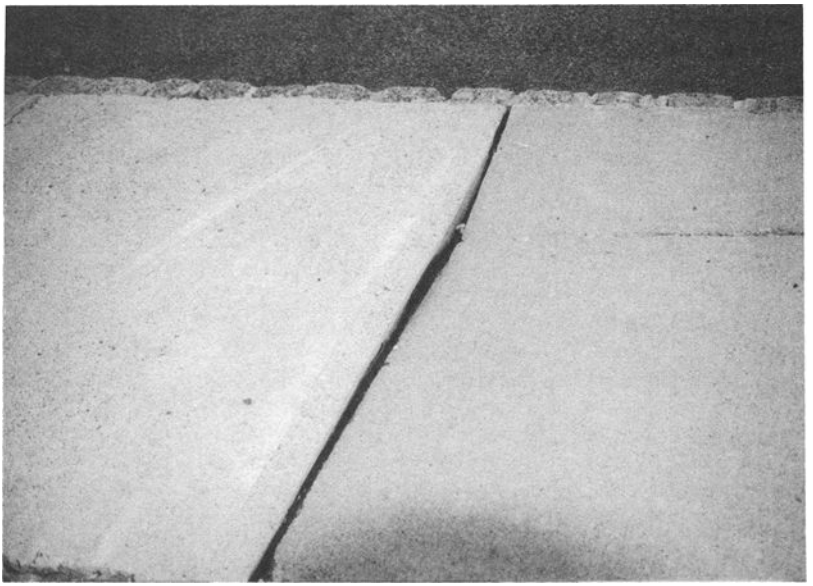
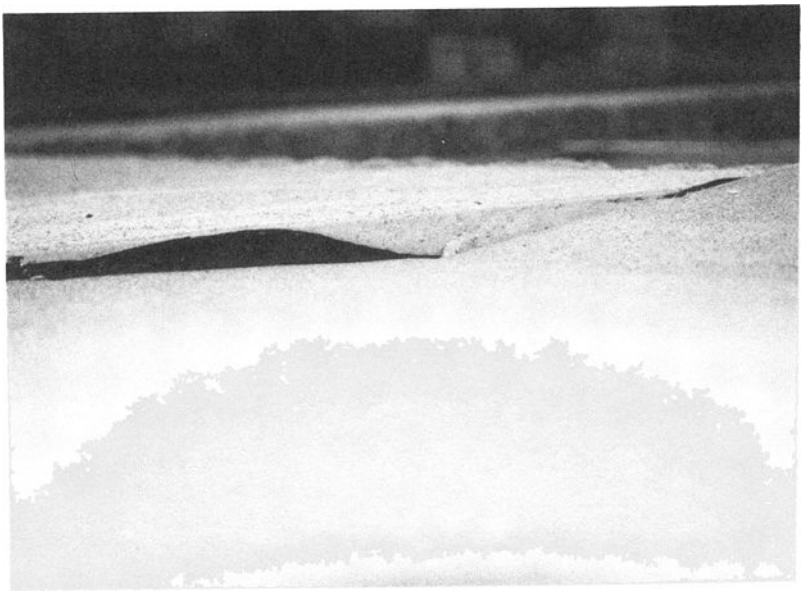


Photograph 5. Although some defects are visible, it is difficult to tell from this perspective what the condition of the sidewalk really is.



Photograph 6. By changing your relative camera perspective, you can fully illustrate the height differential between the sidewalk slabs.

2. Exposure

In-camera exposure meters in modern 35mm SLR cameras are accurate and versatile. However, total reliance on the in camera meter is not wise. Small, dark subjects on light colored backgrounds and small, light colored subjects on dark backgrounds can easily fool an averaging or matrix type of meter. The camera does not know what the subject of the photograph is, but you do. Utilize a spot meter to calculate the proper exposure value for the primary subject. Zone system exposure calculations are usually not necessary, but a review of the process (The Negative, Ansel Adams, Little, Brown & Co. 1983) is highly recommended to gain an understanding of the relationship of contrast and light.

3. Film

Modern color negative (print) film provides a great degree of exposure latitude compared to chrome (slide) films. However, print films require a two step process to get a useable/viewable image, whereas slide films require only a one step process. Most print films will be adequate for most assignments. Use of professional quality, nonenhanced color print film for color critical subjects is recommended.

4. Record Keeping

Utilize a field note sheet to record all key information about the subject, location, date, time and special observations. Proceeding in a logical manner will make later analysis easier. Make frame by frame notes of what you are documenting. This avoids having to recall each subject in a collection of several hundred photographs.

