As per UGC guidelines an electronic bar code is provided to seure your paper

International Journal for Modern Trends in Science and Technology, 8(01): 318-323, 2022

ISSN: 2455-3778 online
DOI: https://doi.org/10.46501/IJMTST0801055
Available online at: http://www.ijmtst.com/vol8issue01.html

An Overview of Marine Textiles

Manisha Kumari | Sakshi*

Department of Clothing and Textiles, College of Home Science, GBPUA&T Pantnagar, Uttarakhand, India.
*Corresponding Author Mail Id: sakshi_ct@rediffmail.com

To Cite this Article
Manisha Kumari | Sakshi. An Overview of Marine Textiles. *International Journal for Modern Trends in Science and Technology* 2022, *8* pp. 318-323. https://doi.org/10.46501/IJMTST0801055

Article Info
Received: 17 December 2021; Accepted: 15 January 2022; Published: 18 January 2022.

ABSTRACT

Textiles are used for both practical and ornamental purposes. Technical textiles include the majority of textiles with functional qualities. Textiles are used in a variety of industries, including the marine sector. Marine and human activity has existed since before the dawn of civilization, and there have been continual improvements to this day. Marine textiles are specialist technical fabrics that must have unique qualities and meet stringent performance requirements. Clothing, furniture, carpets, canvas, burlap, ropes, beds and other textile items are widely utilised in the sea environment are covered in Marine textiles. Textile comfort, design, and aesthetics are vital in maritime areas for providing a soothing experience for users. Technical textiles are used in maritime applications because they demand very high performance criteria and particular qualities. Textiles used in the marine environment should be durable to exposure of sunlight and resistant to action of saltwater and ultraviolet (UV) radiation. Important safety features which must be incorporated are flame-retardancy, light weight and antifouling. Due to harsh environment in marine, natural and synthetic textiles used in marine should be reinforced with different functional materials and techniques. Reinforced composites are used to replace traditional materials for ship construction. More preferred fibers used in marine construction are glass, carbon, Kevlar and resins.

KEYWORDS: Technical textiles, marine textiles, high performance fiber, products, fibres

1. INTRODUCTION

Main aim of textile in the beginning was to protect human being from the varying climatic conditions [21]. Before invention of textiles, man first covered his body with leaves, plant fibres and leather. Now a days textile is used in the different fields apart from covering body (clothing) such as home textiles and technical textiles. Field of technical textiles is expanding area of textile industries. One of reason for expansion in technical textile is researches in development of new yarn and fibres. During 1980s wide range of new materials were introduced in various technical fields such as Agrotech, Geotech, Indutech, Medtech, Mobiltech, Oekotech, Packtech, Protech and Sporttech. Marine industry is one of sector were use of textile has increased over period of time. Marine textiles includes application of textile in marine applications are sailcloth, ropes, boat coverings, awnings, flags[1]. Safety equipment which are used in marine are also made from textiles which includes life jackets and inflatable life rafts, boat covers, decorative trim, exterior upholstery, flooring, headliners, ropes, nets, fabric, coated fabric & composites so on. Apart from this textile are also used for making hoods, tarpaulins, protective covers, rear closures, but also for decorating and boat furnishings.

Marine textiles are specialized technical textiles as they require special properties and high performance specifications. Comfort, design and appearance of

textiles are important for providing users with a relaxing atmosphere in marine environment[17]. Properties of textiles used in marine usage should be durable to sunlight, resistant to action of saltwater and ultraviolet (UV) radiation. Important safety features which must be incorporated are flame-retardancy, light weight and antifouling [18,2]. Due to harsh environment in marine, natural and synthetic textiles used in marine should be reinforced with different functional materials and techniques. Reinforced composites are replacing traditional materials for ship construction. More preferred fibers used in marine construction are glass, carbon, Kevlar and resins.

STRUCTURE OF PAPER

The paper is organized as follows: In Section 1, the introduction of the paper is provided along with the structure, important terms and overall description. In Section 2 we discuss about marine fabric history. In Section 3 we have the complete information about textile materials used in marine applications. Section 4 shares information about reinforcement fabric construction viz woven and knitted reinforcement. Section 5 tells us about the quality standards. Section 6 tells us about the **uses of textiles in marine application** and conclusion of the paper with references.

