SESAM INTERFACE FORMAT DESCRIPTION

Results Interface Format

Finite Element Results Data Types

Valid from SIF version 2

Sesam Interface Format Description

SIF

Date: 2022-05-09

Valid from SIF version 2

Prepared by: Digital Solutions at DNV

E-mail support: software.support@dnv.com

E-mail sales: digital@dnv.com

©DNV AS. All rights reserved

This publication or parts thereof may not be reproduced or transmitted in any form or by any means, including copying or recording, without the prior written consent of DNV AS.

Table of contents

1 Introduction . . . 1
1.1 Purpose . . . 1
1.2 How to Read the Manual . . . 1
2 STRUCTURAL RESULTS INTERFACE . . . 2
2.1 Structural Results Data type Definitions . . . 2
2.1.1 First Level Results Data Type Definitions . . . 2
2.1.1.1 **PDFATPRP**: Fatigue check point properties . . . 4
2.1.1.2 **PDSTRESS**: Fatigue stress component definition . . . 6
2.1.1.3 **PVFATDAM**: Fatigue check point results . . . 8
2.1.1.4 **PVSTRESS**: Fatigue stress results and principal stress direction vectors . . . 11
2.1.1.5 **RBLODCMB**: Combination of first level loads . . . 12
2.1.1.6 **RDELNFOR**: Element nodal force vector component definition . . . 13
2.1.1.7 **RDFATDMG**: Fatigue damage properties . . . 14
2.1.1.8 **RDFORCES**: Force component definition . . . 16
2.1.1.9 **RDIELCOR**: Internal element co-ordinates . . . 18
2.1.1.10 **RDMLFACT**: Modal load factors . . . 20
2.1.1.11 **RDNODBOC**: Definition of type of boundary condition . . . 21
2.1.1.12 **RDNODREA**: Nodal reaction force component definition . . . 22
2.1.1.13 **RDNODRES**: Nodal displacement/velocity/acceleration components . . . 23
2.1.1.14 **RDNODSUM**: Nodal force/moment/load components . . . 24
2.1.1.15 **RDPOINTS**: Element result point definition . . . 25
2.1.1.16 **RDRESCMB**: Combination of basic result cases . . . 32
2.1.1.17 **RDRESREF**: External result case reference data . . . 33
2.1.1.18 **RDSERIES**: Result series definition . . . 36
2.1.1.19 **RDSOIDSP**: Soil displacement data . . . 38
2.1.1.20 **RDSOILDI**: Soil layer diameter data . . . 39
2.1.1.21 **RDSOIPRF**: Soil profile main data . . . 40
2.1.1.22 **RDSTRAIN**: Strain component definition . . . 41
2.1.1.23 **RDSTRESS**: Stress component definition . . . 43
2.1.1.24 **RDTRANS**: Transformation definition . . . 45
2.1.1.25 **RSUMLOAD**: Sum of loads . . . 46
2.1.1.26 **RSUMMASS**: Sum of masses . . . 48
2.1.1.27 **RSUMREAC**: Sum of reaction forces . . . 49
2.1.1.28 **RSUPTRAN**: 1st level super element transformation . . . 51
2.1.1.29 **RVABSCIS**: Result series abscissa values . . . 53
2.1.1.30 **RVELNFOR**: Element nodal force vectors . . . 54
2.1.1.31 **RVFATDAM**: Fatigue damage results . . . 55
2.1.1.32 **RVFATDMG**: Fatigue damage results . . . 58
2.1.1.33 **RVFATDMH**: Fatigue damage results for shell elements . . . 61
2.1.1.34 **RVFATPRP**: Fatigue damage properties . . . 63
2.1.1.35 **RVFORCES**: Force results . . . 65
2.1.1.36 **RVNODACC**: Nodal accelerations . . . 66
2.1.1.37 **RVNODDIS**: Nodal displacements . . . 67
2.1.1.38 **RVNODREA**: Nodal reaction forces and moments . . . 68
2.1.1.39 **RVNODVEL**: Nodal velocities . . . 69
2.1.1.40 **RVORDINA**: Result series ordinate values . . . 70
2.1.1.41 **RVSNCURV**: SN-Curve data values . . . 71
2.1.1.42 **RVSOILAY**: Soil layers summary data . . . 73
2.1.1.43 **RVSOILPY**: Soil layers data for PY curves . . . 75
2.1.1.44 **RVSOILQZ**: Soil layers data for QZ curves . . . 76
2.1.1.45 **RVSOILTZ**: Soil layers data for TZ curves . . . 77
2.1.1.46 **RVSTRAIN**: Strain results . . . 78
2.1.1.47 **RVSTRESS**: Stress results . . . 79

2.1.1.48 **TDELEM**: Name of an Element and/or comment . . . 80
2.1.1.49 **TDFATDAM**: Fatigue damage name definitions . . . 81
2.1.1.50 **TDPVFATD**: Fatigue check point name. . . . 83
2.1.1.51 **TDNODE**: Name of a Node and/or comment . . . 84
2.1.1.52 **TDRESREF**: Result case name and description text . . . 85
2.1.1.53 **TDSERIES**: Series name and description text . . . 86
2.1.1.54 **TDSNCURV**: SN-Curve name description . . . 87
2.1.1.55 **TDSUPNAM**: Name of a Super Element and/or comment . . . 88
2.1.1.56 **TSOILPRF**: Soil profile name and/or comment . . . 89
2.1.2 Higher Level Results Data Type Definitions . . . 90
2.1.2.1 **HIERARCH**: Super Element Hierarchy Description . . . 91
2.1.2.2 **HSUPSTAT**: Super Element Statistical Information . . . 93
2.1.2.3 **HSUPTRAN**: Super Element Transformation . . . 94
3 HYDRODYNAMIC RESPONSE INTERFACE . . . 96
3.1 The User's Guide to the Hydrodynamic Data Types . . . 96
3.2 Definitions . . . 97
3.2.1 Phase definitions . . . 97
3.2.2 Wave direction definition . . . 98
3.2.3 Forward speed definition . . . 98
3.3 Hydrodynamic Data Type Definitions . . . 98
3.3.1 First Level Hydrodynamic Response Data Type Definitions . . . 98
3.3.1.1 **W1ACCELE**: Rigid body acceleration . . . 100
3.3.1.2 **W1EXFORC**: First order excitation force . . . 101
3.3.1.3 **W1MATRIX**: First order hydrodynamic matrices . . . 102
3.3.1.4 **W1MOTION**: Rigid body motion . . . 103
3.3.1.5 **W1PANEL**: Panel definition . . . 104
3.3.1.6 **W1PANPRE**: Panel pressure . . . 105
3.3.1.7 **W1POINT**: Point . . . 106
3.3.1.8 **W1SFORCE**: First order sectional force . . . 107
3.3.1.9 **W1VELOCI**: Rigid body velocity . . . 108
3.3.1.10 **W2EXFDIF**: Second order excitation force at difference frequencies . . . 109
3.3.1.11 **W2EXFSUM**: Second order excitation force at sum frequencies . . . 110
3.3.1.12 **W2FLUDIF**: Second order fluid kinematics at difference frequencies . . . 111
3.3.1.13 **W2FLUSUM**: Second order fluid kinematics at sum frequencies . . . 112
3.3.1.14 **W2HDRIFT**: Second order horizontal mean drift force . . . 113
3.3.1.15 **W2MDRIFT**: Second order mean drift force . . . 114
3.3.1.16 **W2WDDMAT**: Wave drift damping matrix . . . 115
3.3.1.17 **WBODCON**: Body and condition reference data . . . 117
3.3.1.18 **WBODY**: Body definition . . . 118
3.3.1.19 **WCURRPRF**: Current profile . . . 119
3.3.1.20 **WDRESREF**: External result case reference data . . . 120
3.3.1.21 **WDWACHAR**: Deterministic wave characteristics . . . 121
3.3.1.22 **WFKPOINT**: Fluid kinematics reference point definition . . . 122
3.3.1.23 **WFLUIDKN**: Fluid kinematics . . . 123
3.3.1.24 **WGLOBDEF**: Global analysis data . . . 124
3.3.1.25 **WGRESPON**: General responses . . . 125
3.3.1.26 **WHYCOEL**: Hydrodynamic coefficients for elements . . . 127
3.3.1.27 **WHYPREL**: Hydrodynamic properties for elements . . . 128
3.3.1.28 **WMRPOINT**: Motion reference point definition . . . 129
3.3.1.29 **WSCATTER**: Scatter diagram . . . 130
3.3.1.30 **WSECTION**: Section definition . . . 131
3.3.1.31 **WSURFACE**: Surface elevation . . . 132
3.3.1.32 **WWASUMLO**: Wave load sums . . . 134
3.3.1.33 **WWAWIKIN**: Calculated wave and wind kinematics . . . 136

3.3.1.34 **WWGTBUOY**: Calculated weight and buoyancy data . . . 138
3.3.1.35 **WWINDPRF**: Wind profile . . . 140
3.3.1.36 **TDBODNAM**: Body name definitions . . . 141
3.3.1.37 **TDRSNAM**: Response name definitions . . . 142
3.3.1.38 **TSCATTER**: Scatter name definitions . . . 143

1 Introduction

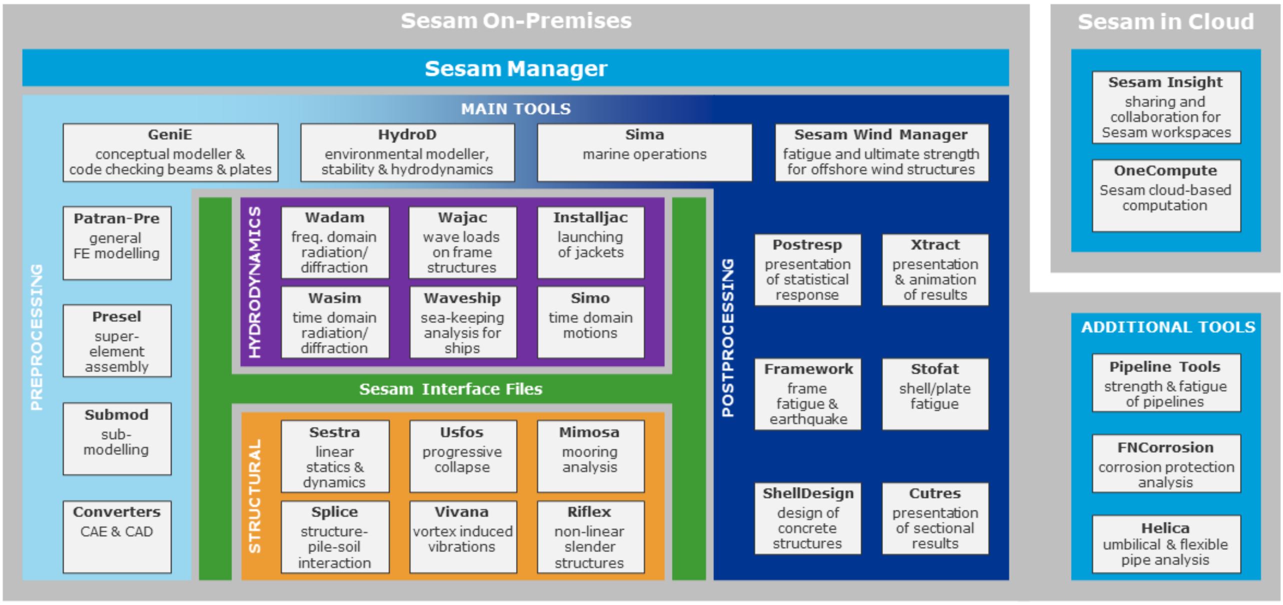


Figure 1.1: The Sesam system

This manual contains the Finite Element Results Data Types.

For the Finite Element Model and Loads Data Types consult [2].

Sesam Interface Format (SIF) provides a standardised basis for data communication in the Sesam system. The data definitions are organised as

- Input Interface data types.
- Load Interface data types.
- Result Interface data types which are further organised into
  - Structural Result Interface data types,
  - Hydrodynamic Result Interface data types.

1.1 Purpose

The purpose of SIF.API is to provide a clear, standardised and versatile data communication in the Sesam system. SIF.API is also intended to be open towards other software systems, as such it is also an interface between Sesam and other program systems.

1.2 How to Read the Manual

SIF.API consists of data types where a data type describes data for a node, an element, a result case etc.

Each data type has its unique name and input reference(s). An input reference may be a node number, an element number, a result case number etc.

2 STRUCTURAL RESULTS INTERFACE

2.1 Structural Results Data type Definitions

2.1.1 First Level Results Data Type Definitions

First level data

PDFATPRP	Fatigue check point properties	see Section 2.1.1.1
PDSTRESS	Fatigue stress component definition	see Section 2.1.1.2
PVFATDAM	Fatigue check point results	see Section 2.1.1.3
PVSTRESS	Fatigue stress results and principal stress direction vectors	see Section 2.1.1.4
RBLODCMB	Combination of first level loads	see Section 2.1.1.5
RDELNFOR	Element nodal force vector component definition	see Section 2.1.1.6
RDFATDMG	Fatigue damage properties	see Section 2.1.1.7
RDFORCES	Force component definition	see Section 2.1.1.8
RDIELCOR	Internal element co-ordinates	see Section 2.1.1.9
RDMLFACT	Modal load factors	see Section 2.1.1.10
RDNODBOC	Definition of type of boundary condition	see Section 2.1.1.11
RDNODREA	Nodal reaction force component definition	see Section 2.1.1.12
RDNODRES	Nodal displacement/velocity/acceleration components	see Section 2.1.1.13
RDNODSUM	Nodal force/moment/load components	see Section 2.1.1.14
RDPOINTS	Element result point definition	see Section 2.1.1.15
RDRESCMB	Combination of basic result cases	see Section 2.1.1.16
RDRESREF	External result case reference data	see Section 2.1.1.17
RDSERIES	Result series definition	see Section 2.1.1.18
RDSOIDSP	Soil profile main data	see Section 2.1.1.19
RDSOILDI	Soil layer diameter data	see Section 2.1.1.20
RDSOIPRF	Soil profile main data	see Section 2.1.1.21
RDSTRAIN	Strain component definition	see Section 2.1.1.22
RDSTRESS	Stress component definition	see Section 2.1.1.23
RDTRANS	Transformation definition	see Section 2.1.1.24
RSUMLOAD	Sum of loads	see Section 2.1.1.25
RSUMMASS	Sum of masses	see Section 2.1.1.26
RSUMREAC	Sum of reaction forces	see Section 2.1.1.27
RSUPTRAN	1st level super element transformation	see Section 2.1.1.28
RVABSCIS	Result series abscissa values	see Section 2.1.1.29
RVELNFOR	Element nodal force vectors	see Section 2.1.1.30

RVFATDAM	Fatigue damage results	see Section 2.1.1.31
RVFATDMG	Fatigue damage results	see Section 2.1.1.32
RVFATDMH	Fatigue damage results for shell elements	see Section 2.1.1.33
RVFATPRP	Fatigue damage properties	see Section 2.1.1.34
RVFORCES	Force results	see Section 2.1.1.35
RVNODACC	Nodal accelerations	see Section 2.1.1.36
RVNODDIS	Nodal displacements	see Section 2.1.1.37
RVNODREA	Nodal reaction forces and moments	see Section 2.1.1.38
RVNODVEL	Nodal velocities	see Section 2.1.1.39
RVORDINA	Result series ordinate values	see Section 2.1.1.40
RVSNCURV	SN-Curve data values	see Section 2.1.1.41
RVSOILAY	Soil layers summary data	see Section 2.1.1.42
RVSOILPY	Soil layers data for PY curves	see Section 2.1.1.43
RVSOILQZ	Soil layers data for QZ curves	see Section 2.1.1.44
RVSOILTZ	Soil layers data for TZ curves	see Section 2.1.1.45
RVSTRAIN	Strain results	see Section 2.1.1.46
RVSTRESS	Stress results	see Section 2.1.1.47
TDELEM	Name of an Element and/or comment	see Section 2.1.1.48
TDFATDAM	Fatigue damage name definitions	see Section 2.1.1.49
TDNODE	Name of a Node and/or comment	see Section 2.1.1.51
TDPVFATD	Fatigue check point name.	see Section 2.1.1.50
TDRESREF	Result case name and description text	see Section 2.1.1.52
TDSERIES	Series name and description text	see Section 2.1.1.53
TDSNCURV	SN-Curve name description	see Section 2.1.1.54
TDSUPNAM	Name of a Super Element and/or comment	see Section 2.1.1.55
TSOILPRF	Soil profile name and/or comment	see Section 2.1.1.56

2.1.1.1 **PDFATPRP**: Fatigue check point properties

This data type contains properties for a Sesam fatigue check point.

Data type definition:

	PDFATPRP		Data type reference.
	NFIELD		Number of data fields on this data type (including this field).
$\rightarrow$	CHECKPOINTID		Fatigue check point number.
	CHECKPOINTTYPE		Fatigue check point type.
		= 1	Fatigue check point type element.
		= 2	Fatigue check point type hot spot.
	NUMSNCURVES		The number of SN-Curves relevant for this check point.
	Repeat for SNCURVES		For each SN-Curve.
	SNCURVEID	$\rightarrow$	Identifier to the SN-Curve specification at the **RVSNCURV** data type.
	NUMRESPTS		Number of results points.
	NUMBEROFTRANSFORMATIONS		Number of results point transformation matrices.
	STRESS-STATE-TYPE		Stress state type.
		= 1	1D stress state.
		= 2	2D plane stress state.
		= 3	3D stress state.
	Repeat for RESPTS		For each result point.
	RESULTPOINTNUMBER		Result point number.
	XPOSITION		Global x-co-ordinate of the result point.
	YPOSITION		Global y-co-ordinate of the result point.
	ZPOSITION		Global z-co-ordinate of the result point.
	WLDOPTION		Option for weld normal line direction vectors.
		$= 1$	Weld normal line direction vectors are included.
		$\neq 1$	No weld normal line direction vectors in the results.
	Repeat for RESPTS		If WLDOPTION=1, then for each result point.
	w_1, w_2, w_3		The three components of the weld normal line direction vector in the tangent plane of the result point represented in the coordinate system specivied by the transformation matrix $\boldsymbol{R}$.
	Repeat for TRANSFORMATIONS		
	R11		The coefficients of the $\boldsymbol{R}$-transformation matrix
	R21		stored in column major order.
	R31		
	R12		
	R22		
	R32		
	R13		
	R23		
	R33		

Let the linear transformation from a local co-ordinate system to the global super element co-ordinate system be

$$\boldsymbol{x}_G = \boldsymbol{R}\,\boldsymbol{x}_L \tag{2.1}$$

where $\boldsymbol{x}_L$ are the co-ordinates in the local system, and where $\boldsymbol{x}_G$ are the co-ordinates in the global super element co-ordinate system.

If the linear transformation $\boldsymbol{R}$ is as defined by (2.1), then stresses transform between co-ordinate systems as follows

$$\boldsymbol{\sigma}_G = \boldsymbol{R}\,\boldsymbol{\sigma}_L \boldsymbol{R}^T \tag{2.2}$$

where $\boldsymbol{\sigma}_L$ is the stress state referred to the result point co-ordinate system and where $\boldsymbol{\sigma}_G$ is the stress state referred to the global - or super element, co-ordinate system.

The 3D *symmetric* stress state at a point in a solid finite element is

$$\boldsymbol{\sigma}_L = \begin{bmatrix} \sigma_{xx} & \tau_{xy} & \tau_{xz} \\ & \sigma_{yy} & \tau_{yz} \\ \text{Symm} & & \sigma_{zz} \end{bmatrix} \tag{2.3}$$

The 3D *symmetric* stress state at a point in a curved shell finite element is

$$\boldsymbol{\sigma}_L = \begin{bmatrix} \sigma_{xx} & \tau_{xy} & \tau_{xz} \\ & \sigma_{yy} & \tau_{yz} \\ \text{Symm} & & 0 \end{bmatrix} \tag{2.4}$$

The 3D *symmetric* stress state at a point in a flat shell finite element and in a membrane finite element is

$$\boldsymbol{\sigma}_L = \begin{bmatrix} \sigma_{xx} & \tau_{xy} & 0 \\ & \sigma_{yy} & 0 \\ \text{Symm} & & 0 \end{bmatrix} \tag{2.5}$$

The stress tensors of (2.8)-(2.10) transform as shown in (2.7).

For membranes and flat shells the transformation $\boldsymbol{R}$ is the same in all result points and the **RDPOINTS** data type contains one $\boldsymbol{R}$ matrix only.

For curved shells the $\boldsymbol{R}$ matrix can be different in each result point – i.e. it is defined in the tangent plane of the result point. Thus for the curved shells there is one transformation matrix $\boldsymbol{R}_i$ at each result point p_i stored at the **RDPOINTS** data type.

All Sesam finite elements define an $\boldsymbol{R}$ transformation matrix, or a set of transformation matrices $\boldsymbol{R}_i$, and the transformations outlined in this section applies for all.

For shell elements, the $\boldsymbol{R}$-matrix transforms from the so-called new stress co-ordinate system to the super element global system. The new stress co-ordinate system has its local x-axis in the element plane for flat shells and in the tangent plane at a result point for curved shell elements.

The transformation from the local element co-ordinate system to the new stress co-ordinate system is performed by the element library routines.

For a Sesam fatigue check point element, the $\boldsymbol{R}$ matrix/matrices is/are copied from the **RDPOINTS** data type as needed to avoid a dependency to the **RDPOINTS** data type in general.

For other Sesam fatigue check points, the $\boldsymbol{R}$ matrix is created as needed.

Note 1: The terms "result point" and "result points" refer to "Sesam fatigue check point result point/points" and "Sesam fatigue check point element result point/points".

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.2 **PDSTRESS**: Fatigue stress component definition

This data type defines the stress components stored for a Sesam fatigue check point, that is – at the result points of the Sesam fatigue check point. There is one **PDSTRESS** component definition for each sequence - over result cases - for a Sesam fatigue check point. The sequence over result cases is defined by one data type **PVSTRESS** for each result case, or in this case - time step.

Data type definition:

	PDSTRESS		Data type reference.
	NFIELD		Number of data fields on this data type (including this field).
→	CMPDEFNUM		Component definition number, usually the same as the fatigue check point number.
	STRESS-STATE-TYPE		Stress state type.
		= 1	1D stress state.
		= 2	2D plane stress state.
		= 3	3D stress state.
	NUMSTRCMP		Number of stress components at the result point.
	Repeat for STRCMP		For each result component.
	ICOMP		Component type number.

Table 2.1: Typical components that can be referenced on data type **PDSTRESS**

ICOMP	Component	Description
1	SIGXX	Normal stress x-direction
2	SIGYY	Normal stress y-direction
3	SIGZZ	Normal stress z-direction
4	TAUXY	Shear stress in y-direction, yz-plane
5	TAUXZ	Shear stress in z-direction, yz-plane
6	TAUYZ	Shear stress in z-direction, xz-plane
27	PSIG1	First principal stress component
28	PSIG2	Second principal stress component
29	PSIG3	Third principal stress component
30	SIGEFF	Equivalent effective stress component
Components 31 and upwards are presently undefined		

Note 1: The component numbering for principal stresses start at 27 in order to avoid mixing a standard stress component number as defined in Table 2.18 at the data type **RDSTRESS**.

Note 2: And, the principal stress component numbers are added to the standard components at data type **RDSTRESS**, see Table 2.18.

Note 3: The terms "result point" and "result points" refer to "Sesam fatigue check point result point/points" and "Sesam fatigue check point element result point/points".

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.3 **PVFATDAM**: Fatigue check point results

This data type contains fatigue damage results for a Sesam fatigue check point.

