

Inspection of the Composite Materials

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Abstract

A non-destructive test method is the main method to examine most of the materials, composite materials in particular. There are too many Non-Destructive Test (NDT) methods to inspect the materials such as, Visual Inspection, Liquid Penetrate Inspection, Eddy-Current Inspection, Phased Array Inspection, Magnetic Particle Inspection and Ultrasonic Inspection. This paper aims to create a unified methodology for engineers depending on research on to study the inspection of the composite materials. The researchers concluded that NDT method is the most suitable method for testing any materials and the composite materials. They also recommended to choose the most suitable NDT method as every materials and composite materials have its own properties as well as the inspection methods had its own capabilities and limitations.

Keywords — Research Onion, NDT, Ultrasonic, Composite Materials.

1. INTRODUCTION

Composite materials are a combination of two materials or more mixed together to obtain a particular structural properties, the mixed materials do not dissolve completely in each other but they act together as one[1].

The purpose of making composite materials is to get high stress, low weight, fatigue resistance and corrosion resistance than the individual material. The demand on composite materials have been increased as the composite materials have increased the performance and reduced the fuel consumption especially aviation industry[2].

Since 60 years NDT has been in continuous development as it is the major method to determine and inspect the composite materials[3].

In the last decades the vendors had a primary research for most composite materials to evaluate these type of materials which are totally different compared to normal materials[4].

The combined materials have provide the manufacturers with a unique features that are unavailable in the normal materials. The designers benefit from the advantages offered by this composite that has light weight, anti-corrosion, and excellent efficiency appropriate for many applications in the industrial region[5].

Due to the complex microscopic structure of these composites NDT methods has been applied frequently to examine these complicated materials[6]. Now these days ultrasonic testing equipment has one of the most used equipment and much popular techniques operated to perform NDT assessment on composite materials used in aviation industry [7, 14].

Despite of the too many types of NDT material inspection, but the ultrasonic method is one of the widespread techniques.

2. RESEARCH METHODOLOGY

2.1 Aims:

To find any defects in the composite materials by using NDT with the ultra-sonic device to determine the ultrasonic capability in the composite materials.

2.2 Objectives:

- Investigate ultrasonic and thermography techniques as NDT method implemented to assess laminated composites.
- Analyse their capabilities and limitations in tracing defects in composite structures.
- For effective NDT experiments, it is important to understand the nature of the material being tested for better results.

2.3 Methodology:

After we agreed the topic of this project we started researching the required information relating to inspection the composite materials by ultrasonic based on previous studies to provide a useful information helping to cover the whole aspects of the topic. Most of the information in this paper gained from previous studies and results published on line in form of books, journals and articles using “Goole Schooler”, related books borrowed from the library as well as books bought from bookshops.

Saunders (2007) has been developed the research onion. When designing a research plan the research onion explains all the areas that should be covered. In the research onion every onion’s layer explains in detail the research procedure [8].

An efficient improvement supplied by the research onion which a research methodology can be resolved. The interest lies in its adoption for the most kind of research methodology and can be used in an assortment of contexts [9].

Thus, the good thing about the research onion is to make a string of stages which the various processes can be understood and explain the procedure step by step by which methodological can be explained. The diagram of the research onion based on three philosophies [9]:

- Ontology
- Epistemology
- Axiology

To carry out a good research it is very essential to select and understand a philosophy of the project, as seen in figure (1).

