



SMALL CRAFT. - SCANTLINGS

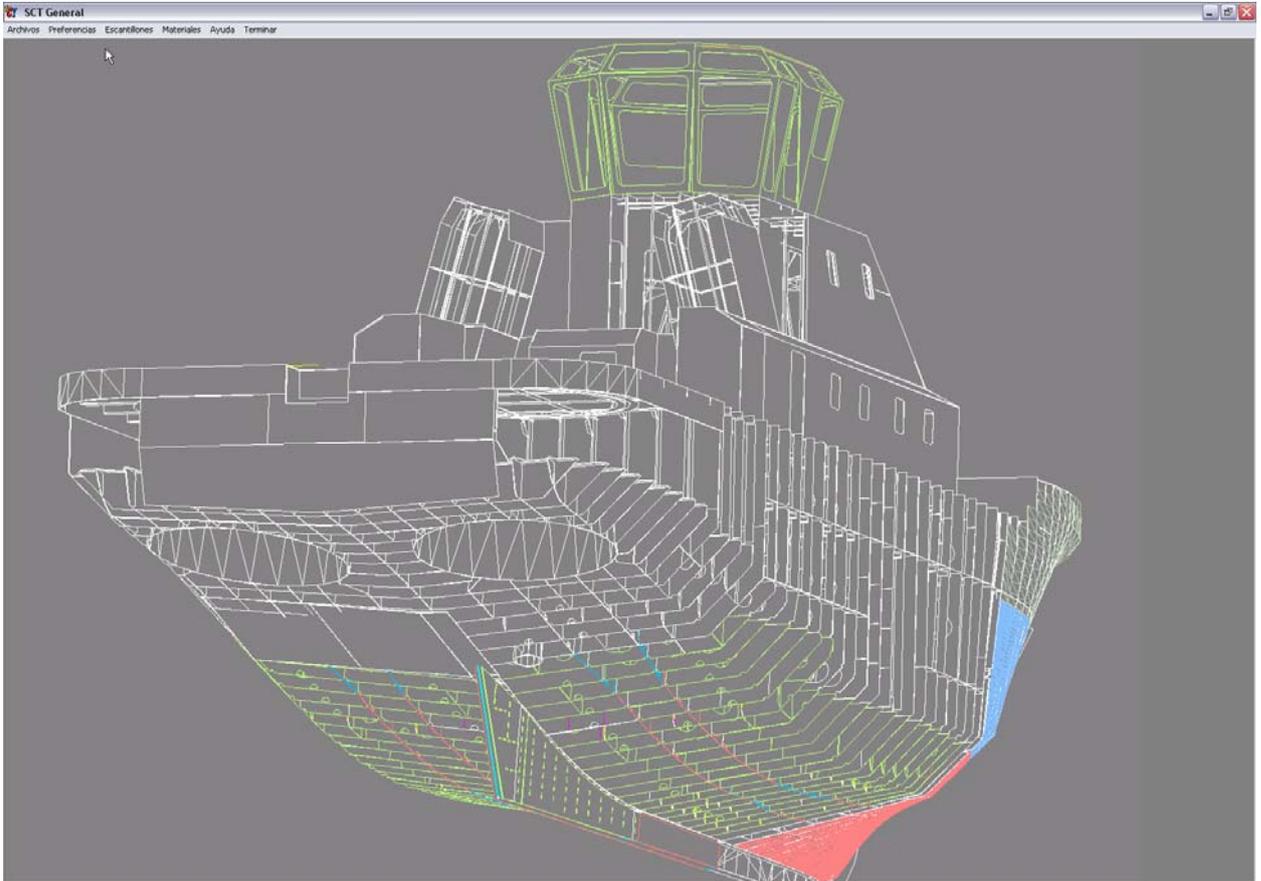
International ISO Standard 12215-5

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INTRODUCTION

SCT is an application that tries to help the designer in the scantling of small crafts, according the ISO Standard 12215-5, inside the scope defined by it self

The initial window of the application looks as follow :

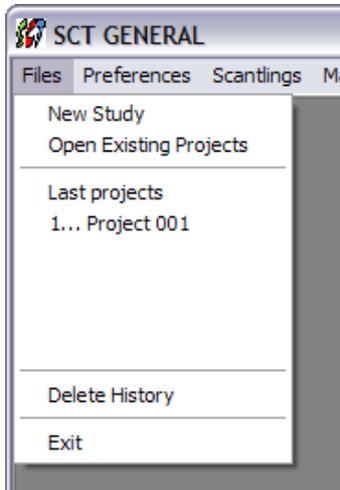
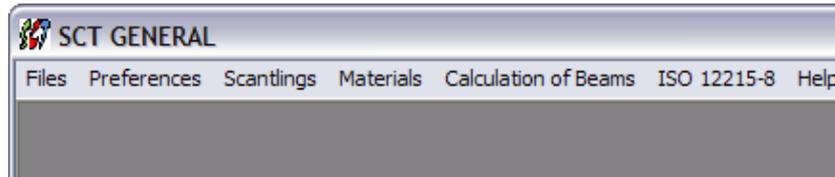


It is a window of the called type "MDI", which acts as a container for several other windows, called secondary windows, than the User can open along the same working session.

This window has its owns heading menus , as we will se later, but, when one of the secondary windows becomes the "active window", the main window will only show the secondary window menus.

For this reason, in order to access to the MDI window's menus, any secondary windows must be unloaded.

HEADER'S MENUS



New Study: opens a secondary Windows to get the directory, identification and any other data for the new study.

Open Existing Projects : opens a dialog box with the Windows Explorer directory tree, to allow the designer to look for any existing project, and load its data.

