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# IGS News

*A Bulletin of Indian Geotechnical Society, Chennai Chapter*

[www.igschennai.org](http://www.igschennai.org)

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## Geotechnical Calendar

### National

- National Symposium on Advances in Geotechnical Engineering (NSAGE 2004), Karnataka Geotechnical Centre, Department of Civil Engineering, Indian Institute of Science, Bangalore, July 22 - 23, 2004. [nsage@civil.iisc.ernet.in](mailto:nsage@civil.iisc.ernet.in)
- Geosynthetics India 2004, IGS, Delhi Chapter at Radisson Hotel, New Delhi, Oct. 27-30, 2004. Prof. G.V. Rao, [gvrao@civil.iitd.ernet.in](mailto:gvrao@civil.iitd.ernet.in)
- International workshop on Risk Management in Site Characterisation and Geotechnical Design (GEORISK), department of Civil Engineering, Indian Institute of Science, Bangalore, November 26 - 27, 2004.
- All India Seminar on Geotechnical Aspects of Infrastructure and Environment, ASCE (India Section), Calcutta, December 10 - 11, 2004.
- Indian Geotechnical Conference - 2004, Ground Engineering - Emerging Techniques GREET, IGS Warangal and Kakinada Chapters, Dec. 17 - 19, 2004, email [igswgl@yahoo.com](mailto:igswgl@yahoo.com)
- Indian Geotechnical Conference - 2005, Indian Geotechnical Society, Ahmedabad Chapter, Ahmedabad, December 2005.

### International

- Joint Speciality Conference on Probabilistic Mechanics and Structural Reliability, Sandia National Laboratories, Albuquerque, New Mexico, July 26 - 28, 2004.
- The Seventh International Conference on the Application of Stress Wave Theory to Piles - Malaysia - August 8-10, 2004 [sec@iem.po.my](mailto:sec@iem.po.my)
- International Symposium on Lowland Technology, International Association of Lowland Technology and Faculty of Engineering, Kasestart University, Bangkok, Thailand, Prof. N Miura, Email [fengwnl@ku.ac.th](mailto:fengwnl@ku.ac.th); <http://enve.eng.ku.ac.th>, Sept. 1-3, 2004
- International Conference on Site Characterisation, Lisbon, Portugal, Sept. 20 - 22, 2004
- International Conference on Geo-Environmental Engineering, Singapore, December 9 - 10, 2004.
- Geo-Frontiers 2005, Geo-Institute of ASCE and Geosynthetic Materials Association, Austin, Texas, USA, January 24-26, 2005.
- XVI International Conference on Soil Mechanics and Foundation Engineering, ISSMGE and Japan Geotechnical Society, Osaka, Japan, September 12 - 16, 2005

## From the Editor's Desk ... Geotechnical Aspects of Earthquake Resistant Design

The devastating effects of earthquakes - destruction of property and loss of livelihood, loss of life and suffering from injuries - are nowadays vividly brought to our drawing rooms by immediate television coverage. Earthquakes are primarily associated with areas of recent mountain building activity and with global rift system. However a number of engineers and earth scientists have expressed their fears that earthquake may occur in Chennai also, because of uncontrolled water extraction and consequent deep-seated earth movements.

The severity of ground motion at a particular point on the surface of earth depends on the total energy released in the form of seismic waves. The exact mode and duration of energy release and the geological conditions are also important factors. The principal motion of the ground is due to the shear component of the seismic wave, which causes shaking of the ground. Nearly all the damages to the structures are caused by the shaking. The foundation of the structure will move with the ground on which it is built. The structure above will oscillate in response to shaking which may not have any resemblance to ground vibrations. The oscillations will cause structural damage.

One of the baffling things about destruction of buildings by earthquakes is the apparent selectivity of the earthquakes. One may see one building badly damaged while a nearby structure of no better or poorer construction survives. The explanation for this is the different sub-soil conditions under the structures. A number of detailed investigations have been undertaken to study the damages to buildings during past earthquakes and they have conclusively shown that the response of structures to earthquakes is closely associated with the vibration characteristics of the underlying soil. The correlation of earthquake motion recordings and structural damages have clearly revealed that variations in local soil and geologic conditions in one section of a particular area make

the response parameters to vary by a factor of three to six from other areas.