Data type definition:

	PVFATDAM		Data type reference.
	NFIELD		Number of data fields on this data type (including this field).
→	RESULTID		Result number, can be wave direction number for time-domain fatigue, etc.
→	CHECKPOINTID		Sesam fatigue check point number. Unique for a fatigue run and used to access data type **TDPVFATD**.
	SESAMENTITYNUMBER		Node or element number according to the check point type. If the fatigue check point is a "hot spot", then SESAMENTITY is a node number. If the fatigue check point is an element, then SESAMENTITY is an element number. See CHECKPOINTTYPE at data type **PDFATPRP**.
	FatigueCheckPointSide		Fatigue check point side.
		= 0	Both sides.
		= 1	Negative z-side.
		= 2	Middle side, or middle plane.
		= 3	Positive z-side.
	TimeSeriesLength		The length T of the time-series in seconds [s]. The damage reported at this data type is the damage per unit time. If the total damage D^{r} at a result point is required, then $D^{\mathrm{r}} = TD^{\mathrm{r}}_{\mathrm{U}}$.
	NUMRESPTS		Number of results points at the fatigue check point. NUMRESPTS is the same for all sectors and for all angles in a sector.
	NumberOfSectors		Number of sectors.
	For each Sector		
	NumberOfCriticalPlanes		The number of critical planes evaluated in this sector.
	FirstCriticalPlaneCandidateAngle		The angle [in unit degrees] to the first critical plane candidate in the sector.
	LastCriticalPlaneCandidateAngle		The angle [in unit degrees] to the last critical plane candidate in the sector.

	The critical plane candidates are sorted according to the value of the angle θ'_{cp}.
For each CriticalPlaneCandidate	
ANGLE	The angle, θ'_{cp} [in unit degrees], that the critical plane candidate is rotated in the result point tangent plane relative to the weld normal line, see Figure 2.1.
For each ResultPoint	
RESULTPOINTNUM	Result point number.
DAMAGE	Fatigue damage D^{r}_{U} per unit time computed at the result point. The time unit is always seconds [s].
CYCLES	The number of cycles, closed hysteresis loops, at the result point. Usually, the number of cycles is the rain flow counted cycles.

Note 1: The terms "result point" and "result points" refer to "Sesam fatigue check point result point/points" and "Sesam fatigue check point element result point/points".

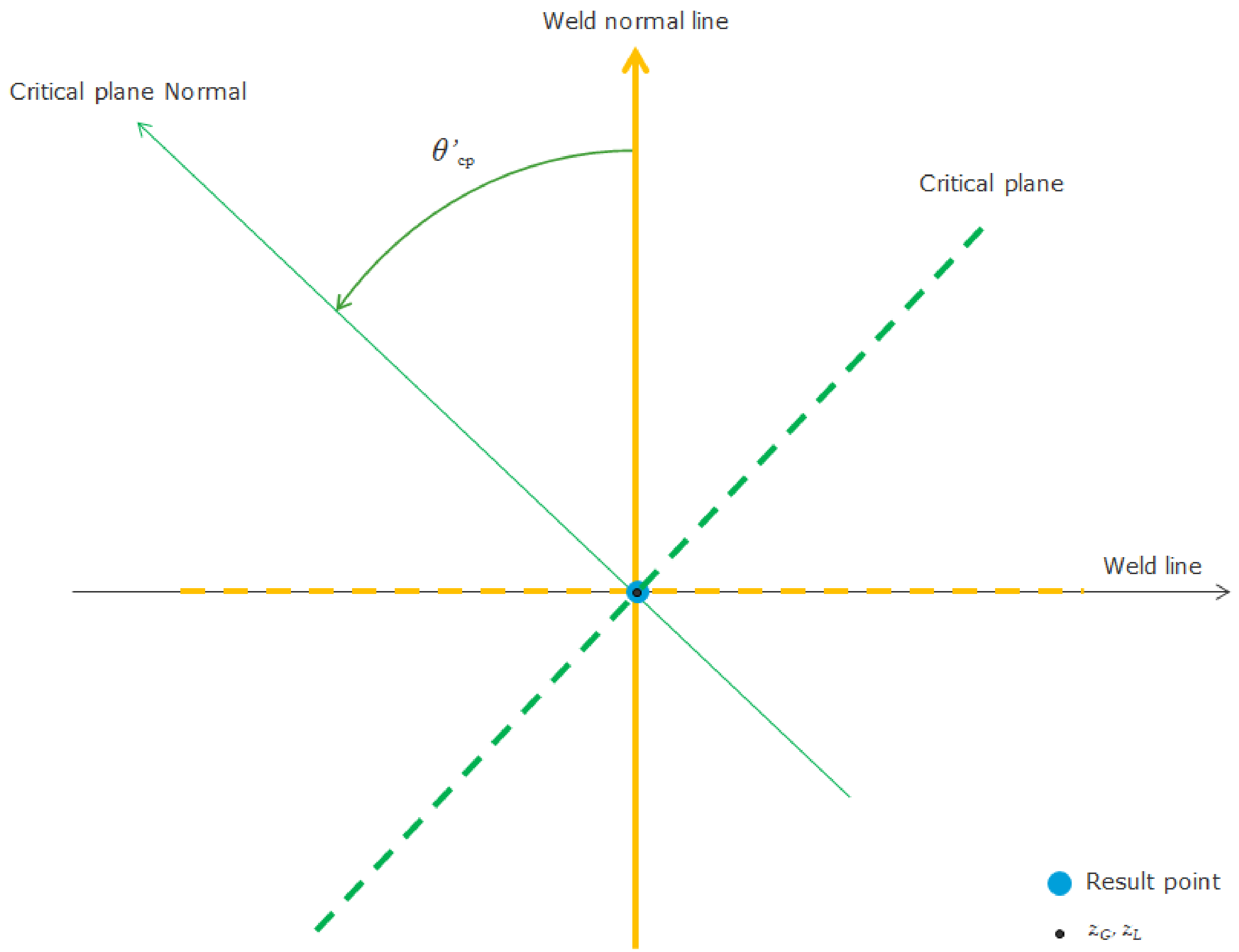


Figure 2.1

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.4 **PVSTRESS**: Fatigue stress results and principal stress direction vectors

This data type contains stress results for a Sesam fatigue check point for result case number RESULTCASEID.

Data type definition:

	PVSTRESS		Data type reference.
	NFIELD		Number of data fields on this data type (including this field).
$\rightarrow$	RESULTCASEID		Result case number.
$\rightarrow$	CHECKPOINTID		Sesam fatigue check point number. In addition, reference number to the accompanion data type **PDSTRESS** and to the data type **PDFATPRP**.
	COMPLEX		Complex flag.
		$= 0$	Real result.
		$\neq 0$	Complex result.
	NUMRESPTS		Number of results points.
	NUMSTRCMP	$= n$	Number of stress components at the result point. Where n = NUMSTRCMP is stored at data type **PDSTRESS**.
	DIROPTION		Option for the first principal stress direction vectors.
		$= 1$	Direction vectors are added to the results.
		$\neq 1$	No direction vectors in the results.
	TIME		The value of time for this result case.
	Repeat for RESPTS		For each result point.
	ResultPointId		The result point Id.
	Repeat for STRCMP		For each result component.
	RSTRESS		Real result value.
	Next		
	Repeat for STRCMP		For each result component.
	ISTRESS		Imaginary result value if complex result.
	Next		
	Next		
	Repeat for RESPTS		If DIROPTION $= 1$, then For each result point.
	v_1, v_2, v_3		The three components of the first principal stress direction vector in the tangent plane at the result point.

Note 1: For time domain fatigue, there are no imaginary components. ISTRESS is added for frequency domain fatigue.

Note 2: Whether this is a complex result is decided by means of the **RDRESREF** data type for this result case.

Note 3: For each result point the vector v is given in the result point tangent plane, and the $\boldsymbol{R}$ matrix at the **PDFATPRP** data type is needed to transform the vectors to the super element global co-ordinate system.

Note 4: The terms "result point" and "result points" refer to "Sesam fatigue check point result point/points" and "Sesam fatigue check point element result point/points".

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.5 **RBLODCMB**: Combination of first level loads

This data type defines combination of 1st level loads to top level (structure) loads. After an analysis there will be a direct correspondence between each RBLODCMB-data type and one of the **RDRESREF**-data types. This data type must not be confused with **RDRESCMB**, which defines a combination of basic result cases.

Data type definition:

	RBLODCMB		Data type reference.
	NFIELD		Number of data fields on this data type (including this field).
$\rightarrow$	IRES		Result case reference number.
	COMPLEX		Complex flag.
		$=0$	Real result.
		$\neq 0$	Complex result.
	NBLC		Number of basic loadcases contributing.
	Repeat for NBLC		
	LLC	$\rightarrow$	Basic load case number.
	FACT		Load case factor.
	PHASE		Phase angle in radians.
	Next BLC		

Note:

IRES: Result case reference number of a top level load case.

COMPLEX: Complex flag indicating whether load combination is real or complex.
= 0 Real values only.
= 1 Complex (real & imaginary) values.

PHASE: Phase angle Φ.

Must always be set=0.0 if no phase shift, even for static loads (see formulae below)

Table 2.2: Formulae for load combination

COMPLEX	Basic load	Contribution to combined load from each basic load	Combined load
0	[R]	[R$cos\Phi$]*FACT	[R]
1	[R]	[R$cos\Phi$,R$sin\Phi$]*FACT	[R]
0	[R,I]	[R$cos\Phi$-I$sin\Phi$]*FACT	[R,I]
1	[R,I]	[R$cos\Phi$-I$sin\Phi$,I$cos\Phi$+R$sin\Phi$]*FACT	[R,I]

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.6 **RDELNFOR**: Element nodal force vector component definition

This data type is referenced from the **RVELNFOR** data type.

Data type definition:

	RDELNFOR	Data type reference.
	NFIELD	Number of data fields on this data type (including this field).
→	RELNF	**RDELNFOR** data type number.
	LENREC	Number of component definition specifications.
	Repeat for LENREC	
	ICOMP	Component type number, see Table 2.3.
	Next	

Table 2.3: Components referenced on data type **RDELNFOR**

ICOMP	Component	Description
1	PX	Force in x-direction
2	PY	Force in y-direction
3	PZ	Force in z-direction
4	MX	Moment about x-axis
5	MY	Moment about y-axis
6	MZ	Moment about z-axis

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.7 **RDFATDMG**: Fatigue damage properties

This data type contains fatigue damage result properties for relevant positions and hot spots of an element.

Data type definition:

	RDFATDMG		Data type reference.
	NFIELD		Number of data fields on this data type (including this field).
→	FATPRP-ID		Fatigue Property Identifier.
→	IMEM		Internal reference number of member.
	NPOS		Number of element results points.
	Repeat for NPOS		
	IPOS		Element position number.
	INAME		Position name number.
	IJOINT		Internal joint/node number at the element position.
	IRSNCRV	→	Unique SN-Curve ID Reference to a **RVSNCURV** data type.
	NPOSPRP		Number of Fatigue Properties for position.
	Repeat for NPOSPRP		
	IPOSPRP		Identifier for Position fatigue Property.
	POSPRP		Position Fatigue Property.
	Next POSPRP		
	NHOTS		Number of fatigue hot spots of the element position.
	Repeat for NHOTS		
	IHOTS		Hot spot number.
	NHOTPRP		Number of Fatigue Properties for hot spot.
	Repeat for NHOTPRP		
	IHOTPRP		Identifier for Hot spot fatigue property.
	HOTPRP		Hot spot Fatigue Property.
	Next HOTPRP		
	Next HOTS		
	Next POS		

The (IPOSPRP) Position Fatigue Properties are as follows:

IPOSPRP	Description	Comment
1	Member Position	Relative Distance from joint/node 1 for member.
2	Mother BeamID	(GeniE) BeamID from which Member is created.
3	Beam Position	Relative Distance projected to mother beam.
4	Member Pos X	co-ordinate of actual position.
5	Member Pos Y	Y co-ordinate of actual position.
6	Member Pos Z	Z co-ordinate of actual position.

continued . . .

IPOSPRP	Description	Comment
7	Fatigue Safety Factor	
8	SCFRule no	Rule for SCF Calculation: 0 = Manual 1 = Efthymiou 2 = Lloyds 3 = Kuang 4 = Wordsworth 5 = Marshall 6 = BUTT-DNVGL2014 7 = BUTT-NORSOK1998 8 = CONE-DNVGL2014 9 = CONE-NORSOK1998 10 = Global 11 = Lotsberg
9	Thickness	Thickness at position. (relevant for SN Curve thickness correction.)
10	SCF Axial	Uniform (Applies for all hot spots).
11	SCF In-plane	Uniform (Applies for all hot spots).
12	SCF Out-of-plane	Uniform (Applies for all hot spots).

Note: For each position, as a minimum position reference must be given by either IPOSPRP no.

- Using 1) will replicate output as from Framework.Lis files.
- Using 2-3) will transform results directly over to beam models as created from GeniE.
- Using 4-6) will enable result transformation to models generated in any other program.
- Any combination of above is allowed.

The (IHOTPRP) Hot spot Fatigue Properties are as follows

IHOTPRP	Description	Comment
1	SCF Axial	Unique for the given hot spot
2	SCF In-plane	Unique for the given hot spot
3	SCF Out-of-plane	Unique for the given hot spot
4	Fatigue Part Damage	(Aggregated from previous fatigue analyses)

If SCF’s are specified at each hot spot, these will overrule any (uniform) SCF’s given at the position.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.8 **RDFORCES**: Force component definition

This data type identifies a data type of force components stored for a number of integration stations in an element. The integration stations are defined on data type **RDPOINTS** using NOK = 1. This data type is referenced from the **RVFORCES** data type.

Data type definition:

	RDFORCES	Data type reference.
	NFIELD	Number of data fields on this data type (including this field).
→	CMPDEFNUM	Component definition number.
	NUMSTRCMP	Number of force components at the result point.
	Repeat for NUMSTRCMP	
	ICOMP	Component type number, see Table 2.4.

Table 2.4: Components referenced on data type **RDFORCES**

ICOMP	Component	Description
1	NXX	Normal force in x-direction, yz-plane
2	NXY	Shear force in y-direction, yz-plane
3	NXZ	Shear force in z-direction, yz-plane
4	NYX	Shear force in x-direction, xz-plane
5	NYY	Normal force in y-direction, xz-plane
6	NYZ	Shear force in z-direction, xz-plane
7	NZX	Shear force in x-direction, xy-plane
8	NZY	Shear force in y-direction, xy-plane
9	NZZ	Normal force in z-direction, xy-plane
10	MXX	Torsion moment around x-axis, yz-plane
11	MXY	Bending moment around y-axis, yz-plane
12	MXZ	Bending moment around z-axis, yz-plane
13	MYX	Bending moment around x-axis, xz-plane
14	MYY	Torsion moment around y-axis, xz-plane
15	MYZ	Bending moment around z-axis, xz-plane
16	MZX	Bending moment around x-axis, xy-plane
17	MZY	Bending moment around y-axis, xy-plane
18	MZZ	Torsion moment around z-axis, xy-plane

ICOMP	Component	Description
Components 19 and upwards are presently undefined		

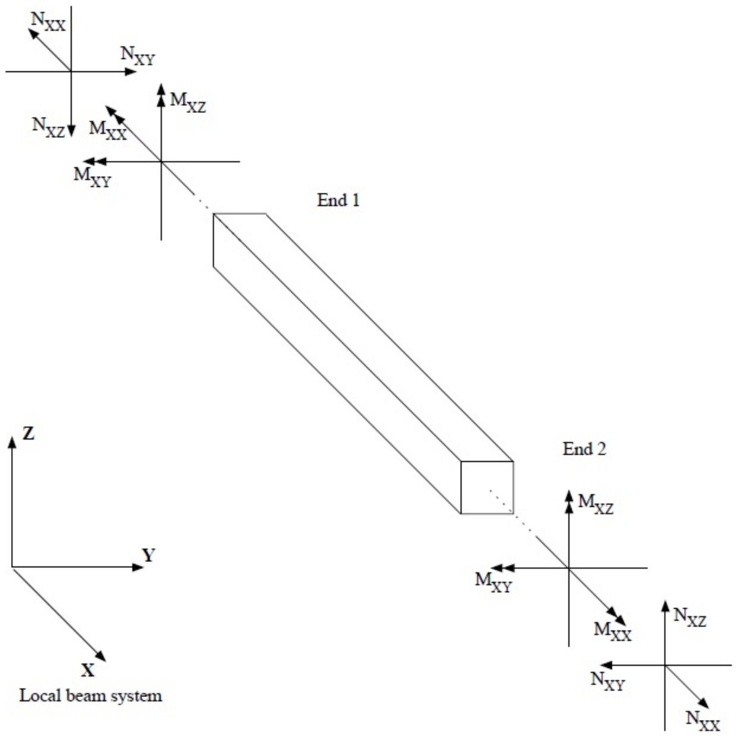


Figure 2.2: Force component definitions for beam elements.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.9 **RDIELCOR**: Internal element co-ordinates

This data type contains internal topology & co-ordinates of result points within one finite element. This data type is referenced from the **RDPOINTS** data type.

Data type definition:

	RDIELCOR	Data type reference.
	NFIELD	Length of the data type (including NFIELD).
→	ICOREF	**RDIELCOR** reference number.
	IGRID	Result point grid type.
	Repeat for NOK	NOK: Number of K planes. Value defined at the **RDPOINTS** data type.
	GAMMA	
	Next	
	Repeat for NOJ	NOJ: Number of J planes. Value defined at the **RDPOINTS** data type.
	ETA	
	Next	
	Repeat for NOI	NOI: Number of I planes. Value defined at the **RDPOINTS** data type.
	XI	
	Next	
	Repeat for NLAY	
	GAMMIN	Lower GAMMA-co-ordinate for actual layer.
	NOKLAY	Number of K-planes in actual layer.
	Next	

Note:

ICOREF Reference number set on the corresponding **RDPOINTS** data type. Note that the reference given on **RDPOINTS** data types should be unique for each element type, i.e. different element types should not refer to the same RDIELCOR-data type, even if all data are identical. Elements of the same type will often refer to the same **RDIELCOR**-data type.

IGRID Grid type.

= 0 I, J, K planes are perpendicular to each other.

= 1 NOTE: Used for one-dimensional elements only.

In this case NOK must be set to 1.

NOI will be interpreted as "number of integration stations".

NOJ will be interpreted as "number of result points per integration station."

GAMMA & ETA values are undefined.

XI values are defined as for IGRID=0.

GAMMA Internal element co-ordinate in the range $[-1, +1]$ – K-direction.

ETA Internal element co-ordinate in the range $[-1, +1]$ – J-direction.

XI Internal element co-ordinate in the range $[-1, +1]$ – I-direction.

NLAY Number of layers in a multilayer element.

A layer may include several K-planes (NOKLAY).

Note that NLAY = 0 for all element types except multilayer elements.

Internal element co-ordinates for one-dimensional elements
When one-dimensional elements (e.g beams) are used, there are two ways of defining stress integration point grids:

IGRID	= 0	Exactly as for other elements.
IGRID	= 1	In this case, only the XI values are defined. The XI values will define the location of each integration station along the element. NOI defines number of result points per integration station. The location of the result points are defined by their global co-ordinates on **RDPOINTS** data type only. This means that the result points do not neccesarily form a grid within an integration station, and that result extrapolation may be unsupported by Sesam. NOK must be set = 1.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.10 **RDMLFACT**: Modal load factors

This data type contains modal load factors for one mode shape of an eigenvalue analysis. For each of the other mode shapes, there will be a similar data type. The data are typically used in linear earthquake analysis. **Data type definition**:

	RDMLFACT		Data type reference.
	NFIELD		Number of data fields on this data type (including this field).
→	IRES		Result case reference number.
	IRDVA	→	Reference to data type **RDNODRES**.
	Repeat for NCOMP		
	MLF		Modal load factor.
	Next		

Note:

IRES	Result case reference number (reference from an **RDRESREF** data type). Note that for this data type, IRES must be referring to a result case of an eigenvalue analysis.
NCOMP	Number of load factor components.
	NCOMP = NFIELD - 3, this value must be equal to the number defined in the referenced **RDNODRES**-data type.
MLF	Modal load factor for components according to definition on the **RDNODRES**-data type.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.11 **RDNODBOC**: Definition of type of boundary condition

This data type defines the boundary conditions at a node for which reaction forces are computed and is referenced from the **RVNODREA** data type.

Data type definition:

RDNODBOC	Data type reference.
NFIELD	Number of data fields on this data type (including this field).
→ IRBOC	Boundary condition data type number.
LENREC	Number of boundary condition specifications.
Repeat for LENREC	
IBOCTYP	Boundary condition type, see Table 2.5.
Next IBOCTYP	

Note:

The data type **RVNODREA** stores (force and moment) components for a node. Force components for degrees of freedoms without boundary conditions will not be stored.

That is, usually forces are only computed for degrees of freedom at a node with boundary condition codes 1, 2, and 6, see Table 2.5.

Sometimes these force components are called "nodal reaction forces".

Table 2.5: Boundary condition types

IBOCTYP	Boundary condition
1	fixed degree of freedom
2	degree of freedom with given displacement
3	linearly dependent degree of freedom
4	super degree of freedom
5	linearly independent degree of freedom coupled to linear dependent degree(s) of freedom
6	degree of freedom with "spring to ground" boundary condition

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.12 **RDNODREA**: Nodal reaction force component definition

This data type defines the force components on the **RVNODREA** data type.

Data type definition:

	RDNODREA	Data type reference.
	NFIELD	Number of data fields on this data type (including this field).
$\rightarrow$	IRREA	Component data type number.
	LENREC	Number of force components.
	Repeat for LENREC	
	ICOMP	Force component type, see Table 2.6.
	Next ICOMP	

Table 2.6: Force component types

ICOMP	Force component
1	X-force
2	Y-force
3	Z-force
4	R_x-moment
5	R_y-moment
6	R_z-moment

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.13 **RDNODRES**: Nodal displacement/velocity/acceleration components

This data type identifies a data type of result components stored for a number of nodes.

This data type is referenced from the **RVNODDIS**, **RVNODVEL**, **RVNODACC** and **RDMLFACT** data types.

Data type definition:

	RDNODRES	Data type reference.
	NFIELD	Number of data fields on this data type (including this field).
→	IRDVA	**RDNODRES** data type number.
	LENREC	Number of component definition specifications.
	Repeat for LENREC	
	ICOMP	Component type number, see Table 2.7.
	Next	

Table 2.7: Components referenced on data type **RDNODRES**

ICOMP	Component	Description
1	X	Displacement/velocity/acceleration in x-direction
2	Y	Displacement/velocity/acceleration in y-direction
3	Z	Displacement/velocity/acceleration in z-direction
4	RX	Rotation, angular velocity/acceleration about x-axis
5	RY	Rotation, angular velocity/acceleration about y-axis
6	RZ	Rotation, angular velocity/acceleration about z-axis

Table 2.8: Dimensions used for components in Table 2.7

Type of result	Dimension used for component
displacements	length unit
velocities	length unit/time unit
accelerations	length unit/(time unit)^2
rotations	radians
angular velocities	radians/time unit
angular accelerations	radians/(time unit)^2

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.14 **RDNODSUM**: Nodal force/moment/load components

This data type defines the force components at the **RSUMREAC** data type and the load components at the **RSUMLOAD** data type.

Data type definition:

	RDNODSUM	Data type reference.
	NFIELD	Number of data fields on this data type (including this field).
$\rightarrow$	IRCOMP	**RDNODSUM** data type number.
	LENREC	Number of component definition specifications.
	Repeat for LENREC	
	ICOMP	Component type number, see Table 2.9.
	Next	

Table 2.9: Components referenced on data type **RDNODSUM**

ICOMP	Force component
1	X-force
2	Y-force
3	Z-force
4	R_x-moment
5	R_y-moment
6	R_z-moment

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.15 **RDPOINTS**: Element result point definition

This data type contains global co-ordinates and local co-ordinate systems of result points within an element. It also contains a reference to the internal element co-ordinate data type **RDIELCOR**.

Data type definition:

	RDPOINTS		Data type reference.
	NFIELD		Number of data fields on this data type (including this field).
$\rightarrow$	IRPALT		Reference number for this result point alternative for the current finite element with internal element number (identification) IIELNO.
$\rightarrow$	IIELNO		Internal element number.
	ICOREF	$\rightarrow$	**RDIELCOR** data type number. See the **RDIELCOR** data type for definitions & restrictions.
	IELTYP		Sesam element type number, see ref [2].
	NRP		The number of result points. The definition is dependent on IJKDIM, see below.
		IJKDIM $\leq$ 0	The number of result points, and NOK=0, NOJ=0, NOI=0.