2. Marine Fabric : A History

The origin of marine materials may be traced back to canvas. Canvas is a strong, tightly woven cloth with a wide range of applications. The term "canvas" is derived from the Arabic word "cannabis," which is the Latin equivalent of "hemp." The weave of canvas is relatively basic, with one thread running over and then beneath the other. This results in a fabric that is extremely robust and frequently water-resistant. Hemp is the world's oldest fabric-yielding plant. People in China were weaving hemp cloth as long back as 3000 B.C. Cotton was woven into garments approximately 1500 B.C. in India, according to records. Cotton was brought to Europe by the Saracens and Moors from North Africa. In Barcelona and Venice, cotton canvas was used to make ship sails, and the technique quickly spread throughout Europe [1].

Traditionally, natural materials such as fish nets and ropes were used to create marine textiles. The biggest disadvantage of natural materials is that they are heavy, absorb water quickly, and are prone to decay[21]. Synthetic fibres/plastic composites are being utilised to replace metallic components and more traditional materials with significant benefits, particularly weight reductions. A composite material is described as a substance made up of two or more materials that has greater qualities than the individual components when utilised separately [4]. Reinforcement and a matrix are the two components. Particle-reinforced, fiber-reinforced and structural composites are the three primary divisions in one basic reinforcement-based methodology for composite material categorization. Composite materials have been utilised in a wide range of structural and nonstructural maritime applications virtually since they were first introduced as commercial materials and their use for these applications is continually increasing. The introduction and/or development of structural materials for ship construction is a never-ending process. Wood was the primary shipbuilding material for centuries until shipbuilders recognised that iron or steel ships were stronger, lighter and simpler to maintain than wooden ships.

Wooden ships were considered costly and outmoded by the early 1880s[5]. After World War II, composites were employed for the first time in the production of small people boats for the US Navy. Between the mid-1940s and the 1960s, these boats proved to be rigid, robust, durable, and easy to repair, and these qualities led to a fast spread of composite use in other types of US Navy craft [15]. Composites (particularly Glass Reinforced Plastic) were widely employed in the boat construction business throughout the 1960s, for both recreational and commercial purposes. Over the next few decades, advancements in materials, manufacturing processes, and design tools led composites to be used in a wider range of applications. To ensure that the hulls they were manufacturing were robust enough, early FRP boat builders used "build and test" or empirical approaches. Designers tended to be careful in their usage of fibreglass because it was a relatively new boatbuilding material[7].

3. Textiles materials used in Marine Applications

Fish nets and ropes were made from natural materials were used in olden days. Natural materials had some disadvantage such as they are heavy in

weight, absorb water easily and got degraded due to rotting. With advance in technology now a days even metallic parts are replaced by composite materials as they are light weight. Materials used in preparation of composite used in marine field are classified into three groups, viz., reinforcement materials, resin materials, and core material [4,14]

Reinforcement Materials: Fibers are the principal constituents in a fiber-reinforced composite material. They occupy the largest volume fraction in a composite laminate and share the major portion of the load acting on a composite structure. Proper selection of the fiber type, fiber volume fraction, fiber length, and fiber orientation is very important, since it influences the characteristics of a composite laminate such as Density, Tensile strength and modulus, Compressive strength and modulus, Fatigue strength as well as fatigue failure mechanisms and Electrical and thermal conductivities[13]. Fibers used as reinforcement material are given in table 1[18].

Table 1 Fiber properties

Fiber	Density lb/in³	Tensile strength psi x103	Tensile modulus psi x103	Ultimate elongation
E glass	0.094	500	10.5	4.8%
S glass	0.090	665	12.6	5.7%
Aramid- Kevlar 49	0.052	525	18.0	2.9%
Spectra 900	0.035	375	17.0	3.5%
Polyester-COMPET	0.049	150	1.4	22.0
Carbon-PAN	0.062-0.065	350-700	33-57	0.38-2.0%

Resins: Different resins are used in making marine composites such as polyester resin, vinyl esters resins, epoxies, bismaleimides, cyanate esters, polymides and phenolics. Relative characteristics of above resin matrices are given in Table 2.