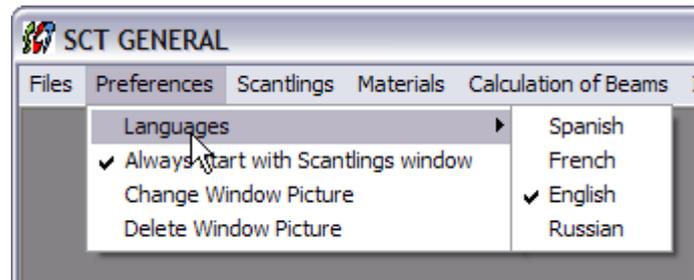
Last projects : shows up to the 5 last projects we have been dealing with. By clicking on its name, the application will load its data and the window "Scantlings" will be open.

Delete History : deletes the list (not the projects) with the last used projects.

Exit . Closes the application

Language : allows the User to select the language to be used by the application.

Always start with Scantlings : when this option is ticked, the window "Scantlings" will automatically be shown when starting any new work session.



Change Window Picture : allows to select a new image for the Background of the MDI window.

Delete Window Picture : no image will appear

REMARK : Options selected with the menu "Preferences" are saved by the application, that will remember them while not further changes.

Scantlings : Opens the window to work with scantlings properly.

Materials : Open the window to work, modify or add, materials.

Calculation of Beams : opens the modulus to calculate frames and continuous beams.

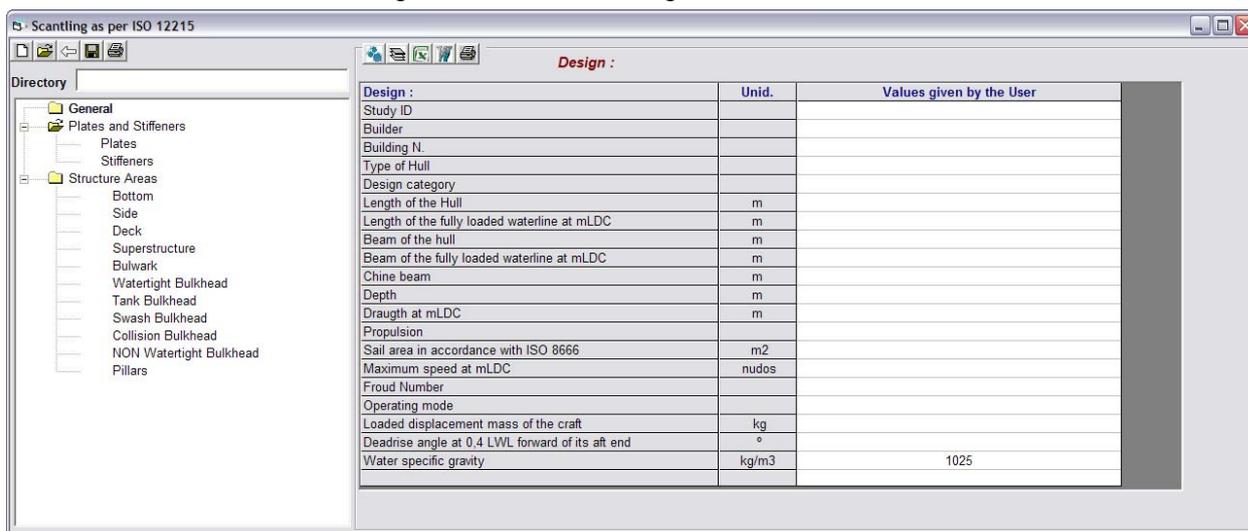
ISO 12215-8 : rudders calculation (*not yet available at this time*)

Help : Opens the User's Manual in pdf format

REMARK : The window "Scantlings" has its own menu "Preferences", that IS DIFFERENT THAN the one we have just described, allowing the User to select specific preferences for working in scantlings.

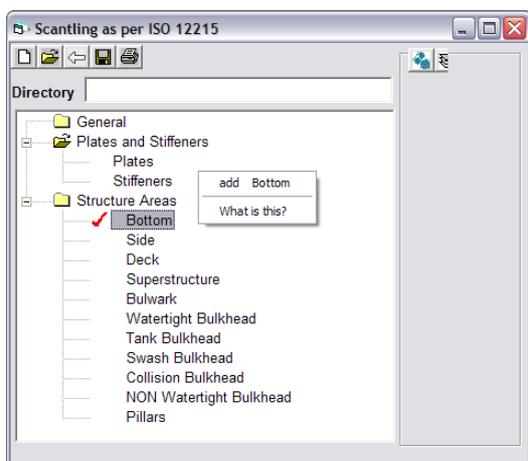
SCANTLINGS

The window to work with scantlings looks like in the image, with two differentiate areas :



- The left one shows all the elements forming the structure of the ship.
- The right hand area relates the properties of any of the precedent elements, as well as the results when applying them the ISO Standard 12215-5.

Clicking with the left button of the mouse over any one of the nodes in the left tree, the table in the right side will show its properties.



Selecting any element in the window with the mouse left button and, then, clicking on the right button, several pop-up menus will appear, helping the User in some tasks as :

- Giving new data
- Modifying existing data
- Adding elements
- Explanations about required data : menu **“What is this?”** (see image)
- Etc.

The total amount of nodes, elements, in the left hand tree is unlimited. However, as every node needs to be linked to a table with its properties, the memory used can be very high and calculations speed may be affected.

Within a complex project the number of nodes can become very high. That's why, in order to avoid confusion, the selected node will appear with the mark so that we can know that the properties in the right hand table are its properties.

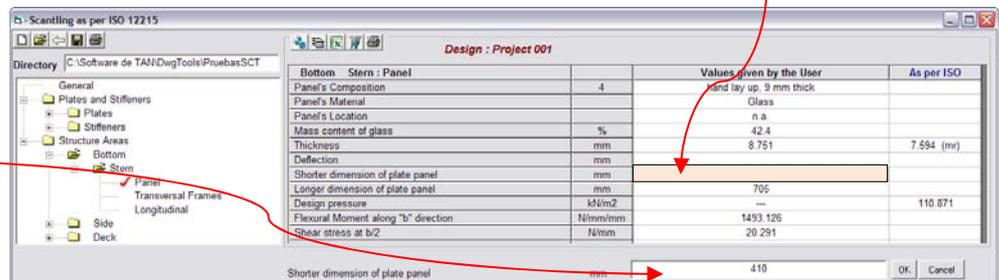
On the other hand, if no node is marked with that icon, and we ask the application to do any calculation, we could get improper or not coherent results.

