General report: Engineering geological problems related to hydraulic and hydroelectric developments

Rapport général: Problèmes de géologie de l'ingénieur liés aux travaux hydrauliques et hydroélectriques

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1. INTRODUCTION

This General Report for the Technical Session on Theme 4 was prepared in attention to the special request of the Congress Organizing Committee when, on the verge of the start of the Conference, it had been understood from correspondence that the erstwhile invited General Reporter, Dr. Bernard Schneider (France), would be unable to attend and had not signified sending a General Report of his own to be presented by proxy. As finally turned out, there were two General Reports prepared in very short available time, and presented in partial and complementary manner. The friendly trust at having been nominated to fill the high incumbence in urgent need, could only be interpreted as an honouring gesture which called for a response of compatible technical and personal enthusiasm: moreover, by coincidence it may serve to emphasize the broad spectrum of thinking, experiences, and conclusions, that is embodied in the efforts within this field, fed from two classically separate professions, which the authors have intensely exercised in collateral academic endeavours and countless major Projects, in a mutually enriching experience through over 20 years.

The analysis of the 49 papers submitted for publication once again exposed the benefit of defining the intertwining interaction of two important branches of human knowledge and endeavour - Geology, and Engineering - which indellibly surface as two distinct major fields of human aptitude-attitude, joining forces, through distinct sciences-technologies-arts-methods-produce, towards the optimization of a common goal, the Civil Work of human scale, touching on the scales of affecting Geologic variant equilibria.

ENGINEERING, be it Civil, Mining, etc... embodies a creative technique for the manipulation of Nature, purporting to do it so "rationally-economically" (historically through physics and deterministic analysis-synthesis calculations, gradually surrendered into statistics, probabilities, "secondary" interferences, etc...).

GEOLOGY is an inquisitive-descriptive science dealing with the understanding of the Earth's body's Natural "Laws". How consider manipulating Something, much bigger and dominant, without first trying to understand It? Thus Geology, indispensable to bigger Engineering works, condescended toward a common language, in Engineering Geology, for facilitating interaction between the two broad professional avenues, the Engineering Synthesis and the Geological Synthesis.

Geology was (and is) not aimed at application: Engineering is nothing but optimized ad hoc application. The hand-in-hand development of a common understanding and applicable language to Engineering Action was greatly helped by the two children dedicated to geomechanical analysis-synthesis "model games", Soil Mechanics, and Rock Mechanics.

We need not dwell on the oft-repeated criticism of classical Geology as having remained mysterious in terminology, mythical in orders of magnitude, and totally insensitive to needs and proportions of human interacting technologies. Nor shall we forget the immense initial debt to the mentors who created recognition of Engineering Geology by being able to dominate both fields at a certain early stage of both. Chronologically society is blessed by the great minds that reject shackles and bridge gaps, opening new avenues with no boundaries other than those inevitable by personal and time limitations. But, as institutionalizations set in, and persons and time become limitless because of teaching and numbers, one can seek end-benefits from analysing possible crises of identity which would generate sterile incomprehensions. The great concern lies with the serious proliferation of a would-be additional compartmentalization of an academic and professional synthesis, while applauding the rapidly advanced methods and results of both: very competent young geologists would advance into poor outmoded engineering-by-rule, while equally competent young engineers would dispense with respectable geology; both could only suffer and hurt, in disrespecting the divergent mental attitudes, and the ever-widening gap wrought by the levels of separate achievements.

The Mechanics of Materials' Testing so successfully pursued in stress-strain-time relationships of specimens and masses (soil continua and rock discontinuities) also inseminated Geology into generating new theories and quantifications, such as Structural Geology, Tectonophysics, Geodynamics, etc...

Thus under the persistent pressure to find a unifying link, one could favour the term Geomechanics (much in vogue), to incorporate the engineering view of Applied Geology, Soil Mechanics, and Rock Mechanics. Would it in any way signify that Geology, as such, would have been incorporated, or lost its place? Of course not. And beware, if under well-meaning attempts at unification we foster promiscuity, and the indifference to the fertility of respect for individuality. The attitude, approach, methods, and aims, of true Geology, unfettered to a restrictive presumed application, continues to be fundamental as a prerequisite. Whenever an engineering project foregoes a data-base of a certain "Natural Science", such as Geology (Meteorology, Hydrology, etc...), it is equivalent to assuming that geology is "constant, or immaterial, invariant, inconsequent".

Engineering Geology does not supplant or suppress Geology: it is a qualified, restricted Geology; firstly, it is a Geology; then it is restricted or simplified, such restriction being specific for the aimed purposefulness, and therefore being more often determined by who does the restricting, i.e. the Engineer.

One might side-step to mention the much less frequent denomination Geological Engineering, which would signify an Engineering qualified by Geology: in some respects it could be a more honest designation, although the exponential difference of scales of the objects of our endeavours, and of the recognized possibilities of natural interferences of Geology, makes us shudder at a qualification disproportionately larger than the substantive. What we practice and intend, is it not really a two-step obligation, Geology (trimmed to scale) followed by Geomechanical Engineering, the Engineering qualified by Geomechanical problems, factors, solutions?

Within our comments on the Papers, we shall attempt to classify, with the above thoughts in mind. In the exponential advances of all fields of knowledge within the past 20 years, it is absurd to attempt to document oneself minimally for productivity in more than one field; it is not by composing out of two distinct fields a new one, to be dominated by individual professionals, that we shall progress. It is indispensable in modern societies, to tune oneself into a symphony orchestra with closely coordinated cross-communication. Fortunately there are always the overlapping interfaces, and consequent constructive give-and-take discussions. But, if a Conference is meant to optimize such interplay, it is a prerequisite that we truly understand a common language, or each other's languages.

2. GENERAL COMMENTS

A broad subdivision of the papers into categories would suggest that of the overall technical content, roughly:-

- 49% belongs within the scope we recognize as geological;
- 21% would fall in the range of geotechnics, geomechanics, materials engineering;
- 15% embodies varied proportions of both the above fields of concerns;
- 15% comprises relatively general papers about projects, dams, social interferences of projects, etc...

The significance of such an estimate, that only about 50% of the overall effort really springs from, and is nourished by, the increasing wealths of geological developments, merits further consideration, because one suspects that the qualification of "engineering" attached to the noun "geology" may be an unsuspecting culprit in dwarfing the broader potentialities. Specific comments will accompany the topics and papers.

