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MEMO

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Release Notes USFOS Version 7.4

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Members of USFOS User Group		x	x	

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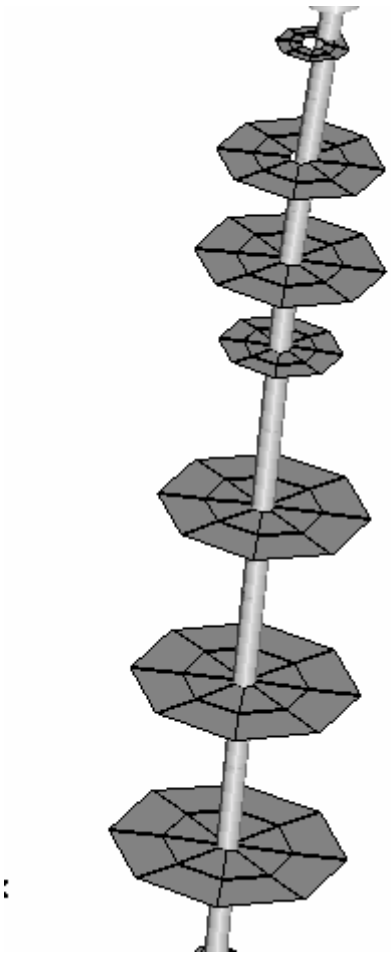
1. Development Activities

1.1. Improved pile/soil interaction

In the analysis of fixed offshore structures a proper modelling of the interaction between soil and structure, both the static and dynamic case, is of major importance. The purpose of this activity was to improve the models for soil-structure interaction. To simplify the user input of the pile geometry and soil properties, a specific pre-processing function is implemented in USFOS. This saves the user from defining the detailed geometry of the pile-spring model.



The soil-pile interface material behaviour, i.e. the spring characteristics is implemented according to a general plasticity formulation. The model is 3-dimensional in the sense that both lateral and axial springs are applied to each node.

The user defines the soil characteristics for each soil layer by P-Y, T-Z and Q-Z curves. With this information, combined with the user's definition of the pile location, type (single or group) and dimensions (diameter and thickness), USFOS generates finite elements (beam and spring). The size of this foundation model varies from approx. 100 - 1000 elements depending on number of piles and number of soil layers.

In XFOS the pile is visualized with discs representing the soil behaviour at the different levels, and the size of the discs reflects the relative strength of the soil. Both soil deformations and utilization are visualized.

By default the 'old' spring model is used. The new spring model is activated by the command:

```
SPRI_MOD  1
```

written in the USFOS control file. Note that this new soil-spring element **does not scale the steps**, and it is then recommended to use small steps and/or iterations (ITMAX=1 is sufficient in most cases).

1.2. Streamlining between SESAM and USFOS

To reduce the time needed for preparing an USFOS structural file based on a 'linear' structural file, ***internal hinges*** defined with the SESAM command BELFIX is handled automatically by USFOS. The internal hinges are accounted for by releasing the actual force components at element level. Only *fully fixed* or *fully released* are possible options. The user may access this option through the special USFOS command BEAMHING as well.

By releasing the degrees of freedom at element level, non-linear geometrical effects are accounted for when the axial degree of freedom and for bending about local Y- and Z-axis are released. However, this option should be used with care, especially in connection with release of shear force transfer.

Intentionally it was planned to include node-to-node linear dependency, but this is an option which may cause problems in connection with non-linear analyses because the reference system is changing as the structure deforms. The initial linear dependency coefficients may become more and more incorrect during the analysis. The special USFOS linear dependency option BLINDP2 which uses a master element reference system accounts for non-linear geometrical effects.

