REVIEW PAPER ON STANDARDIZATION OF DESIGNING METHOD FOR LIGHTWEIGHT SANDWICH T JOINT OF COMPOSITE MATERIAL

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Abstract: Presently a large amount of research is going on with the objective to strengthen the technological basis for the large-scale application of fiber reinforced composite materials for naval vessels and structures. Fiber reinforced composites are widely used in naval ships and aerospace, ground transport, civil infrastructure because of their high strength and stiffness, low mass, excellent durability and ability to be formed into complex shape.and The lightweight T-joint has 20% higher strength than the existing design, and the weight is only about 40% of that of the existing design. A typical T-joint used in naval ships. It consists of a horizontal base panel, a vertical leg pan and fillet and over laminates. The aim of this work is to investigate the behavior of composite T-joints used in marine applications due to variation of different parameters. One type of joint in such a super structure is a T-joint between sandwich panels.

Keywords: Composite material, Design, Lightweight, Testing of T-joint.

1. INTRODUCTION

Composite materials are used widely in many applications. They are made of two or more Homogeneous materials to achieve better properties than the constituent materials. One of the most common advanced composite materials is Fiber Reinforced Plastics (FRP). In marine applications, FRP has been used to build many types of ships, including Pleasure craft, ferries and naval mine-hunters or Mine-Counter-Measure- Vessels. The use of composite materials for military applications is desirable, especially because of some of the material characteristics which are absent in metal-hulled ships, such as lighter weight, corrosion resistance and design flexibility due to its anisotropic nature. Moreover, the non-metal-hulled ships, such as composite materials have the capability to be a radar proof, which means that it allows the ships to go through the enemy zone undetected. It makes the composite materials even more attractive for a military application is desirable. Especially because of some of the material characteristics, which are absent in metal-hulled ships, such as lighter weight, corrosion resistance and design flexibility due to its anisotropic nature. Reduction of weight and increasing strength of the T-joint is one of the objectives. Performance testing of composite sandwich T-joints subjected to both static and dynamic loading commonly used in large panels for naval applications becomes very important. Adhesively bonded T-joints have been extensively used in assembling sandwich structures made from glass fiber reinforced plastic skins and a balsa wood core in naval vessels. The advantage of adhesive bonded joints over bolted or riveted joints is that the use of fastener holes in mechanical joints inherently results in micro and local damages to the composite laminate during their fabrication. One task is developing improved joint for naval ship super structure can be manufactured from fiber composite. One type of joint in such a super structure is a T-joint between sandwich panels. In the first phase of the project, an existing design called base design T-joint has been tested and characterized. The base design T-joint consists of a PVC foam sandwich panels joined by filler forming a smooth transition from the T-panel to base panel, and over laminates with laminates of the fiberglass.

1.1 Sandwich Panel

Sandwich panels are a remarkable product because they can act as strong as a solid material, but weigh significantly less. The trend for "stronger-lighter" is becoming increasingly important in the transportation and aerospace industries, and sandwich panels are

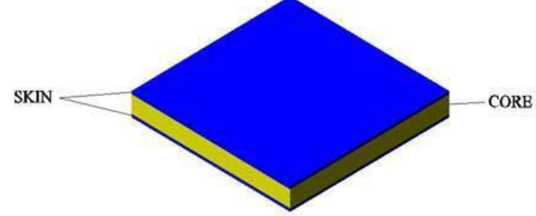

Figure 1.1: Sandwich panel

The common composite sandwich structure is made up of two major elements, the skin and the core. Sandwich panel skins are the outer layers and are constructed out of a variety of materials. Wood, aluminium, and plastics are commonly used. More recently though, advanced composite fibers and resins are being used to create skin material. The core materials provide many of the panels' desirable properties and are often composed of wood, foam, and various types of structural honeycomb. Each core has various advantages; for example, balsa wood is a lightweight core, has high strength, but can rot or mould with exposure to moisture

1.2 Lightweight Structures:

Reasons for using lightweight materials and structural arrangements in ships (as in many other types of transportation vehicles) include the following: They allow a greater payload for a given size or weight of vessel.Theyallowhigher speeds to be achieved. They reduce fuel consumption and environmental emissions for a given payload and distance travelled.