DATA INTRODUCTION

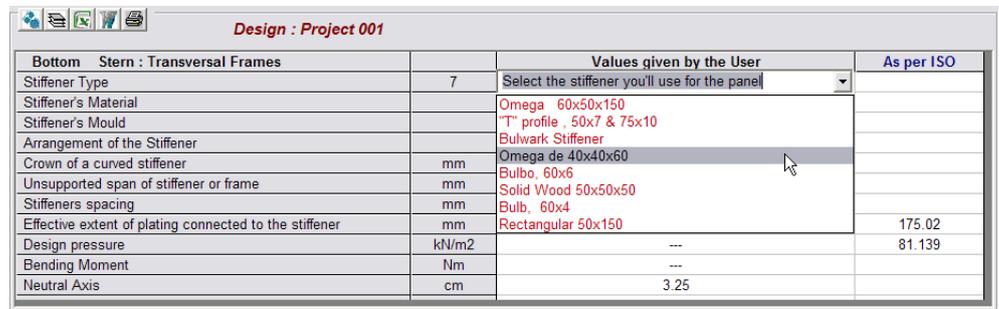
The introduction of data, an always convoluted task in this kind of studies, has been fully simplified. Just we have to act, with the mouse left button, over the row which data we need to introduce :

- In many cases, there is no other solution that do it manually. By clicking on the specific row, the box will change its color and format. Now we can introduce or change the data.

The old data will be shown here



- When possible, opens several pop-up Windows in which we only have to select the relevant option.



Units used by the Standard are not fully homogeneous. For example :

- The major (minor) dimension for a bulkhead's panel must be in millimeters, while the load height for it has to be given in meters.
- The stiffeners spacing for a panel is given in millimeters, while its distance from the App is to be given in meters.
- Etc.

For this reason, the label in the left of the text box, show not only the item to be introduced but also its correct units.

Besides of these facilities, not all the boxes in the table are to be fulfilled by the User, well because they are not necessary for the calculation, either because the application will deduce them from other previously given data.

By instance, once introduced the waterline length, in fully loaded condition, and the vessel speed, will calculate the coefficient V/\sqrt{Lwl} and will deduce if the ship is "Displacement" or "Planning" type. The boxes for these elements are marked with "----" : we don't need to fulfill them.

Stiffeners spacing	mm	1000	
Effective extent of plating connected to the stiffener	mm	---	175.02
Design pressure	kN/m2	---	81.139
Bending Moment	Nm	---	
Neutral Axis	cm	3.25	

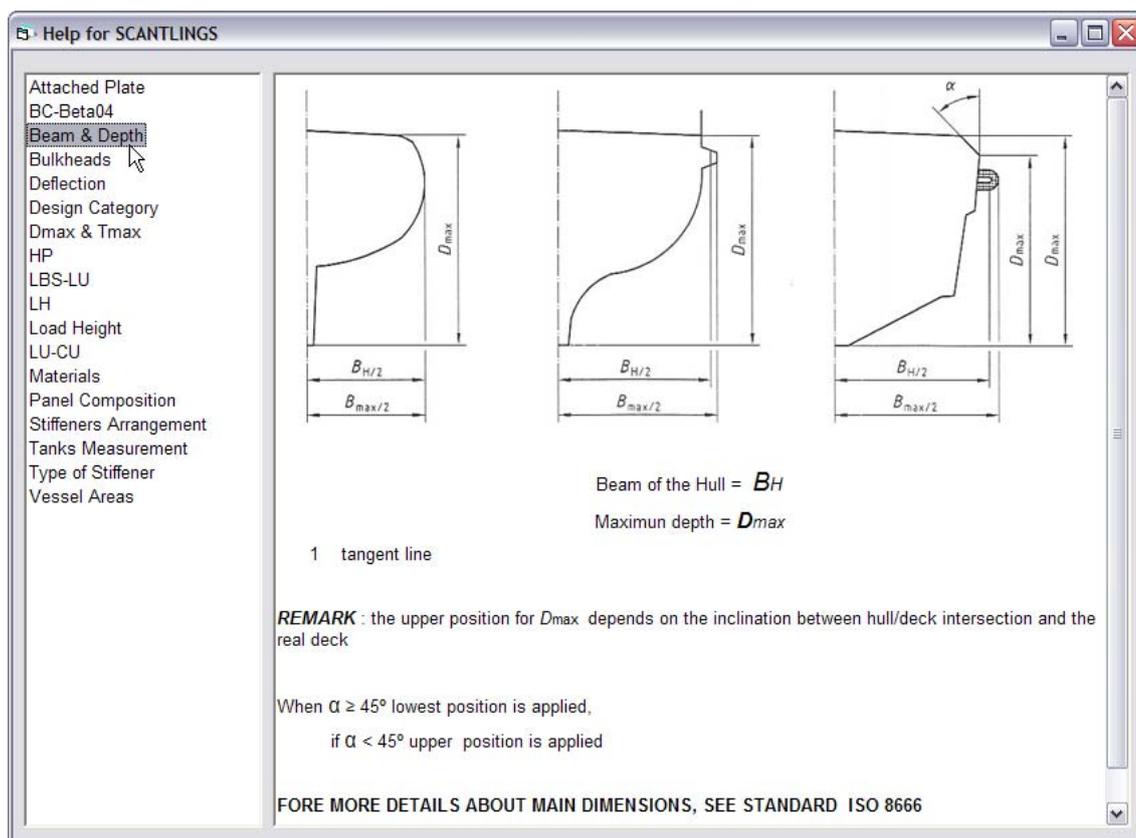
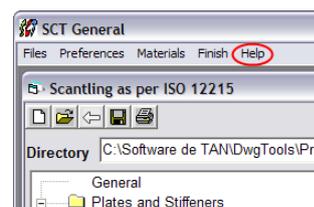
In other cases, the element in the table (that is extracted from a generic template) is not applicable to the current item. The application, then, will write "n.a." in its box : not applicable.