Table 2 Relative characteristics of resin matrices[3]

Resin matrices	Characteristics
Polyester	Used in production of continuous and discontinuous composites. It cheap and has flexibility.
Vinyl esters	Similar to polyesters, but are tougher and have better moisture resistance.
Epoxies	High performance matrix systems for primary continuous fibre composites. Used at temperature range of 250-275ºF. Give better performance than polyesters and vinyl esters.
Bismaleimides	High temperature resin matrices for use in the temperature range of 275-350ºF with epoxy like processing. Requires elevated temperature postcure.
Cyanate esters	High temperature resin matrices for use in the temperature range of 275-350ºF with epoxy like processing. Requires elevated temperature postcure.
Polymides	Very high temperature resin systems for use at 550-600ºF. Very difficult to process.
Phenolics	High temperature resin systems with good smoke and fire resistance. Used extensively for aircraft interiors. Can be difficult to process.

Core material: The basic concept of a sandwich panel is that the facings carry the bending loads (tension and compression), while the interior sandwich or core carries the shear loads, Core materials include metallic and nonmetallic honeycomb core, balsa wood, open and closed cell foams, and syntactics. Honeycomb cores are more expensive than foam cores but offer superior performance.

Table 3 Comparative data for some sandwich core materials [7]

Core Material		Density		Tensile Strength		Compressive Strength		Shear Strength		Shear Modulus	
		lbs/ft³	g/cm³	psi	Mpa	psi	Mpa	psi	Mpa	psi x 10³	Mpa
End Grain Balsa		7	112	1320	9.12	1190	8.19	314	2.17	17.4	120
		9	145	1790	12.3	1720	11.9	418	2.81	21.8	151
Cross-Linked PVC Foam	Termanto, C70.75	4.7	75	320	2.21	204	1.41	161	1.11	1.61	11
	Klegecell II	4.7	75	175	1.21	160	1.10			1.64	11
	Divinycell H-80	5.0	80	260	1.79	170	1.17	145	1.00	4.35	30
	Termanto C70.90	5.7	91	320	2.21	258	1.78	168	1.16	2.01	13
	Divinycell H-100	6.0	96	360	2.48	260	1.79	217	1.50	6.52	45
Linear Structural Foam	Core-Cell	3-4	55	118	0.81	58	0.40	81	0.56	1.81	12
		5-5.5	80	201	1.39	115	0.79	142	0.98	2.83	20
		8-9	210	329	2.27	210	1.45	253	1.75	5.10	35
Airex Linear PVC Foam		5-6	80-96	200	1.38	125	0.86	170	1.17	2.9	29
PMI Foam	Rohacell 71	4.7	75	398	2.74	213	1.47	185	1.28	4.3	30
	Rohacell 100	6.9	111	493	3.40	427	2.94	341	2.35	7.1	49
Phenolic Resin Honeycomb		6	96	n/a	n/a	1125	7.76	200	1.38	6.0	41
Polypropylene Honeycomb		4.8	77	n/a	n/a	218	1.50	160	1.10	n/a	n/a

4. Reinforcement Fabric Construction

Reinforcement materials are combined with resin systems in a variety of forms to create structural laminates.

Woven Reinforcement Structure: Woven composite reinforcements generally fall into the category of cloth or woven roving. The cloths are lighter in weight ranging from 6 to 10 ounces per square yard and it requires about 40 to 50 plies to achieve a one inch thickness. They are mainly used in marine construction of small parts and repairs[20]. Weaves used in reinforcement structure are plain, basket weave and satin weaves. The satin weaves are produced in standard four, five or eight harness configurations. Plain weave pattern with slightly more material in the warp direction most common type of reinforcement used for large marine structures because it is available in fairly heavy weights (24 ounces per square yard is the most common), which enables a rapid buildup of thickness. Impact resistance is enhanced because the fibers are continuously woven[18].

Knitted Reinforcement Structure- These were first introduced by Knytex® in 1975 to provide greater strength and stiffness per unit thickness. It is constructed using a combination of unidirectional reinforcements that are stitched together with a nonstructural synthetic such as polyester. Advantage of knitted reinforcement structure is having the reinforcing fiber lying flat versus the crimped orientation of woven roving fiber. These reinforcements can be oriented along any combination of axes [18].

