AQWA-WAVE
User Manual
Hydrodynamic Load Transfer

Version 14.04
1 December 2006

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Update Sheet for Version 14.04

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Modifications:

The following modifications have been incorporated:

Section	Page(s)	Update/Addition	Explanation
1.1	1-1	Addition	Add reference to ANSYS® and neutral file format
1.2	1-2	Addition	Add reference to Appendix B
2.1	2-1	Addition	Add descriptions of ANSYS® interface
2.4	2-4	Update	Remove note on Morison Loads only for fixed structures
3.1.1	3-1	Addition	Modify overall data structure using HYDR and STRU
3.1.1.1	3-2	Addition	Add possibility of outputting load files
3.1.2	3-2	Addition	Add descriptions of HYDR and STRU commands
3.1.5	3-5	Addition	Add Note 6 to CASE for neutral load output
3.1.6	3-6	Addition	Add command FEPG and notes
A.2.5.3	A-11	Addition	FEPG card – Add ANSYS
App B	B-1 – B-26	Addition	New appendix describing neutral file formats

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1. INTRODUCTION

1.1 Overview

AQWA-WAVE forms part of the ASAS™ and AQWA™ suites of programs developed by Century Dynamics Limited. Its function is to transfer wave loads on fixed or floating structures (calculated by the radiation/diffraction program, AQWA-LINE) to a finite element, structural analysis package.

AQWA-WAVE forms a link between the AQWA and ASAS suites of programs. It can also output wave loads to the ANSYS® system. AQWA-WAVE also has the ability to read in structural and hydrodynamic data defined in neutral format and output the wave loads in neutral format. This facility permits the program to interface with a range of hydrodynamic and FE programs.

AQWA-LINE uses a mesh composed of panels, or facets, to model the structure. It calculates pressures at the facet centroids, due to the incident, diffracted and radiated waves, for a range of wave periods and directions specified by the user.

The pressures calculated by AQWA-LINE effectively relate to waves of unit amplitude. These pressures therefore have to be scaled by AQWA-WAVE to relate to the actual wave height required by the AQWA-WAVE user.

AQWA-WAVE can be used to transfer facet loads to one of two types of structural model:

- a simplified, normally single component, stick model, in which only tube or beam elements are subject to hydrodynamic loads
- a single or multi-component model, in which hydrodynamic loads act mainly upon the wetted surfaces of shell or brick elements.

In the case of brick elements, a special load case is required in the ASAS master component file, to identify which faces of the brick are wetted.

As AQWA-LINE uses linear wave theory, it cannot calculate drag forces. Provision is therefore made for AQWA-WAVE to calculate the drag forces, including the effect of current. The program also allows for both drag and inertial forces to be calculated for additional structural elements in the FE model, which are too small to be modelled using AQWA-LINE facets.

AQWA-WAVE evaluates all forces at a particular phase in the wave cycle. The user can request many wave cases (specified by wave period, wave direction, wave height, wave phase and current profile) in a single run of the program.

When AQWA-WAVE is executed, the program reads a complete set of FE input data files and writes out a new set with all the necessary load cases inserted. For floating structures, balancing accelerations are also written into the output FE files.

There are currently a number of program limitations, which should be noted by the user:

- The facility for calculating drag loads in AQWA-WAVE is not yet implemented for FLOATING structures.
- AQWA-WAVE does not currently recognise either OFFSETS or LOCAL AXES defined for tube or beam elements in the ASAS geometry (GEOM) deck. The user must not therefore define such items in this deck.
- When setting up an ASAS model using SHELL type elements, the user must ensure that the input order of the nodes is **anti-clockwise**, when viewing the wetted surface of the element (the same convention as in AQWA-LINE).

1.2 Manual Layout

Section 2 discusses the theoretical basis of the AQWA-WAVE program.

Section 3 gives a detailed explanation of the AQWA-WAVE data format from Version 14.03.

Section 4 gives information on how to run the program.

Section 5 provides an example of program use.

Appendix A gives a detailed explanation of the AQWA-WAVE data format up to Version 14.02.

Appendix B gives a detailed explanation of the AQWA-WAVE neutral file formats.

2. THEORY

2.1 Program Structures

AQWA-WAVE is currently run as a post-processor to AQWA-LINE to transfer the facet pressures from AQWA™ to a structural model created using ASAS™ data. Optionally, drag and inertia loads on tubular components of the structure may be calculated and added to the diffraction/radiation forces from AQWA-LINE.

The ASAS model may comprise 1D or 3D elements. Typical 1D elements are tubes and beams. The elements that may be loaded by AQWA-WAVE are:

TUBE	BEAM	BM3D

Groups of AQWA facets may be associated with each tube or node in the ASAS model and diffraction/radiation forces assigned accordingly. (The user should decide how the facet loads are to be distributed, <u>before</u> running AQWA-LINE, so that appropriate element groupings can be set up in that run.) Drag and inertia loads on the tubes can also be calculated and added to these forces using Morison's equation.

3D structures comprise solid or shell elements. The elements that may be loaded by AQWA-WAVE are:

BRK6	BRK8	BR15	BR20	
TRM3	TBC3	QUM4	QUS4	MOQ4
TRM6	GCS6	TCS6	STM6	TSP6
QUM8	GCS8	TCS8	SQM8	WAP8

Diffraction radiation forces are once again transferred to these elements, this time by interpolation of facet pressures to the wetted external surface of the elements. Drag forces on the same surfaces can be calculated by the program and again assigned as pressures to the elements.

The ASAS model may be subdivided into components. AQWA-WAVE can load these components according to their position in the final assembled model. Load assembly data will be produced that will allow the ASAS runs to proceed with no further data editing.

Figure 2 - 1 shows the data flow and program structure for a typical analysis using AQWA-LINE and AQWA-WAVE. As can be seen, the AQWA-LINE run is completed first and backing files stored. These same backing files may be used for both 1D and 3D model runs, the type of run being defined in the AQWA-WAVE data file. This file also defines the load cases required from the AQWA-LINE run and the file name for the ASAS model. In the figure, the possibility that the 3D model may be a component analysis is shown. In this event, the program will automatically search for component data files, applying loads and rewriting the data as required.

AQWA-WAVE can also transfer AQWA facet pressures to ANSYS®. In order to use this facility, the user must first create an equivalent ASAS model from the ANSYS model using the ANSTOASAS macro in ANSYS. After running AQWA-WAVE, the structural loading generated can be imported back to the ANSYS model using the /INPUT command while in the solution processor. The interface to ANSYS currently has the following limitations:

- Hydrodynamic loads on beams are ignored (loads on PIPE type elements can be transferred, however).
- The structural model must be modelled as a single structure, i.e. no sub-structure components.

2.2 Selection of Wave Cases

A large number of wave cases may be selected by the user in the AQWA-WAVE data. This is achieved by defining a wave frequency number and a wave direction number from the preceding AQWA-LINE data and then specifying a wave height and phase to be associated with them. The wave height is required since the AQWA-LINE run is for unit wave amplitude and must be scaled to the required height. The phase is necessary as the drag forces that can be produced by the program generally do not vary sinusoidally and cannot be represented dynamically as in AQWA-LINE.

Pressures from the AQWA-LINE analysis are then extracted from the backing files and evaluated for the selected height/phase as follows:

$$P_\theta = \frac{H}{2} \cdot (P_r \cdot \cos\theta + P_i \cdot \sin\theta)$$

Where

P_θ	=	the pressure at the required phase
H/2	=	the required wave amplitude (H is the wave height)
P_r, P_i	=	real and imaginary components of pressure from AQWA-LINE
θ	=	the required phase

Optionally, static pressures may be calculated and added to the above time varying pressures by the setting of the 'STAT' option in the AQWA-WAVE data. The revised pressure is then simply given as:

$$P_{tot} = P_\theta + P_s$$

Where

P_s	=	hydrostatic pressure

Static pressure alone can be obtained by setting the STAT option and specifying a zero wave height.

Load cases created by AQWA-WAVE will be written before any other ASAS load cases and will be sequenced from 1001 unless the user specifies a different load case offset (See LCOF command in Section 3.1.5).

2.3 Incident Diffracted and Radiated Wave Forces

Incident, diffracted and radiated wave forces on the structure are calculated by AQWA-LINE for selected wave periods and directions. These forces may be thought of as relating to a unit wave amplitude, although they are actually forces per unit wave amplitude and relate to infinitesimal waves. The incident wave forces are sometimes referred to as Froude-Krylov forces. The radiated wave forces are zero for a fixed structure. AQWA-LINE stores the incident, diffracted and radiated components of the pressures on the individual facets in a backing file. Real and imaginary components of pressure are retained. The way AQWA-WAVE handles these pressures depends on the type of ASAS model being loaded, tube/beam models or shell/solid models.

For tube/beam models, groups of AQWA facets (specified by element group numbers) may be associated with a given node or element in the ASAS model. This data is provided in the AQWA-WAVE data file. In addition to the group number, the user must also specify which quadrant or half of a symmetric model is to be used. Provision is also made for defining the assembled component to which the element or node belongs.

The program will evaluate the incident and diffracted wave forces for each facet in the AQWA group at the requested wave height, period, direction and phase (see Section 2.2). It will then sum these forces about the node or element centroid requested. Summed forces at a node will be applied as ASAS Nodal Loads. Forces on an element will be applied as distributed loads. Elements and nodes that do not have AQWA groups assigned to them will not be loaded.

For solid/shell elements, a special load case (load case 1000) must be present in the ASAS data for any component that has an external wetted surface. Components with no load case 1000 will be assumed to be wholly internal, or above the water surface. This load case should be an ASAS face pressure or unit load case, defining the wetted faces of all wetted elements. (Note: The actual load values are unimportant, only the face data is used by AQWA-WAVE.)

AQWA-WAVE evaluates pressures for the requested wave height, period, direction and phase, in accordance with Section 2.2, for each node on the wetted surface of each element that appears in load case 1000. Elements in the ASAS model generally will not correspond to facets in the AQWA model and some method is clearly needed to obtain these pressures at the ASAS nodes. The method currently adopted is to locate the ASAS node on the AQWA mesh and then interpolate the pressure.

2.4 Morison Loads

AQWA-LINE does not evaluate drag forces on submerged components. AQWA-WAVE therefore allows Morison forces on such components to be calculated and added to the incident and diffracted wave forces from AQWA-LINE.

Two types of component are considered here:

1. Relatively large diameter tubular components simulated using facets in AQWA-LINE, but for which drag loads are considered important (e.g. GBS shafts)
2. Smaller diameter tubular members subject to drag and inertia loads (e.g. conductor framing on GBS). Although provision is made for modelling the inertia loads on such tubes in AQWA-LINE, this is not the recommended modelling for AQWA-WAVE, and the tubular members do not need to be modelled in AQWA-LINE.

When evaluating Morison loads on such components of the structure, several factors need to be considered:

- The incident flow is expected to be modified by the presence of the main structure due to diffracted wave forces. The particle velocities and accelerations on which the Morison forces are based need to consider this effect.
- The local water surface during the passage of a wave is also expected to be modified due to the presence of the structure, thus affecting the extent of structure subjected to wave loading. A 'caisson effect' (overall increase in water height) and a 'ride up' on vertical members cutting the surface are expected.
- The effects of current velocity on drag should be considered. Current velocities should also be modified to allow for the presence of the structure.
- Although linear wave theory is considered sufficient for evaluating incident and diffracted wave effects, this is often not sufficient for drag loads near the water surface where the particle velocities and water surface elevation can often be in excess of that predicted by simple Airy theory. Some consideration should be given to the effects of higher order wave theory.
- The method of modelling of the ASAS structure should be considered. Although the application of drag and inertia loads to tube elements is relatively straightforward, some further rule needs to be provided to assign pressures to tubular structures defined by plate or solid elements.

The above considerations are addressed in the following two sections under the headings of fluid flow and load application.

2.4.1 Fluid Flow

At any point in the flow outside the AQWA facet model, the incident and diffracted wave flow potential can be calculated using the same Green's function routines as AQWA-LINE. The rate of change of potential in each principal direction gives the velocity of the flow for that direction. The effect of all contributing facets is considered. These can be added as a vector to the incident flow to give the disturbed flow around the structure. Water particle accelerations are derived simply from the rate of change of velocity.

A current profile (variation of current with depth) may be specified in the AQWA-WAVE data for each wave case and phase selected from the AQWA-LINE analysis. The current flow is assumed to be horizontal but the direction may vary with depth. For each given point, a current velocity is then calculated by linear interpolation to the required depth. This velocity is again summed as a vector to the wave velocity in the disturbed flow, calculated as above. The user-defined current profile is assumed to include the effects of the structure disturbing the flow. The program does not modify the current velocities as it does for waves. Principles of momentum preservation or even runs of AQWA-LINE with the current represented as a long duration wave may be helpful in determining this modified profile.

Flow around a massive object tends to cause a local distortion of the still water surface known as a 'caisson effect' and water tends to 'ride up' members that cut the water surface. The latter effect is normally not considered to significantly change global load on the structure, but is of some importance to local design, particularly wave slam, slap and the determination of the required air gap. The 'caisson effect' is significant on GBS type structures and can result in the total load being applied higher up in the structure. AQWA-WAVE calculates most of this effect, which is due to the diffracted wave. (The increase in wave elevation due to diffraction may be obtained explicitly, using the field point facility in AQWA-LINE. The pressure at a given point at the still water level may be obtained using this method and the dynamic displacement of the water surface may be derived from the simple $h = p/(\rho g)$ formulation.)

The effect of this artificial raising of the water surface is simply to increase (or decrease if negative) the extent of structure subject to water pressure loads. If a positive value is found, the undisturbed water-surface motions are assumed to apply over the increase in depth. Otherwise, the motions are cut off at the reduced water surface.

Higher order wave theory may produce higher loads than simple Airy theory and typically account for a raising of the water surface elevation at the crest and a smoothing of the trough. Although not dealt with explicitly by AQWA-WAVE, the user can attempt to model the effect by inputting a scaled-up wave height, obtained using a suitable scaling factor. It is suggested that an estimate for this factor be obtained from a program that does allow for different wave theories, such as ASAS-WAVE.

2.4.2 Load Application

Small diameter tubular members are handled as below:

- The water surface elevations at the ends of the element are evaluated with due allowance for the local increase or decrease mentioned above.
- If both ends of the element are below the water surface, then the member is fully loaded.
- If neither end of the element is below the water surface, then the member is unloaded.
- If only one end of the element is in the water, the member is loaded over the wetted length only.
- The fluid flow at each end of a loaded length is evaluated in accordance with 2.4.1.
- The fluid flows at each loaded end are transformed into loads per unit length perpendicular to the member using Morison's equation as below:

$$F = 0.5\rho C_d D u|u| + C_m \rho A a$$

Where

F	=	the force per unit length
C_d	=	the drag coefficient
ρ	=	the mass density of water
D	=	the member diameter
u	=	the instantaneous velocity resolved normal to the member
C_m	=	the inertia coefficient
A	=	the cross-sectional area = $\pi D^2/4$
a	=	instantaneous acceleration resolved normal to the member

Note: $C_m = 1 + C_a$

Where

C_a = the added mass coefficient.

The user should take into account marine growth when inputting the diameter into the AQWA-WAVE data.

The drag and inertia coefficients can be defined explicitly by the user for all tube elements in the ASAS model. Members with no coefficients will not be considered. The coefficients occur in the AQWA-WAVE data and are referenced by ASAS element number and assembled component name.

- Distributed loads on the element are written to the output data file as ASAS 'BL6' type distributed loads.

Note: The user must not define either OFFSETS or LOCAL AXES for tube elements in the ASAS geometry deck.

Large AQWA substructures, which have cylindrical symmetry (such as the shaft of a GBS) and which have been modelled in AQWA-LINE using PLATE elements can also have their drag loads calculated by AQWA-WAVE. Such substructures are referred to here as 'AQWA components'. (An AQWA component will correspond to one or more ASAS components.)

Ignoring current for the moment, the flow 'seen by' an AQWA component, at any instant of time, is taken to be the flow which, at that instant, is being exactly cancelled (normal to every plate) by the combined flow due to all the hydrodynamic sources on the component. The flow 'seen by' the component can thus be calculated by adding, to the incident flow (assumed undisturbed), the flow due to all the hydrodynamic sources on the whole AQWA structure, EXCEPT those on the component. The resulting flow is evaluated on the central axis of the component and (after adding the constant current) used in Morison's equation to calculate the drag.

The program has no knowledge of what constitutes an AQWA component. If it is required to calculate the drag on such a component, all the elements which constitute the component must be specified in the AQWA-WAVE data (see OMIT command in Section 3.1.7), so that the corresponding hydrodynamic sources can be OMITTED from the drag calculations.

Two cases need to be considered:

a) The tubular shaft is represented by tube elements in the ASAS model.
b) The tubular shaft is represented by solid or shell elements having a wetted surface, as in Section 2.3.

Forces on a tube element idealisation of these shafts may now be calculated exactly as before, except that inertia loading is not generally required and should be prevented by setting C_m to zero.

Shell or solid element models require more data. Such elements should be arranged into ASAS groups, each of which represents a ring of elements. The end co-ordinates, diameter and drag coefficients for each such ring are given in the AQWA-WAVE data. Rings are referenced by ASAS group number and assembled component name in the AQWA-WAVE data.

With two ends, a diameter and a drag coefficient, each ring can now be handled exactly as for the above tubes as far as the evaluation of distributed loads on the length of tubular. The distributed loads (which vary from end to end) now need to be assigned as pressure loads on to the wetted faces. Fortunately, there is ample literature to show the likely distribution of drag pressure around such a cylinder and a pressure distribution as illustrated in Figure 2 - 2 is used. The co-ordinates of each node at each element of the ring is found and transformed relative to the start and end of the tube it represents. From this, a pressure can be derived according to Figure 2 - 1.

The drag loads on the tubular elements and the pressures on the elements of the rings are evaluated as above and are summed with incident/diffraction loads calculated in accordance with Section 2.3, prior to being written to the output ASAS data file in the appropriate format.

It should be noted that the above treatment of the water surface elevation and linearisation of pressure loads is relatively simplistic. Excessive errors will occur if the element mesh is too coarse, particularly near the water surface. This should be remembered when meshing the model.

2.5 Inertial Loads

For floating structures, AQWA-WAVE writes body force and angular acceleration cards into the ASAS LOAD decks of all components containing massive elements. When ASAS is run, these will generate inertial loads to balance the pressure loads transferred from AQWA-LINE. If the 'STAT' option is selected, then static accelerations will be added, to balance the hydrostatic pressures which are included when this option is invoked. If the floating structure is in equilibrium in AQWA-LINE (as it should be) then the static acceleration will simply be the acceleration due to gravity.

For fixed structures, there is no dynamic acceleration and acceleration cards will only be output if the 'STAT' option is selected. In this case, the acceleration output is always the acceleration due to gravity. When ASAS is run, this will create inertial loads equal (in total) to the weight of the structure.

The user should note that there is no force balance in the case of fixed structures, since the reaction at the seabed is not modelled in AQWA-WAVE.

2.6 Units

Provision is made for the case where different units are used in AQWA and ASAS. AQWA-WAVE needs to know what the ASAS length units are and ASAS needs to know what the AQWA load units are. The user must supply this information in the AQWA-WAVE data file (see SCAL and UNIT commands in Section 3.1.6), if the units are not consistent between AQWA and ASAS.