The extensive damages to structures in Nigata, Japan during an earthquake in 1964 were the result of liquefaction of sandy soils of considerable thickness, which supported the foundation. Many structures settled more than 90 cm and an apartment building rotated through an angle of 80 deg. There was no structural damage to buildings, only functional failure. The investigations done after the San Francisco, USA earthquake in 1971 revealed that the 12 to 25 storey buildings founded on deep layers of soft clay suffered much greater damages than the 2 to 5 storey buildings founded in the area. The difference in damages was attributed to the difference in fundamental periods of the structures and the foundation soil. The investigations of Mexico City earthquake of 1957 also revealed a similar trend when many tall buildings on deep deposits of soft soil suffered major damages while older and weaker buildings with smaller periods suffered no damage. It is evident that the response of tall buildings on thick deposits of soft clays will be about three to four times greater than those of similar buildings resting on stiff soils. Conversely the response of relatively short buildings on strong soils will be about three to four times than those of similar structures on thick deposits of soft soils.

The frequency characteristics of the oscillatory motion during an earthquake are an important factor in the structural damages caused to buildings. Sub-soil conditions at the site greatly influence the frequency characteristics. Thick layers of soft clay are particularly dangerous for tall structures as they are capable of inducing long period characteristics, which have high structural damage potential. Danger of liquefaction should be considered when the sub-soil is sand/silt with high water table. It is essential that steps should be initiated so that building codes reflect the potential variation in damage potential due to variations in sub-soil conditions. The influence of soil conditions on earthquake damage potential should be given careful consideration in designing earthquake resistant structures.

## New Location for Highways Research Station

Highways Research Station was one of the earliest Hstate research laboratories in India having been started in early fifties. It has established an enviable national reputation for its research and consultancy work. The proposed construction of new secretariat building of Tamilnadu Government in the adjoining Anna University area also includes shifting of this prestigious institute to a new location. It may be very difficult to re-establish its extensive and well-equipped laboratories in the new cramped premises at Guindy and the shifting is a blow to highways and geotechnical research in Tamilnadu and India.

IGS Chennai Chapter received tremendous support from the engineers of this prestigious institute and very fruitful co-ordination was possible for the benefit of the chapter because of its proximity to Anna University and IIT Madras.



## IGS Election Schedule 2005-2006

The election of the office bearers of Indian Geotechnical Society, New Delhi for the term 2005 – 2006 will be held this year. The election schedule is as follows.

### Notification of Election and

Call for Nominations	July 17, 2004 (Monday)
Last Date for Receipt of Nomination Papers	Sept. 06, 2004 (Monday)
Scrutiny of Nominations	Sept. 06, 2004 (Monday)
Intimation to Candidates	Sept. 16, 2004 (Thursday)
Withdrawal of Candidature	Sept. 23, 2004 (Thursday)
Printing of Biodata of Contesting Candidates	July – Sept. Issue of IGS NEWS
Despatch of Ballot Papers	Oct. 14, 2004 (Thursday)
Last Date of Receipt Back of Ballot Papers	Nov. 16, 2004 (Thursday)
Counting of Votes	Nov. 17, 2004 (Wednesday)
Announcement of Results	Oct-Nov Issue of IGS NEWS

## IGC - 2004 - Warangal

IGS, Warangal and Kakinada Chapters invite all the Geotechnical Engineering professionals for attending IGC-2004, **Ground Engineering - Emerging Techniques GREET**, that will be held during 17-19, 2004 at Warangal.

### REGISTRATION FEE SCHEDULE

	Upto 31.10.04	After 31.10.04
IGS Members	Rs.2200	Rs. 2500
Non-Members from India	Rs.2500	Rs. 2800
Student/-Senior Citizen	Rs 1000	Rs 1200
Accompanying Spouse	Rs. 500	

### ADDRESS FOR CORRESPONDENCE

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## New IGS Chapters

### Bhavnagar

New IGS Chapter of Bhavnagar was inaugurated on 9<sup>th</sup> February 2004 of Bhavsihji Polytechnic, Bhavnagar by Prof A.V.Shraff, President of IGS by lighting the lamp. Prof. B.J.Bhakhad of Applied Mech. Dept. is the Founder Chairman of the Chapter.

### Pune

New IGS Chapter of Pune was inaugurated on 4<sup>th</sup> April at Civil Engineering Dept of Maer's Maharashtra Institute of Technology. Prof. V.R. Phadke, Professor of Civil Engineering is the Honorary Secretary of this chapter.

### Jabalpur

A chapter at Jabalpur was also inaugurated during May 2004.

## Welcome New Life Members

329	Mr. T Balasubramoniam
329	Dr. A. Varadarajan
330	Dr. C.V. Prasad
331	Mr. M. Durai

## Obituary

With deep regret we announce the sad demise of Prof.B.Shankariah, Chairman IGS Warangal Chapter and Organising Committee Chairman IGC-2004 on 10<sup>th</sup> April 2004.

