

Introduction to forensic engineering

[Law](#), [Crime](#)



Forensic engineering may be stated as the application of engineering principles and methodologies for the purpose of court of law. Consequently, it involves the research of substances that are to be used for making a structure which fails to stay as long as it was expected, resulting in injury, and damage to belongings and monetary loss. The failing of the same may result in taking the legal step, i. e. , criminal or civil. This subject also offers with the recollecting the information about the methods and procedures done which led to the accident of cars or in equipment. Basically, the primary motive of the forensic engineer is to discover the cause or causes which led to the failure, or to assist the courtroom in finding the records associated with the accident. It additionally involves the research of the highbrow belongings claims, specifically patents. In the forensic engineering investigation, the process of collecting information about the structure, substances used, components, products is done which includes inspections, measurements, or performing experiments. The responsibilities a forensic engineer is having are as follows:

1. Investigating the crime scene to find the cause of the structural collapse
2. Making reports on the basis of the evidences found at the crime scene which led to the damage
3. Giving opinions and testimony in the court proceeding as an expert witness
4. Preparing a ideal structure which will be safe from any damage

5. Connect with clients and other professionals In this assignment, there will be some information about structural collapse and human injury and case examples for same.

Structural Collapse

Before discussing about structural collapse, there is a term structural integrity. It is an aspect in engineering which deals with the ability of the structure to take load of a designed structure without getting damaged. To create a structure with its integrity, the material used should be examined on the basis of toughness, strength, weight, hardness and add the material accordingly so the structure will be there for long time. Structural collapse involves the loss of the capacity to take the load of the structure which can lead to the formation of deformation and in extreme cases, can result in catastrophic event. Structural collapse can happen by many reasons, these are: –

1. The first will be the poor strength and toughness of the structure to support the load. This can happen due to its size, shape or choice of the material
2. The second can be from the enervation or corrosion of the material used for the construction of the structure which led to the instability of the same.
3. The third can be caused by errors made during the construction of the structure which involves incorrect sizing, improper use of materials, or inferior workmanship.
4. The fourth can be the use of the defective materials.

5. The fifth and the last reason can be the carelessness for considering the minor problems.

These may be minor at first, but further ignorance can result in the catastrophic events. This also includes not making structures resilient to the natural disasters. Therefore proper knowledge of materials which are to be used for constructing the structure can somewhat help in maintaining the structure for a longer time preventing from causing any catastrophic event.

Case Examples

The Royal Palm Hotel consisted of twin 12-storey concrete special moment resisting frames. It was at Tumon Beach, Guam. The building was designed in 1990 in keeping with the necessities of the 1988 Uniform Building Code. Guam is struck frequently by sturdy earthquakes and typhoons. The island was selected as Uniform codification Zone 3, and additionally had wind speeds of a hundred and forty miles per hour. Structural design was created by an engineer, authorized in each island and Calif.

The engineer of record for the project is additionally thought-about because the Special Inspector of record. GU could be a U. S. territory. Licensing laws on GU is sort of same to those in Calif. , with at a civil license and structural title. At the time of the collapse, the structural engineer didn't possess structural title authority. Construction of the building was completed in Gregorian calendar month, 1993. On August eight, 1993 a strong earthquake cask the island, inflicting partial collapse of the structure, that determined to be an entire loss. No fatalities occurred but there are some injuries. A drawn-out continuing ensued following the collapse and in depth structural

investigations were performed by form of U. S. experts. In depth vogue and construction flaws were found at intervals the structure.

These included:

- The analytical model accustomed style the structure had varied errors, along with several columns that were rotated 90o from their actual orientation
- further confinement hoops needed around column splices weren't given on the drawings
- Masonry infill walls created short column conditions throughout the structure
- Strong-column weak beam criteria weren't complied withIt was in addition determined that the contractor failed to follow the structural details on the drawings. Specifically, two vital flaws were found:
 - the contractor substituted “ U” formed stirrups for the closed ties needed at intervals the joints of the special moment resisting frame.
 - The contractor omitted closed hoops in many joints of the concrete special moment frame

Special examination reports, signed by the engineer of record, and indicated that the improperly created joints had been inspected by the engineer that he approved of the placement of reinforcing steel. Further, correspondence and notes on drawings indicate that as a result of the seismic vogue forces for the structure were but the wind forces, compliance with the outline wants for special moment frames, though fascinating, was not essential. Two primary sorts of failure – shear failure of joints at intervals the special

concrete frame and shear failure and compressive crushing of gravity columns occurred at one altogether the two structures' second story. This resulted in partial collapse of the structure, and ultimate demolition of every structure.

