Peer review of the technical white paper authored by Professor emeritus Victor E. Saouma (Univ. of Colorado – Boulder)

By Prof. emeritus Jacky Mazars (Polytechnic Institute –Grenoble Alpes University, France)

Some words About Prof. J. Mazars

Being from the same generation as V. Saouma, I, like him, have over 40 years of experience in research on concrete and concrete structures, mainly focused on analyzing damage to materials caused by mechanical effects and the effects of time. The objective is to analyze the risk in extreme situations for structures when they are subjected to earthquakes, explosions, impacts or other environmental actions.

Background : Doctor from Paris University, Professor at ENS Paris-Saclay then at INP Grenoble (currently emeritus).

Scientific advisor:

- at Electricité De France (EDF) : Vercors research program performed around a mock-up of a Nuclear Enclosure Building and Co-chairman of TINCE'23 (Technological Innovations in Nuclear Civil Engineering -Paris-Saclay 2023) and in this capacity Guest Editor of a special issue TINCE of the European Journal of Environmental and Civil Engineering (Vol. 28, n°13, Nov. 2024)
- at OXAND group providing consultancy and software solutions to help clients optimize their Asset and infrastructures

Committee and expertise - Civil Engineering expert at : ANR France, FRS Belgium, NSRC Canada, NCN Poland; Advisory Board on Structural Earthquake Engineering - European Commission (JRC Ispra Italy), Committee on Testing methods in Fracture Mechanics (RILEM). He was member of several institution: ASCE, ACI, RILEM, AFPS…. and led numerous collaborations: Associated Prof. at Univ. Sherbroooke (Canada), invited Prof at UC Berkeley, Northwertern Univ. and several university in Europe (UK, Italy, Spain, Switzerland & France).

Scientific responsabilities : in France CEOS.fr research program - ARVISE program and in Earthquake Engineering CASSBA, CAMUS, CAMUS 2000 programs – in Europe PREC8, ICONS, SAFERR, ECOEST, LESSLOSS all in the field of Earthquake Engineering.

Scientific production : About 80 peer-review papers and contribution to books chapters and 8 books acting as editor or author including : "Damage and Cracking of Concrete Structures" from J. Mazars & S. Grange – ISTE-WILEY 2022.

Peer review of the technical white paper authored by Dr. Victor E. Saouma

This white paper (WP) aims to alert the relevant authorities to a questionable analysis of the effects of Alkali Silica Reaction (ASR) on the Seabrook power plant.

Based on this WP, four questions are asked by C-10 Research and Education Foundation, which are answered below.

1- Is the paper review technically sound ?

The answer is clearly “yes”. Professor Saouma is a respected figure in the international scientific community, and the presentation of his skills and expertise in the WP confirms this (15 years devoted to ASR, 11 major funded projects, 2 books, dozens of rapport and peer-reviewed papers and the chairmanship of an international RILEM committee on the subject). He is also a leader in the field of concrete structure behavior and has served as president of the International Association of Fracture Mechanics for Concrete and Concrete Structures (FraMCoS), he has advised the Tokyo Electric Power Company (TEPCO-Japan) and was a key contributor to EPRI’s report “Structural Modeling Of Nuclear Containment Structures”. All of this involves numerous collaborations particularly in Europe and, as mentioned above, Japan.

The subject addressed by the WP is the result of his position as an expert witness with C-10 since 2019, as he indicates “His testimony resulted in the implementation of stronger measures for monitoring the state ASR over 20-year license renewal term” and then he is well positioned to evaluate the adequacy of the work conducted at Seabrook NPP.

2- Does the white paper make valid scientific arguments ?

In my opinion there are two key points in the arguments put forward in the WP :

a/ the fact of relying on results from tests carried out on a type of structure that is not representative of the situation in which a Containment Enclosure Building (CEB) is, when it is subjected to ASR and a seismic type loading. The resulting problem is that the results contradict those obtained elsewhere on shear walls representative of in-plane loading (the situation experienced by the CEB), whereas the beam test carried out by NextEra is representative of out-of-plane loading.

Tables 1 & 2 of the WP are clear on this subject :

Results on RC beam (NextERA) : no reduction of shear capacity in ASR–affected concrete

Results on shear walls (NIST) : the presence of ASR caused a # 20% reduction in the shear strength

It should be noted, however, that while this downward trend is confirmed by tests carried out at the University of Colorado (-22%), it is not confirmed by tests carried out in Japan

(Kajima), which did not find a significant decrease, or by tests carried out at the University of Toronto, which found a slight increase in this resistance. All of this confirms that the conclusion drawn from the NextEra's tests is incorrect and that this point should be further investigated.

That said, it is also the use of NextEra's results that poses problems. In summary, the idea is to consider that after the ASR effect, a new concrete with modified mechanical characteristics is obtained and that it is sufficient to use the ACI 318 formulas to move forward, particularly in estimating ASR expansion, which is a major indicator for predicting the behavior of CEB over time.

To fully understand the subject of concrete damage, its internal microstructure is modified by expansions and microcracks and no longer reacts in the same way to traditional stresses. This is reflected in particular in the tests carried out and presented in Figure 5 by a wide dispersion of results, which has a significant impact on the determination of past expansion (Figure 7). The wide dispersion of results leads us to say that conclusions that do not take this wide dispersion into account will produce erroneous results. As stated in the WP "the relationship between compressive strength and elastic modulus cannot be reliably captured by a single equation" (equation (1) in the WP).

3- Are Dr. Saouma's conclusions supported by scientific evidence?

The answer here is also "yes". The WP is the result of an analysis based on the experience and expertise of a man of culture on the topic of ASR, but also on many others subjects (he is very knowledgeable about finite element structural analysis, and his presentation in the WP on the particularities of membrane action (Appendix B) is that of a man experienced in the theme).

His analysis is based on a rich and solid bibliographic knowledge from institutions recognized for the quality of their work.

Thus, in the conclusions presented on page 10 of the WP, I fully endorse what is said :

a/ on "LSTP erroneous test configuration", especially on the points 1 (on the NextEra's tests), the point 4 (the non-use of the membrane theory) and point 5 (the failure to take into account the biaxial confinement present in the CEB).

b/ on "Relevance of NIST report on shear strength", especially on point 1 related to the shear strength of ASR-concrete, which is a major point.

c/ on "Relevance of NIST tests on past expansion". I totally agree with points 1 (inapplicability of the ACI Code equation relating compressive strength to elastic modulus) and 2 (the NextEra's procedure to estimate past expansion) and I confirm Dr. Saouma's opinion on the fact that the current structural monitoring program is fundamentally flawed and presents a significant safety risk (point 3).

4- Do you see a weak link in Dr. Saouma's argumentation?

Following on from what I said above (Q 1, 2 and 3) I can only answer "no" to this question, and I would add that, in my opinion, the arguments developed in the WP and the conclusions drawn from them lead, in my view, to the need to revisit the studies carried out on the basis of the NextERA trials and to incorporate the results of other experiments more suited to the context in order to move forward with a new analysis.

And above all, it is important to be very vigilant when transferring the observed effects to structural calculations, for which the ASR-related risk analysis must be based on nonlinear finite element calculations, which are the only method capable of accurately determining the consequences of ASR development in this plant. In any case, that is what we would try to do in Europe.

Dr. Jacky Mazars, August 2025