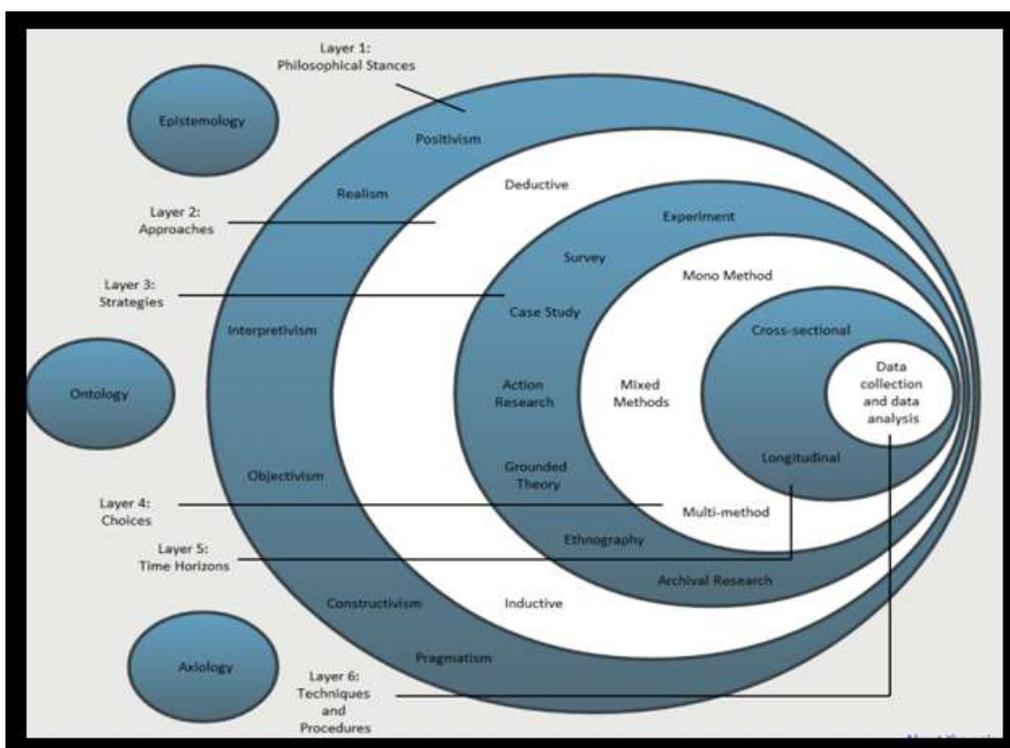


Figure 1 Research Onion Diagram

And this experiment as seen in Figure 2

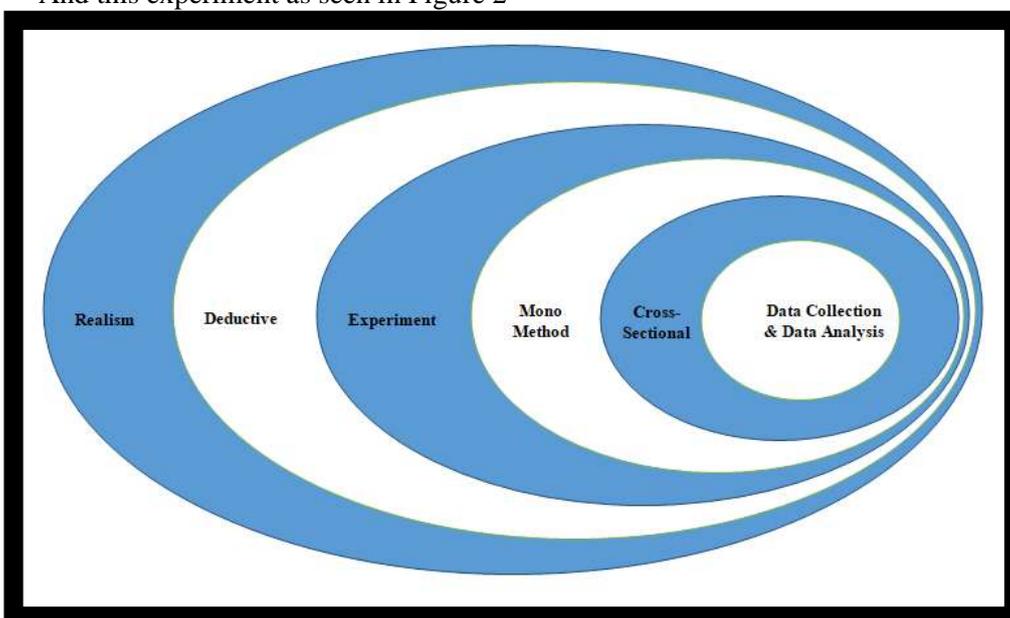


Figure 2 Research Onion Diagram

3. DISCUSSION

In this paper, the researchers are going to inspect the carbon fibre as the ultrasonic inspection is suitable for these type of composites. In 1878 Sir Joseph Wilson Swan produced glaring lamps with carbon threads. Carbon fibre made from about ten layers pressed together

under high pressure, vacuumed and a resin filling up. Carbon fibre composite is a high temperature resistance, weightless and fatigue, corrosion resistance[10] as explained in figure (3).

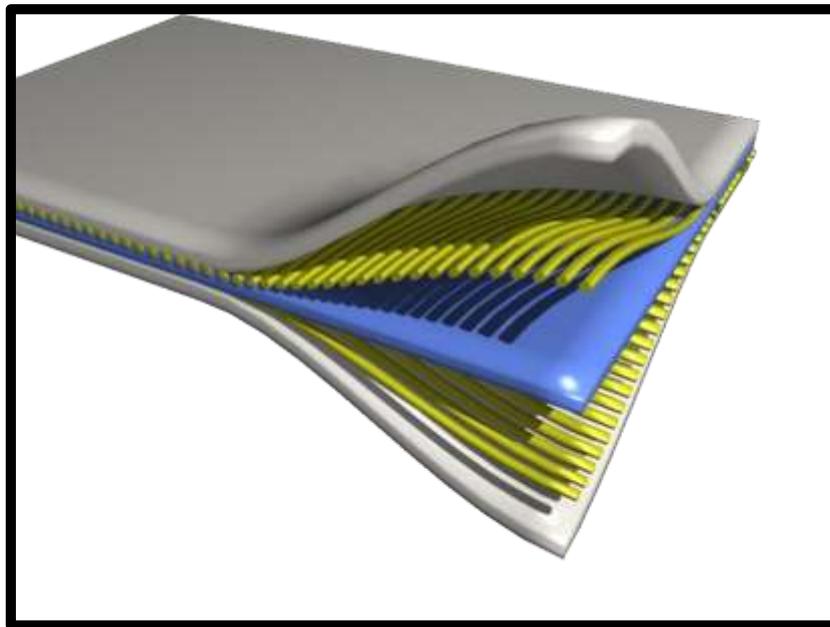


Figure 3 Composite Materials

A contact method is been applied to inspect composite materials by phase array method moved across the tasted piece[2]. A certain amount of frequency could be applied. The surface should be clean and smooth, a medium called couplant is performed between the probe and the examine material to overcome the power dissipation which exists when the sound waves travel between the probe and the surface of the composite and to fill the microscopic gaps providing a very smooth surface to the probe of the ultrasonic equipment to travel on[3]. In aviation industry NDT method considered as a much reliable technique to identify and detect the defects that can badly affect the composite structure leads to tragic disaster especially in formula one, sea, aviation industry and many more[6]. Figure (4) shows the ultrasonic equipment.



Figure 4 Ultrasonic Equipment

A certain frequency will be applied and it can vary between 5 MHz to 10 MHz through a probe which is internally divided in to 64 part to be able to cover as much it can[2]. This frequency will travel through the composite translate the result in to a graph, frequency travelling would reverses if any defect exists otherwise will carry on until the bottom surface of the composite, in the other word the data outcome of the ultrasonic equipment comes as a graph which would able to explained by the engineers[10]. Figure (5) shows the data out come from the ultrasonic equipment.

