

Geotechnical Engineering
Message to
Owners, Architects and
Design Engineers

INDIAN GEOTECHNICAL SOCIETY
Committee on Professional Practice

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GEOTECHNICAL ENGINEERING MESSAGE TO OWNERS, ARCHITECTS AND DESIGN ENGINEERS

To ensure the success of your project, the design team should have a geotechnical consultant who will plan and conduct scientific sub soil investigation programme, evaluate the physical and engineering properties of the sub soil strata and recommend:

- (a) suitable type of sub structure system
- (b) founding depths of the system
- (c) allowable loading intensities on the sub structure
- (d) ground improvement if needed
- (e) soil parameters both static and dynamic (in relevant projects only) to be considered in the structural designs
- (f) liquefaction susceptibility in case of projects in earthquake prone areas
- (g) precautions to be taken during the construction stage and
- (h) if found necessary, monitor the behavior of the sub structure after the commencement of the project
- (i) geotechnical design of earth structures, if any, etc.

For a smooth execution of the project, the IGS recommends that:

- (a) A geotechnical consultancy firm should be selected based on the geotechnical, professional and administrative competence of their executives as well as their experience with the geology of the area and similar types of projects.
- (b) A proper scope of services should be developed with the full participation of the geotechnical consultant, other appropriate design team members and the owner.
- (c) A reasonable fees should be negotiated to ensure proper involvement of the firm in the project.
- (d) A suitable contract agreement including code of conduct and liability clauses should be executed.

SELECTION PROCESS

A global study has concluded that a geotechnical consultancy firm which has its own well equipped field and laboratory testing facilities and offers both consultancy and execution of investigation programmes should be selected for ensuring proper services.

The quality of geotechnical services can make the difference between your projects success and failure.

Qualifications Based Selection (QBS) system ensures quality services from the consultants. The QBS process begins when you obtain recommendations from colleagues and design professionals, among others to identify candidate firms. Invite each to submit a statement of qualifications and references.

After you have completed your review identify two or three firms who are most qualified and experienced. If necessary interview representatives of the selected firms. Judge how much concern each has about the risks your assignment could impose. Be warned about those who will be ever ready to accept any conditions you impose, as those who do not care for their own risks cannot be relied upon to care for your risks. After the interview select the one with whom you feel most comfortable, using the following criteria:

- * Technical Competence; educational qualifications, knowledge of and experience in the geological and geotechnical conditions in the project area.
- * Management Ability
- * Availability of resources
- * Professional independence and integrity
- * Fairness of fee structure

With the selected firm, develop a scope of geotechnical services and negotiate suitable fees.

The role of the finance manager of the project is very crucial. A short message to the financial managers is given in Annexure A.

SCOPE OF SERVICES

Developing a scope of services is the most important element of a geotechnical engineering assignment. The best scope of services is the one developed with the full participation of the geotechnical engineers, other appropriate design team members and the owner. Given the opportunity, each geotechnical engineer firm would suggest different scope of services for any given project. Let the geotechnical engineer explain the alternatives available along with the reasons and the cost associated with each. A recommended list of items under scope of services is provided in Annexure B.

Very often architects and structural designers establish a fixed usually limited geotechnical scope of services in order to create a "level playing field needed to compare various firms' fee estimates". The architects and engineers who develop these unilateral scopes may be forced to accept responsibility and liability for their adequacy. Moreover geotechnical engineers who participate in unilateral

scope procurement often recommend conservative design alternatives, which may lead to costly delays, rework, over run, claims and disputes.

No matter how comprehensive the geotechnical scope of service, risks will still remain; risks that effect more than just the geotechnical engineer alone. However, when the design team functions well; *i.e.*, when communication, co-ordination and co-operation are effective, the chance of these risks materializing is greatly reduced, and the severity of those that do materialize will usually be limited.

The only way to get maximum benefit from a geotechnical consultant is to consult him from the concept stage of the project itself. Otherwise the consultant will not be able to recommend appropriate solutions.

GEOTECHNICAL AUDIT

Finally, a geotechnical auditor, who is a senior professional engineer having wide experience in field practice and not practicing as a regular consultant or testing agency should examine and review all the documents and records to check whether

- (a) a comprehensive programme of field and lab investigations has been executed as per the relevant standards and suitable test parameters have been used in them
- (b) proper design parameters have been evaluated
- (c) latest and proven methods of analysis and design have been adopted
- (d) the recommendations of the geotechnical expert have been fully and effectively used by the design team
- (e) the precautions to be taken during construction, if any recommended by geotechnical consultant, have been recorded and conveyed to the construction team
- (f) a healthy interaction between the design team and the geotechnical team is established.

