International Journal of Engineering & Technology
CENTRE OF PROFESSIONAL RESEARCH PUBLICATIONS
ISSN 2049-3444

International Journal of Engineering and Technology Volume 2 No. 4, April, 2012

Real Time Bridge Inspection through Nanoskin Tube

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ABSTRACT

There are approximately 578,000 highway bridges in the USA. Bridges have average life span of 70 years. Majority of the bridges were built after 1945. Average bridges require repairing when they reach their mid-life. Bridge's loads carrying capacity is affected by corrosion, cracking and other damages. All the damaging factors like (footing, substructure deck and superstructure) of the bridges will periodically be inspected by the engineers. Visual inspection is the primary method for the inspection of the bridges. In this paper we present nanotube skin technique for inspection of the bridges.

Keywords: *bridge, load, corrosion, cracking, visual, nanotube*

I. INTRODUCTION

In effective inspection of the bridges can be harmful for the human lives. Major bridge collapse is very low but results are very severe. Silver bridge collapse in 1967 results loss of 47 lives. However repair and maintenance costs on bridges consumes significant portion of the budget. As bridge's life reaches beyond 75 years corrosion and cracking factors will become more and more important issues. The life extension of the bridges requires periodically inspection or monitoring. Technique used for monitoring of the bridges of the bridges is the visual technique which is obviously not a perfect or reliable technique because human eye can not detect the micro level cracking and other damaging factors of the bridges. In this paper we introduce an advanced technique named as "carbon nanotube skin" for the inspection of the bridges. This technique can detect highly micro level damages of the bridges. We discuss this technique and carbon nanotubes further in detail in this paper. [1]

II. TRADITIONAL BRIDGE INSPECTION

Traditional (old) bridge inspection process starts with the previous reports of the bridge inspection. Experienced bridge inspectors can identify some major problems with the first look on the bridge's profile e.g. the bridge profile is not smooth. Now we understand basic building blocks of the bridge.

A. Deck

Riding surface of the bridge is called deck. Joints of the deck must be working properly to allow temperature changes like expansion and contraction.

i. Superstructure

It mainly supports deck and consists of girders and beams that is constructed of concrete, steel, timber and bearing that connect the substructure with the superstructure.

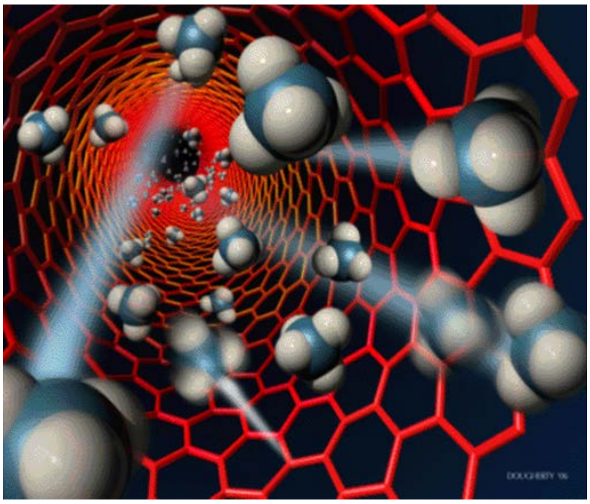
ii. Substructure

It supports the superstructure and transmit load from superstructure to the ground.

B. Carbon nanotubes

Basically Carbon nanotubes are carbon's allotropes whose nanostructure is cylindrical. Nanotubes have 132,000,000:1 length to diameter ratio. These nanotubes posses very unusual properties which make them significant for material sciences such as electronics. carbon nanotubes have electrical, thermal conductivity and mechanical properties. Carbon nanotubes also have various applications in structural materials. A nanotube belongs to "fullerene" structural family which includes spherical buckyballs and these hemispherical buckyballs are used to cap the ends of carbon nanotubes. Hollow structure with the walls made by one-atom-thick sheets of carbon named as "grapheme".

These sheets are rolled at certain "chiral" angles and combination of these rolling angles and radius results nanotube properties e.g. the nanotube shell is metal or semiconductor. Single nanotube aligns itself into a rope which is held by a force called 'Vander wall force'. Nanotubes have certain properties like strength, hardness, kinetic, electrical, optical and thermal. We use here only electrical properties of carbon nanotubes and these electrical properties are due to the graphene structure of carbon nanotubes. [4]

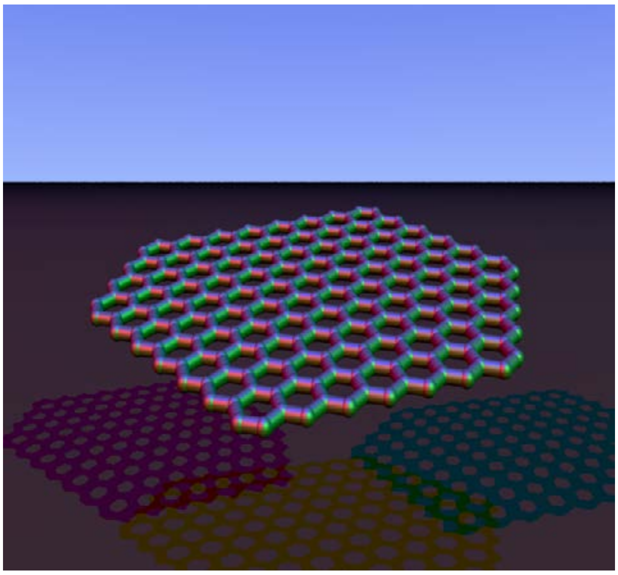


[Fig 1] carbon nanotube

a. Graphene structure

One of the allotrope of carbon having structure of one-atom-thick planner sheets of sp^2 bonded carbon atoms is graphene. Graphene term derived from the combination of graphite and the suffix of ene. Graphene differs from conventional three dimensional materials. At room temperature this allotrope of carbon has high electron mobility. [2]

