

“Garbage In, Garbage Out”

Ensuring the Validity of Finite Element Analysis Models in Subrogation Litigation

by James B. Glennon and George M. Ferreti, Foran Glennon Palandech & Ponzi, Chicago, Illinois

Introduction

Subrogation cases arising out of equipment failures or malfunctions in industrial settings require the retention of one or more engineers with expertise that is appropriate for the loss in question. A proper investigation requires not only a thorough examination of the equipment involved in the loss, but also testing in order to confirm the consultants' opinions and conclusions.

Too often, however, the extent of damage to the involved equipment precludes a meaningful visual analysis or testing. In such cases, counsel and the consulting engineers should consider the use of Finite Element Analysis as part of the failure analysis investigation, particularly where design deficiencies are alleged. Subrogation counsel must carefully monitor consultants' Finite Element Analysis efforts in order to verify that proper data is used to generate a valid model. Additionally, counsel should work with his/her consultants to scrutinize the Finite Element Analysis performed by opposing counsel's consultants in order to identify and address possible grounds for exclusion from evidence at trial.

What is Finite Element Analysis?

Finite Element Analysis (“FEA”) is a computer-based tool used to calculate the strength and behavior of engineering structures. FEA modeling can be used to calculate stress, vibrations, buckling behavior and other conditions faced by equipment during both normal operating conditions and unusual upset conditions.

FEA is performed by breaking down a structure into

thousands of small parts or “elements.” The behavior of each individual element can be described with a set of equations. A computer then joins together the thousands of elements by running thousands of equations in order to describe the behavior of the structure as a whole. By running these equations, the computer can identify the structure's response to different stresses and loads such as static, temperatures, etc. The results of FEA can be demonstrated graphically in “picture” form and can also generate an animation which can be used for demonstrative purposes at trial.

FEA is particularly useful where performing hand calculations would not provide accurate results due to the complexity of the structure being studied. Additionally, where mechanical testing of the particular scenario being investigated is impractical or too expensive, FEA can provide an accurate and relatively cost-effective alternative. Although FEA can be less expensive than mechanical testing, it is not cheap. A typical FEA study of a particular failure can cost anywhere from \$15,000 to over \$50,000, depending on the complexity of the system being investigated and the number of scenarios analyzed. Consequently, FEA may only prove beneficial where the value of the loss is significant and where less expensive testing alternatives are not available.

FEA can be a valuable tool in determining the validity of a particular failure scenario. It also provides an accurate method of confirming the existence of design defects in a particular component. However, the results of the modeling are only as good as the information provided to the FEA software, and counsel must verify that the proper

When engineering consultants work with FEA, they need to know as much as possible about the equipment involved and the process in which it works.

data is used in preparing the model to ensure that expert testimony which relies on the FEA will be admissible at trial.

FEA is only as Good as the Information Used

When engineering consultants work with FEA, they need to know as much as possible about the equipment involved and the process in which it works. This is because they have to input all of the data relating to the design and operating parameters of the equipment into the FEA software for it to be accurate. Once all the data is entered and the model is set up, the software runs calculations for hours or days, depending on the complexity of the problem.

To ensure that all of this work does not result in wasted effort, it is important that subrogation counsel obtain all available data relating to the design, manufacture, and operating conditions for the equipment. Although the type of data required will vary with each situation, the following is a list of typical design and operating data that is needed in order to perform an accurate FEA model:

- Detailed engineering drawings for the involved equipment;
- Exact material composition for all components;
- Material Safety Data Sheets and quantitative material testing data for the exact materials used in the design; and
- All relevant data regarding operating conditions.

Counsel should be vigilant to ensure that no shortcuts are taken in gathering the information necessary to undertake the FEA study. For example, counsel must obtain the data for the exact material being studied instead of a material that is merely *similar* to the material involved in the design in question. The failure to use the exact material qualities will make the model susceptible to criticism by opposing parties. The same holds true for all other data being used to run the FEA model. If the information being used to set up the FEA model is not accurate, the results will be open to question and the expert's credibility could be seriously undermined. Consequently, subrogation counsel must be prepared to take an active role in reviewing the underlying data to be used in the analysis in order to eliminate or minimize the use of any unsupported assumptions in the FEA model.

Use of FEA in Litigation

FEA has successfully been used in litigation for years. In Federal Court, the admissibility of FEA is subject to the standards set for the in the United States Supreme Court's seminal decision in *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579, 125 L. Ed.2d 469, 113 S. Ct. 2786 (1993), which outlined several factors that a District Court should consider when evaluating whether a specific methodology is reliable. Those factors include whether a method is testable, whether it has been subjected to peer review, the rate of error associated with the methodology, and whether the method is generally accepted within the scientific community. *Id.*, 509 U.S. at 593-94.

