Editorial
Volume 13:4, 2022

Journal of Forensic Research

ISSN: 2157-7145

Open Access

Forensic Engineering: An Overview

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Editorial

The analysis of property damage and injuries caused by failures in materials, components, design, and constructions is known as forensic engineering. These can range from trivial occurrences like a crankshaft cracking to catastrophic disasters like a bridge collapse. Manufacturers, builders, insurance companies, and law firms receive the results of forensic engineering investigations. If there was property damage, economic loss, personal injury, or death, forensic evidence, coupled with the investigator's testimony, could be offered in a court of law, arbitration, or other forum [1,2].

"The analysis of defects ranging from serviceability to catastrophic" that may lead to legal action, both civil and criminal, has been classified as forensic engineering. It entails looking at materials, goods, structures, or components that fail or do not perform or function as they should, resulting in physical injury, property damage, or financial loss. Failure may result in legal action under either criminal or civil law, including, but not limited to, health and safety legislation, contract and/or product liability laws, and tort laws. The topic also focuses with retracing processes and procedures that lead to automobile or machinery accidents. The goal of a forensic engineering inquiry is to determine the cause or causes of failure in order to improve a component's performance or life, or to aid a court in ascertaining the facts of an accident. It may also entail looking into intellectual property claims, particularly patents. In the United States, forensic engineers must hold a state-issued professional engineering licence [3].

The field of forensic engineering has evolved in tandem with the field of engineering. Investigations into bridge failures such as the Tay rail bridge catastrophe of 1879 and the Dee bridge accident of 1847 are early examples. The introduction of tensile testing of samples and fractography of failed components was spurred by a number of early train accidents. The practise of examining and collecting data linked to failed materials, goods, structures, or components is critical to the area of forensic engineering. Inspections, evidence gathering, measurements, constructing models, getting exemplar products, and conducting tests are all part of this process. Testing and measurements are frequently carried out in a reputed independent testing laboratory or another unbiased facility.

Analysis

In the context of safety engineering, Failure Mode and Effects Analysis (FMEA) and fault tree analysis approaches look at product or process failure in a structured and methodical fashion. All of these strategies, however, rely on precise reporting of failure rates and identification of the failure types involved. There are some areas where forensic science and forensic engineering overlap, such as scene of crime and accident analysis, evidence integrity, and court appearances. Optical and scanning electron microscopes, for example, are used extensively in both disciplines. They also utilise spectroscopy to assess key evidence (infrared, ultraviolet, and nuclear magnetic resonance). Before destructive testing, radiography employing X-rays (such as X-ray computed tomography) or neutrons is highly useful in evaluating thick products for interior faults. A simple hand lens, on the other hand, can often indicate the source of a problem [4].

When reconstructing the sequence of events in an accident, trace evidence might be helpful. Tire burn imprints on a road surface, for example, can be used to estimate vehicle speeds, when the brakes were applied, and so on. Ladder feet often leave a trace of the ladder's movement during a slip, which might help determine how the accident happened. SEM and Energy-dispersive X-ray spectroscopy (EDX) has done in the microscope can reveal the presence of hostile chemicals that have left traces on the fracture or nearby surfaces when a product breaks for no apparent cause. As a result, an acetal resin water pipe junction failed unexpectedly, causing significant damage to the structure in which it was installed.

Application

The majority of production models will include a forensic component that tracks early failures in order to enhance quality or efficiency. Forensic engineers are used by insurance firms to prove responsibility or non-liability. Most engineering disasters (structural failures such as bridge and building collapses) are investigated forensically by engineers who are familiar with forensic methodologies. When component failure is suspected, forensic engineers investigate rail crashes, airline accidents, and some car accidents. Furthermore, occurrences involving injuries or property damage can trigger investigations of appliances, consumer products, medical devices, structures, industrial machinery, and even simple hand tools like hammers or chisels. Because medical device failures are frequently life-threatening to the user, reporting and analysing them is vital. The body's environment is complicated, and implants must be able to withstand it while also avoiding leaching potentially hazardous contaminants. Breast implants, cardiac valves, and catheters, for example, have all been linked to complications.

Early failures of a new product provide crucial information for the maker to enhance the product. Although new product development seeks to remove flaws through factory testing before to introduction, some may arise throughout the product's early life. Testing items to imitate their behaviour in the real world is a tough talent to master, and it may need expedited life testing. A safety-critical flaw, which can jeopardise life or limb, is the worst type of defect that can occur after launch. When they are discovered, the product is usually recalled or removed entirely from the market. Product problems frequently follow the bathtub curve, with high initial failure rates, a reduced rate during normal use, and then a spike due to wear-out. National and international standards, such as those of ASTM and the British Standards Institute, can assist the designer in improving product integrity [5].

Conflict of Interest

None.

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Received: 01 April, 2022, Manuscript No. jfr-22- 66299; **Editor assigned:** 04 April, 2022, PreQC No. P-66299; **Reviewed:** 15 April, 2022, QC No. Q-66299; **Revised:** 22 April, 2022, Manuscript No. R-66299; **Published:** 29 April, 2022, DOI: 10.37421/2157-7145.2022.13.494

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How to cite this article: Tyagi, Sahani. “Forensic Engineering: An Overview.” J Forensic Res 13 (2022): 494.