

GEOTECHNICAL INVESTIGATION IN INDIA – A WAY FORWARD

(Based on the national survey and
one day workshop at IIT Madras, Chennai on 12 July 2014)

1. Introduction

- 1.1. For many reasons, the quality of geotechnical investigation in India is far below desirable standard, leading to several foundation design and construction problems. Poor geotechnical investigations in major infrastructure and industrial projects are resulting in project delays and cost escalation. The root cause for such poor investigation is the absence of any quality control enforcement in the site as well as in the laboratory and to a great extent is due to lack of internal quality systems and controls by the investigation company. Other reasons for poor state of affairs include lack of training to the site investigation team, improper and inadequate maintenance of testing tools, not adopting advanced investigation techniques, etc. There is a need to improve the quality of geotechnical investigation, especially in the present environment of rapid growth in the infrastructure projects. The new construction technologies employed in the deep foundation construction, deep excavations, underground construction and other important geotechnical works also need good quality geotechnical investigation data so as to fully utilise the potential of such technologies. For example, to fully utilize the capacity of a bored pile or to make a choice between driven pile system and bored pile system an accurate geotechnical data is a must. Similarly, the most appropriate soil retaining system depends on the quality of geotechnical investigation data.
- 1.2. Discussions among consultants, academicians and construction experts unanimously stressed upon the urgent need to improve the situation and these discussions resulted in a one day workshop on the ways and means for achieving the goal of quality improvement in geotechnical investigation. The workshop was held on 12th July 2014 at IIT Madras, Chennai.
- 1.3. A pre-workshop survey on various aspects of a procedure that would result in a quality geotechnical investigation was conducted among geotechnical professionals in India. Even though the response to the survey was very much below expectation when compared with the size of geotechnical community in India, the survey clearly showed the concern for lack of quality and need for significant improvement in the state of affairs.
- 1.4. This note discusses the pre-workshop survey and its response and the outcome of the one day workshop held in July 2014.

2. Pre-Workshop Survey

- 2.1. The survey was initiated after identifying thirteen steps that may improve the quality of geotechnical investigation and reporting. The title of the survey was ‘Geotechnical Investigation in India -Viability & Reliability’. Various (deciding) issues highlighted in the survey are as follows.
 - i. Norms for and accreditation of GI firms
 - ii. Audit of Accrediting Agency(s)
 - iii. Grading of GI Firms
 - iv. Appropriate Specification & Scheduling for a project
 - v. Setting Price Standards & Guidelines

- vi. Independent Audit of Field & Lab work
 - vii. Training of Technicians
 - viii. New technologies and old & conventional procedures
 - ix. Making Field Geotechnical Laboratory Mandatory at all Medium & Large Projects
 - x. Avoiding Clash of Interest of GI Firms
 - xi. Build Geotechnical Data Bank for the country by Sharing the Ownership of GI Data
 - xii. Forming an Association of Geotechnical Investigation Contractors
 - xiii. Forming DFI Task Force Team on GI
 - xiv. Any Other Topics in your Opinion which have merit of consideration
- 2.2. Explanation notes provided in the survey form for each of the above issues are re-produced in Annexure-1. While the participants in the survey are unanimous in saying ‘yes’ for all the above steps for achieving quality geotechnical investigation data and interpretation, issues like setting price standards, building data bank for sharing the data, etc. were accepted by some participants. Similarly, most of the participants in the survey were of the opinion that the new technologies as well as the old ones shall co-exist. The survey results suggested that a proper well equipped accrediting agency shall be in place and all the geotechnical investigation companies aspiring to take up investigation of medium to large projects of public interest shall get them accredited. There were suggestions to segregate the geotechnical investigation and its interpretation from the foundation recommendations. The person providing foundation recommendations should have adequate and relevant experience to formulate the geotechnical investigation specifications and a schedule appropriate to the project requirements and should have adequate experience in designing foundation for important structures.
- 2.3. Summary of the outcome of pre-workshop survey
- 2.3.1. Several suggestions were put forward by the participants in the survey and citing each one is a mammoth task. Salient points that came up from the survey are listed under each topic and presented in Annexure-2.

