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SELECTED CONTRIBUTIONS
CONTRIBUTIONS SÉLECTIONNÉES

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SORTING OUT DISTINCTIONS BETWEEN HAZARDS, RISKS, DETERMINISTIC EFFECTS, AND RESIDUAL PROBABILISTIC RISKS

As a start, compliments to the General Reporter on the excellent overview, and thanks to everybody for the privilege of sharing some thoughts of undisguisable concern. The following reflections are absolutely general, but in a hopefully constructive criticism the example is set through SELF-CRITICISM in the specialization of utmost responsibility of GEOTECHNICAL ENGINEERING.

This branch is a most sensitive instrument for the *symphony orchestra* that is conducted by the complex USER SOCIETY OF ICOLD'S GENERALISTS, dedicated to the global end of water resources, who must recognize, sponsor, and respect each specialized instrument's contributions and failings. Contributions to be continually improved, and failings to be diagnosed and discarded, even if the past, ever insufficiently correct, may have served its purposes, even by failing to expose the failing.

My emphatic call is for us to recognize our *deterministic yes-no interferences in the statistical continuum of reality*, and thus to embark on correcting what can and must be corrected, of what we *deterministically do* in design/construction. Leave unto the realm of statistical/probabilistic CONFIDENCE INTERVALS CI (of best possible REGRESSIONS) the hitherto (and always some residual) indeterminable intervening parameters of: (a) causative factors of defect, for maximizing in prudent design; (b) defect-resisting factors, for judicious minimizing in prudent design.

Probabilistic calculations require repetitive cases, the "universe" of reasonable constancy to establish Statistical Frequency Distribution FDs "Laws", for predictive Probabilistic extrapolations for forthcoming cases. Almost every publication on the topic has shrouded faulty oversimplified concepts, such as:

1) pseudo "statistical universe" by SURNAME, e.g. embankment dams, as distinct from arch, gravity, rockfill, etc.;

2) illogical mixing of causative factor, and passively suffered effect (despite resistance), e.g. insufficient capacity of spillway being destructive to embankments, no matter how intrinsically safe be the dam-body of itself for its function;

3) not recognizing the reality of each case as SINGULAR, only roughly groupable for FDs, in which groupings the deterministic yes-no decisions (e.g. toe filter vs. chimney filter) are much more conditioning (once known) than the "unassessed bag of dispersions";

4) forgetting that civil-geotechnical engineering includes the inevitable start from ignorance and questionable intuitions, progresses through "insufficiently right" stages, and can reach (what it is obliged to reach) a *deterministically zero probability of hazard of catastrophic failures*, by optimizedly "correct" design-construction.

The troubles lie in disguising ignorance unconfessed, into claims of *inexistent zero probabilities*, a naughty half-truth passed from lay-group A to lay-group B. Since statistical regressions are bound to the past, constrained by PAST PRACTICE, the crux of the problems lies in the rapidity of CHANGE from PAST, through PRESENT, into FUTURE.