5. QUALITY STANDARDS

Flame retardancy test is very important. Many of the standards for marine textiles are set by International Maritime Organisation {IMO Resolution A471 (XII) for fire resistance} [11]. The International Maritime Organization is a specialised agency of the United Nations responsible for regulating shipping. The IMO was established following agreement at a UN conference held in Geneva in 1948 and the IMO came into existence ten years later, meeting for the first time in 1959. Head office of IMO is at London, United Kingdom. India joined the IMO in 1959. The IMO currently lists India as among the 10 states with the 'largest interest in international seaborne trade'. Recently, India's acceded to the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships a.k.a Hong Kong Convention, which will help in providing a boost to the ship- recycling industry in India. The IMO adopted the Hong Kong Convention in 2009. It is aimed at ensuring that ships being recycled after reaching the end of their operational lives do not pose any unnecessary risks to human health, safety and the environment.

- **The IMO (International Maritime Organisation)** organized a set of international treaties known as the International Code for Fire Safety Systems (FSS Code) under the SOLAS designed to reduce the risk of fire, aid in emergency.
- **ISO 12402 (Personal flotation devices):** defines buoyancy, performance, materials, and accessories requirements
- **BS ISO 9650-3 ISO 9650-3:2009** specifies requirements and test methods for the materials used in the construction of the inflatable life rafts specified in ISO 9650-1 and ISO 9650-2.

6. USES OF TEXTILES IN MARINE APPLICATION AND CONCLUSION

Boat Covers: Whenever a boat isn't being used, it needs to be covered by cover. Cover will help to protect boat from dust and other damages due to weather which occur when not covered. Boat covers are made of a variety of materials including polyester, acrylic, nylon, and cotton-poly blends. For marine grade covers, fiber deniers in the range of 150 – 1200 denier are commonly used. The higher denier fiber fabrics are stronger, more abrasion-resistant and have a more rugged feel, but they are also heavier and more expensive.

Bimini Tops: It is an open-front canvas top for the cockpit of a boat, usually supported by a metal frame. It can be folded when not in use. The Bimini is used mostly as protection from the sun; it offers no protection from wind, rain, or spray when moving forward at any speed. The top provides rain protection only if the boat is stationary and there is no wind. Vinyl coated fabrics (usually polyester) are used because they are waterproof and will divert water to the sides of the top for runoff. They are non breathable but easy to clean and high quality ones can be very durable.

Boat Fabric Trends Inside: Leather, suede, cotton or linen are used for boat's interior. Leathers and suede have very particular cleaning and treating requirements, Vinyl fabrics, used is both exterior and interior, material because of its property of mold, mildew, insects, chemicals, moisture and oils resistance.

Sails: A sail uses wind power to propel sailing of craft. Nowadays sail is made up of canvas, polyester, laminated membranes of bonded laminates. **Sail fabric is made from polyester, nylon, aramid, UHMWPE, carbon fibre.** Polyester is most commonly used sail fiber because it is strong, durable and relatively inexpensive**. Nylon** is widely used for as it is low cost, is lightweight for its strength, and exhibits good UV stability. **Aramid** fibers are lightweight, have high resistance to stretch and high breaking strength. Aramid fibers are often blended with even lower-stretch and higher strength carbon fibers within the same racing sail. **Ultra PE** (UHMWPE) fibers are highly processed polyethylenes which offer very good UV resistance, very low stretch and very high breaking strength. Ultra PE fiber is expensive, but very long sail life ensures high value in these sails. Carbon Fiber appeared in sails during the 1992 America's Cup and has since been widely accepted in grand prix sailing – including high end cruising applications. Carbon fibers are impervious to UV damage and have extremely high modulus (low stretch), but are quite sensitive to flex.

Inflatable Crafts: They are used as life boats and rescue craft, as freight carrying vessels and as pleasure craft, as well as having several military applications. An inflatable boat is a lightweight boat constructed with its sides and bow made of flexible tubes containing pressurised gas. Inflatable fabrics are typically coated or laminated with synthetic materials to increase their strength and environmental resistance. Among the most widely used materials are polyvinyl chloride (PVC) coated vinyl or nylon, and oxford woven cloth. PVC coated materials are more durable and more expensive. Hypalon(a chlorosulfonated polyethylene (CSPE) synthetic rubber (CSM)) coated onto polyester or nylon fabric with an interior coating of neoprene a very reliable and durable inflatable boat fabric. They can be deflated, folded and packed into a relatively small space when not is use.