3. One Day Workshop on 12 July 2014

- 3.1. The one day workshop was designed to come up with an implementation document that would guide in achieving various components cited as the deciding issues.
- 3.2. The morning session was devoted to presentations of personal experiences with regard to poor geotechnical investigation and discussions on such observations. These presentations highlighted the following.
 - i. The quality of field and laboratory investigations being carried out by most of the investigation companies in India is very poor and needs significant improvement
 - ii. More than 90% of the site investigations in India comprise exploratory boreholes with Standard Penetration tests at 1.50m to 3.0m depth intervals. Standard procedure of conducting SPT is not followed at several sites and as a result most of the SPT data ends up being undependable.
 - iii. Adequate information about the project, structures, loads, functional requirements, etc. is not generally given to the geotechnical investigation company. This lack of

information leads to inadequate investigation and often improper investigation methods.

- iv. Such ignorance about the proposed structures also leads to improper foundation recommendations by the investigation company.
 - v. Often the specifications and schedule of geotechnical investigation do not consider the site conditions and the proposed construction activities. There are several cases of investigations in which the borehole depth is less than a meter because of weathered rock at surface. There are also cases of investigations trial pit excavations where the soil is a very soft deposit of significant depth and extent.
 - vi. The investigation companies do not possess quality equipment and safety equipment to conduct a proper investigation. The quality of work experience is very poor, because the site technicians do not have adequate training in using various testing and sampling tools.
 - vii. The investigation sites are not adequately supervised by qualified and experienced geotechnical engineers and staff.
 - viii. The testing laboratories do not maintain quality equipment. The transit time for samples to reach the laboratory is very large when the site is in a remote area. This results in delay in the testing and wrong reporting of natural conditions.
 - ix. Funds allocated for geotechnical investigation are generally very meagre even in the case of very important projects.
 - x. Often there is an unrealistic time schedule for geotechnical investigation.
 - xi. Different procedures for investigating alluvial deposits and residual deposits are not properly understood.
 - xii. One of the highlighted issues was inadequate correlation studies between the geotechnical data derived from new technologies and the data derived from conventional procedures. Often the data obtained from the investigation using new technologies are not used in the interpretations and recommendations.
- 3.3. Even though most of the above issues are well known among the practicing geotechnical engineers in the country, there is no serious attempt to rectify the wrongs. The main reason for this is said to be the absence of an enforcing authority.
- 3.4. Subsequent to the general discussions on the various issues, the post lunch session was designed as a working session. The first twelve steps listed in Para 2.0 above are regrouped in to five sets. The delegates to the workshop were formed into five groups and each group was assigned with one set, as given below, for further discussion and with a request to come out with suggestions for implementation.

GROUP 1

Norms for and accreditation of GI firms
Audit of accrediting agency
Grading of GI firms
Forming an association of Geotechnical Investigation contractors

GROUP 2

Appropriate specification & Schedule for a project

Setting Price Standards and Guidelines

GROUP 3

Independent Audit of Field and lab work
Training of Technicians

GROUP 4

New technologies and old conventional procedures
Making field geotechnical laboratory mandatory for all medium & large projects

GROUP 5

Avoiding Clash of Interest of GI firms
Build Data Bank for the country by sharing ownership of GI data

3.5. Group 1: Accreditation, Accrediting Agency, Grouping of GI Firms, Association

3.5.1. Norms for accreditation

Geotechnical engineer with minimum experience of two years in GI field Or
graduate engineer with minimum experience of five years in GI field

Equipment with BIS Standard certification and with periodical calibration

In house laboratory with facilities of at least three sets of equipment for index
property tests, consolidation test set up with 3 sets of equipment, one set each for
other standard tests

Computers with professional software for different test data compilation

Field technicians with minimum experience of five years

Lab technicians shall be graduates with relevant experience

Accreditation by third party

The GI organisation shall commit itself to the accreditation

The organisation shall be accountable for maintaining the quality

Periodical visits by experts to verify the claims of accreditation

The organisation shall be disqualified if found violating the terms for accreditation

GI firm shall set up field laboratory according to the size of the project

Equipment and/or experienced staff/agency can be hired after proper auditing to
carry out special tests, Ex. Field tests for dynamic soil parameters, pressuremeter
tests, Cone penetration tests and laboratory tests such as consolidated undrained
and consolidated drained test, tests for radial consolidation, etc.

