Knot strenght in fishing nets: testing a new device developed at POLICAB

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ABSTRACT. This paper presents an analysis of the strength and deformation of the fishing nets developed at POLICAB laboratory at Federal University of Rio Grande, emphasizing: a) the construction of a device to set nets in a mechanical testing machine, b) the development of the appropriate test procedures, c) the execution of the tension tests in fishing nets and d) the analysis and the processing of the data. The study discusses the important mechanical characteristics of the fishing nets and the stress distribution when tension efforts are applied.

KEYWORDS. Fishing nets; Mechanical testing; Stress analysis.

INTRODUCTION

Fishing nets are the tools of the fishing activity and there are several types available. The rupture of the nets during fishing is very common, causing problems to the fishermen and to the environment. Many of these nets are lost, resulting in undesirable residues that pollute the marine environment and may harm wildlife. However, currently, little is known about the mechanical properties of knotted structures such as fishing nets. There is also little material available about this topic. So, the objective of this paper is to develop a study of the characteristics of the fishing nets made of polyamide monofilament when subjected to tensile stress at POLICAB - Laboratory of Stress Analysis at Federal University of Rio Grande (FURG). Some parameters to compare different characteristics of these structures, obtained by mechanical tests, are also established, as well as the design and construction of a set of test devices. The results obtained in this study are compared with the ones that comply with ISO - 1806 (1973).

CONDITIONS OF THE TESTS

In this paper, new devices and test methods for fishing nets are presented. Since we developed these devices and methods, some test characteristics could only be identified after the devices were built. The less known characteristics during the tests were: the net behavior and the behavior and functionality of the devices. Concerning the nets, only information about tests with closed nets are known (ISO – 1806), but the influence of the opening in the results is not known yet. Concerning the device, only planning and project forecast are known, therefore, several preliminary tests were made, changing some test variables to define the best procedure.
The first variable under study was the size of the specimens, limiting the maximum number of horizontal and vertical meshes. The horizontal and vertical directions refer to the position of the test specimen; they do not have relation with normal and transverse directions of the net (Fig. 1). A preliminary test was made using a mesh size of 9 x 10. In this case,

we observed a non-uniform distribution of the stress along the net; filaments near the center line were submitted to higher tension. Thus, we proposed the following limits for the mesh size:
- Horizontal: 9 meshes. This number is limited by the size of the machine span (EMIC DL 2000) available to allocate the gripping device. An odd number of meshes is necessary to provide a central mesh line.
- Vertical: 10 meshes. This number was chosen to obtain square useful meshes (9x9), taking into account that each end uses half cell to grip (10 - 2 x 0.5 = 9 meshes).

Another variable is the presence of the glue to help specimen gripping. We analyzed the possibility of gripping the specimens without the use of glue. Tests without the use of glue have two advantages. One of them is the speed, because it needs neither time to prepare and apply the glue, nor waiting time for the cure. The other advantaged is the reduction of costs. After these considerations, we proposed the following tests:
(a) CP1: Tensile with Open Net; mesh 10 x 10; using Poxipol glue.
(b) CP2: Tensile with Open Net; mesh 10 x 6; using Poxipol glue.
(c) CP3: Tensile with Open Net; mesh 10 x 6; without the glue (the compression of the grip is responsible for holding the specimen).
(d) CP4: Tensile with Open Net; mesh 10 x 4, without the glue.

The tests were carried out using the EMIC DL2000 machine, where signals obtained by a load cell and a position sensor were processed and converted into forces and deformation, respectively.

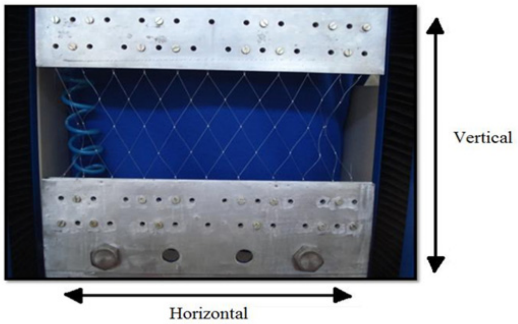


Figure 1: Assembly of the test specimem.

In Fig. 2, CP2 and CP3 curves show that the absence of the glue does not affect the results; if the slip has occurred, some discontinuities would be observed in these curves. This figure shows that the test with six meshes in the vertical direction presents higher resistance than the test with ten meshes. Regarding to the test with four meshes, the load applied to cause rupture in the specimen was higher than the one with six meshes. The reason for this tendency is the diagonal way that the force propagates in the net. Therefore, the longer the vertical length of the test specimen is, the more diagonal lines come loose. So, efforts must be supported by a smaller number of nodes and the length of the filaments must be shorter. However, the number of the free meshes was limited to four, since fewer than four would not represent the real situation well.