Moreover it is of interest to evaluate the percent contributions within the five subthemes selected by the Organizing Committee. Again, a rough estimate would indicate a widely varied distribution of contributions:

- 31% concerning overall geological conditions affecting project siting, that is, used for predicting behavioral tendencies on the basis of varied geological fields of cognizance;

34% reflecting information on slides and leakages in man-made reservoirs;
12% concerning methods of investigation in seismo-tectonic problems;
4% concerning storage dams in valleys in plains, and flood control;
19% discussing soil and rock construction materials, testing and behavior.

In reaching indices we used much indispensable tolerance of judgment, and begin by noting that of the above contribution about 20% really falls outside of the scopes of the desired technical session discussion subthemes. Thus one can see that Conference Organizing Committees often laudably act as a locomotive to a train that will take some years to accelerate and move, especially considering the time for maturing of engineering projects and works.

It is appropriate to mention with enthusiasm the large contribution brought forth by our colleagues from China, accounting for about 25% of the papers, comprising very interesting and instructive reports and analyses on case histories. Altogether the contributions derive from 13 countries. Our Argentinian hosts deserve special applause for their being the second greatest contributors, followed by Brazil and the Soviet Union. We are grateful for the effort put forth by our hosts to enhance the technical success of this Session, alongside with carrying all the load of the organizational and social aspects which make such an event a landmark in our international gatherings.

Incidentally, we profit of the occasion to thank the Organizing Committee for having honoured us with the privilege of acting as General Reporters on this important theme, in parallel with Dr. B. Schneider, personally represented ad hoc by Dr. A. Pautre. As a final peculiarity the two parallel reports were originally in the two parallel official languages, French and English, therefore dispensing with summary translations. By agreement in the presentations Dr. Pautre dedicated predominant attention to subtheme 3, on which our comments are submitted as hopefully complementary.

These General Reporters beg leave to profit of the occasion to put forth a plea on behalf of the profession (although generated by a personal view) with regard to the importance of distinguishing between technical papers sent to Technical Journals, and those submitted to a Conference: the latter should make every effort to air out hypotheses and to entice comparisons and discussions, which is, in the gist, the dominant purpose for gathering and conferring. In line with such reasoning, the sequel of this report will, with due excuses, attempt to call out for points of debate, in an exercise that may prove constructive for chosen themes of future Conferences. Attention will be duly focussed first on the papers that sprout from the basis of Geology: moreover, in each subtheme the contributions principally oriented from viewpoints of geomechanics (soil and rock mechanics) and materials engineering, and those limited to description of broadly accepted collateral thinking, will be discussed as if in an editorial board review of the respective professional field. Engineering Geology is a highly and increasingly challenging professional pursuit of dominant macro-impact in hydraulic impoundment works, and should free itself of slightly outdated renditions of conventional levels of the branches of geomechanical analyses and engineering syntheses.

As planned by the Organizing Committee this report considers the contributions in the sequence of subtheme topics, but not overlooking the above-mentioned growing crisis of identity that inevitably harbours a minimum common denominator of considerable time-lag with respect to separate advances in each field. The gradually and minutely varying shades of collateral contribution could level into mediocrity the present unperceived transpositions into adjacent fields, each pulled forward by its separate virtuosi. The symptoms of underdevelopment in almost any field are the unreflected dichotomic diagnosis, black or white, right-wrong, continuum-discontinuum, simple-awesome, extremes: progressive study, knowledge, and wisdom, make the pendulum swing very little around the central position. Often when an eagerly intentioned colleague transposes the compartmentalized bounds of his creative professional experience, he exposes himself to facile diagnosis by such extreme positions: the "other" field is neither pitifully in the dark, nor totally frightening as a dark mystery understandable only to the few mythical wizards.

In summary the purposeful sequence in our professional tasks involve obligatory definition of (see, for instance, Kayakin Kotinzhan et al. in a similar general vein): (a) first, the geological setting (geologist) and the idealized geological model for the engineering approach which sometimes employs "representative conditions", sometimes considers "critical limiting conditions": the latter function belongs to the engineering geologist. To omit the starting geological model is tantamount to adopting the super-simplified geometric-isotropic-model.

(b) the geomechanical model, qualifying the above idealized geological model within the tools of analysis-synthesis offered for engineering decision-action computational backup (until a given moment of project activity) by Soil and Rock Mechanics.

(c) the engineering model goal, to be constructed under the above contexts and methods, but for the paramount engineering aim of benefit/cost ratio service to Society.

If there is no geological interpretation and orientation, there is no geology: if there is no quantification on materials, services and costs, there is no engineering. It is as simple as that, let us face it: quite often there is almost no engineering nor geology, how can there be engineering geology? Leadership in engineering geology implies the spearheading of quantified predictions based on geology, for use in engineering cost-effective design decisions, analyses, predictions.

The occasion seems ripe for emphasizing a priority need for the Engineering angle, that has seldom been considered by the colleagues from the Geological angle, and that is leading to growing dissatisfaction among investors, owners, designers and constructors. The need is for predictive quantifications of the well recognized conditioning factors. Everybody associated with major civil engineering projects is aware of the importance of faults, karsts, discontinuities, slickensided shear planes, and so on: one is even tired of reading, over and over again, of yet another case-history summarizing such after-the-fact sobering experiences. Time has sped by, and these histories have acquired the tone of grandmothers' lore. The point is that engineering projects have to be built, despite geological difficulties, and very many have: even dams across "active faults". The challenge from Society and investors to the Engineer is the reasonable prediction of costs and contingencies. Without demeaning the magnitude of the task and unknowns, are we not tempted to compare with the exponential successes of other technologies (e.g., "space", etc.) that started from scratch, and suspect that some of the difficulties for engineering geology derive precisely from its attachment to hypotheses and limitations of the rudimentary past?

The relationships between Geologists and Hydroelectric Civil Engineers are far from those prevailing over thirty years ago. Since the need of early geologic assessment is fully recognized and respected, what is present-day reality, and why? Could a sense of "déja vu" boredom, and frequent relative indifference be explained as part of the intimacy that breeds contempt? Perhaps so. In the macro--scales of geologic problems for practical purposes, the Engineer is the one responsible for distinguishing between factors accepted as attributable to the "Acts of God scale", and those amenable to the highly grown construction possibilities. It appears that because of this same macro scale of geologic interferences, the geologist has much greater difficulty at helping the engineering needs of parameters, than he is willing to confess. Engineering is somewhat calloussed to indifference at the continued practice of some geological colleagues in using extreme-condition names, adjectives, or new highly indirect indices at which they themselves are beginning to practice. For instance, a highly documented rock mass classification along a borehole profile might subdivide into zones of C3F2W1, C2F1W1 (consistency, fracturing, weathering) groupings (or the like), offering the unwanted, and shying away from risking giving probable ranges of the well--known fundamental parameters used in geomechanical computations (however illusory) such as E, c, ϕ, k etc.. Almost without exception we find ourselves much more significantly informed by a detailed visual-tactile inspection of the core, or even by good coloured photographs of the coreboxes.

