C++ IO support for various FEM exchange file formats

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Contents

1 Supported FEM file formats

Not all functionality defined for the exchange file formats is supported. The supported subset is currently mainly defined by the functionality supported in GLFrame rspt. the BMF file format.

More detailed information on supported functionality can be found in the according directories in the doc dubdirectory.

1.1 NASTRAN Bulk Data Format (BDF)

1.1.1 BDF Cards supported

	Name	Description	Read	Write
General				
	MAT1	Material definition	✓	☹
	GRID	Grid nodes	✓	☹
Elements				
	CTRIA3	3 node shaped shell elements	✓	☹
	CQUAD4	4 node shaped shell elements	✓	☹
	CBEAM	Complex beams [1]	✓	☹
	CBAR	Simple beams	✓	✓
	CROD	Trusses	✓	☹
	CELAS1	Scalar Spring Connection	☹	☹
Element	properties			
	PSHELL	Properties for CTRIA3, and CQUAD4	✓	☹
	PBEAM	Integral properties for CBEAM	✓	☹
	PBEAML	Properties for CBEAM describing cross section	✓	☹
	PBAR	Integral properties for CBAR	✓	☹
	PBARL	Properties for CBAR describing cross section	✓	☹
	PROD	Properties for CROD	✓	☹
	PELAS	Properties for CELAS*	☹	☹
Load				
	LOAD	Load case combination	✓	✓
	FORCE	Forces on Nodes	✓	✓
	MOMENT	Moments on Nodes	✓	✓
Misc				
	ENDDATA	Marker for end of input file	✓	✓

[1] Twisting CBEAM cross section by using the BIT flag is not supported. Offset via OFFT is only supported for the same offset at *A* and *B* end of beam.

1.2 DNV GL Seasam Input Interface File (FEM)

1.2.1 FEM Cards supported

	Name	Description	Read	Write	Page[2]
General					
	DATE	Date and Program Information	✓	✓	4-2
	GCOORD	Nodal Coordinates	✓	✓	6-56
	GNODE	Correspondence between External and Internal Node Numbering, and Number of Degrees of Freedom of Each Node	✓	✓	6-80
	IDENT	Identification of Superelements	✓	✓	4-3
	IEND	End of a Superelement	✓	✓	4-4
Elements					
	GELMNT1	Element Data Definition	✓	✓	6-65
	GELREF1	Reference to Element Data	✓	✓	6-66
Element properties					
	GBARM	Cross Section Type Massive Bar	✓	✓	6-48
	GBEAMG	General Beam Element Data	✓	✓	6-49
	GECCEN	Eccentricities	✓	✓	6-61
	GELTH	Thickness of Two-dimensional Elements	✓	✓	6-70
	GIORH	Cross Section Type I or H Beam	✓	✓	6-71
	GLSEC	Cross Section Type L-Section	✓	✓	6-76
	GPIPE	Cross Section Type Tube	✓	✓	6-81
	BELFIX	Flexible Joint/Hinge	✓	✓	6-8
Load					
	BLDEP	Nodes with Linear Dependence	✓	✓	6-27
	BNBCD	Nodes with Boundary Conditions	✓	✓	6-30
	BNDISPL	Nodes with Prescribed Displacements and Accelerations	✓	✓	6-31
	BNLOAD	Nodes with Loads	✓	✓	6-35
	MGSPRNG	Element to Ground	✓	✓	6-103
	TDLOAD	**not documented** (Seems to be similar to TDMATER or TDSETNAM)	✓	✓	
	BEUSLO	Elements with Surface Loads	✓	✓	6-21
Superel.					
	BSELL	Subelement Load Description	✓	✓	7-27
	GELMNT2	Subelement Description with Simple Correspondence	✓	✓	7-31
	HSUPSTAT	Superelement Statistical Information	✓	✓	7-40
	HSUPTRAN	Superelement Transformations	✓	✓	7-41
	HIERARCH	Superelement Hierarchy Description	✓	✓	7-38
Misc					
	GSETMEMB	Set (group) of Nodes or Elements (Members)	✓	✓	6-84
	GUNIVEC	Specification of Local Element Coordinate System	✓	✓	6-92
	MISOSEL	Isotropy, Linear Elastic Structural Analysis	✓	✓	6-115
	TDSETNAM	Name and Description of a Set (group)	✓	✓	4-7
	TEXT	User supplied Text	✓	✓	4-10

[2] References page in "Technical Report: Sesam Input Interface File, File Description", Document id: 89-7012, Revision Number 9 / 01

1.2.2 Element Types in SESAM

Conventions for use of the interface file for the elements in SESAM are defined here. Other element types may be introduced for use in other programs.

The table below contains element type numbers already reserved. (Not all of them are included in SESAM).