For ships with many decks (such as cruise vessels) the use of lightweight solutions in the upper decks helps to lower the centre of gravity, thus improving stability and permitting larger height/breadth ratios. In addition, some lightweight solutions (e.g. closed aluminum extrusions and sandwich configurations) are also compact, giving reduced space requirements and leading to smaller overall vertical distances between decks. The main lightweight materials used in ships are fibre reinforced plastic (FRP) composites and aluminum alloys. FRP is used in both single-skin and sandwich configurations; in single-skin applications there is usually a system of stiffeners as illustrated in Fig. 1, but unstiffened monologue solutions are also to be found. (Here we use the term "FRP" to include the special case of glass-reinforced plastics–GRP.) Aluminum alloys are commonly found in welded, stiffened plate configurations and in the form of extruded sections (both open and closed), but sandwich arrangements are also possible. Although not normally considered lightweight materials, high strength steels may also be used to reduce weight; these are to be found in stiffened plate and, recently, some sandwich configurations. There is increasing use of mixed solutions in which various materials recombined in one ship or superstructure. Current and potential applications of lightweight

Materials in ships are mainly related to high speed passenger and car ferries, patrol and rescue craft, smaller naval ships (e.g. mine countermeasure vessels), pleasure craft and sailing yachts. However, they are also used in superstructures of cruise ships and of larger naval ships (e.g. frigates). Furthermore, they are used extensively in secondary structures and components for all types of ships, from masts As a rough guide, in the main hull structure, FRP is used for craft with length up to about 50 m, and aluminum for vessels up to about 120 m, while high-strength steel is mainly used for larger vessels. In recent years, composites have been rarely used in hulls of new ferries; their use has been mainly confined to patrol/rescue craft, pleasure craft, yachts and naval vessels. The main reason for this is the severe restriction on the use of combustible materials that was introduced in the IMO Code of Safety for High Speed Craft in the 1990s. With new, approved fire protection systems now available, FRP has once more become a viable a d safe alternative to aluminum for ferry applications.

2 T-joint Design concepts:

The selected design based on the outcome of the FEA study .The specification for the design, materials and the overall dimensions of the test specimens are summarized in table 1, and the T-joint illustrated in fig 1. The nominal hull, over laminate and bulkhead thicknesses was 43, 2 and 43 mm respectively, while the nominal over laminate angle is 60° (measured at the base of the fillet triangle as seen in Figure 2.The joint was subjected to static tensile pull -off loading in the plane of the bulkhead. The Hull is considered to be restrained near the two ends of the joint, as indicated in Figure 2, with a 400 mm fixing span and a boundary condition between support-and support-slide. In order to construct a new design of composite T- joint based on above theories these Conditions and criteria should be consider:

1.Two plates either core A, B or Hull- Bulkhead assembly should be join at 90 degree and some provision should be made to fix them at 90 degree (by groove or guide).

2. It should be a composite structure i.e. use of two or more material.

3. Over laminates or skin is provided for better strength against tension and to protect filler material in main adhesive bonding zone.

