SURVEYOR ™ Loading Calculator

Description:

This documentation describes the Surveyor stress and stability calculator.

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1. System description

The Surveyor loading calculator is performing strength and stability calculations based on intact stability. The software is fully integrated into the Surveyor level gauging system. The system will perform continuous strength and stability calculations for the online condition, and raise alarms based on stability versus IMO criteria and stress versus class limits. (IMO resolution A.167 (ES.IV))

In addition to the online condition, the system can have three off-line conditions simultaneously in the memory. The system will give a warning, but no alarm if stability or stress limits are exceeded for the offline conditions. It is possible to store an unlimited number of loading conditions. As a standard, the conditions which were used for the approval of the software will be stored as read only, and will be available for future reference.

The software is an integrated part of the Surveyor program. The configuration data is however stored in a separate text file. As with Surveyor level gauging system, all software, and data is stored on a FLASH card. No rotating bulk storage device is used in the system. The software and configuration data is write protected.

The software is object oriented and based on C++.

2. Software specifications:

2.1 General

2.1.1 Online Help - online help is not available.

2.1.2 Stored geometry characteristics data.
Geometry characteristics data are stored on FLASH-memory and is protected from accidental alterations. A procedure is established to handle alterations of the configuration data and is a part of Ariston Norway's quality assurance system.

2.1.3 Stored lightweight data.
Lightweight data are stored on FLASH-memory and is protected from accidental alterations. A procedure is established to handle alterations of the configuration data and is a part of Ariston Norway's quality assurance system.

2.1.4 Stored limit curves.
Limit curves are stored on FLASH-memory and is protected from accidental alterations. A procedure is established to handle alterations of the configuration data and is a part of Ariston Norway's quality assurance system.

2.1.5 General arrangement plan / tank plan.
In the current version of the software, a tank plan is not available. 2.1.6 Erroneous input.
The software is only for tankers, and inputs operator inputs are made in pictures which have a spread sheet form. The system safeguards against erroneous input such as overfilling of tanks and positioning of solid weights at given compartments such as stores and swimming pool.

2.1.7 Integration and interpolation method and limitation.
Depending on the nature of the tables, linear interpolation or second-degree interpolation is used. For integration, Simpson is used. For integration, the criteria for number of intervals are that the result will be improved by less than 0.5% by adding one more interval.

2.1.8 Iteration limits.
All iterations have exit criteria based on both accuracy and a limit on number of iterations. The iteration out-of limits do not exceed 0.1% of the reverting value. If iteration has been terminated because the maximum number of iterations has been exceeded, a warning will be

given. Normally the number of iterations is limited to 20, but for some iterations, the limit may be higher to 40.

2.1.9 Discrepancy between calculated and actual displacement.
If discrepancy between calculated and actual displacement is encountered, the user can add or remove weight. It is not possible to enter the actual displacement or drafts.

2.1.10 Calculation of tank capacities.
Calculation of tank capacity, based on ullage or sounding tables is included, with trim correction.

2.1.11 Loading limitations.
The software takes into account the applicable loading limitations such as minimum GM and issues an alarm or a warning depending on or off-line condition.

2.1.12 Graphical presentation of loading condition.
This version of the software gives a graphical presentation of the load results like GZ-curve, and shear force and bending moments.

2.1.13 Presentation of load results.
The program will give a presentation of the loading conditions, organized over several pages. In addition, it is possible to make printouts, either of the entire loading condition, with all-relevant information, or individual pages.

2.1.13.1 Stability result page.
All relevant stability values like trim, list, drafts, displacement, immersion, GM, KM, KM-margin, GZ-curve, with GZ-areas, moments and centre of gravity.

2.1.13.2 Strength page.
A graphical presentation of bending moment and shear force for seagoing and harbour condition.

2.1.13.3 Frame page.
Presentation of frame related values like bending moment, shear force, limits for shear force and bending moment and utilisation of limits in a spread sheet form.

2.1.13.4 Section page.
Presentation of section related values, like buoyancy, total weight, steel weight, average shear force and bending moment over the section.

The program will issue warnings or raise alarms depending on whether it is an online or off-line condition. All limits, which are exceeded, will be listed.