For ADVANCE, the element types listed are those available from the SESAM preprocessors. In addition to that ADVANCE has a lot of other element types.

Table 1: List of existing Element Types

Typ[3]	Name	N.[4]	Description of Element	Ref.	5	6	7	8	9	Other[10]
1			*Not yet defined*							
2	BEPS	2	2-D, 2 Node Beam	3, 5	✓			✓		
3	CSTA	3	Plane Constant Strain Triangle	2, 4		✓	✓	✓		
4			*Not yet defined*	3						
5	RPBQ	4	Rectangular Plate. Bending Modes	3						
6	ILST	6	Plane Lin. Strain Triangle	2		✓	✓			
7			*Not yet defined*							
8	IQQE	8	Plane Quadrilateral Membrane Element	2		✓	✓			
9	LQUA	4	Plane Quadrilateral Membrane Element	2, 4		✓	✓	✓		
10	TESS	2	Truss Element	2, 4	✓	✓	✓	✓	⌒̈	
11	GMAS	1	1-Noded Mass-Matrix			✓	✓		⌒̈	
12	GLMA	2	2-Noded Mass-Matrix				✓			
13	GLDA	2	2-Noded Damping-Matrix							
14			*Not yet defined*							
15	BEAS	2	3-D, 2 Node Beam	2, 4	✓	✓	✓	✓	⌒̈	FR, LA, PL, PR, WA
16	AXIS	2	Axial Spring		✓	✓	✓	✓[19]	⌒̈	FR
17	AXDA	2	Axial Damper		✓	✓	✓		⌒̈	
18	GSPR	1	Spring to Ground	4	✓	✓	✓	✓	⌒̈	FR
19	GDAM	1	Damper to Ground		✓	✓	✓		⌒̈	
20	IHEX	20	Isoparametric Hexahedron	2		✓	✓	✓		FR
21	LHEX	8	Linear Hexahedron	2, 4		✓	✓	✓		FR
22	SECB	3	Subparametric Curved Beam	2						
23	BTSS	3	General Curved Beam	2		✓	✓			PL, PR
24	FQUS	4	Flat Quadrilateral Thin Shell	4		✓	✓		✓	PL, PR
24	FFQ	4	Free Formulation Quadrilateral Shell	5				✓		
25	FTRS	3	Flat Triangular Thin Shell	4		✓	✓		✓	PL
25	FFTR	3	Free Formulation Triangular Shell	5				✓		
26	SCTS	6	Subparametric Curved Triangular Thick Shell	2		✓	✓			PL
27	MCTS	6	Subparametric Curved Triangular Thick Sandwich Element	2[20]		✓	✓			
28	SCQS	8	Subparametric Curved Quadrilateral Thick Shell	2		✓	✓			PL, PR
29	MCQS	8	Subparam. Curved Quadr. Thick Sandwich Elem.	2[12]		✓	✓			

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Typ[11]	Name	N.[12]	Description of Element	Ref.	13	14	15	16	17	Other[18]
30	IPRI	15	Isoparametric Triangular Prism	2		✓	✓	✓		
31	ITET	10	Isoparametric Tetrahedron	2			✓			
32	TPRI	6	Triangular Prism	2, 4		✓	✓	✓		
33	TETR	4	Tetrahedron	2			✓			
34	LCTS	6	Subparam. Layered Curved Triangular Thick Shell	2[12]		✓	✓			
35	LCQS	8	Subparam. Layered Curved Quadrilat. Thick Shell	2[12]		✓	✓			
36	TRS1	18	2nd Order Hexahed. Transition Elem., Solid / Shell	6			✓			PR
37	TRS2	15	2nd Order Hexahed. Transition Elem., Solid / Shell	6			✓			PR
38	TRS3	12	2nd Order Hexahed. Transition Elem., Solid / Shell	6			✓			PR
39			*Not yet defined*							
40	GLSH	2	General Spring / Shim Element	[21]	✓		✓		⌒̈	
41	AXCS	3	Axisymmetric Constant Strain Triangle	7, 5		✓	✓	✓		
42	AXLQ	4	Axisymmetric Quadrilateral	7, 5		✓	✓	✓		
43	AXLS	6	Axisymmetric Linear Strain Triangle	7		✓	✓			
44	AXQQ	8	Axisymmetric Linear Strain Quadrilateral	7		✓	✓			
45	PILS	1	Pile / Soil	4	✓			✓		
46	PCAB	2	Plane Cable-Bar Element	4	✓			✓		
47	PSPR	1	Plane Spring Element	4	✓			✓		
48		4	4-node Contact Element with triangular Shape	4				✓		
49		2	2-Noded Link Element	4				✓		
50			*Not yet defined*							
51	CTCP	2	2-Noded Contact Element							
52	CTCL	4	4-Noded Contact Element							
53	CTAL	4	4-Noded Axisymmetric Contact Element							
54	CTCC	6	6-Noded Contact Element							
55	CTAQ	6	6-Noded (3+3) Axisymmetric Contact Element			✓				
56	CTLQ	8	8-Noded (4+4) Contact Element	8, 9						PR
57	CTCQ	16	16-Noded (8+8) Contact Element	8, 9		✓				PR
58	CTMQ	18	18-Noded (9+9) Contact Element	8, 9						PR
59			*Not yet defined*							
60			*Not yet defined*							
61	HCQS	9	9-Noded Shell Element			✓				PR
62			*Not yet defined*							
63			*Not yet defined*							
64			*Not yet defined*							
65			*Not yet defined*							