In trial, the jury ultimately found the contractor in charge for the collapse, however not before the engineer of record omitted guiltiness and settled out of the proceedings, let go his insurance cowl at intervals the method.

Although the contractor was ultimately found to be financially in charge for the collapse, for failure to construct the building as shown on the drawings, there isn't any question that the design had many errors which intensive injury, probably as well as collapse, may need occurred whether or not the structure was created as designed. Further, the structural engineer's guiltiness at intervals the wrong construction, as long as he acted as special inspector for the project is whereas not question. The structural engineer didn't have correct understanding of the premise for earthquake resistant necessities at intervals the codification and didn't act prudently either in coming up with the building or acting as its special inspector. Ultimately this resulted at intervals the overall loss of a \$70 million building, simply weeks once its completion and total financial losses that quite doubled the building's construction worth. [image: Image result for rOYAL palm hotel in guam.

On 15th November 2010, around 8. 15 PM, 5 and above storey building near Lalita Park, Laxmi Nagar, East Delhi, collapsed, killing 71 people & injuring 65. Over 60 families, mostly labourers have been living within the restricted area of the 20-year-old building. Little or inadequate damp proofing

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measures had been taken up with the aid of the owner/civic authority for the basement leakage. No measures, such as pumping out of water, sealing of leakage or monitoring of basis deterioration, have reportedly been taken up. The building became suspected to have weakened in the course of heavy monsoon, followed by incipient seepage into the basement, which was present till Rainey well No. 10 started flushing out water in the starting of January 2011. The Government of National Capital Territory of Delhi instituted a Commission of Inquiry to check out the reasons of the collapse of the building, examine the constructed up structures' safety in East Delhi and recommend measures to prevent similar incidents in future. In taking up forensic investigations of this building, some aspects of layout of the structure, construction and movements which are being done maintain the structure have been studied in detail to investigate why, when, how, and what went wrong and more importantly, what are the signs and scenarios that led to a surprise fall about.

This building turned into a privately owned residential constructing under the jurisdiction of Municipal Corporation of Delhi (MCD). It began with one storey constructing in 1988, then extended to three storey in 1990 and then to five storey in 2005. Fundamental principles of constructions prescribed by BIS and NBC-2005 had been hardly ever visible accompanied. This building included complete area of plot (4.7m x 18.6m) with cantilever projections and floating walls on all three facets. It had basement of 3m depth and 12 columns which were located at the plot boundary, thus rendering all footing to be eccentrically loaded. The whole colony comes under Yamuna flood plain yet little or no attention was given in the seepage protective measures.

The constructed height (20.5m) was more than 4 times the plot width (4.7m).

In addition, the overhang from ground floor to full height in the Western side was almost 50% of the base width, thus making it liable to structural instability. The building had 40 odd rooms with reportedly housing greater than 200 human beings. To such building, existing building bye-laws, development control rules, land use policy and master plan etc. cannot be complied with. An investigation from the justice for the incident was ordered and below Section 304 of the Indian legal code, a charge of being guilty or kill however not for murder was recorded against the building's owner, Amrit Singh. Singh tried to flee however was later captured. The authority of Delhi declared AN ex-gratia of Rs two hundred thousand every to the families of these killed and Rs one hundred thousand to the dislocated. [image: Image result for Lalita Park building collapse case study.]

Human Injury

Injury, also known as physical trauma, is damage to the body caused by external force. This may be caused by accidents, falls, hits, weapons, and other causes. Major trauma is injury that has the potential to cause prolonged disability or death. In forensic engineering, the biomechanics of injuries is mainly taken care of. Biomechanics simply means the application of Newton's mechanics to biology. This can also be defined as the application of concept of engineering into biological system. CASE STUDY Phineas Gage, whose story is additionally called the 'American Crowbar Case', was an unwitting and involuntary contributor to the history of neuroscience. In 1848, when he was just 25 years old, Gage sustained a terrible injury to his brain.

