"Mircea cel Batran" Naval Academy Scientific Bulletin, Volume XVIII – 2015 – Issue 2
Published by "Mircea cel Batran" Naval Academy Press, Constanta, Romania // The journal is indexed in:
PROQUEST SciTech Journals, PROQUEST Engineering Journals, PROQUEST Illustrata: Technology, PROQUEST Technology Journals, PROQUEST Military Collection PROQUEST Advanced Technologies & Aerospace

ASPECTS OF OBTAINING COMPOSITE MATERIALS

Aurelia CHIOIBAS[1]
[1]Eng. PhD, lecturer Dep. IMAN, Naval Academy "Mircea cel Batran"

Abstract: *The fiberglass reinforced plastics are characterized through an excellent ratio strength/weight, a good heat insulating and the sound-proofing at ship's side, the fireproof ness, the fatigue endurance limit, the resistance to shock, the water degradation resistance. Those features suggest for the shipbuilding in the military zone and civil.*
Keywords*: the fiberglass reinforced plastics, the shipbuilding*

Introduction

In 1940 he was made the first experimental fiberglass structure of naval domeniu, which demonstrated widespread application possibilities of this new material, whose relation strength / weight is excellent [1]. In the military field, the first ship with MPFS body (plastic reinforced with fiberglass) was mine dredger "Wilton" (England) in 1973. Subsequently were builtspeedboat, mine sweeper, vedette boat, landing ships, boats fleet service, rescue boats and harbor service.

Base materials

Reinforced plastics (MPA) are formed from [1]:
- the plastic liaison (MP) (thermoplastic or thermoset) matrix forming system and ensure the connection between elements reinforcing material, limiting their movement and ensuring their mechanical protection [2];
- reinforcement material (MA) (fibers or particles), which is embedded inplastic material that greatly influence the mechanical properties of the composite; where appropriate, additional materials (pigments, dyes, flame retardants and others) that improve the aesthetics of composition and change in physical properties of its small extent.

Also called *matrix, the bonding materials* can be: a) an organic nature: unsaturated polyester resins [3], epoxy, phenolic, b) inorganic nature: metals, ceramics - used infrequently. For shipbuilding classification societies recommend unsaturated polyester resin.

Reinforcement materials:

a) *Fiber glass*. Under this name is understand different items obtained on glass yarns and fibers in the form of: yarn (roving), chopped or milled fibers, felt (mats) fabrics. They are obtained by the spinning process followed by operations (chopping, weaving) leading to the desired products.
b) *The fibers* can be: twisted (roving), twisted to the left (SI), right (Z) or cords (double twist). For shipbuilding factory next types of unidirectional glass fiber reinforcement, weaving and winding, symbolized as [4]: EC.15.320.P437; EC.15.735.P437; EC.15.1200.P437; EC.15.2400.P437; EC.15.4800.P437; TIP 2117R EC.15.2400.P437R; TIP 2105R EC.10.2400.P421R. Explanation of the symbols is as follows: E - E glass; CA - spinning method is continuous; 15; 10 - the average diameter of the microfilament [μm]; 320; 735; ...; 4800 - shows average filament fineness (weight in grams of 10,000 meters of thread called tex); P437, P437R - indicate the nature of gluing material; the modulus of elasticity of glass fiber is 7300daN / mm2. The wire is also used to getting chopped roving, the mat's, parts in unidirectional mechanical stress occurring, Ground glass fibers are used to obtain composites, forming mixtures and mixtures for repairs and puttys.
c) The Mat is a felting of chopped glass fibers fixed by a binder, made in the form of blankets. Allows the double curved surface modeling, specific the hull having approximately the same physical properties in all directions. The most suitable material for building boats are weighing 450 to 600 g / m2.
d) *The fabrics are made with glass fiber and yarn, which will then be dipped in plastic material (ERF 3, ERF 8).*
e) *The inorganic fibers, minerals and synthetic* Aromatic polyamide fibers (Kevlar) high mechanical properties, which is why they are used for: cable for anchoring traction of the masts and tall chimneys, thermal insulation and sound systems and vibration damping, and others.

The supporting materials:

a) *The separating materials*. Because the resins do not stick to the mold,on its surface is covered by a separating layer (form-release oils).
b) *The materials for the coloring*. The process is the most widely applied the coloring mass by adding pigments or pigment paste in the resin mass.
c) *The thixotropic materials* are introduced in resins for: reducing shrinkage (internal stresses and cracking tendency); influences the mechanical properties; improves surface quality decorative and others.
d) *The flame retardants*, which are intended to retard development of flame.

e) *The light stabilizers*, which are designed to absorb UV or convert it into heat, because unsaturated polyesters strengthen turn yellow at action of sunlight.