The norms for accreditation shall be adequately publicised

The cost of accreditation shall be affordable.

Accrediting agencies

Lloyds, NABL, DFI & IGS, etc.

3.5.2. Grading of firms

The GI firm should have minimum experience of 5 years in geotechnical
investigation

Grade I	Up to 50 lakh turnover per annum
Grade II	50 Lakh to 1 crore
Grade III	1 Crore to 2 Crore
Grade IV	2 Crore to 4 Crore
Grade V	4 Crore and above

3.5.3. Association of GI firms

Recommend to form an All India Association for GI firms. This can be under the umbrella of DFI of India. FI may open membership for GI firms and also form a GI taskforce team for professional advancement of GI practice in India.

3.6. Group 2: Specification and pricing

3.6.1. Specifications

Shall be prepared by the geotechnical expert of the project owner.

Specifications shall be project specific.

Shall be in tune with the expected subsoil stratification expected in the project site.

Specifications shall aim for good and sufficient field and laboratory data relevant to the project.

The number of bore holes, locations, depth of bore holes, type of in-situ tests shall be project specific and to be decided by the geotechnical consultant of the owner.

It will be the responsibility of the owner and the owner's consultant to ensure that the tests carried out are project specific and adequate.

The specifications shall clearly provide the field procedures that are to be adopted for the investigation.

It shall provide adequate directions with regard to sampling procedures.

The specifications shall clearly spell out when required, special tests like Triaxial Undrained test with pore pressure measurement, drained triaxial tests, radial consolidation tests, multistage triaxial tests, etc. These tests shall not be routinely prescribed.

The specifications shall spell out the site supervision requirements depending on the project size and importance.

The GI firm shall have the responsibility to provide complete data compiled in standard formats, site characterisation, with indication to suitability of different types of foundation.

Foundation recommendations by the GI agency shall be optional and depending up on the capability of the firm.

The owner may appoint the geotechnical investigation agency, if the agency has requisite resources and proven track record, as its geotechnical consultant to prepare the project specific specifications for the project and then to execute the investigation. The Geotechnical Investigation agency shall be provided with all necessary data about the type of structures, loading intensity, settlement tolerances, etc.

Standard specification format to be prepared for free circulation. **DFI task force may be entrusted with this work**

3.6.2. **Pricing**

A standard pricing format to be developed

The format shall include components specific to the particular site such as mobilisation, setting up of field laboratory, movement of test facilities within the site, arrangement for water and power at site, mobilisation of technicians and supervisory staff, etc.

The standard tests and sampling to be carried out in an exploratory borehole may be clubbed together and treat along with the borehole excavation

Standard laboratory tests like index classification tests may be clubbed together and treat along with borehole excavation

Special sampling techniques such as piston sampling, unconventional sampling sizes, etc. may be treated separately

Special tests like triaxial tests, direct shear tests, consolidation tests, swell pressure tests, etc. may be treated separately

Special tests like CPTU, pressure meter tests, dilatometer tests, block vibration tests, MASW procedures, other geophysical methods, etc. may be treated as independent tests, but pricing of each test shall include its data acquisition, presentation and interpretation

Separate pricing for compilation of investigation data and its interpretation

A panel may be formed to determine the minimum pricing and its periodical revisions for each of the category. This task may be assigned to DFI task force.

