PROSPECTIVE USE OF COMPOSITE MATERIALS IN CONSTRUCTION OF BRIDGES

EMIRI ANIEKAN DAFE *(Nigeria), Magister of Science*
Peoples' friendship university of Russia

The article discusses the benefits of bridges construction made of fiberglass on the examples of a pedestrian bridge Hyatt in San Diego and a pedestrian bridge built in the Southern District of Moscow. Such bridges have high strength, do not pass electricity, are resistant to millions cycles of loading, are not corroded, and can be assembled within a few days. Perspectives of this material usage for the construction of bridges are proved by numerous examples of such structures worldwide.

KEY WORDS: composite materials, fiberglass, bridges, strength, construction, light weight, corrosion, non-conductivity of electricity.

Composite materials have substantial advantages over traditional materials. This helps maximize the design and construction advantages of a structures. Fiber reinforced polymer (FRP) components can be manufactured by different methods, for example using pultrusion process. These high-strength FRP materials provide the bridge system with a strength-to-weight ratio greater than steel, thereby offering significant design and erection advantages over traditional materials. This article discourses the advantages for fiberglass over common construction materials. Fiberglass is a prospective building material for the following reasons: high strength, lightweight, component construction, easy installation, attractive appearance and low maintenance costs.

Standard FRP components have strengths reaching 689 MPa. Post-tensioned systems include Kevlar cables that have strengths approaching 2757 MPa. The components are light and easily carried as a typical member weighs is less than 40 kg. Pultruded fiberglass shapes generally weigh 75 - 80% less than similar steel shapes and 30% less than similar aluminum shapes.

Bridges can also be delivered on site partially assembled or fully assembled depending on the site or project requirements. Assembly is done without heavy construction equipment. Unassembled and partially assembled bridge spans are designed for quick and easy installation using standard hand tools. The project determines the installation approach. Three persons can install a typical bridge spanning less than 15 m during one day. Longer spans usually require additional workers and 2 or 3 days depending on the span length of the bridge and specific site conditions.

Fiberglass bridges have attractive appearance they are early designed using visually any color. The color is already in the composite, so it does not require any painting. Project can be custom-engineered with signed/sealed CAD drawings and a complete finite element analysis (FEA). FRP/Kevlar testing program has received support from many sources in USA that include the National Science Foundation (NSF) and the Federal Highway Administration (FHWA).

Fiberglass bridges require low maintenance costs. Traditional materials deteriorate in harsh environments. Unlike metal and wood FRP will not rust nor rot. Wet locations, termites, salt and most chemical environments have little or no effect on the material. FRP composites are electrically non-conductive and easy to clean.

Hyatt Island Pedestrian Bridge (fig. 1) is has length 20m and width 2m. It was installed in downtown San Diego where there is harsh saltwater environment. A typical prefabricated steel bridge would be subjected to corrosion so

Fig. 1. Fully assembled 20m bridge

fiberglass bridge system was used instead. The pedestrian bridge had to be fully assembled in the shop before applying the clear coat finish. The bridge was delivered to the site fully assembled. At the site, the teak railing and IPE decking were installed. Installation was completed in 2 days.

Design Specifications of Hyatt Pedestrian Bridge: shipped assembled, stainless steel bolts, straight end design, standard dead load camber, stainless steel mounting clips, design live load = 0.448 MPa, 13 m handrail height above decking, Fiberglass support trusses (two diagonals/panel), custom white colour with urethane clear coat finish, horizontal safety midrails providing 1.2 m max. opening.

The first fiberglass bridge in Russia (fig. 2) is located on the South of Moscow near the railway station Chertanovo (2004). The bridge consists of 3 spans that are installed on the four pillars. Its length is 41.1 m, width - 3 m. The assembly of each flight took 10 days, and the installation of the whole structure on a site - less than a day.

Fig. 2. Fiberglass bridge near the railway station Chertanovo, Moscow

Chertanovo fiberglass bridge was developed and produced using a special machine (a drum which is heated to 200ºC and mixed with glue, liquid plastic components and glass fittings). The mixture is then poured into a special shape of the desired size. The bridge has perfectly withstood not only a given load (560 kg per 1sq.m.) but also a significant overload (800 kg). This bridge was built of composite materials and designed to withstand multimillion cycles' loads from the passage of freight and pedestrians, local trains. In future, this bridge will be covered, as well as equipped with heating for the winter period.

The advantages of this bridge are in its lightness, durability and ease installation. Besides, the surface of the bridge was treated with a coating thickness of 2 mm, consisting of a mixture of glue and sand, which increases its stress resistance up to 4.5 times as compared with concrete. Thus, in contrast to metal and concrete, they do not corrode, and are not affected by acid salts.

It is obvious that using fiberglass for bridges of small spans and especially for pedestrian bridges has a lot of benefits and perspectives. It was proved for many times by the hundreds of such bridges that were built all around the world.

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ПЕРСПЕКТИВЫ ПРИМЕНЕНИЯ КОМПОЗИЦИОННЫХ МАТЕРИАЛОВ В СТРОИТЕЛЬСТВЕ МОСТОВ

ЕМИРИ АНИЕКАН ДАФЕ *(Нигерия), магистр*
Российский университет дружбы народов

В статье рассматриваются преимущества строительства мостов из стеклопластика. Такие мосты прочны, выдерживают многомиллионные циклы нагрузок, не подвержены коррозии, могут быть смонтированы в течение нескольких дней. Перспективность применения таких материалов для строительства мостов доказана многочисленными примерами строительства таких сооружений по всему миру.

КЛЮЧЕВЫЕ СЛОВА: стеклопластик, мосты, прочность, конструкция, легкий вес, коррозия, непроводимость электричества.