Execution of models and dies

Materials for models

They can be made of: plaster, wood, plywood, metal, and others. For shipbuilding prefer the execution models of linden wood, pine or other hardwood that are made mold and which are made part of the MPFS.

Principles constructive of the models

1) The transition from one surface to another is done with radius because the sharp edges make it difficult molding the fiberglass fabrics, and then leading them to fracture in these areas;
2) 2) For the avoidance bending parts with large flat surfaces is recommended that edge to be bent single or double or consolidating these edges, by embedding a wooden rod, pipe or metal bar (fig. 1); to avoid bending of these areas is recommended hardening by profiling without wall thickening (Fig. 2);
3) The holes or crossings through walls (required extraction from the mold of the piece) must lie against

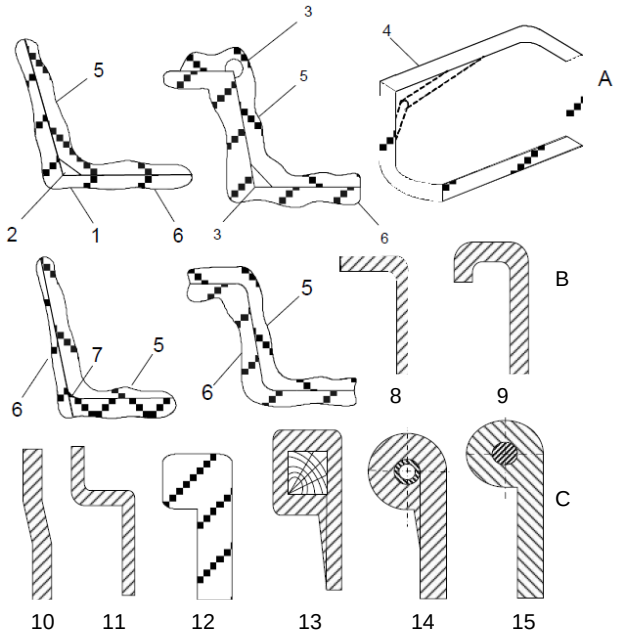

Fig. 1: Formation of the edges and the abuttals: A - faulty edges: 1 – areamore resin; 2 - air included; 3 - separation; 4 - deformed wall; 5 - laminate; 6- Form; B - right edges (rounded); 7 - wax; 8 - simply bent; 9 - double bent; C - reinforced edges: 10 - good; 11 - very good; 12 - undesirable (at most pressing); 13 - wood; 14 - pipe; 15 - bar.

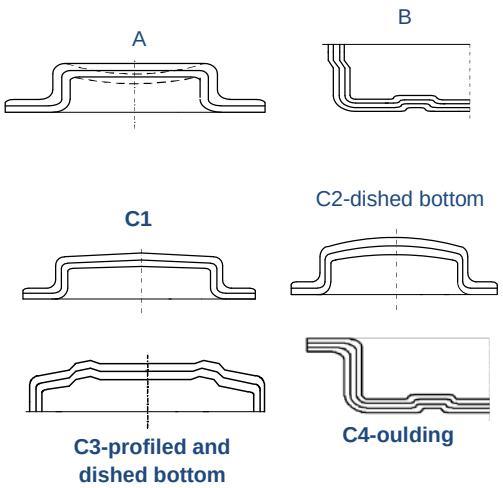

Fig. 2: Hardening by profiling: A - deformation plane surfaces; B - bumps surfaces due to wall thickening; C1 - C4 - hardening by profiling