3.7. Group 3: Independent audit and training

3.7.1. *Independent Auditing*

A panel of experts can be formed by IGS and DFI. This may be coordinated by DFI task force. The project owners / consultants can approach the panel of experts for independent auditing of investigation work at their site

3.7.2. *Training*

Adequate training syllabus and material shall be prepared by IGS and DFI with the help of institutions.

Local institutions such as IIT, NIT, Engineering colleges, ITI, etc. may be given training and mandate to conduct such training courses based on the syllabus and the training material

Training shall be a continuing process

3.8. Group 4: New technologies and field laboratory

3.8.1. *New technologies*

New technologies shall be adopted more frequently and intensively

Both the conventional procedures and new technologies shall co-exist

Quality shall not be compromised.

Technologies that minimize human errors in all test procedures shall be implemented on priority.

3.8.2. *Field Laboratory*

Field laboratory shall be mandatory for all medium and large projects

Most of the basic tests including unconfined compression tests, vane shear tests, where applicable, shall be carried out in the field laboratory.

3.9. Group 5: Clash of interest and data bank

3.9.1. *Clash of Interest*

There is a clash of interest if the consultants for the investigation agency as well as for the bidding foundation contractor are same

There is a clash of interest if the investigation agency is one of the wings, sister concerns of the bidding foundation contractor

There is a clash of interest if the construction phase investigation is executed by the foundation agency itself or by its sister concern

There is a clash of interest if the investigation agency is part of the project management team

The construction phase investigation shall be independent of the project consultants and the foundation execution agency

In summary, the investigation agency shall not have affiliations that lead to/amount to clash of interest.

3.9.2. *Data bank*

Property rights from the owners shall be obtained

A proper agency for maintaining the data bank shall be identified. A nodal agency can be formulated with the help of NIC, DFI and IGS that can be the repository of the data

Data shall be authenticated before acquiring into the data bank

There shall be local nodal agencies to validate and authenticate the data before transferring to the repository

The source of data shall clearly be mentioned in the data

Data shall be made available only on specific requests mentioning the specific purpose of the data and after paying necessary fee.

Data shall not be used for commercial purposes

Data shall not be used for any design purpose

Disclaimer clauses

Purposes of data request may be research, initial planning of geotechnical investigation, for comparing the newly acquired data, preparation of DPR, etc

The data so obtained shall in no way dilute or eliminate the necessity to carry out site specific GI of a project. Site specific GI is mandatory for the purpose of planning and design of project related structures and facilities.

3.10. DFI Task Force

DFI task force may be assigned the task of setting up the norms for and to oversee the formation of an association of Geotechnical Investigation Companies

Can help in identifying the accrediting agency

Standard specification format can be prepared for free circulation

Preparing a standard pricing structure for geotechnical investigation

Forming panel of experts for independent auditing of investigation works (IGS)

Training syllabus and material for field and lab technicians for geotechnical Investigation

Note: Blue highlighted texts are not the outcome of discussions. Generally formulated from the survey results

4. Contributions

- 4.1. Acknowledgements are due to the members of the working committee Prof.S.R.Gandhi, Prof.A.Boominathan, Mr.M.Iyengar, Dr.C.V.Prasad, Dr.V.Balakumar, Mr.I.V.Anirudhan and Dr.K.S.Rama Krishna for their participation in various meetings and their contributions which led to the preparation of National Survey format and the one day workshop.
- 4.2. Acknowledgements are due to the group leaders, Prof. V.S. Raju, Prof. Nitin Som, Prof. Sreerama Rao, Prof. S.R. Gandhi and Dr. M. Muttharam for their notes on the discussions.
- 4.3. The contributions by those participated in the workshop and pre-workshop survey are acknowledged. The list of survey participants are provided in Annexure 3 and the list of participants in the workshop are provided in Annexure 4.
- 4.4. Presentations by Dr. K.S. Ramakrishna, DFI of India; Prof. V.S. Raju, Formerly Director, IIT Delhi; Prof. Nitin Som, Formerly Professor, University, Jhadavpur Kolkata; Mr. Shankar Guha, Simplex Infrastructures India Limited, Chennai, Mr. P.N. Ravi, Geo Foundations and Structures, Chennai; Prof. Muthukumaran, NIT Trichy; Mr. Anirudhan I.V., Geotechnical Solutions, Chennai and Prof. CNV Satyanarayana Reddy, Andhra University.