Hovercrafts Skirts: Hovercraft is also known as an air-cushion vehicle or ACV, is craft capable of travelling over different surfaces. It is a vehicle with several engines, which drives the fan, which is responsible for lifting the vehicle by forcing high pressure air under the craft. Main mechanism is that air inflates the "skirt" under the vehicle, causing it to rise above the surface. Fabric used for this is neoprene coated nylon.

CONCLUSION:

It can be concluded that various parts of boat comprise of textile material. Apart from traditional materials, reinforced composite are also being used in marine field. Composite are made from resin formulation, reinforcement sizing, processing techniques and laminate void content influence the strength. Textile materials have used in the form of composite for various utilities like weight reduction, strength improvement, environmental friendly.

REFERENCES

[1] Administration, M. (1979). Marine Fire Prevention, Firefighting, and Fire Safety. Washington DC: Maritime Training Advisory Board.

[2] Banerjee, I., Pangule, R.C., and Kane, R.S. (2011). Antifouling coatings: recent developments in the design of surfaces that prevent fouling by proteins, bacteria, and marine organisms. Advanced Materials 23: 690–718

[3] Campbell, F.C. (2010). Structural Composite Materials. ASM International, ISBN-10: 0-61503-037-9.

[4] Composite Tandem Wing Boosts Hydroplane Stability, Advanced Composites, Advanstar Communications, Sep/Oct 1992, pp. 15-16.

[5] Evangelista Joe, Wade Stewart H., Swaim Caryln and P. Rife. James (2013), The History of the American Bureau of Shipping 150th Anniversary, 7th Edition, ABS, Houston, ISBN 0-943870-03-8.

[6] Evans, J. Harvey, Ship Structural Design Concepts, Cambridge, MD; Cornell Maritime Press, 1975

[7] Greene Eric (1999), Marine Composites, 2nd edition, Eric Greene and Associates, Annapolis, MD, ISBN 0-9673692-0-7.

[8] Guide for Building and Classing High-Speed and Displacement Motor Yachts ,bythe American Bureau of Shipping, Paramus, NJ, 1990

[9] Guide for Building and Classing Offshore Racing Yachts, American Bureau of Shipping, 1986, Paramus, New Jersey.

[10] Gurit holding (2013), Gurit Guide to Composites V5, Gurit Holding AG, Retrieved from https://www.canvasetc.com/marine-fabric-uses/ on 20/10/2021.

[11] J. Troitzsch,'International Plastics Flammability Handbook, 2nd edition, Hanser Publications, NewYork, 1990, 322–323.

[12] Johannsen, Thomas J., One-Off Airex Fiberglass Sandwich Construction, Buffalo, NY: Chemacryl, Inc., 1973.

[13] Mallick P.K. (2008), Fiber-reinforced Composites Materials, Manufacturing, And Design, CRC Press.

[14] Market Development, CI on Composites, SPI Composites Institute, New York, NY, Aug/Sep 1994, pp. 10-11.

[15] Mouritz A.P., Gellert E, Burchill P., Challis K. (2001), Review of advanced composite structures for naval ships and submarines, Journal of Composite Structures, Vol. 53(1), pp. 21-42.

[16] NAVSEA High Performance MarineCraft Design Manual Hull Structures, NAVSEACOMBATSYSENGSTA Report 60-204, July 1988. Distribution limited 8

[17] Seddighi, M. and Hejazi, S.M. (2015). Water–oil separation performance of technical textiles used for marine pollution disasters. Marine Pollution Bulletin 96 (1–2): 286–293.

[18] Singha, M. and Singha, K. (2012) Applications of textiles in marine products. Marine Science, 2(6): 110-119.

[19] Sorathia, U., Rollhauser, C.M., and Hughes, W.A. (1992). Improved fire safety of composites for naval applications. Fire and Materials 16: 119–125.

[20] Thomas EJ, 'Coated material for specialised end uses', Progress in Textiles Coating and Laminating, BTTG Conference, Chester 2-3 July 1990, BTTG, Manchester.

[21] W. Fung, Textiles in transportation. In: A.R. Horrocks, S.C. Anand (eds), Handbook of Technical Textiles. Cambridge: Woodhead Publishing, 2000: 490–528.