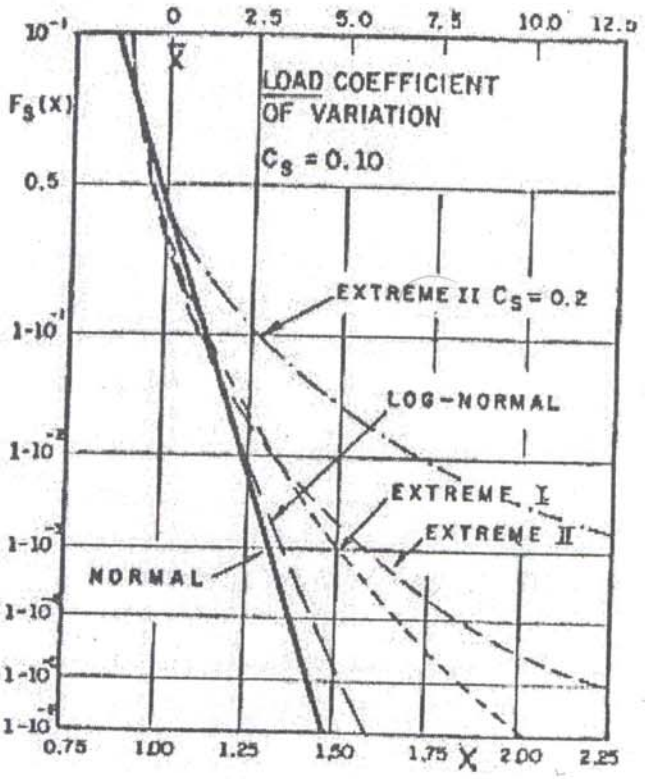
Regrettably even in revered text-books, and in Institutional Bulletins, *wrong* (now recognized) *primordial concepts continue to be taught* without reference to how they served a historic step of earnest idealization but died. Thus the dominance of "satisfied pseudo-precedents" leads to incidents and accidents tending to be human-provoked, "country-wise", and based on "schools of concepts", sometimes considered as reasonable "personal preferences".

Such hypotheses of ECRD symmetrical core sections as considered in R.16 should merely be condoned as cases from the past. I dare to resort to my Rankine Lecture (Géotechnique 1977) to insist, stand or fall, that a chimney-filter inclined to upstream is "much more right", enough so to determine discarding the past rather than playing with its hazard probabilities on on-going dams. How thick does a sandy-clay core have to be, to perform satisfactorily? Depends on profiting of the thoroughly proven virtues of seepage compressive stresses (against non-erodible supports). How often have wide cracks in CFRD face slabs been completely sealed by sedimenting a few decimeters of material self-grading by Stokes' law? Quite different are, indeed, the risks of seepages exiting downstream with trends towards accompanying or abetting tensile stressing. Width of core is secondary to compressive vs. tensile stressing.

We need to debate and discard honourably, even if moving only a step better, quantifiable, while recognizing that even with Factors of Prudence (FS) our decisions despite doubts are often much favoured by chance. In statistical dispersions, we must distinguish between % CIs on "averages" (applicable to

cumulative behaviors, e.g. compressibility) and % CIs on "points", applicable to singularities of preferential (non-homogeneous) conditions (e.g. tension, shear, preferential flow, etc.).

Taken abridged from my Rankine Lecture Fig. 1, the first thought is that kind mathematical idealizations of *extreme value probabilities* are an illusion: the solution calls for a physical change of statistical universe, in lieu of indeterminations of multiplying near ZERO hazard by near INFINITE consequence. Let us face honestly (cf. Fig. 1) the analogy of having 30-80 years of flood peaks and extrapolating to 10 000-yr. recurrence (shackling God's Nature to which equation?).