There are no short cuts to acquiring experience at formulating acceptable quantifications. One has to suffer in the flesh, from offering the numerical predictions that the engineering methods of analysis-synthesis require, and from being struck in the face by the after-the-fact observations, - much bigger or much smaller than guessed in first estimates. Gradually, hopefully, future numerical predictions will approach more and more the desired and needed precisions of estimates. It is in this common playfield of geomechanical parameters that Geologists and Engineers should play at prior-prediction and posterior Bayesian revision: it is in this playground that, having humbly separated the Acts of God conditions, the Engineering Geologist should be the coach and referee in counting the number of goals of the "acts of man engineering".

Finally, in the Engineer's request for quantifications, the Geological contributions should take comfort in the stepwise manner in which the confidence bands on estimated parameters are to be supplied, but should respect the need for meticulously filling out, at each step, the complete checklist of recognized parameters, with whatever dispersion the degree of ignorance may dictate. Failure to supply some parameter is conceptually equivalent to signifying its irrelevance - an unacceptable presumption, to the Engineer. The honest mutual recognition of the degree of ignorance is an important training, and basis for pinpointing critical needs for follow-up. A minimum of three stages pertain to typical projects and progressive decisions: (A) project feasibility quantifications; (B) design--construction indirect complementary quantifications (N.B. even in situ tests are indirect, because of interpretative hypotheses, scale effects etc..); (C) reservoir filling and short-term operation quantifications, the minimum acceptable "proof of the pudding".

In the subsequent discussions the above subdivision (A), (B), (C) will be maintained for compactness of reference to the contents of papers: thus, as an example a paper will be referred as directed to 2(A)(C) if it pertains to subtheme 2 and progressive decision levels (A) and (C). Initial discussions should be focussed on what is interpreted to have been the direct intent and invitation of the conference call for papers: it may be concluded that regretably small is the percentage of technical content replying directly to the call. Thereupon, since undisputably valuable contributions are provided under collateral topics, the papers are further briefly submitted to plenary discussion as to their presented contents, irrespective of these General Reporters' interpreted restricted theme invitations, reputed indispensable for making a conference technical session fruitful.

Because of the approach chosen, it will be understood that some of the papers have to be mentioned in these general introductory statements because they do not pertain specifically to any of the five subthemes.

3. PRELIMINARY APPRAISALS OF SOME PAPERS, AS REFERRED TO THE CALL FOR THE DISCUSSION THEMES OF THE CONFERENCE

Any general contribution, such as Rampon's submitting a "typical and flexible conceptual study program" for small dams, is separated as hardly finding resonance in the present gathering, to which the recommendation of minimum oriented and orientative geologic bases is a foregone requirement. The audience and readers are active in the selfsame purpose, and not passively in need of such warnings: the dynamics of the conference technical sessions, of very high social cost per hour, urges focussing on the specific, restricted themes of the invitation.

Meanwhile the case-history described by Mongereau and Gevin mentions the astoundingly different pH and soluble salt values of reservoir vs. seepage-loss waters for concluding, in a granitic bedrock of detailed mineralogical description, that the considerable water loss was (obviously) due to "cavernous or fissured" concrete membrane corrosion of the rockfill dam by aggressive waters. The contribution, valuable per se, should not belong to the present conference but, with indispensable closer cause-effect engineering detail, would find great interest in an ICOLD Conference. In similar vein, the much documented contribution by Morbidoni and Larangeira, on slope unstabilizing conditions and analyses of eroded scarps along the Parana Médio river, might have enticed more discussion in a Soil Mechanics Conference (triaxial test applicable criteria and parameters, non-circular sliding surfaces, critical flownet conditions, etc..), and really cannot fit into Discussion Subtheme 2, which was intended to focus on "in man--made storage reservoirs": how could the important soil mechanics details of such a paper be profitably debated in a technical session of engineering geology? At any rate one should inquire if the strongly stratified nature of the sedimentary series would not lead to a possibly significant anisotropy, both of strength and of permeabilities and flownets. Therefore after running the simplified index comparisons as well conducted and described, one would suggest that some typical cases, average and limiting (most and least critical) should be submitted to comparative analyses using more realistic sliding surfaces, shear strength anisotropies,and pore pressure conditions under drawdown (possibly almost exiting horizontally, with vertical equipotentials).

The general approach emphasized by Qi Xiaojun and Huang Dingcheng in some manner covers Subthemes 1, 2 and 3, but in a sense diametrically opposed to the aimed Subtheme 1, of geological conditionings affecting siting of dams, since it reflects the mirror image thereof: how major reservoirs have shown their effects on the surrounding geological environment, and not the invited comparative siting as effectively affected by geologic factors. One attitude of the past was that engineering works were of insufficient magnitude and significance to (a) affect age-old geologic equilibria within the very slow rates of change of matured natural environments, (b) need to consider, not merely the conventional "temporarily static" condition of geology, but rather, the very change that the project causes on the slow-rate dynamics of geologic and geohydrologic changes. The modern attitude is undisputed, and thereupon the case histories only emphasize the great need of more detailed data, case by case, regarding the engineering treatments of grouting and drainage that must have been employed, resulting in the described geologic and geohydrologic descriptions. In the case of the 88m high concrete buttress and multiple-arch dam where the steeper right abutment,jointed,slightly weathered,granite suffered "damaging deformations" "after many years of completion (Nov. 1962)", and was stabilized by prestressed anchoring coupled with grouting and drainage, the immediate questions are on the quantitative data regarding the interpretation of the causes: the development of deformations, seepages, uplift pressures etc. are inevitable, but the need lies in justifying the postulated reduction of shearing strength, and the rough boundaries for acceptable vs. unacceptable developments of these deteriorations. Similarly in the case of the rock slide "influenced by vibration during big charge explosion", the engineering geologist's need would be to quantify what blasting charges and consequent vibrations might establish a boundary between acceptable vs. unacceptable. Similarly in the case of the major slide volume upon filling of the Zhaxi reservoir "because of the softening of unfavorably dipping sedimentary rocks", the geologic information for the engineering project decisions would be highly benefited by Rock Mechanics Models, parameters, analyses for roughly quantifying the critical conditions. All five other qualitative effects listed merit the same dual appraisal: qualitatively anticipated, but devoid of the desired quantifications in first degree approximation.