Although FEA is a widely accepted method, it is imperative that the model be based on accurate data in order to ensure its admissibility. The pitfalls that can result from sloppy modeling are illustrated in *Coffey v. Dowley Manufacturing, Inc.*, 187 F. Supp.2d 958 (M.D. Tenn. 2002). In that case, the plaintiff retained an expert to analyze an automotive tool that caused him injuries. The expert conducted a Finite Element Analysis of the product at issue, but, at a *Daubert* hearing, he conceded that the model was based on certain "assumptions." In ruling that the expert's testimony would be inadmissible, the Court observed:

Nevertheless, the evidence submitted and presented to this Court indicates that Dr. Wilson, although an accomplished Professor with a wealth of knowledge, has not presented "expert" opinions in this case. Most significantly, Dr. Wilson's second finite element analysis is based on hypothesized "guesstimations" regarding a number of important variables. For example, Dr. Wilson failed to convince this Court, either through his affidavits, Rule 26 Reports or his Daubert hearing testimony, that these assumptions had any grounding in actual physical findings. In fact, Dr. Kinsler's testimony disproved some of Dr. Wilson's assumptions. As Dr. Wilson stated in his deposition, "garbage in, garbage out." In other words, if Dr. Wilson assumed certain parameters for his computerized finite element analysis, and those parameters were later proven to be incorrect, then the conclusion reached by the computer model would also be incorrect. This would be true if any of the parameters assumed by Dr. Wilson were incorrect.

Id., at 974. (emphasis added) As the above-

cited passage confirms, it is imperative that the information provided to the FEA software be accurate in order to ensure that the expert's testimony will withstand a *Daubert* challenge. Although some Courts have concluded that minor inaccuracies in the variables used in computer modeling affect the weight to be given to the evidence as opposed to its admissibility, see *Quiet Technology DC-8 v. Hurel-Dubois UK Ltd.*, 326 F.3d 1333 (11th Cir. 2003), an expert's reliance on inaccurate or misleading FEA results can seriously undermine his credibility or result in his testimony being barred at trial.

When confronted with an opposing expert's FEA analysis, it is critical that counsel obtain all the underlying data used by the opposing expert in performing the FEA prior to the expert's deposition. Counsel should provide the data to his experts so that they can verify the accuracy of the data and possibly identify critical assumptions that can render the FEA susceptible to attack. All assumptions, approximations and shortcomings in the data used to conduct the FEA analysis should be identified on the record during the opposing expert's deposition.

It is also critical for the expert to be intimately involved in the FEA study and that the expert not delegate the entire project to his subordinates. If the expert is not well versed in the field of FEA but instead routinely relies on others' FEA work in conjunction with his investigation, it is important that the engineers who conduct the FEA be disclosed as testifying experts as well. Otherwise, there is a significant risk that the results of the FEA, and any opinions relying on same, will not be admissible at trial. The plaintiffs learned this lesson all too well in *Dura Automotive Systems of Indiana, Inc. v. CTS Corporation*, 285 F.3d 609 (7th Cir. 2002). In that case, the plaintiff's lead

expert, a hydrologist, relied on computer modeling conducted by others employed with his consulting firm. The expert, however, was not a computer modeling expert himself, and the people who performed the computer modeling were not separately disclosed as testifying experts by the plaintiffs. The Court barred the hydrologist's expert testimony, concluding that, because the expert lacked sufficient expertise to determine whether the modeling was appropriately performed, the plaintiff's failure to disclose the people who performed the modeling was fatal to the plaintiff's expert disclosures.

Conclusion

FEA is an effective tool in building and strengthening a subrogation case which involves sophisticated engineering analyses, particularly where design defects are involved. When working with engineering consultants who undertake an FEA study, subrogation counsel must ensure that complete and accurate data is employed in the process. Additionally, subrogation counsel should work closely with his/her experts in order to carefully scrutinize the underlying data used by opposing experts in their FEA studies, to determine whether the FEA software is not being "massaged" with erroneous data or unsupported assumptions or "guesstimates."

The validity and admissibility of FEA in litigation is, in large part, driven by the use of accurate data without relying on any unsupported assumptions. Otherwise, the "*garbage in, garbage out*" principle applies, and counsel bears the risk that the FEA results will be excluded from trial, since an FEA model, while an effective tool indeed, is only as good as the information used to build it. ■