	Operation		*Command*
Conclusion:	Releasing of axial, Y-, or Z bending	:	BELFIX / BEAMHING
	Releasing of shear forces	:	BLINDP2
	Node to node linear dependency	:	BLINDP2

1.3. Earthquake analysis

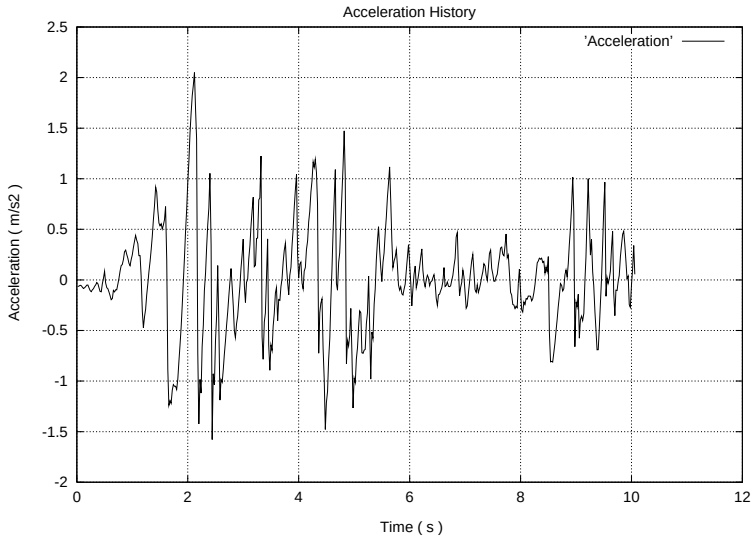
The demand to document the structure's safety during earthquake is a major concern in many regions with frequent earthquake activities. According to API regulations, structures in seismic regions shall be designed to withstand;

- Earthquake with return period of one hundred years
- Earthquake with return period of several thousand years

For the latter case significant ductile behaviour is allowed to dissipate the earthquake energy.

However, safety against total collapse has to be documented. This may be done by performing non-linear collapse analyses exposing the structure to a representative set of earthquake acceleration histories (or for instance equivalent displacement histories).

In the project "Reassessment of Marine Structures" a reliable cyclic material model formulation was developed.



Acceleration Time History

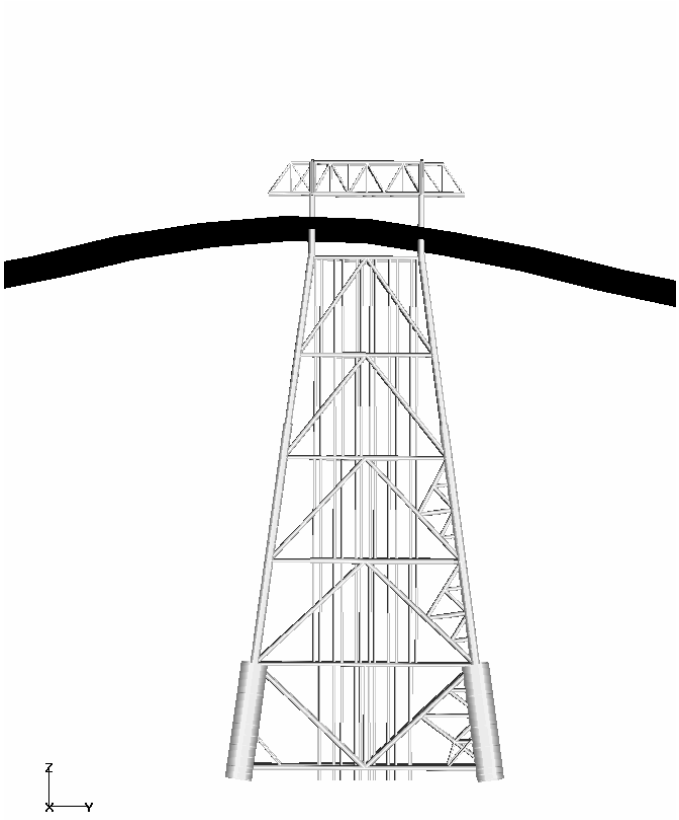
The technique used to apply acceleration histories is to transfer ('exact' integration) the acceleration history to the corresponding displacement history as an *internal pre-processing* task . The displacement history is then applied as prescribed displacements (constraint).