Another contribution of interest is that of Zhu Jian Ye, which really straddles between the specific subthemes 1, 2 and 3, but would not fit into a fluid and productive give-and-take technical discussion in any of the three sessions. It presents general recommendations regarding geomorphological studies of river valleys for the detection of seismo-tectonically stable blocks and assessment of regional tectonic Magnitude risks, with a view to considering the siting of dams. Similarly it discusses geomorphologic indications of slope instabilities in interstratified soft discontinuities, and, finally, different geomorphologic elements that would reflect different features of karstic terrain, as predictably important for the siting of reservoirs. Case histories are summarily cited. However, in strict adherence to the keynote, of comparative quantifications necessary for engineering, we submit that on the one hand the contribution is automatically accepted in its general geologic propositions, on the other hand, the professionals of engineering geology are not benefited in the much-sought quantifiable indications for accept-reject decisions on siting. One has to refrain from discussing such general statements as "reservoirs can only be built in such karstic regions where the underground water divide in both banks of the valley is higher than the storage level ...." because while an important index consideration, irrefutable, it cannot meet the engineering needs of benefit/cost comparative evaluations for the day-to-day cases.

Further within the general category we must mention two contributions of extreme interest for the geology of hydraulic resources development but that do not fit into the visualized subtheme discussions. Sãenz Ridruejo and Gil Sauri submit an invaluable contribution on the gliptogenetic characteristics of the hollowing out of glacier basins and lakes in Spain, with documented statistical data and equations on geometric relationships etc.., all of which have proved of considerable interest for the planning of pumped storage hydroelectric schemes. One notes that among the natural sciences a first step involves meteorology leading to glaciation: subsequent glacier consequences as conditioned by geology are not the dominant interest of the authors. The other contribution, by Schuster and Costa could constitute a conference theme in itself: as professionals we cannot but exult at receiving information of such valuable content as this, concerning the effects on landslide-produced dams in rivers, in mountainous regions. However, it is curious to note how fertile are the variations on a theme, wrought out by combinations and permutations of the keywords of the conference organizing committee's call for papers. Sliding of big masses can be an important geomorphological factor conditioning siting of dams: the paper really focusses on another very interesting question, which is mass sliding in mountainous river valleys, as providing temporary dams subsequently overtopped and breached, generally with catastrophic flooding effects downstream. The question remains: why failure of landslide dams; what about failure of man-made dams? Do downstream dams take any account at all, in their spillway capacities (and/or reservoir operation etc.) of the risk of release of reservoir volume, on top of high flood flows? The fact is that this is one of the most important modern considerations, in rivers fully developed with reservoirs in steps, favouring one type of dam in comparison with another: no dam that can have a sudden failure is acceptable. Great preferences point to rockfills and earth-rock with highly "plastic" difficult to erode core. One approach is to try to control the rate of erosion, so that high--viscosity mud is taken along, ratios of water to solids not greater than about 3 or 4 to 1. For instance, the 60m high Euclides da Cunha dam (Brazil) failed by overtopping, eroded in about 12 hours, causing no damage downstream except the consequent failure of the much smaller Limoeiro Dam immediately downstream (1976).

The contribution by Turk on the Kastel Dam case-history in Turkey is an interestingly documented paper including geologic, geophysical and rock testing data of value, but does not fit into the discussion themes.

Finally, with regard to Couturier's contribution it may be noted that the broad spectrum of professionals may be reminded that it is often in low dikes (the 8m high case in calcareous-marly terrain) that the indispensable routine sequence of analyses and decisions, however simplified, is often forgotten or too abbreviated, with frustrating consequences. Neither the grossly embarrasing slope instabilities due to the very borrow-pit excavations, steepened at the bottom of natural slopes, nor the outrageous water losses associated with canaliculi and surface fissures drained by underlying karsts, nor the finally proposed engineering solution of compaction blanketing of the microreservoir bottom, would call for any special consideration under Subtheme 2, where the paper would belong. One must honestly pinpoint when an oversight has been at play, of interest for warning stingy clients, and not the professionals convened at such an international conference.

4. SUBTHEME 1. GEOMORPHOLOGICAL, GEOLOGICAL AND STRUCTURAL CONDITIONS AFFECTING PROJECT SITING

The definition of a project site, predominantly conditioned by parameters of benefit/cost ratios of the project's purpose,and therefore by the hydrologic--meteorologic water uses, are well known to have strong influences both on safety and on costs based on geological aspects (secondarily influencing also topography and materials etc.): it even suffers from collateral influences from strategic and socio-economic-political, and environmental considerations. The point to emphasize is that the purpose benefits have been reasonably definable in present-worth of stable currencies: the important need is for the direct and indirect cost influences from geologic factors to be reasonably equated in similar manner. Geological factors have been associated with some of the most catastrophic failures, both of projects and of budgets: this on the one hand has promoted the importance of geology, on the other hand has subconsciously retarded progress by favouring an aura of the impossibility of quantifying geological factors, risks and contingencies for benefit/cost assessment of alternate siting possibilities. The latter stance is false and unacceptable, as would have also applied to most other collateral fields when they started: the hydrologic catastrophes on dams were just as awe-inspiring until the statistical recurrence intervals began to express themselves, and risk-cost probabilities began to define themselves. The difference lies in the non-yearly, questionably periodic, cycles of geologically significant episodes, and the corresponding difficulty at estimating statistical probabilities of the dismaying dispersions.

