Orcina SOFTWARE NEWS June 1990

NEW FEATURES, NEW PROGRAMS, AND MORE ON THE WAY

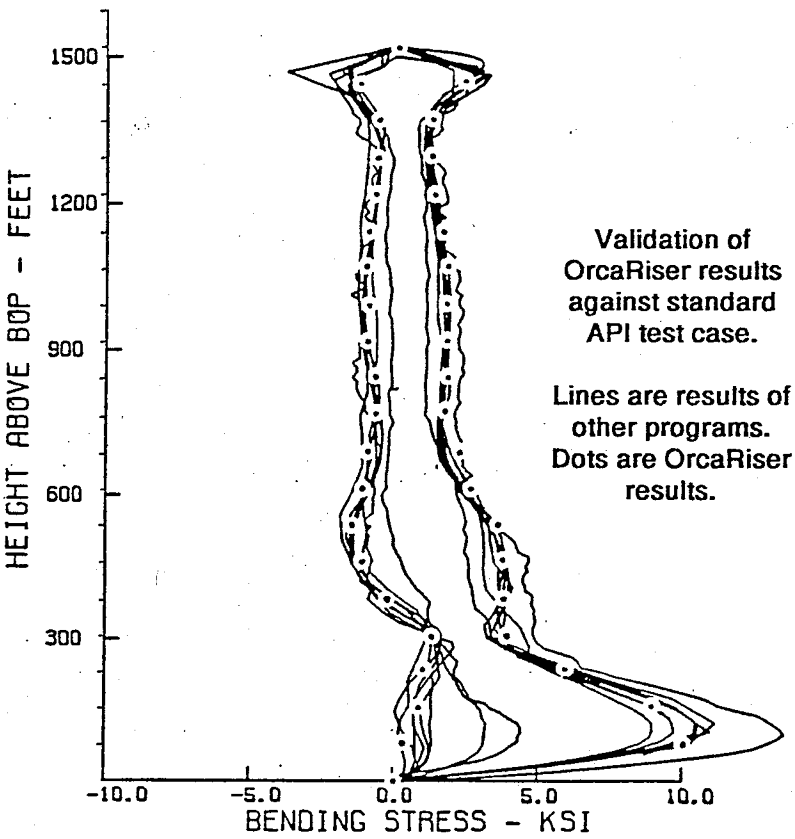
We've been pretty busy with developments over the last year, and not found as much time as we'd like to keep in touch with our clients. So this newsletter is to try to bring you up to date with what's new on the software front.

OrcaRiser Launched & On Trial

We have recently launched OrcaRiser, a time domain program for analysing tensioned risers. It has good facilities for modelling the riser end conditions, including detailed modelling of the tensioner system and incorporatng vessel motions where appropriate. Time domain analysis allows the inclusion of non-linear terms such as drag, and we also allow for differences in hydrodynamic properties in the principal riser directions.

OrcaRiser incorporates our new pseudo-random sea modeller (see page 3). If you share the general concern about predicting extreme values of a non-linear system, then this offers you an alternative approach which does not demand exorbitant run times.

Following its launch OrcaRiser has been under evaluation by BP, including comparison with mainframe programs.



Validation of OrcaRiser results against standard API test case.

Lines are results of other programs. Dots are OrcaRiser results.

We've been both developing our original programs - OrcaFlex, OrcaMotion and OrcaHose - and also writing several new ones. Several of the improvements benefit all our programs - in particular optimisation has given a major speed increase (eg OrcaFlex 4 is three times faster than OrcaFlex 3) and all our programs now offer a choice of CGA, EGA or VGA graphics (VGA gives especially attractive results).

As well as the speed increase, OrcaFlex now includes modelling of sloping seabeds and seabed friction (details on back page), and two new programs have been released - OrcaRiser for static and dynamic analysis of tensioned risers, and OrcaPull for simulating pipeline pull-in to a seabed termination. The packages are described in more detail in the boxes on this page and page 2.