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Continued from previous page

Typ[11]	Name	N.[12]	Description of Element	Ref.	13	14	15	16	17	Other[18]
66	SLQS	8	Semiloof Quadrilateral Curved Thin Shell (32 d.o.fs)							
67	SLTS	6	Semiloof Triangular Curved Thin Shell (24 d.o.fs)							
68	SLCB	3	Semiloof Curved Beam (11 d.o.fs)							
69			*Not yet defined*							
70	MATR	*n*	General Matrix Element with arbitrary no. of nodes (*n*)					✓		SP
...										
100	GHEX	21	General Hexahedron				✓			
...										
163	GHEX	27	General Hexahedron				✓			

1.2.3 Contents of FQUS and FTRS: Flat Quadrilateral/Triangular Thin Shell

1.2.3.1 GELMNT1: Element Data Definition (mandatory)

Table 2: GELMNT1 record layout

GELMNT1	ELNOX NODIN1	ELNO NODIN2	ELTYP NODIN3	ELTYAD (NODIN4)

- ELNOX: External element number (specified or controlled by user).
- ELNO: Internal element number (generated by program)
- ELTYP: 24 (FQUS), or 25 (FTRS).
- ELTYAD: Not used here.
- NODIN: Internal node numbers in the assembly, to which this element is connected.

  The sequence of the node numbers is in accordance with the local node numbering of the basic element.

  By 'internal node numbers' is meant the node numbering of the entire superelement of which the element ELNOX is a part. The internal node number refers to the node number generated by the program. The program-defined element number ranges from 1 up to number of elements. The sequence of the records will correspond to the program-defined element numbering, ELNO.

  4 entries for FQUS, 3 entries for FTRS.

[3] ELTYP
[4] Number of nodes
[5] Indcluded in program PREFRAME
[6] Included in program PREFEM
[7] Included in program SESTRA
[8] Included in program ADVANCE
[9] Included in program Poseidon
[10] **FR** = FRAMEWORK, **LA** = LAUNCH, **PL** = PLATEWORK, **PR** = PRETUBE, **SP** = SPLICE, **WD** = WADAM, **WJ** = WAJAC
[11] Temporarily ADVANCE interprets Axisl Spring as link element, ignoring the material reference. The 6 matrix numbers are given in direct input to ADVANCE.
[12] The element subroutines are the same as for the subparametric curved thick shells (SCQS and SCTS).
[13] As General Spring it is just a 2-noded spring (12x12 matrix) which may be in a local coordinate system. As a shim element the preprocessor(s) will only insert stiffness in the local x- and y-direction. In the analysis program(s), shim members and general springs are treated exactly in the same manner.

1.2.3.2 GNODE Correspondence between External and Internal Node Numbering and Number of Degrees of Freedom of Each Node (mandatory)

Table 3: GELMNT1 record layout

GNODE	NODEX	NODENO	NDOF	ODOF

There will be one record with the identifier GNODE for each node. The sequence of the records will correspond to the internal node number, NODENO.

Example: NDOF 3, =ODOF =135 means 3 degrees of freedom in x, z and Ry direction respectively in the superelement's coordinate system, unless a local nodal coordinate system is specified (see the BNDOF and BNTRCOS record).

- NODEX: External node number (specified or controlled by user).
- NODENO: Internal node number defined by the program (may be generated by internal node numbering optimalizer). The internal node numbers range from 1 up to number of nodes.
- NDOF: Number of degrees of freedom of nodal point NODENO.
- ODOF: Order of degrees of freedom. NDOF digits.

1.2.3.3 GCOORD Nodal Coordinates (mandatory)

Table 4: GCOORD record layout

GCOORD	NODENO	XCOORD	YCOORD	ZCOORD

- NODENO: Program defined (internal) node number
- XCOORD: Cartesian X-coordinates of node NODENO.
- YCOORD: Cartesian Y-coordinates of node NODENO.
- ZCOORD: Cartesian Z-coordinates of node NODENO.