		IJKDIM $>$ 0	NRP = $n_m + n_e$,
			where
			n_m: the number of mandatory existing result points.
			n_e: the number of additional existing result points. n_e can be zero.
			If the element has a regular result point distribution, then
			NRP $=$ NOK * NOJ * NOI.
			If the element has an irregular result point distribution, then
			NRP $<$ NOK * NOJ * NOI.
			In this case some points are defined as non-existing, or "cut-out" points. Check the following pages for a detailed description of legal uses of cut-out points.

	IJKDIM		An option that decides how to interpret the result point data.
		$\leq$ 0	This is the case when Sesam finite element post-processors compute the element force/stresses. In this case the result point lay-out is not known. Thus, there are no restrictions to the sequence of result points.
		$>$ 0	This is the case when IJKDIM represents a coded form of I, J and K dimensions. IJKDIM $=$ NOK*10000 + NOJ*100 + NOI NOK $=$ IJKDIM/10000 NOJ $=$ MOD(IJKDIM,10000)/100 NOI $=$ MOD(IJKDIM,100) where MOD() is the standard modulus. **Restriction**: As NOI & NOJ are limited to 2 digits, the maximum value of each parameter is 99. Maximum NOK value is 999. Notice that in practice, this is the case when Sesam finite element solvers compute the element force/stresses. Thus, the result point lay-out is regular and according to the IJK-planes.
	NRPTRA		Number of result points with transformation.

= 0	All stresses refer to global (1st level) system.
= 1	One local co-ordinate system common to all result points.
= NRP	One local co-ordinate system per result point.
NLAY	Number of layers in the element thickness direction for multilayer elements. Note that NLAY=0 for all element types except multilayer elements.

If IJKDIM $\leq$ 0 **Then**

Repeat for NRP	That is, for each result point.
IPOINT	Result point number.
XGLOB	x – co-ordinate in the first level super element.
YGLOB	y – co-ordinate in the first level super element.
ZGLOB	z – co-ordinate in the first level super element.
Next RP	Next result point.

End If

If IJKDIM $>$ 0 **Then**

Repeat for NOK		NOK $=$ No. of K-planes (local z-direction, in the thickness direction for shell elements).
Repeat for NOJ		NOJ $=$ No. of J-planes (local y-direction).
Repeat for NOI		NOI $=$ No. of I-planes (local x-direction).
IPOINT		Result point number. This variable is also used to indicate non-existing result points in case of irregular result point distribution (as may be the case in triangular elements):
	$>$ 0	A result point number is given.
	$=$ -1	A non-existing point ("cut-out point").
		Restriction: Positive result point numbers (indicating existing result point) should be sequential in the range from 1 to NRP inclusive.
		Note: If cut-out points are used, the co-ordinates of these points are not written. Only the value -1 for IPOINT is stored on the result file.
XGLOB		x – co-ordinate in the first level super element.
YGLOB		y – co-ordinate in the first level super element.
ZGLOB		z – co-ordinate in the first level super element.
Next I		
Next J		
Next K		

End If

Repeat for NRPTRA

R11	The coefficients of the R-transformation matrix
R21	stored in column major order.
R31	
R12	

R22

R32

R13

R23

R33

Let the linear transformation from a local co-ordinate system to the global super element co-ordinate system be

$$\boldsymbol{x}_G = \boldsymbol{R}\,\boldsymbol{x}_L \tag{2.6}$$

where $\boldsymbol{x}_L$ are the co-ordinates in the local system, and where $\boldsymbol{x}_G$ are the co-ordinates in the global super element co-ordinate system.

If the linear transformation $\boldsymbol{R}$ is as defined by (2.6), then stresses transform between co-ordinate systems as follows

$$\boldsymbol{\sigma}_G = \boldsymbol{R}\,\boldsymbol{\sigma}_L \boldsymbol{R}^T \tag{2.7}$$

where $\boldsymbol{\sigma}_L$ is the stress state referred to the result point co-ordinate system and where $\boldsymbol{\sigma}_G$ is the stress state referred to the global - or super element, co-ordinate system.

The 3D *symmetric* stress state at a point in a solid finite element is

$$\boldsymbol{\sigma}_L = \begin{bmatrix} \sigma_{xx} & \tau_{xy} & \tau_{xz} \\ & \sigma_{yy} & \tau_{yz} \\ \text{Symm} & & \sigma_{zz} \end{bmatrix} \tag{2.8}$$

The 3D *symmetric* stress state at a point in a curved shell finite element is

$$\boldsymbol{\sigma}_L = \begin{bmatrix} \sigma_{xx} & \tau_{xy} & \tau_{xz} \\ & \sigma_{yy} & \tau_{yz} \\ \text{Symm} & & 0 \end{bmatrix} \tag{2.9}$$

The 3D *symmetric* stress state at a point in a flat shell finite element and in a membrane finite element is

$$\boldsymbol{\sigma}_L = \begin{bmatrix} \sigma_{xx} & \tau_{xy} & 0 \\ & \sigma_{yy} & 0 \\ \text{Symm} & & 0 \end{bmatrix} \tag{2.10}$$

The stress tensors of (2.8)-(2.10) transform as shown in (2.7).

For membranes and flat shells the transformation $\boldsymbol{R}$ is the same in all result points and the **RDPOINTS** data type contains one $\boldsymbol{R}$ matrix only.

For curved shells the $\boldsymbol{R}$ matrix can be different in each result point – i.e. it is defined in the tangent plane of the result point. Thus for the curved shells there is one transformation matrix $\boldsymbol{R}_i$ at each result point p_i stored at the **RDPOINTS** data type.

All Sesam finite elements define an $\boldsymbol{R}$ transformation matrix, or a set of transformation matrices $\boldsymbol{R}_i$, and the transformations outlined in this section applies for all.

For shell elements, the $\boldsymbol{R}$-matrix transforms from the so-called new stress co-ordinate system to the super element global system. The new stress co-ordinate system has its local x-axis in the element plane for flat shells and in the tangent plane at a result point for curved shell elements.

The transformation from the local element co-ordinate system to the new stress co-ordinate system is performed by the element library routines.

Legal and illegal uses of cut-out points:
All the result points (both the mandatory- and the additional existing results points and the non-existing cut-out points) within one element will define a regular 1-, 2- or 3- dimensional IJK grid in the ξ, η, γ-space. The cut-out points are used to fill in "holes" in the irregular matrix defined by the actual existing result points.

The only exception to this is when one-dimensional elements are used with parameter IGRID=1 on data type **RDIELCOR**, see description of **RDIELCOR**.

Because the mandatory existing result points are used in Sesam in order to create nodal results data by means of extrapolation, certain rules will apply for the use of cut-out points.

Notation used in tables and figures:
The IJK grid are planes perpendicular to ξ, η and γ axes, respectively. The NOI, NOJ & NOK planes are the highest IJK planes defined for the current finite element.

Table 2.10: Notation used in tables and figures

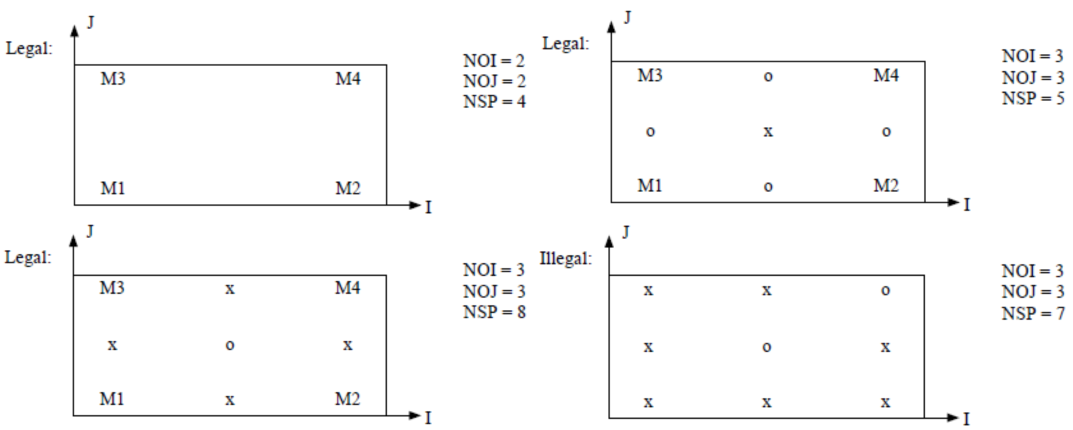
Mn	Existing mandatory result point.
x	Additional existing not mandatory result point.
o	Non-existing cut-out point.

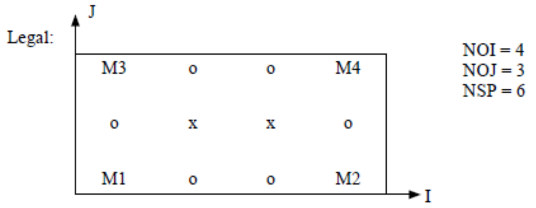
Quadrilateral shell & membrane elements
Restrictions on NOI and NOJ in order to create the mandatory result points:

1. NOI ≥ 2: NOI = $2, 3, 4, \cdots$
2. NOJ ≥ 2: NOJ = $2, 3, 4, \cdots$

Table 2.11: 4 mandatory result points in the element plane for each result point layer (in each of the K-planes for multilayered elements)

Mandatory result points	I	J
M1	1	1
M2	NOI	1
M3	1	NOJ
M4	NOI	NOJ





Triangular shell & membrane elements

Restrictions on NOI and NOJ in order to create the mandatory result points Sestra 10:

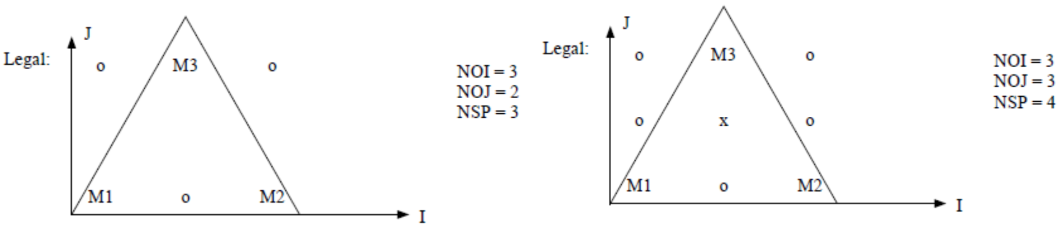
1. NOI must be odd and NOI ≥ 3: NOI = $3, 5, 7, \cdots$
2. NOJ ≥ 2: NOJ = $2, 3, 4, \cdots$

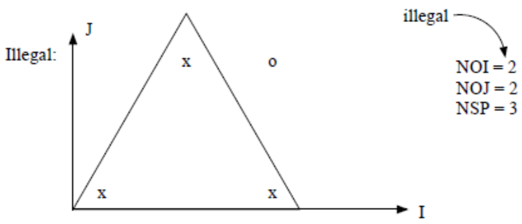
Obsolete: Restrictions on NOI and NOJ in order to create the mandatory result points Sestra 8:

1. NOI must be odd and NOI ≥ 1: NOI = $1, 3, 5, \cdots$
2. NOJ ≥ 1: NOJ = $1, 2, 3, \cdots$

Table 2.12: 3 mandatory result points in the element plane for each result point layer (in each of the K-planes for multilayered elements)

Mandatory result points	I	J
M1	1	1
M2	NOI	1
M3	NOI/2 + 1	NOJ





Hexahedron solid elements

Restrictions on NOI, NOJ and NOK in order to create the mandatory result points:

1. NOI ≥ 2: NOI = $2, 3, 4, \cdots$
2. NOJ ≥ 2: NOJ = $2, 3, 4, \cdots$
3. NOK ≥ 2: NOK = $2, 3, 4, \cdots$

Table 2.13: 8 mandatory result points

Mandatory result points	I	J	K
M1	1	1	1
M2	NOI	1	1
M3	1	NOJ	1
M4	NOI	NOJ	1
M5	1	1	NOK
M6	NOI	1	NOK
M7	1	NOJ	NOK
M8	NOI	NOJ	NOK

Triangular-prism solid elements
Restrictions on NOI, NOJ and NOK in order to create the mandatory result points:

1. NOI must be odd and NOI ≥ 1: NOI = $1, 3, 5, \cdots$
2. NOJ ≥ 1: NOJ = $1, 2, 3, \cdots$
3. NOK ≥ 2: NOK = $2, 3, 4, \cdots$

Table 2.14: 6 mandatory result points

Mandatory result points	I	J	K
M1	1	1	1
M2	NOI	1	1
M3	NOI/2 + 1	NOJ	1
M4	1	1	NOK
M5	NOI	1	NOK
M6	NOI/2 + 1	NOJ	NOK

Tetrahedron solid elements
Restrictions on NOI, NOJ and NOK in order to create the mandatory result points:

1. NOI must be odd and NOI ≥ 1: NOI = $1, 3, 5, \cdots$
2. NOJ must be odd and NOJ ≥ 1: NOJ = $1, 3, 5, \cdots$
3. NOK ≥ 1: NOK = $1, 2, 3, \cdots$

Table 2.15: 4 mandatory result points

Mandatory result points	I	J	K
M1	1	1	1
M2	NOI	1	1
M3	NOI/2 + 1	NOJ	1
M4	NOI/2 + 1	NOJ/2 + 1	NOK

Shell/solid transition elements
Restrictions on NOI, NOJ and NOK in order to create the mandatory result points:

1. NOI ≥ 2: NOI = $2, 3, 4, \cdots$
2. NOJ ≥ 2: NOJ = $2, 3, 4, \cdots$
3. NOK ≥ 2: NOK = $2, 3, 4, \cdots$

Table 2.16: 8 mandatory result points

Mandatory result points	I	J	K
M1	1	1	1
M2	NOI	1	1
M3	1	NOJ	1
M4	NOI	NOJ	1
M5	1	1	NOK
M6	NOI	1	NOK
M7	1	NOJ	NOK
M8	NOI	NOJ	NOK

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.16 **RDRESCMB**: Combination of basic result cases

This data type defines combination of basic result cases to combined result cases, and must not be confused with **RBLODCMB**, which is combination of basic LOAD cases. Each **RDRESCMB**-data type must have a corresponding **RDRESREF**-data type with an ICALTY-value among those allowed for combined result cases (see definition of **RDRESREF**).

Data type definition:

	RDRESCMB		Data type reference.
	NFIELD		Number of data fields on this data type (including this field).
$\rightarrow$	IRES		Internal result case reference number of the combined result case.
	COMPLEX		Complex flag.
		$= 0$	Real result.
		$\neq 0$	Complex result.
	NRES		Number of basic result cases contributing to combination.
	Repeat for NRES		
	IRES	$\rightarrow$	Basic result case reference number.
	FACT		Result case factor.
	PHASE		Phase angle in radians.
	Next RES		

Note:

Definitions and formulae described for **RBLODCMB** will also apply for this data type, except that reference to local load case (LLC) from **RBLODCMB** is replaced with reference to basic result case (IRES) from **RDRESCMB**.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.17 **RDRESREF**: External result case reference data

This data type defines data connected to a result case such as frequency, time instant, angular position etc.

A results case is due to either:
A load case, a frequency, a time instant, a load increment, a wave angle, a harmonic component etc. or a combination of above. A result case may contain either real or complex results.

Data type definition:

	RDRESREF		Data type reference.
	NFIELD		Number of data fields on this data type (including this field).
$\rightarrow$	IRES		Internal result case reference number.
	IRNO		Run number created by the analysis program.
	IERES		External result case identification number.
	ICALTY		Sesam calculation type number.
	COMPLEX		Complex flag.
		$= 0$	Real result.
		$\neq 0$	Complex result.
	NUMTYP		Number of reference types.
	Repeat for NUMTYP		
	IREFTY		Type of reference value.
	IDREF		Reference identification number.
	REFDAT		Reference identification value.
	Next TYP		

Note:

IRES: Internal result case reference number.

IRES is a sequential number from 1 to number of result cases, i.e. IRES must not be greater than number of **RDRESREF**-data types present and there must not be "holes" in the IRES-numbers. Two **RDRESREF**-data types may NOT have identical IRES-numbers.

IRNO: Run number created by the analysis program.

This number is used to separate results from different analysis program runs, which may have otherwise identical external result case identifications.

IERES: External result case identification number.

This is the user-defined or analysis-program-defined identification of the actual result case. Two or more result cases may share a common IERES as long as they are separated by one (and ONLY one) reference identification number IDREF.

Examples:

1. Linear static analysis.

   In this case, there is a 1:1 correspondence between load-case vectors and result case vectors. Therefore, one MAY assign IERES = load case number for linear static analyses. To ensure trouble free interpretation, linear static analyses must always include IREFTY=10 in the result case reference data loop.

2. Time-domain analysis.

   In this case, there are typically more result case vectors than loadvectors (loadcases). Therefore, one should use IERES to externally identify all result cases of the complete time-domain analysis. Each time increment will be identified in the reference data loop (IREFTY=2, IDREF stores time increment number, REFDAT stores time increment value).

   An alternative is to store the time increment number directly in IERES. The consequence of this is that the common external identification is lost, and that the result cases belonging to the same time-domain analysis cannot be externally distinguished from result cases of other time-domain analyses stored on the same result file.

3. Frequency-domain analysis.

   Same rules as in Example 2.

4. Static non-linear analysis.

   Same rules as in Example 2.

5. Quasi-Static analysis.

   Same rules as in Example 1, except that load case vectors and result case vectors contain both a real and an imaginary part.

6. Non-linear static analysis, with free harmonic analyses at specified static increments.

   The non-linear static analysis should here be stored in a similar way as described in Example 2 (i.e. IERES is common to all static increments, each increment is identified in the reference data loop). Each of the free harmonic analyses should again have a unique IERES. The eigenvalue numbers are stored in the reference data loop.

   In addition, one may refer to the relevant static increment in the same reference data loop.

ICALTY: SESAM calculation type number.

=	0	Static linear analysis.
=	1	Free harmonic response analysis (eigenvalues).
=	2	Forced linear harmonic response analysis, frequency domain.
=	3	Forced linear arbitrary response analysis, time domain.
=	4	Static non-linear analysis.
=	5	Forced non-linear arbitrary response analysis, time domain.
=	6	Quasi-static linear analysis.
=	7	Forced linear frequency response analysis, periodic non-harmonic loads.
=	8	Axis-symmetric analysis with non-axis-symmetric loads.
=	9	Linear buckling analysis.
=	[100,109]	Combined result case of type ICALTY-100. For combined result cases, a **RDRESCMB**-data type using same IRES-reference as the current **RDRESREF**-data type must exist.

COMPLEX: Complex flag.

=	0	Results are not complex.
=	1	Complex (real & imaginary) results are stored.

Table 2.17: The triple **IREFTY**, **IDREF** and **REFDAT**.

IREFTY	**IDREF**	**REFDAT**	**REFDAT** dimension
1	Response frequency number	Response frequency	[radians/second]
2	Time instant number	Time instant	[second]
3	N/A	Angle (axis-symmetry)	[radians]
4	Load parameter number	Load parameter	[dimensionless]
5	Wave direction number	Wave direction	[radians]
6	N/A	Wave height	[length unit]
7	Excitation frequency number	Excitation frequency	[radians/second]
8	N/A	Water depth	[length unit]
9	Critical load level number	Critical load level	[dimensionless]
10	External load case number	Load case value	[undefined]
11	Component number for stress points	Component number for stress points	
11		Component number for wind velocity	
12		Mean wind velocity	
13		(Wind direction angle in degrees) times (2π/360)	[rad]
14		Mean wind velocity level relative to the still water	
15		Height exponent	
16		Wind profile formula number	
17		Mud-line	[m]
18		Gust factor	
19		Mean period ratio, T_a/T_{a0}	
20		Wind length adjustment factor	
21		Period	[s]

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.18 **RDSERIES**: Result series definition

This data type contains the definition of a series of data with its actual values stored on data type **RVSERIES**. The series is constructed from a list of abscissa values with a corresponding list of ordinate values.

Data type definition:

	RDSERIES		Data type reference.
	NFIELD		Number of data fields on this data type .
→	IDSERI		Internal series identification number.
	IRES	→	Reference to **RDRESREF**.
	ITYORI		Type of origin for values stored.
	IDREF	→	origin identification reference.
	IDNUM		origin identification number.
	ITYABS		Type of values for abscissa.
	ITYORD		Type of values for ordinate.
	ICOMP		ordinate value component number.
	ABSMIN		Lowest abscissa value.
	ABSMAX		Highest abscissa value.
	LENSER		Length of series (number of instances).
	IDLSTA	→	Reference to data type **RVABSCIS**.
	IDLSTO	→	Reference to data type **RVORDINA**.

Note:

IRES: Reference to **RDRESREF**.

= 0 No reference defined.
> 0 IRES points to a **RDRESREF** data type containing relevant reference data and external result case identification number.

ITYORI: Origin of values stored.

= 1 Element.
= 2 Node.
= 2 General (other) values.

IDREF, IDNUM: Data origin reference & identification numbers:

ITYORI	1	2	11
IDREF	Internal element no.	Internal node no.	N/A
IDNUM	Result point no.	N/A	N/A

ITYABS: Type of values for abscissa.

See Table 2.17 for definition of ITYABS = IREFTY.

ITYORD: Type of values for ordinate.

=	1	Displacements.
=	2	Velocities.
=	3	Accelerations.
=	4	Stresses.
=	5	Strains.
=	6	Forces (structural).
=	7	Reaction Forces.

ICOMP: Ordinate value component number.

ITYORD	=	1, 2, 3	See Table 2.7 (**RDNODRES**).
ITYORD	=	4	See Table 2.18 (**RDSTRESS**).
ITYORD	=	5	See Table **??** (**RDSTRAIN**).
ITYORD	=	6	See Table 2.4 (**RDFORCES**).
ITYORD	=	7	See Table 2.4 (**RDFORCES**).

IDLSTA: Reference to list of abscissa values.

This is a reference to the **RVABSCIS** data type containing time instances or frequencies or any of the above defined abscissa values.

IDLSTO: Reference to list of ordinate values.

This is a reference to the **RVORDINA** data type containing displacements or stresses or any of the above defined ordinate values.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.19 **RDSOIDSP**: Soil displacement data

This data type contains given soil displacements and open hole diameters passed to Splice from Gensod.
Data type definition:

	RDSOIDSP	Data type reference.
	NFIELD	Length of the data type (including NFIELD).
$\rightarrow$	SOIL-PROFILE-ID	Reference to data type **RDSOIPRF**.
$\rightarrow$	DISP-ID	Displacement identifier.
	ZLEV	Z-level where the data is given-
	DSP-X	Given soil displacement in global x-direction.
	DSP-Y	Given soil displacement in global y-direction.
	DSP-Z	Given soil displacement in global z-direction.
	HOLE-DIAM	Diameter of open hole around the pile.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.20 **RDSOILDI**: Soil layer diameter data

This data type contains diameters used by soil curves in Gensodand read by Splice. It is referenced from **RVSOILPY**, **RVSOILQZ** and **RVSOILTZ** datatypes.

Data type definition:

	RDSOILDI	Data type reference.
	NFIELD	Number of data fields on this data type (including this field). Always 4 for this card.
→	SOIL-PROFILE-ID	Reference to data type **RDSOIPRF**.
→	SOIL-DIAMETER-ID	Diameter reference number.
	DIAMETER	The value of the diameter.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.21 **RDSOIPRF**: Soil profile main data

This is a data type for general soil profile data which is input to Splice from Gensod.

It is referenced from the **TSOILPRF**, **RVSOILPY**, **RVSOILQZ** and **RVSOILTZ** data types.

Data type definition:

	RDSOIPRF	Data type reference.
	NFIELD	Length of the data type (including NFIELD).
$\rightarrow$	SOIL-PROFILE-ID	Soil profile Id.
	REVISION	Splice Revision. Will be 20090901 for Revision V.
	ZSURF	Z-level of non scoured soil surface given in the Splice global co-ordinate system, i.e. positive Z in pile tip direction.
	SCRGEN	Depth of general scour below zsurf
	NUMLAY	Number of soil layers.
	NUMLAYM	Nunber of main soil layers. Only relevant for revision V, zero otherwise.
	NUMDSP	Number of displacements.
	NUMDIA	Number of diameters.
	ESOL0	Soil e-modulus variation with z for pile/soil/pile interaction only.
	ESOL1	Soil modulus increase with depth $ESOL(Z) = ESOL0 + ESOL1 * Z$.
	EVHRAT	EVHRAT Ratio $E_v(Z)/E_h(Z), E_v(Z)$ = E-soil for axial group effect.
	POSAVR	Average Poisson's ratio for pile/soil/pile interaction only.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.22 **RDSTRAIN**: Strain component definition

This data type identifies a data type of strain components stored for a number of result points.