2.1.13.5 Result page.
The result page gives an overview summary of weight and volume for each cargo.

2.1.13.6 Planning page, liquids.
Presentation and input of tank related values, like cargo specification, weights, volumes, ullages, levels, densities, expansion coefficients, vertical horizontal and longitudinal centre of gravity, free surface and free surface moments. The values are presented in a spread sheet form. For the online condition, even cargo specification, including weight and density is obtained from the online system for cargo tanks. For other online tanks, the correct weight will be obtained. For off-line conditions, and for off-line tanks in the online condition, the user must manually enter the cargo specifications and weight.

2.1.13.7 Planning page, solids.
Presentation and input of solids related values. The software can be pre-configured with a number of fixed locations like stores and stores forward. The user can add additional solids, with LCG, TCG and VCG.

2.1.13.8 Cargo type.
Presentation and input of cargo types. In this picture, the user can enter the cargo name and specifications. In the planning picture for tanks, the user can make a link from any tank to any cargo type.

2.1.14 Judgement of loading condition.
The software perform checking for a given condition: a Limits given in 2.1.11.
a Shear forces and bending moments against stored strength limit values. a Corrected GM and KG against stored stability limit values.

2.1.15 Online interface.
The loading calculator is a fully integrated part of the Surveyor software. It means that loading calculator has direct memory access to data from the level gauging system.
The system has one online condition, where values from online tanks are passed from the online level gauging system to the loading calculator. If however one or more tanks fail, it is possible to disable input, and enter values manually. Values must anyway be entered manually for off-line tanks.
The system has three additional off-line conditions, which can be used for planning. An unlimited number of conditions can be stored. The user can copy the online condition to off-line or vice versa.

2.2 Intact Stability.

2.2.1 Free surface effect as correction to GM.
Free surface effect, as correction to GM is included.
Only tanks with more than 1% and less than 98% filling are added to the free surface moment. The total free surface moment is used to correct the GM according to the following formulas:
KGsolid = Total VerticalMoment
Displacement
KGadjust = TransverceFreeSurfaceMom
Displacement
KG = KGSolid + KGAdjust
KM = KMT-Tab- > GetValue (DraftMidship,Trim) GMSolid = KM - KGSolid GMLiquid = KM – KG

2.2.2 Free surface as correction to GZ.
The GZ-values for the intact condition is based on a virtual increase of KG caused by the free surface moment.

2.2.3 Calculation of GZ-curve.
The software calculates the righting lever GZ-curve with 1-degree steps up to 60 degrees. 2.2.4 Calculations with respect to the intact stability criteria.
The software calculate intact stability based on the righting lever GZ curve , including correction for the free surface effect, such as area under GZ-curve for 0-30 degrees, 0-40 degrees, 30-40 degrees, angle of maximum GZ as well as value of initial GM.

2.2.5 Calculation of external heeling moment.
Calculation of external heeling moment is not included.

2.2.6 Graphical presentation of GZ-curve.
See 2.1.13.1 for further reference.

2.3 Damage stability.
The software check only against stability limit curves.

2.4 Longitudinal strength.

2.4.1 Control of stillwater shear force against limit values.
The software will compare calculated, corrected stillwater shear forces with limit values for seagoing- and harbour conditions, and can show the utilisation of the limit values. For the online condition, an alarm will be risen, and for the off-line, a warning if the limits are exceeded.

2.4.2 Correction of shear force for bulk carriers.
The Surveyor loading calculator is only for tankers and is not available for bulkers

2.4.3 Correction of shear force for tankers.
Correction of shear forces is optional.

2.4.4 Control of still water bending moments.
The software will compare calculated stillwater bending moments with limit values for seagoing and harbour conditions, and show the utilisation of the limit values. If limit values are exceeded, an alarm or warning will be risen, depending on online or offline condition.

2.4.5 Control of longitudinal stress and torsion.
Longitudinal stress is controlled and utilization of allowable limits is available from the frame picture (Ref. 2.1.13.3) and section pictures. (Ref. 2.1.13.4)

Torsion is not in included.

2.5 Local Strength.

2.5.1 Limits for maximum mass in any hold as function of draft.
Limits for maximum mass in any hold as function of draft is available

2.5.2 Limits for maximum mass in any two adjacent holds as a function of draft.
Limits for maximum mass in any two adjacent holds as a function of draft is

2.5.3 Limits to filling height as a function of cargo density.
Limits to filling height as a function of cargo density is available

2.5.4 Limits to distributed loads on deck.
Limit to distributed loads on deck is not available

2.5.5 Control of container lashing.
Control of container lashing is not available.