5. Processing

After exposing the film, choose a processor that will handle your film carefully and reliably. Professional color lab processing is more expensive than small, automated "mini-labs," but is well worth the time and inconvenience. If you have special processing requirements, only a professional lab will have the ability to produce useable results. Do not use bulk process mailers, as the risk of loss during delivery and return is higher than for a location to which you can drop off and pick up your film.

6. Digital Issues

While the use of digital technology is a significant change in the way images are recorded, it is the opinion of the authors that two primary constraints limit the viability of digital image capture. Resolution is inadequate with most equipment for high magnification images and enlargements. Of greater concern is that original image integrity is currently unverifiable for most digital imaging methods. The use

of computer image manipulation software is often undetectable, making it difficult to prove (or disprove) the validity of an image that is captured digitally. The use of high resolution scanning equipment to digitize negatives (or positives) is preferred at present, as there is a verifiable original. Keep in mind, however, that image manipulation of traditional emulsion based photographs is also possible; however, the difficulty of doing so undetectably is much higher than that for digital image capture.

7. Presentation Exhibits

The images you capture will typically be processed and output in "proof" form such as 4" x 6" prints. For presentation to larger audiences such as a jury, the image may need to be enlarged and mounted on a structural backing material or projected onto a screen via a computer or slide projector. The preferred method of presentation is best determined through discussion with the client or other party to the investigation.

8. Testimony

The forensic investigator will occasionally be required to testify to the findings of the investigation and to the photographs utilized in the investigation. You must be familiar with the equipment and film used, the processing, the location/possession of the originals and/or negatives since the images were made, etc. Good record keeping is essential to making this part of your testimony a convincing (and relatively painless) process.

9. Experience

As stated above, experience is the greatest asset you can have when performing your own forensic evidence photography tasks. Your judgement will determine if you are capable of performing the job adequately or whether a professional should be hired.

Conclusion

The importance of competently performed forensic evidence photography and the requirement, importance and relevance it has in the presentation of arguments in a forensic engineering investigation should not be ignored. The investigating engineer is the person in the best position to make judgements about what should be documented and who is to perform that function. The decisions made will affect the presentation of arguments and perhaps the outcome of the assignment. Perishable evidence that is thoroughly documented through clear, properly exposed and composed photographs will be the key link between the event and the judgements made regarding that event.

References

Adams, Ansel, The Negative, Little, Brown & Co., 1983.

American Society for Testing and Materials, ASTM E860-82, *Standard Practice for Examining and Testing Items That Are Or May Become Involved In Products Liability Litigation*, September 1, 1982 (Reapproved 1987).

American Society for Testing and Materials, ASTM E1188-87, *Standard Practice for Collection and Preservation of Information and Physical Items by a Technical Investigator*, November 16, 1987.

Evidence Photographers International Council, Inc. (EPIC), 600 Main Street, Honesdale, PA 18431 USA.

Greenspun, Professor Philip, General Photography Information Forum, www.photo.net, Department of Engineering & Computer Science, Massachusetts Institute of Technology, Boston, Massachusetts, USA.

The Oxford Desk Dictionary, American Edition, Oxford University Press, 1995.

Forensic Engineering: The Integration of Engineering Analysis and Law into a Specialized Profession

M. Derek Barrentine, PE[1]

Abstract

Historically, attorneys would call upon an engineer whom they believed had technical knowledge on specific issues, while frequently overlooking the consequences of the engineer's limited "legal" experience. Today however, attorneys who use engineers in litigation (which in reality still make up a very small percentage of the attorney population) have become increasingly aware of the importance of the engineer's prior testifying experience. It is nearly imperative that a prospective attorney-client will ask, "How many times have you testified?" before proceeding into the details of a specific case.

Introduction

"**Forensic** [fo-ren'sik] *adj* belonging to courts of law; used in law pleading." – Webster's Dictionary

"**Forensic engineering.** The application of the principles and practice of engineering to the elucidation of questions before courts of law. Practice by legally qualified professional engineers who are experts in their field, by both education and experience, and who have experience in the courts and an understanding of jurisprudence. A forensic engineering engagement may require investigations, studies, evaluations, advice to counsels, reports, advisory opinions, depositions and/or testimony to assist in the resolution of disputes relating to life or property in cases before courts, and other lawful tribunals." – Blacks Law Dictionary, sixth edition.

Literal interpretation of Black's definition is to understand the importance of studying and implementing legal procedures, in concert with the ability to perform accurate and credible engineering analysis.

[1] CEO, Consulting Engineer, BARRENTINE, P.C., PO Box 1463, Hartselle, AL 35640 and member Committee on the Dissemination of Failure Information, ASCE

Since the word "forensic" is so commonly used in the phrase "forensic medicine," the general public typically believes that "forensic engineering" has something to do with medicine. The use of science in the legal profession was at one time almost exclusively limited to medical analysis such as autopsies, laboratory tests or dental records in criminal applications. However, growth of the legal profession has since created a need for forensic science in many areas other than medicine. The need to understand physics, materials and technology is more common in civil litigation than ever before; forcing advocates to gather technical and regulatory information from every facet of civilization. Hence the ever-growing demand for the Forensic Engineer.

