C++ IO support for various FEM exchange file formats

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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	✓	☹
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`	✓	☹
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
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
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
	TDLOAD	**not documented**			

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.

[2] References page in "Technical Report: Sesam Input Interface File, File Description", Document id: 89-7012, Revision Number 9 / 01 November 1996

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]		✓	✓			
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]		✓	✓			

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Typ[11]	Name	N.[12]	Description of Element	Ref.	13	14	15	16	17	Other[18]
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*							
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
...										

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Typ[11]	Name	N.[12]	Description of Element	Ref.	13	14	15	16	17	Other[18]
100	GHEX	21	General Hexahedron				✓			
...										
163	GHEX	27	General Hexahedron				✓			

[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.