Research Article

# APPLICATIONS OF COMPOSITES IN MARINE INDUSTRY

Dr. S. Selvaraju, S.Ilaiyavel*

**Address for Correspondence**

*Asst-Profesor Mechanical Engg Department
Sri venkateswara College of engineering, sriperumbudur, Chennai-105
Email ilaiyavel@svce.ac.in

**ABSTRACT**:

A Composite material is a combination of two or more different materials. Whose quality is superior than its constituents. Composite materials can be used not only for structural applications, but also in electrical, thermal and various other applications. FRP materials are widely used in various engineering industries because of their superior performance and tailor made properties.

**KEYWORDS:** Composite, FRP, GRP, Advanced Composites, Marine, Naval

## 1.0 INTRODUCTION

A composite material is a combination of two or more chemically distinct and insoluble phases; its properties and structural performance are superior to those of the constituents acting independently. Composites are now one of the most important classes of engineered materials. Composites are used not only for their structural properties but also for their electrical, thermal, tribologic and environmental application. Modern composite materials are actually optimized to achieve a particular balance of properties for a given range of application, Many composite materials are composed of just two phases. One is termed the matrix which is continuous and surrounds the other phase often called the dispersed phase.

## 2.0 CLASSIFICATION OF COMPOSITES:

Composite materials are usually classified by the type of reinforcement used. This reinforcement is embedded into a matrix that holds it together. The reinforcement is used to strengthen the composite. For example, in GFRP, the matrix material is polymer and the reinforcement is glass fiber. Common composite types include random-fiber or short-fiber reinforcement, continuous-fiber or long-fiber reinforcement, particulate reinforcement, flake reinforcement, and filler reinforcement.

## 3.0 MARINE APPLICATION:

The first marine application of fiber reinforced polymer (FRP) composite material was in the construction of boats shortly after World War II. Boat builders began to use FRP composites instead of timber, which was traditionally used in small maritime craft, because wood was becoming increasingly scarce and expensive, timber was as losing favour with many boat builders and owners because wooden boats were easily degraded by seawater and marine organisms and therefore required ongoing maintenance and repairs that can be expensive. The earliest attempts to fabricate boat hull with FRP composites was in 1947 when twelve small surf boats were made for the UNITED STATES NAVY. Most maritime craft are built using glass reinforced polyester (GRP) composites; although sandwiched composites and advanced FRP materials containing carbon are aramid fibers with vinyl ester or epoxy resin matrices They are commonly used for high performance structural applications.

### 3.1 NAVAL APPLICATION OF FRP COMPOSITES:

The application of FRP composites to maritime crafts was initially driven by a need for lightweight, strong, corrosion resistant durable naval boats.

Most of these early applications were driven by the need to over come corrosion problems experienced with steel or aluminum alloys or environmental degradation suffered by wood. Another reason for using composite was to reduce weight, particularly the topside weight of ships. The high acoustic transparency of composites also resulted in their use in rodomes on ships and sonar domes on submarines.

### 3.2 EARLY NAVAL APPLICATION OF FRP COMPOSITES:

1. MINE SWEEPER (15.5 METER)
2. LANDING CRAFT (15.2 METER)
3. PERSONNEL BOAT (7.9 METER )

4. SHEATHING OF WOOD HULLS
5. SUBMARINE SONAR DOME
6. SUBMARINE FIRS
7. LANDING CRAFT RECONNAISSANCE (15.8 METER)
8. SUBMARINE NON PRESSURE HULL CASING

Increasingly, naval patrol boats are being built with an all-composite design or a composite hull fitted with an aluminum super structure. The growing popularity of FRP patrol boat is due mainly to their excellent corrosion resistance, which reduces maintenance costs, and lightweight. This can result in better speed and fuel economy. It is estimated that the composite patrol boats are usually approximately 10% lighter than an aluminum boat and over 35% lighter than a steel boat of the same size. Carbon fiber composites are rarely used on naval vessels because of their high cost. The feasibility of using composite in a wide variety of secondary structures and equipments of warships and submarine under investigation. For example, a major effort has been made for the development of composite propellers, Propulsors and propulsion shafts. The composite are expected to Offer a number of important benefits over metal when used in propulsion systems, including lower cost, reduced weight, lower magnetic signature, better noise damping properties and superior corrosion resistance. It is anticipated that propulsion shafts made of composites will be 18 to 25% lighter than steel shafts of the same size and will reduce life cycle cost by at least 25% because of fewer problems associated with corrosion and fatigue. Composite propeller shafts have only been installed on a small number of patrol boats. However within the next 10 years the use of composite in these applications is expected to increase, albeit at a slow rate. The composites are also being evaluated for use in rudders for ships and control surfaces for submarines. Other potential applications include funnels, bulkheads, decks, watertight doors, machinery foundation, pipes, ventilation ducts and components for diesel engines and heat exchanger on large war ships.

**3.3 LEISURE, SPORTING AND COMMERCIAL FRP COMPOSITE CRAFT:**

The diverse application of composite material to naval vessel is matched by their wide ranging use in leisure, sporting, commercial and small submersibles. Composites were first used in leisure craft, and yachts in 1950's and commercial crafts such as fishing trawlers and pilot boats as well as submersibles. The composite material most commonly used in leisure and commercial craft is GRP in the form of a thick laminate or a sandwich composite. Over 95% of all composite marine craft are built with GRP because of low cost.