4. Minimum use of filler material or resin to make it lightweight.

5. Good appearance and simplicity in handling.

6. Dimensions should round off so that manufacturing becomes easy.

7. From above considerations, a new T-joint can be constructed as shown in fig1.

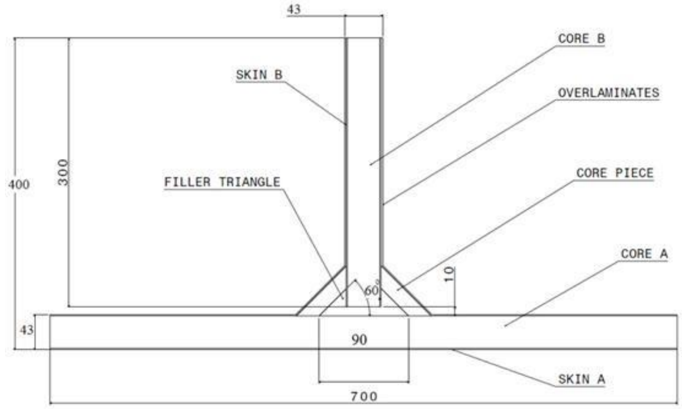

Figure. 2- Conceptual composite T-joint outline

3. Manufacturing of Test Specimens:

The sandwich panels for the T-joints are manufactured by a hand lay-up technique. Resins are impregnated by hand into fibres, which are in the form of woven, knitted, stitched or bonded fabrics. This is usually accomplished by rollers or brushes, with an increasing use of nip-roller type Impregnators for forcing resin into the fabrics by means of rotating rollers and a bath of resin. Laminates are left to cure under standard atmospheric conditions. The edges of the infused panels are trimmed to the desire geometry, and the T-panel, the filler and the triangular fillets are applied and mounted manually. Small pieces of PVC foam are used as spacers to ensure correctgapfor the filler. The T-joints are manufactured and completed.

Hull and Bulkhead:

Hull and bulkhead are made of core laminated with skin. PVC foam is used as core. Whereas skins made from fiberglass. PVC foam soft and pores material can be cut easily on machine saw. It is cut according to following dimensions and quantity. A surface preparation is carried out on above four plates by scratching on surfaces by blade. Uniform layer of epoxy is applied on them and attached them like a sandwich. A 700 mm and 347 mm length pieces are joined separately with epoxy and kept for solidifying. It requires 30-45 min for solidifying. Then fiberglass is cut according to above dimensions, glued to PVC foam, and kept to solidify.

Table 1:Dimension and quantity of PVC foam to cut.

Sr.No.	Length(mm)	Width (mm)	Thickness (mm)	Quantity
1	700	150	18	2
2	347	150	18	2

Core pieces:

Core pieces were cut according to dimensions at 60-degree angle with the help of hex blade.

Filler Triangle:

Filler Triangle is made from resin Epoxy 520 mixed with Hardener Epoxy PAM. It is in liquid form hence great care is taken for its use to avoid leakage. This resin is suitable for pouring and capable to cover small spaces or gaps. Hence we have decided to make a mould containing hull and bulkhead and resin is poured in it. So on a flat table, covered with thick paper or card sheet, these two plates were kept at 90 degree and gap of 10 mm. Core pieces are placed at its measured position. Outer portion is covered with card sheet and plastic paper to avoid leakage while pouring**.** Whole mould is fixed on table with nails to ensure positional accuracy and to avoid movements while working.

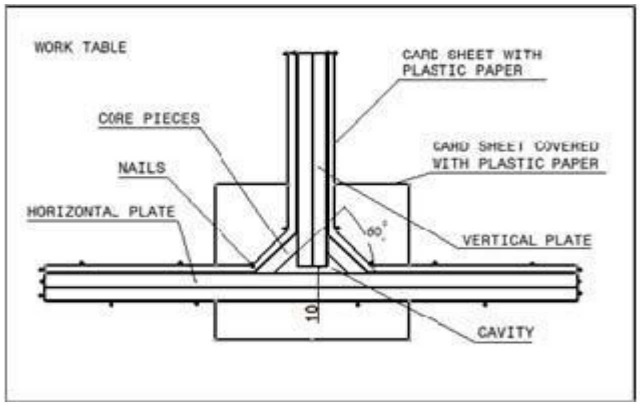

Figure 3 Typical mould arrangement for filler triangle.

