TEXTILE STRUCTURES AND PANELS ASSEMBLY FOR LIMITING THE EFFECTS OF MARITIME AND FLUVIAL DISASTERS

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Abstract: *This study presents the constructive solutions for the dams made of textile materials, used in case of disasters in the maritime and fluvial area. The choice of blocking/storage systems must take into account several factors, such as: type and amount of pollutant recovered, flow of recovery units, area of use, hydro-weather conditions in the field, mode of transport, mode of location in terrain. The CAD/CAM/CAE design allowed the realization of 7 textile structures that formed the basis of the CAD design of 14 experimental models (EM), differentiated by: the dimensions used, the materials of the floats, the skirt and the area of use (maritime from 4bf to 10 bf or fluvial).*

Key words: *3D simulation, CAD, digitized technology, pattern, woven fabrics, patterns.*

1. INTRODUCTION

Pollution of the marine environment with hydrocarbons is a worrying phenomenon, which has taken an unprecedented scale since the 1960s.

The sources and causes of pollution have multiplied year by year in proportion to the emergence and proliferation of risk factors, especially between 1970s and 1980s.

Incidents in drilling, extraction, transport, transfer operations, loading/unloading, refining, storage, etc. have generated imminent risks, given the dangerous properties of oil and petroleum products. In addition, marine oil pollution may be caused by acts of war against shore-side oil installations [1,2].

The floating element is in the form of a continuous "curtain" and consists of:

- the free board that follows the shape of the wave;
- the skirt that does not allow the pollutant to move in the water and is fixed under the floating element;
- auxiliary systems for fixing the floating elements to each other, maintaining the floating element and the extended skirt in a horizontal position (ballast and chaining), coupling elements.

To describe the phenomena that arise when the fluid is isolated from a floating structure that delimits a mixture (e.g. water and hydrocarbons in open space) and to be able to clearly predict the efficiency of the gravitational storage-separation system, it is necessary to take into account the theories regarding the type of wave, the shape of the seabed and the dimensions of the floating superstructure [3].

Starting from the fundamental theory of system construction, the theories of Fluid Mechanics were studied, which allowed the determination of the potential equations for small amplitude waves, the equilibrium equations for the Trochoidal waves (with solutions for the Stokes waves). These led to the conclusion that, for the realization of water-hydrocarbon mixture separation-storage systems, textile structures with a mass of 180 m2 - 400 g/m2, thicknesses of 0.2 - 0.5 mm and a thermal resistance of 0.071 m2K/W (for the balance heat flow in summer or in the situation when it passes from inside to outside, during winter must be used) [4,5].

The woven textiles under analysis contain cotton, polyester (PES), polyamide (PA) and polyamide 6.6 (PA6.6) yarns, with tenacity values of min. 0.60 N/tex and max. 12.4 N/tex, loop resistance of min. 100 N, knot strength of min. 80 N.

For the calculation and simulation (FEM), the real exploitation conditions of the marine environment, the state of agitation of the sea at 4bf, 6bf, 7bf and 10bf, which implies a wind speed of 11 - 55 kt (20 - 102 km/h), wave height from 1.5 m to 12 m and distributed pressures starting with 1500 N/m2 and increasing up to 12000 N/m2, respectively, were taken into account.[5.6]

2. MATERIALS AND METHOD

2.1 Textile structures used for the development of the experimental models

The results obtained following the use of CAD/CAM/CAE techniques allowed the design and development of composite structures for the realization of the experimental models (EM) (table 1)

Table 1: Composite structures design data and characteristics

Composite structure	Design data / Identification EM	
1	2	
C1	Fibrous composition	100% bbc
	Width	140 cm
	Weave	Basket weave
	Finishing type	polyurethane (PU) film coating
	Colour	Khaki
C2	Fibrous composition	45%/55% PES/PA
	Width	150 cm
	Weave	Rep weave
	Finishing type	PU impregnation
	Colour	Orange
C3	Fibrous composition	45%/55% PA6.6/PES
	Width	150 cm
	Weave	Rep weave
	Finishing type	PU impregnation
	Colour	Purple
C4	Fibrous composition	100% PA6.6
	Width	150 cm
	Weave	Plain weave
	Finishing type	PU film coating
	Colour	White