The advantages using this approach are:

- Accurate prediction of the ground motion, and the ground motion in terms of displacement as a function of time is not dependent on the user's choice of time increment in the dynamic analysis.
- The user may input the prescribed ground motion as displacement- velocity- or acceleration histories.
- The ground motion may be set equal for all structural supports, but individual ground movements are possible as well.
- Prescribed displacements are available in connection with both static and dynamic analyses.

1.4. User defined Load routines

In connection with dynamic analysis of structures exposed to loads which are dependent on the structural response, it is not possible to pre-define the load history. The loads must be calculated during the analysis.



A new load module has been developed and implemented in USFOS.

This new module is designed to handle:

- Hydrodynamic loads
- Aerodynamic loads
- User defined load routines

In connection with the hydrodynamic load module, the following are implemented:

- **Hydrodynamic coefficients**, C_d and C_m .
  The coefficients may be defined by depth profiles and/or element by element.
- **Marine Growth**.
  The marine growth thickness is defined by a depth profile.
- **Buoyancy**.
  The buoyancy is calculated during the analysis which means that elements in the splash zone become buoyant/non buoyant as the surface moves up and down.
- **Flooded members**
- **Current**.
  The current is defined by speed, direction and depth profile.
- **Kinematics Reduction Factor**
- **Hydrodynamic Damping**

The wave theories implemented in USFOS are:

- Airy, extrapolated
- Airy stretched
- Stoke's 5'th (Skjelbreia, Hendrickson)
- Stream Function Theory (Dean, Dalrymple)

Current and wave must be combined in the same loadcase, and it is possible to combine several (basic) waves to an irregular seastate.

In XFOS the sea surface elevation is visualized as a 'carpet' with dimensions 2*wave length in X- and Y- direction. The surface elevation which in fact presents the travelling of the wave accounts for the actual current, (which increases/decreases the propagation of the waves). An irregular seastate is visualized adding components from each basic wave to the resulting surface elevation.

The **aerodynamics** implemented is a part of a Ph.D. study within dynamic response of slender structures exposed to fluctuating wind. The study is not yet completed.
For more information, please contact us.

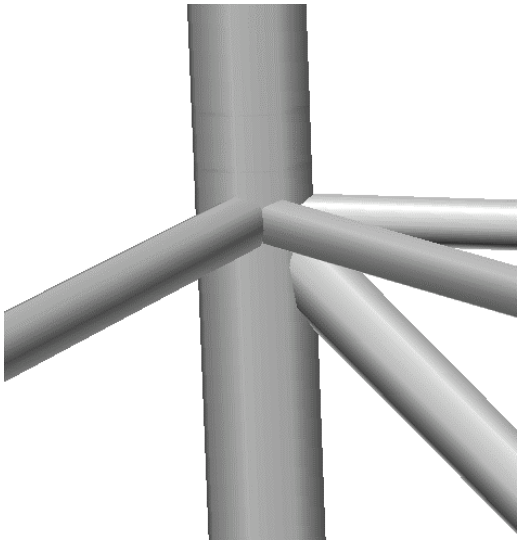
The **user defined load** routines open for a possibility for the users to link their own load routines with USFOS. For more details, please contact us.

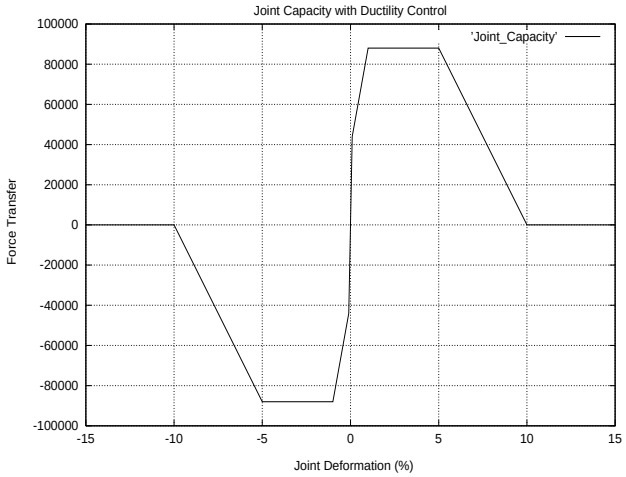
1.5. Analysis Monitoring

A "monitor" function is implemented in XFOS allowing for continuos updating of the XFOS images as the USFOS simulations are proceeding.