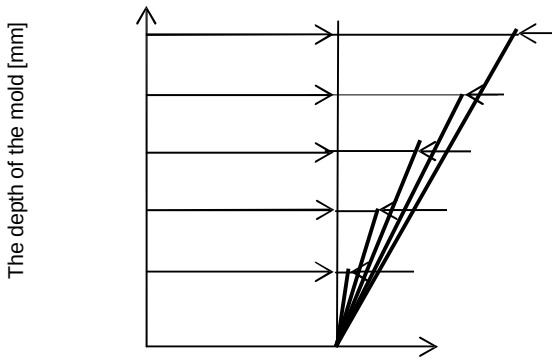

Fig. 3: Tilting of the walls piece depending on the depth

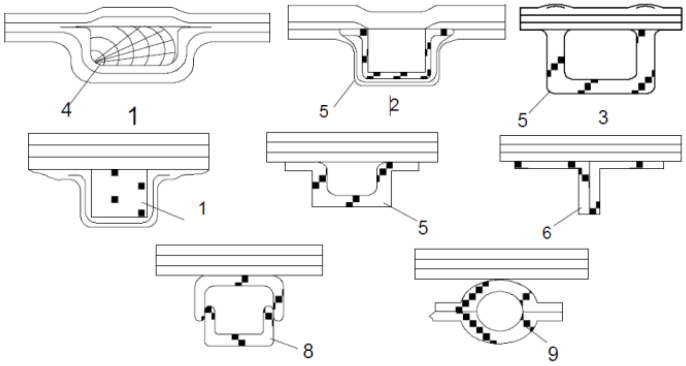

Fig. 4: Stiffener by ribbing: 1 - embossing; 2 - recess; 3 - waves; 4 - rib of the wood; 5 - rib steel; 6 - rib reinforced polyester; 7 - rib rigid polyurethane foam square shaped, trapezoidal or semicircular; 8, 9 - ribbed reinforced polyester

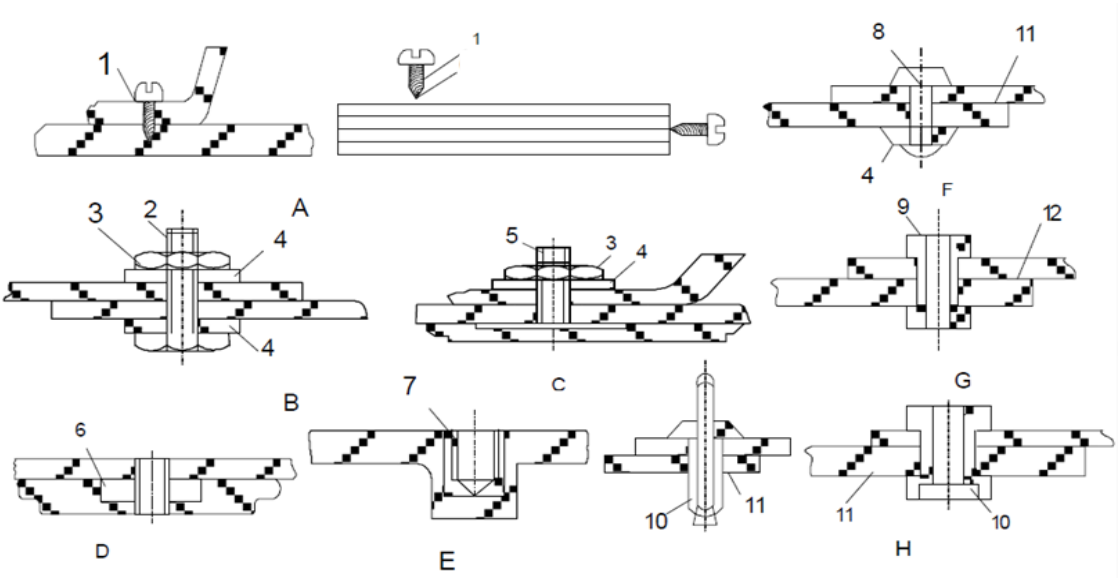

Fig. 5: Systems for screwed and riveted butt: A - clamping grub screw (1); B - the clamping screw (2), the ring (4) and the nut (3); C - clamping with threaded bolt (5); D - Built-threaded mounting plate (6); E - expandable fixing nut (7); F - round head rivet fasteners (8); G - rivet fastening pipe (9), H - pop rivet fasteners (10); 11 - metal; 12 - plastic

the wall or to each other at a distance of at least twice the diameter of the hole;

4) To remove of the parts from molds, their walls must present obligatory inclination, which depends on the depth of the mold (Fig, 3);
5) The tolerances are established depending on the piece size and processing mode (manual, cold). Edges model are higher by 20 mm, so that after cutting them to size, edge play to stay clean.

The execution of the molds

The mold is rigid support which seals tightly fiberglass reinforcement and liquid resin in sustaining the goes to solid state. It is done manually on wood models or existing object. To die is very important to have a surface layer of gel 0.4 mm reinforced mat surface. The molds can be made from wood, metal, heavy metal (the costs are amortized only a large number of products), polyester resin reinforced with fiberglass, gypsum, concrete. The molds used for manual molding process for small and medium series are made of polyester resin reinforced with fiberglass [5].