However, even if in a semi-quantitative manner, presumably the invitation and earnest hope was that papers would compare alternate sites as justifiably selected because of geology. One would look for comparisons of differentiated geologies as reflecting on engineering design and cost estimates, and, thereupon, the choice. It appears that by space limitations the values of papers are being regrettably impaired. The paper by Chen de Ji concurs with this broad thesis: it would doubtless present much geologic backup for the choice of the siting of the Three Gorge Project on the Yangtze on the crystalline rocks vs. the limestone rock stretch, but summarizes the rejection of the latter because "the valley is so narrow that the layout of the hydraulic structure and construction conditions are very difficult" (a ponderous engineering consideration). Other parts of the paper summarize impressive statistics on geologic, geophysical, and geomechanical efforts, on installations for tectonic investigation, and on potential sliding of the reservoir rim, each of which, with the eagerly sought backup data, would have provided valuable separate papers for careful study of the methods employed and interpretations. Finally, for the project site chosen, the wealth of geomechanical data supplied, alongside with recommended stable slopes for deep excavations in the rock masses, constitute contributions that the profession would savour either in retrospective study of how the analyses evolved (as there are no known universal conventional procedures) or in forthcoming eager expectation of how the predictions will prove out. All over the world,the lack of investigations and analyses of 35 years ago has been substituted, in big projects, by the opposite, if anything a plethora of predesign routine investigations: the proliferation has shifted the professional need to querying the procedures and conclusions. Where do our clients, the collateral professionals,conclude how these engineering geology and geomechanical determinations were really influential in conditioning the site and project selection?

As mentioned under item 3, the paper by Kayakin, Kotinzhan et al also concurs with our broad thesis of sequential analyses-interpretations, and presents interesting case-histories, but remains in qualitative indices and focusses principally on leachable vs. non-leachable rocks, which, under different emphasis (of reservoir karst leakage behavior) would befit Subtheme 2.

A type of contribution quite distinct from the above pattern that is submitted as being well aimed at the call of this conference session and subtheme, is the paper by Bolotina and Smulsky regarding the trap rock (diabase) intrusions as influencing canyon-shaped sites and subsequent engineering geology problems of foundations of high gravity dams. The authors well emphasize that "each trap intrusion features its own peculiarities", and so some experiences might be different (as was ours at the Boa Esperança embankment dam) but the engineering geology principle of a conditioning siting feature is irrefutable. Special attention is dedicated to problems of settlements on differentiated rock masses, furnishing observed data of considerable value, but for the purpose of prediction leading to comparative siting alternates there remains an unbridgeable gap between geology of group 1(A), as above referred, and behavior of group 1(C).

In a rough attempt at sequencing the discussion we refer firstly to the interesting contribution by Falkowski pointing out to the need of revising classic classifications of river geomorphology: with due recognition, it is a paper of essentially pure geology-geomorphology, with no attempt at introducing engineering implications. The paper by Garcia Yagüe and Delgado Navarro summarizes a conventional combination of geophysical investigations for preliminary evaluation of a given site's problems, but neither introduces innovations in these investigations, nor focusses on comparative sites under the geologic context as approximately definable by them. In a similar vein the paper by Chamon, Pupo et al on the Cachoeira Porteira dam site selection concentrates on the use of the VLF-EM geophysical method, in conjunction with the conventional methods: the senior General Reporter has been closely connected with this project in the Amazon basin and takes the liberty to commend highly the extraordinary efforts that led to the optimization of siting of the dam with respect to geology, as is further discussed in the paper by Pupo Scarminio et al: it is noted, however, that the methods of investigation were not the real invitation, and in the subdivision of the global project effort into two papers, it would have been hoped that more emphasis could have been directed to engineering comparative quantifications in complementing the well-directed geologic appraisals.

Monticelli and Simões appropriately consider the question of siting of dams along a river inventory case. Geologic problems such as that of a karstic formation and intrusion rocks etc. are routinely mentioned as having called for geologic and geomorphological maps, but one is surprised to find that specifically for the present conference no geologic maps are offered, and the presentation describes (without comparative details) the divisions of hydraulic heads and the (secondary) social effects of reservoir flooding of land, houses and roads. From our knowledge of the area and its high susceptibility to sudden slides under intense rainfalls, and other problems (e.g. mining etc..) more associated with the geologic context, we would question if once again the appropriate balance of geology plus engineering was not sacrificed, although the paper is reminescent of a group 1(A) type of effort.

The Markov and Moulina contribution initially classified under Subtheme 3 (seismotectonic investigation methods) would really merit reclassification into general considerations affecting siting: it describes neotectonic block movements as affecting morphology and siting. However, once again, there is no advance into the quantifying engineering comparisons of differentiated areas affected as described.

Considering project feasibility qualifications for choice between sites, mention may be made of the paper by Yu Ke-Li in which one finds a comparison between four sites one of which was excluded by qualitative evaluations: the author closely concurs with the general principle of three-stage evolution of geologic definition, preliminary, during construction excavations, and truly during operation, but one seems to underestimate how important it is to quantify estimates and dispersion contingencies, because as engineering advances, the point-of-no-return on decisions becomes increasingly rigid and expensive. Incidentally in that paper our curiosity is greatly aroused by the apparently innovative mention of phenomena of "air blow out and air absorption" associated with karsts and other fractures. In similar feasibility qualitative comparisons between sites of different geology, the Cachoeira Porteira Dam case, already mentioned above as well-known to the senior Reporter, is presented by Pupo, Scarminio et al in conditions of group 1(A) so noticeable that the minimized foundation problems of the chosen geology would seem to be justifying beyond need of quantification: it is a good example for discussion; at any rate, the use of first-degree quantifications of comparisons would always enhance the decision and serve the purpose of generating examples and experience.

Some of the papers discuss problems on sites already chosen: truly this cannot be interpreted as having been the principal invitation, but the contributions merit some additional appraisals. Kayakin, Markov et al discuss problems of shear resistance and sliding potentiality of foundations of concrete dams, and furnish some representative Rock Mechanics shear parameters from certain case histories, suggesting a method of classifying the types of rock-mass fracture patterns. It is of collateral interest to note that,as is typical of geologic heterogeneities, whereas Bolotina and Smulsky, above mentioned, had considered the unfavourable features of intrusive dikes, in the present paper the Boguchany dam case points to the favorable fact that an "intrusion is associated with a subvertical zone of tectonic rupture which was healed up by the dolerites intrusion". Quartino and Maisterrena consider a sited dam project in gneiss bedrock crossed by a fault that through complementary investigations, group 1(B), including petrographic details, they demonstrate to have been soldered by recrystallization, and therefore healed of geotechnical problem significance. Quartino et al further report on geological problems of the Alicura dam project, because of a siting already chosen by preliminary studies: the problems may be summarily defined as the "fault on the left-hand slope" and the "pelitic levels as sliding surfaces". This case calls for a question of the greatest interest to engineers and their clients,because if the erstwhile siting had not foreseen these contingencies, and their consequent costs, the example would forcefully prove the importance of rough quantifications on predictable geologic contingencies: unfortunately clients seldom furnish the incremental costs generated, so that the professional sense of responsibility may be suitably enhanced. Another contribution by Palma et al also discuss, in very summary manner, the evolution of studies "up to the final mapping after the excavations", thereby carrying through the group (B) phase: the great interest, again, would have been to discuss any possible cost influences that may have changed significantly, as viewed from geological factors, but these are difficult to extract. Meanwhile such details as Lugeon test values and conjugate grouting information are given, as well as operational data of "two strong (what magnitudes ?) earthquakes that struck nearby areas" all of such data being summarized so tightly that no conclusion of engineering consequence can be extracted. In short, in this report one is greeted with good geologic information, but insufficient means of assessing the engineering and economic associations. Finally, the contribution by Nagata et al again refers to a sited project, and describes geologic investigations that should belong to group (B): for the concrete gravity dam the weathering profiles of the abutments are indispensably investigated and discussed. The Lugeon test investigations and qualitative Rock Mechanics profiling suggest that these details of the case could merit more profitable discussions in conferences and technical sessions directly oriented to such quantified indices, themselves subject to unavoidable developmental debate.