FEE STRUCTURE

There are two systems of developing a fee structure in case of smaller projects where the scope of services has been clearly defined, a lump sum amount may be agreed upon, with a overriding clause of additional payments for increased scope of work if found necessary during the investigation state. In case of medium to large projects in addition to having a well defined scope of services, item rates for individual tests and services can be agreed upon.

The fee structure depends upon:

- (a) scope of services

- (b) quality of services and
- (c) experience of the firm

The scope of services normally has an investigation part and a consultancy part. Be cautious of the consultants who accept a very nominal investigation programme citing their wide experience in the project area. They may even offer their consultancy services at a nominal fee. The sub soil conditions are never uniform throughout an area. There are several instances in practice where the sub soil properties have varied considerably between adjacent plots. One might offer very low charges as the firm has underpaid and low quality supporting staff who are not even on permanent basis. All this will lead to very conservative and expensive design involving at times very high risk also.

Quality work and expert brains do cost money. But the project will benefit not only on the technical aspects but also on the economy aspect. Cheap engineering invariably tends to be expensive. Common sense dictates that firms will not generally offer their own comprehensive services to a client who evidently is interested in their low fees. Mutual development of the scope of services gives you the opportunity to work with the firm you consider most qualified in determining what can be eliminated or modified in order to reduce fees, in the light of your own risk management goals.

CONTRACT AGREEMENT

This is a legal document and hence has to be very carefully drafted. Basically, it is a contract of skill. Superfluous clauses like inclusion of methods of testing and analyzing will not only be futile but also will reduce the strength of the agreement as the relevant IS codes will have to be followed. Primarily, the contract documents should contain

- (a) A short description of the project and its location along with a route map and a contour plan of the site
- (b) Lay out plan within the site
- (c) Scope of services
- (d) Detailed plan showing the test locations
- (e) Tests to be performed at site and in laboratory
- (f) Schedule of quantities and respective charges
- (g) The contents of the report
- (h) Programme of work, including time schedule
- (i) Terms of payment
- (j) A code of conduct
- (k) Liabilities clause and
- (l) Dispute resolution clause

The technical report is the most important legal document which is the result of the entire exercise. It should contain all the necessary details regarding the scope of investigations, programme of work, codes of practice that have been followed, test results, analysis and recommendations. A checklist for a typical report is given in Annexure C.

A typical code of conduct for a geotechnical consultant is given in Annexure D. By insisting the consultant to sign accepting to follow this code of conduct as a part of the contract agreement, you will safeguard your interests.

The geotechnical consultant's liability is normally limited to the refund of amount of fees paid and/or to the cost of confirmatory tests if the same are required due to exclusive negligence attributed to the geotechnical consultant. The consultant assumes no third party liability. However, the consultant might be liable for the consequences attributed to incorrect/deficient geotechnical recommendations.

LEGALITIES

Important documents for legal actions are the contract agreements and the final report along with all the supporting documents. The individuals who have signed these documents will be personally responsible and liable for action in a legal case.

In legal parlance, the "facts" are:

- (a) Test locations and tests performed under the supervision of owner's representative
- (b) Samples available for inspection
- (c) Lithological description of soils and rocks
- (d) Measured water tables
- (e) Test results and
- (f) Site topography

These facts cannot be challenged.

However, all other issues like assumptions, interpretations, analysis and design procedures may be challenged. In fact any negligence during investigations, description and analysis of information and lack of communications are serious lapses.

On the whole, application of standard skill and care is expected from a professional irrespective of the quantum of remuneration.

Only a committed and enlightened professional can ensure avoidance of legal cases.

"WISH YOUR PROJECT GREAT SUCCESS"

A MESSAGE TO FINANCE MANAGERS OF PROJECTS

1. The success of a project in terms of profitability depends upon the project cost including the maintenance and service expenses. These costs depend upon the quality of the engineering services employed. You, as a very important member on the selection team for consultants have a crucial role to play.
2. The Geotechnical consultant in the engineering team plays one of the crucial roles and is responsible for the design of the sub structure system which connects all structures to the ground. The efficiency and the safety of the structures depends upon the quality of the design recommendations made by the geo-consultant.
3. The services of a geo-consultant include conduct of scientific and laboratory tests on the underground soil strata, analysis of all test results and based on one's experience in the geographical area and in similar projects, evolve recommendations for the selection and design of a suitable sub structure system.
4. The best method to select a geo-consultant is "quality based system of selection". Apart from the qualifications, the cost of providing the services is also a very important factor. But it is very risky to select a consultant on the famous "lowest bidder system" from among the chosen few. The lowest bidder particularly when the quoted fees is much lower than the estimated value, very often may not realize his own risks involved in lowering the fees. Such a person cannot be relied upon to take serious care of your risks. To quote the guideline issued by the Appellate Code of Illinois (USA), "determine the lowest responsible bidder" (LRB).
5. Your role in the selection of LRB is most crucial. Collaborate with other members of the selection team in the evaluation and selection process.