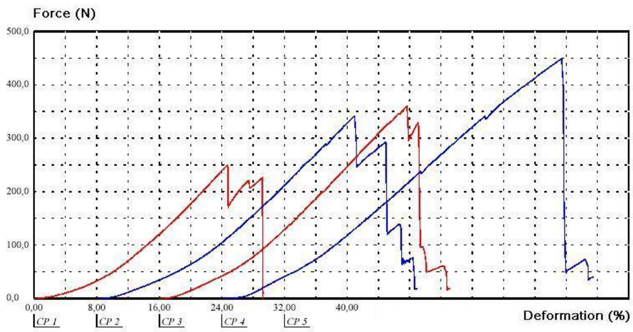
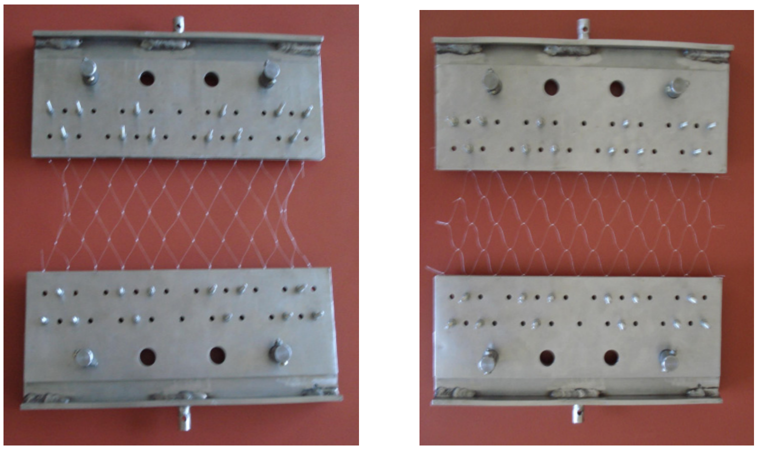


Figure 2: Deformation versus force for tests: (CP1) 10 x 10 mesh with glue, (CP2) 10 x 6 mesh with glue, (CP3) mesh 10 x 6 without glue, (CP4) mesh 10 x 4 without glue.

Another necessary variation was the position of the net related to the force direction (Fig. 3). Firstly the force is applied to the normal direction of the net (Fig. 3 (a)). Secondly, it is applied to the transversal direction (Fig. 3 (b)). A series of tests were made to observe the influence of the net position in the results.



(a) (b)

Figure 3: Assembly of the specimens. (a) In normal direction and (b) in transversal direction.

RESULTS

Fig. 4 shows the test results in terms of force versus deformation for three situations: considering the net in the normal direction, in the transversal direction and in ISO 1806 procedures. Tab. 1 presents some statistic parameters of the tests for each case, including average and standard deviation.

A comparison between open net results shows that the averaged rupture force for the transversal direction is higher than that for normal direction. Besides, the specimen deformation in the transversal position is larger than the other case.

We have observed that the nodes that suffer the first rupture are located near the gripping in both tests. It may happen because this region is more rigid, absorbing more energy and, consequently, more stress.

A comparison between the open net and the ISO 1806 results shows that the former presents higher average forces and lower standard deviation.

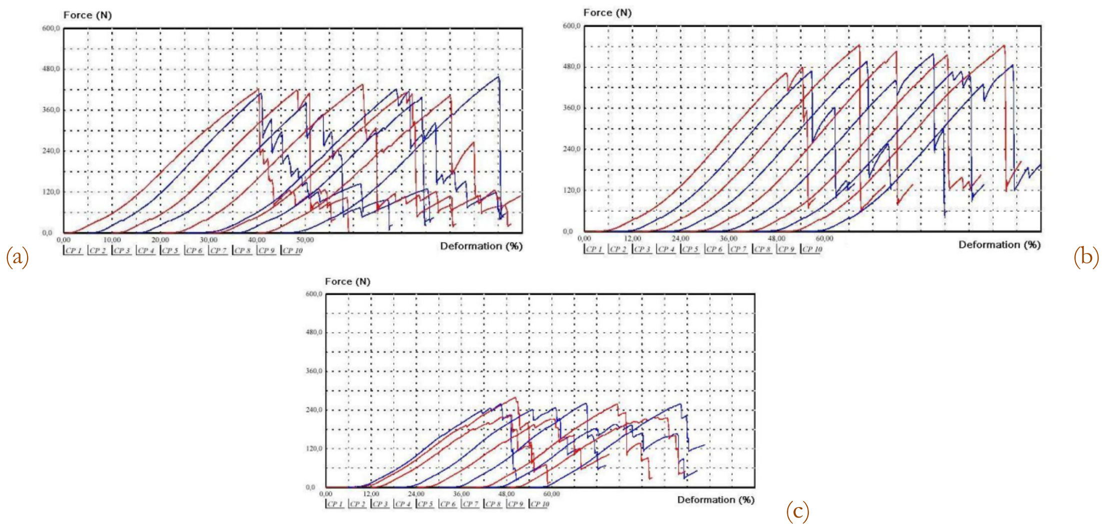


Figure 4: Forces versus deformation for cases: (a) open net in normal position, (b) open net in Transversal position and (c) ISO 1806 procedure.

CONCLUSIONS

In this paper, we have presented an analysis of the tension tests in the fishing nets developed at POLICAB laboratory, located in Rio Grande, Brazil. For the study, we adopted two methodologies; one uses an open net (a new proposal procedure) and the other one is based on ISO – 1806 standard.

Preliminary studies have shown that the use of glue to help specimen gripping was not necessary. Without glue, the speed of the test was increased and the cost was reduced. We have studied the influence of the net position in the deformation and in the rupture of the filaments, concluding that averaged rupture force and deformation for the transversal direction are higher than the ones for normal direction.
Results obtained using the ISO methodology presented lower rupture forces comparing to those in open nets. The latter procedure is a new proposal that can be an option to test fishing nets.

Characteristics / Case	Force [N]		Deformation at Maximum Force [%]		Elongation at Maximum Force [mm]	
	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation
Open Net Normal Position	415.125	25.566	39.35	2.678	47.17	3.215
Open Net Transverse Position	485.185	35.585	52.60	2.781	63.12	3.345
Standard ISO	242.300	26.900	40.32	4.254	48.38	5.105

Table 1: Statistics of the force and deformation for the three cases.

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