A contribution such as that presented by Alba et al would roughly suggest the extreme condition wherein geologic conditions are minimally described and quantified as geology, and in compensation geotechnical characterizations are maximally developed through investigations, test results, and formula-fitted interpretations. It would seem that geotechnicians duly interested and experienced in the said quantifying tests would keenly appreciate delving further into these aspects. In short, however,once again the needs of conjugated geology and engineering for engineering-geology quantifications of optimized siting and decisions, continue to await the opportunities of future conferences.

5. SUBTHEME 2. SLIDING AND LEAKAGE IN MAN-MADE RESERVOIRS

In our interpretation,the Organizing Committee's invitation for special attention in the technical discussion session, would be for case-histories of significant slides and leakages observed in operational reservoirs, to be appraised from the engineering geology standpoint.

There is one significant paper to comment on problems of leakages in a karst foundation, Pueblo Viejo Dam, Guatemala, by Ewert. An initial appraisal is that the geologic investigations and presentation have been dwindled, in favor of what would be considered dominantly geotechnical step-by-step conventional reevaluations based on the grouting work. The paper would be grouped in the 2(B), 2(C) category. Close spacing of holes and high pressure grouting to improve interconnecting cracking between holes are obvious reasoning: what were the numerical ranges of alternates and comparative cost-benefit predictions and realities? Subsequent decisions for closely-spaced piezometers transformable into relief wells are also obvious engineering trends, but do not favor engineering progress until roughly quantified. Similarly, the final engineering of stepwise partial impoundment is obviously reasonable: in our experience, we have often favoured higher incorporated upstream cofferdams in the light of having the preferential foundation leakages pretested by any diversion-period flood raising of upstream water levels. Our attention was drawn to general engineering conclusion that associates a first affirmation, comprehensible and supported, with a second one clearly requiring explanation and qualification: "zones of an effective curtain are often not identical with those of larger takes ($\gtrsim$ 1000 kg/m, incidentally, not very high for karsts etc.)" (agreed), ... "rather, the opposite relationship" (questioned?).

An important contribution such as Guidicini and Nieble's, proposing hydrogeotechnical models for seepage studies under concrete hydraulic structures, would be intensely digested and debated in a geomechanical discussion session; the zonings are not referred to geologies but to "average" variations of joint intensities with depths, the latter being associated with improved analyses of pressure water loss tests. The gradual revisions of Lugeon test procedures and analyses have been accelerating very laudably of recent, bearing in mind the first questionings in 1956-58 (paper by de Mello, 1st Panamerican Conference SMFE, Mexico 1959): but, conceptually, the crucial problem remains as the much smaller significance of "average" values of many finer joints, in comparison with extreme conditions of single or few wide-open joints.

The contribution by Garcia Yague and Montero comprises a valley well studied geologically and geomorphologically with regard to historic slides, for estimating probability of huge sliding risks, towards affecting reservoir and optimized dam siting. The stratified sandstones and claystones stand out as a feature of significant and repeated slope unstabilization, with obvious importance of rainfall infiltration: the reference to "lubricating action" must be interpreted as classic, and really analysed by soil mechanics and geomechanics as combined swelling and softening of claystones partly relieved of overburden stresses by more rigid sandstones, conjugated with pore-pressures, both of the infiltration flownets and of possible cleft-waters in cracks. More realistic behaviors of rainfall infiltrations and unstabilizing mechanical action may have to be calculated through effective stresses applied to the soil or rock masses by the seepage flownets (cf. de Mello, Closing Remarks, Vol. 3, 4th Landslide Conference, Toronto 1984). There is a very interesting pseudo-statistical descriptive classification of a great number of slides with reference to apparent geometries of the slide volumes: from the geomechanical standpoint it would be of interest to submit a sample case with corresponding calculations, which nowadays are no longer as uniform as hoped. From the point of view of reservoir risks one should recall that ever since Vajont 1963, the principal concern concentrates not so much on slide volumes and probabilities (varying inevitably with time) but on the eventual tendency to sudden catastrophically rapid movements (Vajont, Mantaro, Guavio dam construction, etc..).

Khasanov and Niyazov respond directly to the subtheme interest in slides, drawing conclusions principally from reservoirs in "loess rock" regions, where 70% of the dam failures have occurred after 10-15 years "as a result of large landslides and avalanches of water storage banks". The cases are classified under three groups. Firstly those due to elimination of drying (arid areas) suction, possibly with some effect of capillary rise attack on "cementation", which should be checked by strength tests in natural (dry) vs. soaked conditions (with careful and bonafide suction measurements). Secondly the mass sliding immediately after large, rapid drawdown of the reservoir is the type most classically analysed by soil mechanics applied to earth dams, although it may be noted that methods for the respective stability analyses are under renewed scrutiny. The authors are requested to expatiate on the so-called accompanying "interlayer suffosion", both in a general but specifically meticulous definition of "suffosion", and in its alleged applicability to these cases. Thirdly, there is the undisputable importance of "intensive precipitations" (which, as mentioned under Zhuoyuan and

Guangxin, must be substituted by "intense rainfall infiltrations"): in this third group, since rainfall infiltrations should not change from before, to after, reservoir filling, the geotechnical interpretation would emphasize the changed infiltration flownets due to the raising of the groundwater elevations generated by reservoir filling. The case-histories are described, a commendable starting contribution by the engineering geologist, calling for complementation by geotechnical quantifications. As regards the eagerly sought perspective of forecast of slide developments, one notes that the suggestions offered are based on observations of movements and rates of movements, which unfortunately does not help in design forecasts until there could be some correlations with changes and rates of changes of causes. The Guavio (Colombia, 1983) hillside and the Carsington dam (UK, 1984) cases well emphasize that one can be very carefully observing, without any inkling when a sudden "change of rheology" can lead to the change from slide movements to catastrophic displacement. We would question the generalized statements as "Progressive failure is usually accompanied by sharp increase of the landslide displacement velocity" (an obvious fact, but not a forecasting basis) and "thus, initial and critical acceleration took place during shorter period of time than pore pressure": there is a time lag in registering and recording pore pressure changes, and usually only by a very rare coincidence would one be registering the Δu values along the surface of the "final" shear catastrophe. The paper is surely singled out as one meriting close attention because of the important quantifications offered.