The mold wall thickness (4-8 mm) should be 2 times thicker than the finished piece and is obtained by applying several layers of material. Hardening of the molde with ribs from wood, metal or plastic armed is obligatory for it to not deform during work (Fig. 4). Because the piece to be easily removed or to delineate parts of the mold is necessary to establish the separation plane, which can be placed in the right ribs or planes of symmetry of the object.

Technologies execution of the tiles of plastic material glass fiber reinforced (MPFS)

The manual technology forming

The technological process of casting a MPFS boat coversfollowing steps ([5], [6]):

A) Surface preparation of the mold:
1. degrease mold of possible traces of polyvinyl alcohol and wax from previous casting;
2. are abraded any irregularities with fine sandpaper;
3. be controlled through palpation of the smoothness along or breadth of the mold;
4. eliminate all traces of dust with compressed air gun;
5. cover any openings for introducing compressed airrequired to retrieve the piece.

B) Application of releasing agent (of separation):
1. apply an even layer of wax and after drying apply the second;
2. after drying polished with a soft cloth;
3. apply a layer of polyvinyl alcohol and after drying apply the second.

C) Application of decorative coating (gelcoat) rich in resin:
1. apply a layer of resin and was allowed to gel;
2. apply the second layer, which is reinforced with mat (veil) to the surface;
3. after drying, if necessary, apply a sanding.

D) The application of successive layers of resin impregnated reinforcement materialunsaturated polyester:
1. degrease the surface with solvent;
2. apply a coat of resin followed by application of a fabric;
3. after drying the surface is polished;
4. reinforcement layers are applied to the required thickness FS;
5. the inside finishing is processed by.

E) The polymerization and curing the resin:
1. the molded product is left for 24 hours at room temperature;
2. cut the surpluses that exceed the edges of of the mold;
3. the verification of polymerization is done by measuring hardness cure or measurementssonic (hitting product).

F) Demolding the product:
1. compressed air is introduced between the mold and the product;
2. to help remove product with wooden wedges.

G) The finishing of product:
1. remove polyvinyl alcohol and wax;
2. air pockets will be puttied;
3. burrs with sandpaper is finished with water and soap.

H) Maturation (post polymerization) is performed for 21 days so that the mechanical properties of the laminate to reach maximum values; after stripping the object is placed on tripods to prevent deformation of.

Mechanical processing of MPFS. Defects and Impairments

Mechanical working

The further processing [7] are less numerous due to the content reinforcement and filler materials which require the use of special tools, tougher, equipped with carbide plates or diamond impregnated. Removing dust require wet processing.

To the manual formation, cutting operations can be applied in a gel state, but have the disadvantage of flaking and delamination occurrence. Not recommended for cutting in its cured state using band saws or circular steel due to rapid wear. For this reason using diamond cutting discs electrically operated or pneumatically. Cutting to curved contours are executed with diamond cutting discs with cooling liquid.

Lathe tools, milling cutters and drill bits have a special geometry and are equipped with carbide plates or diamond impregnated. The processing is

performed only by cooling. A cutting mode incorrectly can cause overheating of the material and its closure in color.
Surface grinding is wet belt sander, disc or soles vibrating devices. Abrasive materials are strips or sheets whith"electrocorundon" granules, silicon carbide. Polishing is done with brushes and discs that were preloaded with polishing paste.