1.2.3.4 GELREF1: Reference to Element Data (mandatory)

Table 5: GELREF1 record layout

GELREF1	ELNO MINTNO GEONO/OPT GEONO (1) ... ECCNO (N)	MATNO STRANO FIXNO/OPT ... FIXNO (1) TRANSNO (1)	ADDNO STRENO ECCNO/OPT GEONO (N) ECCNO (1) ...	INTNO STREPONO TRANSNO/OPT FIXNO (1) ... TRANSNO (N)

- ELNO: Internal element number (generated by the program).
- MATNO: Material number
  - $= 0$ no material data attached to the element
- ADDNO: Additional data type number, i.e. number referring to additional data specification
  - $= 0$ no additional data attached to the element
- INTNO: *not used here*

- MINTNO: Integration station reference number for mass and damping matrices. Integration station, see INTNO.

  MINTNO $= 0$: Default values of the analysis program are employed.

- STRANO: Initial strain number, i.e. number referring to the specification of initial strains. The data type containing these data is not yet defined.
- STRENO: Initial stress number, i.e. number referring to the specification of initial stresses. The data type containing these data is not yet defined.
- STREPONO: *not used here*
- GEONO_OPT: Geometry reference number or option for geometry reference number specified later in this record sequence.
  - > 0: The geometry reference number (the same for all nodes in the element). GEONO (1), ..., GEONO (N) will not be specified.

    As FQUS, and FTRS do not allow thickness variation, this is the recommended entry type. Otherwise a mean thickness has to be calculated.
  - $= -1$: Reference numbers to geometry data are specified later in this record sequence for all nodes, i.e. all GEONO (1), ..., GEONO (N) will be given.
- FIXNO_OPT: Fixation reference number or option for fixation reference numbers specified later in this record sequence. The meaning assigned to the values of FIXNO_OPT corresponds to those for GEONO_OPT.
- ECCNO_OPT: Eccentricity reference number or option for eccentricity reference numbers specified later in this record sequence. The meaning assigned to the values of ECCNO_OPT corresponds to those for GEONO_OPT.
- TRANSNO_OPT: Reference number for local coordinate system specification or option for specification of local nodal coordinate systems later in this record sequence. Refers to GUNIVEC or BNTRCOS record. The meaning assigned to the values of TRANSNO_OPT corresponds to those for GEONO_OPT.
- GEONO: Geometry reference number for the local nodes of the element.
- FIXNO:Number referring to the specification of degree of fixation (Data type BELFIX). FIXNO (0) is the reference number for the 1st local node of the element, FIXNO ($i-1$) will be the reference number for the i 'th local node.
- ECCNO: Eccentricity number for the local nodes of the element, i.e. number referring to the specification of eccentricities.
- TRANSNO: Number referring to the specification of the local element coordinate system for the local nodes of the element. Refers to BNTRCOS or GUNIVEC record depending on element type.

1.2.3.5 GELTH: Thickness of Two-dimensional Elements (mandatory)

Table 6: GELTH record layout

GELTH	GEONO	TH	NINT	

- GEONO: Geometry type number, i.e. referenced to by GELREF1.
- TH: Thickness of the element, measured in a specific node.
- NINT: Number of integration points through thickness.

1.2.3.6 one of (mandatory)

1.2.3.6.1 MISOSEL: Isotropy, Linear Elastic Structural Analysis

Table 7: MISOSEL record layout

MISOSEL	MATNO DAMP	YOUNG ALPHA	POISS *DUMMY*	RHO YIELD

- MATNO: Material number, i.e. reference number referenced to by the element specification.
- YOUNG: Young's modulus.
- POISS: Poisson's ratio.
- RHO: Density.
- DAMP: Specific damping.
- ALPHA: Thermal expansion coefficient.
- *DUMMY*: *undocumented*
- YIELD: Yield stress.

1.2.3.6.2 MORSMEL: Anisotropy, Linear Elastic Structural Analysis, 2-D Membrane Elements and 2-D Thin Shell Elements *Not supported by Poseidon import*

1.2.3.7 MTRMEL: Local Transformation of the Axes of Anisotropy, 2-D Membrane Elements and 2-D Thin Shell Elements *Not supported by Poseidon import*

1.2.3.8 BEUSLO: Elements with Surface Loads

Table 8: BEUSLO record layout

BEUSLO	LLC ELNO RLOAD1 RLOAD(NDOF)	LOTYP NDOF RLOAD2 ILOAD1	COMPLX INTNO	LAYER SIDE ... ILOAD(NDOF)

If phase shift is not specified, i.e. COMPLX $= 0$, the fields or positions ILOAD1, ILOAD2, etc. are left out.

Normal pressure means that only one pressure component is specified for each node, and this pressure component is acting normal to the surface.

