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NATURAL FIBRE USED IN RAISERS AND LIFTERS IN SUBSEA APPLICATION

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Abstract

This paper presents a summary of research work in the field of comparison of natural fibre of jute and banana and analyzes the physical and mechanical properties of the composites. Banana fibers obtained from the stem of banana plant (Musa sapientum) have been characterised for their diameter variability and their mechanical properties.

1. INTRODUCTION

Composite materials (also called composition materials or shortened to composites) are materials made from two or more constituent materials with significantly different physical or chemical properties, that when combined, produce a material with characteristics different from the individual components. The individual components remain separate and distinct within the finished structure. The new material may be preferred for many reasons: common examples include materials which are stronger, lighter or less expensive when compared to traditional materials

By considering the performance cost effectiveness of composites, a composite material is being developed for risers in subsea using polymer matrix material instead of using current material stainless steel. Finally, a comparison testing is made between the two materials in order to figure out the performance of the composite material from stainless steel.

2. MATERIALS AND METHODS:

Risers:

Conduits to transfer materials from the seafloor to production and drilling facilities atop the water's surface, as well as from the facility to the seafloor, subsea risers are a type of pipeline developed for this type of vertical transportation.

Types of risers:

There are some types of risers; they are pull type risers, steel catenary risers, top tensioned risers, riser’s towers and flexible riser’s configurations, as well as drilling risers.

In these risers, mainly stainless steel is used for higher strength and to withstand corrosion. Stainless steel does not readily corrode, rust or stain with water as ordinary steel does However, and it is not fully stain-proof in low-oxygen, high-salinity, or poor air-circulation environments.

This project is to improve the riser strength and corrosion resistance by replacing the stainless material with polymer matrix composite material. Thermoplastic (polypropylene) and fibre glass (chopped strand) used for this composite material.

- Stainless steel
- Composite material
- Polypropylene.
- Glass fiber.
- Epoxy resin.

Stainless steel

In metallurgy, stainless steel, also known as inox steel or inox from French "inoxydable", is a steel alloy with a minimum of 10.5% chromium content by mass. A wide range of component using stainless steel for its high strength and corrosion resistance properties.

Composite material:

Composites are formed by combining materials together to form an overall structure that is better than the sum of the individual components. The individual components remain separate and distinct within the finished structure. The new material may be preferred for many reasons: common examples include materials which are stronger, lighter or less expensive when compared to traditional materials.

Types of composite material:

There are three main types of composite matrix materials:

Ceramic matrix - Ceramic matrix composites (CMCs) are a subgroup of composite materials. They consist of ceramic fibers embedded in a ceramic matrix, thus forming a ceramic fiber reinforced ceramic (CFRC) material. The matrix and fibers can consist of any ceramic material. CMC materials were designed to overcome the major disadvantages such as low fracture toughness, brittleness, and limited thermal shock resistance, faced by the traditional technical ceramics.

- Metal matrix - Metal matrix composites (MMCs) are composite materials that contain at least two constituent parts – a metal and another material or a different metal. The metal matrix is reinforced with the other material to improve strength and wear. Where three or more constituent parts are present, it is called a hybrid composite. In structural applications, the matrix is usually composed of a lighter metal such as magnesium, titanium, or aluminum. In high temperature applications, cobalt and cobalt-nickel alloy matrices are common. Typical MMC's manufacturing is basically divided into three types: solid, liquid, and vapor. Continuous carbon, silicon carbide, or ceramic fibers are some of the materials that can be embedded in a metallic matrix material. MMCs are fire resistant, operate in a wide range of temperatures, do not absorb moisture, and possess better electrical and thermal conductivity. They have also found applications to be resistant to radiation damage, and to not suffer from out gassing. Most metals and alloys make good matrices for composite applications.

- Polymer matrix - Polymer matrix composites (PMCs) can be divided into three sub-types, namely, thermoset, thermoplastic, and rubber. Polymer is a large molecule composed of repeating structural units connected by covalent chemical bonds. PMC's consist of a polymer matrix combined with a fibrous reinforcing dispersed phase. They are cheaper with easier fabrication methods. PMC's are less dense than metals or ceramics, can resist atmospheric and other forms of corrosion, and exhibit superior resistance to the conduction of electrical current. In polymer matrix is used for its high corrosion resistance properties and less weight.

- Polypropylene: Polypropylene (PP), also known as polypropene, is a thermoplastic polymer used in a wide variety of applications including packaging and labeling, textiles (e.g., ropes, thermal underwear and carpets), stationery, plastic parts and reusable containers of various types, laboratory equipment, loudspeakers, automotive components, and polymer banknotes. An addition polymer made from the monomer propylene, it is rugged and unusually resistant to many chemical solvents, bases and acids.
- Fabrication of composite material
- The fabrication of composite material is the process of combining the different material of thermoplastic (polypropylene), glass fibre (chopped strand) and epoxy resin into one material. In this, epoxy resin is used to enhance the adhesion between the thermoplastic and glass fibre material. In general, this type of composite material is known as polymer matrix material.

Followings are some of important considerations needed to manufacture the composite material. They are

- Design specification.
- Composition of mixture.
- Fabrication process.

Composition of mixture:

The composition for the composite material is fixed based on the major property requirements of the composite material. A riser material requires high strength and corrosion resistance. The manufacture of composite material used here is polypropylene, glass fiber and epoxy resin. For this composite material Polypropylene gives high corrosion resistance and glass fibre gives high strength where epoxy gives increase in adhesion between two materials.