Mobility of electrons and holes should be nearly same. Graphene sheet have resistivity of $10^{-6}\Omega$ cm which is less than the resistivity of silver. This property of graphene helps to conduct the current very smoothly.



[Fig 2] Graphene structure

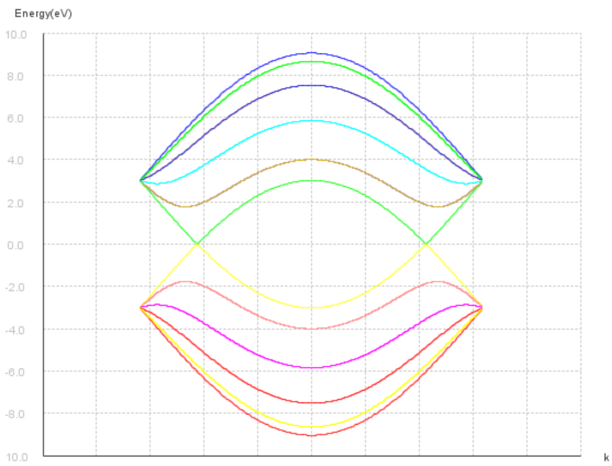
III. PROCESS

Spray is developed with carbon nanotubes that are used to coat the bridge for checking the damages without visual inspection. Bridge surface is coated with this spray, skin containing carbon nanotubes conduct electric current. If the bridge having cracking or corrosion or any damages than the current through skin will be break and electrical resistance will be increased and the location of the damage can be point out by the computer.

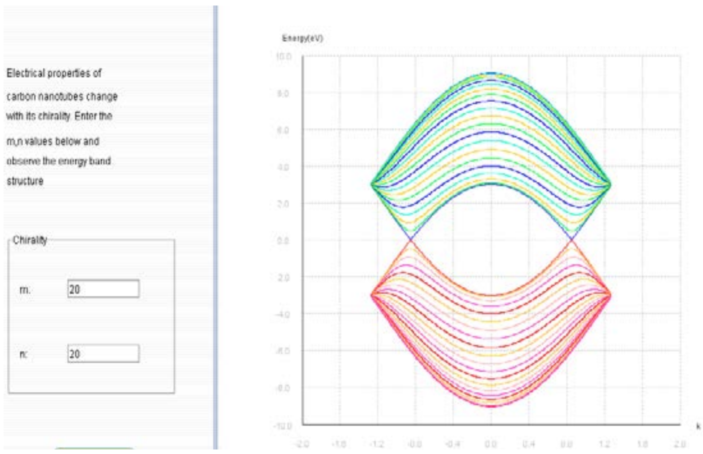
When this skin is applied to bridge surface corrosion and cracking can be self-detected. Computer creates the damage map where exactly the bridge is cracked or damaged. By using this technique we can detect micro level damages in the bridge.

IV. SIMULATION

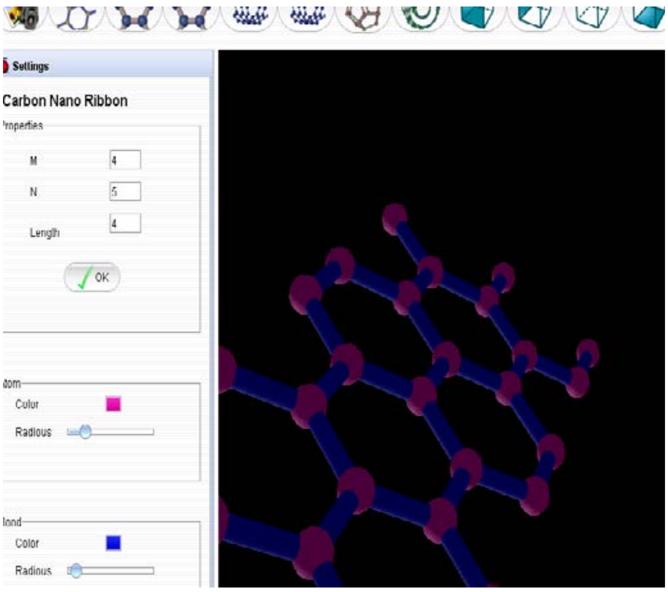
Simulation is performed in NINITHI software suitable for nano analysis of parameters.



[Fig 3] Electrical Properties of nanoskin



[Fig: 4] m=20, n=20



[Fig 5] Graphene simulation

V. CONCLUSION

By using ordinary visual technique we can not detect micro level damages in the bridge. Carbon nanotube using graphene property produces easier way to inspect the bridge damages using electric properties of carbon nanotubes.

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