GETTING HELP

There are two ways to get help :

1. At the top left of the window, among several other menus, is the one called **Help**.

By clicking on it, a secondary window will appear with a list with the different available help topics.



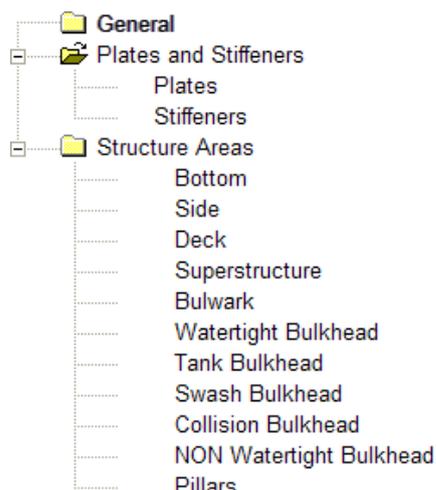
Pressing in the left area, over the required item, the right hand area will show appropriate explanations. They are, usually, existing figures in the ISO Standard 12215-5.

2. Pressing in the main window over a node, label or box, first with the mouse left button and, then, with the right hand button, the **What is This?** pop-up menu will appear.

Stiffeners : Rectangular 50x150	Units	Values given by the User
Type of Stiffener		User defined, rectangular
Stiffener's Material		Glass
laminated kind of ply		Select lay-up
Glass content in mass	%	30
Moulding Type		Open mould simple surface
Web Depth	mm	150
Base Width of the Profile	mm	50

Pressing now on it, appropriate explanations will be shown to the User. Sometimes the application will indicate that does not exist such explanation, well because it is obvious or because we just have to choose among the possibilities listed in a pop-up window, making unnecessary more details.

DEFINING THE STRUCTURE



The application shows a tree, similar to the one in the figure, with the different areas that a generic new project needs to have.

We have, also, to define the plates and stiffeners needed to build any element of the several areas..

And, of course, we need some general data defining the overall ship.

In this area, left part of the program's window, we don't need to write anything. Everything works by means of pop-up menus appearing when selecting a node and clicking, then, the right button of the mouse.

It is possible to add or delete elements, or change their names.

Every AREA can have as many elements, **with different designations**, as we consider necessary to fully define the ship's structure and fully study its possible problems (see image).

First thing the application will do, when trying to add a new element, is asking us for a name for the item, that gives it an unequivocal identification.

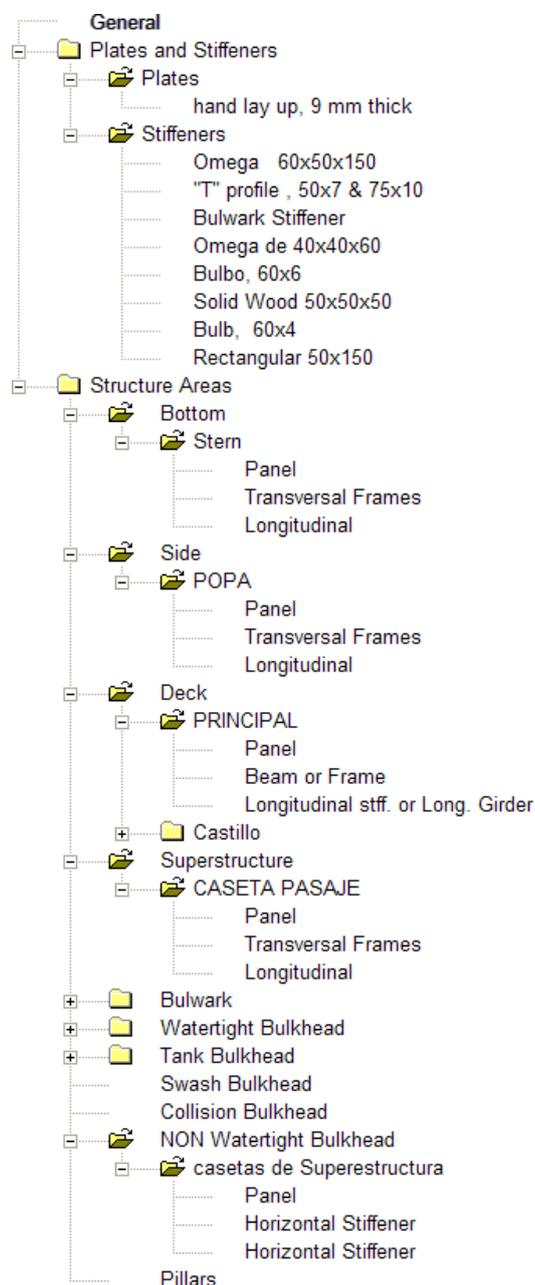
Every possible element is considered to be formed by a plate panel, with transversal and longitudinal stiffeners (vertical and horizontal for vertical elements of the structure).

Although some of them will not be necessary, it does not matter as we will not fill in the boxes in the table and no calculations will be performed about them.

Those panels and stringers must be one of the previously defined in the upper part of the nodes tree, called **"Plates and Stiffeners"**.

Example : The bottom panel Central will be formed by the Hand laminated of 8 mm thick and as stringers we'll use the **Omega de 60x50x150**, for frames, and **Omega de 40x40x60**, for longitudinal.

We will see later how to indicate plates and stiffeners to be assigned to each element.