Based on the characteristics properties corrosion and strength required, the composition of mixture to be fixed in ratio of 1:1 (polypropylene & glass fiber).

The weight ratio of materials is to be 250 grams (each of polypropylene & glass fiber). The epoxy resin added quantity to be 50ml. for using epoxy resin, an epoxy hardener is added at ratio of 5:1. So that the quantity of epoxy hardener is added to the resin is 10. The composition of mixture of polypropylene and glass fiber is shown in figure1

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Fig. 1 polypropylene mixed with glass fiber
Fig.2 Composite Material

Fabrication process:

Fabrication of composite materials is accomplished by a wide variety of techniques. Composite fabrication usually involves wetting, mixing or saturating the reinforcement with the matrix, and then causing the matrix to bind together (with heat or a chemical reaction) into a rigid structure. The operation is usually done in an open or closed forming mold, but the order and ways of introducing the ingredients varies considerably. Here, the composite material fabrication is done using the transfer molding technique.

Fabrication procedure

In this process, the mixture of polypropylene and glass fibre are preheated and the mixture is placed in a pot like vessel .The mixture is further heated at 400-500`C.At this temperature the mixture is melted where epoxy resin is added to the mixture. The melted mixture is poured into the wood pattern which is coated with PVA(Poly vinyl acetate) for better removal of material from the pattern. After the melted mixture is poured into the wood pattern, its allowed to set for some time to get a required composite materials. The sample of composite materials shown in fig 2.

3. Results and discussion

Hardness is a characteristic of a material, not a fundamental physical property. It is defined as the resistance to indentation, and it is determined by measuring the permanent depth of the indentation. More simply put, when using a fixed force (load) and a given indenter, the smaller the indentation, the harder the material. Indentation hardness value is obtained by measuring the depth or the area of the indentation using one of over 12 different test methods. One of the most commonly used hardness test method is Rockwell hardness test method.

Testing Process:

The Rockwell method measures the permanent depth of indentation produced by a force/load on an indenter. First, a preliminary test force (commonly referred to as preload or minor load) is applied to a sample using a diamond indenter. This load represents the zero or reference position that breaks through the surface to reduce the effects of surface finish. After the preload, an additional load, call the major load, is applied to reach the total required test load. This force is held for a predetermined amount of time (dwell time) to allow for elastic recovery. This major load is then released and the final position is measured against the position derived from the preload, the indentation depth variance between the preload value and major load value. This distance is converted to a hardness number. Preliminary test loads (preloads) range from 3 kgf (used in the "Superficial" Rockwell scale) to 10 kgf (used in the "Regular" Rockwell scale) to 200 kgs (used as a macro scale and not part of ASTM E-18; see ASTM E-1842). Total test forces range from 15kgf to 150 kgf (superficial and regular) to 500 to 3000 kgf (macro hardness).

Test results:

Sl. No	Sample Id	Testing Values			Avg Value
		1	2	3	
1.	Polyproplyene mixed with glass fibre.	54	54	56	55

Table .1 Hardness of composite.

Hardness test on stainless steel:

The test result of hardness of stainless steel.

Material description: Stainless steel.

Test method: Rockwell hardness test method.

Compression test on composite material:

Material description:

Specimen Shape: Flat

SpecimenType: Plastic

Specimen Description: polypropylene + Epoxy Resin + Glass fibre

Specimen Width: 40 mm

Specimen Thickness: 15 mm

Distance Between Grips: 0 mm

Pre Load Value: 0 kN

Max. Load: 400 kN

Max. Elongation: 200 mm

Specimen C S Area: 600 mm2.

Test results:

Load at Peak : 2.960 kN

C.H.TravelatPeak : 3.160 mm

Comp.Strength : 4.933 N/mm2

S.No	Sample Id	Observed Values, HRC			Average, HRC
		1	2	3	
1.	Stainless Steel	34	34	35	34

Table. 2 Hardness of stainless steel.

4. Conclusion:

While comparing the results of two materials, it is conclude that the strength of stainless steel is high. Even though, the composite material used here produce comparable results over from its original form of thermoplastics competing with stainless steel. In future, the advancement of this composite material will help it to increase its strength. Further increase in strength of this composite will gives replacement of stainless steel material in subsea applications.

5. References:

1. Cobb, Harold M. (2010). The History of Stainless Steel. ASM International. p. 360. ISBN 1-61503-010-7.
2. Material Properties Data: Marine Grade Stainless Steel. Makeitfrom.com. Retrieved on 29 June 2012.
3. Malamed, Stanley. Handbook of Local Anesthesia, 5th Edition.Mosby, 072004.VitalBook file. page 99.
4. Heather Lechtman and Linn Hobbs "Roman Concrete and the Roman Architectural Revolution", Ceramics and Civilization Volume 3: High Technology Ceramics: Past, Present, Future, edited by W.D. Kingery and published by the American Ceramics Society, 1986; and Vitruvius, Book II:v,1; Book V:xii2
5. Waterman, Pamela J. "The Life of Composite Materials". Desktop Engineering Magazine. April 2007.
6. Benedikt, G. M. and Goodall, B. L. (eds.) (1998) Metallocene Catalyzed Polymers, ChemTech Publishing: Toronto. ISBN 978-1-884207-59-4.