Data type definition:

	RDSTRAIN	Data type reference.
	NFIELD	Number of data fields on this data type (including this field).
$\rightarrow$	CMPDEFNUM	Component definition number.
	NUMSTRCMP	Number of strain components at the result point.
	Repeat for NUMSTRCMP	
	ICOMP	Component type number.

ICOMP	Component	Description
1	EPSXX	Normal strain x-direction
2	EPSYY	Normal strain y-direction
3	EPSZZ	Normal strain z-direction
4	GAMXY	Shear strain in y-direction, yz-plane
5	GAMXZ	Shear strain in z-direction, yz-plane
6	GAMYZ	Shear strain in z-direction, xz-plane
7	EPSMX	Membrane strain x-direction
8	EPSMY	Membrane strain y-direction
9	EPSBYX	Normal bending strain, yz-plane, around y
10	EPSBZX	Normal bending strain, yz-plane, around z
11	EPSBXY	Normal bending strain, xz-plane, around x
12	EPSBZY	Normal bending strain, xz-plane, around z
13	EPSBXZ	Normal bending strain, xy-plane, around x
14	EPSBYZ	Normal bending strain, xy-plane, around y
15	GAMBXY	Shear bending strain, yz-plane, y-direction
16	GAMBXZ	Shear bending strain, yz-plane, z-direction
17	GAMBYX	Shear bending strain, xz-plane, x-direction
18	GAMBYZ	Shear bending strain, xz-plane, z-direction
19	GAMBZX	Shear bending strain, xy-plane, x-direction
20	GAMBZY	Shear bending strain, xy-plane, y-direction
21	GAMTXY	Torsional shear, yz-plane, y-direction
22	GAMTXZ	Torsional shear, yz-plane, z-direction
23	GAMTZY	Torsional shear, xy-plane, y-direction
24	EPSRR	Normal strain radial direction

ICOMP	Component	Description
25	GAMRZ	Shear strain for axis-symmetry
26	HOOP	Hoop strain for axis-symmetry
Components 27 and upwards are presently undefined		

Non-linear strain components

Components 1 to 100 inclusive are total strain components.
Components 101 to 200 inclusive are plastic strain components.
Components 201 to 300 inclusive are creep strain components.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.23 **RDSTRESS**: Stress component definition

This data type defines the stress components stored at a result point for a Sesam finite element.

Data type definition:

	RDSTRESS	Data type reference.
	NFIELD	Number of data fields on this data type (including this field).
→	CMPDEFNUM	Component definition number.
	NUMSTRCMP	Number of stress components at the result point.
	Repeat for NUMSTRCMP	
	ICOMP	Component type number.

Table 2.18: Components referenced on data type **RDSTRESS**

ICOMP	Component	Description
1	SIGXX	Normal stress x-direction
2	SIGYY	Normal stress y-direction
3	SIGZZ	Normal stress z-direction
4	TAUXY	Shear stress in y-direction, yz-plane
5	TAUXZ	Shear stress in z-direction, yz-plane
6	TAUYZ	Shear stress in z-direction, xz-plane
7	SIGMX	Membrane stress x-direction
8	SIGMY	Membrane stress y-direction
9	SIGBYX	Normal bending stress, yz-plane, around y
10	SIGBZX	Normal bending stress, yz-plane, around z
11	SIGBXY	Normal bending stress, xz-plane, around x
12	SIGBZY	Normal bending stress, xz-plane, around z
13	SIGBXZ	Normal bending stress, xy-plane, around x
14	SIGBYZ	Normal bending stress, xy-plane, around y
15	TAUBXY	Shear bending stress, yz-plane, y-direction
16	TAUBXZ	Shear bending stress, yz-plane, z-direction
17	TAUBYX	Shear bending stress, xz-plane, x-direction
18	TAUBYZ	Shear bending stress, xz-plane, z-direction
19	TAUBZX	Shear bending stress, xy-plane, x-direction
20	TAUBZY	Shear bending stress, xy-plane, y-direction
21	TAUTXY	Torsional shear, yz-plane, y-direction
22	TAUTXZ	Torsional shear, yz-plane, z-direction
23	TAUTZY	Torsional shear, xy-plane, y-direction

ICOMP	Component	Description
24	SIGRR	Normal stress radial direction
25	TAURZ	Shear stress for axis-symmetry
26	HOOP	Hoop stress for axis-symmetry
27	PSIG1	First principal stress component
28	PSIG2	Second principal stress component
29	PSIG3	Third principal stress component
30	SIGEFF	Equivalent effective stress component
Components 31 and upwards are presently undefined		

Stress component definitions

$$\boldsymbol{\sigma} = \begin{bmatrix} \text{SIGXX} & \text{TAUXY} & \text{TAUXZ} \\ \text{TAUYX} & \text{SIGYY} & \text{TAUYZ} \\ \text{TAUZX} & \text{TAUZY} & \text{SIGZZ} \end{bmatrix}$$

Where symmetry gives

$$\text{TAUYX} = \text{TAUXY}$$
$$\text{TAUZX} = \text{TAUXZ}$$
$$\text{TAUZY} = \text{TAUYZ}$$

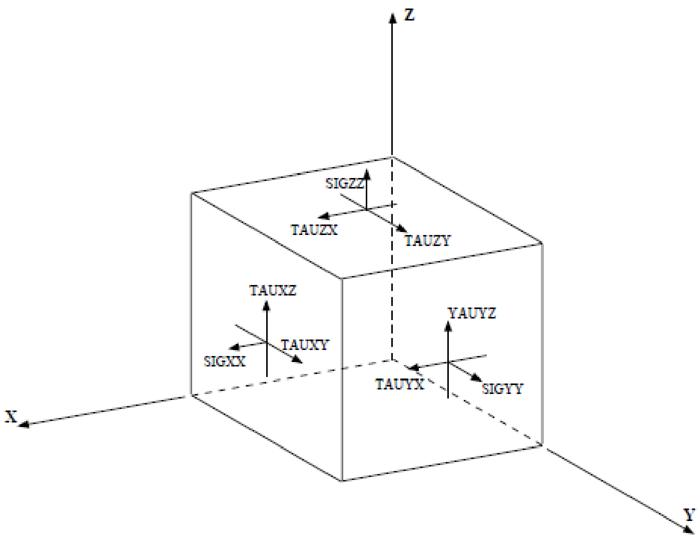


Figure 2.3: Stress component definitions.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.24 **RDTRANS**: Transformation definition

This data type is referenced from **RVELNFOR**.

Data type definition:

	RDTRANS	Data type reference.
	NFIELD	Number of data fields on this data type .
→	IRTRANS	Transformation reference number.
	NTRANS	Number of transformations.
		(One transformation may be given if all nodes have the same transformation, else transformations must be defined for each element node.)
	Repeat for NTRANS	
	Repeat for j=1,3	
	Repeat for i=1,3	
	RIJ	Local to global transformation.
	Next i	
	Next j	
	NEXT TRANS	

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.25 **RSUMLOAD**: Sum of loads

Data type definition:

	RSUMLOAD	Data type reference.
	NFIELD	Number of data fields on this data type (including this field).
→	IRES	Internal result case reference number of the combined result case. I.e IRES is a reference to data type **RDRESREF**.
	IRCOMP	Reference to data type **RDNODSUM** that specifies the components. The only implemented option – IRCOMP = 0.
	Repeat for NCOMP	
	RCOMP	Load Real term component value.
	ICOMP	Load Imaginary term component value if Complex results are specified at the data type **RDRESREF**.
	Next	

Note:

- For IRCOMP = 0 (the only implemented option), it is required that – NCOMP = 6 – load component values are stored in the order shown
  1. X-load - sum of applied loads in super element X-direction
  2. Y-load - sum of applied loads in super element Y-direction
  3. Z-load - sum of applied loads in super element Z-direction
  4. R_X-moment - sum of applied moments around super element X-axis
  5. R_Y-moment - sum of applied moments around super element Y-axis
  6. R_Z-moment - sum of applied moments around super element Z-axis

  for Real data, and
  1. X_{Real}-load - sum of applied loads in super element X-direction
  2. X_{Imag}-load - sum of applied loads in super element X-direction
  3. Y_{Real}-load - sum of applied loads in super element Y-direction
  4. Y_{Imag}-load - sum of applied loads in super element Y-direction
  5. Z_{Real}-load - sum of applied loads in super element Z-direction
  6. Z_{Imag}-load - sum of applied loads in super element Z-direction
  7. $R_{X_{\text{Real}}}$-moment - sum of applied moments around super element X-axis
  8. $R_{X_{\text{Imag}}}$-moment - sum of applied moments around super element X-axis
  9. $R_{Y_{\text{Real}}}$-moment - sum of applied moments around super element Y-axis
  10. $R_{Y_{\text{Imag}}}$-moment - sum of applied moments around super element Y-axis
  11. $R_{Z_{\text{Real}}}$-moment - sum of applied moments around super element Z-axis
  12. $R_{Z_{\text{Imag}}}$-moment - sum of applied moments around super element Z-axis

  for Complex data as specified at the data type **RDRESREF**

- Definitions and formulae described for **RBLODCMB** will also apply for this data type, except that reference to local load case (LLC) from **RBLODCMB** is replaced with reference to basic result case (IRES) from **RSUMLOAD**.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.26 **RSUMMASS**: Sum of masses

Data type definition:

RSUMMASS	Data type reference.
NFIELD	Number of data fields on this data type (including this field).
XCOOR	x- co-ordinate of the centre of mass.
YCOOR	y- co-ordinate of the centre of mass.
ZCOOR	z- co-ordinate of the centre of mass.
M11	
M21	
M31	
M41	
M51	
M61	The 6 x 6 = 36 components of the mass matrix.
M12	
M22	
M32	
⋮	
M56	
M66	

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.27 **RSUMREAC**: Sum of reaction forces

Data type definition:

	RSUMREAC	Data type reference.
	NFIELD	Number of data fields on this data type (including this field).
→	IRES	Internal result case reference number of the combined result case. I.e IRES is a reference to data type **RDRESREF**.
	IRCOMP	Reference to data type **RDNODSUM** that specifies the components. The only implemented option – IRCOMP = 0.
	Repeat for NCOMP	
	RCOMP	Force Real term component value.
	ICOMP	Force Imaginary term component value if Complex results are specified at the data type **RDRESREF**.
	Next	

Note:

- For IRCOMP = 0 (the only implemented option), it is required that – NCOMP = 6 – force component values are stored in the order shown

  1. X-force - sum of reaction forces in super element X-direction
  2. Y-force - sum of reaction forces in super element Y-direction
  3. Z-force - sum of reaction forces in super element Z-direction
  4. R_X-moment - sum of reaction moments around super element X-axis
  5. R_Y-moment - sum of reaction moments around super element Y-axis
  6. R_Z-moment - sum of reaction moments around super element Z-axis

  for Real data, and

  1. X_{Real}-force - sum of reaction forces in super element X-direction
  2. X_{Imag}-force - sum of reaction forces in super element X-direction
  3. Y_{Real}-force - sum of reaction forces in super element Y-direction
  4. Y_{Imag}-force - sum of reaction forces in super element Y-direction
  5. Z_{Real}-force - sum of reaction forces in super element Z-direction
  6. Z_{Imag}-force - sum of reaction forces in super element Z-direction
  7. $R_{X_{\text{Real}}}$-moment - sum of reaction moments around super element X-axis
  8. $R_{X_{\text{Imag}}}$-moment - sum of reaction moments around super element X-axis
  9. $R_{Y_{\text{Real}}}$-moment - sum of reaction moments around super element Y-axis
  10. $R_{Y_{\text{Imag}}}$-moment - sum of reaction moments around super element Y-axis
  11. $R_{Z_{\text{Real}}}$-moment - sum of reaction moments around super element Z-axis
  12. $R_{Z_{\text{Imag}}}$-moment - sum of reaction moments around super element Z-axis

  for Complex data as specified at the data type **RDRESREF**

- Definitions and formulae described for **RBLODCMB** will also apply for this data type, except that reference to local load case (LLC) from **RBLODCMB** is replaced with reference to basic result case (IRES) from **RSUMREAC**.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.28 **RSUPTRAN**: 1st level super element transformation

This data type defines a super element transformation directly from highest level super element ("structure level") to the actual 1st level super element.

See also highest level data type **HSUPTRAN**, which defines transformation from a parent super element to its child super element.

Data type definition:

	RSUPTRAN	Data type reference.
	NFIELD	
$\rightarrow$	ITREF	
	NTRANS	Number of transformations. (One transformation may be given if all nodes have the same transformation, else transformations must be defined for each element node.)
	Repeat for j=1,4	
	Repeat for i=1,4	
	TIJ	Local to global transformation.
	Next i	
	Next j	

Comments:

As there will be only 1 **RSUPTRAN** data type per superelement repetition, **ITREF** must be set $= 1$ for this data type.

Superelement transformation:

$$\begin{bmatrix} X' \\ Y' \\ Z' \\ 1 \end{bmatrix} = \begin{bmatrix} T11 & T12 & T13 & T14 \\ T21 & T22 & T23 & T24 \\ T31 & T32 & T33 & T34 \\ 0 & 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} X \\ Y \\ Z \\ 1 \end{bmatrix}$$

$\begin{bmatrix} X' \\ Y' \\ Z' \end{bmatrix} =$ Actual first level co-ordinate system.

$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} =$ Highest level ($=$ structure level) co-ordinate system.

$\begin{bmatrix} T14 \\ T24 \\ T34 \end{bmatrix} = \begin{bmatrix} DX \\ DY \\ DZ \end{bmatrix} =$ Displacement terms of superelement transformation.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.29 **RVABSCIS**: Result series abscissa values

The abscissa values are typically time instants, frequencies, etc.

Two data types, **RVABSCIS** & **RVORDINA**, will together form a series that can be plotted as a graph or processed in other ways. The two data types are referenced from the **RDSERIES** data type. One **RVABSCIS** data type can be referenced from several **RDSERIES** data types so that if different series share the same abscissa values (e.g. time instants), then the list of abscissa values will be written only once.

A series of results can in principle be of unlimited length, but a results file data type should not be too long. Therefore, a list of abscissa values should be stored on several **RVABSCIS** data types in sequence as shown below. Note that the abscissa values must be sorted in ascending order.

Data type definition:

	RVABSCIS	Data type reference.
	NFIELD	
→	IDLSTA	Abscissa list identification number.
→	INDXLS	List data type index number.
	ISPACE	Type of spacing for abscissa values.
	Repeat for NVALUES	NVALUES = NFIELD - 4.
	VALUE	Abscissa value.
	Next VALUE	

Note:

ISPACE	=	0	Unknown/variable abscissa value spacing within this block.
	=	1	Equidistant abscissa value spacing within this block.
	=	2	Equidistant abscissa value spacing within this block, only start value, spacing value and number of step values stored (NVALUES = 3, VALUE1 = start value, VALUE2 = spacing value, VALUE3 = no. of steps).

NOTE: Max allowed NFIELD for this particular data type is 1024.

Example:

If the series contains more than 1024-4 = 1020 instants, more than one **RVABSCIS** data type must be used. If, for instance, the series contains 4893 instants then at least (4893/1020) + 1 = 5 data types must be used. The 4 first data types will contain 1020 values each, while the last data type will contain 4893 - 4*1020 = 813 values. All five data types will have the same list identification number **IDLSTA**, but will have unique list data type index numbers **INDXLS** from 1 through 5.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.30 **RVELNFOR**: Element nodal force vectors

Data type definition:

	RVELNFOR		Data type reference.
	NFIELD		Number of data fields on this data type.
→	IRES		Internal result case number.
→	IIELNO		Internal element number.
	IRTRANS	→	Reference to transformation data type **RDTRANS**, zero if referenced to the global co-ordinate system.
	IRELNF	→	Reference to **RDELNFOR**.
	Repeat for NELNOD		
	Repeat for LENREC		
	ELNFORCE		Result value.
	IELNFORCE		Imaginary result value if complex result.
	Next REC		
	Next ELNOD		

Comments:

NELNOD is number of element nodes, sequence is as defined in GELMNT1 data type.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.31 **RVFATDAM**: Fatigue damage results

This data type contains fatigue damage results for relevant positions and hot spots of an element.

Data type definition:

	RVFATDAM	Data type reference.
	NFIELD	Number of data fields on this data type (including this field).
→	IRES	Internal result case reference number.
→	IIELNO	Internal element number.
	IERES	External result case identification number.
	IRNO	Run number created by the analysis program.
	IFATYP	Fatigue check type.
	IELTYP	Sesam element type number.
	NPOS	Number of element results points.
	NPARAM	Number of parameters.
	Repeat for NPARAM	
	IPARAM	Parameter identification number, see below.
	PARAM	Parameter as defined below.
	Next PARAM	
	Repeat for NPOS	
	IPOS	Element position number.
	INAME	Position name number.
	IJOINT	Internal joint/node number at the element position.
	NHOTS	Number of hot spots of the element position containing damage results.
	Repeat for NHOT	
	IHOT	Hot spot number.
	DAMAGE	Fatigue damage per unit time as computed in Framework.
	CYCLES	Number of stress cycles.
	Next HOT	
	Next POS	

Note:

IFATYP Fatigue check type.

IFATYP = 1: Stochastic fatigue

IFATYP = 2: Deterministic fatigue

IFATYP = 3: Time history fatigue

IRES: Internal result case reference number.

IFATYP = 1 : IRES = Sea state number

IFATYP = 2 : IRES = Wave high number

IFATYP = 3 : IRES = Time series number

IJOINT: Internal joint number at the element position

IJOINT = 0: No joint/node at element position

IJOINT > 0: Joint/node number at element position

Table 2.19: Parameter reference on data type **RVFATDAM**

PARAM	Parameter	Description
1	STEPS	Number of time steps of time series.
2	DT	Time increment of the time series.
3	TTOT	Total duration of time series.
4	DIR	Wave direction/Direction of time series load.
5	IFACT	Option for use of probability factors in damage calculation: IFACT = 0: Appropriate factors applied to the damage. IFACT = 1: Factors not applied (non-scaled damage).
6	ITIME	Fatigue exposure time option: ITIME = 0: Design fatigue life. TIME = Fatlife (years) * year (s) = Fatlife *3.1536E+7 (s) ITIME = 1: Unit time. TIME = 1 (s) ITIME = 2: Time series duration. TIME = Duration of time series in seconds (s) ITIME = 3: User defined exposure time. TIME = User time (seconds) Damage per unit time = DAMAGE / TIME.
7	TIME	Fatigue exposure time.

Table 2.20: Position name reference on data type **RVFATDAM**

INAME	Component	Description	Corresponding POSNAM[1]
0	None	No name	None
1	CHORD-SIDE	Chord side of section at position	Joint-name
2	BRACE-SIDE	Brace side of section at position	Joint-name
3	BOTH-SIDES	Both sides of section at position	Joint-name
4	SECTION	Section transition position	Section-name
5	ASSIGNED	Framework member assigned position name	Position-name

[1]Note: **RVFATDAM** is used together with **TDFATDAM**.

There is a correspondence between INAME at a **RVFATDAM** data type and POSNAM at a **TDFATDAM** data type as given in the table above.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.32 **RVFATDMG**: Fatigue damage results

This data type contains fatigue damage results for relevant positions and hot spots of an element.

Data type definition:

	RVFATDMG		Data type reference.
	NFIELD		Number of data fields on this data type (including this field).
→	IRES		Internal result case reference number.
→	IMEM		Internal reference number of member.
	FATPRP-ID	→	Fatigue Property Identifier. Refers to **RDFATDMG** data type. See the **RDFATDMG** data type for definitions & restrictions.
	IERES		External result case identification number.
	IRNO		Run number created by the analysis program.
	IFATYP		Fatigue check type.
	IELTYP		Sesam element type number.
	NPOS		Number of element results points.
	NPARAM		Number of parameters.
	Repeat for NPARAM		
	IPARAM		Parameter identification number, see below.
	PARAM		Parameter as defined below.
	Next PARAM		
	Repeat for NPOS		
	IPOS		Element position number.
	INAME		Position name number.
	IJOINT		Internal joint/node number at the element position.
	NHOTS		Number of hot spots of the element position containing damage results.
	Repeat for NHOT		
	IHOT		Hot spot number.
	DAMAGE		Fatigue damage per unit time as computed in Framework.
	CYCLES		Number of stress cycles.
	Next HOT		
	Next POS		

Note:

IFATYP Fatigue check type.

IFATYP = 1: Stochastic fatigue

IFATYP = 2: Deterministic fatigue

IFATYP = 3: Time history fatigue

IRES: Internal result case reference number.

IFATYP = 1 : IRES = Sea state number

IFATYP = 2 : IRES = Wave high number

IFATYP = 3 : IRES = Time series number

IJOINT: Internal joint number at the element position

IJOINT = 0: No joint/node at element position

IJOINT > 0: Joint/node number at element position

Table 2.21: Parameter reference on data type **RVFATDMG**

PARAM	Parameter	Description
1	STEPS	Number of time steps of time series.
2	DT	Time increment of the time series.
3	TTOT	Total duration of time series.
4	DIR	Wave direction/Direction of time series load.
5	IFACT	Option for use of probability factors in damage calculation: IFACT = 0: Appropriate factors applied to the damage. IFACT = 1: Factors not applied (non-scaled damage).
6	ITIME	Fatigue exposure time option: ITIME = 0: Design fatigue life. TIME = Fatlife (years) * year (s) = Fatlife *3.1536E+7 (s) ITIME = 1: Unit time. TIME = 1 (s) ITIME = 2: Time series duration. TIME = Duration of time series in seconds (s) ITIME = 3: User defined exposure time. TIME = User time (seconds) Damage per unit time = DAMAGE / TIME.
7	TIME	Fatigue exposure time.

Table 2.22: Position name reference on data type **RVFATDMG**

INAME	Component	Description	Corresponding POSNAM[1]
0	None	No name	None
1	CHORD-SIDE	Chord side of section at position	Joint-name
2	BRACE-SIDE	Brace side of section at position	Joint-name
3	BOTH-SIDES	Both sides of section at position	Joint-name
4	SECTION	Section transition position	Section-name
5	ASSIGNED	Framework member assigned position name	Position-name

[1]Note: **RVFATDMG** is used together with **TDFATDAM**.

There is a correspondence between INAME at a **RVFATDMG** data type and POSNAM at a **TDFATDAM** data type as given in the table above.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.33 **RVFATDMH**: Fatigue damage results for shell elements

This data type contains fatigue damage results for relevant fatigue points for plate and shell elements. Valid for element and hot spot plate/shell fatigue analysis.

Data type definition:

	RVFATDMH	Data type reference.
	NFIELD	Number of data fields on this data type (including this field).
→	IRES	Internal result case reference number.
	FATPRP-ID	Fatigue Property Identifier.
	IERES	External result case identification number.
	IRNO	Run number created by the analysis program.
	IFATYP	Fatigue check type.
	NPOS	Number of element results points.
	NPARAM	Number of parameters.
	Repeat for NPARAM	
	IPARAM	Parameter identification number, see below.
	PARAM	Parameter as defined below.
	Next PARAM	
	Repeat for NPOS	
	IPOS	Element position number.
	IIELNO	Element number.
	IELTYP	Sesam element type number.
	DAMAGE	Damage value.
	CYCLES	Number of stress cycles.
	Next POS	

Note:

IFATYP Fatigue check type.

IFATYP = 1: Stochastic fatigue

IFATYP = 2: Deterministic fatigue

IFATYP = 3: Time history fatigue

IRES: Internal result case reference number.