For volume elements a positive value means normal pressure directed into the element. For shell elements, a positive value means normal pressure in the local z-direction.

- LLC: Local load case number (positive integer number).
- LOTYP: Load type.

  Only LOTYP $= 1$ is really supported by FQUS and FTRS as only pressures actibg perpendicular to the element surface can be used. Other componets are ignored with LOTYP $= 2$.

  - $= 1$: normal pressure, conservative load
  - $= 2$: load given in component form, conservative load

- COMPLX: Phase shift definition.
  - $= 0$: no phase shift
  - $= 1$: phase shift
- LAYER: Layer number for elements with more than one layer. If LAYER equals 0, the surface load will be positioned in the shell layer (in opposition to a stiffener layer). If more than one shell layer and LAYER equals 0, the programs shall stop and give an error message. For elements which are treated as one layer in the load calculations (e.g. the sandwich element in SESTRA), LAYER does not have any meaning.
- ELNO: Internal element number (generated by the program).
- NDOF:
  - If LOTYP $= 1$: number of nodes of the specified element side
  - If LOTYP $= 2$: number of translational degrees of freedom of the specified element side
- INTNO: Integration station reference number. Referring to record GELINT. This reference is usually not used ($= 0$). It means that the program performing the load calculation chooses integration points.
- SIDE: Side definition

  For shell elements:
  - $= 1$: loads referred to element side where $z = -1$
  - $= 2$: loads referred to element side where $z = 0$
  - $= 3$: loads referred to element side where $z = 1$
- RLOADi: The real part of the load with respect to the i th degree of freedom or i th node of the element side.
- ILOADi: The imaginary part of the load with respect to the i th degree of freedom or i th node of the element side.

  If LOTYP $= 3$, RLOAD $= \pm 1.0$ indicating which side the element pressure comes from. (+1 indicates shell element SIDE $= 1$ ($z = -1$), -1 indicates shell element SIDE $= 3$ ($z = 1$)). For solids when LOTYP $= 3$, RLOAD must be +1.0.

1.2.3.9 BELL02: Elements with Line Loads, Solid, 3-D Shell, 2-D Shell-, Membrane and Curved Beam Elements *Not supported by Poseidon import*

1.2.3.10 BEISTE: Elements with Initial Strain Due to Thermal Expansion *Not supported by Poseidon import*

1.2.3.11 BGRAV: Gravitational Load (Constant of Gravity) *Not supported by Poseidon import*

1.2.3.12 BNACCL0: Nodes with Acceleration Load *Not supported by Poseidon import*

1.2.4 Contents of BEAS: 3-D, 2 Node Beam

1.2.4.1 GELMNT1: Element Data Definition (mandatory)

Table 9: GELMNT1 record layout

GELMNT1	ELNOX NODIN1	ELNO NODIN2	ELTYP	ELTYAD

- ELNOX: External element number (specified or controlled by user).
- ELNO: Internal element number (generated by program)
- ELTYP: 15.
- ELTYAD: Additional information related to element type.
  - For two noded beam elements used to specify structural / non-structural elements:
    $= 0$: Structural beam
    $= 1$: Non structural beam
- NODIN: Internal node numbers in the assembly, to which this element is connected.

  The sequence of the node numbers is in accordance with the local node numbering of the basic element.

  By 'internal node numbers' is meant the node numbering of the entire superelement of which the element ELNOX is a part. The internal node number refers to the node number generated by the program. The program-defined element number ranges from 1 up to number of elements. The sequence of the records will correspond to the program-defined element numbering, ELNO.

1.2.4.2 GBEAMG: General Beam Element Data (mandatory)

Table 10: GBEAMG record layout

GBEAMG	GEONO IY WYMIN SHCENY	*void* IZ WZMIN SHCENZ	AREA IYZ SHARY SY	IX WXMIN SHARZ SZ

- GEONO: Geometry number, referenced to on GELREF1.
- AREA: Cross section area.
- IX: Torsional moment of inertia about the shear center.
- IY: Moment of inertia about the y axis $= \int z^2 dA$.
- IZ: Moment of inertia about the z axis $= \int y^2 dA$.
- IYZ; Product of inertia about y and z axis $= \int yz dA$.
- WXMIN: Minimum torsional section modulus about shear center ($= IX/rmax$ for a PIPE element).
- WYMIN: Minimum sectionmodulus about y axis $= IY/zmax$.
- WZMIN: Minimum sectionmodulus about z axis $= IZ/ymax$.
- SHARY: Shear area in the direction of y axis. If zero, shear is not included.

- SHARZ: Shear area in the direction of z axis. If zero, shear is not included.
- SHCENY: Shear center location y component.
- SHCENZ: Shear center location z component
- SY: Static area moment about y -axis $= \int z dA$.
- SZ: Static area moment about z -axis $= \int y dA$.

