12}
	1-8	Empty	8X	
	9-21	Strain value of XX-component	E13.5	E_{11}
	22-34	Strain value of YY-component	E13.5	E_{22}
	35-47	Strain value of ZZ-component	E13.5	E_{33}
	48-60	Strain value of YZ-component	E13.5	E_{23}
	61-73	Strain value of ZX-component	E13.5	E_{31}
	74-86	Strain value of XY-component	E13.5	E_{12}
	1-8	Empty	8X	
	9-21	von Mises stress	E13.5	$\bar{\sigma}$
	22-34	Effective plastic strain	E13.5	$\bar{\varepsilon}^p$
	35-47	Dummy value (Undefined Elemental Data A)	E13.5	
	48-60	Dummy value (Undefined Elemental Data B)	E13.5	
	61-73	Dummy value (Undefined Elemental Data C)	E13.5	
	74-86	Density	E13.5	

Example of CML formatted file

Ex. 1:   Macroscopic FE Model for "GNGLAN"

```
/TITLE/
Sample data of CML format (Macroscopic Model for  "GNGLAN" )
/COORD/
       4
       1    0.00000E+00     0.00000E+00     0.00000E+00
       2    1.00000E+00     0.00000E+00     0.00000E+00
       3    1.00000E+00     1.00000E+00     0.00000E+00
       4    0.00000E+00     1.00000E+00     0.00000E+00
/QUAD4/
       1
       1    1    1    1    1       1       2       3       4
/MATER/
     1
     1
 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
/EULER/
     1
     1 0.00000E+00  0.00000E+00  0.00000E+00
/CONST/
     0    2    0
         1 110000 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         4 100000 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
/LOADC/
     1
     0    1    0
         1       2       3 0.00000E+00  1.00000E+00  0.00000E+00  0.00000E+00
/SOLUT/
    10    1    0    0    0
     1    1    0    0    0
/PSTEP/
     2
     1    1
     2   10
/PELEM/
     2
     1    1    1
     2    1    4
/LASTD/
/ENDOF/
```

Document of the CML-formatted file

Ex. 2: Microscopic FE Model for "GNGLAN"

```
/TITLE/
Sample data of CML format (Microscopic Model for "GNGLAN")
/COORD/
        9
        1    0.00000E+00    0.00000E+00    0.00000E+00
        2    1.00000E+00    0.00000E+00    0.00000E+00
        3    2.00000E+00    0.00000E+00    0.00000E+00
        4    0.00000E+00    1.00000E+00    0.00000E+00
        5    1.00000E+00    1.00000E+00    0.00000E+00
        6    2.00000E+00    1.00000E+00    0.00000E+00
        7    0.00000E+00    2.00000E+00    0.00000E+00
        8    1.00000E+00    2.00000E+00    0.00000E+00
        9    2.00000E+00    2.00000E+00    0.00000E+00
/QUAD4/
        4
        1    2    1    1    1       1       2       5       4
        2    1    1    1    1       2       3       6       5
        3    1    1    1    1       4       5       8       7
        4    2    1    1    1       5       6       9       8
/MATER/
     2
     1
 1.00000E+02 3.00000E-01 0.00000E+00 0.00000E+00 0.00000E+00
 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 1.00000E+05
 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
     2
 5.00000E+01 2.30000E-01 0.00000E+00 0.00000E+00 0.00000E+00
 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 2.50000E-02
 1.20000E+01 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
/EULER/
     1
     1   0.00000E+00   0.00000E+00   0.00000E+00
/CONST/
     0    0    5
        1    7    1
        3    7     1.00000
        1    7    1
        7    7     1.00000
        1    7    1
        9    7     1.00000
        2    7    1
        8    7     1.00000
        4    7    1
        6    7     1.00000
/LASTD/
/ENDOF/
```

Document of the CML-formatted file