The user is free to select which data type to be presented in the image-window as well as the definition of the 'history plot'. In addition, relevant step-information is displayed in the XFOS 'text-window'

1.6. Joint Capacity





The existing joint capacity option is extended to have a control of the ***joint deformation***, not only the force level to be transferred through the brace/chord connection.

The force - displacement characteristics (P_d curve) of the individual brace/chord connections are derived from the actual peak capacities (according to f.inst. API) as follows:

Deformation = 0.1% of chord diameter defines 'yielding'.
Deformation = 1.0% of chord diameter defines peak value.
Deformation = 5.0% of chord diameter defines end of peak value.
Deformation = 10 % of chord diameter defines joint fracture.

The generated curves are printed to the '.out' file, and in XFOS the peak capacities are printed using the Verify/Element/Information option. The joint behaviour is inspected in XFOS using the Result/History plot, and by selecting Element displacement vs. Element force for **end 2** of the joint spring elements, the load through the joint is visualized. This new option is controlled by the new USFOS command: JNT_FORM.

The peak capacities are easily scaled up and down using the command JSURFSIZ, (sensitivity studies, cracked joints, reinforced joints, etc.).

In addition, a ***new user defined*** joint capacity option is implemented. This option allows the user to 100% control the P_d curves of any brace/chord connection.

2. New input identifiers

Since last release, following input identifiers are added:

STATIC	Static analysis, time history format
JNT_FORM	Joint formulation switch
PILE	Definition of a pile.
PILEGEO	Definition of pile geometry (single and group)
PILE_D-T	Definition of a pile diameter/thickness depth profile
SOILCHAR	Definition of soil characteristics defined through P-Y, T-Z and Q-Z curves. NOTE: The API_SOIL option is not yet implemented
SPRI_MOD	Defining the soil spring model to be used.
TOTL2INC	New 'name' of the existing WAVELOAD command (name changed to avoid confusion between this option and the hydrodynamic load option).
WAVEDATA	Defining a wave condition to be applied on the structure.
CURRENT	Defining a current to be combined with a wave condition.
REL_VELO	Accounting for relative movement between structure and the fluid 'particles' (hydrodynamic damping, aerodynamic damping).
WAVECASE1	Print control of generated loads.
M_GROWTH	Marine growth profile definition
HYD_CdCm	Definition of C_d and C_m element by element.
HYDRO_Cd	Defining C_d by a depth profile.
HYDRO_Cm	Defining C_m by a depth profile.
Wave_KRF	Kinematics Reduction Factor (2D waves vs. 3D waves)
BUOYANCY	Buoyancy switch
FLOODED	Flooded members
WINDFIELD	Wind definition
NODEDISP	Prescribed nodal displacement
NODEVELO	Prescribed nodal velocity (dynamic analysis only)
NODEACC	Prescribed nodal acceleration (dynamic analysis only)

3. Changes since last release

The following changes since last release (version 7.2) should be noted.

- The 'prototype' CDYNAMIC record is removed. All dynamic analyses are now controlled by the record DYNAMIC which was introduced in the 7.0 version in 1995.

- The option SUB_CYCL is removed. Sub cycles (which are 'silent' steps with no disc access) are introduced automatically in connection with dynamic analyses where the time between result saving is longer than the analysis time increment.

- The option WAVELOAD has 'changed name' to TOTL2INC, (transfer *total* input loads to *incremental* loads).

- Overlapping braces are accounted for in connection with the CHJOINT option. Earlier the gap were set = 0.0 for overlapping braces. In version 7.4 overlapping braces are identified when the gap becomes negative. Depending on joint geometry, overlapping braces may get up to the double capacity compared to non-overlapping braces. The calculated capacities as well as the key input parameters to the capacity formulas are listed in the '.out' file.

