

COMPOSITES IN CONSTRUCTION OF ROADS AND BRIDGES

Developing Infrastructure and its related systems is integral to the economic and social well being of a nation. Such systems affect our daily lives ranging from the ability to move from one location to another to such fundamental issues as the quality of air we breathe and water we drink. Because these systems are so all-encompassing and complex, they are often taken for granted, resulting in low levels of maintenance and uneven levels of attention from policy makers and technologists alike. The level of capital and running investment in the nation's infrastructure is massive and keeping these assets in usable condition is one of the major challenges facing any nation.

Civil Engineers are known to test the limits of structures, by going higher, longer or lighter. On the other hand, Civil Engineers are working against the unpredictable elements of nature like water, wind, snow, earthquakes, soft grounds etc which at most times are difficult to quantify. Hence, they are perforce very conservative. These two professional characteristics come together when Civil Engineers are exploring the exciting opportunities offered by the high-tech engineering materials available to them, today. The challenges to reduce weight, increase spans, build higher or slender constructions automatically mean they must look at new engineering materials in their designs.

A composite is multiphase material formed from a combination of two or more materials that differ in composition or form, bonded together, but retaining

their identities and properties. In composites, one of the materials will be in "Reinforcing phase" and the other will be in "Matrix phase". Typically, reinforcing material in the form of fibres, sheets or particles are strong with low densities while the matrix is usually a ductile or tough material. The outcome of this 'Composition' is that the newly formed material has superior properties over its individual components.

Many people do not realize that composites are probably the most common structural materials in the world and have always been an essential part of their lives. Man's first use of such composite materials was probably the earth reinforced structures using layers of bamboos and earth. Plywood is another example of Man's attempts to capture and employ Nature's inherent wisdom. Third example of a composite material is reinforced concrete, as is used in the construction of roads and bridges. Despite the fact that composites are generally more expensive in comparison to traditional construction materials, they have the advantages of being stronger, better resistant to environmental degradation, have higher strength and other material properties like high temperature resistance, excellent thermal insulation, sound damping properties etc. The development and application of new Advanced Composite Materials are among the fastest growing sectors of modern technological endeavours. At the end, these may prove to be cheaper on a life cycle cost analysis.

The decay of steel and concrete in bridges entails a huge amount of efforts and money in


repair and replacement. Increased service loads, traffic volumes, changes in use, deteriorated reinforcements, errors in design and construction and structural modifications etc mean that in many cases reinforced concrete structures need to be repaired or re-constructed. External plate bonding is being widely used to increase the strength of such under reinforced structures. Literature survey has revealed that advanced composite material such as Carbon Fibre Reinforced Plastic (CFRP) strips could be externally bonded to existing structures to strengthen them. This is an economical, speedy and practical solution for extending the service life of structures. Fibre reinforced plastic has greater strength capabilities and is less susceptible to environmental deterioration than steel. Such composites also do not deteriorate in the presence of salts, which shorten the life of a conventional structure near the coasts. Studies have found that fibre reinforced plastic has weight to strength ratio of 50 times compared to that of concrete and 18 times that of steel. This technique has been developed in Switzerland, Canada, USA and Japan and as a result, it is now possible to replace the heavy steel plates with light carbon fibre material.

For certain applications, the use of composites rather than metals has in fact resulted in savings of both cost and weight. The design of a structural component using composites involves both material and structural design. Unlike conventional materials e.g., steel, the properties of the composite material can be designed considering the structural aspects and strength requirements. Composite properties like stiffness, thermal expansion, etc can be varied continuously over a broad range of values under the control of the designer. The use of composite structural members, deck surfaces and bridge railings can decrease the “dead load” associated with the bridges and allow for reduced weight of bridges or increased vehicle-load-carrying capabilities or both.

In the construction of roads, when dealing with difficult sites, the conventional practice was limited to either replacing the unsuitable soils, or bypassing them with costly deep foundations. Additionally, the age-old problems of land scarcity, need to rebuild ageing infrastructure in urban areas, increased realization of seismic hazards and regulations have given the impetus for evolution of a number of ground improvement techniques. Innovative ground modification approaches are routinely used, nowadays, to solve unique soil-related problems and often are considered to be the most economical means to improve an undesirable site condition. Geosynthetics have proven to be amongst the most versatile and cost-effective ground modification material.

In addition, Civil Engineering today faces challenges that require building reinforced structures which can withstand natural disasters like earthquakes, tsunami and landslides etc. This requires the creative use of composite materials in existing structures and future infrastructure systems. Composites are now successfully applied in making reinforced concrete structures more earthquake resistant, around the world.

Roads and bridges face problems of cracking, rutting, deterioration, corrosion, overloading, traffic jams and partial or complete failure of structures etc. It is, therefore, essential to make the existing structures, as well as new projects to be envisaged in future, sustainable, durable and long lasting with use of natural and creative composite materials. Composite materials have the potential to be “the civil engineering structural materials for the 21st century.”


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