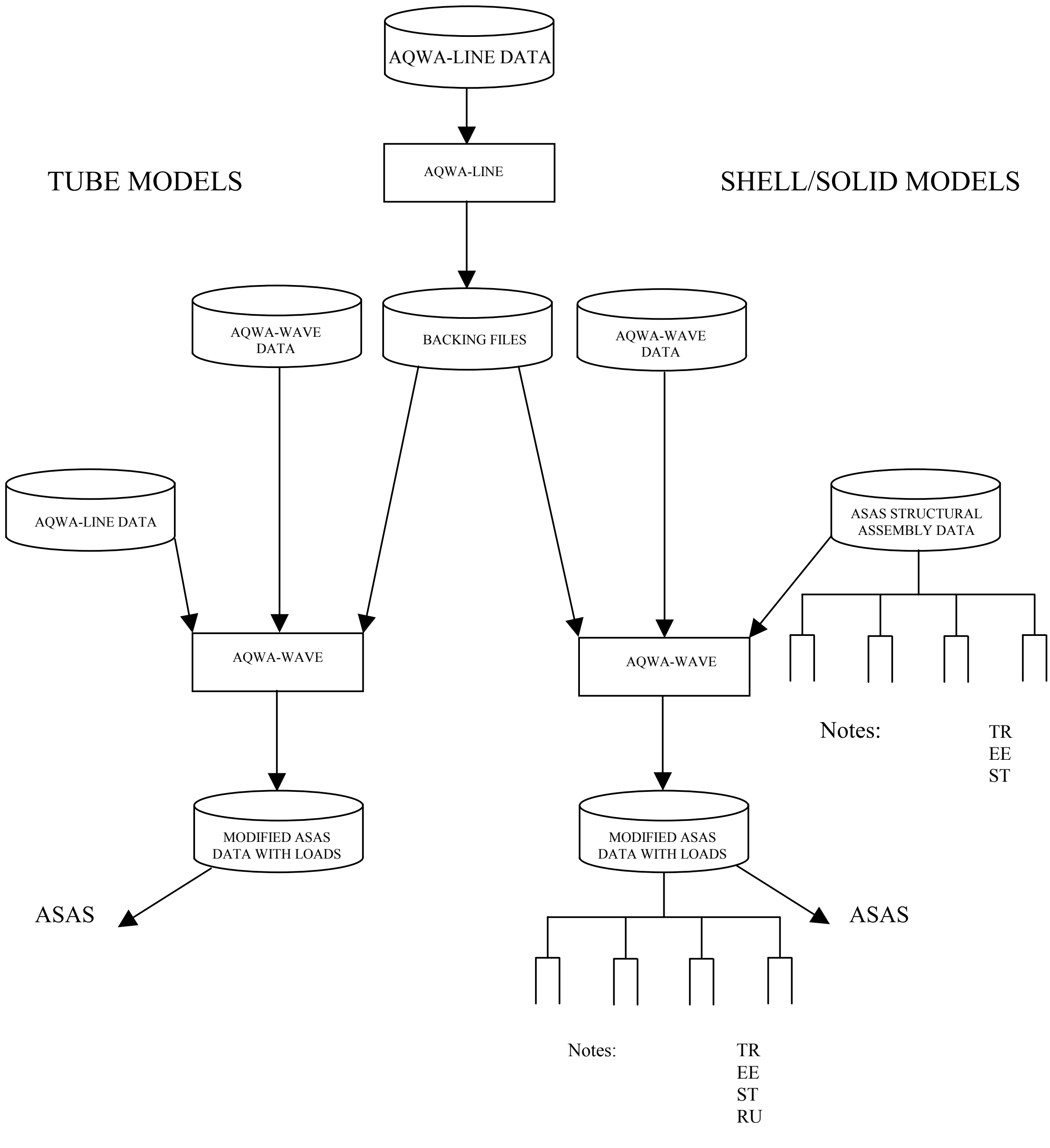


Figure 2 - 1: Analysis Flow Chart

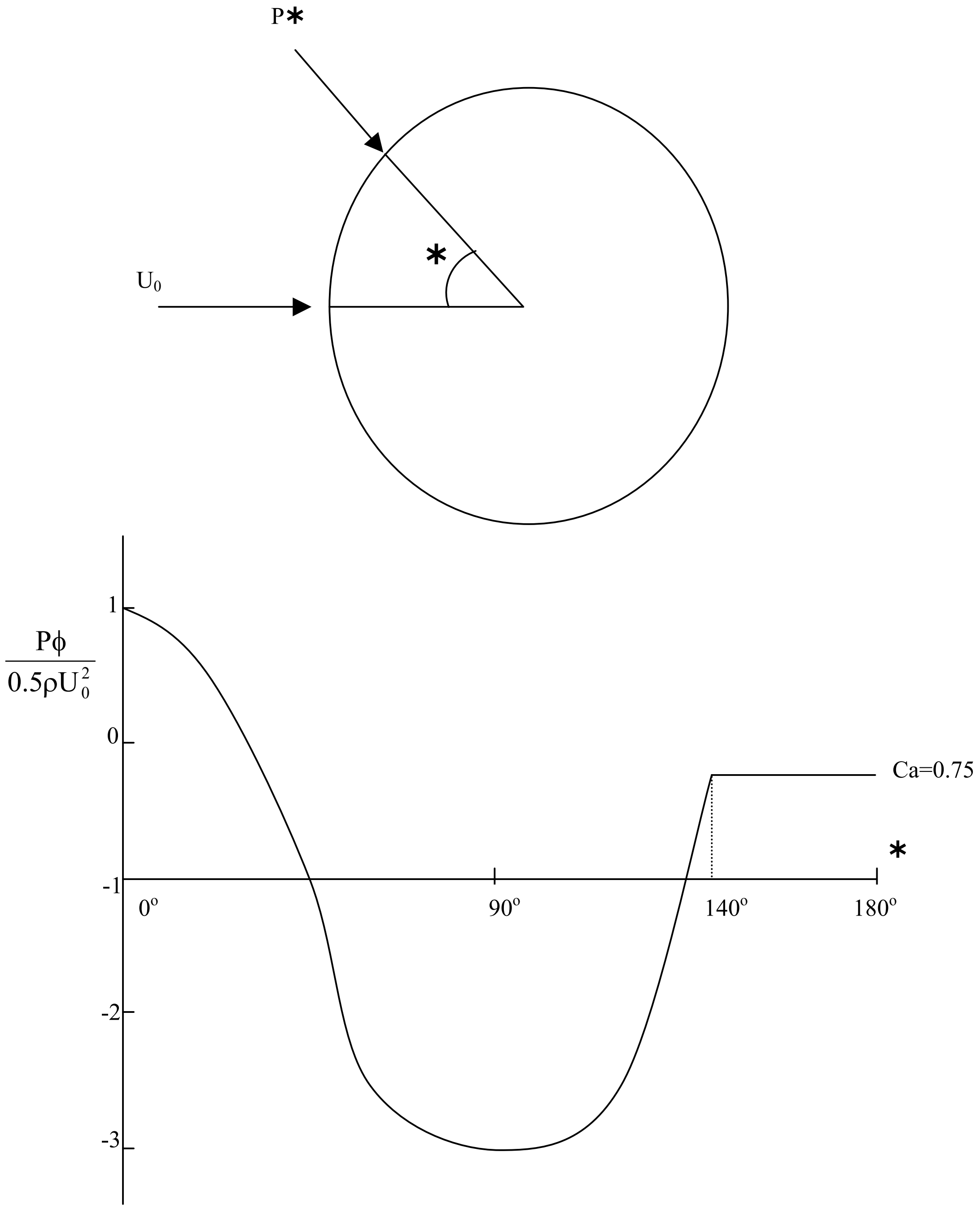


Figure 2 - 2: Variation of Drag Pressure around a Cylinder

3. DATA REQUIREMENTS AND PREPARATION

This chapter describes the form in which data is expected by the program and is intended as a list of the data requirements and format for each type of analysis that may be performed when running AQWA-WAVE. Note that the data structure has been substantially revised in version 14.2 and the need of having a separate load generation data file is no longer required. The old data requirements prior to this program version are documented in Appendix A.

The data required for running AQWA-WAVE is split into two data sets:

1. A data file providing information about the ASAS™ project, the constituent ASAS and AQWA™ files to be processed and data giving information about the load generation that is to be undertaken from the AQWA model defined. This is the file submitted to AQWA-WAVE and which references the following data.
2. ASAS input files containing the structural model assembly to be loaded.

3.1 Input Data file

The input file in AQWA-WAVE must include

- The project name of the ASAS model to be processed.
- The names of the ASAS data file(s) that constitute(s) the complete structural assemblage.
- The identifier used for the AQWA model database.
- The load generation details.

Other optional input data to AQWAWAVE can include

- The amount of computer memory to be used in the assembly process.
- Extension to be used for the generated file names.

3.1.1 Overall Data Structure

```
SYSTEM DATA AREA memory
JOB NEW LINE
PROJECT pname
OPTIONS option
EXTENSION ext
END
STRU filename
HYDR aqwaid
END
AQWAID aqwaop
CURR
current data
END
LOAD
load case data
END
FELM
finite element program data
END
ASGN
assignment data
END
```

```
STOP
```

3.1.1.1 EXTENSION Command

This command specifies the file extensions used when outputting the new data or load files.

EXTE extension

Parameters

EXTE keyword

extension three letter extension

Note

The new data or load files are formed using **extension**. If omitted, the new files will have extension 'dat' on the basic structural data file names. This must not conflict with the extension of the original data files.

3.1.2 Hydrodynamic and Structural File Information

The first part of the AQWA-WAVE data file after the preliminary data consists of one or more structural data file names, which define the structural model to be loaded together with a command defining the hydrodynamic model.

3.1.2.1 ASAS File Information

The ASAS model can be specified by simply providing one or more data file names.

`filename`

Parameters

`filename` Name of a file residing in the current directory containing ASAS data pertaining to the structural analysis (alphanumeric, up to 32 characters).

Notes

1. All the files required for a substructure assembly must be provided. The order in which they are supplied is immaterial.
2. The data file names need to be provided in the correct case on machines that are case sensitive.

3.1.2.2 Structural Model Information

The STRU command is a more general form for defining the structural model. This can be used in place of the ASAS file definition in the previous section.

```
├── STRU ──── (prog) ──── filename ──
```

Parameters

`STRU`	Keyword to denote definition of structural data file
`prog`	Identifier of structural analysis program as follows (optional): ASAS ASAS (default) NEUT Neutral format
`filename`	Name of a file residing in the current directory containing structural data pertaining to the structural analysis (alphanumeric, up to 32 characters).

Notes

1. All the files required for a substructure assembly must be provided. The order in which they are supplied is immaterial.
2. The data file names need to be provided in the correct case on machines that are case sensitive.
3. Only one structural file (i.e. no substructure) is allowed for neutral format input.
4. Refer to Appendix B.2 for details of the neutral structural file format.

3.1.2.3 Hydrodynamic Model Information

The HYDR command defines the hydrodynamic model.

HYDR —— (prog) —— filename ——

Parameters

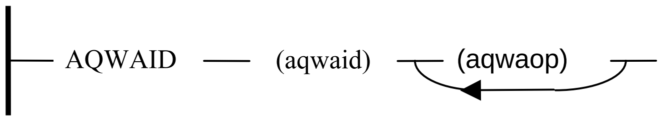
`HYDR`	Keyword to denote definition of hydrodynamic model
`prog`	Identifier of hydrodynamic analysis program as follows (optional): AQWA AQWA (default) NEUT Neutral format
`filename`	For AQWA, this is the name of the AQWA model to be processed. This is the name associated with the .RES file generated by AQWA-LINE without the extension. For NEUT, this is the name of a file residing in the current directory containing hydrodynamic data pertaining to the hydrodynamic analysis (alphanumeric, up to 32 characters).

Notes

1. The data file names need to be provided in the correct case on machines that are case sensitive.
2. Only one hydrodynamic model definition is allowed within a job.
3. For the AQWA option, the model database files (`.res`, `.pot` and `.uss`) must use the name given by `filename.`
4. Refer to Appendix B.1 for details of the neutral hydrodynamic file format.

3.1.3 AQWA Identifier Information

This defines the identifier associated with the AQWA model databases and any analysis options related to the load generation. This command is compulsory,



Parameters

`AQWAID`	Keyword
`aqwaid`	Name of the AQWA model to be processed. This is the name associated with the .RES file generated by AQWA-LINE (optional, Alpha-numeric, up to 8 characters.
`aqwaop`	Analysis options (optional). Valid options are: FIXD fixed structure STAT add static pressures PRDL Print data list

Note:

1. The parameter `aqwaid` is only required if the hydrodynamic model is not defined using HYDR and it must be omitted otherwise.
2. If `aqwaid` is specified, the model database files (`.res, .pot` and `.uss`) must use the name given by `aqwaid.`

Example

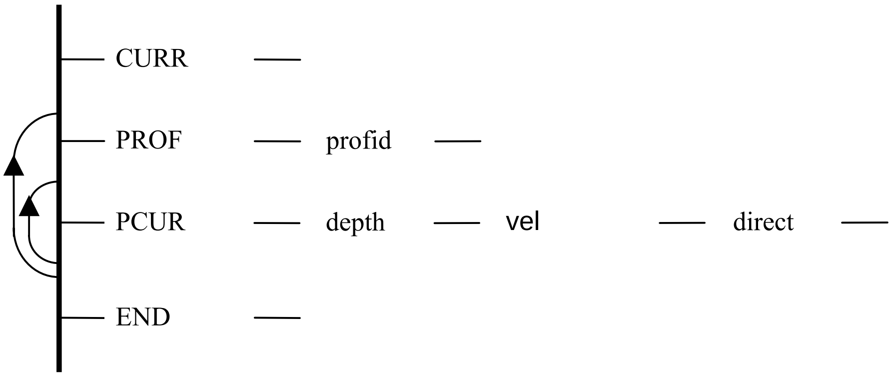
```
AQWAID awsemisb
```

This will result in the program searching for the following files:

`awsemisb.res`
`awsemisb.pot`
`awsemisb.uss`
	Restart database files

3.1.4 Current Definition - CURR

This deck contains information on current profiles for combination with wave particle kinematics. This data block can be omitted if the effect of current is to be ignored.



Parameters

CURR Compulsory header to define the start of current definition data.

PROF Command keyword for profile creation.
profid Profile identifier. (Integer, >0)

PCUR Command keyword for point current values
depth Depth measured downwards from SWL. (Real)
vel Current velocity. (Real)
direct Direction in degrees. (Real)

END Compulsory keyword to denote the end of data block

Notes for PROF command

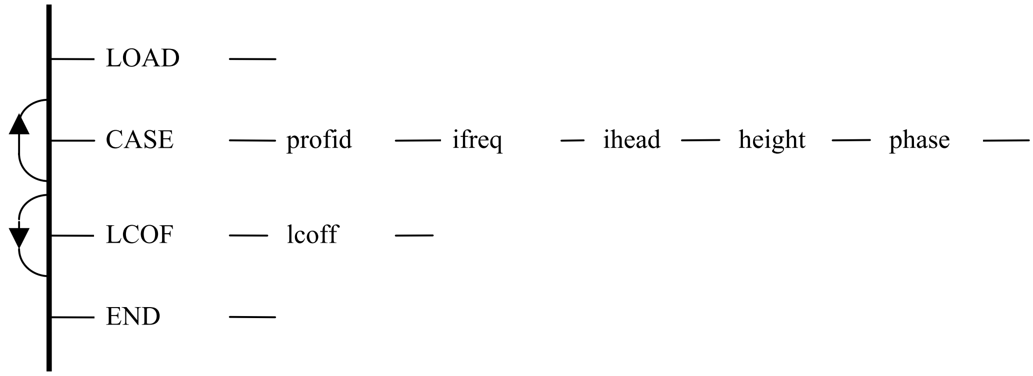
1. The profile identifier is referenced by the LOAD deck on successive CASE cards. The profile is defined by successive PCUR data until the next PROF command, or the end of the data block.
2. Up to ten profiles can be created in each run of AQWA-WAVE.

Notes for PCUR command

1. The depth is measured downwards from SWL. Values of velocity and direction are linearly interpolated between depths. Depths should be strictly increasing on successive cards.
2. The velocities are always horizontal, in the direction and at the depth specified.
3. The direction is measured in degrees, positive in the sense of moving from the AQWA global X-axis to the AQWA global Y-axis.
4. Up to ten point current values may be specified for each profile.

3.1.5 Load Case Data - LOAD

This deck specifies which load cases from AQWA-LINE are required to be transferred to the structural model. This data block is compulsory.



Parameters

LOAD Compulsory header to define the start of load case definition data.

CASE	Command keyword for load case definition.
profid	Current profile identifier defined in the CURR data, 0 if no current. (Integer)
ifreq	Wave frequency number (see note 2). (Integer)
ihead	Wave heading direction number (see note 3). (Integer)
height	Wave height (see note 4). (Real)
phase	Wave phase in degrees (see notes 5 and 6). (Real)

LCOF	Command keyword for load case offset definition
lcoff	Offset which is added to load case numbers produced by AQWA-WAVE. Default is 1000. (Integer)

END Compulsory keyword to denote the end of data block

Notes for CASE command

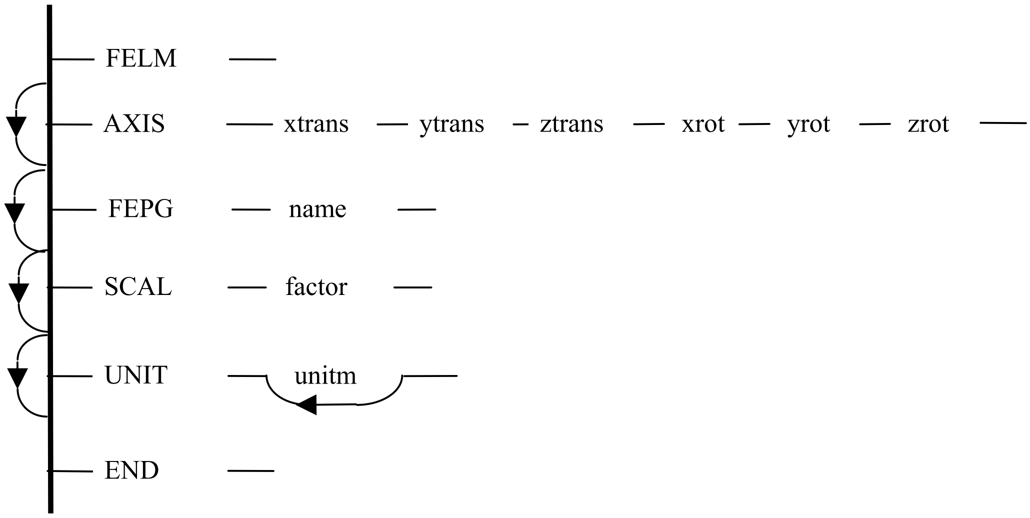
1. The current profile number references profiles set up in the CURR data block.
2. The wave frequency number is defined in Deck 6 of the preceding AQWA-LINE run and identifies the particular wave frequency to which the floating body is subjected.
3. The wave heading direction number is defined in Deck 6 of the preceding AQWA-LINE run and identifies the heading angle of the wave relative to the AQWA global X-axis.
   NB: Wave cases must be ordered, first by frequency number (increasing), and then by direction number (increasing).
4. The wave height, not wave amplitude, is input.
5. A positive phase defines a wave whose crest passed over the structure centre of gravity (T * phase/360) seconds ago, where T is the wave period.
6. For neutral load output, the phase data is ignored and the real and imaginary load results will always be generated. Refer to Appendix B.3 for details.

Notes for LCOF command

1. This command (optional) is used to add an offset to the load case numbers produced by AQWA-WAVE. This allows the user to create further load cases, by running AQWA-WAVE again, without creating duplicate load case numbers. (The output .DAT files from the previous AQWA-WAVE run must first be renamed as .NWL) For example, if the load case offset is specified as 2000, then the first load case produced by AQWA-WAVE will be load case number 2001.

3.1.6 Finite Element Program Information - FELM

This deck controls the information pertaining to linkage of the finite element program and AQWA. This data block is optional.



Parameters

FELM Compulsory header to define the start of finite element program information data.

AXIS	Command keyword for defining top level ASAS axis system relative to the AQWA axis system
xtran	X coordinate of the FE Structural Axis origin from the AQWA Structural Axis origin. (Real)
ytran	Y coordinate of the FE Structural Axis origin from the AQWA Structural Axis origin. (Real)
ztran	Z coordinate of the FE Structural Axis origin from the AQWA Structural Axis origin. (Real)
xrot	Roll rotation of the FE Structural Axes from the AQWA Structural Axes in degrees. (Real)
yrot	Pitch rotation of the FE Structural Axes from the AQWA Structural Axes in degrees. (Real)
zrot	Yaw rotation of the FE Structural Axes from the AQWA Structural Axes in degrees. (Real)

FEPG Command keyword to define the finite element package to be linked with
name Name of the finite element package
- ASAS - ASAS (default)
- ANSY - ANSYS®
- NEUT - Neutral format

SCAL Command keyword to define conversion factor from ASAS length units to AQWA length units.
factor Conversion factor from ASAS length units to AQWA length units for coordinates data. (Real)

UNIT Command keyword to instruct AQWA-WAVE to output an ASAS UNITS command at the beginning of each load data block.
unitm Name of units utilised in AQWA, specified according to the ASAS rules for an ASAS UNITS command. (Character)

END Compulsory keyword to denote the end of data block

Notes for AXIS command

1. The AXIS card is only required if the co-ordinate system used to define the AQWA structure (in Deck 1) is not identical to the top level ASAS co-ordinate system.
2. The translation defines the origin of the FE structural axis system from the origin of the AQWA fixed reference axes (used to define the AQWA structure in Deck 1), in AQWA length units.

3. The rotations of the FE structural axes from the AQWA fixed reference axes are in degrees. The rotations are applied in the order roll, pitch, yaw (where roll, pitch and yaw are defined as rotations about the AQWA fixed reference axes).

Notes for FEPG command

1. If the input file format is neutral, the output will always be given in neutral format irrespective of the name specified in the FEPG data. Currently, neutral output format is not available for non-neutral input files.
2. Refer to Appendix B.3 for details of the neutral output file format.

Notes for SCAL command

1. The SCAL command is only required if the ASAS length units are different from the AQWA length units.
2. The scale factor, which is used to multiply the ASAS co-ordinates, in order to convert them from ASAS length units to AQWA length units. For example, if the ASAS units were feet and the AQWA units were metres, then the appropriate scale factor would be 0.3048.

Notes for UNIT command

1. The UNIT command is only required if the units used in ASAS and AQWA are different.
2. The units used in AQWA, specified according to the ASAS rules for an ASAS UNITS command.

   For example, if the AQWA force and length units were Newtons and metres, then the AQWA UNIT card would be

   UNIT N m

   in order to produce an ASAS UNITS command

   UNITS N m

3. If a UNIT command is used in the AQWA-WAVE data, then each ASAS master component file which has loads written to it by AQWA-WAVE must contain a UNITS command in the preliminary data, to define the ASAS units being used. Otherwise, ASAS will not know how to convert the data.