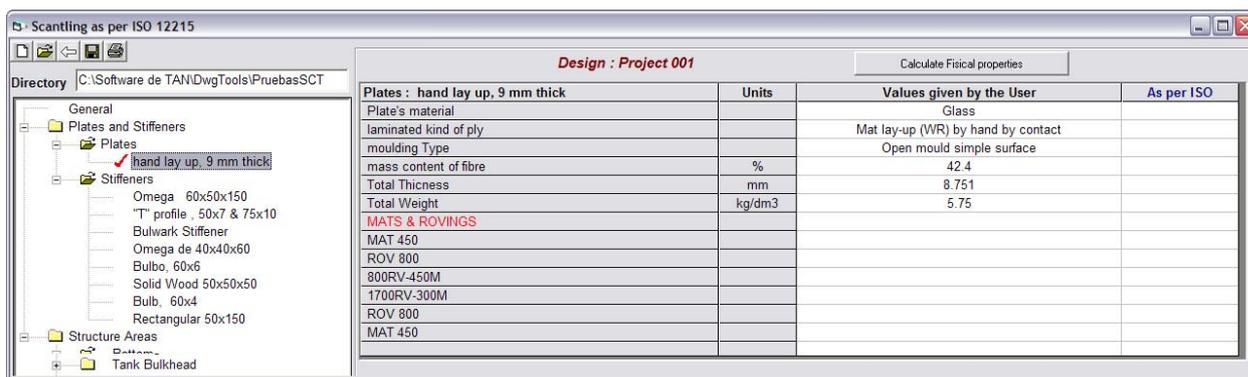


In turn, when defining plates and stiffeners, we will have to specify the material they are made with, as well as the thickness, in case of plates. With stiffeners we have to indicate the profile type : flat bar, bulb bar, composed “T”, omega profile, etc. and to give the dimensions.

All this will be carried out by introducing data in the boxes of the table that the application prepares for every element (pop-up Windows and text boxes) as mentioned before.

Each table is activated by clicking on the correspondent node’s name in the left hand tree.

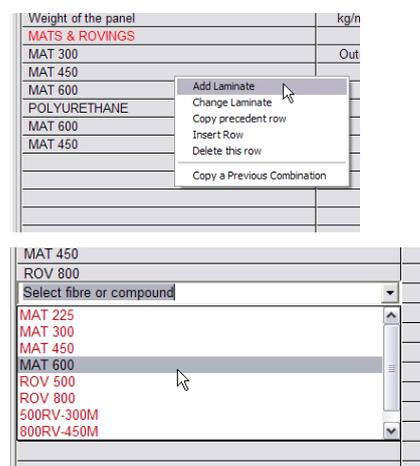
When working with a plate, the following window will be shown :



Initially boxes with white back color do not contains any data and they have to be filled in as previously indicated, acting over the boxes in grey back color, mouse left button and/or right button.

We have to give the thickness but, when it comes that the plate’s material is Glass, Carbon or Aramid, the application will include several additional rows, to receive data about mats, rovs, etc., that form every ply. In order to add a laminate :

1. Pick the corresponding row with the left mouse button..
2. Act over the right mouse button : a pop-up menu will appear and we will select the option “Add laminate”.
3. Over the selected row will appear a pop-up list with the diverse available elements.
4. Selecting one of and it will be incorporated in the selected row box.



And so on till complete all the plies needed for the laminate.

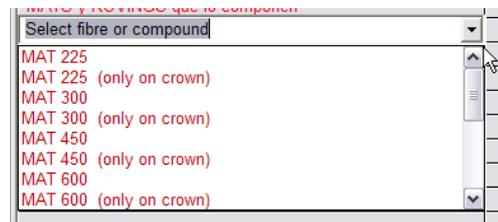
There exists the option of **Copy a Previous Combination** combination in a previous panel .

- When choosing this option, a pop-up Windows appears with the list of existing panels.
- Selecting one of them, its mats-rovs will be copied in the actual table, starting with the row we have picked-up first (see point 1)



Once this has been done, the button **Calculate Fisical properties** will calculate the physical properties of the current plate and the application will write them in the boxes of the table, without any additional action from our side. These properties will be taken into account at the moment of analyze the panels forming the structure.

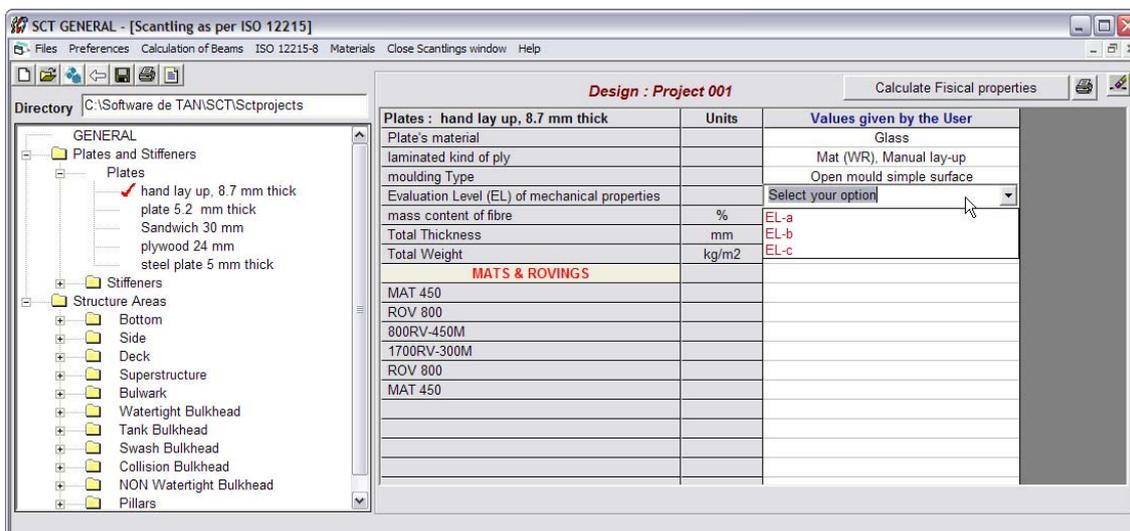
Working with a stiffener the procedure is fully similar but we need to give also, its dimensions and, when dealing with glass, carbon or aramid, the composition for the laminate. There is a special option to put mat, rovs, only on the crown head. At this purpose the pop-up window undergoes a small change (see picture)



VERY IMPORTANT NOTE

In the case of fibres, we have to fill the appropriate box :

Evaluation Level of mechanical properties



A dropdown list appears with three options :

EL-a : The physical properties of materials that we use for the various layers must have been derived by standard tests in the laboratory. These values have been indicated previously by the user in the window “Materials” of the application

.The application will use the values entered by the user to calculate the stresses in each layer

EL-b : The physical properties are calculated according to the default values in tables C.4 to C.7, all based on the amount of fiber mass and the component of the layer.