Our most recent release is OrcaMoor. This program provides static analysis of an array of catenary moorings, including allowance for sloping seabeds, seabed friction, non-linear current drag and clump weights. As well as calculating the line positions and mooring loads for a given position of the moored vessel, OrcaMoor will calculate the equilibrium position of the vessel under given environmental load.

Call us if you want further details - or a demonstration disk - on any of our programs.

OrcaPull Launched At ASPECT-90

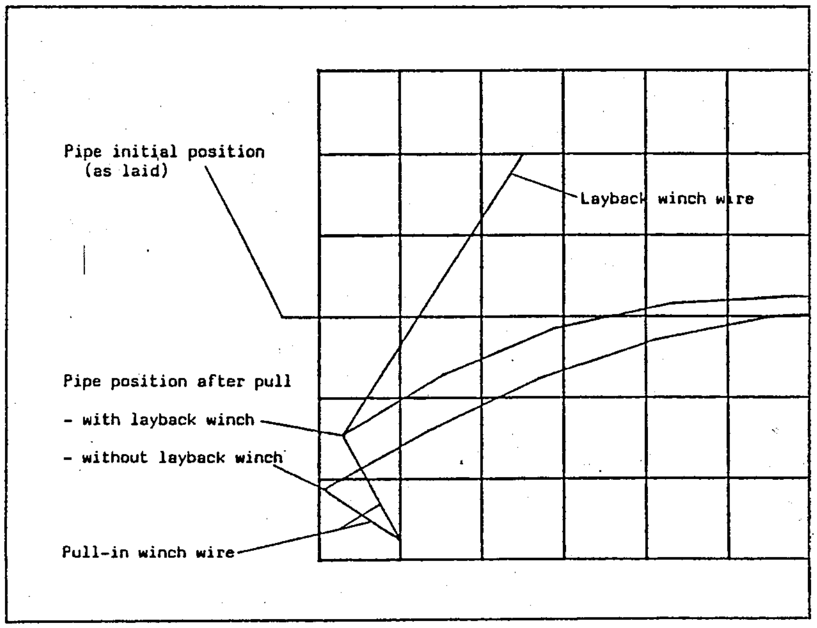
This new program is being launched at ASPECT '90, the SUT meeting on Pipeline Technology (Aberdeen 30-31 May). OrcaPull simulates the lateral pull-in of a pipe or cable across the sea bed, eg to a well head termination, using one or more winches. The program is interactive, and allows the engineer to develop a pull-in strategy progressively. At each stage of the operation, he can try alternative winch actions: select the most suitable: and proceed to the next stage. He can review the pull-in operation from the start, and backtrack to intermediate stages if the operation is going wrong. He can change the winch positions and re-run. Finally, he can document the complete operation in a form suitable for development as an installation procedure.

We think the program will appeal to the engineer who prefers to make his mistakes in private, on the desk top, rather than at sea. Straightening a buckled pipe is easier when it is still just a simulation!

Although the typical pull-in is a 2-D operation, the program is fully 3-D. We have exploited this to use the program for other tasks eg modelling the lift of a pipe or cable at a midpoint for repair.

OrcaPull runs quite fast, especially with a reduced axial stiffness model, and it might be practical to use it offshore in parallel with an actual pull-in operation, as a control procedure.

We have a demonstration disk available, and an interim descriptive leaflet - let us know if you would like more details.



OrcaPull plot illustrating the effect of adding a layback winch on the movement of the pipe. In this example, the pipe near the free end was assumed to be buoyed off the seabed under drag chain control.

OrcaFlex Validation

We have taken part in two intercomparisons of flexible riser programs. The first, a confidential exercise by Brasnor, concluded that ... 'there is no indication of major discrepancies between any of the programs'. Also in progress at present is an ISSC comparison, due for publication in 1991.

We have ourselves done a comparison of OrcaRiser results with the published API intercomparison. The results fall neatly on the mean line (see page 1): we will be pleased to show them to interested parties.

Custom Programs

Because of the very modular structure of our programs, we can efficiently produce customised programs, at almost off the shelf prices, by modifying the relevant modules. So if your problem doesn't fit the standard mould let us quote for developing a program tailored to your job.