3.1.7 Assignment Data - ASGN

This deck defines the correlation between the AQWA and the FE model data and allows hydrodynamic coefficients to be assigned to FE elements.

This deck is not needed if the user simply wants to transfer pressures to a shell or brick model, and does not wish to calculate additional drag loads.

The TUBE, NODE and RING cards allow coefficients to be set for selected nodes, elements or groups of elements in the FE model. Since the FE model may be a component analysis, the component to which this data must be applied must also be specified. This is achieved by COMP cards. Once a component has been selected, it remains current for subsequent data until a new COMP card is given. At the start of the deck, the top level structure is assumed current. No COMP card is therefore needed for a single-shot analysis.

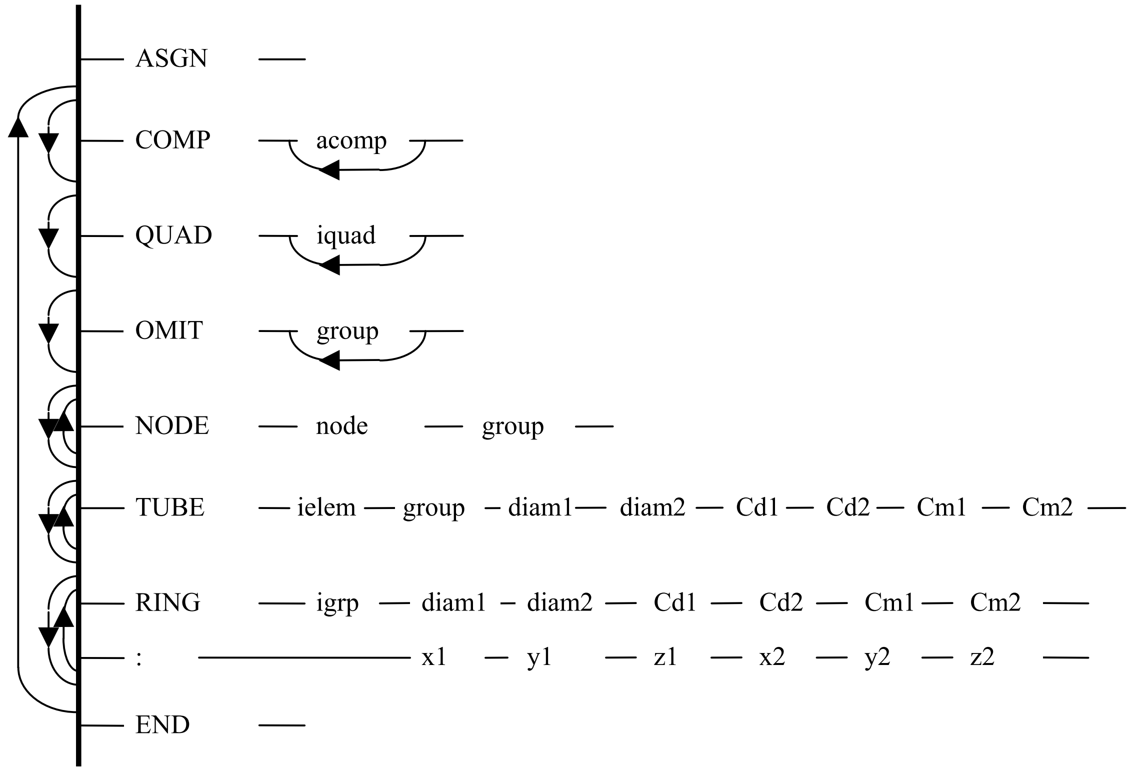
QUAD cards are used to define which quadrants (or halves) of a symmetric AQWA model are currently selected. As AQWA element groups are numbered only in the definition quadrant, the use of the QUAD card allows the user to reference corresponding element groups in other quadrants.

OMIT cards are used ONLY if the user wishes to calculate drag loads on large, cylindrically symmetrical, AQWA components, which have already been modelled in AQWA-LINE by means of PLATE elements.

The OMIT card effectively defines an AQWA component by specifying all the AQWA element groups which constitute it. (In general, QUAD cards will also be needed to fully specify the component.) The component remains selected, and loads can be calculated for sections of it, using TUBE or RING cards (see below), until another AQWA component is defined. It should be noted that an AQWA component may correspond to more than one ASAS component (defined on COMP cards).

The purpose of the OMIT card is to instruct the program to OMIT all the hydrodynamic sources associated with the elements of the component, when calculating drag loads (see Section 2.4.2).

OMIT and QUAD cards may be interspersed as required in the data. Several OMIT cards can be specified to provide a long list of groups. OMIT cards are only cumulative in this way when they are consecutive in the data. When separated by other cards, only the selections on the latest card are applied. Thus, an OMIT card on its own with no parameters would revert to using the whole AQWA model, the default at the start of the deck. Groups of OMIT cards continue to apply to successive data until a further group is specified.



Parameters

FELM	Compulsory header to define the start of assignment data.
COMP	Command keyword to define the ASAS component to be considered
acomp	Up to 10 assembled component names defining a branch down the component tree (A4 character)
QUAD	Command keyword to define the quadrant(s) to be considered
iquad	Up to 4 quadrant numbers (1 to 4). (Integer)
OMIT	Command keyword to define the AQWA groups to be omitted
group	A list of AQWA group numbers to be omitted. The groups specified as being omitted will remain so until a further OMIT command is given. (Integer)
NODE	Command keyword to define the ASAS node number where incident and diffracted wave forces from AQWA-LINE facets will be transferred
node	ASAS node number to which incident and diffracted wave forces from the AQWA-LINE facets will be transferred.. (Integer)
group	AQWA group number that defines the facets whose faces will be transferred to the ASAS node. (Integer)
TUBE	Command keyword to define the hydrodynamic properties on an ASAS beam/tube element.
ielem	ASAS tube or beam user element number. (Integer)
group	AQWA group number whose facets are associated with the beam element. Specify 0 if incident/diffracted forces are not required on this element. (Integer)
diam1	Diameter at end 1 of the element. (Real)
diam2	Diameter at end 2 of the element. (Real)
Cd1	Drag coefficient at end 1 of the element. (Real)
Cd2	Drag coefficient at end 2 of the element. (Real)
Cm1	Inertia coefficient at end 1 of the element. (Real)
Cm2	Inertia coefficient at end 2 of the element. (Real)

RING	Command keyword to define the hydrodynamic properties on a ring of elements.
igrp	ASAS group number for the elements that form a ring (or part ring) in the FE model. (Integer)
diam1	Diameter at end 1 of the ring axis. (Real)
diam2	Diameter at end 2 of the ring axis. (Real)
Cd1	Drag coefficient at end 1 of the ring axis. (Real)
Cd2	Drag coefficient at end 2 of the ring axis. (Real)
Cm1	Inertia coefficient at end 1 of the ring axis. (Real)
Cm2	Inertia coefficient at end 2 of the ring axis. (Real)
x1	X coordinate at end 1 of the ring axis. (Real)
y1	Y coordinate at end 1 of the ring axis. (Real)
z1	Z coordinate at end 1 of the ring axis. (Real)
x2	X coordinate at end 2 of the ring axis. (Real)
y2	Y coordinate at end 2 of the ring axis. (Real)
z2	Z coordinate at end 2 of the ring axis. (Real)

If necessary, additional data for a command may be specified using the continuation symbol colon (:).

Notes for COMP command

1. The assembled component names define a 'branch' down the component tree for subsequent data to refer to. The branch can be up to ten names long, but will often be shorter. The first name in the lists must be the final structure name, with each successive assembled component name being a valid substructure of the last.
2. The COMP card remains valid until another appears in the data. At the start of the deck, the global structure is assumed. Care should be taken not to refer to one component twice in the deck, as only the first occurrence will be used.

Notes for QUAD command

1. The quadrant numbers are designated 1 to 4. For a singly symmetric structure, only halves 1 and 2 are available. If symmetry has not been used, only one quadrant is defined.

   Quadrant 1 is always the modelled quadrant and quadrant 2 is the mirror of this for singly symmetric structures. For doubly-symmetric models, the following is the case:
   Quadrant 2 is the mirror of the model about the Y-axis;
   Quadrant 3 is the mirror of the model about the X-axis;
   Quadrant 4 is the diagonally opposite quadrant.

   All subsequent AQWA-LINE group definitions on OMIT, NODE, RING and TUBE commands will refer to the selected quadrant or quadrants until another QUAD card appears to redefine this. At the start of the deck, all possible quadrants are active.

Notes for OMIT command

1. The group(s) specified as being OMITted will remain so until a further OMIT command or group of commands is given.
2. OMIT commands are used to specify the AQWA element groups which make up the AQWA component (eg. GBS shaft), on sections of which the user wishes drag loads to be calculated. Subsequent TUBE and RING cards relate to this component. The element groups specified are OMITted in the calculation of fluid flow. The AQWA-WAVE program is thus able to calculate the correct effective flow 'seen by' the TUBE and RING sections, as required by Morison's equation. If the user does not OMIT these groups, then the diffracted component of the flow calculated by the program will be erroneous.
3. OMIT commands only define that part of the AQWA component which is in the definition quadrant. QUAD commands may also be needed to define the complete component.

Notes for NODE command

1. Six degrees of freedom are currently assumed at the FE node so that the moment about the point can also be generated.

Notes for TUBE command

1. The beam/tube element on the currently selected component will be loaded.
2. The group of AQWA facets relates to all selected quadrants. Incident/diffracted forces on the selected groups of facets will be summed and applied as global distributed loads to the selected element. Note that, in general, the inertia coefficients should be zero if the incident/diffracted forces are transferred, as both relate to the same effect.
3. The diameters may be different at the two ends and may differ from the structural diameter (for marine growth, for instance).
4. Inertia coefficient (C_m) is defined by $C_m = C_a + 1$, where C_a is the added mass coefficient.

Notes for RING command

1. Elements that belong to the specified group for the currently selected component alone are considered. It is possible to select part of a ring in one component, and other parts later.
2. The diameters may be different at the two ends and may differ from the structural diameter (for marine growth, for instance).
3. The inertia coefficients (C_m) would normally be zero, as inertia loads would be provided by incident/diffracted forces except above the SWL. Where provided, they are defined by $C_m = C_a + 1$.

   If a RING is above the SWL and on which inertia and drag loads are to be calculated and transferred to ASAS, the faces on this RING should then be defined in load case 1000 as if they are on the wetted faces. The wave pressures from AQWA will not be transferred to these nodes when their z co-ordinate is greater than zero.
4. End co-ordinates of the axis of the ring are defined in AQWA Structural Axes (as defined in AQWA Deck 1).

3.1.7.1 Sample Assignment Deck

The following is an example of an ASGN deck for AQWA-WAVE:

```
    ASGN
TUBE    1     0     1.20      1.20       0.7       0.7       1.5       1.5
TUBE    3     0     1.20      1.20       0.7       0.7       1.5       1.5
TUBE    5     0     1.25      1.25       0.7       0.7       1.5       1.5
COMP STRC CMP1
OMIT    3    4    5    6
NODE   95    4
TUBE  162    3      5.90      6.15       1.0       1.0       0.0       0.0
TUBE   71    5      5.65      5.90       1.0       1.0       0.0       0.0
COMP STRC CMP1 HALF LEFT
QUAD    1
OMIT   10   11   12   13   14   15
RING  111           6.15      6.40       1.0       1.0       0.0       0.0
:                   15.00     15.00     79.00     15.00     15.00     74.00
RING  112           6.40      6.65       1.0       1.0       0.0       0.0
:                   15.00     15.00     74.00     15.00     15.00     69.00
RING  113           6.65      6.80       1.0       1.0       0.0       0.0
:                   15.00     15.00     69.00     15.00     15.00     64.00
END
```

The first three TUBE cards assign diameters, drag and mass coefficients to beam type elements in the final structure, the default at the start of the data. The members are not represented in the AQWA-LINE run by facets, as the AQWA group field is blank. Inertia coefficients are supplied instead.

A lower level component is then selected, CMP1, a component of STRC. Forces from AQWA group 4 are assigned to node 95 and two further tubes are loaded, this time taking incident/diffracted forces from AQWA groups and having no inertia forces.

Finally, a much lower level component is selected and quadrant 1 (perhaps the unmirrored half?) selected. After omitting several AQWA groups from this quadrant, three rings (groups 111, 112 and 113) are defined and will be loaded.

4. RUNNING INSTRUCTIONS

4.1 General

Every attempt has been made to create a program that, in spite of its broad scope of application, is easy to handle on any given machine. The commands to run the program have been kept to a minimum and all file assignments are handled automatically from within the program.

This chapter contains some general instructions for running the program. Exact details depend on the computer and on the way the program has been installed. Users should contact their local ASAS™ representative for further information if any problems are encountered.

4.2 How to Run AQWA-WAVE

Prior to running AQWAWAVE it is necessary to ensure that the necessary files required to run the program exist. As stated in Section 2 the AQWA-WAVE data consists of two data sets

1. A data file providing information about the ASAS™ project, the constituent ASAS and AQWA™ files to be processed and data giving information about the load generation that is to be undertaken from the AQWA model defined. This is the file submitted to AQWA-WAVE and which references the following data.
2. ASAS input files containing the structural model assembly to be loaded.

In addition to these data files the AQWA-LINE database files must be available. In common with other programs in the AQWA suite it is conventional to rename the database such that the first two letters correspond to the program being run. This is not strictly necessary for AQWA-WAVE since the name of the database is given explicitly by the `aqwaid` command given in the AQWA-WAVE data file. For consistency with AQWA, however, it is suggested that this convention is adopted. The AQWA database files (.`res`, .`uss` and .`pot`) should be renamed so that the first two letters are `aw`.

For example

For an AQWA analysis whose run identifier is `hull`, AQWA-LINE will generate the following database files

```
alhull.res
alhull.uss
alhull.pot
```

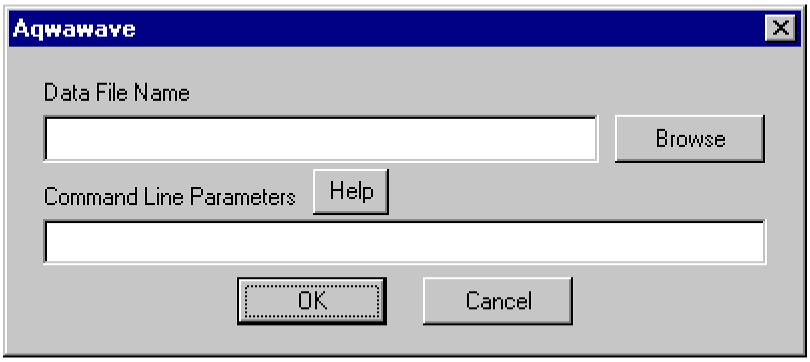
Following the convention these files should be renamed as `awhull.res`, `awhull.uss` and `awhull.pot` respectively. The `aqwaid` given in the AQWA-WAVE data will then be `awhull`.

4.2.1 Running AQWA-WAVE on the PC

The PC version of AQWA-WAVE is run as a Windows process. The program is issued with an accompanying icon that may be displayed on the main Windows desktop. There are three ways in which a program may be run

1. Click on the Program Icon

By clicking on the program icon, the following form will be displayed:



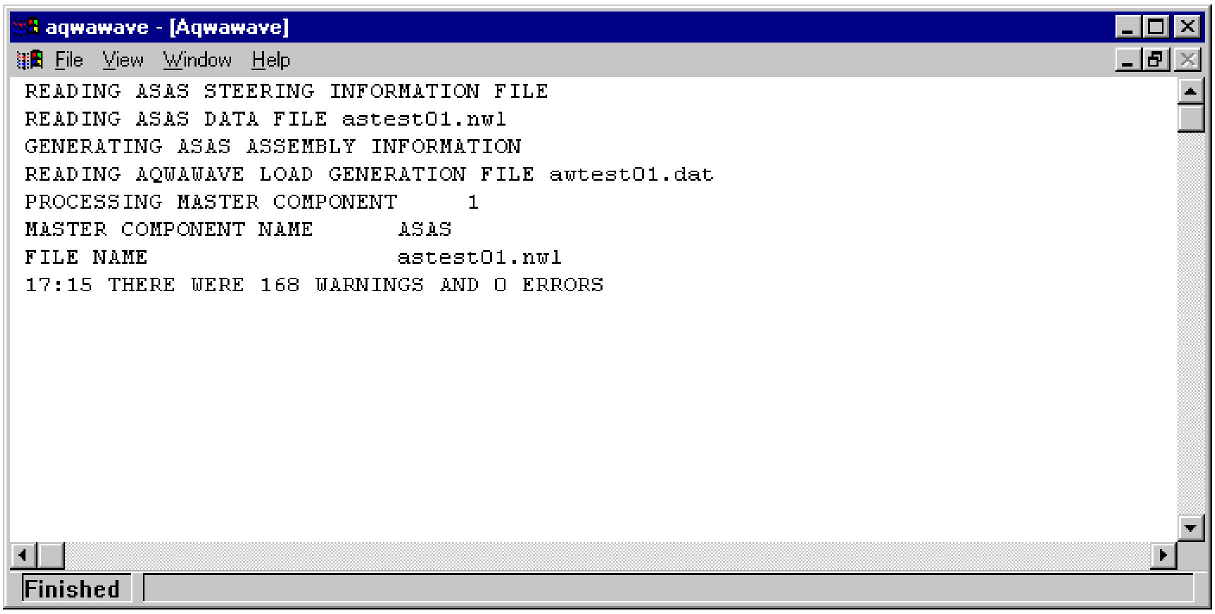
The data file name may be identified by clicking on the Browse button. A file structure will be displayed from which the data file may be identified. Double clicking on the file will place it in the Data File Name display box. Alternatively, the data file name and its path may be typed in the display box. By default, the program will be run in the directory defined by the path to the data file.

Command line parameters can be defined in this display box. The following parameters may be used:

/DATA=	will define the name of the data file and, optionally, its location. By default `.dat` will be appended if no file extension is given.
/OUT=	will define the name of the results file and, optionally, its location. By default this will be set to the data file prefix appended with `.out`. e.g. for an input file of `hull.dat` the results file will be `hull.out`.
/PATH=	will define the path to the data and results file. This will be used if there is no path defined on /DATA= or /OUT=
/BACK=	will define the directory in which the program is to be run. This may be different from the location of the data and results files.
/CLEAR	will clear the dialog window. The default is for it to remain in position at the end of the run.
/LOCK	will write a lock file. This may be interrogated with the WAITLOCK process to determine when the AQWA-WAVE process has completed. See note below.

Parameters must be separated by a space on the command line.

To start the program, click on the OK button. This will display a dialog window similar to that shown below:



At the end of the run a message is displayed that the program has completed and requests an Exit confirmation. Clicking on ”Yes” or pressing the ENTER key on the keyboard will close the dialog window. Clicking on ”No” will allow the window to be processed according to the command buttons. Note that the use of /CLEAR automatically closes the dialog window when the program has completed.

2. Drag and Drop

Using Windows Explorer, a data file may be dragged and dropped on the program icon. This will automatically initiate the program in the directory of the data file.

3. Using a DOS Shell

The program can be run in a DOS Shell using a command of the form:

aqwawave DataFileName

or

aqwawave /DATA=DataFileName /OUT=ResultsFileName [/parameter]

assuming the directory where the program is installed (e.g. c:\asash) in on the path correctly. The optional /parameter equates to any of the valid command line parameters given above e.g. /CLEAR, /PATH=c:\asas\test.

Typing the program name on its own is equivalent to clicking on the program icon as described above.
It is not now possible on the PC to use the redirect symbols < and > to define data and results files.

4.2.2 Running ASAS from batch files on PCs

As AQWAWAVE now runs as a process, it may not be possible for a number of jobs to be run consecutively. This is because when a command is issued to start an AQWAWAVE run, the process begins and control may return immediately to the DOS shell or the .BAT file. So, if a .BAT file is being used, as each process begins, control is returned to the file and the next command is executed.

This has been overcome with the use of a LOCK file. If the /LOCK parameter (see above) is used, a file called $_$_LOCK is created. A program WAITLOCK has been written that can then be run following an AQWA-WAVE analysis. This program will wait until the LOCK file has been deleted, which occurs when the preceding AQWA-WAVE run completes. When the LOCK file has been deleted, WAITLOCK itself completes and allows the next command to be executed.

Example Batch File

```
AQWAWAVE      hull   /LOCK
WAITLOCK
copy          awhull.res    awhulla.res
copy          awhull.pot    awhulla.pot
AQWAWAVE      hulla
```

4.3 AQWA-WAVE Initialisation File

The ASAS initialisation file allows the user to define the default file extensions to be used in AQWA-WAVE. The file is called `asas.ini`. There are three locations in which the file may be stored. These are searched in the following order:

1. In the current directory
2. In a directory pointed to with the environmental variable ASAS_INI.
3. In a directory pointed to with the environmental variable ASAS_SEC.

Currently, the following data items may be defined in the `asas.ini` file.

The first line must be `[General]` starting in column 1.