SCOPE OF SERVICES

1. Preliminary survey comprising of a number of shallow (about 6m depth) boreholes randomly located over the site, to obtain a general idea of soil profile so that the layout of the structures can be done to avoid foundation problems.
2. The detailed survey should basically comprise of adequate number of boreholes suitably located at locations of important and sensitive structures. Plate Load tests, Cone Penetration tests, Trial Pits, Electrical Resistivity tests and Seismic tests may be planned to supplement the borehole data.
3. Special investigations like dynamic soil tests, liquefaction studies, permeability studies, and pressure meter tests may be performed for special structures.
4. The depth of investigations should be at least 1.5 times the depth of influence zone, or rock level, whichever is less. When a rock stratum is encountered, the boreholes should be extended preferably to a depth of 5m.
5. All laboratory tests needed for classification of soils and rocks, as well as their strength parameters like shear tests, compression tests, consolidation tests and compaction tests, should be performed as per relevant standards. Special tests like dynamic tests, CBR etc should be done depending upon the structure and soil conditions.
6. Compile and analyze all the test results and recommend the design parameters needed by the design team.
7. Detailed instructions regarding any special treatments for the soil as well as the precautions to be taken during construction should be recommended.
8. Frequent site visits during construction period and providing reports thereof.
9. Monitor the behavior of the substructures after their construction.

CONTENTS OF A GEOTECHNICAL REPORT

1. Introduction including the authority and the scope of the investigation who finalized/specified the scope of investigations.
2. Description of the proposed project location and the geological conditions at the site.
3. Details of the field exploration programme date and duration indicating the number of borings, and other tests, their locations and depths.
4. Details of the methods of boring, sampling and other field tests.
5. Details of the laboratory tests conducted on the soil samples collected and the results obtained.
6. General description of the sub soil conditions as evaluated from all field and laboratory tests.
7. Depth of the ground water table and its variation.
8. Analysis and discussion of test results.
9. Design criteria like allowable settlements.
10. Calculations for determining safe bearing pressure, pile capacities etc.
11. Recommendations on choice of type of foundations, of allowable bearing pressure, slope stability, ground improvement etc.
12. Recommended soil parameters including their selection process for design of earth structures as well as those needed for analysis of soil-structure interaction.
13. Tables containing bore logs and other field and laboratory test results.
14. Soil profile tables for each bore hole location showing the depths and thickness of different soil strata along with N-values, grain size distribution, natural density and water content, atterberg limits, results of triaxial test, consolidation tests etc, at regular depth intervals.
15. Drawings which include an index plan, a site plan, test results plotted in the form of charts and graphs, soil profiles etc.
16. Special precautions if any to be taken during constructions.
17. Limitation of the investigations should also be briefly stated.

CODE OF CONDUCT FOR GEOPROFESSIONALS

PREAMBLE

The advice of geotechnical professional becomes very critical in several projects. Hence, for best results, the relationship between the consultant and the client has to be based upon the moral philosophy comprising of honesty, integrity, courtesy and mutual confidence and respect between them. The following are the basic principles on which the geo-professionals should conduct their practice.

A. WORK ETHOS

1. Should carry out the work based on relevant standards and sound engineering judgment.
2. Should confine comments only to the specified scope of work. However, one can bring out comments on allied activities in the interests of the projects.
3. Should present clearly the consequences to be expected if the professional judgment is overruled or ignored.
4. Should be personally available to provide service for the changed or deviated ground conditions other than those revealed from investigations.

B. TOWARDS CLIENT

1. Should offer services, advice and assignment only in the areas of one's competence and furnish true information of one's areas of qualification and experience to concerned clients.
2. Should never accept any kind of favour from anyone which might compromise the impartiality of the recommendations or prejudice one's duties to the client.
3. Should make clients aware of the risks and uncertainties involved in the project as well as the consequences.
4. Honesty, truthfulness and unbiased recommendations shall be the upper most values of the professions.
5. The results, analysis and recommendations shall be transparent, and made available to the client, when asked for.
6. Should keep the results of investigations confidential and be made public or published only with the permission of the owner.

C. TOWARD OTHER PROFESSIONALS

1. Should not try to supplant another geo-professional in any particular assignment nor attempt to intervene in the work which has already been entrusted to another geo-professional.
2. Should not knowingly compete unfairly with another geo-professional by charging less fees below those customary for others in the profession, practicing in the same area.
3. Should not directly or indirectly injure or attempt to injure the professional reputation or practice or prospects of another professional provided that this rule will not prohibit the expression of technical opinion before a tribunal on behalf of a client.

Caution: The conclusions and recommendations given in the report may not be final. Some elements of the project may require independent analysis in consultation with the design engineer. Hence, the recommendations stage is a continuing process.