An example is OrcaLift, a custom program developed for Subsea Intervention Systems Ltd (SISL). This is a derivative of OrcaFlex which models a multiline subsea system as it is lifted and tensioned from a moving ship. A general model of the tensioning winches is incorporated, and it became clear during preliminary work on this system that the strongly non-linear response, including snatching, demanded proper modelling in a random sea. This was the initial stimulus to develop our random wave module.

Random Sea Modelling

We have had several enquiries about random sea modelling in OrcaFlex and other programs. The first firm requirement arose in OrcaLift and we have since incorporated the random sea module into OrcaRiser. Implementation in other programs will follow as opportunity offers. Our approach differs from the usual ones in several respects and a brief description may be of general interest.

Random sea modelling is a difficult and confusing topic which quickly leads into areas such as the statistics of non-linear processes which are not well understood. It can also be very costly in computing effort with long run times and a need for extensive post-processing to reduce the results to manageable proportions. For many purposes, regular wave analysis is sufficient, and much easier to understand! However there are circumstances where random sea modelling is important. We have tried to produce a modelling technique which is efficient both in computing terms and in the demands it makes on the design engineer.

The requirement arises when we expect system response to, say, a single large wave in a train of smaller waves to differ significantly from response to one of a train of large waves. A system subject to snatch loading is a good example. Usually, we will be interested in maximum response to extreme sea conditions (eg extreme operating or maximum design seas).

The rigorous approach involves modelling the sea state as a Fourier series. To model, say, 1 hour of random sea at 0.5 second intervals requires 3600 Fourier components, each with randomly chosen amplitude and phase. All the properties of the sea state which are involved in the calculation of forces on the riser are then represented as time histories by Fast Fourier Transforms (FFTs). Separate FFTs are required for water surface elevation, riser head motions, and for wave particle velocity and acceleration in three directions at all points of interest. This calls for a 3-D array of FFTs within which we interpolate for wave kinematics at the instantaneous positions of the riser nodes. This is very heavy on computing and quite prohibitive on a PC.

We can reduce the computing load in two ways: use less wave components than the Fourier series, or simulate for a short time and extrapolate the results statistically. Both methods have problems. Reducing the number of wave components reduces the randomness of the sea state and leads to errors in the extreme values, precisely where the interest lies. Extrapolating from short runs is only possible by assuming system linearity.

Our approach is to identify and then simulate short sections of random sea which are likely to be of interest. From our understanding of the system being modelled, we may anticipate severe loads or violent motions in, say, particularly high or particularly steep waves, or perhaps in a short, steep wave following a relatively calm period. Using standard wave statistics we can quantify these criteria into specific load cases with known probability of occurrence. The software then provides facilities to scan quickly through the sea state and identify short sections which correspond to the required load cases. These short sections are then modelled in the time domain. For speed of computing, a relatively small number of wave components is used, not a full Fourier series. Since each simulation is of short duration the reduction in randomness is not important.

This approach to random sea modelling is unconventional but has several big advantages. It is easy to understand; it uses the engineer's intuitive knowledge of his system; and it simplifies the job of examining system behaviour in severe conditions. A further advantage is that the use of statistics to determine probabilities of occurrence is applied to the waves, not to the responses of a non-linear system.

Work on random seas is still at a preliminary stage and we would welcome any comments on the validity and usefulness of our approach. The present software modules are fully developed and tested but we would appreciate any feedback from potential users which could help us provide the most useful engineering design tool.

OrcaHose Improvements

OrcaHose users may have noticed that the program can only find one static solution to any hose configuration, although there are some combinations of geometry and pipe properties which should give more than one stable solution. A new development to the program allows the user to define an approximate configuration using a small number of coordinates. The program fits an initial splined shape to these user points, and then iterates to the nearest actual solution. For the rare multi-solution cases, you can now select the one you want by your choice of starting shape. You can also use the initial shape to speed up convergence in difficult cases.