The next lines may be one or more of the following, all starting in column 1:

`Default_input_extension=`*ext*	where *ext* is the user's preferred extension for the input file. Default is `.dat`
`Default_output_extension=`*ext*	where *ext* is the user's preferred extension for the output file. Default is `.out`
`Noclobber=on` (or `ON` or `On`)	prevents the output file from being overwritten if it already exists in the current directory

The two default extensions will only be used if no extension is given for either input or output files on the command line, e.g.

```
Aqwawave.exe          hull
```

The output default extension will also be used if the input file name is specified **with** an extension and no output file is specified on the command line, e.g.

```
aqwawave.exe          hull.dat
```

5. SAMPLE PROBLEM

5.1 General Description

An example problem of a Concrete Gravity Based Structure (GBS) is presented. This is illustrated in the attached figures. These show in sequence:

- The hydrodynamic simulation of the platform for AQWA-LINE (Figure 5 - 1)
- A simple stick (beam) element model to test the loading and determine critical phases, etc. (Figure 5 - 2)
- A multi-level component model of the structure for final loading and code checking. (Figure 5 - 3)

Only one half of the GBS is modelled for AQWA-LINE and use is made of the symmetry facility to represent the entire structure.

5.2 Stick Model Subject to Diffraction Loading (Model t1666)

The first example shows the application of incident/diffraction loading obtained from AQWA-LINE. The FE data for the stick model should include all geometry, materials, etc. and load cases other than the wave cases. There are no wetted surfaces, so pressure case 1000 is not needed. All incident/diffracted wave forces therefore need to be assigned to tubes or nodes.

A sample data file for this problem is attached. After the preliminary deck, current and load data are defined. For this example there is no current loading. A single load case from the AQWA-LINE analysis is selected, by choosing the wave frequency number (2) and the wave direction number (3) required. This corresponds to a wave period of 16 seconds, a wave direction of 60 degrees. The additional data on the CASE data line defines the wave phase position (270 degrees) and wave height (20 metres).

The FE model deck is used to define the relationship between the AQWA™ and FE analyses. In this case, the FE structural origin and the AQWA structural origin are coincident so the AXIS command is blank.

The assignment data deck tells AQWA-WAVE how to transfer loads to the elements and nodes of the stick model. In this case, there are three types of load transfer:

1. AQWA groups representing the cell walls are associated with vertical beam elements in the base. No drag or inertia loads are needed, so the diameter and coefficients are left blank (zero). The QUAD card is used to select the ‘quadrant’ to which the data applies. For groups that cross the boundary, both ‘quadrants’ (actually symmetric themselves) are needed.
2. Loads from the cell top domes are transferred to nodes on the stick model. The QUAD card is again used to select which occurrences of these groups are needed.
3. Elements in the shafts below water level are processed next. The AQWA shaft facets loads are transferred to the tubular elements in the structural model using a series of TUBE cards. Once again, selected quadrants are associated with the elements in each shaft. Neither drag factors nor inertia coefficients are defined since drag loading is not required and the incident/diffracted wave forces will be transferred directly from the AQWA-LINE model.

5.3 Stick Model Subject to Drag Loading Only (Model t1667)

As with above this utilises a stick model to represent the GBS. In this case, however, drag loading is included from Morison's equation and the diffraction/radiation loading is ignored.

In order to compute drag loading both current and wave data need to be defined. In the example seven current profiles are defined and the first one is utilised for the analysis (corresponding to a direction of zero degrees). A single load case from the AQWA-LINE analysis is selected, by choosing the wave frequency number (1) and the wave direction number (1) required. This corresponds to a wave period of 19 seconds, a wave direction of zero degrees. The additional data on the CASE data line defines the wave phase position (0 degrees) and wave height (2 metres).

The remainder of the data defines the load transfer information for each of the shafts. The AQWA shaft facets are omitted so that the associated hydrodynamic sources will not contribute to the diffracted flow seen by the shaft. Selected quadrants are associated with the structural elements in each shaft. Drag factors are assigned to each end of each member, but inertia coefficients are not defined since inertia effects are not being considered.

5.4 Component Model (Model t1668)

Selected loads now need to be transferred to the component model. A data file for this is included and is described below.

The preliminary, current, load and finite element system decks are very similar to those for the stick model above. In this case a wave height of 20 metres and a phase angle of 315 degrees is chosen for the analysis.

The assignment deck is somewhat different. In the first two commands, the shaft facet groups are omitted from the calculation of the diffracted flow seen by the shaft. Note that incident and diffracted wave forces are not affected by this command. These are automatically transferred to any element faces that appear in the ASAS™ data defined in load case 1000 and that are above the water line.

Sets of RING cards for each shaft component follow, firstly the top and bottom of shaft 1, then shaft 2, then shaft 3. The COMP instructions specify which component of the assembled structure is required, tracing its assembled component names down a unique branch. Most shaft elements will have received incident/diffracted wave forces from AQWA. The upper shaft rings, however, are above the water level and need inertial forces. If required, inertia coefficients may be added to the normally specified co-ordinates, diameters and drag coefficients for those elements that are above the water level (this is NOT shown in the example).

5.5 Files utilised in the analyses

All three models utilise a common AQWA-LINE model. This is given in Figure 5 - 4. When this is analysed using AQWA-LINE three AQWA database files are generated:

```
alt1666.res
alt1666.pot
alt1666.uss
```

Below is a table of the files used for each of the models given in 5.2 to 5.4 above.

AQWA-LINE generated files	alt1666.res alt1666.pot alt1666.uss		
	Copy to↓	Copy to↓	Copy to↓
AQWA database files	awt1666.res awt1666.pot awt1666.uss	awt1667.res awt1667.pot awt1667.uss	awt1668.res awt1668.pot awt1668.uss
AQWAWAVE Data File	t1666aqw.dat	t1667aqw.dat	t1668aqw.dat
ASAS Structural model file(s)	t1666asa.dat	t1667asa.dat	t1668as1.dat t1668as2.dat t1668as3.dat t1668as4.dat
Generated ASAS load file(s)	t1666asa.inp	t1667asa.inp	t1668as1.inp t1668as2.inp t1668as3.inp t1668as4.inp

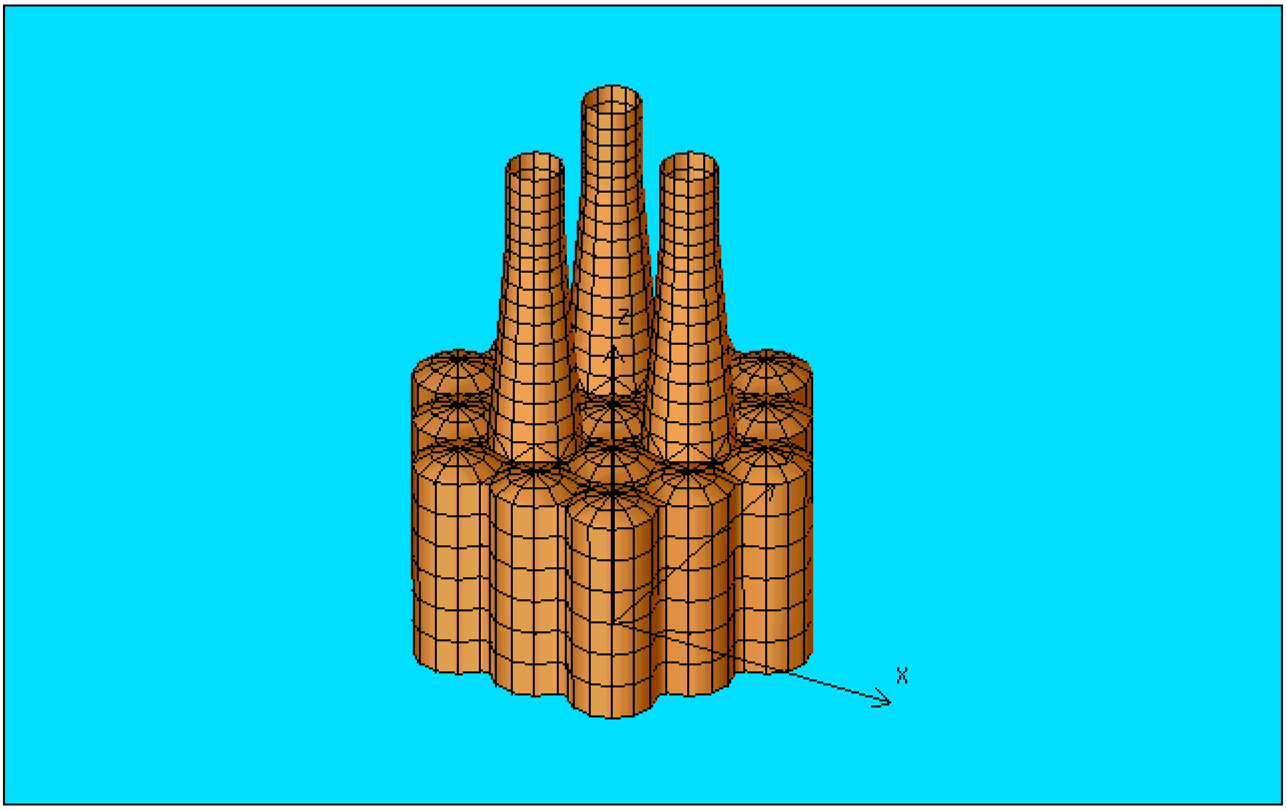


Figure 5 - 1: AQWA-LINE Model

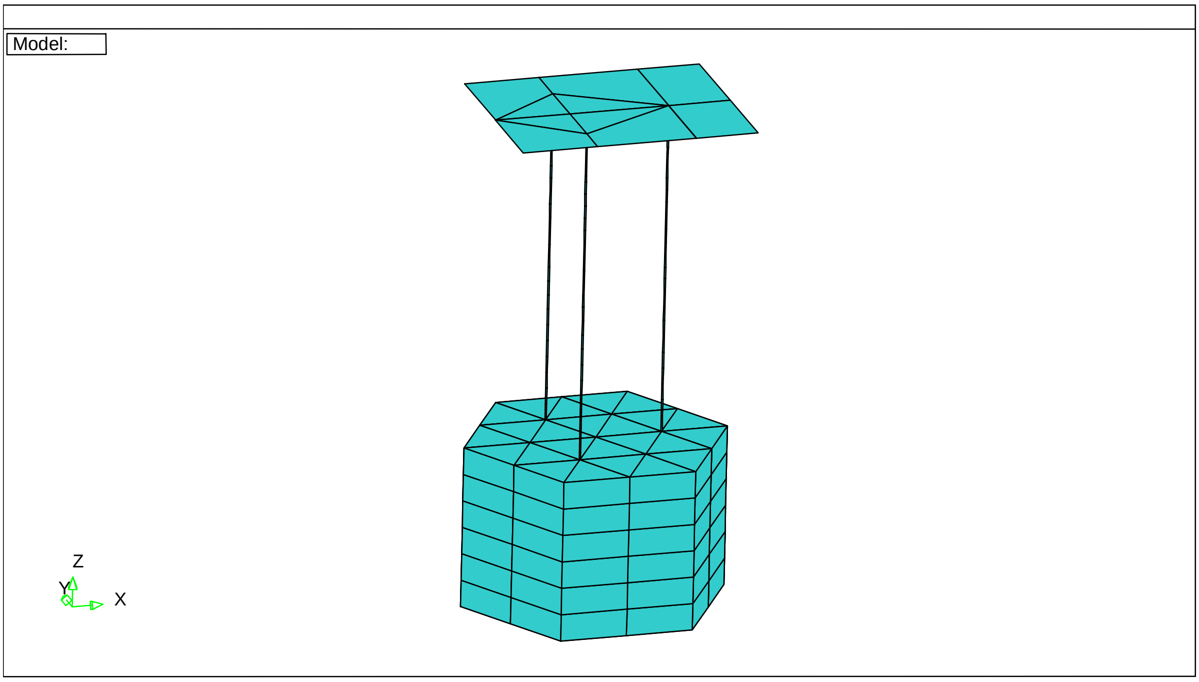
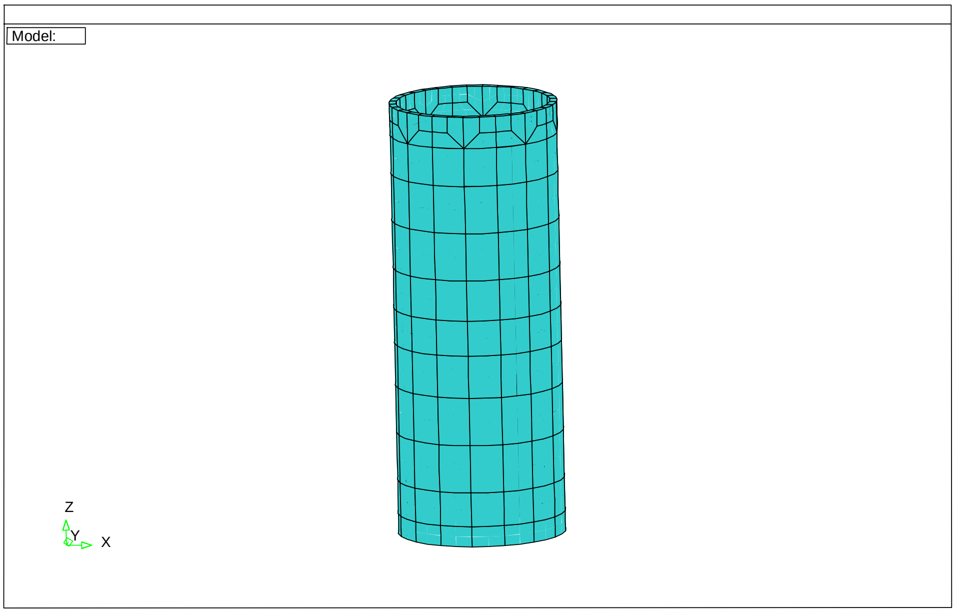
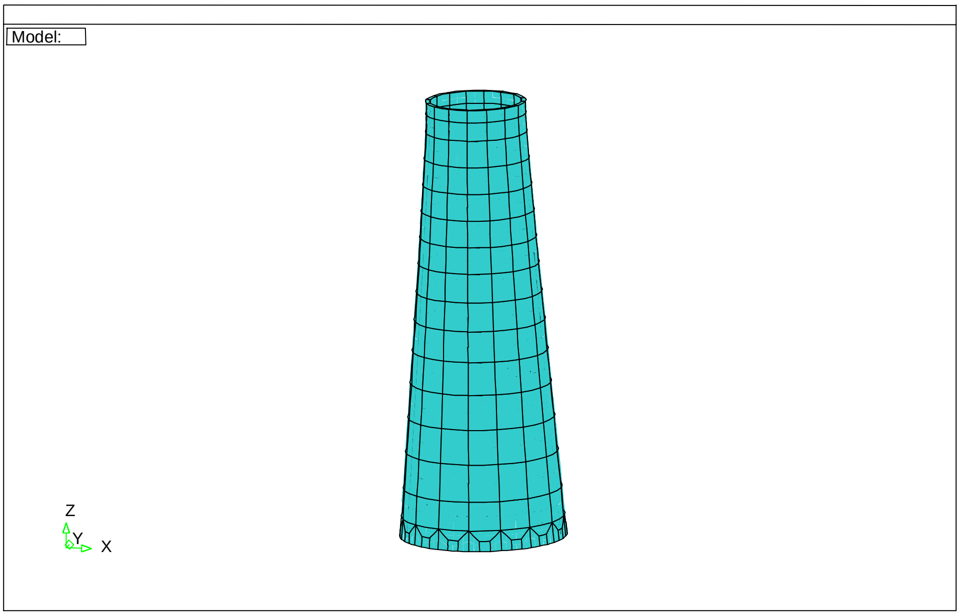


Figure 5 - 2: Simplified Stick Model - Single Level



a) Shaft Bottom



b) Shaft Top

Figure 5 - 3: Detailed Component Model - Multi-Level Substructures

```
*******************************************************************
*
*   Run Title:      Model 1
*   Job Number:     3614
*   Model Type:     Hydrodynamic (AQWA-LINE) model
*   Description:    One half (y > 0) of complete condeep input (the
*                   rest obtained by symmetry) - run for a complete
*                   range of wave frequencies and directions
*   Case Number:
*   Units:          Gg m s
*
*
*******************************************************************
JOB AL1A  LINE  FIXD
TITLE               CONDEEP - MODEL 1
OPTIONS GOON LDOP REST END
RESTART   1  3
    01    COOR
         1             -4.3448   20.5855  123.7300
         2             -3.4700   17.3205  123.7300
         3             -4.3448   20.5855  119.5475
         4             -3.4700   17.3205  119.5475
         5             -4.3448   20.5855  115.3650
.
.
.
       577             33.1350   11.8905   55.1500
       578             30.0000   11.0505   55.1500
       579             26.8650   11.8905   55.1500
       580             35.4300   14.1855   55.1500
       581             36.2700   17.3205   55.1500
 END01 999              0.0       0.0      52.6500
    02    ELM1
    02SYMX
    02QPPL DIFF 1327 (1)  (215) (216) (213) (214)
    02QPPL DIFF 1326 (1)  (213) (211) (212) (214)
    02QPPL DIFF 1325 (1)  (211) (205) (208) (212)
    02QPPL DIFF 1324 (1)  (205) (206) (209) (208)
    02QPPL DIFF 1323 (1)  (206) (207) (210) (209)
    02QPPL DIFF 1324 (1)  (217) (208) (209) (218)
    02QPPL DIFF 1323 (1)  (218) (209) (210) (219)
    02QPPL DIFF 1325 (1)  (220) (212) (208) (217)
.
.
.
    02QPPL DIFF  515 (1)  (198) (120) (135) (200)
    02TPPL DIFF  516 (1)  (199) (200) (201)
    02TPPL DIFF  516 (1)  (200) (202) (201)
    02QPPL DIFF  515 (1)  (200) (135) (150) (202)
    02TPPL DIFF  516 (1)  (203) (204) (193)
    02TPPL DIFF  516 (1)  (204) (194) (193)
    02QPPL DIFF  515 (1)  (204) (165) (180) (194)
    02TPPL DIFF  516 (1)  (201) (204) (203)
    02TPPL DIFF  516 (1)  (201) (202) (204)
    02QPPL DIFF  515 (1)  (202) (150) (165) (204)
 END02PMAS           (1)  (999) (999) (999)
    02    FINI
    03    MATE
 END03          999     180.0
    04    GEOM
 END04PMAS      999   18000.0       0.0       0.0   18000.0       0.0   18000.0
    05    GLOB
    05DPTH     120.2
    05DENS   1.025E3
 END05ACCG     9.807
    06    FDR1
    06PERD    1    2      19.0      16.0
    06DIRN    1    6       0.0      30.0      60.0      90.0     120.0     150.0
 END06DIRN    7    7     180.0
    07    WFS1
 END07ZCGE              -71.08
    08    NONE
```