1.2.4.3 GELREF1: Reference to Element Data (mandatory)

Table 11: GELREF1 record layout

GELREF1	ELNO MINTNO GEONO/OPT GEONO (1) ... ECCNO (N)	MATNO STRANO FIXNO/OPT ... FIXNO (1) TRANSNO (1)	ADDNO STRENO ECCNO/OPT GEONO (N) ECCNO (1) ...	INTNO STREPONO TRANSNO/OPT FIXNO (1) ... TRANSNO (N)

- ELNO: Internal element number (generated by the program).
- MATNO: Material number
  - $= 0$ no material data attached to the element
- ADDNO: Additional data type number, i.e. number referring to additional data specification
  - $= 0$ no additional data attached to the element
- INTNO: Integration station reference number for stiffness matrix, i.e. number referring to the specification of integration stations. An integration station is defined as:
  - an assembly of integration points over a cross section of a 1-dimensional (beam or bar) element,
  - an assembly of integration points on a line through the thickness of a 2-dimensional element,
  - one single integration point for a 3-dimensional element. For further explanation see record GELINT.

  INTNO $= 0$: Default values of the analysis program are employed.
- MINTNO: Integration station reference number for mass and damping matrices. Integration station, see INTNO.

  MINTNO $= 0$: Default values of the analysis program are employed.
- STRANO: Initial strain number, i.e. number referring to the specification of initial strains. The data type containing these data is not yet defined.
- STRENO: Initial stress number, i.e. number referring to the specification of initial stresses. The data type containing these data is not yet defined.
- STREPONO: Stresspoint specification reference number. See record GELSTRP for further information.
- GEONO_OPT: Geometry reference number or option for geometry reference number specified later in this record sequence.

  BEAS supports constant cross section only.

- > 0: The geometry reference number (the same for all nodes in the element). GEONO (1), ..., GEONO (N) will not be specified.
- $= 0$: No geometry data is given, i.e. neither here nor on GEONO (1), ..., GEONO (N).
- $= -1$: Reference numbers to geometry data are specified later in this record sequence for all nodes, i.e. all GEONO (1), ..., GEONO (N) will be given.

- FIXNO_OPT: Fixation reference number or option for fixation reference numbers specified later in this record sequence. The meaning assigned to the values of FIXNO_OPT corresponds to those for GEONO_OPT.

- ECCNO_OPT: Eccentricity reference number or option for eccentricity reference numbers specified later in this record sequence. The meaning assigned to the values of ECCNO_OPT corresponds to those for GEONO_OPT.

- TRANSNO_OPT: Reference number for local coordinate system specification or option for specification of local nodal coordinate systems later in this record sequence. Refers to GUNIVEC or BNTRCOS record. The meaning assigned to the values of TRANSNO_OPT corresponds to those for GEONO_OPT.

- GEONO: Geometry reference number for the local nodes of the element.

- FIXNO:Number referring to the specification of degree of fixation (Data type BELFIX). FIXNO (0) is the reference number for the 1st local node of the element, FIXNO ($i-1$) will be the reference number for the i 'th local node.

- ECCNO: Eccentricity number for the local nodes of the element, i.e. number referring to the specification of eccentricities.

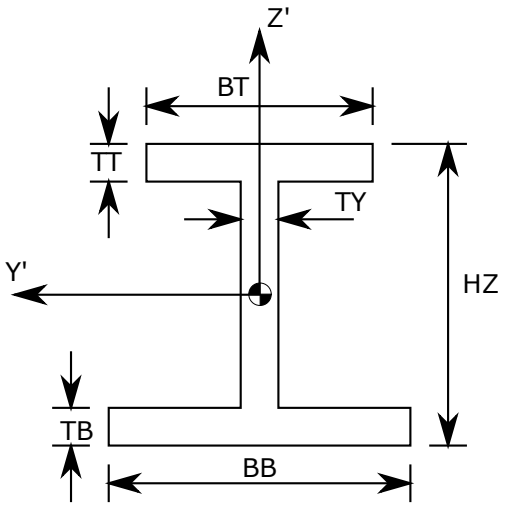
- TRANSNO: Number referring to the specification of the local element coordinate system for the local nodes of the element. Refers to BNTRCOS or GUNIVEC record depending on element type.