IFATYP = 1 : IRES = Sea state number

IFATYP = 2 : IRES = Wave hight number

IFATYP = 3 : IRES = Time series number

Table 2.23: Parameter reference on data type **RVFATDMH**

PARAM	Parameter	Description
1	STEPS	Number of time steps of time series.
2	DT	Time increment of the time series.
3	TTOT	Total duration of time series.
4	DIR	Wave direction/Direction of time series load.
5	IFACT	Option for use of probability factors in damage calculation: IFACT = 0: Appropriate factors applied to the damage. IFACT = 1: Factors not applied (non-scaled damage).
6	ITIME	Fatigue exposure time option: ITIME = 0: Design fatigue life. TIME = Fatlife (years) * year (s) = Fatlife *3.1536E+7 (s) ITIME = 1: Unit time. TIME = 1 (s) ITIME = 2: Time series duration. TIME = Duration of time series in seconds (s) ITIME = 3: User defined exposure time. TIME = User time (seconds) Damage per unit time = DAMAGE / TIME.
7	TIME	Fatigue exposure time.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.34 **RVFATPRP**: Fatigue damage properties

This data type contains fatigue damage properties for relevant positions and hot spots of an element.

Data type definition:

	RVFATPRP	Data type reference.
	NFIELD	Number of data fields on this data type (including this field).
→	IIELNO	Internal reference number of member.
	IFATYP	Fatigue check type.
	IELTYP	Sesam element type number.
	NPOS	Number of element results points.
	Repeat for NPOS	
	IPOS	Element position number.
	INAME	Position name number.
	IJOINT	Internal joint/node number at the element position.
	IRSNCRV	→ Unique SN-Curve ID Reference to a **RVSNCURV** data type.
	NPOSPRP	Number of Fatigue Properties for position.
	Repeat for NPOSPRP	
	IPOSPRP	Identifier for Position fatigue Property.
	POSPRP	Position Fatigue Property.
	Next POSPRP	
	NHOTS	Number of fatigue hot spots of the element position.
	Repeat for NHOTS	
	IHOTS	Hot spot number.
	NHOTPRP	Number of Fatigue Properties for hot spot.
	Repeat for NHOTPRP	
	IHOTPRP	Identifier for Hot spot fatigue property.
	HOTPRP	Hot spot Fatigue Property.
	Next HOTPRP	
	Next HOTS	
	Next POS	

The (IPOSPRP) Position Fatigue Properties are as follows:

IPOSPRP	Description	Comment
1	SCF Axial	Uniform (Applies for all hot spots)
2	SCF In-plane	Uniform (Applies for all hot spots)
3	SCF Out-of-plane	Uniform (Applies for all hot spots)
4	Fatigue Safety Factor	

continued . . .

IPOSPRP	Description	Comment
5	Thickness	Thickness at position (relevant for SN Curve thickness correction)

The (IHOTPRP) Hot spot Fatigue Properties are as follows

IHOTPRP	Description	Comment
1	SCF Axial	Unique for the given hot spot
2	SCF In-plane	Unique for the given hot spot
3	SCF Out-of-plane	Unique for the given hot spot
4	Fatigue Part Damage	(Aggregated from previous fatigue analyses)

If SCF’s are specified at each hot spot, these will overrule any (uniform) SCF’s given at the position.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.35 **RVFORCES**: Force results

This data type contains force results for each force station in one element of the super element. The forces refer to the local co-ordinate system(s) defined on data type **RDPOINTS**.

Note that number of K-planes defined on **RDPOINTS** data type referenced from **RVFORCES** data type must always be = 1. This means that the defined result points defined will be interpreted as force stations.

Data type definition:

	RVFORCES		Data type reference.
	NFIELD		Number of data fields on this data type.
→	IRES		Result case reference number.
→	IIELNO		Internal element number.
	IRPALT	→	Reference to data type **RDPOINTS**.
	IRFORC	→	Reference to data type **RDFORCES**.
	Repeat for NRP		
	Repeat for LENREC		
	FORCE		Result value.
	IFORCE		Imaginary result value if complex result.
	Next REC		
	Next RP		

Comments:

IRPALT	Result point alternative number as defined on data type **RDPOINTS**.
IRFORC	Stress component data type number as defined on data type **RDFORCES**.
NRP	No. of result points as stored on data type **RDPOINTS**. Full reference to **RDPOINTS** is (IRPALT, IIELNO) as stored above.
LENREC	No. of results components as stored on data type **RDFORCES**. Full reference to **RDFORCES** is (IRFORC) as stored above.
COMPLEX	Complex flag as stored on data type **RDRESREF**.
	Full reference to **RDRESREF** is (IRES) as stored above.
	The following error check should be performed while reading **RVFORCES** data:
	NFIELD = NRP*LENREC*(COMPLEX+1) + 5

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.36 **RVNODACC**: Nodal accelerations

This data type contains the nodal acceleration results and references to its component definitions and transformations.

Data type definition:

	RVNODACC		Data type reference.
	NFIELD		Number of data fields on this data type.
→	IRES		Result case reference number.
→	IINOD		Internal node number.
	IRDVA	→	Reference to acceleration component definition.
	ITRANS		Nodal transformation flag.
	Repeat for NACC		
	ACC		Acceleration value.
	IACC		Imaginary term if complex results.
	Next ACC		

Note:

IRDVA			Reference to data type **RDNODRES**.
ITRANS			Nodal transformation flag.
	=	0	If node has no transformation.
	=	1	If node is transformed.
			References to transformations are found on **BNDOF** data types. Actual transformation data are found on **BNTRCOS** data types.
NACC	=		(NFIELD-5)/(COMPLEX+1) (Integer division).
COMPLEX			Complex flag as stored on **RDRESREF** data type.
			Full reference to **RDRESREF** is (IRES) as stored above.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.37 **RVNODDIS**: Nodal displacements

This data type contains the nodal displacement results and references to its component definitions and transformations.

Data type definition:

	RVNODDIS		Data type reference.
	NFIELD		Number of data fields on this data type (including this field).
→	IRES		Result case reference number.
→	IINOD		Internal node number.
	IRDVA	→	Reference to displacement component definition at data type **RDNODRES**.
	ITRANS		Nodal transformation flag.
		= 0	If the node has no transformation.
		= 1	If the node is transformed. References to transformations are found at **BNDOF** data types. Actual transformation data are found at **BNTRCOS** data types.
	Repeat for NDIS	=	(NFIELD-5)/(COMPLEX+1) (Integer division), where COMPLEXis found at the corresponding **RDRESREF** data type.
	RDIS		Real displacement value.
	IDIS		Imaginary displacement value, as defined at the corresponding **RDRESREF** data type if the result case is complex.
	Next		

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.38 **RVNODREA**: Nodal reaction forces and moments

Data type definition:

	RVNODREA		Data type reference.
	NFIELD		Number of data fields on this data type (including this field).
→	IRES		Result case reference number.
→	IINOD		Internal node number.
	IRREA	→	Reference to force component definitions on data type **RDNODREA**.
	IRBOC	→	Reference to boundary condition definitions on data type **RDNODBOC**.
	ITRANS		Nodal transformation flag.
	Repeat for NFORCES		
	FORCE		Force component value.
	IFORCE		Imaginary term if complex results.
	Next FORCE		

Note:

NFORCES is the number of (force and moment) components that are stored for the node **IINOD**. Force components for degrees of freedoms without boundary conditions will not be stored.

NFORCES must be equal to **LENREC** on the **RDNODREA** referenced by **IRREA**.

NFORCES is thus less than or equal to the number of degrees of freedom at the node **IINOD**.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.39 **RVNODVEL**: Nodal velocities

This data type contains the nodal velocity results and references to its component definitions and transformations.

Data type definition:

	RVNODVEL		Data type reference.
	NFIELD		Number of data fields on this data type.
→	IRES		Result case reference number.
→	IINOD		Internal node number.
	IRDVA	→	Reference to velocity component definition.
	ITRANS		Nodal transformation flag.
	Repeat for NVEL		
	VEL		Velocity value.
	IVEL		Imaginary term if complex results.
	Next VEL		

Note:

IRDVA			Reference to data type **RDNODRES**.
ITRANS			Nodal transformation flag.
	=	0	If node has no transformation.
	=	1	If node is transformed.
			References to transformations are found on **BNDOF** data types. Actual transformation data are found on **BNTRCOS** data types.
NVEL	=		(NFIELD-5)/(COMPLEX+1) (Integer division).
COMPLEX			Complex flag as stored on **RDRESREF** data type.
			Full reference to **RDRESREF** is (IRES) as stored above.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.40 **RVORDINA**: Result series ordinate values

The ordinate values are typically stresses, displacements, etc.

Two data types, **RVABSCIS** & **RVORDINA**, will together form a series that can be plotted as a graph or processed in other ways. The two data types are referenced from the **RDSERIES** data type. One **RVABSCIS** data type can be referenced from several **RDSERIES** data types so that if different series share the same abscissa values (e.g. time instants), then the list of abscissa values will be written only once. Each **RVORDINA** data type is typically referenced only once.

A series of results can in principle be of unlimited length, but a results file data type should not be too long. Therefore, a list of ordinate values can be stored on several **RVORDINA** data types in sequence as shown below.

Note that the ordinate values must be sorted in accordance with the abscissa value sorting.

Data type definition:

	RVORDINA		Data type reference.
	NFIELD		Number of data fields on this data type (MAX=1024).
→	IDLSTO		Ordinate list identification number.
→	IINOD		List data type index number.
	COMPLEX		Complex flag.
		$= 0$	Real result.
		$\neq 0$	Complex result.
	Repeat for NVALUES		
	VALUE		Ordinate value.
	IVALUE		Imaginary ordinate value if complex values.
	Next VALUE		

Note:

NOTE:			Max allowed NFIELD for this particular data type is 1024.
COMPLEX	=	0	Real values only.
	=	1	Real and imaginary values.
NVALUES	=		(NFIELD-4)/(COMPLEX+1).

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.41 **RVSNCURV**: SN-Curve data values

This data type contains the data for the SN-Curve.

Data type definition:

	RVSNCURV		Data type reference.
	NFIELD		Number of data fields on this data type (including this field).
$\rightarrow$	IRSNCRV		SN-Curve reference number (unique).
	SnCurveType		The SN-Curve Type.
		$= 0$	Not specified.
		$= 1$	User defined.
		$= 2$	$\log A$.
		$= 3$	Stochastic.
	m_0	> 0	The inverse slope of the first branch of the SN-Curve.
		$= 0$	The first branch of the SN-Curve is horisontal.
	m_1	> 0	The inverse slope of the second branch of the SN-Curve.
		$= 0$	The second branch of the SN-Curve is horisontal.
		< 0	The second branch of the SN-Curve is not defined.
	m_2	> 0	The inverse slope of the third branch of the SN-Curve.
		$= 0$	The third branch of the SN-Curve is horisontal.
		< 0	The third branch of the SN-Curve is not defined.
	N_0	> 0	The logarithm of the number of cycles at the intersection between the first and the second branch.
	N_1	> 0	The logarithm of the number of cycles at the intersection between the second and the third branch.
		< 0	The logarithm is not defined for the SN-Curve.
	S_0		The stress level at the intersection between the first and the second branch. (Unit: MN/m^2)
	S_1		The stress level at the intersection between the second and the third branch. (Unit: MN/m^2)
	$\log A_0$	> 0	The intercept of the $\log N$-axis by the first branch of the SN-Curve. (Unit: Stress in N/m^2)
	$\log A_1$	> 0	The intercept of the $\log N$-axis by the second branch of the SN-Curve. (Unit: Stress in N/m^2)
		< 0	The logarithm is not defined for the SN-Curve.
	$\log A_2$	> 0	The intercept of the $\log N$-axis by the third branch of the SN-Curve. (Unit: Stress in N/m^2)
		< 0	The logarithm is not defined for the SN-Curve.

$\log K_0$		The intercept of the $\log N$-axis by the mean of the SN-Curve.
		(Unit: Stress in N/m^2)
σ	> 0	The standard deviation of $\log K_0$ for the SN-Curve. Note. $\log A_0 = \log K_0 - 2\sigma$.
	$= 0$	The SN-Curve is not stochastic.
t_{exp}		The exponent used in the thickness correction. *3,4
t_{ref}		The reference thickness.
		The thickness t for which the SN-Curve is valid without correction. *1,4
		(Unit: mm). Applies for all current SN-Curves of the Sesam Core Library.
t_{cut}		The cut-off thickness used in SN-Curve thickness correction. *2,4.
		(Unit: mm). Applies for all current SN-Curves of the Sesam Core Library.

Note:

- If t_{ref} is not given, no thickness correction is associated with the SN-Curve.
- Standard T-curve $(t_{cut} = t_{ref}, t_{exp} = 0.25)$.
- t_{ref}, t_{cut} & t_{exp} need only to be given for one (the first) segment.

ToDo 1: What are the factors/numbers/reference "*3,4", "1,4", and "**2,4" above referring to?

Further **Notes** from the Stofat users manual [1]:

Note 1: The unit of the thickness correction and cut-off criteria are related to the units of the SN-Curve and the length unit applied in the analysis. For user defined SN-Curves, both SN-Curve data and thickness corrections must be consistent with the units applied in the analysis. Thickness corrections must accordingly be assigned in same length unit as applied in the analysis.

Note 2: The SN-Curve libraries may have predefined default thickness corrections (reference thickness and cut-off thickness) defined in SI unit meters. These values are multiplied with a unit length factor entered by the command DEFINE SHELL-FATIGUE-CONSTANTS. The purpose is to convert the thickness corrections to the length unit of the current analysis.

Note 3: If the length unit of the analysis is mm and default thickness corrections (in meters) of library SN-Curves are applied, a unit length factor of 1000 must be used. However, if thickness corrections are assigned by the user in same length unit as applied in the analysis, a unit length factor of 1.0 should be used.

Note 4: Note that the unit length factor is only applied to thickness corrections of build-in library SN-Curves and that the same unit length factor is applied to all library SN-Curves applied in the analysis. Thickness corrections of all library SN-Curves applied must accordingly be in same length unit, i.e if predefined thickness corrections are used for one library SN-Curve, thickness corrections assigned to another library SN-Curve by the user must also be in meters.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.42 **RVSOILAY**: Soil layers summary data

Data type definition:

	RVSOILAY		Data type reference.
	NFIELD		Length of the data type (including NFIELD).
→	SOIL-PROFILE-ID		Reference to data type **RDSOIPRF**.
→	SOIL-LAYER-ID		Soil main layer identifier.
	ZBOTM		Z-level at the bottom of the layer given in the Splice global co-ordinate system, i.e. positive Z in pile tip direction.
	ZLAY		Layer z-level given in the Splice global co-ordinate system. Will be layer bottom if a pile is used for automatic sub-division of the main soil layers.
	DEPTH		Layer depth from average soil surface to ZLAY.
	GAMEFF		Layer effective unit weight.
	PHIR		Angle of internal friction (degr). Includes the material coefficient for the friction angle, SFTPHI
	SURED		Layer undrained shear strength. Includes the material coefficient on undrained shear strength, SFU.
	SIGZRES		Layer vertical effective stress at level zlay.
	DSIGZ		Vert stress change due to surface loading.
	POISZ		Poisson's ratio.
	EMOD		Modulus of elasticity.
	GMOD		Shear modulus.
	PY-CODE	= 000:	Manual input of p and y values for each layer and pile diameter.
		= 100 + N:	Automatic generation using a set of simple rules. The p-max value is calculated from J. Brinch Hansen (1961) earth pressure theory, displacement y to reach p-max is set to 0.1 times pile diameter. All $p - y$ curves pass through this point, the value of N determines curve shape. N = 0, gives a line. N = 1, bilinear. N = 2, trilinear, etc.
		= 214:	$p - y$ is generated by the API 2014 edition rules.
		= 284:	$p - y$ is generated by the API 1984 edition rules.
		= 287:	$p - y$ is generated by the API 1987 edition rules.
		= 380:	$p - y$ is generated by the DNV 1980 edition rules.
		= 404:	$p - y$ is generated by the ISO (2004) recommendations.

	= 570:	$p-y$ is generated by "Modified Matlock".
	= 588:	$p-y$ is generated for calcareous sands.
	= 600:	$p-y$ is generated for soft clays, NGI-11 method.
TZ-CODE	= 000:	Manual input of t and z values for each layer and pile diameter.
	= 100 + N:	Automatic generation as for $p-y$ above.
	= 200:	$t-z$ data is generated by the Kraft et al. (1-981) procedures.
	= 214:	$t-z$ data is generated by API-2014 procedures.
	= 293:	$t-z$ data is generated by API-1993 procedures.
	= 588:	$t-z$ data is generated with strain softening, see the Gensod Engineering Documentation.
QZ-CODE	= 000:	Manual input of q and z values for each layer and pile diameter.
	= 100 + N:	Automatic generation as for $p-y$ and $t-z$ above.
	= 200:	A bi-linear $q-z$ curve is generated.
	= 214:	$q-z$ data is generated by API-2014 procedures.
	= 293:	$q-z$ data is generated by API-1993 procedures.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.43 **RVSOILPY**: Soil layers data for PY curves

This is a data type for lateral resistance soil curves produced by Gensod.

Data type definition:

	RVSOILPY	Data type reference.
	NFIELD	Length of the data type (including NFIELD).
$\rightarrow$	SOIL-PROFILE-ID	Reference to data type **RDSOIPRF**.
$\rightarrow$	SOIL-DIAMETER-ID	Reference to data type **RDSOILDI**.
$\rightarrow$	SOIL-LAYER-ID	Soil main layer identifier.
	MAXLP	Max lateral stress.
	MAXSTIFF	Maximum stiffness (F/L^3.)
	HOLE	Code for open/close hole. Open = 1. Closed = 0.
	NUMPNT	Number of Py points in the layer.
	Repeat for NUMPNT	
	Py-Stress	
	Py-Displacement	
	Next Point	

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.44 **RVSOILQZ**: Soil layers data for QZ curves

This is a data type for pile tip resistance soil curves produced by Gensod.

Data type definition:

	RVSOILQZ	Data type reference.
	NFIELD	Length of the data type (including NFIELD).
$\rightarrow$	SOIL-PROFILE-ID	Reference to data type **RDSOIPRF**.
$\rightarrow$	SOIL-DIAMETER-ID	Reference to data type **RDSOILDI**.
$\rightarrow$	SOIL-LAYER-ID	Soil main layer identifier.
	MAXLP	Max pile tip stress compression.
	MAXSTIFF	Maximum stiffness (F/L^3).
	HOLE	Max pile tip stress tension.
	NUMPNT	Number of Py points in the layer.
	NUMPNT	Number of Qz points in the layer. Mid point is the origin, i.e. $bs = 0.0$ and $y = 0.0$.
	Repeat for NUMPNT	
	Qz-Stress	
	Qz-Displacement	
	Next Point	

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.45 **RVSOILTZ**: Soil layers data for TZ curves

This is a data type for skin friction soil curves produced by Gensod.

Data type definition:

	RVSOILTZ	Data type reference.
	NFIELD	Length of the data type (including NFIELD).
$\rightarrow$	SOIL-PROFILE-ID	Reference to data type **RDSOIPRF**.
$\rightarrow$	SOIL-DIAMETER-ID	Reference to data type **RDSOILDI**.
$\rightarrow$	SOIL-LAYER-ID	Soil main layer identifier.
	MAXLP	Max axial stress compression.
	MAXSTIFF	Maximum stiffness (F/L^3).
	HOLE	Max axial stress tension.
	NUMPNT	Number of $Bs - y$ points in the layer. Mid point is the origin, i.e. $bs = 0.0$ and $y = 0.0$.
	Repeat for NUMPNT	
	Tz-Stress	
	Tz-Displacement	
	Next Point	

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.46 **RVSTRAIN**: Strain results

This data type contains strain results for each integration point in one element of the super element. The strain values refer to the local co-ordinate system(s) defined on data type **RDPOINTS**.

Data type definition:

	RVSTRAIN		Data type reference.
	NFIELD		Number of data fields on this data type(including this field).
→	IRES		Result case reference number.
→	IIELNO		Internal element number.
	IRPALT	→	Reference to data type **RDPOINTS**.
	IRSTRN	→	Reference to data type **RDSTRAIN**.
	Repeat for NRP		
	Repeat for LENREC		
	STRAIN		Result value.
	ISTRAIN		Imaginary result value if complex result.
	Next REC		
	Next RP		

Note:

IRPALT	Result point alternative number as defined on data type **RDPOINTS**.
IRSTRN	Stress component data type number as defined on data type **RDSTRAIN**.
NRP	No. of result points as stored on data type **RDPOINTS**. Full reference to **RDPOINTS** is (IRPALT, IIELNO) as stored above.
LENREC	No. of results components as stored on data type **RDSTRAIN**. Full reference to **RDSTRAIN** is (IRSTRN) as stored above.
COMPLEX	Complex flag as stored on data type **RDRESREF**.
	Full reference to **RDRESREF** is (IRES) as stored above.
	The following error check should be performed while reading **RVSTRAIN** data:
	NFIELD = NRP*LENREC*(COMPLEX+1) + 5

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.47 **RVSTRESS**: Stress results

This data type contains stress results for each integration point in one element of the super element. The stress values refer to the local co-ordinate system(s) defined at the data type **RDPOINTS**.

Data type definition:

	RVSTRESS		Data type reference.
	NFIELD		Number of data fields on this data type(including this field).
→	IRES		Result case reference number.
→	IIELNO		Internal element number.
	IRPALT	→	Reference to data type **RDPOINTS**.
	IRSTRS	→	Reference to data type **RDSTRESS**.
	Repeat for NRP		
	Repeat for LENREC		
	STRESS		Result value.
	ISTRESS		Imaginary result value if complex result.
	Next REC		
	Next RP		

Note:

IRPALT	Result point alternative number as defined on data type **RDPOINTS**.
IRSTRN	Stress component data type number as defined on data type **RDSTRESS**.
NRP	No. of result points as stored on data type **RDPOINTS**. Full reference to **RDPOINTS** is (IRPALT, IIELNO) as stored above.
LENREC	No. of results components as stored on data type **RDSTRESS**. Full reference to **RDSTRESS** is (IRSTRS) as stored above.
COMPLEX	Complex flag as stored on data type **RDRESREF**. Full reference to **RDRESREF** is (IRES) as stored above. The following error check should be performed while reading **RVSTRESS** data: NFIELD = NRP*LENREC*(COMPLEX+1) + 5

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.48 **TDELEM**: Name of an Element and/or comment

TDELEM	NFIELD	→ ELNO	CODNAM	CODTXT
	Name			
	Comment line			
	. . .			
	Comment line			

This data type will associate a name and/or a comment to the element with identification ELNO.

NFIELD — Number of numeric data fields at this data type before text data (MAX = 1024).

ELNO — Internal element number (unique).

CODNAM — Coded dimension of the Name:
CODNAM = NLNAM*100 + NCNAM. The inverse relation will then be:
NLNAM = integer part of (CODNAM/100)
NCNAM = remaindering of (CODNAM/100)
NLNAM number lines used to store the name. Legal range = [0,1]
= 0, no name defined
= 1, name is defined
NCNAM - number of characters in the name. Legal range = [0,64]

CODTXT — Coded dimension of the Comment:
CODTXT = NLTXT*100 + NCTXT. The inverse relation will then be:
NLTXT = integer part of (CODTXT/100)
NCTXT = remaindering of (CODTXT/100)
NLTXT - number of lines used to store the comment. Legal range = [0,5]
= 0, no comments defined
$\geq$ 1, number of physical records with comments
NCTXT - number of characters in the comment – each comment line must be of the same length. Legal range = [0,64]

Name — A user set name.

Comment line — User set comment lines.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.49 **TDFATDAM**: Fatigue damage name definitions

TDFATDAM	NFIELD	IIELNO / IMEM	CODNAM	CODTXT
	Name from Framework			
	Name from GeniE			
	POSNAM 1			
	POSNAM 2			
	⋮			
	POSNAM NPOS			

This data type contains element / member names from Framework and GeniE, and position names (POSNAM *i*) corresponding to the positions at **RVFATDAM** and / or **RVFATDMG** data types. NPOS is the number of element results points at **RVFATDAM** and / or **RVFATDMG** data types. Each position *i* has a unique name POSNAM *i* at an element or a member. Please notice that **TDFATDAM** cannot be repeated on index. This means that if a model contains both an **RVFATDAM** data type and an **RVFATDMG** data type with index IIELNO / IMEM = 1, only one **TDFATDAM** data type with index IIELNO / IMEM = 1 can be written.

NFIELD — Number of numeric data fields at this data type before text data (MAX = 1024).