Figure 5 - 4: AQWA-LINE Model

```
SYSTEM DATA AREA  1000000
JOB NEW LINE
PROJECT ASAS
TITLE AQWAWAVE VERIFICATION                                T1666AQW.DAT 18/11/99
TEXT  ********************************************************************************
TEXT  CREATED 18/11/99
TEXT  MODIFIED 08/06/04 - FREE FORMAT DATA
TEXT  ALT1666.DAT  AQWALINE ANALYSIS
TEXT  T1666AQW.DAT AQWAWAVE DATA FILE
TEXT  T1666ASA.DAT ASAS STRUCTURAL MODEL FILE
TEXT  NOTE THAT DATABASE FILES CREATED BY ALT1666.DAT MUST BE CHANGED TO AWT1666
TEXT  BEFORE RUNNING AQWAWAVE
TEXT  ********************************************************************************
EXTENSION inp
END
t1666asa.dat
end
**********************************************************************
*
*   Project:        Fixed Concrete Structure Analysis
*   Run Title:      AQWA-WAVE Test Run No 1
*   Models Used:    AQWA-LINE Model + ASAS Stick Model
*   Description:    Transfers loads from AQWA-LINE for one wave case
*                   No drag loads calculated.
*                   No current
*
*                   Wave period      16 secs  (1)
*                   Wave direction   60 degs  (1)
*                   Wave phase      270 degs
*                   Wave height      20 metres
*
*   Units:          Gg m s
*
**********************************************************************
aqwaid awt1666 fixd
          LOAD
 END  CASE   0     2    3      20.0     270.0
          ASGN
      QUAD    1
      NODE  109  221
      NODE  109  222
      NODE   83 1420
      NODE   83 1421
      NODE   83 1422
      NODE   27 1521
      NODE   27 1522
      NODE   56 1620
      NODE   56 1621
      NODE   56 1622
      NODE   28 1721
      NODE   28 1722
      NODE   84 1820
      NODE   84 1821
      NODE   84 1822
      QUAD    1    2
      NODE  110  421
      NODE  110  422
      NODE  111  620
      NODE  111  621
      NODE  111  622
      NODE   41 1321
      NODE   41 1322
      NODE   42 1921
      NODE   42 1922
      QUAD    2
      NODE  112  221
      NODE  112  222
      NODE   81 1820
      NODE   81 1821
      NODE   81 1822
      NODE   25 1721
      NODE   25 1722
      NODE   55 1620
      NODE   55 1621
      NODE   55 1622
      NODE   26 1521
      NODE   26 1522
      NODE   82 1420
      NODE   82 1421
      NODE   82 1422
      QUAD    1
```

```
      TUBE   71 1423
      TUBE   67 1424
      TUBE   63 1425
      TUBE   59 1426
      TUBE   55 1427
      TUBE   51 1428
      TUBE   23 1523
      TUBE   19 1524
      TUBE   15 1525
      TUBE   11 1526
      TUBE    7 1527
      TUBE    3 1528
      TUBE   48 1623
      TUBE   46 1624
      TUBE   44 1625
      TUBE   42 1626
      TUBE   40 1627
      TUBE   38 1628
      TUBE   24 1723
      TUBE   20 1724
      TUBE   16 1725
      TUBE   12 1726
      TUBE    8 1727
      TUBE    4 1728
      TUBE   72 1823
      TUBE   68 1824
      TUBE   64 1825
      TUBE   60 1826
      TUBE   56 1827
      TUBE   52 1828
      QUAD    1    2
      TUBE   36 1923
      TUBE   34 1924
      TUBE   32 1925
      TUBE   30 1926
      TUBE   28 1927
      TUBE   26 1928
      TUBE   35 1323
      TUBE   33 1324
      TUBE   31 1325
      TUBE   29 1326
      TUBE   27 1327
      TUBE   25 1328
      QUAD    2
      TUBE   69 1823
      TUBE   65 1824
      TUBE   61 1825
      TUBE   57 1826
      TUBE   53 1827
      TUBE   49 1828
      TUBE   21 1723
      TUBE   17 1724
      TUBE   13 1725
      TUBE    9 1726
      TUBE    5 1727
      TUBE    1 1728
      TUBE   47 1623
      TUBE   45 1624
      TUBE   43 1625
      TUBE   41 1626
      TUBE   39 1627
      TUBE   37 1628
      TUBE   22 1523
      TUBE   18 1524
      TUBE   14 1525
      TUBE   10 1526
      TUBE    6 1527
      TUBE    2 1528
      TUBE   70 1423
      TUBE   66 1424
      TUBE   62 1425
      TUBE   58 1426
      TUBE   54 1427
      TUBE   50 1428
      QUAD    1
      TUBE  162  501
      TUBE  159  502
      TUBE  156  503
      TUBE  153  504
      TUBE  150  505
      TUBE  147  506
```

```
      TUBE  144  507
      TUBE  141  508
      TUBE  138  509
      TUBE  135  510
      TUBE  132  511
      TUBE  129  512
      TUBE  126  513
      TUBE  123  514
      TUBE  120  515
      TUBE  117  516
      QUAD    1    2
      TUBE  160  101
      TUBE  157  102
      TUBE  154  103
      TUBE  151  104
      TUBE  148  105
      TUBE  145  106
      TUBE  142  107
      TUBE  139  108
      TUBE  136  109
      TUBE  133  110
      TUBE  130  111
      TUBE  127  112
      TUBE  124  113
      TUBE  121  114
      TUBE  118  115
      TUBE  115  116
      QUAD    2
      TUBE  161  501
      TUBE  158  502
      TUBE  155  503
      TUBE  152  504
      TUBE  149  505
      TUBE  146  506
      TUBE  143  507
      TUBE  140  508
      TUBE  137  509
      TUBE  134  510
      TUBE  131  511
      TUBE  128  512
      TUBE  125  513
      TUBE  122  514
      TUBE  119  515
 END  TUBE  116  516
Stop
```

Figure 5 - 5: AQWA-WAVE Data File Model T1666 (t1666aqw.dat)

```
SYSTEM DATA AREA  1000000
JOB NEW LINE
PROJECT ASAS
TITLE AQWAWAVE VERIFICATION                                T1666ASA.DAT 18/11/99
TEXT  ***************************************************************************
TEXT  CREATED 18/11/99
TEXT  ALT1666.DAT  AQWALINE ANALYSIS
TEXT  T1666AQW.DAT AQWAWAVE STEERING FILE
TEXT  AWT1666.DAT  AQWAWAVE HYDRODYNAMIC TRANSFER DATA
TEXT  T1666ASA.DAT ASAS STRUCTURAL MODEL FILE
TEXT  NOTE THAT DATABASE FILES CREATED BY ALT1666.DAT MUST BE CHANGED TO AWT1666
TEXT  BEFORE RUNNING AQWAWAVE
TEXT  ***************************************************************************
OPTIONS GOTP END
GOTP    0.0    0.0    52.65
UNITS M          N
UNITS DISP M
UNITS STRE M          N
END
COOR
CART
        1    20.0000        -34.6410         3.53000
        2    20.0000        -34.6410         11.7167
        3   -20.0000        -34.6410         3.53000
        4   -20.0000        -34.6410         11.7167
        5   -20.0000         34.6410         3.53000
        6   -20.0000         34.6410         11.7167
.
.
.
      215   -168.390        0.000000E+00     112.220
      216   -168.390        0.000000E+00     100.700
      217   -168.390        0.000000E+00     89.1900
      218   -168.390        0.000000E+00     75.9900
      219   -168.390        0.000000E+00     62.7900
      220   -168.390        0.000000E+00     49.6000
      221   -168.390        0.000000E+00     36.4000
      222   -168.390        0.000000E+00     23.2000
END
ELEM
GROU      1
MATP      1
BEAM       1       2       1       1
BEAM       3       4       1       2
BEAM       5       6       1       3
BEAM       7       8       1       4
BEAM       2       9       1       5
.
.
.
GROU     47
BEAM     217     218      47     516
GROU     48
BEAM     218     219      48     517
GROU     49
BEAM     219     220      49     518
GROU     50
BEAM     220     221      50     519
GROU     51
BEAM     221     222      51     520
GROU     52
MATP      2
TBC3       5     117      61      52     427
TBC3       5      45     117      52     428
TBC3      45      85     117      52     429
TBC3      45       7      85      52     430
.
.
.
TBC3     131      81     112      52     468
TBC3     131      42      81      52     469
TBC3      82     132      26      52     470
TBC3     132      55      26      52     471
TBC3     132     112      55      52     472
TBC3     112      25      55      52     473
TBC3     112      81      25      52     474
GROU     53
MATP      1
QUS4     114     113      31      32      53     175
```

```
QUS4     114    113     63     64     53    176
QUS4     114    113     85     86     53    177
QUS4     114    113     89     90     53    178
.
.
.
QUS4      56     54     24     28     53    424
QUS4      28     24     80     84     53    425
QUS4      84     80     40     42     53    426
GROU     54
MATP      3
QUM4     200    201    199    204     54    500
QUM4     201    202    197    199     54    501
QUM4     202    203    206    197     54    502
QUM4     204    198    208    207     54    503
QUM4     198    197    209    208     54    504
QUM4     197    206    210    209     54    505
TRM3     199    205    204     55    506
TRM3     199    197    205     55    507
TRM3     204    205    198     55    508
TRM3     205    197    198     55    509
END
MATE
    1 ISO    31000.      0.20000      0.00000E+00  0.24000E-02
    2 ISO    31000.      0.20000      0.00000E+00  0.46800E-02
    3 ISO   0.20500E+06  0.30000      0.00000E+00  0.00000E+00
END
GEOM
     1 BEAM    18.3000        1570.00        1595.00       0.000000E+00
     2 BEAM    18.3000        1417.00        1620.00       0.000000E+00
     3 BEAM    12.2000        1531.00        1265.00       0.000000E+00
     4 BEAM    12.2000        1294.00        1529.00       0.000000E+00
     5 BEAM   0.000000E+00    1113.00        1113.00       0.000000E+00
     6 BEAM   0.000000E+00    1113.00        1113.00       0.000000E+00
     7 TUBE TUB000000000
     8 TUBE TUB000000000
     9 TUBE TUB000000000
    10 TUBE TUB000000001
    11 TUBE TUB000000001
    12 TUBE TUB000000001
    13 TUBE TUB000000001
    14 TUBE TUB000000001
    15 TUBE TUB000000001
    16 TUBE TUB000000001
    17 TUBE TUB000000001
    18 TUBE TUB000000001
    19 TUBE TUB000000001
    20 BEAM    1.88700        37.8100        37.8100        75.0000
    21 BEAM    1.88700        37.8100        37.8100        75.0000
: OFFS   0.0000E+00 0.0000E+00 -5.000     0.0000E+00 0.0000E+00 0.0000E+00
    22 BEAM   0.386000        7.20000       0.870000E-01    42.5000
    23 BEAM   0.491000        8.28200       0.980000E-01    45.1000
    24 BEAM   0.327000        6.35700       0.800000E-01    40.7000
    25 BEAM   0.273000        4.91900       0.620000E-01    25.9000
    26 BEAM   0.811000        11.6070       0.121000        17.8000
    27 BEAM   0.754000        9.18300       0.131000        17.8000
    28 BEAM   0.868000        13.0330       0.261000        17.4000
    29 BEAM   0.348000        6.29600       0.730000E-01    19.0000
    30 BEAM   0.717000        12.7870       0.215000        15.6000
    31 BEAM   0.928000        13.5330       0.261000        17.8000
    32 BEAM   0.645000        11.9340       0.206000        14.7000
    33 BEAM   0.273000        4.91900       0.620000E-01    25.9000
    34 BEAM   0.754000        9.18300       0.131000        17.8000
    35 BEAM   0.811000        11.6070       0.121000        17.8000
    36 BEAM   0.910000        13.5830       0.270000        17.6000
    37 BEAM   0.348000        6.29600       0.730000E-01    19.2000
    38 BEAM   0.336000        6.71700       0.870000E-01    35.3000
    39 BEAM   0.488000        8.44000       0.960000E-01    38.8000
    40 BEAM   0.327000        6.35700       0.800000E-01    34.5000
    41 BEAM   0.237000        3.13000        2.40000        5.53000
: OFFS   0.0000E+00 0.0000E+00  4.080     0.0000E+00 0.0000E+00  5.530
    42 BEAM   0.450000        11.1000        11.1000        22.2000
    43 BEAM   0.450000        11.1000        11.1000        22.2000
    44 BEAM   0.566000        14.9800        14.9800        29.9600
    45 BEAM   0.566000        14.9800        14.9800        29.9600
    46 BEAM   0.720000        20.1500        20.1500        40.3000
    47 BEAM   0.454000        20.0600        13.5700        33.6300
    48 BEAM   0.454000        36.8300        13.5700        50.4000
    49 BEAM   0.454000        58.6700        13.5700        72.2400
    50 BEAM   0.454000        85.5600        13.5700        99.1300
    51 BEAM   0.454000        117.510        13.5700        131.080
```

```
    52 TBC3   0.450000
    53 QUS4   0.609000
    54 QUM4   0.200000E-01
    55 TRM3   0.200000E-01
END
SECT
TUB000000000 TUB  XSEC  20.01     0.7370
TUB000000000 TUB  XSEC  19.23     0.7020
TUB000000000 TUB  XSEC  18.46     0.6670
TUB000000001 TUB  XSEC  17.68     0.6320
TUB000000001 TUB  XSEC  16.90     0.5970
TUB000000001 TUB  XSEC  16.12     0.5620
TUB000000001 TUB  XSEC  15.35     0.5260
TUB000000001 TUB  XSEC  14.64     0.5000
TUB000000001 TUB  XSEC  13.87     0.5000
TUB000000001 TUB  XSEC  13.16     0.5000
TUB000000001 TUB  XSEC  12.57     0.5000
TUB000000001 TUB  XSEC  12.24     0.5000
TUB000000001 TUB  XSEC  12.20     0.5000
END
SUPP
       Z                       1
       Z                       3
       Z                       5
       Z                       7
       Z                      29
       Z                      31
       Z                      43
       Z                      45
       Z                      57
       Z                      59
       Z                      61
       Z                      63
       Z                      85
       Z                      87
       Z                      89
       Z                      91
       Z                     113
       Z                     115
       Z                     117
       X                      89
       Y                      89
       RZ                     89
       Y                     212
       X                     222
       Y                     222
       Z                     222
       RZ                    222
END
CONS
       X  211  -5.76  RY  204  1  X  204
       Y  211   5.76  RX  204  -9.03  RZ  204  1  Y  204
       Z  211   9.03  RY  204  1  Z  204
END
STOP
```

Figure 5 - 6: ASAS Structural File Model T1666 and T1667 (t1666asa.dat and t1667asa.dat)

```
SYSTEM DATA AREA  1000000
JOB NEW LINE
PROJECT ASAS
TITLE AQWAWAVE VERIFICATION                                 T1667AQW.DAT 18/11/99
TEXT  ************************************************************************
TEXT  CREATED 18/11/99
TEXT  MODIFIED 08/06/04 - FREE FORMAT DATA
TEXT  ALT1667.DAT  AQWALINE ANALYSIS
TEXT  T1667AQW.DAT AQWAWAVE DATA FILE
TEXT  T1667ASA.DAT ASAS STRUCTURAL MODEL FILE
TEXT  NOTE THAT DATABASE FILES CREATED BY ALT1667.DAT MUST BE CHANGED TO AWT1667
TEXT  BEFORE RUNNING AQWAWAVE
TEXT  ************************************************************************
EXTENSION inp
END
t1667asa.dat
end
**********************************************************************
*
*   Project:        Fixed Concrete Structure Analysis
*   Run Title:      AQWA-WAVE Test Run No 9
*   Models Used:    AQWA-LINE Model + ASAS Stick Model
*   Description:    Drag loads only for a single wave case
*                   Current profile   1
*                   Wave period      19 secs    (1)
*                   Wave direction    0 degs    (1)
*                   Wave phase        0 degs
*                   Wave height     2.0 metres
*
*   Units:          Gg m s
*
**********************************************************************
aqwaid awt1667 fixd
          CURR
      PROF    2
      PCUR       0.0     0.655      30.0
      PCUR      20.2     0.555      30.0
      PCUR      40.2     0.450      30.0
      PCUR      80.2     0.365      30.0
      PCUR     117.2     0.240      30.0
      PCUR     120.2     0.000      30.0
      PROF    3
      PCUR       0.0     0.655      60.0
      PCUR      20.2     0.555      60.0
      PCUR      40.2     0.450      60.0
      PCUR      80.2     0.365      60.0
      PCUR     117.2     0.240      60.0
      PCUR     120.2     0.000      60.0
      PROF    4
      PCUR       0.0     0.655      90.0
      PCUR      20.2     0.555      90.0
      PCUR      40.2     0.450      90.0
      PCUR      80.2     0.365      90.0
      PCUR     117.2     0.240      90.0
      PCUR     120.2     0.000      90.0
      PROF    5
      PCUR       0.0     0.655     120.0
      PCUR      20.2     0.555     120.0
      PCUR      40.2     0.450     120.0
      PCUR      80.2     0.365     120.0
      PCUR     117.2     0.240     120.0
      PCUR     120.2     0.000     120.0
      PROF    1
      PCUR       0.0     0.655       0.0
      PCUR      20.2     0.555       0.0
      PCUR      40.2     0.450       0.0
      PCUR      80.2     0.365       0.0
      PCUR     117.2     0.240       0.0
      PCUR     120.2     0.000       0.0
      PROF    6
      PCUR       0.0     0.655     150.0
      PCUR      20.2     0.555     150.0
      PCUR      40.2     0.450     150.0
      PCUR      80.2     0.365     150.0
      PCUR     117.2     0.240     150.0
      PCUR     120.2     0.000     150.0
      PROF    7
      PCUR       0.0     0.655     180.0
      PCUR      20.2     0.555     180.0
```

```
      PCUR      40.2      0.450      180.0
      PCUR      80.2      0.365      180.0
      PCUR     117.2      0.240      180.0
 END  PCUR     120.2      0.000      180.0
          LOAD
 END  CASE    1    1    1       2.0       0.0
          ASGN
      OMIT  501  502  503  504  505  506  507  508
      OMIT  509  510  511  512  513  514  515  516
      QUAD    1
      TUBE  162    0     12.70      12.70       1.0       1.0
      TUBE  159    0     12.70      12.70       1.0       1.0
      TUBE  156    0     12.70      12.70       1.0       1.0
      TUBE  153    0     12.70      12.70       1.0       1.0
      TUBE  150    0     12.84      12.70       1.0       1.0
      TUBE  147    0     13.30      12.84       1.0       1.0
      TUBE  144    0     13.95      13.30       1.0       1.0
      TUBE  141    0     14.61      13.95       1.0       1.0
      TUBE  138    0     15.26      14.61       1.0       1.0
      TUBE  135    0     16.07      15.26       1.0       1.0
      TUBE  132    0     16.87      16.07       1.0       1.0
      TUBE  129    0     17.68      16.87       1.0       1.0
      TUBE  126    0     18.48      17.68       1.0       1.0
      TUBE  123    0     19.29      18.48       1.0       1.0
      TUBE  120    0     20.09      19.29       1.0       1.0
      TUBE  117    0     20.90      20.09       1.0       1.0
      OMIT  101  102  103  104  105  106  107  108
      OMIT  109  110  111  112  113  114  115  116
      QUAD    1    2
      TUBE  160    0     12.70      12.70       1.0       1.0
      TUBE  157    0     12.70      12.70       1.0       1.0
      TUBE  154    0     12.70      12.70       1.0       1.0
      TUBE  151    0     12.70      12.70       1.0       1.0
      TUBE  148    0     12.84      12.70       1.0       1.0
      TUBE  145    0     13.30      12.84       1.0       1.0
      TUBE  142    0     13.95      13.30       1.0       1.0
      TUBE  139    0     14.61      13.95       1.0       1.0
      TUBE  136    0     15.26      14.61       1.0       1.0
      TUBE  133    0     16.07      15.26       1.0       1.0
      TUBE  130    0     16.87      16.07       1.0       1.0
      TUBE  127    0     17.68      16.87       1.0       1.0
      TUBE  124    0     18.48      17.68       1.0       1.0
      TUBE  121    0     19.29      18.48       1.0       1.0
      TUBE  118    0     20.09      19.29       1.0       1.0
      TUBE  115    0     20.90      20.09       1.0       1.0
      OMIT  501  502  503  504  505  506  507  508
      OMIT  509  510  511  512  513  514  515  516
      QUAD    2
      TUBE  161    0     12.70      12.70       1.0       1.0
      TUBE  158    0     12.70      12.70       1.0       1.0
      TUBE  155    0     12.70      12.70       1.0       1.0
      TUBE  152    0     12.70      12.70       1.0       1.0
      TUBE  149    0     12.84      12.70       1.0       1.0
      TUBE  146    0     13.30      12.84       1.0       1.0
      TUBE  143    0     13.95      13.30       1.0       1.0
      TUBE  140    0     14.61      13.95       1.0       1.0
      TUBE  137    0     15.26      14.61       1.0       1.0
      TUBE  134    0     16.07      15.26       1.0       1.0
      TUBE  131    0     16.87      16.07       1.0       1.0
      TUBE  128    0     17.68      16.87       1.0       1.0
      TUBE  125    0     18.48      17.68       1.0       1.0
      TUBE  122    0     19.29      18.48       1.0       1.0
      TUBE  119    0     20.09      19.29       1.0       1.0
 END  TUBE  116    0     20.90      20.09       1.0       1.0
Stop
```