EL-c : The physical properties are calculated as for **EL-b** but the values deduced from the tables C.4 to C.7 will be multiplied by a factor of 0,8

Should be consulted and proper understanding of the Annex C of the standard ISO 12215-5, paragraphs 1.2, 1.3, 1.4 and 1.5, before choosing the method used for the project under study

In most instances, it will be in the builders’ interest to adopt level “a” or combination of levels “a” and “b”. Use of level “c” carries a considerable penalty since neither the actual fibre content by mass, nor the quality of fabrication can be quantified with any certainty.

WORKING PROCEDURE

As it can be deduced from the precedent, the normal working procedure would be as follows:

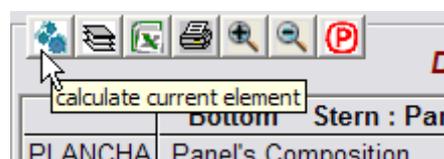
1. DEFINITION

- Introduction of the general data for the ship
- Definition of the materials we need to use in this project: mats, rovs, types of steel or/and aluminum, woods, etc
- Define plates and stiffeners to be used at every zone.
- Specify the zones we need to divide the structure, which plate to use for every panel and type of stiffener for frames and longitudinals bordering the panel.

2.- CALCULATION

Once all dimensions have been defined as well as the position of every element in the structure, the application will deduce the real properties for everyone, and comparing them with the ISO Standard 12215.-5 requirements.

These requirements will appear on the fourth column of the table, marking with red color those properties below the requirements.



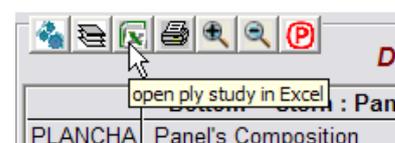
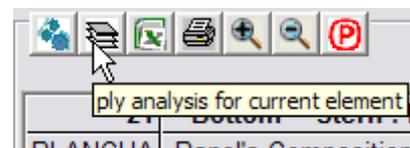
3.- CHECK

Looking at the results we can decide the convenience or not of modifying elements properties, spacing of stiffeners, the plate assigned to each panel, etc

4.- ANALYSIS PLY BY PLY

After properly tuning the structure, it is possible, if desired (sometimes it is compulsory) to carry out an analysis ply by ply. This analysis will provide the degree of acceptance of each layer and, as a result, the possibility of decreasing thicknesses without exceeding allowed design stresses and moments.

The application carries out this task with no more than to act on the toolbar's button indicated in annexed figure. All the necessary data are present in the different tables of the various elements and available to .



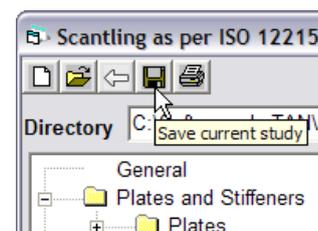
On a template, specially prepared for this purpose in MS Excel, and fully similar to the one showed in the ISO Standard 12215-5, will be arranged the results of the analysis.

Any amount of analysis can be performed and all of them will be added into a single Excel file.

5.- SAVE THE STUDY

The toolbar in the figure allows the User to save data and results.

It is very convenient to save them with some frequency in order to do not lose any one of them.

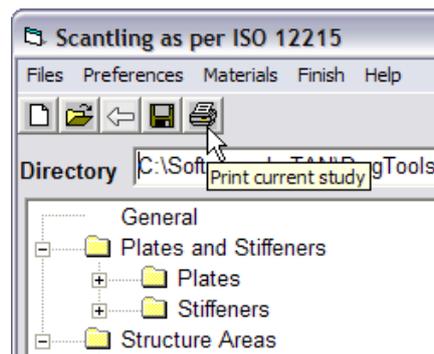


6.- OUTPUTS

The button in the toolbar of the Scantling window creates a document in MS Word with the data introduced for the study, the table properties for each element as well as the results for them.

Writing in Word is a slow procedure and, given that the structure may have a lot of components, it may last several minutes.

In the calculations of each panel or reinforcement are used several pressures and coefficients that can be displayed in a separate subwindow, if we click on the figure. The list of results in MS Word also displays these values

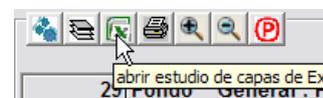


ANALYSIS PLY BY PLY

The ply analysis for each panel or stiffener are shown directly in an Excel Work Sheet specifically prepared for this study.