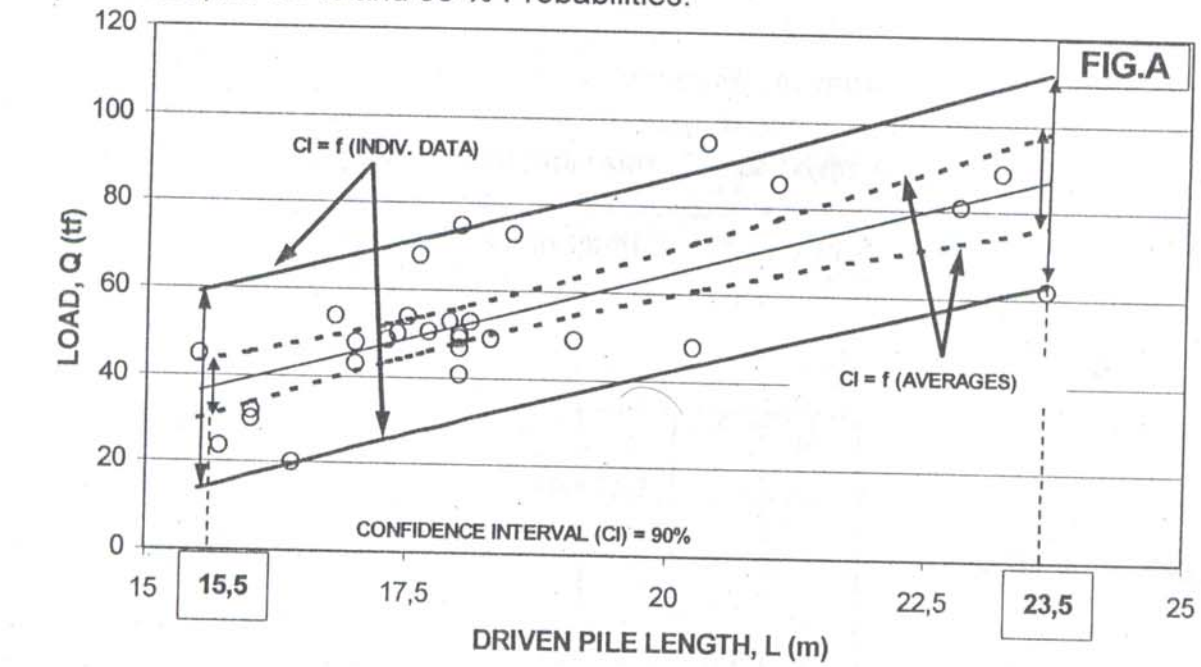


DISTRIBUTION FUNCTIONS FS (X) FOR VARIABLE X
(BORGES & CASTANHETA, 1971)

Fig. 1
Great variations of probabilities at low risks depending on extreme-value distribution assumed.

As a second step, Fig. 2 is presented to summarize how to handle statistically a set of reasonably quantified data, for projecting towards probabilistic CIs and recommendable Factors of Prudence FPs, for (a) maximizing possible causes (b) minimizing foreseeable resistances. Lacking bona fide data on dams, the example is offered from a set of 29 load tests on driven piles of a big foundation project. The computed CI bands are shown both for AVERAGES and for INDIVIDUAL POINTS. Statisticians routinely use CIs varying between 80 % and 95 % and we wonder what they mean in comparison with our conventional FS numbers historically picked from the hat. Well, $FS \geq (FP_1)(FP_2)$ where FP_1 = factor of increase of active agent (loadings) and FP_2 = factor of reduction of

reactive agent (resistances). If the CIs are expressed as percentages of Standard Deviation divided by Average, the graphs for FP_1 and FP_2 are derivable directly, as presented, for 80 % and 95 % Probabilities.