Figure 5 - 7: AQWA-WAVE Steering File Model T1667 (t1667aqw.dat)

```
SYSTEM DATA AREA  1000000
JOB NEW LINE
PROJECT MIKE
TITLE AQWAWAVE VERIFICATION                                T1668AQW.DAT 18/11/99
TEXT  ***********************************************************************
TEXT  CREATED 18/11/99
TEXT  MODIFIED 08/06/04 - FREE FORMAT DATA
TEXT  ALT1668.DAT  AQWALINE ANALYSIS
TEXT  T1668AQW.DAT AQWAWAVE DATA FILE
TEXT  T1668AS1.DAT ASAS COMPONENT MODEL - UPPER SHAFT
TEXT  T1668AS2.DAT ASAS COMPONENT MODEL - LOWER SHAFT
TEXT  T1668AS3.DAT ASAS COMPONENT MODEL - SHAFT ASSEMBLY
TEXT  T1668AS4.DAT ASAS ASSEMBLY RUN - THREE LEGS (SHAFTS)
TEXT  NOTE THAT DATABASE FILES CREATED BY ALT1668.DAT MUST BE CHANGED TO AWT1668
TEXT  BEFORE RUNNING AQWAWAVE
TEXT  ***********************************************************************
EXTENSION inp
END
t1668as1.dat
t1668as2.dat
t1668as3.dat
t1668as4.dat
end
**********************************************************************
*
*   Project:        Fixed Concrete Structure Analysis
*   Run Title:      AQWA-WAVE Test Run No 15
*   Models Used:    AQWA-LINE Model + ASAS Brick Model
*   Description:    Transfers loads from AQWA-LINE for 1 wave case
*                   Drag loads calculated.
*
*   Frequency       19.0 secs
*   Direction       0 degrees
*   Phase           315 degrees
*
*   Units:          Gg m s
*
**********************************************************************
aqwaid awt1668 fixd
          CURR
      PROF    1
      PCUR       0.0     0.655       0.0
      PCUR      20.2     0.555       0.0
      PCUR      40.2     0.450       0.0
      PCUR      80.2     0.365       0.0
      PCUR     117.2     0.240       0.0
      PCUR     120.2     0.000       0.0
      PROF    2
      PCUR       0.0     0.655      30.0
      PCUR      20.2     0.555      30.0
      PCUR      40.2     0.450      30.0
      PCUR      80.2     0.365      30.0
      PCUR     117.2     0.240      30.0
      PCUR     120.2     0.000      30.0
      PROF    3
      PCUR       0.0     0.655      60.0
      PCUR      20.2     0.555      60.0
      PCUR      40.2     0.450      60.0
      PCUR      80.2     0.365      60.0
      PCUR     117.2     0.240      60.0
      PCUR     120.2     0.000      60.0
      PROF    4
      PCUR       0.0     0.655      90.0
      PCUR      20.2     0.555      90.0
      PCUR      40.2     0.450      90.0
      PCUR      80.2     0.365      90.0
      PCUR     117.2     0.240      90.0
      PCUR     120.2     0.000      90.0
      PROF    5
      PCUR       0.0     0.655     120.0
      PCUR      20.2     0.555     120.0
      PCUR      40.2     0.450     120.0
      PCUR      80.2     0.365     120.0
      PCUR     117.2     0.240     120.0
      PCUR     120.2     0.000     120.0
      PROF    6
      PCUR       0.0     0.655     150.0
      PCUR      20.2     0.555     150.0
      PCUR      40.2     0.450     150.0
      PCUR      80.2     0.365     150.0
      PCUR     117.2     0.240     150.0
```

```
      PCUR     120.2     0.000     150.0
      PROF    7
      PCUR       0.0     0.655     180.0
      PCUR      20.2     0.555     180.0
      PCUR      40.2     0.450     180.0
      PCUR      80.2     0.365     180.0
      PCUR     117.2     0.240     180.0
 END  PCUR     120.2     0.000     180.0
          LOAD
 END  CASE    1    1    1      20.0     315.0
*          FELM
*       AXIS
* END
          ASGN
      QUAD    1    2
      OMIT  101  102  103  104  105  106  107  108
      OMIT  109  110  111  112  113  114  115  116
      COMP LEGS SHF1 SHUP
      RING   11         12.200    12.200       1.0       1.0       0.0       0.0
 :                     20.0000    0.0000    138.80   20.0000    0.0000    136.50
      RING   10         12.200    12.200       1.0       1.0       0.0       0.0
 :                     20.0000    0.0000    136.50   20.0000    0.0000    133.70
      RING    9         12.200    12.200       1.0       1.0       0.0       0.0
 :                     20.0000    0.0000    133.70   20.0000    0.0000    130.20
      RING    8         12.200    12.200       1.0       1.0       0.0       0.0
 :                     20.0000    0.0000    130.20   20.0000    0.0000    126.70
      RING    7         12.200    12.200       1.0       1.0       0.0       0.0
 :                     20.0000    0.0000    126.70   20.0000    0.0000    123.73
      RING    6         12.200    12.200       1.0       1.0       0.0       0.0
 :                     20.0000    0.0000    123.73   20.0000    0.0000    121.13
      RING    5         12.200    12.200       1.0       1.0       0.0       0.0
 :                     20.0000    0.0000    121.13   20.0000    0.0000    118.00
      RING    4         12.200    12.200       1.0       1.0       0.0       0.0
 :                     20.0000    0.0000    118.00   20.0000    0.0000    114.50
      RING    3         12.200    12.200       1.0       1.0       0.0       0.0
 :                     20.0000    0.0000    114.50   20.0000    0.0000    111.00
      RING    2         12.200    12.200       1.0       1.0       0.0       0.0
 :                     20.0000    0.0000    111.00   20.0000    0.0000    108.50
      RING    1         12.200    12.200       1.0       1.0       0.0       0.0
 :                     20.0000    0.0000    108.50   20.0000    0.0000    107.00
      COMP LEGS SHF1 SHLO
      RING   16         12.200    12.228       1.0       1.0       0.0       0.0
 :                     20.0000    0.0000    107.00   20.0000    0.0000    105.50
      RING   15         12.228    12.372       1.0       1.0       0.0       0.0
 :                     20.0000    0.0000    105.50   20.0000    0.0000    103.25
      RING   14         12.372    12.800       1.0       1.0       0.0       0.0
 :                     20.0000    0.0000    103.25   20.0000    0.0000    100.00
      RING   13         12.800    13.290       1.0       1.0       0.0       0.0
 :                     20.0000    0.0000    100.00   20.0000    0.0000     96.75
      RING   12         13.290    13.780       1.0       1.0       0.0       0.0
 :                     20.0000    0.0000     96.75   20.0000    0.0000     93.50
      RING   11         13.780    14.270       1.0       1.0       0.0       0.0
 :                     20.0000    0.0000     93.50   20.0000    0.0000     90.25
      RING   10         14.270    14.760       1.0       1.0       0.0       0.0
 :                     20.0000    0.0000     90.25   20.0000    0.0000     87.00
      RING    9         14.760    15.334       1.0       1.0       0.0       0.0
 :                     20.0000    0.0000     87.00   20.0000    0.0000     83.50
      RING    8         15.334    15.910       1.0       1.0       0.0       0.0
 :                     20.0000    0.0000     83.50   20.0000    0.0000     80.00
      RING    7         15.910    16.526       1.0       1.0       0.0       0.0
 :                     20.0000    0.0000     80.00   20.0000    0.0000     76.25
      RING    6         16.526    17.180       1.0       1.0       0.0       0.0
 :                     20.0000    0.0000     76.25   20.0000    0.0000     72.25
      RING    5         17.180    17.880       1.0       1.0       0.0       0.0
 :                     20.0000    0.0000     72.25   20.0000    0.0000     68.00
      RING    4         17.880    18.454       1.0       1.0       0.0       0.0
 :                     20.0000    0.0000     68.00   20.0000    0.0000     64.50
      RING    3         18.454    19.028       1.0       1.0       0.0       0.0
 :                     20.0000    0.0000     64.50   20.0000    0.0000     61.00
      RING    2         19.028    19.520       1.0       1.0       0.0       0.0
 :                     20.0000    0.0000     61.00   20.0000    0.0000     58.00
      RING    1         19.520    19.934       1.0       1.0       0.0       0.0
 :                     20.0000    0.0000     58.00   20.0000    0.0000     55.00
      QUAD    2
      OMIT  501  502  503  504  505  506  507  508
      OMIT  509  510  511  512  513  514  515  516
      COMP LEGS SHF3 SHUP
      RING   11         12.200    12.200       1.0       1.0       0.0       0.0
 :                    -10.0000  -17.3205    138.80  -10.0000  -17.3205    136.50
      RING   10         12.200    12.200       1.0       1.0       0.0       0.0
 :                    -10.0000  -17.3205    136.50  -10.0000  -17.3205    133.70
```

```
     RING    9         12.200    12.200       1.0       1.0       0.0       0.0
 :                    -10.0000  -17.3205    133.70  -10.0000  -17.3205    130.20
     RING    8         12.200    12.200       1.0       1.0       0.0       0.0
 :                    -10.0000  -17.3205    130.20  -10.0000  -17.3205    126.70
     RING    7         12.200    12.200       1.0       1.0       0.0       0.0
 :                    -10.0000  -17.3205    126.70  -10.0000  -17.3205    123.73
     RING    6         12.200    12.200       1.0       1.0       0.0       0.0
 :                    -10.0000  -17.3205    123.73  -10.0000  -17.3205    121.13
     RING    5         12.200    12.200       1.0       1.0       0.0       0.0
 :                    -10.0000  -17.3205    121.13  -10.0000  -17.3205    118.00
     RING    4         12.200    12.200       1.0       1.0       0.0       0.0
 :                    -10.0000  -17.3205    118.00  -10.0000  -17.3205    114.50
     RING    3         12.200    12.200       1.0       1.0       0.0       0.0
 :                    -10.0000  -17.3205    114.50  -10.0000  -17.3205    111.00
     RING    2         12.200    12.200       1.0       1.0       0.0       0.0
 :                    -10.0000  -17.3205    111.00  -10.0000  -17.3205    108.50
     RING    1         12.200    12.200       1.0       1.0       0.0       0.0
 :                    -10.0000  -17.3205    108.50  -10.0000  -17.3205    107.00
     COMP LEGS SHF3 SHLO
     RING   16         12.200    12.228       1.0       1.0       0.0       0.0
 :                    -10.0000  -17.3205    107.00  -10.0000  -17.3205    105.50
     RING   15         12.228    12.372       1.0       1.0       0.0       0.0
 :                    -10.0000  -17.3205    105.50  -10.0000  -17.3205    103.25
     RING   14         12.372    12.800       1.0       1.0       0.0       0.0
 :                    -10.0000  -17.3205    103.25  -10.0000  -17.3205    100.00
     RING   13         12.800    13.290       1.0       1.0       0.0       0.0
 :                    -10.0000  -17.3205    100.00  -10.0000  -17.3205     96.75
     RING   12         13.290    13.780       1.0       1.0       0.0       0.0
 :                    -10.0000  -17.3205     96.75  -10.0000  -17.3205     93.50
     RING   11         13.780    14.270       1.0       1.0       0.0       0.0
 :                    -10.0000  -17.3205     93.50  -10.0000  -17.3205     90.25
     RING   10         14.270    14.760       1.0       1.0       0.0       0.0
 :                    -10.0000  -17.3205     90.25  -10.0000  -17.3205     87.00
     RING    9         14.760    15.334       1.0       1.0       0.0       0.0
 :                    -10.0000  -17.3205     87.00  -10.0000  -17.3205     83.50
     RING    8         15.334    15.910       1.0       1.0       0.0       0.0
 :                    -10.0000  -17.3205     83.50  -10.0000  -17.3205     80.00
     RING    7         15.910    16.526       1.0       1.0       0.0       0.0
 :                    -10.0000  -17.3205     80.00  -10.0000  -17.3205     76.25
     RING    6         16.526    17.180       1.0       1.0       0.0       0.0
 :                    -10.0000  -17.3205     76.25  -10.0000  -17.3205     72.25
     RING    5         17.180    17.880       1.0       1.0       0.0       0.0
 :                    -10.0000  -17.3205     72.25  -10.0000  -17.3205     68.00
     RING    4         17.880    18.454       1.0       1.0       0.0       0.0
 :                    -10.0000  -17.3205     68.00  -10.0000  -17.3205     64.50
     RING    3         18.454    19.028       1.0       1.0       0.0       0.0
 :                    -10.0000  -17.3205     64.50  -10.0000  -17.3205     61.00
     RING    2         19.028    19.520       1.0       1.0       0.0       0.0
 :                    -10.0000  -17.3205     61.00  -10.0000  -17.3205     58.00
     RING    1         19.520    19.934       1.0       1.0       0.0       0.0
 :                    -10.0000  -17.3205     58.00  -10.0000  -17.3205     55.00
     QUAD    1
     OMIT  501  502  503  504  505  506  507  508
     OMIT  509  510  511  512  513  514  515  516
     COMP LEGS SHF5 SHUP
     RING   11         12.200    12.200       1.0       1.0       0.0       0.0
 :                    -10.0000   17.3205    138.80  -10.0000   17.3205    136.50
     RING   10         12.200    12.200       1.0       1.0       0.0       0.0
 :                    -10.0000   17.3205    136.50  -10.0000   17.3205    133.70
     RING    9         12.200    12.200       1.0       1.0       0.0       0.0
 :                    -10.0000   17.3205    133.70  -10.0000   17.3205    130.20
     RING    8         12.200    12.200       1.0       1.0       0.0       0.0
 :                    -10.0000   17.3205    130.20  -10.0000   17.3205    126.70
     RING    7         12.200    12.200       1.0       1.0       0.0       0.0
 :                    -10.0000   17.3205    126.70  -10.0000   17.3205    123.73
     RING    6         12.200    12.200       1.0       1.0       0.0       0.0
 :                    -10.0000   17.3205    123.73  -10.0000   17.3205    121.13
     RING    5         12.200    12.200       1.0       1.0       0.0       0.0
 :                    -10.0000   17.3205    121.13  -10.0000   17.3205    118.00
     RING    4         12.200    12.200       1.0       1.0       0.0       0.0
 :                    -10.0000   17.3205    118.00  -10.0000   17.3205    114.50
     RING    3         12.200    12.200       1.0       1.0       0.0       0.0
 :                    -10.0000   17.3205    114.50  -10.0000   17.3205    111.00
     RING    2         12.200    12.200       1.0       1.0       0.0       0.0
 :                    -10.0000   17.3205    111.00  -10.0000   17.3205    108.50
     RING    1         12.200    12.200       1.0       1.0       0.0       0.0
 :                    -10.0000   17.3205    108.50  -10.0000   17.3205    107.00
     COMP LEGS SHF5 SHLO
     RING   16         12.200    12.228       1.0       1.0       0.0       0.0
 :                    -10.0000   17.3205    107.00  -10.0000   17.3205    105.50
     RING   15         12.228    12.372       1.0       1.0       0.0       0.0
```

```
 :                     -10.0000   17.3205    105.50  -10.0000   17.3205    103.25
      RING   14          12.372   12.800      1.0       1.0       0.0       0.0
 :                     -10.0000   17.3205    103.25  -10.0000   17.3205    100.00
      RING   13          12.800   13.290      1.0       1.0       0.0       0.0
 :                     -10.0000   17.3205    100.00  -10.0000   17.3205     96.75
      RING   12          13.290   13.780      1.0       1.0       0.0       0.0
 :                     -10.0000   17.3205     96.75  -10.0000   17.3205     93.50
      RING   11          13.780   14.270      1.0       1.0       0.0       0.0
 :                     -10.0000   17.3205     93.50  -10.0000   17.3205     90.25
      RING   10          14.270   14.760      1.0       1.0       0.0       0.0
 :                     -10.0000   17.3205     90.25  -10.0000   17.3205     87.00
      RING    9          14.760   15.334      1.0       1.0       0.0       0.0
 :                     -10.0000   17.3205     87.00  -10.0000   17.3205     83.50
      RING    8          15.334   15.910      1.0       1.0       0.0       0.0
 :                     -10.0000   17.3205     83.50  -10.0000   17.3205     80.00
      RING    7          15.910   16.526      1.0       1.0       0.0       0.0
 :                     -10.0000   17.3205     80.00  -10.0000   17.3205     76.25
      RING    6          16.526   17.180      1.0       1.0       0.0       0.0
 :                     -10.0000   17.3205     76.25  -10.0000   17.3205     72.25
      RING    5          17.180   17.880      1.0       1.0       0.0       0.0
 :                     -10.0000   17.3205     72.25  -10.0000   17.3205     68.00
      RING    4          17.880   18.454      1.0       1.0       0.0       0.0
 :                     -10.0000   17.3205     68.00  -10.0000   17.3205     64.50
      RING    3          18.454   19.028      1.0       1.0       0.0       0.0
 :                     -10.0000   17.3205     64.50  -10.0000   17.3205     61.00
      RING    2          19.028   19.520      1.0       1.0       0.0       0.0
 :                     -10.0000   17.3205     61.00  -10.0000   17.3205     58.00
      RING    1          19.520   19.934      1.0       1.0       0.0       0.0
 :                     -10.0000   17.3205     58.00  -10.0000   17.3205     55.00
 END
Stop
```

Figure 5 - 8: AQWA-WAVE Steering File Model T1668 (t1668aqw.dat)

```
SYSTEM DATA AREA   4000000
JOB NEW COMP
PROJECT MIKE
COMPONENT C001
FILES C001
TITLE AQWAWAVE VERIFICATION                               T1668AS1.DAT 18/11/99
TEXT  **************************************************************************
TEXT  CREATED 18/11/99
TEXT  ALT1668.DAT  AQWALINE ANALYSIS
TEXT  T1668AQW.DAT AQWAWAVE STEERING FILE
TEXT  AWT1668.DAT  AQWAWAVE HYDRODYNAMIC TRANSFER DATA
TEXT  T1668AS1.DAT ASAS COMPONENT MODEL - UPPER SHAFT
TEXT  T1668AS2.DAT ASAS COMPONENT MODEL - LOWER SHAFT
TEXT  T1668AS3.DAT ASAS COMPONENT MODEL - SHAFT ASSEMBLY
TEXT  T1668AS4.DAT ASAS ASSEMBLY RUN - THREE LEGS (SHAFTS)
TEXT  NOTE THAT DATABASE FILES CREATED BY ALT1668.DAT MUST BE CHANGED TO AWT1668
TEXT  BEFORE RUNNING AQWAWAVE
TEXT  **************************************************************************
TEXT WRITTEN BY FEMGEN TO ASAS TRANSLATOR VERSION 10.14
TEXT TIME:   9:24    DATE:  14/ 9/  92
OPTIONS GOON NOBL NODL PRNO FDMS BODY
PASS 1
WARN 1
SAVE FEMM FILES
END
*-------------------------------------------------
COOR
CART
        1   0.000000E+00     5.60000         107.000
        2    2.14303         5.17373         107.000
        3    3.95980         3.95980         107.000
        4    5.17373         2.14303         107.000
        5    5.60000        0.000000E+00     107.000
        6   0.000000E+00     5.60000         108.500
        7    2.14303         5.17373         108.500
        8    3.95980         3.95980         108.500
        9    5.17373         2.14303         108.500
       10    5.60000        0.000000E+00     108.500
.
.
.
     1568    2.87552        -5.37972         138.800
     1569    1.77074        -5.83734         138.800
     1570   0.597905        -6.07063         138.800
     1571    1.14128        -5.73759         138.800
     1572    2.23870        -5.40470         138.800
     1573    3.25009        -4.86410         138.800
     1574    3.25009        -4.86410         137.650
     1575    2.23870        -5.40470         137.650
     1576    1.14128        -5.73759         137.650
END
*-------------------------------------------------
ELEM
GROU      1
MATP     11
BR20       1      11       2      16       7      20       6      15      51      50
:         54      53      24      34      25      39      30      43      29      38
:          1
BR20       2      12       3      17       8      21       7      16      50      49
:         55      54      25      35      26      40      31      44      30      39
:          2
BR20       3      13       4      18       9      22       8      17      49      48
:         56      55      26      36      27      41      32      45      31      40
:          3
BR20       4      14       5      19      10      23       9      18      48      47
:         52      56      27      37      28      42      33      46      32      41
:          4
.
.
.
BR20    1466    1503    1494    1549    1538    1546    1535    1541    1486    1528
:       1573    1574    1476    1523    1514    1567    1556    1564    1553    1559
:        205
BR20    1535    1546    1538    1550    1539    1547    1536    1544    1574    1573
:       1572    1575    1553    1564    1556    1568    1557    1565    1554    1562
:        206
BR20    1536    1547    1539    1551    1540    1548    1537    1545    1575    1572
:       1571    1576    1554    1565    1557    1569    1558    1566    1555    1563
:        207
```

```
BR20    1537   1548   1540   1552   1150   1160   1119   1543   1576   1571
:       1191   1143   1555   1566   1558   1570   1172   1182   1131   1561
:        208
END
*-------------------------------------------------
MATE
    1 ISO    30000.      0.20000      0.10000E-04  0.25000E-02
    2 ISO    30000.      0.20000      0.10000E-04  0.25000E-02
    3 ISO    30000.      0.20000      0.10000E-04  0.25000E-02
    4 ISO    30000.      0.20000      0.10000E-04  0.25000E-02
    5 ISO    30000.      0.20000      0.10000E-04  0.25000E-02
    6 ISO    30000.      0.20000      0.10000E-04  0.25000E-02
    7 ISO    30000.      0.20000      0.10000E-04  0.25000E-02
    8 ISO    30000.      0.20000      0.10000E-04  0.25000E-02
    9 ISO    30000.      0.20000      0.10000E-04  0.25000E-02
   10 ISO    30000.      0.20000      0.10000E-04  0.25000E-02
   11 ISO    30000.      0.20000      0.10000E-04  0.25000E-02
END
*-------------------------------------------------
LINK
*
* 138.8 AB
*
ALL  379  398  357  394  372
ALL  380  402  358  395  373
ALL  381  401  359  396  374
ALL  382  400  360  397  375
ALL  383  399  361  442  422
.
.
.
ALL  474  495  454  482  462
ALL  475  494  455  483  463
ALL  476  493  456  484  464
END
 LOAD     2
*********
CASE    1 'TOTAL DEAD WEIGHT                       '
BODY FOR
    0.000000E+00   0.000000E+00   -9.81000
END
CASE 1000 'AQWA SURFACE DEFINITION                 '
PRESSURE
U     1.00000         24     25     30
U     1.00000         25     26     31
U     1.00000         26     27     32
U     1.00000         27     28     33
U     1.00000         29     30     72
.
.
.
U     1.00000       1339    963    991
U     1.00000        174   1360   1383
U     1.00000       1360   1361   1384
U     1.00000       1361   1362   1385
U     1.00000       1362    991   1019
END
*-------------------------------------------------
STOP
```