1.2.4.4 One of

1.2.4.4.1 GIORH: Cross Section Type I or H Beam

Table 12: GIORH record layout

GIORH	GEONO TT SFZ	HZ BB NLOBYT	TY TB NLOBYB	BT SFY NLOBZ



- GEONO: Beam stress type number, i.e. reference number used for element data definition of cross sectional properties of beams.
- HZ: Height of beam at current location
- TY: Thickness of beam web
- BT: Width of top flange
- TT: Thickness of top flange
- BB: Width of bottom flange
- TB: Thickness of bottom flange
- SFY: Factor modifying the shear area calculated by the preprocessor program such that the modified shear area is

$$SHARY(MOD) = SHARY(PROG) \cdot SFY \tag{1}$$

  (The shear areas on GBEAMG are SHARY(MOD)).
- SFZ: Factor modifying the shear area calculated by the preprocessor program such that the modified shear area is

$$SHARZ(MOD) = SHARZ(PROG) \cdot SFY \tag{2}$$

  (The shear areas on GBEAMG are SHARZ(MOD)).
- NLOBYT: Number of integration points in top flange (optional)
- NLOBYB: Number of integration points in bottom flange (optional)
- NLOBZ: Number of integration points in beam web (optional)

1.2.4.4.2 GUSYI: Cross Section Type Unsymmetrical I-Beam

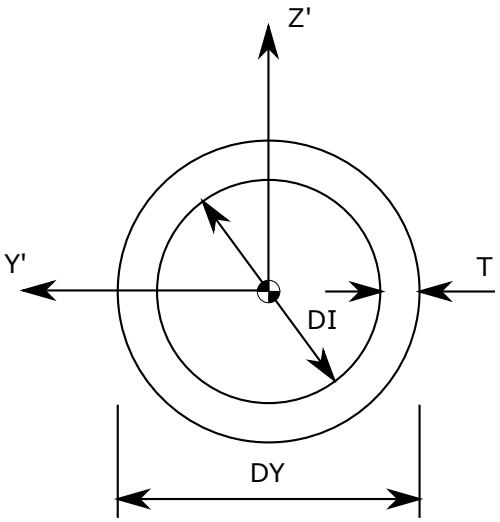
1.2.4.4.3 GCHAN: Cross Section Type Channel Beam

1.2.4.4.4 GBOX: Cross Section Type Box Beam

1.2.4.4.5 GPIPE: Cross Section Type Tube

Table 13: GIORH record layout

GPIPE	GEONO SFY	DI SFZ	DY NDIR	T NRAD



- GEONO: Geometry type number, i.e. reference number used for element data definition of geometry properties (Cross sectional properties) of beams.
- DI: Inner diameter of tube.
- DY: Outer diameter of tube (mandatory).
- T: Thickness of tube (not necessary if DI is given).
- SFY: Factor modifying the shear area calculated by the preprocessor program such that the modified shear area is

$$SHARY(MOD) = SHARY(PROG) \cdot SFY \tag{3}$$

  (The shear area on GBEAMG is SHARY(MOD)).
- SFZ: Factor modifying the shear area calculated by the preprocessor program such that the modified shear area is

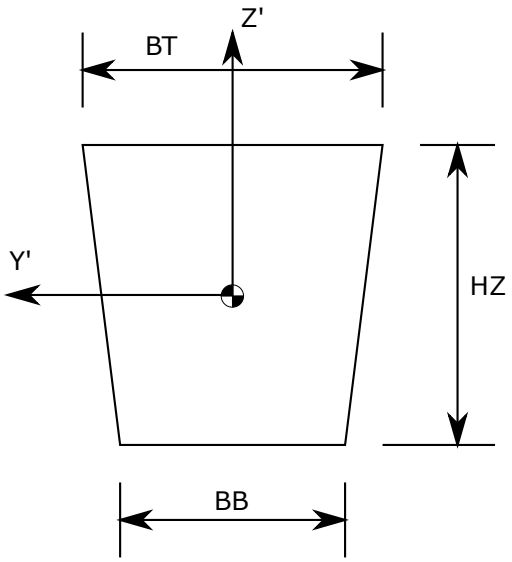
$$SHARZ(MOD) = SHARZ(PROG) \cdot SFZ \tag{4}$$

  (The shear area on GBEAMG os SHARZ(MOD)).
- NCIR: Number of integration points in circumferential direction (optional)
- NRAD: Number of integration points in radial direction (optional)

1.2.4.4.6 GBARM: Cross Section Type Massive Bar

Table 14: GBARM record layout

GBARM	GEONO SFY	HZ SFZ	BT NLOBY	BB NLOBZ



- GEONO: Geometry type number, i.e. reference number used for element data definition of geometry properties (Cross sectional properties) of beams.
- HZ: Height of beam.
- BT: Width of bar at top. For massive bars which are not able to have different widths at top and bottom this variable is used as the width of the beam.
- BB: Width of bar at bottom.
- SFY: Factor modifying the shear area calculated by the preprocessor program such that the modified shear area is

$$SHARY(MOD) = SHARY(PROG) \cdot SFY \tag{5}$$

  (The shear area on GBEAMG is SHARY(MOD)).
- SFZ: Factor modifying the shear area calculated by the preprocessor program such that the modified shear area is

$$SHARZ(MOD) = SHARZ(PROG) \cdot SFZ \tag{6}$$

  (The shear area on GBEAMG is SHARZ(MOD)).
- NLOBY: Number of integration points in Y' direction (optional)
- NLOBZ: Number of integration points in Z' direction (optional)