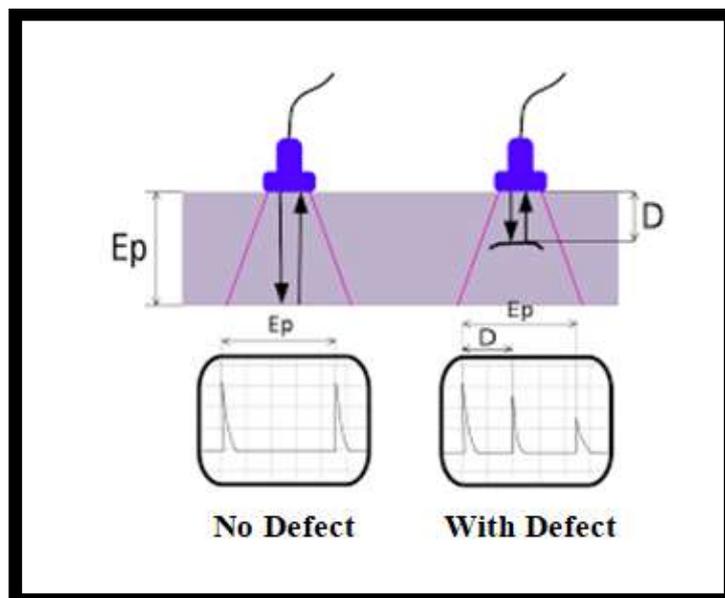


Figure 5 The Data out come from the Ultrasonic Equipment

4. LITERATURE REVIEW

As a result of previous studies have demonstrated that the engineer and the designers always struggle and working hard to provide best, effective and reliable equipment at lowest possible cost with a better performance to produce the most accurate equipment that the engineers could rely on to provide a safer environment.

In 1929 and 1935 ultrasonic waves studied by Sokolov to detect metal objects. In 1931 Mulhauser acquired a patent in ultrasonic wave by using two transducers to expose defects in solids. Firestone and Simons (1940) (1945) respectively improved pulsed ultrasonic testing by using a pulse-echo technique. Josef Krautkrämer and Karl Deutsch 1949 in Germany both started in improvements without the knowledge of each other. Josef Krautkrämer and his brother the physicist Herbert working in oscilloscopes field. Karl Deutsch a mechanical engineer and Hans-Warner Branscheid a radar technician who had got some extra technical experience during the 2nd world two. The ultrasonic equipment has been presented by the two companies and still competing each other until now these days[11].

4.1 Capabilities:

The ultrasonic test is suitable for testing the composite materials for quite few reasons[12]:

- It can determine the size and the location of the flaws.
- Resolution adjustment available not like the other equipment.
- Mobile and compact, so it is so practical and could be carried to the location of the composite to be inspected which is very useful especially in aviation industry as the

ultrasonic equipment can be utilised in a work field without the requirement of laboratory environment .

- Ultrasonic test can assure composite materials thickness to confirm life expectancy.
- The depth of flaws defects along the composite materials can be estimated.
- Ultrasonic test equipment can be applied from one side if there is any restrictions to access the laminates.

4.1 Limitations:

There are quite few limitations using ultrasonic test on composite materials such as[13]:

- To perform a successful test experience and training are required.
- A thin materials are very difficult to measure.
- The composite surface has to be clean and smooth with couplant to be added.
- An inaccurate results caused by power loss when the signal travel from the probe to the surface.
- In some high level ends they are expensive to buy.
- A bubble formed as a result of vacuum operation during manufacturing process could confuse the equipment as the ultrasonic waves only travel through the air and would reflect their.

5. CONCLUSION AND RECOMMENDATION

As we can see from the research has been carried out that the Non-Destructive Test method is the most suitable method for testing any materials and the composite materials as we used the ultrasonic inspection method, but this method was not perfect method for this test as it has quite few limitations limiting this method to be a unique method in NDT. Our recommendation is to choose the most suitable NDT method as every materials and composite materials have its own properties as well as the inspection methods had its own capabilities and limitations.

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