The presentations in pdf form are available at <http://www.dfi-india.org/GIworkshop.html>

- 4.5. Draft document prepared by Dr.K.S. Ramakrishna and Mr. I.V. Anirudhan, DFI of India

ANNEXURE 1

‘Geotechnical Investigation in India -Viability & Reliability’ Survey Issues and Explanatory Notes

1. Norms for & Accreditation of GI Firms:

It is important that a set of norms and standards are in place to start a technically very important business such as Geotechnical Investigation. A GI firm should have a minimum number of qualified and experienced persons to man the field and laboratory investigations, to compile, analyse and write factual as well as comprehensive geotechnical engineering reports. It should have a wide range of technically acceptable equipment both for field and laboratory work. It is also important that accreditation of GI firms is made compulsory to take up projects of public interest and of national importance.

2. Audit of Accrediting Agency(s)

It is important to also check on the resources available at the accrediting agency. Many times, these agencies employ professionals on a call basis and once the job is done they are discharged. The practice need to be examined closely to avoid dilution of responsibility and increase the credibility. It is therefore important to have an audit of the accrediting agency and the audit should be made public. Do you agree with the above?

3. Grading of GI Firms

The quantum of geotechnical investigation varies depending on the project size and importance. It may be necessary to grade the firms as per their resources, experience and client satisfaction certificates so that they can take up GI projects according to their capacity. Such grading would help the investigation firms themselves as well as the project owners to decide on the executing capability. In Singapore the Building and Construction Authority (BCA) grades the firms in the building and construction industry according to certain guidelines such as volume and value of works, quality certificates, client feedback, resources, etc. We can adopt similar guidelines to streamline our GI activities and business in India. Do you agree with the above?

4. Appropriate Specification & Scheduling for a Project

It is observed that owner companies and their representatives give out technical specifications and bill of quantities when they float tenders for GI and many times these do not adequately spell out the requirements, at times even specify irrelevant and wrong specifications and quantities. It is important that specifications and quantities cater to the purpose and technical requirements of the project. It is also important to realize that adequate time is given to GI in order to produce quality data. Rushing GI would ultimately increase the cost and time of the construction and may even lead to wrong conclusions on type, load carrying capacity and performance of foundations. Do you agree with the above?

5. Setting Price Standards & Guidelines

As we all know and some of us have a direct experience, geotechnical investigation as a business is many times not viable for various reasons, such as not having a good support price, the system of lowest bidder, etc. These factors lead to the entry of unqualified investigation agencies producing unreliable geotechnical data. There is a certain cost associated with quality and all must recognize and uphold it and insist on it. We need to find a mechanism to work out the minimum basic cost of each activity related to geotechnical investigation so as to ensure reliable geotechnical data. It is not going to be easy to build a mechanism but we can take a leaf out of some consultancy firm

associations who have been able to come out with upper bound and lower bound guidelines a consultancy firm can quote for a particular project based on the estimated value of the project. It

is worth trying as it would go a long way in establishing a credible and healthy environment for all concerned with GI. Do you agree with the above?

6. Independent Audit of Field & Lab work

An independent audit of methods, and systems followed in field and laboratory works by experts selected from among the stake holders would be very useful to establish the credibility of data. The audit need not be full scale but on a random basis to be made mandatory for every project. The cost should be added to the GI contract value and the audit agency approved by the client/client representative. Do you agree with the above?

7. Training of Technicians

Needless to say this is vital for the GI profession. We need institutes and firms to do this more as a service to the profession and to the nation. We cannot estimate the damage that can be wrought on the entire engineering profession and on the health and cost of projects directly or indirectly by the untrained "technicians" in GI. Do you agree with the above?