Finally, attention is focussed on the paper by Zhuoyuan and Guangxin, reporting a case of a major landslide revived by heavy rainfall. Calculations of unstabilizing action are of a generalized index nature, and in Soil Mechanics terms one would reconsider claims that "saturated" conditions led to lower results of residual strengths, "the slide zone must have been saturated" etc..: the necessary refinements pertain to geotechnique. Landslide problems associated automatically with heavy rains have undergone important readjustments in the past couple of years. To what extent is it at all realistic to use limit-state "rigid block" geomechanical statics when in a very big area of the slide mass one cannot possibly conceive that two strains would equivalently develop to corresponding shear strength values at the same time? In the Hong Kong landslide studies (e.g. Brand, 1984, 1985 TropicaLS Conference, etc.) there have been some rough indices (obvious) associating landsliding with rainfall intensities, accumulated precipitations, hourly rates, etc.. The problem, however (cf. de Mello, 1985 TropicaLS etc.) is that we are looking at the "print of the photograph" (easier) rather than at the "negative" (generator of the problem). What matters is infiltration intensities, and their effects on pore pressures, seepage effective stresses, etc.. Rainfall is equivalent to infiltration plus runoff, but beyond a certain infiltration (intensity and accumulation) all the excess becomes runoff: if we try to correlate with rainfall, we would be assuming, implicitly, the runoff as constant, which is far from true. One needs to begin collecting data on what really matters, and not on what is easier to measure.

6. SUBTHEME 3. METHODS OF INVESTIGATION IN SEISMO-TECTONIC PROBLEMS

As a general statement we begin by submitting that there are important problems of conceptual superpositions and/or separations of professional areas of Geology--Tectonics, Seismology, Statistics-Probability, and Engineering-consequences--preparedness.

The contribution by Po et al began as classified under Subtheme 2, on sliding; obviously, no clearcut separations are valid, especially since sliding into man-made reservoirs can be important if triggered by seismic factors; and thus a case of seismo-tectonic investigation (3) leads to a forecast consideration of reservoir sliding possibility (2A). The paper is a definitive contribution regarding seismo-tectonic assessment by special remote sensing of a belt of anomalous gravity gradient. The tabulation of seismic episodes is loosely termed "statistics", but merely reflects a greater qualitative degree of activity. The use of geology and seismotectonic technique of interest make the contribution well placed in the present discussion subtheme.

Perucca et al, in a similar vein, also use remote sensing analysis methodology for assessment of tectonic lineaments, aiming at obtaining structural data to identify the systems of forces. Landsat Imagery followed by schematic geologic mapping of meso, macro and mega-lineaments define broad belts of seismic susceptibility. One notes, however, that there is no follow-up of association with predictable magnitudes and recurrences of seismic episodes. Meanwhile Chou and Qi discuss "high crustal stresses" for the express purpose of interpretations toward assessing neotectonic seismic potential. They use crustal stress measurements made by Academia Sinica and seismo-geological groups of renown: one should desire being referenced to papers furnishing details of such all-important data-bases. The subsequent crustal stress interpretations employ conventional methods, including the finite element mathematical modelling, with restrictive hypotheses of Poisson coefficient values, linear Mohr-Coulomb strengths, etc.. It would be of interest to assess influences of parametric variations of the hypotheses, on the results and interpretations.

Bastias and Puigdomenech, alongside with Hancox et al, and also Varga, present three very important contributions relating to methods of "investigation assessment" of seismo-tectonic risk-consequence "statistics and probabilities" for practical engineering conclusions, principally based on observations of fault movements. We shall forego the discussion of techniques and precisions of data collection, by "detailed mapping and trenching" and corresponding "dating" of each event. The intent is to predict tectonic magnitudes etc.., or what is being termed the "Maximum Credible Earthquake" from geological quasi-deterministic dimensions, and very rough recurrence probabilities (e.g. 0.1% to 12% in 150 years!!). The very concept of recurrence, statistical-probabilistic is conceptually questioned in a behavior that is not cyclic but in some ways cumulative followed by discharges. For instance, Varga's statement "it appears inefficient to introduce a certain period of time passed from the latest recorded movements to this concept" (different genetic factors of modern movements in faults) would generate interesting debates with the contribution of Hancox et al. From the Civil Engineering point of view of risks and damages it is curious to note that one tends to employ the adjective of wishful thinking prodded by guilty conscience: in hydrology it is The Maximum Probable Flood which is devoid of any "probability assignments", and in earthquakes it would be the Maximum Credible Earthquake to which we would hope to attach credibility. How can we, however, compare the really low recurrences (e.g. 1:10000 yr.) required of repeatedly suffered hydrologic problems, with the statement that up to 12% probability in 150 years for the Maximum Credible Earthquake is compatibly low? One reasons that there seems to be some confusion: although the earthquake probability computed would be really high, there is a subconscious intuition of low credibility, low recurrence probability, or low consequent damage probability. These are important problems tying geotectonics, through seismology and probability, with the needs of Engineering.

Finally the paper by Wang et al seems to report a surprising case inasfar as microseisms are mentioned as generated by a 40m high cofferdam (rarely submitted to the maximum head). Again the use of remote sensing methods coupled with trenching and dating (carbon 14 and thermoluminescent surface texture of quartz in gouges) constitute direct responses to the subtheme. It would seem, however, that subsequent developments in the paper, including the mathematical and model simulations, have employed parameters to a precision that would be enviable in any project: it would be of interest to question the significance of the various geomechanical parameters, in reference to probable parametric variations.