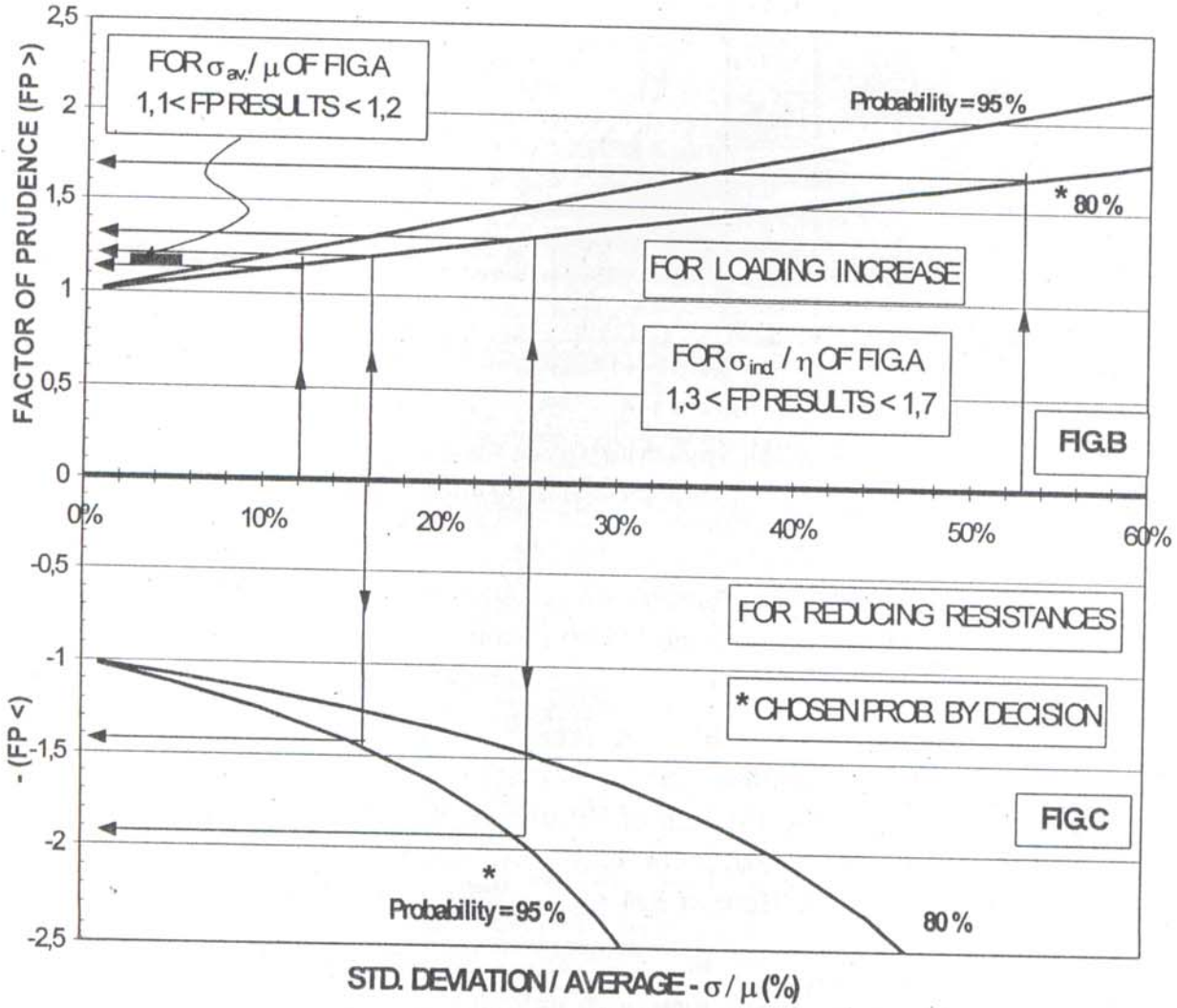


Fig. 2
Sample use of CIs tying % probabilities to FPs → FS.

As regards calculations inherited from Structures, a revision is necessary because of the irreversible and history-memorized behaviors of soils and rocks. The concept of failure at FS = 1.00, from statics and deterministic, must be abandoned, with preference (theory of errors) for successive stability calculations to determine $\Delta FS = FS_i - FS_f$, and failure when ΔFS carries through the transient condition FS = 1.00. An example is provided in R.5 for the destabilizing potentialities of the US slope of a dam under end-of-construction with 3 steps to reach full height and then followed by reservoir filling, and rapid drawdown, every step through a CHANGE OF CONDITION *ΔFS applied to the previous*.

Regarding seismicity hazards, and general resort to and reliance on instrumentation monitoring, some questionable concepts are exposed in R.5, which reiterate needs for thorough revisions, incorporating above all the importance of deterministic decisions. However, such human decisions are also subject to statistical/probabilistic hazards, hitherto unexposed, unknown. Thus finally, a strong recommendation is made for a method of *anonymizing existing projects* and submitting them to Prediction vs. Performance challenges in order to reach logically adjusted FDs of different Designers. Hitherto published FDs and PDFs are erroneous, conducted without separate specialised analyses of the phenomena and decisions that determined (and will continue, with some dispersions, to determine) meaningful universes of performances. This can surely be corrected.