8. New Technologies and Old and Conventional Procedures

There are several new procedures emerged as effective geotechnical investigation tools, but not yet common in Indian practice. It is necessary to bring in such good procedures common in our working system by making it affordable, at-least in the medium and big projects. Several projects now a days use new procedures, but often remain in the investigation reports without using the data (often very expensive) in the foundation design. There is also a tendency to judge the old technologies as very faulty. Do we phase down the old technology completely and embrace the new technology OR do we find a healthy way for co-existence. Do you agree with the above?

9. Making Field Laboratory Mandatory at all Medium & Large Projects

Our country is vast and many important projects of public and national interest are generally located in remote and not easily accessible areas. Leaving aside quality supervision because staff do not like to go to such areas, even transportation of soil samples is fraught with risks of damage and total loss during transit, high cost of handling and transportation as the samples and tubes are heavy, etc. Some important quick tests such as Atterberg limits, moisture content, unconfined compression tests on UD samples, classification tests, pocket penetrometer and laboratory vane shear tests, etc. can be conducted on a percentage of soil samples in the field itself by setting up the site laboratory or a mobile laboratory. This would definitely add to quality and speed of producing data and would in all likelihood justify the cost. Do you agree with the above?

10. Avoiding Clash of Interests of GI Firms

There is a need to identify clash of interests in the field of geotechnical investigation and avoid such clash for healthy practice of geotechnical investigation. A geotechnical investigation firm run by a geotechnical contracting firm is one example. Similarly there can be clash of interest wherein a geotechnical consultant advising a project owner also has affiliation with a geotechnical contracting firm. Do you agree with the above?

11. Build Data Bank for the Country by Sharing the Ownership of GI Data

Vast amounts of GI data have been generated in the country in the past 50 to 60 years and to date we do not have a data bank. It is essential that a data bank is initiated and data from every project site is made available to this bank. It would go a long way in aiding research and development and in the development of appropriate foundation solutions for each region. Do you agree with the above?

12. Forming an Association of Geotechnical Investigation Contractors

To our knowledge there is no association of Geotechnical Investigation (GI) firms in India. An association similar to IGS, DFI, BAI would help in bringing to the table the main issues troubling the professional growth of the GI industry and the steps that can be taken to collectively address so that the profession meets its desired goals to the satisfaction of all stake holders. The association can also set guide lines and standards for the entry, continuation and grading of a geotechnical investigation firm so as to ensure minimum desired, organizational structure, resources and quality and take up jobs. Do you agree with the above?

13. DFI Task Force Team on GI

Deep Foundations Institute of India is working towards promoting the professional practice in geotechnical and foundation engineering in India with the help and support of DFI, USA and the experts from IGS, academic institutes, specialist foundations construction companies foundation equipment manufacturing firms, special materials suppliers, testing agencies, individual professionals, etc. DFI of India intends to form a task force team comprising experts from these support groups to continuously update the state of practice in India vis-à-vis the same in the developed world and help bridge the gap through seminars, workshops and conferences. Do you agree with the above?

ANNEXURE 2

Summary of Pre-Workshop Survey Responses

The salient points came up from the survey are listed under each topic and presented below

1. Norms for and accreditation of GI firms

All the GI firms conducting medium to large projects of national importance shall have the accreditation.

Organisations like ISO, NABL, NHAI, etc. can be approached

Organisations like IGS (Indian Geotechnical Society), ISEG (Indian Society of Engineering Geology), BIS (Bureau of Indian Standards), etc. can jointly set up a group

There are several GI firms with ISO and NABL accreditation, but their performance is not promising.

Shall introduce Professional Engineer (PE) type registrations as a pre-requisite for accreditation.

A firm similar to NATA (National Association of Testing Authorities, Australia) is appropriate

2. Audit of Accrediting Agency(s)

Credibility of the accrediting agency is very important

There shall be periodical scrutiny of the accrediting agency.