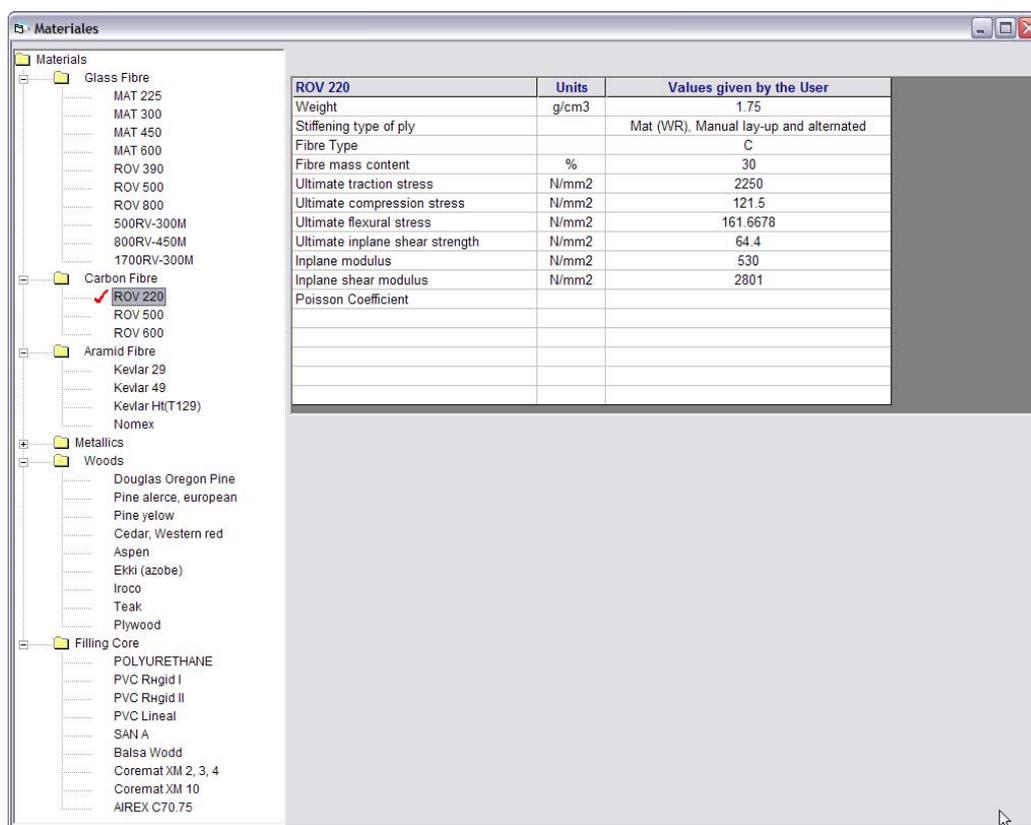
Project 001 Panels Ply Analysis.xlsx															
Design : Project 001														date : 09/11/2011	
Laminate calculation for the Panel : Tank Bulkhead, D.O. Tank in Engine Room															
Design Pressure P	Panel short dim b	Design Shear force Fd/mm	Design Bending Mt												
HN/m2	mm	N/mm	Nmm/mm												
20	1000	8,47	1512,261												
Laminate calculation for a 1 mm wide strip laminate															
Ply Nº	Definition	Fibre dry mass	type	Content Ψ	Modulus Eii	σy/σu	Interlaminar τu	σ'cd / σ'cu	σ'cd	τd	Thickness ti	Ei x ti	Dist Zgi from outside	Ei x ti x Zgi	
		kg/m2			N/mm2	N/mm2	N/mm2		N/mm2	N/mm2	mm	N/mm	mm	N	
		input	G, C, A	C.1	Table C.5			Table 7	(7)x(9)	(8)x(9)	Ecc.1 & C.3	(8)x(12)	calc.	(13)x(14)	
1	outer	MAT 450	G	0,3	8400	85	17,25	0,5	42,5	8,625	1,051	6726,4	0,53	3564,992	
2		ROV 800	G	0,48	13240	182,92	14,1	0,5	91	7,05	1,035	13703,4	1,57	21514,338	
3		800RV-450M	G	0,45	12100	163	14,625	0,5	81,5	7,3125	1,761	21308,1	2,97	63285,057	
4		1700RV-300M	G	0,45	12100	139,5	14,625	0,5	69,5	7,3125	2,818	34097,8	5,26	179354,428	
5		ROV 800	G	0,48	13240	144	14,1	0,5	72	7,05	1,035	13703,4	7,18	98390,412	
6		MAT 450	G	0,3	8400	117	17,25	0,5	58,5	8,625	1,051	6726,4	8,23	55358,272	
		5,75		0,424							8,751	96265	4,38	421467	
													ZNA		
Ply Nº	Definition	Ei x ti x Zgi ²	Ei x ti ³ /12	(EI) _i From base	Zcrit from ZNA	SMi	σi	Compliance factor	Shear stress analysis					Compliance factor	
		N mm	N mm	N mm ²	mm	mm ³ /mm	N/mm ²		Location of τ	Z calc. from NA	First mt Q	Shear flow q	τi media	τd/τi	
				calc.	calc.					mm	N mm	N/mm	N/mm ²		
1	outer	MAT 450	1889,446	619,166	2508,612	-4,38	18,36	82,4	0,52	Traction	3,329	25897	0,43	0,43	20,2
2		ROV 800	33777,511	1223,285	35000,796	-3,33	11,67	129,6	0,7	Traction	2,294	64404	1,06	1,06	6,6
3		800RV-450M	187956,619	5506,583	193463,202	-2,29	18,55	81,5	1	Traction	0,533	94448	1,56	1,56	4,7
4		1700RV-300M	943404,291	22564,571	965968,862	2,29	-18,56	-81,5	-0,85	Compression	-2,285	64442	1,06	1,06	6,9
5		ROV 800	706443,158	1223,285	707666,443	3,32	-11,7	-129,2	-0,56	Compression	-3,32	26072	0,43	0,43	16,4
6		MAT 450	455598,579	619,166	456217,745	4,38	-18,36	-82,4	-0,71	Compression	-4,371	175	0	0	2991,1
		2328070		2360826	514040										
				Eibase	EIBA										
Available bending moment according to the minor acceptance factor 786.4 Nmm/mm															
According to the medium fibre contents, 0.424, design stress (table C4.a) :99 N/mm ²															
and the required thickness, according to eq. 35, is : 9.59 mm															

You can access the existing studies using the button in Figure



DEFINITION OF MATERIALS

This issue deserves a separate chapter and, in fact, the application has a separate window to deal with them, window that can be accessed through the header menu “Materials”.



On the window's left part, a nodes tree shows all the materials we have at our disposal.

The table on the right part shows the physical or mechanical properties for the specific material we selected on the tree.

incorporates a collection of materials that, probably, will be enough for the 90% of the options we will ever shuffle in this issue.

Although it is possible to modify the lists and the properties of every item, it would be preferable to consult to any distributor of the application to add or modify materials.

When adding a new material, it is necessary to introduce all its mechanical properties. In the case of laminates, however, you only need to indicate the fiber content in %. The application, according with the formulas in the ISO Standard 12215- 5, will calculate them.