7. SUBTHEME 4. STORAGE DAMS IN VALLEYS IN THE PLAIN. FLOOD CONTROL

One would question the intention of the Organizing Committee: clearly the prospective contributors felt likewise. One contribution, by Dubois, summarizes analyses of foundation conditions in the Parana Médio macro-valley plains; the other, by Fili, also deals with the same project and broaches the angle of predictions on geohydrology etc.., but with no presentation of striking consequence to the technical session.

Since these General Reporters would expect this Subtheme, and the first paper, as much more profitably situated in a geotechnical conference, a generalized comment is submitted herein. It is very important for the composer of a symphony (a professional synthesizer, Geologist, Engineer), or even for the conductor of a symphony orchestra rendition, to have appropriate knowledge of methods, results, and limitations of each of the component instruments and their partitures. There is, of course, a difference of approach, creativity, and precision, with which one recognizes an artist, and an art-critic. The problems presented have been tackled with intensive and extensive research efforts by geotechnicians, especially within the nearly interdisciplinary fields of slurry hydraulics, initial sedimentation and large-strain consolidation, soft soil stress-strain-strength behavior, etc. Such a test as the SPT is far too brutal to be used even in an index test in such cases: even the other conventional tests of soil mechanics (in-situ vane,triaxial unconsolidated-undrained, etc.) are recognized, as again demonstrated in this paper, to result in dispersions much greater than compatible with design computations using conventional Factors of Safety around 1.5. As shown in many Soil Mechanics publications, the further big unknown and dispersion affects transferring test date to project behavior. The subject of hydraulic fills on soft soils constitutes one of the key problems of Soil Mechanics; the authors are often to be commended for profiting of this Engineering Geology conference to inform geologists and engineering geologists of which component field handles that instrument and its tuning to effectiveness.

8. SUBTHEME 5. CONSTRUCTION MATERIALS: SOILS AND ROCKS

The intent should be to discuss the means whereby the Engineering Geologic characterizations of quarries and borrowpits could lead to predictions of the subsequent geomechanical behaviors of the rock, aggregate, and soil materials, mostly as compacted. Of course, one first need is for uniformity of terminology: one notes, for instance that the term "laterites" is used differently by Bian and by Machado Filho et al. Another general point to be made is that modern construction equipment is so potent, and increasingly so, that often the engineering geology characterizations stand only as a secondary conditioning, of indication of what equipment and procedures to use in order to produce the desired end products irrespective of the starting rock mass: of course the above comment refers principally to disintegration, and not to the reverse, lithification of existing fines.

Veiga Pinto et al furnish geomechanical data on rocks from basalts and limestones. To a greater degree of refinement of anticipated contribution from the engineering geologist one would hope that within the two general petreous qualifications, there would arise distinctive trends for different geologic settings. The present stage of investigation is fundamentally one of Materials Testing: the principal question to the geologist, aiming at serving soil-rock--materials mechanics, and their users in projects, is, to what extent could we predict and orient, based on in-situ geologic data, so that the quarrying, handling, and quality-controlled construction, might be reasonably specified, with the hope of avoiding the many cases of claims by Contractors regarding unforeseen construction problems. The authors used quarried materials, presumably from pilot-quarries. Since most design and specification decisions are based on core from drillholes, our earnest desire as engineering geologists would be to see such testing comparatively conducted on the basis of pre-construction geologic design data and tests, so that the link between professional responsibilities might begin to be established.

Šamaliková submits an example of the type of efforts that belong clearly in geology for engineering purposes: they show the promise of the uses of SEM (scanning electron microscopy) alongside with many other "microscopic" predesign tests. However, until many tested materials, of different predicted "degrees of weakening", have been really used in project conditions, it will not be possible to stipulate the limits between acceptability or not.

Increasing interest has been dedicated to soft rocks, weak sedimentary rocks (sandstones, mudstones etc..) both in their unweathered condition with poor cementation, and in the weathered (saprolite) condition. The tendency seems to be for the material after handling to be limited to extremes, big blocks (better lithified, locally dispersed within the formation) and the parent-rock fines. The papers by Maranesi and Campos (two papers) and by Wang and Dong, merit close interest. Our experience of about 35 years in dams in Brazil fully supports the stated preference of Wang and Dong ... "it is favourable to keep a certain grain content of mother rock in a compacted earth body" (even when the mother rock has been intensely weathered): there are great advantages to trafficability, incompressibility, minimized construction pore pressures: based on our experience we submit the prediction that in their forthcoming projects the prototype behaviors will be noticeably better than as indicated by the conventional soil mechanics laboratory tests. The principal unknowns to be supplied by engineering geology concern the planning of construction equipment and procedures for optimized results, often restricting equipment weights and pressures to avoid excessive disintegration. The papers by Maranesi and Campos first discuss the selection of quarrying details with the hope of preserving bigger rock sizes: any big blocks that resisted the high energy blasting and handling, constituting a "natural selection", are concluded to prove well selected to resist the more moderate requirements of erosion. Thus, in such cases, the principal variable of consequence ends up being the different percentages of usable volumes of rocks vs. fines. As regards the behaviors of the blocks in the Rosana and Porto Primavera cofferdams, the value of the paper could be enhanced by furnishing more quantified data on the differentiated carbonate vs. ferruginous cementations.

Machado Filho et al discuss the fully disintegrated materials, colluvial and residual, from sedimentary rocks, as used for compacted earth construction. Would one expect geology, and engineering geology, to introduce any differentiation in the soil mechanics behavior of fully disintegrated and compacted soils, especially it they derive from sediments, transformed into sedimentary rocks, and returned into soils by weathering? The dominant contribution belongs to the subordinate field of soil mechanics. A similar general statement could be directed at the paper by Bian, with the additional proviso, that in soil mechanics one should be wary of broader generalizations: as long as we restrict ourselves to first-degree approximations, there is agreement with the broader characterizations of engineering geology, but when more refined design analyses are at stake, hopefully the geotechnicians profit of the second-degree differentiations, for increased safety and economy.

Finally brief mention is made of the contribution by Lins et al since the authors appropriately use the term "so-called conventional soils", since in geotechnique every single case is different unless reasonably proved as acceptably similar to another. The General Reporters inquire if the principal data supplied would not be more profitably evoked in a geotechnical conference. For the engineering geologist an important point brought forth is that one should use any material available (which depends on geology), but under conditions of design and construction that do not go much beyond one's own experience, without prudently resorting to proven experience in the area that is felt lacking.

The overall composition of optimized expertise and efforts is the aim of each and every project, as also of any conference's technical discussion session.