Table 1: Continue

1	2	
C5	Fibrous composition	100% PES
	Width	150 cm
	Weave	Plain weave
	Finishing type	PU film coating
	Colour	Green
C6	Fibrous composition	100% PES
	Width	140 cm
	Weave	Basket weave
	Finishing type	PU film coating
	Colour	Grey
C7	Fibrous composition	100%PES
	Width	150 cm
	Weave	Rep weave
	Finishing type	PU film coating
	Colour	Turquoise

2.2 Constructive solutions for the experimental models of floating elements

The constructive solutions for the floating elements, the dimensions of the patterns that will be modelled and simulated using specialized program, as well as the developing technology of the 14 experimental models are presented below.

EM01 and EM02 - use: marine environment and fluvial area

Float construction shape: straight circular cylinder;

Float dimensions: bases – circles with diameter of 300 mm, length 900 mm

Float material type: C4 and C5;

Float closure mode: 20 mm wide Velcro tape placed at 1800 from the skirt;

Assembly method: the joint of the circles of straight circular cylinder with the rectangle is a French seam, finished on the outside with 2 mm pin stitch. When joining the skirt with the floating cylinder, the grosgrain is added in order to increase the resistance of the seam.

EM03 and EM04 - use: marine environment and fluvial area

Float construction shape: straight circular cylinder;

Float dimensions: bases - circular surfaces with diameter 600 mm, length 1200mm

Float material type: C1;

Float closure mode: 20 mm wide Velcro tape placed at 1800 from the skirt;

Assembly method: as per EM01 and EM02

EM05 and EM06 - use: marine environment and fluvial area

Float construction shape: straight circular cylinder;

Float dimensions: bases - circular surfaces with diameter of 300 mm, length of 900 mm;

Float material type: C3 and C6

Assembly method: the joint of the circles of straight circular cylinder with the rectangle is a French seam, finished on the outside with 2 mm pin stitch. On the diameter of the cylinder bases are applied 250 mm wide grosgrain tapes that allow the cylinders to be fastened, in order to be able to lock the cylinders between them and capture the oil fractions.

EM07 and EM08 - use: marine environment and fluvial area

Float construction shape: straight circular cylinder;

Float dimensions: bases - circular surfaces with diameter of 600 mm, length of 1200 mm;

Float material type: C1 and C5;

Assembly method as EM05 and EM06

EM09, EM10 and EM11 - use: marine and fluvial harbors

Float construction shape: frustum

Float dimensions: large base with diameter of 530 mm, small base with diameter of 100 mm;

Float material type: C3, C4 and C7;

Assembly method: the large base of the circle of the frustum cone is assembled through a French seam followed on the outside by 2 mm pin stitch. The small base of the frustum consists of 2 overlapped circles, stitched together, and on the diameter of the small circle was applied 50/60 mm grosgrain tape. To cover and reinforce the edge of the small circle of the frustum 25 mm einfas tape was added. A loop of 100 mm folded length grosgrain tape with the 20 mm width was added over the wide grosgrain tape. Through this loop, a cable tape will be inserted to hold the frustums between them in order to achieve the system of blocking and capturing the oil fractions. On the side of the cone trunk a waterproof zipper with a length of 360 mm was stitched.

EM12, EM13 and EM14 - use: marine environment and fluvial area

Constructive shape of the float: straight circular cylinder;

Float 1 dimensions: bases - circular surfaces with a diameter of 300 mm, length of 1200 mm;

Float 1 material type: C2 and C3;

Float 1 colour: EM12 (C3), EM13 (C3) and EM14 (C2);

Float 2 and 3 dimensions - submerged elements: bases - circular surfaces with diameter of 300 mm, length of 1200 mm;

Float 2 and 3 material type: C2, C4 and C3;

Float 2 and 3 colours: EM12 (C2), EM13 (C4) and EM14 (C3);

Assembly method: 2 overlapping tapes of 300 mm length each (grosgrain) were applied on the film-coated side of the float and on the film-coated side of the submerged elements. 20 mm length of each end of the grosgrain tape is reinforced.. When joining each skirt with each float, the 20 mm wide grosgrain tape was added in order to increase the resistance of the seam.. On the diameter of the floating cylinder, the grosgrain tapes were added, which allow the cylinders to be attached to each other to achieve the system of blocking and capturing oil fractions. 1070 mm length waterproof zippers were applied on each base of the cylinder.

