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SNAP JOINT TECHNOLOGY FOR COMPOSITE STRUCTURES

THE NEED

For the past few decades, the Aerospace industry was the major users for polymer composites. In the majority of the aircraft composite structural components, both bolted and/or adhesive bonded joint was used. Most of the details are similar to those for metal joints. It was shown from extensive testing on bolted composite joints that failure always occurs in a catastrophic manner due to high stress concentration developed at the bolt locations. Due to the inherent low bearing and interlaminar shear strengths of composites, these stress concentrations threaten the downfall of ever piece of the composite structure.

FIGURE 1 SNAP JOINT DESIGN

THE TECHNOLOGY

The optimum composite joint design is the one capable of distributing stresses over a wide area rather than to concentrate them at a point. Adhesively bonded joints can satisfy these requirements, however, most of the adhesives are brittle, and brittle failure is unavoidable. This was the motivation of developing what is called the SNAP joint.

The snap joint technology developed by W. Brandt Goldworthy & Associates, Inc. The concept is based on similar joining technology used for connecting wooden parts (wood

is considered as natural orthotropic composites). Also, this technique is very similar to techniques which were used a decade or so ago for plastic.

FIGURE 2 SNAP JOINT CONCEPT

The following figure shows a pultruded structural composite member (A) with one end shaped as a fir-tree, and therefore has a large load bearing area. In this figure, part (A) has been snapped into another structural shape (B). From these figures, one can see that the latter shape has been designed to combine its structural shape with functionality that allows for the engagement of the load-bearing surface of member (A). It is possible to "snap" joint both parts together since part (A) has been cut for a short distance along its length to provide enough lateral flexibility to move out of the way when entering part (B). In order to make this joining concept successful, the fiber architecture of part (A) must be designed in such a way that the load bearing surfaces have higher interlaminar shear strength capacity. Also, it can be noticed from the figure, that a circular hole was introduced at the end of the horizontal slot of part (A) to inhibit the crack propagation along the length of the pultruded member.

FIGURE 3 HARDWARE FOR FASTENERLESS SNAP JOINT

THE BENEFITS

- The structures are easy to assembly.
- Installation of structure members become faster.
- Installation needs smaller number of labor and equipment.
- Since it use composite materials, its weight is less than traditional structures.

STATUS

The first prototype or "Demonstration project" using this joining method was in designing and construction of three Transmission Tower Structures near Los Angeles by W. Brandt Goldworthy & Associates, Inc. and Ebert Composites Corporation. The 1999 CERF Charles Pankow Award for Innovative Applications was granted to the developers for this innovative composite transmission tower.

The developers have also proposed an 18-story all-composite structure as a stack & checkout tower for rockets at Commercial Spaceport, USKA, Vandenberg Airforce Base, California. According to the developers, the estimated cost of this structure is about 20 million dollars including machinery cost.

This year, through California Department of Transportation (Caltrans), they have proposed the design and the construction of a truss structure to carry highway singes. The project was submitted as a part of the Federal Highway T-21 program.

More details discussion on this emerging joining technique as well other similar techniques will be presented in the separate Chapter in the ASCE Connection Design Manual which I am writing, and which is expected to be published by the Middle of year 2000.

BARRIERS

The snap joining technique is considered to be one of the optimum techniques to join composite structural members. However, it has a major limitation, and can only be used in specific applications. That is, this method can only be used to transmit axial loads, which make it ideal for truss-type structures. However, in my opinion, this method should NOT be recommended when out-of-plane loads or any shear loads are introduced since the connection is not design to carry any major bending moments. Under flexural loads, it is expected that the joint will be very flexible, and the artificial cracks introduced to members will propagate and a complete failure will occur even under moderate service flexural and/or shear loading.

More details discussion on this emerging joining technique as well other similar techniques will be presented in the separate Chapter in the ASCE Connection Design Manual, and is expected to be published by the Middle of year 2000.

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REVIEWERS

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