There is however a number of other reasons for the popularity of GRP composite in marine craft, and these include –

1. Ability to easily and inexpensively mould GRP to the **near net shape**, even for marine structure with complex shape, such as boat hulls thus making it suitable for mass production.
2. Excellent corrosion resistance
3. Light weight, resulting in reduced fuel consumption.
4. Simple to repair
5. Ability to absorb noise and dampen vibrations, which makes for a more comfortable ride on motor powered boats.

Advanced fabrication processes, such as resin transfer, resin film intrusion, or auto craving are used in the construction of hull and decks to produce composites that are defect free, excellent dimensional balance and high fiber content for maximum stiffness, strength and fatigue resistance.

**3.5 OFFSHORE APPLICATION OF FRP COMPOSITES:**

The greatest problem with using steel in an offshore structure is the poor corrosion resistance against seawater and other highly corrosive agents, such as hydrogen chloride. It is estimated that the oil industry spends several billion dollars each year in maintaining, repairing and replacing corroded steel structures. Composites offer the potential to reduce these costs because of their outstanding corrosion resistance against most types of chemicals.

It is estimated that composites provide a weight saving of 30 to 50%. Compared to steel for many nonstructural components.

The most common types of composites used are GRP and phenolic composites, with the latter being used because of good fire resistance. Advanced composites containing carbon fiber, kelvar fibers, or epoxy resins are used sparingly because of their high cost.

Some of the current applications of FRP materials are

1. Low pressure pipes
2. Diesel Storage tanks, Lube tanks and utility tanks
3. Cable ladders and trays

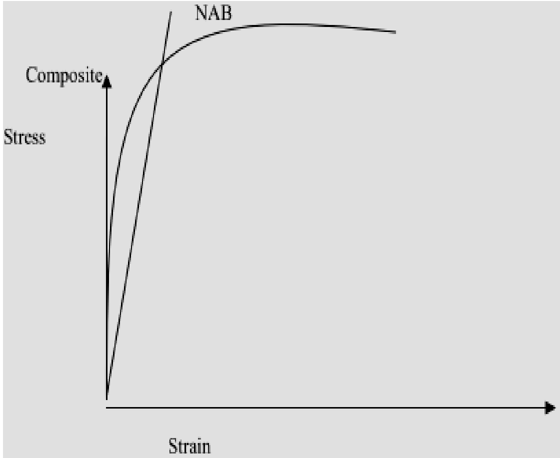
**3.6 FIRE PROTECTION PANELS AND SECTIONS OF ACCOMMODATION MODULES:** An important safety concern is that most FRP materials have poor fire resistant properties, such as short ignition time and high rates of heat release, smoke production and flame spread, while it is generally recognized that composites have much lower thermal conductivity than metallic material. These factors make it difficult for composites to meet the stringent fire safety requirements applied to offshore oil and gas platforms.

**COMPOSITE PROPELLER**:

The material used within the composite are commercially available, and it is the development of the right mix of fibers, resin and laminate lay-up that provide the desired mechanical and environmental performance for marine applications. The extensive development trials include durability testing in the marine environment, water uptake and fouling test.

**OPTIMISING PROPERTIES OF THE COMPOSITE PROPELLER**:

The fundamental mechanical properties required in this application include stiffness, strength and fatigue performance. The structure was optimized to be stiffest along the length of the blade and strong enough to have a significant factor of safety upon the design load. On material basis the composite was about half as stiff as NAB but had similar strength. Structural stiffness was regained through improved design of the propeller itself. Additionally the fatigue performance of the metal insert at the root also improved during the test, failure was initiated by flaws in the NAB while the composite remained undamaged.




**IMPROVED CAVITATION PERFORMANCE:** Theoretical models give a cavitation inception speed of 30% higher for the composite propeller design, compared with the original NAB propeller. The use of the lighter composite materials meant that the blades could be thicker without significantly adding to the weight of the propeller. Thicker blades offer the potential for improved cavitation performance, so reducing vibration underwater signatures. The composite propeller is expected to last for the lifetime of the vessel where as a NBA propeller would be expected to suffer cavitation erosion and corrosion and needs to be replaced periodically.

**REFERENCES**

1. T.M BUERMANN and R.J DELLA RUCCA, fiber glass reinforced plastics for marine applications, proc of the spring meeting of the society of naval architects and marine engineers 26-28 June 1960, pg 138-192
2. S.R HELLER, the use of composite material in naval ships, mechanics of composite material, proc of the fifth symposium on structural mechanics 8-10 may 1967, perganon press, oxford pg 69-111
3. J.F WELLICOME composites in offshore structures, in composite materials in marine structures vol 2 R.A SHENOI and J.F.WILLICOME Ed. Cambridge university press, Cambridge page 199-228
4. K.MAKINEN, S-E.HELLBRAT and K.A.OLSSON, the envelopment of sandwich structure. A.VAUTRIN, Ed. Kluwer Academic publishers, Netherlands, 1998 page 13-28
5. R.H.DIXON, B.W.RAMSEY and P.J.USHER, design and build of GRP hull of HMS wilton, ROYAL institution of naval symposium on GRP ship construction (LONDON) 1972 page 1-32