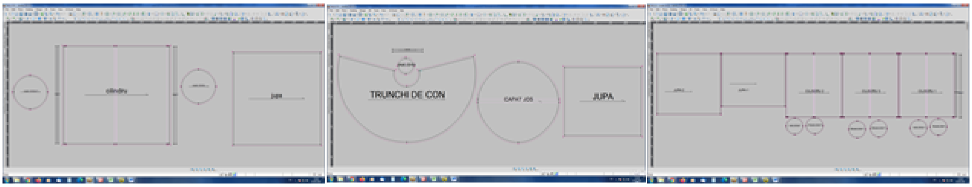
3. RESULTS

3.1 CAD design of the experimental models

In order to obtain the virtual experimental models (EM01 - EM14), the Optitex Pattern Making PDS software (EFI Optitex) from INCDTP was used. Using the modules included in the program, the changes made to the patterns were transferred to the virtual model.

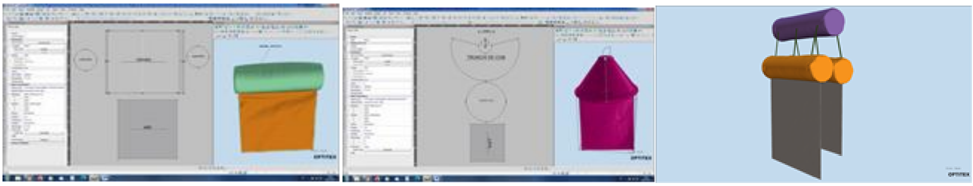
3.2. Design stages EM01 - EM14

Construction of the 2D pattern, with the help of the integrated PDS software (figures 2 and 3).



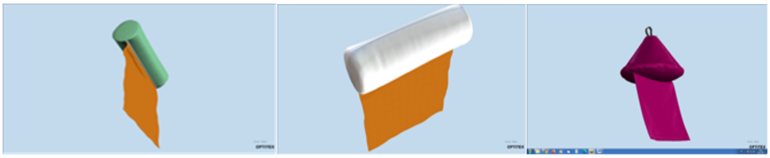
a b c

Figure 2: Design of the patterns for: a - EM01 - EM08; b - EM09 - EM11; c - EM12 - EM14

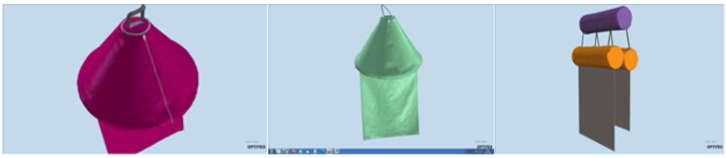


a b c

Figure 3: Insertion of the determining parameters values of the materials for: a - EM01 - EM08; b - EM09 - EM11; c - EM12 - EM14



a b c



d e f

g h

Figure 4: 3D simulation for: a and b - EM01 - EM08; c, d and e - EM09 - EM11; f, g and h- EM12 - EM14

4. CONCLUSIONS

- The 14 experimental models that have been designed vary depending on size, material and pattern in order to meet the requirements of the marine and fluvial environment. The EMs meet several requirements imposed by the exploitation in real conditions of use, such as the concentration on a strictly delimited area of oil residues, distance from the intervention base to the polluted area, the state of agitation of the marine environment.
- The use of CAD/CAM/CAE techniques allowed the design and development of 7 composite structures identified as C1-C7, which were used to make the experimental models EM01-EM14.
- The combination of woven fabrics for different dimensions of floating elements and skirts was made in order to verify the dimensional stability of the composite material, resistance to solar radiation, to large temperature variations and to sea agitation (4bf-10bf) [2].
- The CAD design made using the Optitex software allowed the visualization of the patterns created for each experimental model. All 14 experimental models were assembled within the pilot station of INCDTP, using provided equipment. The developed experimental models will be tested at the berth in the Port of Constanta and at the embankment in the Port of Galati.

5. REFERENCES

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