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His miraculous survival, and the effects of the injury upon his character, made Gage a curiosity to the public and an important case study for scientists hoping to understand more about the brain. In 1848 Gage was working as a foreman on the construction of the Rutland and Burlington Railroad in Vermont, USA.

Workers often used dynamite to blast away rock and clear a path for the railway. On 13 September, Gage was using a tamping iron (a long hollow cylinder of iron weighing more than 6 kilos) to compact explosive powder into the rock ready for a blast. The iron rod hit the rock, creating a spark that ignited the explosives. The rod was propelled through Gage's skull, entering through his left cheekbone and exiting through the top of his head. It was later found some 30 yards away from Gage, " smeared with blood and brain". Despite his horrific injury, within minutes Gage was sitting up in a cart, conscious and recounting what had happened. He was taken back to his lodgings, where he was attended by Dr John Harlow.

The doctor cleaned and dressed his wound, replacing fragments of the skull around the exit wound and making sure there were no fragments lodged in the brain by feeling inside Gage's head with his finger. Despite Harlow's efforts, the wound became infected and Gage fell into a semi-comatose state. His family did not expect him to survive: they even prepared his coffin. But Gage revived and later that year was well enough to return to his parents' home in New Hampshire. In 1850 Henry J Bigelow, Professor of Surgery at Harvard University, reported Gage to be " quite recovered in faculties of body and mind". It seems that physically, Gage made a good

recovery, but his injury may have had a permanent impact on his mental condition. Although accounts from the time are sometimes conflicting and often unreliable, numerous sources report that Gage's character altered dramatically after his accident.

In 1868 Harlow wrote a report on the 'mental manifestations' of Gage's injuries. He described Gage as "fitful, irreverent, indulging at times in the grossest profanity... capricious and vacillating" and being "radically changed, so decidedly that his friends and acquaintances said he was 'no longer Gage'." The damage to Gage's frontal cortex caused by the iron rod seems to have resulted in a loss of social inhibitions. The role of the frontal cortex in social cognition and decision making is now well-recognized; in the 19th century, however, neurologists were only just beginning to realize these connections. Gage's injuries provided some of the first evidence that the frontal cortex was involved in personality and behaviour. One of the pioneering researchers in this field at the time was David Ferrier, a Scottish neurologist who performed extensive experimental research into cerebral function. In a lecture to the Royal College of Physicians in 1878, Ferrier observed that in his experiments on primates, damage to the frontal cortices seemed to have no effect on the physical abilities of the animal but brought about "a very decided alteration in the animal's character and behavior". He used the experience of Phineas Gage as a case study to support his claims.

The details of Gage's life after his accident are unclear. It is known that he worked as a coach driver for several years in New Hampshire and then in Chile and that in 1859 his health deteriorated and he returned to the USA.

He died in San Francisco in 1860 after suffering seizures that resulted from his injury. His brain was not examined after his death, but in 1867 his body was exhumed and his skull was sent to Dr Harlow to be studied. It now resides, along with the tamping iron, at Warren Anatomical Museum at the Harvard University School of Medicine.

Since then, scientists have made various attempts to use the skull to reconstruct Gage's injury and establish which areas of his brain were damaged. A team led by Jack Van Horn of UCLA's Laboratory of Neuroimaging (part of the Human Connectome Project) created a new digital model of the rod's path. It suggested that the damage to Gage's brain was more extensive and severe than had previously been estimated: up to 4 per cent of the cerebral cortex and about 11 per cent of the total white matter in the frontal lobe were destroyed. The model also indicates that the accident damaged the connections between the frontal cortex to the limbic system, which are involved in the regulation of emotions. This would seem to support some of the contemporary reports of Gage's behaviour. In the 19th century, Gage's survival seemed miraculous. Fascination with his plight encouraged scientific research into the brain, and the continuing research into Gage's condition is proof that this same curiosity is still alive today.