Figure 5 - 9: ASAS Component (Upper Shaft) File Model T1668 (t1668as1.dat)

```
SYSTEM DATA AREA   4000000
JOB OLD COMP
PROJECT MIKE
COMPONENT C002
FILES C002
TITLE AQWAWAVE VERIFICATION                               T1668AS2.DAT 18/11/99
TEXT  ***************************************************************************
TEXT  CREATED 18/11/99
TEXT  ALT1668.DAT  AQWALINE ANALYSIS
TEXT  T1668AQW.DAT AQWAWAVE STEERING FILE
TEXT  AWT1668.DAT  AQWAWAVE HYDRODYNAMIC TRANSFER DATA
TEXT  T1668AS1.DAT ASAS COMPONENT MODEL - UPPER SHAFT
TEXT  T1668AS2.DAT ASAS COMPONENT MODEL - LOWER SHAFT
TEXT  T1668AS3.DAT ASAS COMPONENT MODEL - SHAFT ASSEMBLY
TEXT  T1668AS4.DAT ASAS ASSEMBLY RUN - THREE LEGS (SHAFTS)
TEXT  NOTE THAT DATABASE FILES CREATED BY ALT1668.DAT MUST BE CHANGED TO AWT1668
TEXT  BEFORE RUNNING AQWAWAVE
TEXT  ***************************************************************************
TEXT WRITTEN BY FEMGEN TO ASAS TRANSLATOR VERSION 10.14
TEXT TIME:  12:35    DATE:  14/ 9/  92
OPTIONS GOON NOBL NODL PRNO FDMS BODY
PASS 1
WARN 1
SAVE FEMM FILES
END
*-------------------------------------------------
COOR
CART
        1    9.21300        0.000000E+00     55.7500
        2    8.51170         3.52566         55.7500
        3    9.22688         1.21474         54.5000
        4    8.98939         2.40870         54.5000
        5    9.40000        0.000000E+00     53.2500
        6    9.31958         1.22694         53.2500
        7    9.07970         2.43290         53.2500
        8    8.68447         3.59722         53.2500
        9    9.03597         1.79737         55.7500
       10    9.23992        0.605616         55.1250
.
.
.

     2280   -4.31830        -4.31830         106.250
     2281   -5.64213        -2.33705         106.250
     2282   -1.19005        -5.98279         107.000
     2283   -3.38898        -5.07196         107.000
     2284   -5.07196        -3.38898         107.000
     2285   -5.98279        -1.19005         107.000
     2286   -2.23870        -5.40470         107.000
     2287   -4.13657        -4.13657         107.000
     2288   -5.40470        -2.23870         107.000
END
*-------------------------------------------------
ELEM
GROU      1
MATP     16
BR20        1      10       3      12       4      11       2       9      44      45
:          46      43      20      29      22      31      23      30      21      28
:           1
BR20        1      13       5      17       6      14       3      10      44      42
:          41      45      20      32      24      36      25      33      22      29
:           2
BR20        3      14       6      18       7      15       4      12      45      41
:          40      46      22      33      25      37      26      34      23      31
:           3
.
.
.

BR20     2243    2250    2244    2270    2267    2273    2266    2269    2263    2264
:        2287    2286    2253    2260    2254    2280    2277    2283    2276    2279
:         302
BR20     2244    2251    2245    2271    2268    2274    2267    2270    2264    2265
:        2288    2287    2254    2261    2255    2281    2278    2284    2277    2280
:         303
BR20     2245    2252    1172    1204    1200    2275    2268    2271    2265    1196
:        1224    2288    2255    2262    1184    1216    1212    2285    2278    2281
:         304
```

```
END
*-------------------------------------------------
MATE
    1 ISO    30000.      0.20000      0.10000E-04  0.25000E-02
    2 ISO    30000.      0.20000      0.10000E-04  0.25000E-02
    3 ISO    30000.      0.20000      0.10000E-04  0.25000E-02
    4 ISO    30000.      0.20000      0.10000E-04  0.25000E-02
    5 ISO    30000.      0.20000      0.10000E-04  0.25000E-02
    6 ISO    30000.      0.20000      0.10000E-04  0.25000E-02
    7 ISO    30000.      0.20000      0.10000E-04  0.25000E-02
    8 ISO    30000.      0.20000      0.10000E-04  0.25000E-02
    9 ISO    30000.      0.20000      0.10000E-04  0.25000E-02
   10 ISO    30000.      0.20000      0.10000E-04  0.25000E-02
   11 ISO    30000.      0.20000      0.10000E-04  0.25000E-02
   12 ISO    30000.      0.20000      0.10000E-04  0.25000E-02
   13 ISO    30000.      0.20000      0.10000E-04  0.25000E-02
   14 ISO    30000.      0.20000      0.10000E-04  0.25000E-02
   15 ISO    30000.      0.20000      0.10000E-04  0.25000E-02
   16 ISO    30000.      0.20000      0.10000E-04  0.25000E-02
END
*-------------------------------------------------
LINK
ALL    7  623  639  625  641  627 1785 1773
ALL 1787 1775 2277 2267 1212 1200 1214 1202
ALL  144  128  105   89   66   50
ALL   24    5 1287 1271 1324 1308
ALL 1361 1345 1859 1843 1896 1880
ALL  791  775  752  736  713  697
END
 LOAD     2
*********
CASE    1 'TOTAL DEAD WEIGHT                      '
BODY FOR
    0.000000E+00   0.000000E+00   -9.81000
END
CASE 1000 'AQWA SURFACE DEFINITION                '
PRESSURE
U     1.00000        139    101    176
U     1.00000        101     63    177
U     1.00000         63     21    178
U     1.00000         21     20    179
U     1.00000        175    176    209
U     1.00000        176    177    210
.
.
.
U     1.00000       1282   1285   1286
U     1.00000       1283   1286   1287
U     1.00000       1284   1287   1247
U     1.00000       1244   1245   1246
U     1.00000       1244   1247   1248
U     1.00000       1245   1248   1249
U     1.00000       1246   1249     24
END
*-------------------------------------------------
STOP
```

Figure 5 - 10: ASAS Component (Lower Shaft) File Model T1668 (t1668as2.dat)

```
SYSTEM DATA AREA 4000000
JOB OLD COMP
PROJECT MIKE
COMPONENT SHFT
FILES SHFT
OPTIONS GOON
TITLE AQWAWAVE VERIFICATION                               T1668AS3.DAT 18/11/99
TEXT  **************************************************************************
TEXT  CREATED 18/11/99
TEXT  ALT1668.DAT  AQWALINE ANALYSIS
TEXT  T1668AQW.DAT AQWAWAVE STEERING FILE
TEXT  AWT1668.DAT  AQWAWAVE HYDRODYNAMIC TRANSFER DATA
TEXT  T1668AS1.DAT ASAS COMPONENT MODEL - UPPER SHAFT
TEXT  T1668AS2.DAT ASAS COMPONENT MODEL - LOWER SHAFT
TEXT  T1668AS3.DAT ASAS COMPONENT MODEL - SHAFT ASSEMBLY
TEXT  T1668AS4.DAT ASAS ASSEMBLY RUN - THREE LEGS (SHAFTS)
TEXT  NOTE THAT DATABASE FILES CREATED BY ALT1668.DAT MUST BE CHANGED TO AWT1668
TEXT  BEFORE RUNNING AQWAWAVE
TEXT  **************************************************************************
PASS 1
SAVE FEMM FILES
END
*
* TOPOLOGY DECK
*
TOPO
*
* TOP SHAFT
*
ORIG   0.0000   0.0000   0.0000
C001 SHUP
*
* BOTTOM SHAFT
*
ORIG   0.0000   0.0000   0.0000
C002  SHLO
END
*
* LINK DECK WRITTEN BY ASASLINK
*
STOP
```

Figure 5 - 11: ASAS Assembly (Shaft) File Model T1668 (t1668as3.dat)

```
SYSTEM DATA AREA 4000000
PROJECT MIKE
JOB OLD LINE
TITLE AQWAWAVE VERIFICATION                                T1668AS4.DAT 18/11/99
TEXT  **************************************************************************
TEXT  CREATED 18/11/99
TEXT  ALT1668.DAT  AQWALINE ANALYSIS
TEXT  T1668AQW.DAT AQWAWAVE STEERING FILE
TEXT  AWT1668.DAT  AQWAWAVE HYDRODYNAMIC TRANSFER DATA
TEXT  T1668AS1.DAT ASAS COMPONENT MODEL - UPPER SHAFT
TEXT  T1668AS2.DAT ASAS COMPONENT MODEL - LOWER SHAFT
TEXT  T1668AS3.DAT ASAS COMPONENT MODEL - SHAFT ASSEMBLY
TEXT  T1668AS4.DAT ASAS ASSEMBLY RUN - THREE LEGS (SHAFTS)
TEXT  NOTE THAT DATABASE FILES CREATED BY ALT1668.DAT MUST BE CHANGED TO AWT1668
TEXT  BEFORE RUNNING AQWAWAVE
TEXT  **************************************************************************
STRUCTURE LEGS
FILES LEGS
OPTIONS GOON
PASS 1
SAVE FEMM FILES
END
*
TOPO
*
* SHAFT 1
*
ORIG  20.0000   0.0000   0.0000
SHFT SHF1
*
* SHAFT 3
*
ORIG -10.0000 -17.3205   0.0000
SHFT SHF3
*
* SHAFT 5
*
ORIG -10.0000  17.3205   0.0000
SHFT SHF5
END
STOP
```

Figure 5 - 12: ASAS Assembly (Three legs) File Model T1668 (t1668as4.dat)

Appendix A. OLD DATA REQUIREMENTS

This chapter describes the form in which data is expected by AQWA-WAVE prior to Version 14.03.

The data required for running AQWA-WAVE is split into three data sets:

1. A data file providing information about the ASAS™ project and the constituent ASAS and AQWA™ files to be processed. This is the file submitted to AQWA-WAVE and which references the following data.
2. A data file giving information about the load generation that is to be undertaken from the AQWA model defined.
3. ASAS input files containing the structural model assembly to be loaded.

A.1 Information file

The input file in AQWA-WAVE must include

- The project name of the ASAS model to be processed.
- The names of the ASAS data file(s) that constitute(s) the complete structural assemblage.
- The identifier used for the AQWA model database and load generation data file.

Other optional input data to AQWAWAVE can include

- The amount of computer memory to be used in the assembly process.
- Extension to be used for the generated file names.

A.1.1 Overall Data Structure

```
SYSTEM DATA AREA memory
JOB NEW LINE
PROJECT pname
OPTIONS option
EXTENSION ext
END
AQWAID aqwaid
filename
STOP
```

A.1.1.1.1 EXTENSION Command

This command specifies the file extensions used when outputting the new data files.

EXTE extension

Parameters

EXTE keyword

extension three letter extension

Note

The new data files are formed using **extension**. If omitted, the new data files will have extension 'dat'. This must not conflict with the extension of the original data files.

A.1.2 AQWA Identifier Information

This defines the identifier associated with the AQWA model databases and the wave load generation data file. This command is compulsory,

`AQWAID aqwaid`

Parameters

`AQWAID` Keyword
`aqwaid` Name of the AQWA model to be processed. This is the name associated with the .RES file generated by AQWA-LINE. Alpha-numeric, up to 8 characters.

Note:

The wave load generation data file (see A.2) should use the name given by `aqwaid`, appended with `.dat`. Similarly the model database files (`.res, .pot` and `.uss`) must use the name given by `aqwaid.`

Example

`AQWAID awsemisb`

This will result in the program searching for the following files:

`awsemisb.dat` Wave load generation file
`awsemisb.res` Restart database files
`awsemisb.pot`
`awsemisb.uss`

A.1.3 ASAS File Information

The remainder of the AQWA-WAVE data file consists of one or more ASAS data file names, which define the structural model to be loaded.

`filename`

Parameters

`filename` Name of a file residing in the current directory containing ASAS data pertaining to the structural analysis (alphanumeric, up to 32 characters).

Notes

5. All the files required for a substructure assembly must be provided. The order in which they are supplied is immaterial.
6. The data file names need to be provided in the correct case on machines that are case sensitive.

A.2 AQWA Wave load generation file

The data is divided into units of related information called decks. Each deck is composed of a deck identifier and a number of data input strings written in card image format.

A.2.1 Administration Control - Deck 0 - Preliminary Deck

This deck is always required when performing AQWA program analysis runs. The information input relates directly to the administration of the job being done and the control of the AQWA program being used.

Program control has the following functions:

- Identification of the program to be used within the AQWA suite.
- The type of program analysis to be performed (ie. if choice exists).

Administration of the analysis being performed:

- User title identification given to the analysis.
- Choice of output required from program run (ie. program options).

The above information is input to the program through the following cards contained within Deck 0:

JOB card	-	this contains information stating the program to be used, the type of program analysis to be undertaken, and the user identifier for the run in question;
TITLE card	-	this lets the user prescribe a title for the run;
OPTIONS card	-	various program options are available within the AQWA suite, some of which are common to all programs, others of which are for use with specific programs. The options for AQWA-WAVE control the type of output required from the program;
RESTART card	-	specifies the restart stages of the analysis to be performed.

A.2.2 Deck 0 - Preliminary Control Deck

The function of this deck is to define the overall administration parameters of the analysis. This includes the type of analysis (JOB card), various options (OPTIONS card) controlling facilities, printing, etc., and the post-processor restart (RESTART card).

A.2.2.1The JOB Card

Position	Format	Description
1-3	A3	Compulsory Card Header
5-8	A4	User Defined Job Identifier (see 1. below)
11-14	A4	Program Name (see 2. below)
17-20	A4	Analysis Type (see 3. below)

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

JOB UDJI  WAVE
```

1. The 4-letter code is for the convenience of the user and is not used by the program.
2. An abbreviation of the program name must be input to specify the overall data input format to be expected by the program. If left blank or the incorrect name is input, the program will output an error message and abort after the preliminary deck has been read.
   For the AQWA-WAVE post-processor, the expected abbreviation is WAVE.
3. The analysis type must be entered as FIXD for a fixed structure and left blank for a floating structure.

A.2.2.2The TITLE Card

Position	Format	Description
1-5		Compulsory Card Header
21-54	A4	Title to be used for Annotation of Results

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

TITLE               THIS IS A TITLE OF THE PROGRAM RUN
```


A.2.2.3 The OPTIONS Card

Position	Format	Description
1-7		Compulsory Card Header
9-80	(1X,A4)	One or More OPTIONS, separated by single spaces (see 1. below)

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

OPTIONS REST OPT2 END
```

1. The options list MUST include the restart (REST) option. The other valid options are:

PRDL	-	PRint Data List from the restart file;
STAT	-	add STATic pressures.

A.2.2.4 The RESTART Card

Position	Format	Description
1-7		Compulsory Card Header
11	I1	Start stage (see 1. below)
14	I1	Finish stage (see 1. below)

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

RESTART   7  7
```

1. The start and finish stages for AQWA-WAVE must be both 7.

A.2.3 Deck 31 (CURR) - Current Definition

This deck contains information on current profiles for combination with wave particle kinematics.

A.2.3.1Deck Header

Position	Format	Description
5-6	A2	Optional User Identifier
11-14	A4	Compulsory Card Header

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
----------------------------------------------------------------------------------
          CURR
```

A.2.3.2The Profile Creation (PROF) Card

Position	Format	Description
5-6	A2	Optional User Identifier
7-10	A4	Compulsory Card Header
11-15	I5	Profile Identifier (see 1. below)

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
----------------------------------------------------------------------------------
      PROF
```

3. The profile identifier is referenced by the LOAD deck on successive CASE cards. The profile is defined by successive PCUR cards until the next PROF card, or the end of the deck.

Up to ten profiles can be created in each run of AQWA-WAVE.

A.2.3.3 The Point Current Values (PCUR) Card

Position	Format	Description
2-4	A3	Compulsory End on last card in deck only
5-6	A2	Optional User Identifier
7-10	A4	Compulsory Card Header
11-20	F10.0	Depth (see 1. below)
21-30	F10.0	Velocity (see 2. below)
31-40	F10.0	Direction (see 3. below)

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

 END  PCUR
```

5. The depth is measured downwards from SWL. Values of velocity and direction are linearly interpolated between depths. Depths should be strictly increasing on successive cards.
6. The velocities are always horizontal, in the direction and at the depth specified.
7. The direction is measured in degrees, positive in the sense of moving from the AQWA global X-axis to the AQWA global Y-axis.

Up to ten point current values may be specified for each profile.

A.2.4 Deck 32 (LOAD) - Load Case Data

A.2.4.1 Deck Header

This deck specifies which load cases from AQWA-LINE are required to be transferred to the structural model.

Position	Format	Description
5-6	A2	Optional User Identifier
11-14	A4	Compulsory Deck Header

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

          LOAD
```

A.2.4.2The CASE Card (At Least One Compulsory)

Position	Format	Description
2-4	A3	Compulsory END on last card in deck only
5-6	A2	Optional User Identifier
7-10	A4	Compulsory Card Header
11-15	I5	Current Profile (see 1. below)
16-20	I5	Wave Frequency Number (see 2. below)
21-25	I5	Wave Heading Number (see 3. below)
26-35	F10.0	Wave Height (see 4. below)
36-45	F10.0	Wave Phase (see 5. below)

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

 END  CASE
```

7. The current profile number references profiles set up in Deck 31.
8. The wave frequency number is defined in Deck 6 of the preceding AQWA-LINE run and identifies the particular wave frequency to which the floating body is subjected.
9. The wave heading direction number is defined in Deck 6 of the preceding AQWA-LINE run and identifies the heading angle of the wave relative to the AQWA global X-axis.

   NB: Wave cases must be ordered, first by frequency number (increasing), and then by direction number (increasing).

10. Note that wave height, not wave amplitude, is input. The default of the height of the wave is unity.
11. The wave phase is in degrees. A positive phase defines a wave whose crest passed over the structure centre of gravity (T * phase/360) seconds ago, where T is the wave period.

A.2.4.3The Load Case Offset (LCOF) Card

This card is (optionally) used to add an offset to the load case numbers produced by AQWA-WAVE. (The default offset is 1000.) This allows the user to create further load cases, by running AQWA-WAVE again, without creating duplicate load case numbers. (The output .DAT files from the previous AQWA-WAVE run must first be renamed as .NWL)

Position	Format	Description
2-4	A3	Compulsory END on last card in deck only
5-6	A2	Optional User Identifier
7-10	A4	Compulsory Card Header
11-15	I5	Load Case Offset (see 1. below)

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

 END  LCOF
```

1. The offset which is to be added to load case numbers produced by AQWA-WAVE.

For example, if the load case offset is specified as 2000, then the first load case produced by AQWA-WAVE will be load case number 2001.

A.2.5 Deck 33 (FELM) - Finite Element Program Information

This deck controls the information pertaining to the particular finite element program with which the post-processor is to be linked.

A.2.5.1Deck Header

Position	Format	Description
5-6	A2	Optional User Identifier
11-14	A4	Compulsory Deck Header

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

          FELM
```

A.2.5.2The AXIS Card

The AXIS card is only required if the co-ordinate system used to define the AQWA structure (in Deck 1) is not identical to the top level ASAS co-ordinate system.

Position	Format	Description
5-6	A2	Optional User Identifier
7-10	A4	Compulsory Card Header
11-40	3F10.0	Vector Co-ordinates to the FE Structural Axis Origin from the AQWA Structural Axis Origin (see 1. below)
41-70	3F10.0	Rotation of the FE Structural Axes from the AQWA Structural Axes (see 2. below)

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

        AXIS    XTRANS    YTRANS    ZTRANS      XROT      YROT      ZROT
```

1. The translation of the origin of the FE structural axis system from the origin of the AQWA fixed reference axes (used to define the AQWA structure in Deck 1), in AQWA length units.
2. The rotations of the FE structural axes from the AQWA fixed reference axes, in degrees. The rotations are applied in the order roll, pitch, yaw (where roll, pitch and yaw are defined as rotations about the AQWA fixed reference axes).

A.2.5.3The FEPG Card

Position	Format	Description
5-6	A2	Optional User Identifier
7-10	A4	Compulsory Card Header
12-15	A4	Finite Element Package to be linked with (see 1. below)

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

        FEPG NAME
```

1. The abbreviations used in ‘NAME’ for the finite element packages are:

ASAS	-	ASAS (default);
ANSY	-	ANSYS®;
NAST	-	NASTRAN® (not yet available);
SESAM	-	SESAM® (not yet available).

A.2.5.4 The FILE Card

This command is no longer used by AQWAWAVE, but should be provided with a blank field.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
 END  FILE
```

A.2.5.5The Scale (SCAL) Card

This card is only required if the ASAS length units are different from the AQWA length units.

The scale (SCAL) card is used to instruct AQWA-WAVE to multiply the ASAS coordinates by a scale factor, in order to convert them from ASAS length units to AQWA length units.