Most engineers use engineering principles solely in *project design* applications; integrating traces of analysis during the initial stages of a project or in the quality control efforts during construction. Conversely, performing full investigations into the causes of construction failures and accidents after they occur requires additional knowledge in the area of *engineering analysis.* Although engineering analysis, and subsequent testifying, are not likely to become the engineer's sole practice, it will require an initial investment of time and attention devoted to the details and promotions of this added service.

Traditionally learned through self-study and peer interaction, this specialized profession requires the willingness of the individual to advance beyond design experience, as a pioneer in a profession of new parameters and technical procedures. Since engineering analysis frequently involves testifying in courts of law, it also demands a sharp-witted understanding of jurisprudence. This blend of engineering and law requires candor and intuition, and is best suited for the people-oriented professional who is equipped with an engineer's education.

Qualifications of the Forensic Engineer

The forensic engineer differs from other expert witnesses in that he is a technical professional "by design." He is a licensed Professional Engineer (PE) in one or more states, as required by States' laws before one is allowed to proclaim himself an "Engineer."

Initially, the PE completes the engineering curriculum of an accredited college or university, then successfully completes a state-administered examination, offered in accordance with NCEE (National Council of Engineering Examiners) specifications. Engineering examinations (sixteen hours) are given with emphasis on: 1) engineering principles according to academic teaching, and 2) specific fields of pre-exam experience, such as civil, mechanical or chemical engineering.

Each license is issued as a Professional Engineering license at large, since engineering principles between various fields of practice are generally homogeneous. This allows engineers to carefully and responsibly "cross train" between disciplines

during their careers; sometimes changing the chosen prefix of their engineering title. Reciprocity between states is generally acknowledged; therefore, licensure within each state is not typically required to qualify an engineer for testifying in court. While there is no minimum required number of years for design experience before practicing as a forensic engineer, the ability to draw from practical application is as important to the engineer's credibility as his formal education.

The title Forensic Engineer, as opposed to Civil, Mechanical, Chemical Engineers, etc., implies a higher level of specialty. Herein, a PE previously skilled in the design of new products and systems, has further studied the procedures of analysis and jurisprudence. Using information obtained through accident reconstruction and detailed analyses, he then must opine the cause(s) of such failure on record, and generally under cross-examination. He may often design retrofits and mitigation to prevent future failures. Personal experience has shown that the title of "Consulting Engineer," or to retain the original prefix, may be more locally accepted than "Forensic Engineer" in some areas.

In function, he has developed the ability to dissect the components of existing products and systems; analyzing them for physical points of failure. He also understands contractual obligations and professional liability in order to determine infractions to contracts and regulatory statutes by parties of the respective dispute. The successful forensic engineer effectively coordinates engineering and law throughout the case; and above all, conveys technical information into litigation with the communication skills to present complex facts in layman's terms.

Changing Trends

The rules for practicing law have changed with time, and so have the rules for forensic engineering. Previous convention held that anyone with credentials and a good three-piece suit could give expert opinions without contest. Now it's Daubert, Daubert, Daubert. Rules governing expert testimony and the criteria for rendering opinions continue to grow. Should forensic engineering testimony *always* be at the scrutiny of scientific study? Of course not. Precedence set by regulations or undisputed facts of the case are frequently sufficient to substantiate the Forensic Engineer's opinions. Frequently, incidental facts and evidence specific to a case simply can't be recreated. Furthermore, the objective conclusions of professional experience are actually nothing more than undocumented research, and are generally accepted from the engineer who possesses the credentials.

Regardless, the credibility of expert witnesses has been damaged by the previous actions of "professional testifiers." This requires even the most ethical experts to take extra measures to demonstrate and maintain their credibility. Listed below are a few important measures that will specifically assist forensic engineers to that end.

Legal and Ethical Constraints

While opposing attorneys frequently attack the engineer's character for providing litigation services, this is merely a ploy to incite defensiveness or break his self-confidence. The experienced forensic engineer knows that the profession exists in its current form as a result of legal and ethical guidelines. Below are a few truths that opposing counsel may wish you didn't know:

Forensic engineers can only work for plaintiff or defense in a given case; not both. Even so, cross-examining attorneys frequently make weak attempts to portray the testifier as illicitly "monogamous" by asking:

"Who has hired you as an expert in this case?" and "What are your terms?"