4. Efficient use of USFOS, introduction to new features

4.1. New features

During the last years USFOS has been extended with many new options. These new options may open for use of USFOS within new areas of problems as well as existing problem areas are solved in a quite different way.

Dynamic analysis:

Dynamic 'pushover' using the hydrodynamic module
Earthquake analysis
Explosion
Dropped objects
Ship impact

Foundation modelling:

Pile soil interaction
Soil spring models

Joint modelling:

Joints with ductility control
User defined joint P_d curves

4.2. Efficient use of USFOS in UNIX environment

In typical USFOS studies, a large number of analyses have to be performed. It is then of great importance to have efficient procedures established to avoid mixing of result data and tedious waiting for the analyses to be completed.

Many users have already established their procedures for efficient use of the different computer codes involved in their daily work, but some may not.

SINTEF has used USFOS in various types of analysis projects, and based on the experience from these studies we may have some useful ideas of how to run USFOS in UNIX environment.

By using UNIX scripts the user may design the data flow:

1. Establishing the models from 'master' files + 'special' files
2. Running USFOS
3. Extracting and saving the interesting results from the analysis

The items 1 - 3 may be built into loops which means that a large number of analyses can be performed according to a pre-defined plan. The user may then utilize the computer resources at night and weekends and then use daytime for work with the analysis results.

4.3. Special Designed USFOS Courses

To meet the challenges described in sect. 4.1 and 4.2 above, SINTEF will offer the following for the members of the USFOS User Group:

Based on the individual companies' needs SINTEF will prepare for a 1 or 2 days USFOS course at the companies premises, (one experienced USFOS user will come). The contents of such courses will vary from company to company depending on types of analyses, user experience etc.:

- Basic course, introduction to the USFOS theory and basic features
- Introduction to new features
- Efficient use of USFOS in UNIX environment
- Assistance in connection with specific USFOS analyses, the course covers necessary options for the specific study.
- etc....

Costs:

The man-hours involved for preparation and executing the courses are covered by the service agreement, but the travelling costs are to be covered by the individual companies.

For more information, please contact SINTEF.

5. Hints, Frequently asked questions

This information is taken from the USFOS home page:

http://www.sintef.no/units/civil/bygg/ktek/usfos.htm

System Setup

1996-05-21 Do you work with a link to an old XFOS resource file?
Be aware that, when installing the USFOS program system according to the installation procedure, the USFOS run script (eg, $USFOS_HOME/etc/usfos.cshrc) will automatically create a XFOS file on the home directory of each of the users of USFOS, being a symbolic link to the original file on the $USFOS_HOME/etc directory. However, if this file already exists, it will not be re-created, and thus it might happen that it points to an old USFOS directory. To remove this potential problem, delete the XFOS resource file on your $HOME directory, and do a re-login (or create a new xterm window).

1996-05-15 The XFOS resource file is the key to user customization
The Xfos resource file is the key to user customization of the XFOS part of the USFOS program system. If required, you may download a memo (postscript format) with a complete description of all the items in the resource file.

1996-05-11 Check the value of xfos*Postfos in the XFOS resource file
*Be aware that in the previous release of USFOS (v7.2) the identifier xfos*postfosSize in the Xfos resource file, limiting the memory usage of the POSTFOS module, has been set to a default value of 1 (ie, one million words). You should increase this to f.inst. 5.*

Modelling

1996-05-15 BELFIX data types implemented in USFOS version 7.2 / 1996-01-25
(and later versions)
If BELFIX data types are included in your model, USFOS version 7.2 /1996-01-25 may give results different than version 7.0. If you do not needthe BELFIX cards (ie not intended to include internal hinges), you shouldcomment them out. This is because BELFIX (card for specifying internal hinges) is implemented as a new functionality in version 7.2, while the BELFIX card simply isignored in earlier versions of USFOS.