IIELNO / IMEM — Internal reference number of element / member, respectively.

CODNAM — Coded dimension of the Name:
CODNAM = NLNAM*100 + NCNAM. The inverse relation will then be:
NLNAM = integer part of (CODNAM/100)
NCNAM = remaindering of (CODNAM/100)
NLNAM number lines used to store the name. Legal range = [0,1]
= 0, no name defined
= 1, name is defined
NCNAM - number of characters in the name. Legal range = [0,64]

CODTXT — Coded dimension of the Comment:
CODTXT = NLTXT*100 + NCTXT. The inverse relation will then be:
NLTXT = integer part of (CODTXT/100)
NCTXT = remaindering of (CODTXT/100)
NLTXT - number of lines used to store the comment. Legal range = [0,5]
= 0, no comments defined
$\geq$ 1, number of physical records with comments
NCTXT - number of characters in the comment – each comment line must be of the same length. Legal range = [0,64]

Name from Framework — Element / Member name as defined by Framework.

Name from GeniE — Element / Member name as defined by GeniE.

POSNAM *i*	NPOS lines that for each line contains one position name. The lines are ordered according to position numbers at **RVFATDAM** and / or **RVFATDMG** data types.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.50 **TDPVFATD**: Fatigue check point name.

TDPVFATD	NFIELD	CHECKPOINTID	CODNAM	CODTXT
	Name			
	Comment line			
	. . .			
	Comment line			

This data type will associate a name and/or a comment to the **PVFATDAM** data type with identification CHECKPOINTID.

NFIELD	Number of numeric data fields at this data type before text data (MAX = 1024).
CHECKPOINTID	SN-Curve reference number (unique).
CODNAM	Coded dimension of the Name: CODNAM = NLNAM*100 + NCNAM. The inverse relation will then be: NLNAM = integer part of (CODNAM/100) NCNAM = remaindering of (CODNAM/100) NLNAM number lines used to store the name. Legal range = [0,1] = 0, no name defined = 1, name is defined NCNAM - number of characters in the name. Legal range = [0,64]
CODTXT	Coded dimension of the Comment: CODTXT = NLTXT*100 + NCTXT. The inverse relation will then be: NLTXT = integer part of (CODTXT/100) NCTXT = remaindering of (CODTXT/100) NLTXT - number of lines used to store the comment. Legal range = [0,5] = 0, no comments defined $\geq$ 1, number of physical records with comments NCTXT - number of characters in the comment – each comment line must be of the same length. Legal range = [0,64]
Name	A user set name.
Comment line	User set comment lines.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.51 **TDNODE**: Name of a Node and/or comment

TDNODE	NFIELD	→ NODENO	CODNAM	CODTXT
	Name			
	Comment line			
	...			
	Comment line			

This data type will associate a name and/or a comment to the node with identification NODENO.

NFIELD Number of numeric data fields at this data type before text data (MAX = 1024).

NODENO Node number.

CODNAM Coded dimension of the Name:
CODNAM = NLNAM*100 + NCNAM. The inverse relation will then be:
NLNAM = integer part of (CODNAM/100)
NCNAM = remaindering of (CODNAM/100)
NLNAM number lines used to store the name. Legal range = [0,1]
= 0, no name defined
= 1, name is defined
NCNAM - number of characters in the name. Legal range = [0,64]

CODTXT Coded dimension of the Comment:
CODTXT = NLTXT*100 + NCTXT. The inverse relation will then be:
NLTXT = integer part of (CODTXT/100)
NCTXT = remaindering of (CODTXT/100)
NLTXT - number of lines used to store the comment. Legal range = [0,5]
= 0, no comments defined
$\geq$ 1, number of physical records with comments
NCTXT - number of characters in the comment – each comment line must be of the same length. Legal range = [0,64]

Name A user set name.

Comment line User set comment lines.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.52 **TDRESREF**: Result case name and description text

TDRESREF	NFIELD	IRES	CODNAM	CODTXT
	Name			
	Comment line			
	. . .			
	Comment line			

NFIELD	Number of numeric data fields at this data type before text data (MAX = 1024).
IRES	Internal result case number (unique).
CODNAM	Coded dimension of the Name: CODNAM = NLNAM*100 + NCNAM. The inverse relation will then be: NLNAM = integer part of (CODNAM/100) NCNAM = remaindering of (CODNAM/100) NLNAM number lines used to store the name. Legal range = [0,1] = 0, no name defined = 1, name is defined NCNAM - number of characters in the name. Legal range = [0,64]
CODTXT	Coded dimension of the Comment: CODTXT = NLTXT*100 + NCTXT. The inverse relation will then be: NLTXT = integer part of (CODTXT/100) NCTXT = remaindering of (CODTXT/100) NLTXT - number of lines used to store the comment. Legal range = [0,5] = 0, no comments defined $\geq$ 1, number of physical records with comments NCTXT - number of characters in the comment – each comment line must be of the same length. Legal range = [0,64]
Name	A user set name.
Comment line	User set comment lines.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.53 **TDSERIES**: Series name and description text

TDSERIES	NFIELD	IDSERI	CODNAM	CODTXT
	Name			
	Comment line			
	. . .			
	Comment line			

NFIELD	Number of numeric data fields at this data type before text data (MAX = 1024).
IDSERI	Internal series number (unique).
CODNAM	Coded dimension of the Name: CODNAM = NLNAM*100 + NCNAM. The inverse relation will then be: NLNAM = integer part of (CODNAM/100) NCNAM = remaindering of (CODNAM/100) NLNAM number lines used to store the name. Legal range = [0,1] = 0, no name defined = 1, name is defined NCNAM - number of characters in the name. Legal range = [0,64]
CODTXT	Coded dimension of the Comment: CODTXT = NLTXT*100 + NCTXT. The inverse relation will then be: NLTXT = integer part of (CODTXT/100) NCTXT = remaindering of (CODTXT/100) NLTXT - number of lines used to store the comment. Legal range = [0,5] = 0, no comments defined $\geq$ 1, number of physical records with comments NCTXT - number of characters in the comment – each comment line must be of the same length. Legal range = [0,64]
Name	A user set name.
Comment line	User set comment lines.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.54 **TDSNCURV**: SN-Curve name description

TDSNCURV	NFIELD	IRSNCRV	CODNAM	CODTXT
	Name			
	Comment line			
	. . .			
	Comment line			

This data type will associate a name and/or a comment to the **RVSNCURV** data type with identification IRSNCRV.

NFIELD
Number of numeric data fields at this data type before text data (MAX = 1024).

IRSNCRV
SN-Curve reference number (unique).

CODNAM
Coded dimension of the Name:
CODNAM = NLNAM*100 + NCNAM. The inverse relation will then be:
NLNAM = integer part of (CODNAM/100)
NCNAM = remaindering of (CODNAM/100)
NLNAM number lines used to store the name. Legal range = [0,1]
= 0, no name defined
= 1, name is defined
NCNAM - number of characters in the name. Legal range = [0,64]

CODTXT
Coded dimension of the Comment:
CODTXT = NLTXT*100 + NCTXT. The inverse relation will then be:
NLTXT = integer part of (CODTXT/100)
NCTXT = remaindering of (CODTXT/100)
NLTXT - number of lines used to store the comment. Legal range = [0,5]
= 0, no comments defined
$\geq$ 1, number of physical records with comments
NCTXT - number of characters in the comment – each comment line must be of the same length. Legal range = [0,64]

Name
A user set name.

Comment line
User set comment lines.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.55 **TDSUPNAM**: Name of a Super Element and/or comment

TDSUPNAM	NFIELD	IHREF	CODNAM	CODTXT
	Name			
	Comment line			
	. . .			
	Comment line			

NFIELD	Number of numeric data fields at this data type before text data (MAX = 1024).
IHREF	Internal hierarchy reference number (unique).
CODNAM	Coded dimension of the Name: CODNAM = NLNAM*100 + NCNAM. The inverse relation will then be: NLNAM = integer part of (CODNAM/100) NCNAM = remaindering of (CODNAM/100) NLNAM number lines used to store the name. Legal range = [0,1] = 0, no name defined = 1, name is defined NCNAM - number of characters in the name. Legal range = [0,64]
CODTXT	Coded dimension of the Comment: CODTXT = NLTXT*100 + NCTXT. The inverse relation will then be: NLTXT = integer part of (CODTXT/100) NCTXT = remaindering of (CODTXT/100) NLTXT - number of lines used to store the comment. Legal range = [0,5] = 0, no comments defined $\geq$ 1, number of physical records with comments NCTXT - number of characters in the comment – each comment line must be of the same length. Legal range = [0,64]
Name	A user set name.
Comment line	User set comment lines.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.1.56 **TSOILPRF**: Soil profile name and/or comment

TSOILPRF	NFIELD	SOIL-Profile-ID	CODNAM	CODTXT
	Name			
	Comment line			
	. . .			
	Comment line			

This data type will associate a name and/or a comment to the **RDSOIPRF** data type with identification SOIL-Profile-ID.

NFIELD	Number of numeric data fields at this data type before text data (MAX = 1024).
SOIL-Profile-ID	Soil Profile identification number.
CODNAM	Coded dimension of the Name: CODNAM = NLNAM*100 + NCNAM. The inverse relation will then be: NLNAM = integer part of (CODNAM/100) NCNAM = remaindering of (CODNAM/100) NLNAM number lines used to store the name. Legal range = [0,1] = 0, no name defined = 1, name is defined NCNAM - number of characters in the name. Legal range = [0,64]
CODTXT	Coded dimension of the Comment: CODTXT = NLTXT*100 + NCTXT. The inverse relation will then be: NLTXT = integer part of (CODTXT/100) NCTXT = remaindering of (CODTXT/100) NLTXT - number of lines used to store the comment. Legal range = [0,5] = 0, no comments defined $\geq$ 1, number of physical records with comments NCTXT - number of characters in the comment – each comment line must be of the same length. Legal range = [0,64]
Name	A user set name.
Comment line	User set comment lines.

Back to Section 2.1.1 **First Level Results Data Type Definitions**

2.1.2 Higher Level Results Data Type Definitions

Higher level data

HIERARCH	Super Element Hierarchy Description	see Section 2.1.2.1
HSUPSTAT	Super Element Statistical Information	see Section 2.1.2.2
HSUPTRAN	Super Element Transformation	see Section 2.1.2.3

2.1.2.1 **HIERARCH**: Super Element Hierarchy Description

HIERARCH	NFIELD	$\rightarrow$ IHREF	ISELTY	INDSEL
	ISLEVL	ITREF	IHPREF	NSUB
	$\text{IHSREF}_{(1)}$	$\text{IHSREF}_{(2)}$	...	$\text{IHSREF}_{(\text{NSUB})}$

This data type identifies a super element in the hierarchy. All the **HIERARCH** data types are written in the highest level (top level) T-file.

The set of **HIERARCH** data types stored will define the super element hierarchy, see Figure 2.4. Note that the reference IHREF is unique for all "nodes" in the super element tree, i.e. unique for every **HIERARCH** data type. If super elements are repeated, each repetition will have a unique hierarchy reference IHREF, although the super element type number is identical.

NFIELD	Number of data fields on this data type (including this field and embedded not used fields).
IHREF	Hierarchy reference number. Number 1 is reserved for the top level super element. In the Sesam system, the super element pre-processor Presel is writing the **HIERARCH** data types and defining a unique number (IHREF) for each appearance of the different super elements. See also Figure 2.4 below.
ISELTY	Super element type number.
INDSEL	Super element index number. Super element index in case of repeated super elements. If super element is not repeated, INDSEL=1 must be used.
ISLEVL	Super element level.
ITREF	Reference to data type **HSUPTRAN**, defining super element transformation between actual super element and parent super element.
IHPREF	Reference to **HIERARCH** data type of parent super element.
NSUB	Number of sub elements in this super element.
$\text{IHSREF}_{(i)}$	Reference to **HIERARCH** data type for sub element number i.

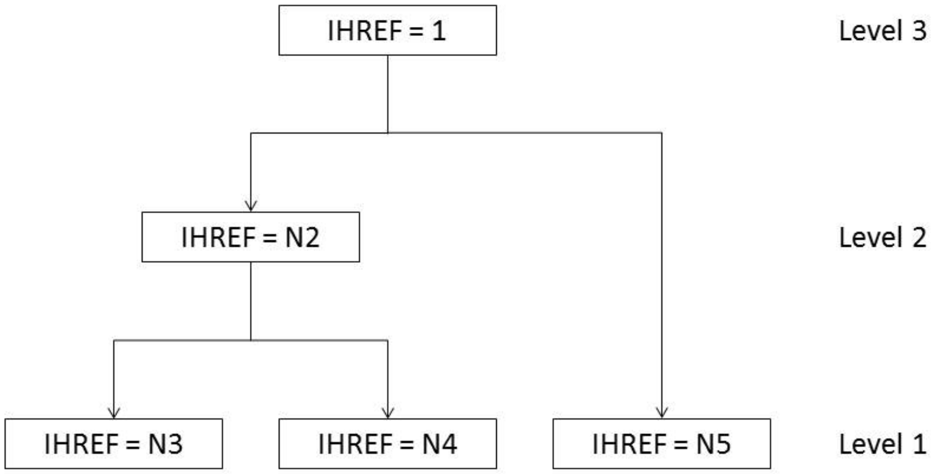


Figure 2.4: Super element hierarchy with 3 levels.

In Figure 2.4 above, please notice that N2, N3, N4, and N5 may take any values as long as they are unique in the hierarchy. Further notice that the top level super element has IHREF = 1 as required for the top level super element.

Back to Section 2.1.2 **Higher Level Results Data Type Definitions**

2.1.2.2 **HSUPSTAT**: Super Element Statistical Information

HSUPSTAT	NFIELD	→ ISELTY	NIDOF	NRDOF
	NBAND	NELT	LINDEP	RELOADC
	COMPLC			

This data type lists statistical information about super elements. All the **HSUPSTAT** data types are written in the highest level (toplevel) T-file. The **HSUPSTAT** data type is referenced from the **HIERARCH** data type through the super element type number (ISELTY).

NFIELD	Number of data fields on this data type (including this field and embedded not used fields).
ISELTY	Super element type number.
NIDOF	Estimated number of internal degrees of freedoms.
NRDOF	Estimated number of retained degrees of freedoms.
NBAND	Estimated bandwidth of the internal degrees freedoms. The estimated bandwidth shall be equal to -1 if no bandwidth information exists.
NELT	Estimated number of elements. The estimated number of elements is only required for first level super elements.
LINDEP	If LINDEP > 0, this super element has linear dependent nodes.
RELOADC	Number of real load cases.
COMPLC	Number of complex load cases.

Back to Section 2.1.2 **Higher Level Results Data Type Definitions**

2.1.2.3 **HSUPTRAN**: Super Element Transformation

HSUPTRAN	NFIELD	→ ITREF	$T_{(1,1)}$	$T_{(2,1)}$
	$T_{(3,1)}$	$T_{(4,1)}$	$T_{(1,2)}$	$T_{(2,2)}$
	$T_{(3,2)}$	$T_{(4,2)}$	$T_{(1,3)}$	$T_{(2,3)}$
	$T_{(3,3)}$	$T_{(4,3)}$	$T_{(1,4)}$	$T_{(2,4)}$
	$T_{(3,4)}$	$T_{(4,4)}$		

This data type is defining the super element transformation between actual super element and parent super element. All the **HSUPTRAN** data types are written in the highest level (the top level) T-file. The **HSUPTRAN** data type is referenced from the **HIERARCH** data type through the super element transformation reference number, ITREF.

NFIELD: Number of data fields on this data type (including this field and embedded not used fields).

ITREF: Reference to the **HSUPTRAN** data type (from the **HIERARCH** data type).

$T_{(i,j)}$: Term with indices i, j of the transformation matrix between actual super element and parent super element, defined by:

$X'_{actual} = T \cdot X_{parent}$

The general transformation matrix T is defined through the following relation between the sub element co-ordinate system x' and the assembly, or basic super element assembly co-ordinate system x

$$x' = Tx,$$

where

$$\begin{bmatrix} x' \\ 1 \end{bmatrix} = \begin{bmatrix} t_{(1,1)} & t_{(1,2)} \\ t_{(2,1)} & t_{(2,2)} \end{bmatrix} \begin{bmatrix} x \\ 1 \end{bmatrix},$$

and where the sub-matrices are defined as follows

$$\begin{bmatrix} x'_1 \\ x'_2 \\ x'_3 \\ 1 \end{bmatrix} = \begin{bmatrix} T_{(1,1)} & T_{(1,2)} & T_{(1,3)} & T_{(1,4)} \\ T_{(2,1)} & T_{(2,2)} & T_{(2,3)} & T_{(2,4)} \\ T_{(3,1)} & T_{(3,2)} & T_{(3,3)} & T_{(3,4)} \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ 1 \end{bmatrix}. \tag{2.11}$$

The 9 terms (cosines) of the first sub matrix $t_{(1,1)}$, i.e.

$$[t_{(1,1)}] = \begin{bmatrix} T_{(1,1)} & T_{(1,2)} & T_{(1,3)} \\ T_{(2,1)} & T_{(2,2)} & T_{(2,3)} \\ T_{(3,1)} & T_{(3,2)} & T_{(3,3)} \end{bmatrix},$$

are due to a possible rotation and/or mirroring of the sub element in question.

The three terms of the second sub matrix $t_{(1,2)}$, i.e.

$$[t_{(1,2)}] = \begin{bmatrix} T_{(1,4)} \\ T_{(2,4)} \\ T_{(3,4)} \end{bmatrix},$$

are the co-ordinates of the origin of the global (assembly) co-ordinate system in the sub element co-ordinate system.

Notice: as can be seen from equation 2.11 the explicit matrix zeros and unity element, i.e. $T_{(4,1)} = 0$, $T_{(4,2)} = 0$, $T_{(4,3)} = 0$, and $T_{(4,4)} = 1$ are given on the **HSUPTRAN** data type. This definition differs from the **GELMNT2** data type where they are not given.

Back to Section 2.1.2 **Higher Level Results Data Type Definitions**

3 HYDRODYNAMIC RESPONSE INTERFACE

3.1 The User's Guide to the Hydrodynamic Data Types

This section defines the names, the content and the reference structure of the hydrodynamic interface data types.

The data types are identified with a **W** as the first character. Those data types with the digits 1 or 2 as the second character, reflects that these data types contains data associated with first or second order wave theory, respectively. The following data types are defined:

W1ACCELE	Rigid body acceleration	see Section 3.3.1.1
W1EXFORC	First order excitation force	see Section 3.3.1.2
W1MATRIX	First order hydrodynamic matrices	see Section 3.3.1.3
W1MOTION	Rigid body motion	see Section 3.3.1.4
W1PANEL	Panel definition	see Section 3.3.1.5
W1PANPRE	Panel pressure	see Section 3.3.1.6
W1POINT	Point	see Section 3.3.1.7
W1SFORCE	First order sectional force	see Section 3.3.1.8
W1VELOCI	Rigid body velocity	see Section 3.3.1.9
W2EXFDIF	Second order excitation force at difference frequencies	see Section 3.3.1.10
W2EXFSUM	Second order excitation force at sum frequencies	see Section 3.3.1.11
W2FLUDIF	Second order fluid kinematics at difference frequencies	see Section 3.3.1.12
W2FLUSUM	Second order fluid kinematics at sum frequencies	see Section 3.3.1.13
W2HDRIFT	Second order horizontal mean drift force	see Section 3.3.1.14
W2MDRIFT	Second order mean drift force	see Section 3.3.1.15
W2WDDMAT	Wave drift damping matrix	see Section 3.3.1.16
WBODCON	Body and condition reference data	see Section 3.3.1.17
WBODY	Body definition	see Section 3.3.1.18
WCURRPRF	Current profile	see Section 3.3.1.19
WDRESREF	External result case reference data	see Section 3.3.1.20
WDWACHAR	Deterministic wave characteristics	see Section 3.3.1.21
WFKPOINT	Fluid kinematics reference point definition	see Section 3.3.1.22
WFLUIDKN	Fluid kinematics	see Section 3.3.1.23
WGLOBDEF	Global analysis data	see Section 3.3.1.24
WGRESPON	General responses	see Section 3.3.1.25
WHYCOEL	Hydrodynamic coefficients for elements	see Section 3.3.1.26
WHYPREL	Hydrodynamic properties for elements	see Section 3.3.1.27
WMRPOINT	Motion reference point definition	see Section 3.3.1.28
WSCATTER	Scatter diagram	see Section 3.3.1.29

continued . . .

WSECTION	Section definition	see Section 3.3.1.30
WSURFACE	Surface elevation	see Section 3.3.1.31
WWASUMLO	Wave load sums	see Section 3.3.1.32
WWAWIKIN	Calculated wave and wind kinematics	see Section 3.3.1.33
WWGTBUOY	Calculated weight and buoyancy data	see Section 3.3.1.34
WWINDPRF	Wind profile	see Section 3.3.1.35
TDBODNAM	Body name definitions	see Section 3.3.1.36
TDRSNAM	Response name definitions	see Section 3.3.1.37
TSCATTER	Scatter name definitions	see Section 3.3.1.38

In addition to the **W** data types, the existing SIF data types **TDBODNAM**, **TDRSNAM** and **TSCATTER** are used to store body and result case related text strings.

The reference mechanism for the hydrodynamic result data types is based on two separate reference pointers. That is, to address specific results, both the **WBODCON** and **WDRESREF** data types must be inspected. First, by inspecting the **WBODCON** data types, the IBCOND reference number for a given body and condition can be obtained. Secondly by inspecting the **WDRESREF** data type, the IWRES reference number for a given result case can be obtained. The obtained IBCOND and IWRES reference numbers can then be used to access specific result data types.

Those of the **W** data types containing a complex flag may contain complex results. By convention, complex results are stored on the form:

. . . component *i*	Real part
. . . component *i*	Imaginary part
. . . component *i*+1	Real part
. . . component *i*+1	Imaginary part

The data on the **W** data types are stored with dimensions. The only restriction on the units of the data on the SIF file is the requirement that the data must be internally consistent.

3.2 Definitions

3.2.1 Phase definitions

The hydrodynamic response interface will contain several data groups that describe response variables of dynamic nature, calculated on basis of linear wave excitation. Typical examples are wave exciting forces and rigid body motions. In order to be able to utilize these results and maintaining the correct phase relationships, it is necessary to know the exact phase definition used in the generation of the results.

For the hydrodynamic response interface, the dynamic response variables are written as complex numbers, and are said to be due to excitation by a linear incoming wave given by:

$$\eta = \mathrm{Re}[a \cdot \mathrm{e}^{\mathrm{i}(\omega t - k(x\cos\beta + y\sin\beta))}] \tag{3.1}$$

or

$$\eta = a\cos(\omega t - k(x\cos\beta + y\sin\beta)) \tag{3.2}$$

which represent a wave with its crest at the origin for *t=0*, see Figure 3.1(b). Here β is the direction of the incident wave, see Figure 3.1(a), ω the incoming wave angular frequency, k the wave number and a the wave amplitude.

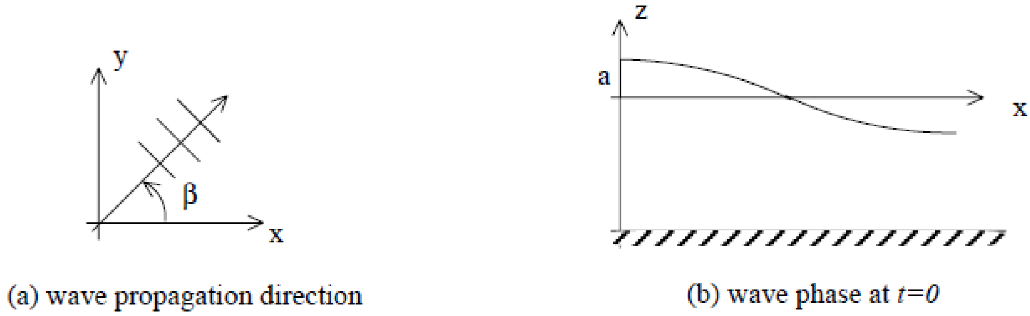


Figure 3.1: Surface wave definitions

As a consequence of the phase definition given in 3.1, any dynamic response variable written to the hydrodynamic response interface as a real part and an imaginary part, can be expressed time dependent as:

$$R(t) = \mathrm{Re}[re^{\mathrm{i}\omega t}] \tag{3.3}$$

resulting in

$$R(t) = r^{\mathrm{Re}}\cos(\omega t) - r^{\mathrm{Im}}\sin(\omega t) \tag{3.4}$$

It is emphasised that this phase definition in an integral part of the hydrodynamic response interface description, and that the standard adopted here must be followed by both generating programs, and programs applying the file.