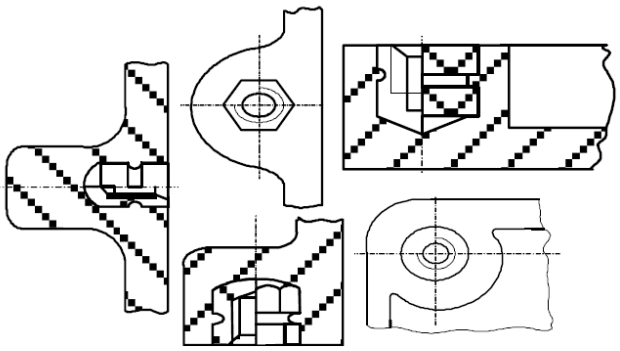

Fig.6. The recessed of the nuts in the teats

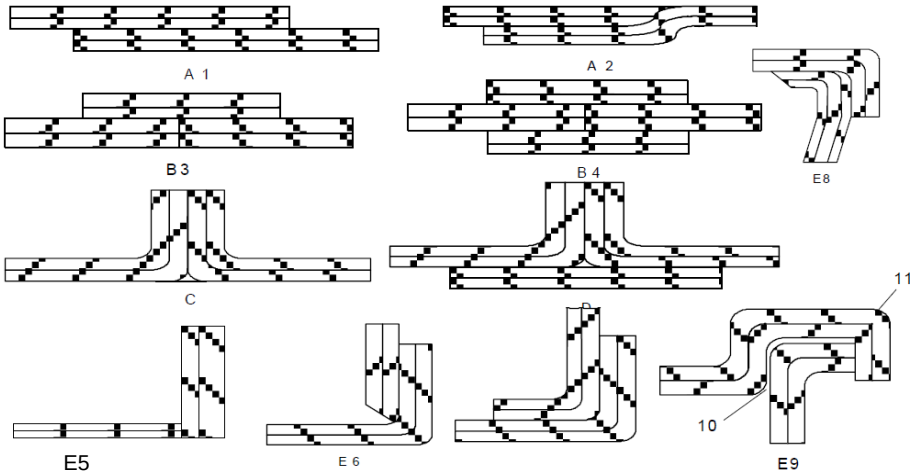

Fig. 7. Soldered joints: A1, A2 - simple overlapping and bending;
B3, B4 - single-strap lap joint; C - angle; D - angle and strap band;
E5 - E9 angle of two parts; 10 - adhesive; 11 - added material

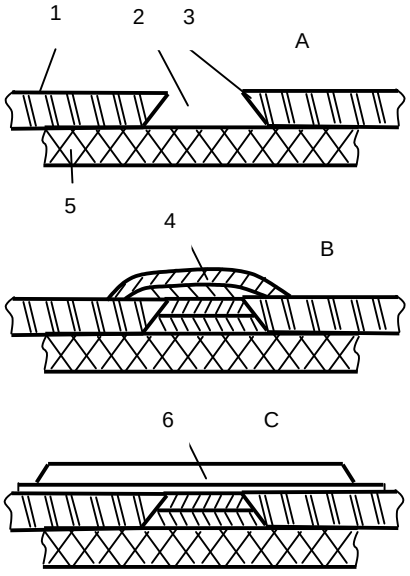

Fig. 8: Repair of a break through technology in a laminated polyester; A -site preparation; B- fracturerepair; C- strengtheningrepair; 1 -laminate; 2 - damaged area; 3 -chamfer; 4 -multilayerrepair; 5 - temporarymoldorcellophane; 6 -rib

The parts of resins is made in two ways:

1. mechanical: with self-tapping screws - perpendicular to the reinforcement piece; with nuts embedded in the wall piece or a boss; with bolts / screws, nuts and washers large; with nuts expandable screw to screw; slight rivets (pop rivets) (fig. 5.6);
2. by sticking on large surfaces when shear forces appearing (Fig. 7).

Malfunctions and deteriorations

Remediable manufacturing defects that may occur are: wrinkling of the decorative surface layer (gel-coat), star-shaped cracks, pores, voids in part thickness, surface cracks. Deep cracks and delamination are practically irreparable.

Superficial damage repair with fast setting polyester putty, then apply abrasing and polishing. Ruptures be remedied by reassembling the pieces and sticking them. After hardening,abrasing both sides, and cover with several layers of fabric or material, while the front will be putty and painted.

Cracks can be repaired according to the following technology:

1. the edge cracks cut with a saw and then make chamfer with a rasp;
2. the face that remains smooth apply a cellophane, and on the opposite increases the surface roughness on the ring width 5 cm;
3. apply successive layers of material or fabric and resin, starting the hole and then a larger area; if large breach on behind repair is fixed one or two ribs (Figure 8);
4. the face is polished, isputted and is painted;
5. in the case of very large breaches, repair is done by placing the piece inside mold.

BIBLIOGRAPHY:

[1] IspasȘ., *Materiale compozite,* Editura Tehnică București, 1987
[2] Horun S., *Memorator de material plastic și auxiliari,* EdituraTehnicăBucurești,1973, seria "Polimeri"
[3] Motiu M., Palade T., *Rășini poliesterice nesaturate. Sinteză și aplicare,* Editura Tehnică București, 1987
[4] Mihalcu M., *Materiale plastic armate,* EdituraTehnică București, 1986
[5] Patrichi I., *Contribuții la calculul și construcția planșeelor confecționate din mase plastic armate cu fibră de sticlă*, Teză de doctorat, Galați, 1998
[6] Patrichi I, Novac I, Construcția și calculul structurilor navale din material plastic armat cu fibră de sticlă, EdituraGaudeamus, Constanța 2000
[7] Gibbs and Cox, Inc, *Marine design manal for fiberglass reinforced plastics. Naval Arhitects and marine Engineers*, 1960