Over laminates:
Over laminates were made from fiberglass. It was cut by size with the help of scissor. It is also joined by HLU method. With the help of painting brush, resin is spread on the surface of horizontal as well as vertical plates and on core pieces and fiberglass was glued on it. A small layer of resin was applied on the outer surface of over laminates to cover strings of fiber and glass particles Extra part of it cut down by scissor, hex blade, and kept it to solidify for 10 days to ensure full solidification at the room temperature.

Proposed Work:
The objective of the project is to manufacture the T-joints and perform static tensile tests on them. The strength and failure mode will b**e s**tudied experimentally and by finite element analysis. Load vs. displacement curves will be plotted.

Testing:

The machine operator filled necessary Information in computer attached to UTM. The Machine operated and Published Controlled by software and results were displayed on computer screen. Initially Preload was kept zero and displacement brought to zero. There were two possibilities, one that the material of T-joint might fail and second was, failing might occurred in fixture. Because there was no way to predict the failure. Fixture could be replaced if it was failed, but if T-joint would fail then results directly belonged to its strength. Hence, we have decided to take test as trials. They were as follows:

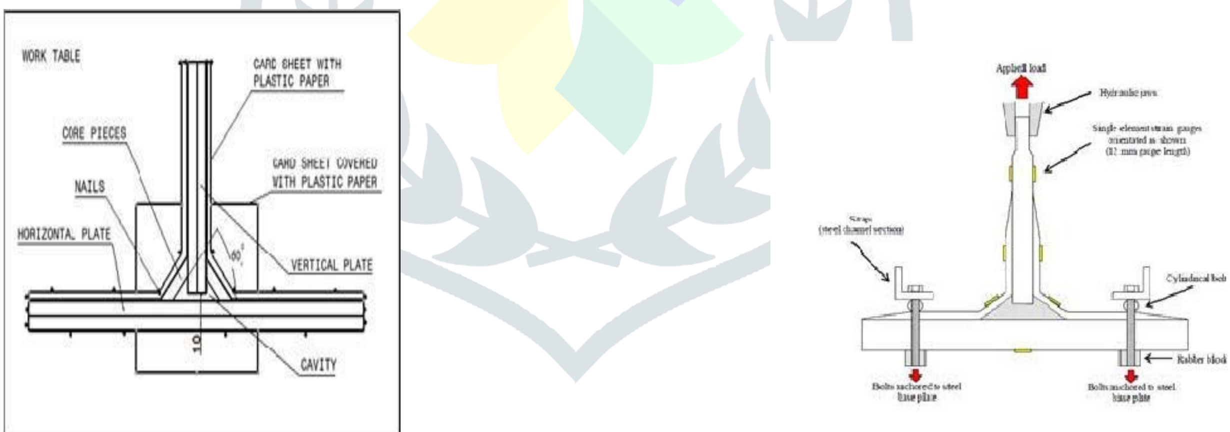

Fig.4 Experimental set up of Schematic T Joint.

4. CONCLUSION:

1.The lightweight -joint is designed for sandwich panels with two sheets of 18 mm thick PVC foam core and 1.5 mm thick fiber glass skin laminates. The panels are joined by use of filler and two supporting core pieces of PVC foam.
2. CATIA V5 R17 was used for Finite Element study of T-joint with static loading condition.
3. The different joint configurations have been compared based on relative stresses in the different parts of the joint. They were compared based on Von Misses stress distribution.
4. 2 kN load was used to stimulate the finite element model.
5. The selected sandwich T-joint will tested in static tension in special design fixture.
6. The failure load of new T-joint is nearly 20% higher than that of the reference Base Design T- joint.
7. Both the failure load and deformation matched very well the predictions from the FE parameter study.
8. The failure mode is initiated from over laminate to foam core A by shear failure.
9. The release of energy from the shear failure of the core A causes the T-joint itself to fail as well. The load vs. deflection curve is almost linear until a load is acting.

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