3.2.2 Wave direction definition

The direction of the wave propagation is described with the angle β which is measured relative to the positive x-axis in a right handed co-ordinate system. β is increasing in the counter clockwise direction as shown in Figure 3.1(a). β is measured in radians.

3.2.3 Forward speed definition

A forward speed is defined as positive when the vessel moves towards $x = -\infty$, i.e. a wave direction of 0 degrees corresponds to head sea and a wave direction of 180 degrees corresponds to following sea.

3.3 Hydrodynamic Data Type Definitions

This section defines the content and the format of the hydrodynamic response data types.

3.3.1 First Level Hydrodynamic Response Data Type Definitions

First level data

W1ACCELE	Rigid body acceleration	see Section 3.3.1.1
W1EXFORC	First order excitation force	see Section 3.3.1.2
W1MATRIX	First order hydrodynamic matrices	see Section 3.3.1.3
W1MOTION	Rigid body motion	see Section 3.3.1.4
W1PANEL	Panel definition	see Section 3.3.1.5
W1PANPRE	Panel pressure	see Section 3.3.1.6

continued . . .

W1POINT	Point	see Section 3.3.1.7
W1SFORCE	First order sectional force	see Section 3.3.1.8
W1VELOCI	Rigid body velocity	see Section 3.3.1.9
W2EXFDIF	Second order excitation force at difference frequencies	see Section 3.3.1.10
W2EXFSUM	Second order excitation force at sum frequencies	see Section 3.3.1.11
W2FLUDIF	Second order fluid kinematics at difference frequencies	see Section 3.3.1.12
W2FLUSUM	Second order fluid kinematics at sum frequencies	see Section 3.3.1.13
W2HDRIFT	Second order horizontal mean drift force	see Section 3.3.1.14
W2MDRIFT	Second order mean drift force	see Section 3.3.1.15
W2WDDMAT	Wave drift damping matrix	see Section 3.3.1.16
WBODCON	Body and condition reference data	see Section 3.3.1.17
WBODY	Body definition	see Section 3.3.1.18
WCURRPRF	Current profile	see Section 3.3.1.19
WDRESREF	External result case reference data	see Section 3.3.1.20
WDWACHAR	Deterministic wave characteristics	see Section 3.3.1.21
WFKPOINT	Fluid kinematics reference point definition	see Section 3.3.1.22
WFLUIDKN	Fluid kinematics	see Section 3.3.1.23
WGLOBDEF	Global analysis data	see Section 3.3.1.24
WGRESPON	General responses	see Section 3.3.1.25
WHYCOEL	Hydrodynamic coefficients for elements	see Section 3.3.1.26
WHYPREL	Hydrodynamic properties for elements	see Section 3.3.1.27
WMRPOINT	Motion reference point definition	see Section 3.3.1.28
WSCATTER	Scatter diagram	see Section 3.3.1.29
WSECTION	Section definition	see Section 3.3.1.30
WSURFACE	Surface elevation	see Section 3.3.1.31
WWASUMLO	Wave load sums	see Section 3.3.1.32
WWAWIKIN	Calculated wave and wind kinematics	see Section 3.3.1.33
WWGTBUOY	Calculated weight and buoyancy data	see Section 3.3.1.34
WWINDPRF	Wind profile	see Section 3.3.1.35
TDBODNAM	Body name definitions	see Section 3.3.1.36
TDRSNAM	Response name definitions	see Section 3.3.1.37
TSCATTER	Scatter name definitions	see Section 3.3.1.38

3.3.1.1 **W1ACCELE**: Rigid body acceleration

This data type contains the rigid body acceleration per unit wave amplitude.

Data type definition:

	W1ACCELE	Data type reference.
	NFIELD	Number of data fields on this data type (including this field).
→	IBCOND	Internal body and condition reference number.
→	IWRES	Internal result case reference number.
	COMPLEX	Complex flag.
		= 0 Real values only.
		= 1 Complex (real & imaginary) values.
	RBA1	Rigid body acceleration, component 1.
	RBA2	Rigid body acceleration, component 2.
	RBA3	Rigid body acceleration, component 3.
	RBA4	Rigid body acceleration, component 4.
	RBA5	Rigid body acceleration, component 5.
	RBA6	Rigid body acceleration, component 6.

Note:

The rigid body accelerations are given in the IBODY co-ordinate system.

Complex values are stored as follows:

. . . component i	Real part
. . . component i	Imaginary part
. . . component $i+1$	Real part
. . . component $i+1$	Imaginary part

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.2 **W1EXFORC**: First order excitation force

This data type contains the first order excitation forces per unit wave amplitude.

Data type definition:

	W1EXFORC	Data type reference.
	NFIELD	Number of data fields on this data type (including this field).
→	IBCOND	Internal body and condition reference number.
→	IWRES	Internal result case reference number.
	COMPLEX	Complex flag. = 0 Real values only. = 1 Complex (real & imaginary) values.
	EF1	First order excitation force, component 1.
	EF2	First order excitation force, component 2.
	EF3	First order excitation force, component 3.
	EF4	First order excitation force, component 4.
	EF5	First order excitation force, component 5.
	EF6	First order excitation force, component 6.

Note:

The first order excitation forces are given in the IBODY co-ordinate system.

Complex values are stored as follows:

. . . component *i*	Real part
. . . component *i*	Imaginary part
. . . component *i*+1	Real part
. . . component *i*+1	Imaginary part

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.3 **W1MATRIX**: First order hydrodynamic matrices

This data type contains the different 6 by 6 hydrodynamic matrices for first order wave theory results.

Data type definition:

	W1MATRIX	Data type reference.	
	NFIELD	Number of data fields on this data type (including this field).	
$\rightarrow$	IMATRIX	Internal matrix reference number.	
	IBCONI $\rightarrow$	Internal body and condition reference number.	
	IBCONJ $\rightarrow$	Internal coupling body and condition reference number.	
	IWRES $\rightarrow$	Internal result case reference number.	
		= 0	In this case, the matrix is independent of the result case reference types defined by the **WDRESREF** data type.
		= *i*	Internal result case reference number – $\{1, \ldots, i, \ldots, n\}$.
	IMTYP	Matrix Type.	
		= 11	First order body mass matrix.
		= 12	First order added mass matrix at given frequency.
		= 21	First order potential damping matrix at given frequency.
		= 22	First order viscous damping matrix, frequency independent.
		= 31	First order hydrostatic restoring matrix.
		= 32	First order mooring restoring matrix.
	Repeat for J=1,6		
	Repeat for I=1,6		
	HMAT(I,J)	Hydrodynamic matrix.	
	Next I		
	Next J		

Note:

The IBCONI and IBCONJ reference numbers represent the row and column positions for the actual 6 by 6 matrix in a multibody matrix. Note that it is required to perform a separate calculation to obtain the relevant IBCONI, IBCONJ numbers for a body with a given set of conditions in a multibody system.

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.4 **W1MOTION**: Rigid body motion

This data type contains the rigid body motion per unit wave amplitude.

Data type definition:

	W1MOTION	Data type reference.
	NFIELD	Number of data fields on this data type (including this field).
→	IBCOND	Internal body and condition reference number.
→	IWRES	Internal result case reference number.
	COMPLEX	Complex flag.
		= 0 Real values only.
		= 1 Complex (real & imaginary) values.
	RBM1	Rigid body motion, component 1.
	RBM2	Rigid body motion, component 2.
	RBM3	Rigid body motion, component 3.
	RBM4	Rigid body motion, component 4.
	RBM5	Rigid body motion, component 5.
	RBM6	Rigid body motion, component 6.

Note:

The rigid body motions are given in the IBODY co-ordinate system.

Complex values are stored as follows:

. . . component *i*	Real part
. . . component *i*	Imaginary part
. . . component *i*+1	Real part
. . . component *i*+1	Imaginary part

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.5 **W1PANEL**: Panel definition

This data type contains the definition of each panel in the hydrodynamic model.

Data type definition:

	W1PANEL	Data type reference.
	NFIELD	Number of data fields on this data type (including this field).
$\rightarrow$	IBCOND	Internal body and condition reference number.
$\rightarrow$	IPPAN	Internal reference panel number (pointer).
	ISYMM1	Symmetry plane number or section number.
	AREA	Area of the panel.
	IPAN	Panel number.
	ISYMM2	Group number (usually symmetry plane number or section number).
	X0	x-co-ordinate of centroid.
	Y0	y-co-ordinate of centroid.
	Z0	z-co-ordinate of centroid.
	NX	x-co-ordinate of unit normal vector, out into the fluid.
	NY	y-co-ordinate of unit normal vector, out into the fluid.
	NZ	z-co-ordinate of unit normal vector, out into the fluid.
	X1 X2 X3 X4	} x-co-ordinates of corner 1–4 (node 1–4).
	Y1 Y2 Y3 Y4	} y-co-ordinates of corner 1–4 (node 1–4).
	Z1 Z2 Z3 Z4	} z-co-ordinates of corner 1–4 (node 1–4).

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.6 **W1PANPRE**: Panel pressure

This data type contains the pressure for a given element (panel) in the hydrodynamic model.

Data type definition:

	W1PANPRE	Data type reference.
	NFIELD	Number of data fields on this data type (including this field).
→	IBCOND	Internal body and condition reference number.
→	IWRES	Internal result case reference number.
→	IPPAN	Internal reference panel number (pointer).
	ISYMM1	Symmetry part number (or "dense" section number).
	COMPLEX	Complex flag. = 0 Real values only. = 1 Complex (real & imaginary) values.
	P	Pressure.
	IPAN	Panel number.
	ISYMM2	Symmetry part number (Wadam) or section number (Waveship).

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.7 **W1POINT**: Point

This data type contains a defined point in the hydrodynamic model.

Data type definition:

	W1POINT	Data type reference.
	NFIELD	Number of data fields on this data type (including this field).
$\rightarrow$	IBCOND	Internal body and condition reference number.
$\rightarrow$	IPPOI	Internal point reference number.
	ISYMM	Number of symmetry planes or section number.
	X	x-co-ordinate of point.
	Y	y-co-ordinate of point.
	Z	z-co-ordinate of point.

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.8 **W1SFORCE**: First order sectional force

This data type contains the first order sectional forces per unit wave amplitude.

Data type definition:

	W1SFORCE	Data type reference.
	NFIELD	Number of data fields on this data type (including this field).
→	IBCOND	Internal body and condition reference number.
→	ISECT	Internal section reference number.
→	IWRES	Internal result case reference number.
	COMPLEX	Complex flag.
		= 0 Real values only.
		= 1 Complex (real & imaginary) values.
	FSEC1	First order sectional force, component 1.
	FSEC2	First order sectional force, component 2.
	FSEC3	First order sectional force, component 3.
	FSEC4	First order sectional force, component 4.
	FSEC5	First order sectional force, component 5.
	FSEC6	First order sectional force, component 6.

Note:

The first order sectional forces are given in the IBODY co-ordinate system.

Complex values are stored as follows:

. . . component i	Real part
. . . component i	Imaginary part
. . . component $i+1$	Real part
. . . component $i+1$	Imaginary part

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.9 **W1VELOCI**: Rigid body velocity

This data type contains the rigid body velocity per unit wave amplitude.

Data type definition:

	W1VELOCI	Data type reference.
	NFIELD	Number of data fields on this data type (including this field).
→	IBCOND	Internal body and condition reference number.
→	IWRES	Internal result case reference number.
	COMPLEX	Complex flag.
		= 0 Real values only.
		= 1 Complex (real & imaginary) values.
	RBV1	Rigid body velocity, component 1.
	RBV2	Rigid body velocity, component 2.
	RBV3	Rigid body velocity, component 3.
	RBV4	Rigid body velocity, component 4.
	RBV5	Rigid body velocity, component 5.
	RBV6	Rigid body velocity, component 6.

Note:

The rigid body velocities are given in the IBODY co-ordinate system.

Complex values are stored as follows:

. . . component *i*	Real part
. . . component *i*	Imaginary part
. . . component *i*+1	Real part
. . . component *i*+1	Imaginary part

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.10 **W2EXFDIF**: Second order excitation force at difference frequencies

This data type contains the second order difference frequency force and moments (Quadratic Transfer Functions, or QTF's) for given incident wave pairs.

Data type definition:

	W2EXFDIF	Data type reference.	
	NFIELD	Number of data fields on this data type (including this field).	
→	IBCOND	Internal body and condition reference number.	
→	IWRES	Internal result case reference number.	
	COMPLEX	Complex flag.	
		= 0	Real values only.
		= 1	Complex (real & imaginary) values.
	SEFD1	Second order excitation force, difference frequency, component 1.	
	SEFD2	Second order excitation force, difference frequency, component 2.	
	SEFD3	Second order excitation force, difference frequency, component 3.	
	SEFD4	Second order excitation force, difference frequency, component 4.	
	SEFD5	Second order excitation force, difference frequency, component 5.	
	SEFD6	Second order excitation force, difference frequency, component 6.	

Note:

The second order excitation forces at difference frequencies are given in the IBODY co-ordinate system.

Complex values are stored as follows:

. . . component i	Real part
. . . component i	Imaginary part
. . . component i+1	Real part
. . . component i+1	Imaginary part

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.11 **W2EXFSUM**: Second order excitation force at sum frequencies

This data type contains the second order sum frequency force and moments (Quadratic Transfer Functions, or QTF's) for given incident wave pairs.

Data type definition:

	W2EXFSUM	Data type reference.
	NFIELD	Number of data fields on this data type (including this field).
→	IBCOND	Internal body and condition reference number.
→	IWRES	Internal result case reference number.
	COMPLEX	Complex flag.
		= 0 Real values only.
		= 1 Complex (real & imaginary) values.
	SEFS1	Second order excitation force, sum frequency, component 1.
	SEFS2	Second order excitation force, sum frequency, component 2.
	SEFS3	Second order excitation force, sum frequency, component 3.
	SEFS4	Second order excitation force, sum frequency, component 4.
	SEFS5	Second order excitation force, sum frequency, component 5.
	SEFS6	Second order excitation force, sum frequency, component 6.

Note:

The second order excitation forces at sum frequencies are given in the IBODY co-ordinate system.

Complex values are stored as follows:

. . . component i	Real part
. . . component i	Imaginary part
. . . component $i+1$	Real part
. . . component $i+1$	Imaginary part

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.12 **W2FLUDIF**: Second order fluid kinematics at difference frequencies

This data type contains the the second order fluid kinematics data at difference frequencies for a given reference point.

Data type definition:

	W2FLUDIF	Data type reference.
	NFIELD	Number of data fields on this data type (including this field).
→	IWRES	Internal result case reference number.
→	IFKPNT	Fluid kinematics reference point number.
	COMPLEX	Complex flag.
		= 0 Real values only.
		= 1 Complex (real & imaginary) values.
	IPRES	Flag guiding if pressure is stored.
		= 0 No pressure is stored.
		= 1 Pressure is stored.
	P	Pressure.
	IELEV	Flag guiding if elevation is stored.
		= 0 No elevation value is stored.
		= 1 Elevation value is stored.
	ETA	Elevation.
	IVEL	Flag guiding if additional data are stored.
		= 0 No additional data are defined.
		= 1 Additional data are defined.

Note:

Note that the format of this data type may be extended in the future. Any extentions shall be appended after the already defined data.

Complex values are stored as follows:

... component i	Real part
... component i	Imaginary part
... component i+1	Real part
... component i+1	Imaginary part

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.13 **W2FLUSUM**: Second order fluid kinematics at sum frequencies

This data type contains the the second order fluid kinematics data at sum frequencies for a given reference point.

Data type definition:

	W2FLUSUM	Data type reference.
	NFIELD	Number of data fields on this data type (including this field).
→	IWRES	Internal result case reference number.
→	IFKPNT	Fluid kinematics reference point number.
	COMPLEX	Complex flag.
		= 0 Real values only.
		= 1 Complex (real & imaginary) values.
	IPRES	Flag guiding if pressure is stored.
		= 0 No pressure is stored.
		= 1 Pressure is stored.
	P	Pressure.
	IELEV	Flag guiding if elevation is stored.
		= 0 No elevation value is stored.
		= 1 Elevation value is stored.
	ETA	Elevation.
	IVEL	Flag guiding if additional data are stored.
		= 0 No additional data are defined.
		= 1 Additional data are defined.

Note:

Note that the format of this data type may be extended in the future. Any extentions shall be appended after the already defined data.

Complex values are stored as follows:

. . . component *i*	Real part
. . . component *i*	Imaginary part
. . . component *i*+1	Real part
. . . component *i*+1	Imaginary part

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.14 **W2HDRIFT**: Second order horizontal mean drift force

This data type contains the second order horizontal mean drift forces per unit wave amplitude.

Data type definition:

	W2HDRIFT	Data type reference.
	NFIELD	Number of data fields on this data type (including this field).
→	IBCOND	Internal body and condition reference number.
→	IWRES	Internal result case reference number.
	SEFS1	Second order horizontal mean drift force, component 1.
	SEFS2	Second order horizontal mean drift force, component 2.
	SEFS6	Second order horizontal mean drift force, component 6.

Note:

The second order horizontal mean drift forces are given in the IBODY co-ordinate system.

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.15 **W2MDRIFT**: Second order mean drift force

This data type contains the second order mean drift forces per unit wave amplitude.

Data type definition:

	W2MDRIFT	Data type reference.
	NFIELD	Number of data fields on this data type (including this field).
$\rightarrow$	IBCOND	Internal body and condition reference number.
$\rightarrow$	IWRES	Internal result case reference number.
	SMFOR1	Second order mean drift force, component 1.
	SMFOR2	Second order mean drift force, component 2.
	SMFOR3	Second order mean drift force, component 3.
	SMFOR4	Second order mean drift force, component 4.
	SMFOR5	Second order mean drift force, component 5.
	SMFOR6	Second order mean drift force, component 6.

Note:

The second order mean drift forces are given in the IBODY co-ordinate system.

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.16 **W2WDDMAT**: Wave drift damping matrix

This data type contains the mean second order wave drift damping matrix due to a slow motion in the horizontal modes.

Data type definition:

	W2WDDMAT	Data type reference.
	NFIELD	Number of data fields on this data type (including this field).
→	IBCOND	Internal body and condition reference number.
→	IWRES	Internal result case reference number.
	B11	Wave drift damping coefficient in surge due to a slow surge motion.
	B12	Wave drift damping coefficient in surge due to a slow sway motion.
	B16	Wave drift damping coefficient in surge due to a slow yaw motion.
	B21	Wave drift damping coefficient in sway due to a slow surge motion.
	B22	Wave drift damping coefficient in sway due to a slow sway motion.
	B26	Wave drift damping coefficient in sway due to a slow yaw motion.
	B61	Wave drift damping coefficient in yaw due to a slow surge motion.
	B62	Wave drift damping coefficient in yaw due to a slow sway motion.
	B66	Wave drift damping coefficient in yaw due to a slow yaw motion.

Note:

The coefficients are given in the IBODY co-ordinate system.

The wave drift force (F_x, F_y, M_z) is defined by:

$$\begin{bmatrix} F_x \\ F_y \\ M_z \end{bmatrix} = \begin{bmatrix} F_{x_0} \\ F_{y_0} \\ M_{z_0} \end{bmatrix} - \begin{bmatrix} \text{B11} & \text{B12} & \text{B16} \\ \text{B21} & \text{B22} & \text{B26} \\ \text{B61} & \text{B62} & \text{B66} \end{bmatrix} \begin{bmatrix} \tau_U \\ \tau_V \\ \tau_\Omega \end{bmatrix} \tag{3.5}$$

where

F_{x_0}	Wave drift force in surge.
F_{y_0}	Wave drift force in sway.
M_{z_0}	Wave drift force in yaw.
$F_{x_0}, F_{y_0}, M_{z_0}$	Zero speed wave drift force.
$\tau_U = U \cdot \frac{\omega}{g}$	
$\tau_V = V \cdot \frac{\omega}{g}$	
$\tau_\Omega = \frac{\Omega}{\omega}$	
U	Slow surge velocity.
V	Slow sway velocity.
Ω	Slow yaw angular velocity.
ω	Wave frequency.

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.17 **WBODCON**: Body and condition reference data

This data type contains the first order excitation forces per unit wave amplitude.

Data type definition:

	WBODCON	Data type reference.
	NFIELD	Number of data fields on this data type (including this field).
→	IBCOND	Internal body and condition reference number.
	IBODY →	External body identification number.
	NUMCON	Number of reference conditions.
		= 0 In this case, the results identified by IBCOND are independent of the reference conditions defined in the table below.
		= *n* Number of reference conditions.
	Repeat for I=1, NUMCON	
	ICONTY	Type of condition value.
	ICOREF	Sequence number of condition value.
	CONDAT	Condition value.
	Next I	

Note:
The permitted set (ICONTY) of body reference conditions:

ICONTY	CONDAT	CONDAT dimension
1	Forward speed	[1/s]

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.18 **WBODY**: Body definition

This data type contains the characteristica for a body with a given set of conditions.

Data type definition:

	WBODY	Data type reference.
	NFIELD	Number of data fields on this data type (including this field).
→	IBCOND	Internal body and condition reference number.
	CLENB	Characteristic length of the body.
	BMASS	Total mass of the body.
	WSAREA	Wet surface area of the body.
	WPAREA	Water plane area of the body.
	VOL	Submerged body volume.
	XCG YCG ZCG	Co-ordinates of body centre of gravity defined in the IBODY co-ordinate system.
	XCB YCB ZCB	Co-ordinates of body centre of buoyancy defined in the IBODY co-ordinate system.
	XRB YRB ZRB	Body result point co-ordinates defined in the IBODY co-ordinate system.

Repeat for J=1, 4

Repeat for I=1, 4

TIJ — Entry I, J in the homogeneous IBODY to global transformation matrix.

Next I

Next J

Note:

Note that BMASS and WPAREA also can be derived from the global mass matrix and the hydrostatic stiffness matrix, respectively.

The local to global transformation matrix T is defined as follows:

$$X_{\text{Global}} = T \cdot X_{\text{IBODY}} \tag{3.6}$$

where

$$X_{\text{Global}} = \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}_{\text{Global}} , \quad X_{\text{IBODY}} = \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}_{\text{IBODY}} , \quad \text{and} \quad T = \begin{bmatrix} T_{11} & T_{12} & T_{13} & T_{14} \\ T_{21} & T_{22} & T_{23} & T_{24} \\ T_{31} & T_{32} & T_{33} & T_{34} \\ 0 & 0 & 0 & 1 \end{bmatrix} \tag{3.7}$$

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.19 **WCURRPRF**: Current profile

Data type definition:

WCURRPRF	Data type reference.
NFIELD	Number of data fields on this data type (including this field).
NCRNT	Number of current profiles.
MUDLINE	Elevation of mudline in structure global co-ordinate system. Reference elevation for visualization
Repeat for L=1, NCRNT	
CTNO	Current profile (Table) Id.
ProfileType	Profile type.
	= 1 Vx,Vy,Vz given for each elevataion.
	= 2 V hor & direction for each elevation.
	= 3 V (in direction of wave) for each elevation.
NCEL	Number of Current Elevations.
Repeat for I=1, NCEL	
Elevation	
Velocity data	Consistent with Current Profile Type; 3,2 or 1 value(s).
Next I	
NWDEPTHS	Number of (optional) reference elevations for visualizations.
Repeat for I=1, NWDEPTHS	Typically 0, 1 (mean) or 2 (min, max) water depths.
WATERDEPTH	
Next I	
Next L	

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.20 **WDRESREF**: External result case reference data

This data type defines the data connected to a result case.
This data type should be made obsolete and its contents should be merged with the data type **RDRESREF**.