Position	Format	Description
2-4	A3	Compulsory END on last card in deck only
5-6	A2	Optional User Identifier
7-10	A4	Compulsory Card Header
11-20	F10.0	Scale Factor (see 1. below)

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
 END  SCAL
```

1. The scale factor, which is used to multiply the ASAS co-ordinates, in order to convert them from ASAS length units to AQWA length units.

For example, if the ASAS units were feet and the AQWA units were metres, then the appropriate scale factor would be 0.3048.

A.2.5.6The UNIT Card

This card is only required if the units used in ASAS and AQWA are different.

The UNIT card is used to instruct AQWA-WAVE to output an ASAS UNITS command, at the beginning of each load data block, to define the AQWA units being used.

The items entered on the AQWA UNIT card, to define the units, must conform to the ASAS rules for defining units on an ASAS UNITS command.

Position	**Format**	**Description**
2-4	A3	Compulsory END on last card in deck only
5-6	A2	Optional User Identifier
7-10	A4	Compulsory Card Header
12-60	A49	Units used in AQWA (see 1. below)

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
 END  UNIT
```

1. The units used in AQWA, specified according to the ASAS rules for an ASAS UNITS command.

For example, if the AQWA force and length units were Newtons and metres, then the AQWA UNIT card would be

UNIT N m

in order to produce an ASAS UNITS command

UNITS N m

Note: If a UNIT card is used in the AQWA-WAVE data, then each ASAS master component file which has loads written to it by AQWA-WAVE must contain a UNITS command in the preliminary data, to define the ASAS units being used. Otherwise, ASAS will not know how to convert the data.

A.2.6 Deck 34 (ASGN) - Assignment Deck

This deck defines the correlation between the AQWA and the FE model data and allows hydrodynamic coefficients to be assigned to FE elements.

This deck is not needed if the user simply wants to transfer pressures to a shell or brick model, and does not wish to calculate additional drag loads. (In this case, the user should simply code NONE for the Deck Header, see below.)

The TUBE, NODE and RING cards allow coefficients to be set for selected nodes, elements or groups of elements in the FE model. Since the FE model may be a component analysis, the component to which this data must be applied must also be specified. This is achieved by COMP cards. Once a component has been selected, it remains current for subsequent data until a new COMP card is given. At the start of the deck, the top level structure is assumed current. No COMP card is therefore needed for a single-shot analysis.

QUAD cards are used to define which quadrants (or halves) of a symmetric AQWA model are currently selected. As AQWA element groups are numbered only in the definition quadrant, the use of the QUAD card allows the user to reference corresponding element groups in other quadrants.

OMIT cards are used ONLY if the user wishes to calculate drag loads on large, cylindrically symmetrical, AQWA components, which have already been modelled in AQWA-LINE by means of PLATE elements.

The OMIT card effectively defines an AQWA component by specifying all the AQWA element groups which constitute it. (In general, QUAD cards will also be needed to fully specify the component.) The component remains selected, and loads can be calculated for sections of it, using TUBE or RING cards (see below), until another AQWA component is defined. It should be noted that an AQWA component may correspond to more than one ASAS component (defined on COMP cards).

The purpose of the OMIT card is to instruct the program to OMIT all the hydrodynamic sources associated with the elements of the component, when calculating drag loads (see Section 2.4.2).

OMIT and QUAD cards may be interspersed as required in the data. Several OMIT cards can be specified to provide a long list of groups. OMIT cards are only cumulative in this way when they are consecutive in the data. When separated by other cards, only the selections on the latest card are applied. Thus, an OMIT card on its own with no parameters would revert to using the whole AQWA model, the default at the start of the deck. Groups of OMIT cards continue to apply to successive data until a further group is specified.

A.2.6.1Deck Header

Position	Format	Description
5-6	A2	Optional User Identifier
11-14	A4	Compulsory Deck Header

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

          ASGN
```

A.2.6.2The Component Selection (COMP) Card

Position	**Format**	**Description**
5-6	A2	Optional User Identifier
7-10	A4	Compulsory Card Header
11-80	12 (1X,A4)	Up to 10 Assembled Component Names (see 1. below)

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

      COMP
```

3. The assembled component names define a ‘branch’ down the component tree for subsequent data to refer to. The branch can be up to ten names long, but will often be shorter. The first name in the lists must be the final structure name, with each successive assembled component name being a valid substructure of the last.

The COMP card remains valid until another appears in the data. At the start of the deck, the global structure is assumed. Care should be taken not to refer to one component twice in the deck, as only the first occurrence will be used.

A.2.6.3The QUADrant Definition Card

Position	Format	Description
5-6	A2	Optional User Identifier
7-10	A4	Compulsory Card Header
11-30	4I5	Up to 4 Quadrant Numbers (see 1. below)

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

      QUAD
```

2. Up to four quadrant numbers may be specified. These are designated 1 to 4. For a singly symmetric structure, only halves 1 and 2 are available. If symmetry has not been used, only one quadrant is defined.

   Quadrant 1 is always the modelled quadrant and quadrant 2 is the mirror of this for singly symmetric structures. For doubly-symmetric models, the following is the case:

   Quadrant 2 is the mirror of the model about the Y-axis;
   Quadrant 3 is the mirror of the model about the X-axis;
   Quadrant 4 is the diagonally opposite quadrant.

   All subsequent AQWA-LINE group definitions on OMIT, NODE, RING and TUBE cards will refer to the selected quadrant or quadrants until another QUAD card appears to redefine this. At the start of the deck, all possible quadrants are active.

A.2.6.4The OMIT Group Card

Position	FormatDescription	
5-6	A2	Optional User Identifier
7-10	A4	Compulsory Card Header
11-80	14I5	Up to 14 AQWA-LINE Group Numbers (see 1. below)

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

      OMIT
```

4. Up to 14 groups may be specified on this card. If more are needed to be omitted, they can be specified on subsequent, consecutive OMIT cards. The group specified as being OMITted will remain so until a further OMIT card or group of cards is given.

   OMIT cards are used to specify the AQWA element groups which make up the AQWA component (eg. GBS shaft), on sections of which the user wishes drag loads to be calculated. Subsequent TUBE and RING cards relate to this component. The element groups specified are OMITted in the calculation of fluid flow. The AQWA-WAVE program is thus able to calculate the correct effective flow 'seen by' the TUBE and RING sections, as required by Morison's equation. If the user does not OMIT these groups, then the diffracted component of the flow calculated by the program will be erroneous.

   Note that the OMIT cards only define that part of the AQWA component which is in the definition quadrant. QUAD cards may also be needed to define the complete component.

A.2.6.5The NODE Data Card

Position	Format	Description
2-4	A3	Compulsory END on last card in deck only
5-6	A2	Optional User Identifier
7-10	A4	Compulsory Card Header
11-15	I5	FE Model Node Number (see 1. below)
16-20	I5	AQWA-LINE Group Number (see 2. below)

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

  END NODE
```

2. This is the FE node number to which incident and diffracted wave forces from the AQWA-LINE facets will be transferred. Six degrees of freedom are currently assumed at this node so that the moment about the point can also be generated.
3. This is the AQWA group number that defines the facets whose forces will be transferred to the FE node.

A.2.6.6The TUBE Data Card

Position	Format	Description
2-4	A3	Compulsory END on last card in deck only
5-6	A2	Optional User Identifier
7-10	A4	Compulsory Card Header
11-15	I5	FE Tube or Beam Element Number (see 1. below)
16-20	I5	AQWA Element Group (see 2. below)
21-40	2F10.0	Diameters (see 3. below)
41-60	2F10.0	Drag Coefficients (see 4. below)
61-80	2F10.0	Inertia Coefficients (see 5. below)

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

 END  TUBE
```

5. This is the FE user element number to which this data applies. The element on the currently selected component will be loaded.
6. This is the group of AQWA facets associated with this element. The groups relate to all selected quadrants. Incident/diffracted forces on the selected groups of facets will be summed and applied as global distributed loads to the selected element. This group may be blank or zero if incident/diffracted forces are not required on this element. Note that, in general, the inertia coefficients should be zero if the incident/diffracted forces are transferred, as both relate to the same effect.
7. These are the diameters at the first and second end of the element in question. They may be different and may differ from the structural diameter (for marine growth, for instance).
8. Drag coefficients (C_d) apply to each end of the element.
9. Inertia coefficients (C_m) apply to each end of the element.
   Note that $C_m = C_a + 1$, where C_a is the added mass coefficient.

A.2.6.7The RING Data Cards

First Card

Position	Format	Description
5-6	A2	Optional User Identifier
7-10	A4	Compulsory Card Header
11-15	I5	FE Group (see 1. below)
21-40	2F10.0	Diameters (see 2. below)
41-60	2F10.0	Drag Coefficients (see 3. below)
61-80	2F10.0	Inertia Coefficients (see 4. below)

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

        RING
```

Second Card

Position	Format	Description
2-4	A3	Compulsory End on last card in deck only
5-6	A2	Optional User Identifier
21-50	3F10.0	X,Y,Z of First End (see 5. below)
51-80	3F10.0	X,Y,Z of Second End (see 6. below)

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

   END
```

5. The FE group number for the elements that form a ring (or part ring) in the FE model. Elements for the currently selected component alone are considered. It is possible to select part of a ring in one component, and other parts later.
6. Diameters at each end of the ring axis. See TUBE card.
7. Drag coefficients (C_d) at each end of the ring axis. See TUBE card.
8. Inertia coefficients (C_m) at each end of the ring axis. These would normally be zero, as inertia loads would be provided by incident/diffracted forces except above the SWL. Where provided, they are defined by
   $C_m = C_a + 1$.
   If a RING is above the SWL and on which inertia and drag loads are to be calculated and transferred to ASAS, the faces on this RING should then be defined in load case 1000 as if they are on the wetted faces. The wave pressures from AQWA will not be transferred to these nodes when their z co-ordinate is greater than zero.
9. Co-ordinates of first end of the axis of the ring, in AQWA structural axes (as defined in AQWA Deck 1).
10. Co-ordinates of second end, as (5).

A.2.6.8Sample Assignment Deck

The following is an example of an ASGN deck for AQWA-WAVE:

```
        ASGN
    TUBE    1          1.20      1.20      0.7       0.7       1.5       1.5
    TUBE    3          1.20      1.20      0.7       0.7       1.5       1.5
    TUBE    5          1.25      1.25      0.7       0.7       1.5       1.5
    COMP STRC CMP1
    OMIT    3    4    5    6
    NODE   95    4
    TUBE  162    3     5.90      6.15      1.0       1.0       0.0       0.0
    TUBE   71    5     5.65      5.90      1.0       1.0       0.0       0.0
    COMP STRC CMP1 HALF LEFT
    QUAD    1
    OMIT   10   11   12   13   14   15
    RING  111          6.15      6.40      1.0       1.0       0.0       0.0
                      15.00     15.00     79.00     15.00     15.00     74.00
    RING  112          6.40      6.65      1.0       1.0       0.0       0.0
                      15.00     15.00     74.00     15.00     15.00     69.00
    RING  113          6.65      6.80      1.0       1.0       0.0       0.0
 END                  15.00     15.00     69.00     15.00     15.00     64.00
```

The first three TUBE cards assign diameters, drag and mass coefficients to beam type elements in the final structure, the default at the start of the data. The members are not represented in the AQWA-LINE run by facets, as the AQWA group field is blank. Inertia coefficients are supplied instead.

A lower level component is then selected, CMP1, a component of STRC. Forces from AQWA group 4 are assigned to node 95 and two further tubes are loaded, this time taking incident/diffracted forces from AQWA groups and having no inertia forces.

Finally, a much lower level component is selected and quadrant 1 (perhaps the unmirrored half?) selected. After omitting several AQWA groups from this quadrant, three rings (groups 111, 112 and 113) are defined and will be loaded.

Appendix B NEUTRAL FILE FORMATS

The hydrodynamic and structural data required by AQWA-WAVE may be specified in neutral format files. In this mode, data are provided via two free format ASCII neutral files, one for the hydrodynamic related information, and a second for the structural (FE) data. These will be divided into a series of data blocks, each delimited by a header. Details of each data block are described below. The results of the load mapping are written to a separate file.

B.1 Neutral Hydrodynamic Input File

B.1.1 Model title

This enables the user to input a descriptive text for the model.

```
TITLE description
```

Parameters

`TITLE`	keyword
`description`	Up to 72 character description of the model

B.1.2 Hydrodynamic surface geometry

The hydrodynamic surface geometry provides information related to the panel definition of the model. As with AQWA allowance is made for symmetric models.

```
HYDR
length gravity
symx symy
npanels
x1(1) y1(1) z1(1) x2(1) y2(1) z2(1) x3(1) y3(1) z3(1) x4(1) y4(1) z4(1)
.
.
x1(npan) y1(npan) z1(npan) x2(1)  …  x4(npan) y4(npan) z4(npan)
```

Parameters

`HYDR`	keyword to denote start of hydrodynamic panel description
`length`	Non-dimensionalizing length unit, at this stage must be set to 1.0
`gravity`	Acceleration of gravity in analysis units
`symx`	Set to 1 if model has symmetry about body local x axis, otherwise 0
`symy`	Set to 1 if model has symmetry about body local y axis, otherwise 0
`npanels`	Number of panels to be defined
`xk(j)`	X coordinate for panel k, node j
`yk(j)`	Y coordinate for panel k, node j
`zk(j)`	Z coordinate for panel k, node j

Note

1. If a model contains no panel element (i.e. only Morison elements), then it is only required to specify length and gravity after the HYDR header.

2. The three coordinates of four nodes must always be input for each panel. Triangles are represented by allowing the coordinates of two adjacent nodes to coincide.

B.1.3 Wave periods

This defines the wave periods where hydrodynamic pressures have been computed.

```
PERD
nperd
period(1) period(2) ... period(i)
period(i+1) period(i+2) ... period(nperd)
```

Parameters

`PERD`	keyword to denote start of wave period data
`period(i)`	the ith wave period

The data may be specified in one or more lines until all the periods are entered.

B.1.4 Wave directions

This defines the wave directions where hydrodynamic pressures have been computed.

```
DIRN
ndirn
heading(1) heading(2) ... heading(i)
heading(i+1) heading(i+2) ... heading(ndirn)
```

Parameters

`DIRN`	keyword to denote start of wave direction data
`heading(i)`	the ith wave direction (degrees)

The data may be specified in one or more lines until all the directions are entered.

B.1.5 Panel pressures

This defines the pressures at the centroids of the panels defined above in the HYDR data. Data should be given for every panel for each wave period and direction specified.

```
PRES
Period heading    region panel magnitude phase real imaginary
```

Parameters

`PRES` keyword to denote start of hydrodynamic pressure values
`Period` wave period
`Heading` wave direction (degrees)
`Region` index for either quadrant or half
If two planes of symmetry (symx and symy set to 1)
    region 1 corresponds to +ve x +ve y
    region 2 corresponds to +ve x –ve y
    region 3 corresponds to –ve x –ve y
    region 4 corresponds to –ve x +ve y
If one plane of symmetry (symx or symy set to 1)

	region 1 corresponds to +ve x or y as appropriate region 2 corresponds to –ve x or y as appropriate
`panel`	panel number (must be between 1 and npanels)
`magnitude`	pressure amplitude
`phase`	associated phase angle (wrt to wave at CoG) (degrees)
`real`	real component of pressure
`imaginary`	imaginary component of pressure

Notes

1. The HYDR, PERD and DIRN data must be defined before the PRES data.
2. Period and Heading must correspond to the values specified in the PERD and DIRN data.
3. If no input pressure is given to a panel at a particular period and direction, the pressure on this panel will be assumed to be zero. If more than one set of pressures are defined, their effects will be cumulative, i.e. the real and imaginary parts of each set will be summed together.

B.1.6 Morison element hydrodynamic definition

This data describes the line elements used to provide slender body loading.

```
MORI
nmori
x1(1) y1(1) z1(1) x2(1) y2(1) z2(1)
.
.
x1(nmori) y1(nmori) z1(nmori) x2(nmori) y2(nmori) z2(nmori)
```

Parameters

`MORI`	keyword to denote start of Morison hydrodynamic element description
`Nmori`	number of Morison elements defined
`xk(j)`	X coordinate for line element k, node j
`yk(j)`	Y coordinate for line element k, node j
`zk(j)`	Z coordinate for line element k, node j

Note

1. A Morison element always consists of two nodes.

B.1.7 Morison element load definition

This data describes the element forces at the centroid of the Morison elements defined above. Loading is given as a force per unit length.

```
LINE
period heading element realx imagx realy imagy realz imagz
```

Parameters

`LINE`	keyword to denote start of Morison loading definition
`period`	wave period
`heading`	wave direction (degrees)
`element`	element number referencing the Morison element list
`real[xyz]`	real component of the element global force at the Morison element centroid
`imag[xyz]`	imaginary component of the element global force at the Morison element centroid

Notes

1. The HYDR, MORI, PERD and DIRN data must be defined before the LINE data.
2. Period and Heading must correspond to the values specified in the PERD and DIRN data.
3. If no input load is given to a Morison element at a particular period and direction, the loading on this element will be assumed to be zero. If more than one set of loads are defined, their effects will be cumulative, i.e. the real and imaginary parts of each set will be summed together.

B.1.8 Mass properties

This is required in order that the acceleration loads may be computed.

```
MASS
xcg ycg zcg
Mass(1,1) mass(1,2) .. mass(1,6)
.
.
Mass(6,1) mass(6,2) .. mass(6,6)
```

Parameters

`MASS`	keyword to denote start of mass information
`xcg ycg zcg`	X, Y and Z coordinate of CoG wrt to mean water level (as with AQWA™). X and Y are otherwise assumed to be in the vessel local axis set
`mass(j,k)`	mass matrix term

B.2 Neutral Structural Input File

B.2.1 Model title

This enables the user to input a descriptive text for the model.

```
TITLE description
```

Parameters

`TITLE`	keyword
`description`	Up to 72 character description of the model

B.2.2 Structural finite element description

This defines the points on the structural model to which the hydrodynamic loading is to be mapped. The loading may be applied to a node, an element centroid, or an element integration point, depending upon the target FE program. The mapping will be undertaken in the same way irrespective of the type of point which is being defined.

```
GEOM
npoints
x(1) y(1) z(1) position
.
.
x(npoints) y(npoints) z(npoints) position
```

Parameters

`GEOM`	keyword to denote start of FE geometry definition
`npoints`	number of data points being defined
`x(j)`	X coordinate for point j
`y(j)`	Y coordinate for point j
`z(j)`	Z coordinate for point j
`position`	data items identifying load position in the FE program (optional)

Note

1. The position data is always ignored, i.e. this will have no effect to the load mapping.

B.2.3 Structural line element description

This defines the points on the structural model to which the hydrodynamic loading on line elements is to be mapped. The loading may be applied to a node, an element centroid, or an element integration point, depending upon the target FE program. The mapping will be undertaken in the same way irrespective of the type of point which is being defined.

```
BEAM
npoints
x(1) y(1) z(1) position
.
.
x(npoints) y(npoints) z(npoints) position
```

Parameters

`BEAM`	keyword to denote start of line element structural definition
`npoints`	number of data points being defined
`x(j)`	X coordinate for point j
`y(j)`	Y coordinate for point j
`z(j)`	Z coordinate for point j
`position`	data items identifying load position in the FE program (optional)

Note

1. The position data is always ignored, i.e. this will have no effect to the load mapping.

B.3 Load Results File

The results of the mapping are to be written to a separate file. The format of this file is as follows.

B.3.1 Mapped pressures

This provides the pressure loading on panels in the model. Loading is defined in terms of the real and imaginary components or amplitude and phase.

```
PRES
period heading body point magnitude phase real imaginary
```

Parameters

`PRES`	keyword to denote start of hydrodynamic pressure values
`period`	wave period
`heading`	wave direction (degrees)
`body`	structure number associated with this model, always set to 1
`point`	point number as defined in the structural finite element data (must be between 1 and npoints)
`magnitude`	pressure amplitude
`phase`	associated phase angle (wrt to wave at CoG) (degrees)
`real`	real component of pressure
`imaginary`	imaginary component of pressure

B.3.2 Mapped line loads

These are the Morison element loads. The results will be in terms of real and imaginary loads at a point (either element centroid or integration point, or at a node). Loading is given as a force per unit length.

```
LINE
period heading body point realx imagx realy imagy realz imagz
```

Parameters

`LINE`	keyword to denote start of Morison loading definition
`period`	wave period
`heading`	wave direction (degrees)
`body`	structure number associated with this model, always set to 1
`point`	point number referencing the Morison element structural list
`real[xyz]`	real component of the element global force at the Morison element centroid
`imag[xyz]`	imaginary component of the element global force at the Morison element centroid

B.3.3 Acceleration loads about CoG

Six terms will be computed, the three linear accelerations and three angular accelerations.

```
ACCE
period heading body real imaginary
```

Parameters

`ACCE`	keyword to denote acceleration data
`period`	wave period
`heading`	wave direction (degrees)
`body`	structure number associated with this model, always set to 1
`real`	real component of the accelerations at the CoG.
`imaginary`	imaginary component of the accelerations at the CoG.

Note

1. The data line is defined six times for X, Y, Z, RX, RY, RZ accelerations

B.4 Sample AQWA-WAVE Data for Neutral Load Transfer

An example data file for neutral load transfer is shown below.

```
SYSTEM DATA AREA  1000000
```

```
JOB NEW LINE
PROJECT ansy
TITLE VERIFICATION FOR PARTIALLY SUBMERGED ELEMENTS
EXTENSION LOD
END
stru neut stru.fil
hydr neut hydr.fil
end
load
CASE    0     1    1       2.0       0.0
CASE    0     1    2       2.0       0.0
end
felm
fepg     neut
end
stop
```

In this example, the neutral hydrodynamic data is specified in a file called hydr.fil while the neutral structural data is in file stru.fil. Two wave cases will be considered and the load results will be written to a file called stru.lod (file extension LOD defined in the EXTENSION command).