Ironically, both Bar and Bench would consider it blatantly unethical to work for both sides, since doing so would be a conflict of interests and possibly violate attorney-client privileges. This is substantiated by the (Alabama) Code of Ethics for engineers, Canon III, which states,

> "The Engineer shall safeguard and preserve the confidences and private information of clients and employers."

Consequently, it is the forensic engineer's responsibility to completely and competently evaluate the issues of the case; substantiated by the Code of Ethics, Canon IV, which states:

> "The Engineer shall endeavor to build a practice of professional reputation on the merit of services."

It is the opposing attorneys' responsibility to ask the appropriate questions; as substantiated by the Code of Ethics, Canon I, which states:

> "The Engineer shall exercise independent judgements, decisions and practices on behalf of clients and employers."

When asked by opposing attorneys about your financial terms, tell him. Likewise, be sure to ask, on record, for a copy of the deposition transcript of the opposing attorney's expert in the case.

Credibility of the Forensic Engineer

Historically, the legal profession has proclaimed that engineers who testify frequently will develop a reputation as a "court whore." However, it is not the experience of the testifier, but the credibility of his testimony that matters. Recent history has shown that forensic engineers who are confident in cross examination,

and assisting with preparing claims, interrogatories, requests for production, etc. are in higher demand those without such abilities.

During collateral attacks, I proclaim the importance of practicing forensic engineering as a specialized profession. This is typically addressed in my testimony as follows:

Q: Isn't it true that you frequently consult as a litigation assistant to attorneys?

A: Absolutely! The lives and careers of people are in the balance. Engineering analysis is a specialized profession that I take very seriously; this is not a hobby.

Forensic engineering is a valuable and respected area of specialty, provided the expert remains active in his field of expertise, and is truly accurate in his analysis. In litigation, people's lives and careers *are* in the balance, and it is important that forensic engineers are completely current and forthright. Likewise, credible methods for determining the facts and accurate discernment should be pursued to the greatest extent whenever possible. The opportunity to prove one's opinions using scientific study should be welcomed.

In order for the forensic engineer to successfully take an emphatic posture, he must be able to demonstrate his competence as a professional and in his opinions of the specific case. The opportunity to provide this information will come during collateral attacks, as the deposing attorney attempts to discredit the expert and the expert's opinions.

Following are recommendations on how to maintain such credibility while building your forensic services:

1. Don't pursue work as an expert witness before you have substantial practical experience in engineering analysis. Testifiers who don't perform thorough analyses in the area of testimony are "professional testifiers." We don't need "court whores" further deteriorating the reputation of our profession.

2. Be sure you know what is common knowledge within the industry. For example, it isn't necessary to perform studies to validate accepted vehicle dynamics calculations. "It's simple physics and common knowledge within the industry." Networking, studying and continued design practice is a good method of staying current on industry standards.

3. Continue to communicate on a regular basis with peers from your field of expertise. This is easily accomplished by continued design practice and regular attendance to the meetings of your professional associations' local chapters. This is also an efficient method of marketing your specialty, since

most design professionals are wary of litigation and will likely refer to you when the situation arises.

4. Attend continuing education courses specific to your casework, regardless of the minimum professional development hours required to maintain any licenses.

5. Continue to study updated texts specific to your casework. In addition to the text material, bibliographies provide useful resources for reports and statistical data.

   Research and mathematical/scientific data are typically derived in a controlled and sterile laboratory environment; then utilized by design engineers. Likewise, the Forensic Engineer is expected to gather credible information for use in his analyses. Be ready to cite your resources when questioned.

6. As much as you can, use proven, acceptable testing methods to determine or validate your case-specific opinions. Understand the basic principles behind such tests, even when performed by an outside laboratory. While you might not be responsible for knowing all laboratory procedures, it is important that you have confidence in the laboratory and the staff's attention to detail. Recognize Daubert rulings and try to maintain the integrity of the expert witness profession. Try to find ways to validate your opinions.

7. Stay inside your area of expertise. While every profession involves learning more with each new experience, you should never "reach" beyond your previous educational and experience foundation. Remember, the farther you reach, the more off balance you become; running the risk of disqualification by the courts, and possibly an unpopular stigma to explain. If local demographics do not provide the necessary market base to practice in your area of expertise, be prepared to travel.

8. Follow up by practicing dissemination. Demonstrate a good faith effort to protect society from future safety and liability risks by sharing the knowledge gained through litigation assistance. It is not only credible to know how to design new facilities or to analyze existing facilities, but even greater to assist in the advancement of future developments.

Rather than trying to wordsmith your way through a poorly investigated testimony, you must have every desire to investigate thoroughly and validate your opinions. "Hired guns" are on their way out, as those who live by a legitimate code of ethics begin to nudge their way past the bar.