Data type definition:

	WDRESREF	Data type reference.
	NFIELD	Number of data fields on this data type (including this field).
→	IWRES	Internal result case reference number.
	NRESRF	Dimension of result reference space.
	NUMTYP	Number of reference identifications.
		= 0 In this case, the results identified by IWRES is independent of the result case reference types defined in the table below.
		= *n* Number of reference identifications.
	Repeat for J=1, NUMTYP	
	IREFTY	Type of result case reference value.
	Repeat for I=1, NRESRF	
	IDREF	Sequence number for result case reference value.
	REFDAT	Result case reference value.
	Next I	
	Next J	

Note:
The permitted set (IREFTY) of result case reference types:

IREFTY	REFDAT	REFDAT dimension
1	Wave direction angle	[rad]
2	Wave frequency value	[rad/s]
3	Time instant	[s]

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.21 **WDWACHAR**: Deterministic wave characteristics

Data type definition:

WDWACHAR	Data type reference.
NFIELD	Number of data fields on this data type (including this field).
NSEASTAT	Number of sea states.
MUDLINE	Elevation of mudline in structure global co-ordinate system.
Repeat for L=1, NSEASTAT	
SEASTATNO	
NWAVCHAR	Number of Stored Wave Characteristic Data.
Repeat for I=1, NSTORE	
ISTORE	
VALUE	
Next I	
Next L	

Note:
The (IWAVCHAR) components are as follows:

IWAVCHAR	VALUE	Comments
1	THEO	(same definition as on SEA card in Wajac.)
2	Water Depth.	
3	Current Profile ID.	
4	Wind Profile ID.	
5	Wave direction.	
6	Wave Height.	
7	Wave Period.	
8	Wave Length.	
9	Wave Crest Elevation.	
10	Wave Trough Elevation.	
11	Wave Crest Duration.	
12	Wave Trough Duration.	
13	Wave Height Depth Ratio.	
14	Wave Height Length Ratio.	
15	Initial Phase Angle.	
16	Phase Step.	
17	NStep.	

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.22 **WFKPOINT**: Fluid kinematics reference point definition

This data type contains the point co-ordinates for a fluid kinematics reference point.

Data type definition:

	WFKPOINT	Data type reference.
	NFIELD	Number of data fields on this data type (including this field).
→	IFKPNT	Fluid kinematics reference point number.
	XFKPNT YFKPNT ZFKPNT	Point co-ordinates given in the global co-ordinate system.

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.23 **WFLUIDKN**: Fluid kinematics

This data type contains the fluid kinematics data for a given reference point.

Data type definition:

	WFLUIDKN	Data type reference.
	NFIELD	Number of data fields on this data type (including this field).
→	IWRES	Internal result case reference number.
→	IFKPNT	Fluid kinematics reference point number.
	COMPLEX	Complex flag.
		= 0 Real values only.
		= 1 Complex (real & imaginary) values.
	P	Pressure.
	VX	Particle velocity, x direction.
	VY	Particle velocity, y direction.
	VZ	Particle velocity, z direction.

Note:

Note that the sea surface elevation per incident wave is identical to the non dimensional pressure P at the still water line. This implies that the wave elevation can be derived as

$$\eta = \frac{\mathrm{P}}{\rho \cdot g} \tag{3.8}$$

for points at the still water level.

Complex values are stored as follows:

... component *i*	Real part
... component *i*	Imaginary part
... component *i*+1	Real part
... component *i*+1	Imaginary part

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.24 **WGLOBDEF**: Global analysis data

This data type defines the global hydrodynamic data which are used for all the results stored on a Sesam Results Interface file. By definition each Sesam Result Interface file can only contain one **WGLOBDEF** data type.

Data type definition:

WGLOBDEF	Data type reference.	
NFIELD	Number of data fields on this data type (including this field).	
G	Gravitational constant.	
RO	Density of the fluid.	
IDEPTH	Depth flag.	
	= 0	Unlimited depth.
	= 1	The depth is specified by the DEPTH value.
DEPTH	Water depth (distance from seabed to still water level).	

Note:

The origo of the global co-ordinate system is by definition located at the still water level. Furthermore, the still water level and the sea bottom must be parallel to the xy-plane.

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.25 **WGRESPON**: General responses

This data type defines the transfer function for a general response type.

Data type definition:

	WGRESPON	Data type reference.	
	NFIELD	Number of data fields on this data type (including this field).	
→	IBCOND	Internal body and condition reference number.	
→	IGRES	Internal result type identification number.	
→	IWRES	Internal result case reference number.	
	COMPLEX	Complex flag.	
		= 0	Real values only.
		= 1	Complex (real & imaginary) values.
	IDPNT	Result point identification, i.e. element or node number.	
	IGRTYP	General response identification code.	
		= 0	Undefined response.
		= 1	Displacements.
		= 2	Velocities.
		= 3	Accelerations.
		= 4	Stresses.
		= 5	Strains.
		= 6	Forces (structural).
		= 7	Reaction forces.
	ICOMP	Component identification number.	
		= 1,2,3	See table 2.7 at data type **RDNODRES**.
		= 4	See Table 2.18 at data type **RDSTRESS**.
		= 5	See Table **??** at data type **RDSTRAIN**.
		= 6	See Table 2.4 at data type **RDFORCES**.
		= 7	See Table 2.4 at data type **RDFORCES**.
	ISTRPT	Stress point, integration station or for a beam element the section number.	
	RESPON	Transfer function for general response.	

Note:

This data type type is included for documentation purposes only. No new result data should be stored on this data type type.

Complex values are stored as follows:

. . . component *i*	Real part

continued . . .

. . . component *i*	Imaginary part
. . . component *i*+1	Real part
. . . component *i*+1	Imaginary part

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.26 **WHYCOEL**: Hydrodynamic coefficients for elements

Purpose: To document which coefficients are used per time step per beam element.

In Wajac, there are in all 9 different methods to define the hydrodynamic force coefficients for drag and inertia. In general, any element may have different coefficients for each calculation point, as well as the coefficients may vary with the phase angle (time step) of the wave.

Data type definition:

WHYCOEL	Data type reference.
NFIELD	Number of data fields on this data type (including this field).
ELNO	Element number.
SEASTATE	If zero, Coefficients are independent of waves.
STEP NO	If zero, Coefficients are independent of waves.
PHASE/TIME	
NCALCPOINT	Number of (Wajac) calculation Points for the element.
	If values are constant for element, NCALCPOINT may be 1.
NUMCOEFF	Number of coefficients for current property.
Repeat for L=1, NCALCPOINT	
DISTANCE	Distance to Calculation Point from Node 1.
Repeat for I=1, NUMCOEFF	
TYPECOEFF	Coefficient number (ref. value table below).
VALUE	The actual Coefficient value applied in force.
Next I	
Next L	

Note:
The (TYPECOEFF) components are as follows:

TYPECOEFF	VALUE	Comments
601	Longitudinal Drag coefficient CDL	Concept local coordinate system X.
602	Normal Drag coefficient CDN	If directional CDâĂŹs are specified, the actual combination of CDx & CDy.
603	Longitudinal Inertia coefficient CML	Concept local coordinate system X.
604	Normal Inertia coefficient CMN	If directional CMâĂŹs are specified, the actual combination of CMx & CMy.

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.27 **WHYPREL**: Hydrodynamic properties for elements

Purpose: To document which hydrodynamic properties coefficients are used per beam element.

While Hydrodynamic coefficients (ref. **WHYCOEL**) may vary also with time (phase), the hydrodynamic properties here are constant over all time steps (phases). But for each element, the properties may vary for each calculation point, as these properties may be a function of the water depth or (varying) member section properties.

Data type definition:

WHYPREL	Data type reference.
NFIELD	Number of data fields on this data type (including this field).
ELNO	Element number.
NCALCPOINT	Number of (Wajac) calculation Points for the element.
	If values are constant for element, NCALCPOINT may be 1.
NUMPROP	Number of properties for current property.
Repeat for L=1, NCALCPOINT	
DISTANCE	Distance to Calculation Point from Node 1.
Repeat for I=1, NUMPROP	
TYPEPROP	Property number (ref. value table below).
VALUE	The actual Property value.
Next I	
Next L	

Note:
The (TYPEPROP) components are as follows:

TYPEPROP	VALUE	Comments
605	Hydro-Dynamic Diameter	Will account for SPEC/SPEX.
606	Buoyancy Non-flooded Area	Will account for BUOA & SPROHYDR.
607	Buoyancy Flooded Area	Will account for BUOA & SPROHYDR.
608	Marine Growth	Will account for MEMGRW & MGRW.

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.28 **WMRPOINT**: Motion reference point definition

This data type contains the point co-ordinates for a motion reference point.

Data type definition:

	WMRPOINT	Data type reference.
	NFIELD	Number of data fields on this data type (including this field).
$\rightarrow$	IBCOND	Internal body and condition reference number.
	XMRP YMRP ZMRP	x, y, z – point co-ordinates given in the global co-ordinate system.

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.29 **WSCATTER**: Scatter diagram

This data type contains a scatter diagram.

Data type definition:

WSCATTER	Data type reference.
NFIELD	Number of data fields on this data type (including this field).
→ ISCATR	Internal result case reference number.
→ INDEX	Internal result case reference number.
IWRES →	Internal result case reference number.
IMTYP	Number of reference identifications.
	= 0 Probability.
	= 1 Occurrences.
TOTROW	Total number of rows in the scatter diagram matrix.
MDIM	Number of rows.
NDIM	Number of columns.
Repeat for J=1, NDIM	
Repeat for I=1, MDIM	
SCATTER(I,J)	Scatter diagram entry (I,J).
Next I	
Next J	

Note:

There exists a maximum length of a data type that can be accessed through the SIFTOOL subroutines. When this limit is exceeded the scatter diagram must be partitioned into separate **WSCATTER** data types with ISCATR being fixed and with INDEX running from one to the number of **WSCATTER** data types connected to the same scatter diagram.

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.30 **WSECTION**: Section definition

This data type contains the definition of all the sections for a given body.

Data type definition:

	WSECTION	Data type reference.		
	NFIELD	Number of data fields on this data type (including this field).		
→	IBODY	External body identification number.		
→	ISECT	Internal section reference number.		
	ISECTY	Section definition type.		
		= 1	A general section where:	
			Section point 1	Defines a point in the section plane.
			Section point 2	Defines a normalised direction vector in the IBODY co-ordinate system normal to the section plane.
			Section point 3	Defines a moment reference point.
		= 2	The section is defined as a volume with its sides normal to the axis in the IBODY co-ordinate system such that:	
			Section point 1	Defines a corner point with minimum x value.
			Section point 2	Defines the corner point diagonal to section point 1.
			Section point 3	Defines a moment reference point.
	SECUSR	User defined section identification.		
	XP1 YP1 ZP1	} Section point 1.		
	XP2 YP2 ZP2	} Section point 2.		
	XP3 YP3 ZP3	} Section point 3.		

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.31 **WSURFACE**: Surface elevation

This data type contains the surface elevation for a set of points on the free surface.

Data type definition:

	WSURFACE	Data type reference.
	NFIELD	Number of data fields on this data type (including this field).
→	IWRES	Internal result case reference number.
→	INDXWR	Result case index number.
	COMPLEX	Complex flag.
		= 0 Real values only.
		= 1 Complex (real & imaginary) values.
	NNODE	Dimension of result reference space.
	ICOMPX	Component flag, X-direction.
		= 0 The x-component of ZELEV is NOT stored.
		= 1 The x-component of ZELEV is stored.
	ICOMPY	Component flag, Y-direction.
		= 0 The y-component of ZELEV is NOT stored.
		= 1 The y-component of ZELEV is stored.
	ICOMPZ	Component flag, Z-direction.
		= 0 The z-component of ZELEV is NOT stored.
		= 1 The z-component of ZELEV is stored.
	Repeat for I=1, NFIELD-8	
	NODENO	Internal node number. The internal node number as defined on **GNODE** data types
	ZELEV	Relative Z-elevation vector for a given node. If COMPLEX = 1, then both real and imaginary vector components are stored.
	Next I	

Note:

Note: The length of ZELEV is (ICOMPX+ICOMPY+ICOMPZ).

Note: Max. allowed NFIELD for this particular data type is 1024.

Note: The standard SIF data types **GELMNT1**, **GNODE**, **GCOORD** must be used to define:

1. the surface points for which relative surface elevation shall be displayed, and
2. the connectivity between the different surface points.

Complex values are stored as follows:

. . . component *i*	Real part

continued . . .

. . . component *i*	Imaginary part
. . . component *i*+1	Real part
. . . component *i*+1	Imaginary part

Example:

Given ICOMPL = 0 (real values) and a sea surface mesh containing more than (1024-8) /2 = 508 nodes, then more than one textbfWSURFACE data type must be used for each IWRES pointer. If, for instance, the mesh contains 2000 nodes, with real sea surface elevations, then at least (2000/508) + 1 = 4 data types must be used. All four data types will have the same IWRES number, but they will have unique result case index numbers INDXWR ranging from 1 to 4.

Given the same example, but with complex sea surface elevations, (1024-8)/3 = 338 nodes on each data type can be stored. Again, for 2000 nodes, at least (2000/338) + 1 = 6 data types must be used.

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.32 **WWASUMLO**: Wave load sums

Data type definition:

WWASUMLO	Data type reference.
NFIELD	Number of data fields on this data type (including this field).
Phase/TimeFlag	Phase / time flag.
	= 1 Phases.
	= 2 Time steps.
MOMT_x	Moment reference point for which moments are reported.
MOMT_y	If no MOMT point is given, the origin of the co-ordinate system is used.
MOMT_z	
NSEASTAT	Number of sea states.
Repeat for L=1, NSEASTAT	
SEASTATNO	
NSTEP	
NSUMLOAD	Number of summary load sums.
Repeat for I=1, NSUMLOAD	
ISUM	
	Where ISUM corresponds to the following load sums:
	1 Maximum Base Shear.
	2 Maximum Overturning Moment.
	3 Minimum Base Shear.
	4 Minimum Overturning Moment.
	5 Base Shear Magnitude (?? As reported on TRF.OUT).
	6 Overturning Moment Magnitude (?? As reported on TRF.OUT).
LOADSUM	
STEPNO	Corresponding step number for the actual load sum.
Phase/TimeStep	Corresponding phase/time-step for the actual load sum.
Next I	
Repeat for I=1, NSTEP	Loop over all steps in the actual sea state.
STEPNO	
Phase/TimeStep	
Repeat for F=1, NFOR	
FOR	Force component value.
IFOR	Imaginary term if complex results.
Next F	

When Definition reference is empty or zero, 6 Force component values are stored in the order shown:

FOR component

1 X-force - Sum of given loads in global (superelement) X-direction.

2 Y-force - Sum of given loads in global (superelement) Y-direction.

3 Z-force - Sum of given loads in global (superelement) Z-direction.

4 Rx-moment âĂŞ Sum of moments about MOMT X-axis from given loads.

5 Ry-moment âĂŞ Sum of moments about MOMT Y-axis from given loads.

6 Rz-moment âĂŞ Sum of moments about MOMT Z-axis from given loads.

Next I

Next L

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.33 **WWAWIKIN**: Calculated wave and wind kinematics

Data type definition:

WWAWIKIN	Data type reference.
NFIELD	Number of data fields on this data type (including this field).
NPOINT	Number of Points where wave/wind kinematics is calculated.
NSTORE	Number of Stored values at each point.
NSEASTAT	Number of sea states.
Repeat for I=1, NPOINT	
POINTNO	Point number.
XCOORD	x-co-ordinate.
YCOORD	y-co-ordinate.
ZCOORD	z-co-ordinate.
Next I	
Repeat for L=1, NSEASTAT	
SEASTATNO	
NSTEP	Each Sea-state may have different number of steps.
Repeat for K=1, NSTEP	
STEPNO	
PHASE/TIME	Can be used both for deterministic waves & time simulations
Repeat for J=1, NPOINT	
POINTNO	Point number.
Repeat for I=1, NSTORE	
ISTORE	
VALUE	
Next I	
Next J	
Next K	
Next L	

Note:
The (ISTORE) components are as follows:

ISTORE	VALUE	Comments
1	SURFACE_ELEVATION	
2	Wave/Wind X	Velocities

continued . . .

ISTORE	VALUE	Comments
3	Wave/Wind Y	
4	Wave/Wind Z	
5	Current X	
6	Current Wave/Wind Y	
7	Current Wave/Wind Z	
8	Total X	
9	Total Y	
10	Total Z	
		Accelerations
11	Accel X	
12	Accel Y	
13	Accel Z	

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.34 **WWGTBUOY**: Calculated weight and buoyancy data

Data type definition:

WWGTBUOY	Data type reference.
NFIELD	Number of data fields on this data type (including this field).
NDEPTHS	Number of Water Depths.
MUDLINE	Elevation of Mudline in structure global co-ordinate system.
NWEIGHT	Number of Weight Data.
Repeat for L=1, NWEIGHT	
IWEIGHT	See IWEIGHT correspondence table below
VALUE	
Next L	
Repeat for L=1, NDEPTHS	Buoyancy depending on the water-depth.
WaterDepth	
NBUYO	Number of Buoyancy Data.
Repeat for K=1, NBUYO	Buoyancy depending on the water-depth.
IBUYO	See IBUOY correspondence table below.
VALUE	.
Next K	
Next L	

Note:
The (IWEIGHT) components are as follows:

IWEIGHT	VALUE	Comments
1	STRU-DRY	Dry weight of Structural Members (including Piles).
2	MG-DRY	Dry weight of Marine Growth.
3	TOTAL-DRY	Total Dry Weight.
4	COG-EXMG-X	Centre of Gravity excluding Marine Growth.
5	Y	
6	Z	
7	COG-INMG-X	Centre of Gravity including Marine Growth.
8	Y	
9	Z	

The (IBUOY) components are as follows:

IBUOY	VALUE	Comments
21	BUOY-MG	Buoyancy of Marine Growth.
22	BUOY-STRU	Buoyancy of Structure.
23	BUOY-NFS	Buoyancy of Air for Non-Flooded Structure.
24	BUOY-TOT	Total Buoyancy.
25	COB-EXMG-X	Centre of Buoyancy excluding Marine Growth.

continued . . .

IBUOY	VALUE	Comments
26	COB-EXMG-Y	
27	COB-EXMG-Z	
28	COB-INMG-X	Centre of Buoyancy including Marine Growth.
29	COB-INMG-Y	
30	COB-INMG-Z	

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.35 **WWINDPRF**: Wind profile

Data type definition:

WWINDPRF	Data type reference.
NFIELD	Number of data fields on this data type (including this field).
NWIND	Number of wind profiles.
Repeat for L=1, NWIND	
WID	Wind profile (Table) Id.
NWPPAR	Number of wind profile parameters.
Repeat for I=1, NWPPAR	
IPAR	See IPAR correspondence below.
VALUE	
Next I	
NELVIZ	Number of Elevations for visualization of Wind Profile (0 for no viz data; Optional data).
Repeat for I=1, NELVIZ	
Elevation	Calculated Wind Velocity at the elevation.
Wind Velocity	
Next I	
Next L	

Note:
The (IPAR) components are as follows:

IPAR	VALUE	Comments
1	WindProfileType	The Wind Profile type can have the following values = 0: General = 1: Norsok = 2: API 21st = 3: API 21st ENG = 4: ABS
2	VEL	Mean wind velocity at reference height.
3	ANGLE	Wind angle: defined in Section 2.4.9. WAJAC UM.
4	GUSTF	Gust factor: f defined in Section 2.4.9.
5	H0	Mean wind velocity reference level relative to SWL.
6	HEXP	Height exponent: P defined in Section 2.4.9.
7	PRAT	Mean period ratio.

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.36 **TDBODNAM**: Body name definitions

TDBODNAM	NFIELD	IBODY	CODNAM	CODTXT
	Name			
	Comment line			
	. . .			
	Comment line			

This data type contains body related text.

NFIELD — Number of numeric data fields at this data type before text data (MAX = 1024).

IBODY — External body reference number.

CODNAM — Coded dimension of the Name:
CODNAM = NLNAM*100 + NCNAM. The inverse relation will then be:
NLNAM = integer part of (CODNAM/100)
NCNAM = remaindering of (CODNAM/100)
NLNAM number lines used to store the name. Legal range = [0,1]
= 0, no name defined
= 1, name is defined
NCNAM - number of characters in the name. Legal range = [0,64]

CODTXT — Coded dimension of the Comment:
CODTXT = NLTXT*100 + NCTXT. The inverse relation will then be:
NLTXT = integer part of (CODTXT/100)
NCTXT = remaindering of (CODTXT/100)
NLTXT - number of lines used to store the comment. Legal range = [0,5]
= 0, no comments defined
$\geq$ 1, number of physical records with comments
NCTXT - number of characters in the comment – each comment line must be of the same length. Legal range = [0,64]

Name — A user set name.

Comment line — User set comment lines.

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.37 **TDRSNAM**: Response name definitions

TDRSNAM	NFIELD	IGRES	CODNAM	CODTXT
	Name			
	Comment line			
	. . .			
	Comment line			

This data type contains response name definitions related text.

NFIELD	Number of numeric data fields at this data type before text data (MAX = 1024).
IGRES	Internal result type identification number.
CODNAM	Coded dimension of the Name: CODNAM = NLNAM*100 + NCNAM. The inverse relation will then be: NLNAM = integer part of (CODNAM/100) NCNAM = remaindering of (CODNAM/100) NLNAM number lines used to store the name. Legal range = [0,1] = 0, no name defined = 1, name is defined NCNAM - number of characters in the name. Legal range = [0,64]
CODTXT	Coded dimension of the Comment: CODTXT = NLTXT*100 + NCTXT. The inverse relation will then be: NLTXT = integer part of (CODTXT/100) NCTXT = remaindering of (CODTXT/100) NLTXT - number of lines used to store the comment. Legal range = [0,5] = 0, no comments defined $\geq$ 1, number of physical records with comments NCTXT - number of characters in the comment – each comment line must be of the same length. Legal range = [0,64]
Name	A user set name.
Comment line	User set comment lines.

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

3.3.1.38 **TSCATTER**: Scatter name definitions

TSCATTER	NFIELD	ISCATR	CODNAM	CODTXT
	Name			
	Comment line			
	. . .			
	Comment line			

This data type contains scatter diagram related text.

NFIELD — Number of numeric data fields at this data type before text data (MAX = 1024).

ISCATR — External scatter diagram reference number.

CODNAM — Coded dimension of the Name:
CODNAM = NLNAM*100 + NCNAM. The inverse relation will then be:
NLNAM = integer part of (CODNAM/100)
NCNAM = remaindering of (CODNAM/100)
NLNAM number lines used to store the name. Legal range = [0,1]
= 0, no name defined
= 1, name is defined
NCNAM - number of characters in the name. Legal range = [0,64]

CODTXT — Coded dimension of the Comment:
CODTXT = NLTXT*100 + NCTXT. The inverse relation will then be:
NLTXT = integer part of (CODTXT/100)
NCTXT = remaindering of (CODTXT/100)
NLTXT - number of lines used to store the comment. Legal range = [0,5]
= 0, no comments defined
$\geq$ 1, number of physical records with comments
NCTXT - number of characters in the comment – each comment line must be of the same length. Legal range = [0,64]

Name — A user set name.

Comment line — User set comment lines.

Back to Section 3.3.1 **First Level Hydrodynamic Response Data Type Definitions**

References

[1] Sesam, stofat, fatigue damage calculation of welded plates and shells. 2.1.1.41

[2] Finite element model and loads data types. Technical report 89-7012, DNV, 2021. 1, 2.10

About DNV

We are the independent expert in risk management and quality assurance. Driven by our purpose, to safeguard life, property and the environment, we empower our customers and their stakeholders with facts and reliable insights so that critical decisions can be made with confidence. As a trusted voice for many of the world's most successful organizations, we use our knowledge to advance safety and performance, set industry benchmarks, and inspire and invent solutions to tackle global transformations.

Digital Solutions

DNV is a world-leading provider of digital solutions and software applications with focus on the energy, maritime and healthcare markets. Our solutions are used worldwide to manage risk and performance for wind turbines, electric grids, pipelines, processing plants, offshore structures, ships, and more. Supported by our domain knowledge and Veracity assurance platform, we enable companies to digitize and manage business critical activities in a sustainable, cost-efficient, safe and secure way.

DNV | digital@dnv.com | dnv.com/digital