Only limited number of agencies shall be given the mandate and they shall have enough expertise to do the auditing of GI firms

3. Grading of GI Firms

Grading of GI firms depending on the size / turnover alone may not be worth. The grading shall also consider the resource.

Grading shall primarily be based on the manpower and equipment resources, project track record and client certification of completed jobs.

Having obtained the accreditation, prequalification of the agency by the end user is adequate to decide on the capability of a GI firm. There is no need for further grading.

Grading will help big projects to short list the GI firms.

4. Appropriate Specification & Scheduling for a project

Many investigation projects suffered from inadequate time for investigation

The specification shall be drawn by a geotechnical expert, rather than architect or structural designer.

The geotechnical engineer must be associated with the project and has the technical details and requirements of various structures of the project.

The investigation for large projects may be scheduled in phases, including investigation during construction.

Bill of quantities shall allow adequate flexibility so as to cater for soil variations.

Irrelevant tests shall be removed from the schedule so that relevant tests are done with less cost.

5. Setting Price Standards & Guidelines

There shall be an indication of minimum cost

Difficult to establish since the rate will depend upon the geography of the site, remoteness, local issues, etc.

Increasing the rates need not necessarily improve the quality

6. Independent Audit of Field & Lab work

The project owners shall appoint competent agencies to oversee the investigation work, in spite of the accreditation.

Independent audit is not necessary once the accredited agency is employed.

It will add to the cost of investigation.

7. Training of Technicians

Training of technicians is very important as they have to carry out accurate testing procedures.

Institutes like NIT and IIT can conduct training courses.

Large business establishments like construction companies and engineering consultants shall take up this task

ITTs can start geotechnical Investigation training courses

Training the technicians shall be sole responsibility of the GI firm itself

8. New technologies and old and conventional procedures

Old technologies shall remain, but the quality of testing procedures shall improve so that several established correlations can be used effectively

New technologies are adopted in several sites, but results remain only in the data sheet without using it in the foundation characterisation.

Both shall co-exist and depending on the project importance, new technologies shall be extensively used

The new procedures shall be incorporated in codes so that the testing procedures are standardised and authenticated.

Reliable correlations between the new procedures and the old procedures shall be established and gradually the new technologies can be given more importance for saving time and also for producing good quality GI data.

9. Making Field Laboratory Mandatory at all Medium & Large Projects

Filed laboratory for large projects shall be made mandatory

Shall decide what are the tests to be conducted in the field laboratory

Field laboratory during construction stage investigation is extremely helpful in making fast decisions.

There are several limitations to the proposal especially when the investigation time is short. Appointing trained technicians to do these tests is not an easy task.

10. Avoiding Clash of Interests of GI Firms

Many responders found it difficult to define clash of interest

Clash of interest may emerge when the investigation agency is likely to be bidding for foundation construction also

Consultant in an investigation company is acting as independent consultant for the owner also

11. Build Data Bank for the country by Sharing the Ownership of GI Data

Many opined that this is a very good idea

Ample chance for misuse of data

There shall be certain amount of uniformity in presentation of data

NIC (National Informatics Centre), NDC (National Developments Council), etc. can be approached for creating the data bank with adequate security.

The data shall be included after proper audit by a competent authority.

Data will be useful for preliminary analysis and also for developing detailed investigation programme for major projects

12. Forming an Association of Geotechnical Investigation Contractors

An association will help in improving the quality and pricing standards.

There are possibilities of cartelising the group.

The association shall be a professional body.

The eligibility criteria to become member of the society shall be established.

The association may be a wing of any other appropriate professional body.

13. DFI Task Force Team on GI

A taskforce will help bridge the gap through seminars, workshops and conferences.

IGS and local chapters of IGS should play a key role here

Task force may be formed.

It is very important collaborative nature of works.

It must contain people from exploration, executing agencies academia and consultants. It can be split into smaller groups.

Such move will enhance our professional practice to international standards.

Good initiative of DFI India.

Excellent idea

ANNEXURE 3

List of Participants in the Pre-workshop Survey

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ANNEXURE 4

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