1.2.4.4.7 GTONP: Cross Section T on Plate

1.2.4.4.8 GDOBO: Section Type Double Bottom

1.2.4.5 MISOSEL: Isotropy, Linear Elastic Structural Analysis (mandatory)

Table 15: MISOSEL record layout

MISOSEL	MATNO DAMP	YOUNG ALPHA	POISS *DUMMY*	RHO YIELD

- MATNO: Material number, i.e. reference number referenced to by the element specification.

- YOUNG: Young's modulus.
- POISS: Poisson's ratio.
- RHO: Density.
- DAMP: Specific damping.
- ALPHA: Thermal expansion coefficient.
- *DUMMY*: *undocumented*
- YIELD: Yield stress.

1.2.4.6 GUNIVEC: Specification of Local Element Coordinate System (mandatory)

Table 16: MISOSEL record layout

GUNIVEC	TRANSNO	UNIX	UNIY	UNIZ

The GUNIVEC records are used for beam elements only, i.e. basic element types 2, 15 and 23. Other basic element types may refer to BNTRCOS records. No ambiguity thus exists if both a GUNIVEC and BNTRCOS record have same TRANSNO, but they should preferably have separate numbering (TRANSNO) to avoid possible program problems.

- TRANSNO: Unit vector number, referenced to on record GELREF1.
- UNIX: x component of Unit vector given in superelement coordinate system along the local z-axis (reference axis in z-direction) of the element in the particular node.
- UNIY: y component of Unit vector given in superelement coordinate system along the local z-axis (reference axis in z-direction) of the element in the particular node.
- UNIZ: z component of Unit vector given in superelement coordinate system along the local z-axis (reference axis in z-direction) of the element in the particular node.

1.2.4.7 GECCEN: Eccentricities

Table 17: GECCEN record layout

GECCEN	ECCNO	EX	EY	EZ

- ECCNO: Eccentricity number, referenced to on record GELREF1.
- EX: x component of eccentricity vector given in superelement coordinate system, the vector points from the global node towards the local element node.
- EY: y component of eccentricity vector given in superelement coordinate system, the vector points from the global node towards the local element node.
- EZ: z component of eccentricity vector given in superelement coordinate system, the vector points from the global node towards the local element node.

1.2.4.8 BEDRAG1: Hydrodynamic Drag and Damping from Wave Load Program

Not supported by Poseidon import

1.2.4.9 BEMASS1: Hydrodynamic added Mass from Wave Load Program

Not supported by Poseidon import

1.2.4.10 BELOAD1: Beams with Line Loads *Not supported by Poseidon import*

1.2.4.11 BGRAV: Gravitational Load (Constant of Gravity) *Not supported by Poseidon import*

1.2.4.12 BNACCL0: Nodes with Acceleration Load *Not supported by Poseidon import*

1.2.4.13 BEISTE: Elements with Initial Strain Due to Thermal Expansion *Not supported by Poseidon import*

1.2.4.14 BELFIX: Flexible Joint/Hinge

Table 18: BELFIX record layout

BELFIX	FIXNO A(1) A(5)	OPT A(2) A(6)	TRANO A(3)	*void* A(4)

- FIXNO: Fixation number to a node.

  FIXNO is referenced to from GELREF.

- OPT:
  - =FIXATION: A(i) = ai is a value between 0 and 1, and gives the degree of fixation (connectivity) to degree of freedom number i in the node. The extreme values of a is described by:
    - a = 0, fully released
    - a = 1, fully connected
  - =SPRING: A(i) = Ci is the interelement elastic spring stiffness to degree of freedom number i in the node. The degrees of freedom which are neither flexible nor free will be given Ci = -1 (instead of Ci = ∞). The relation between Ci and ai is

    ai = Ci / (kii + Ci) ≥ 0.0

    where kii is the diagonal term of the element stiffness matrix corresponding to degree of freedom number i of the current node.

- TRANO:
  - = -1: The fixation/flexibility (=A(i)) is given in the superelement coordinate system.
  - =0: A(i) is given in the local element coordinate system
  - >0: A(i) is given in a local coordinate system defined by TRANO, which refers to a transformation matrix given on record BNTRCOS. The transformation matrix is defined by transformation from global to local system.

- A: See above (under the explanation of OPT).