When defining any plate, one of the text boxes in the properties Table will ask us for the Plate's Material. Picking over this box a pop-up window will appear, with the list of all available materials.

Plates : steel plate 5 mm thick	Units	Values given by the User
Plate's material		Select a Material
moulding Type		Glass
Total Thickness	mm	Carbon
Ultimate tensile strength	N/mm2	Aramid
Ultimate compressive strength	N/mm2	Solid Wood
Ultimate flexural strength	N/mm2	Plywood
Ultimate inplane shear strength	N/mm2	Mild Steel E24/A
Inplane modulus	N/mm2	Mild Steel E32-AH32
Total Weight	kn/m2	Mild Steel E36-AH36

Quite similar procedure for stiffeners.

Project 001

03/03/2012

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IMPORTANT NOTE

Weights indicated for laminates in tables below are dry fibre weights.

It is necessary to have practical data about how much weights, per sqm, a laminate with an X% of fibre.

On average, it can be said that for a laminate with a 40% in mass of fibre they are necessary about 650 gr/m² of fibre, for every mm in laminate thickness, when using a "mat", and about 1000 gr/m² when using "roving".

GENERAL

Builder		
Building N.		
Type of Hull		Mono Hull
Design category		A "ocean"
Power or Sail		Motor
Length of the Hull	m	24
Length of the fully loaded waterline at mLDC	m	23.56
Beam of the hull	m	5.8
Beam of the fully loaded waterline at mLDC	m	5.75
Chine beam	m	5.5
Depth	m	2.6
Draught at mLDC (TC)	m	1.95
Maximum speed at mLDC	knots	16
v/SQR(Lwl) Coefficient		3.296
Operating mode		Displacement
Loaded displacement mass of the craft	kg	68500
Deadrise angle at 0,4 LWL forward of its aft end	°	25
Water specific gravity	kg/m ³	1025

PLATES**hand lay up, 8.7 mm thick**

Plate's material		Glass
laminated kind of ply		Mat (WR), Manual lay-up
moulding Type		Open mould simple surface
Evaluation Level (EL) of mechanical properties		EL-b
mass content of fibre	%	40.7
Total Thickness	mm	9.217
Total Weight	kg/m ²	5.75

MATS & ROVINGS

MAT 450

ROV 800

800RV-450M

1700RV-300M

ROV 800

MAT 450

STIFFENERS

Glass Rectangular 50x150

Type of Stiffener		User defined, rectangular
Stiffener's Material		Glass
laminated kind of ply		Mat lay-up (WR) by hand by contact
Glass content in mass	%	30
Moulding Type		Open mould simple surface
Evaluation Level (EL) of mechanical properties		EL-b
Web Depth	mm	150
Base Width of the Profile	mm	50
Web Thickness	mm	5.254
Flange Thickness	mm	8.777
Neutral Axis	cm	7.5
Shear Section Area	cm ²	7.88
Minimal value for First Moment of area	cm ³	78.219
Second Moment of area	cm ⁴	586.6425
Weight or the Stiffener	kg/ml	4.75

MATS & ROVINGS

MAT 300

MAT 450

MAT 600

800RV-450M (only on crown)

800RV-450M (only on crown)

MAT 600

MAT 300

BOTTON

Stern : panelbotton	Units	Values given by the User	As per ISO 12215-5
Panel's Composition		hand lay up, 8.7 mm thick	
Panel's Material		Glass	
Mass content of glass	%	40.7	
Thickness	mm	9.217	7.894 (formula 35)
Deflection	mm		
Shorter dimension of plate panel	mm	410	
Longer dimension of plate panel	mm	705	
Design pressure	kN/m ²	---	70.378
Flexural Moment along "b" direction	N/mm/mm	948.377	
Shear stress at b/2	N/mm	12.869	
Distance of mid panel from of aft end of LWL	m	3.2	
Minimun dry fibre mass por the lay-up	kg/m ²	3.963	3.39
Panel's weight	kg/m ²	5.75	

COEFFICIENTS AND PRESSURES USED IN THE CALCULATIONS

$$k_{DC} = 1$$

$$n_{CG} = 3$$

$$k_{AR} = 1$$

$$k_L = 0.614$$

$$PBMD \text{ base} = 114.621$$

$$PBM \text{ MIN} = 38.946$$

$$PBMD = 70.378$$

$$k_2 = 0.481$$

$$k_3 = 0.026$$

$$k_C = 1$$

$$k_{SHC} = 0.446$$

SIDE

Stern : frmside	Units	Values given by the User	As per ISO 12215-5
Stiffener Type		Omega 40x40x60	
Stiffener's Material		Glass	
Stiffener's Mould		Open mould simple surface	
Glass content in mass	%	30	
Arrangement of the Stiffener		attached to hull or panel	
Crown of a curved stiffener	mm		
Unsupported span of stiffener or frame	mm	1000	
Stiffeners spacing	mm	750	
Effective extent of plating connected to the stiffener	mm	---	215.02
Design pressure	kN/m ²	---	38.817
Bending Moment	Nm	---	
Neutral Axis	cm	1.47	
Shear area, Stiffener + Attached Plate	cm ²	24.28	7.043
First moment of area (Wx)	cm ³	123.592	57.082
Second moment of area (Ix)	cm ⁴	181.5218	23.6541
Stiffener's weight + attached `plate	kg/ml	12.769	
Height of stiffener's midpoint above WL	m	1	
Distance of mid stiffener from of aft end of LWL	m	2	

COEFFICIENTS AND PRESSURES USED IN THE CALCULATIONS

$$k_{DC} = 1$$

$$n_{CG} = 3$$

$$k_{AR} = 0.593$$

$$k_L = 0.572$$

$$k_Z = 0.998$$

$$PDM \text{ base} = 22.846$$

$$PSM \text{ MIN} = 21.204$$

$$PSMP = 0.0155$$

$$k_{CS} = 1$$

$$k_{SA} = 7.5$$