We are offering the new feature to existing users for a nominal update fee.

Modelling of Seabed Friction and Sloping Seabeds

Two recent engineering design problems, where sea bed friction was critical to the system success, have led us to develop slope and friction modelling.

The first involved a flexible export line from a floating production system to an off-loading tanker for an extended well test. The client wished to avoid elaborate pipe installation and anchoring, and planned to rely on sea bed friction to hold the pipe in place against the imposed motions of the vessels coupled to each end. This system was analysed using an upgraded version of OrcaFlex 4, and the operation has since taken place successfully.

The second involved the installation of a single buoy mooring on a steeply sloping sea bed. The client was concerned about clashing between the flexible riser and the adjacent catenary mooring. Change in water depth across the site and friction near touchdown had significant effects on system behaviour.

Sea bed friction is also important in establishing anchor loads where a substantial amount of ground chain contributes to the anchoring capacity.

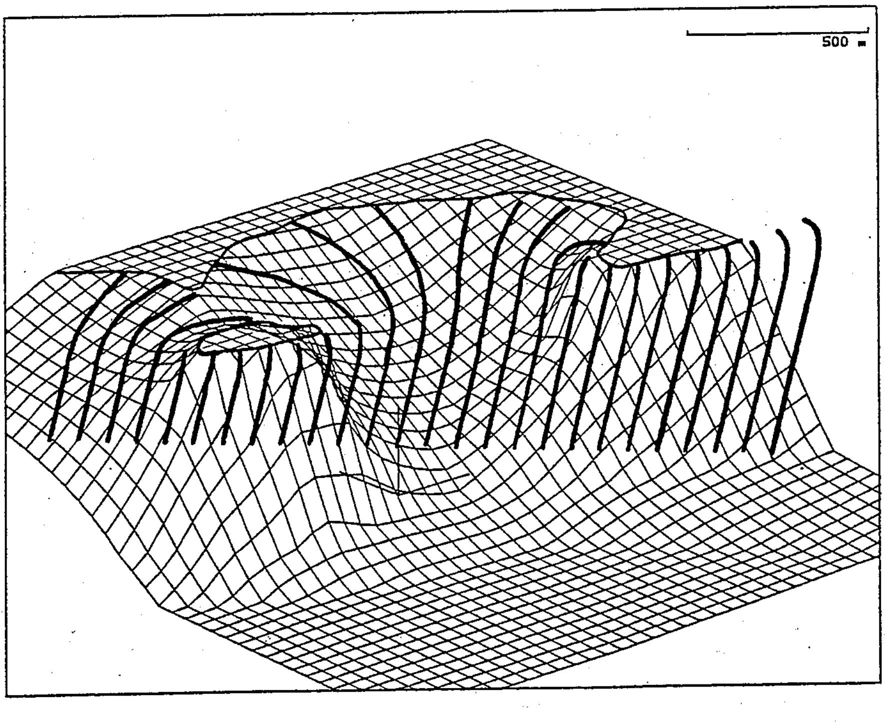
Sea bed friction creates an analytical/logical problem, in that the static position is no longer uniquely determined. We have found a reasonable approach to this, by asking the user to define the 'Laydown Direction' - ie the direction in which the line has been installed. The program then seeks equilibrium by allowing the smallest possible deviation from this initial configuration. This approach has the merit of shadowing the probable installation quite closely.

As a result of this work, we can now offer sea bed friction and sloping sea beds as an upgrade to OrcaFlex 4.

Coastal Wave Refraction

Recent work for the aquaculture industry has encouraged us to write our own inshore wave refraction program, OrcaWave. At present it is in-house only, but we are proud of it and especially of its graphics presentation. It uses the inward ray tracing method, and includes bottom friction and wave breaking effects.

The major task of entering the sea bed bathymetry is approached in two alternative ways: a grid of spot depths, or a contour entry. We generally favour the latter, as it reduces dramatically the number of data points to be entered, and gives a smoother result.



OrcaWave plot of bathymetry and refraction pattern

For details of our software products call or fax us on 0229 54742.

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