## Personal Column

- 1 Er. Subhash Chandra Bose, (LM-36), Dy Director (Soils), Highways Research Station retired from service on 30.4.2004
- 2 Dr. K. Premalatha, (LM-15), College Of Engineering Guindy, delivered an invited lecture, " Bulk Utilization of Quarry Waste and Flyash in Construction Industry" at the Conference on Green Building Concepts held at Madurai on June 17, 2004. Another paper titled "A Preliminary study on ground contamination of Perungudi" was also presented by her.
- 3 Mr. K. Muthukumar, (LM-726), attended 5th International Conference on Case Histories in Geotechnical Engineering, held at University of Missouri – Rolla, New York, USA, and presented his research paper titled "Monitoring Lateral Deflections of a Berthing Structure during Dredging-A Case Study"

Members are requested to write to the society about their activities and other personal achievements. Members may please send their email ID for better communication.

## Lateral Loading of Piles - Initial Conclusions

### Summary By Core group

#### 1 Parameters

- a) Fixity conditions at the top / head of pile

This will enhance the lateral carrying capacity of single pile. Or reduce the lateral deflection of a single pile.

- b) Group effects

Studies have shown that presence of number of piles in the group at relatively closer spacing leads to increased deflection of individual piles within the group depending upon its position in the group and number of piles in the group.

- c) In the case of short piles (because of shallow rock formations), it is advisable to sufficiently socket into competent rock if lateral loading is critical.

Therefore, to extend the results of test conducted on a free-headed single pile to a group of piles will be inappropriate.

#### 2 Approach for Pile design for Lateral Capacity

- a) Full and full field test approach will not be suitable for designing pile with fixed head because of varying fixity conditions in reality.
- b) The only definite condition that can be achieved in the field is free head condition and such tests can be conducted in field.
- c) For larger projects, test on group shall be conducted to study the group effects on individual piles. However, such tests will be applicable only to pile group of compatible sizes, say, 3x3 group.

### The approach shall be in the following steps.

- a) A suitable analytical procedure shall be adopted to arrive at load-deflection behaviour of a free-headed single pile for the subsoil conditions encountered.
- b) Field test should be conducted as per IS 2911 Part 4 as a free headed pile and load deflection behaviour at pile head is obtained (at cut-off level)
- c) This shall be compared with the load deflection behaviour obtained by analytical approach.
- d) In case of discrepancy between actual and analytical results, the assumptions made for the soil parameters in the analysis can be suitably modified to obtain convergence with the field test.
- e) The modified value can be used for the pile group design taken into account of fixity factors and group effects.

## Seismic Vulnerability of Buildings and Structures in Chennai

Dr. B. Ram Prasad, ME, PhD (Texas A&M),  
Managing Director,

M/s. Prasad Armstrong Yen Gotech Engr. Consultants (P) Ltd.

Two news items appeared in "The Hindu" dated 21 & 24 Oct. 03 regarding the CMDA and Chennai Corporation's study of stability analyses of the building for seismic considerations. Bureau of Indian Standards (BIS) has incorporated Chennai city and Tamil Nadu in Zone III of seismic zonal classification – same as Ahmedabad, Gujarat where major loss to life was witnessed during January '01 earthquake.

It appears from both these news items that the CMDA and Chennai Corporation are concentrating only on the structural aspects of buildings with little or no consideration to type of foundation and site soil stratigraphy. For any structure, the most important aspect of the structural stability under seismic conditions is site soil stratigraphy along with structural aspects. Structural stability of buildings and other structures depends very much on the site soil conditions, foundation type, and structural design of the structure.

Without due consideration to site soil conditions and foundation provided will not make the building seismic resistant even if the structure (concrete and steel) is designed for all the possible seismic forces. This is similar to ignoring condition of the ground on which a strong person has to run. Even if the person is very strong (super structure) and provided with best running shoes (foundation) but he will not be able to move if the ground on which he is supposed to run is weak (soil with degraded strength) that his legs get stuck in the soil. Therefore, it is imperative that the site soil conditions and foundation type must also be studied in concurrence along with building's structural (concrete and steel) capabilities to arrive at buildings stability under seismic conditions.

In all major earthquake events (Gujarat, San Francisco, Alaska, Nigata to name a few) many buildings supported on shallow foundations (footings and combined raft) have tilted or sunk with minimum structural damage. In almost all cases, it was established and identified that soil profile under the buildings and general area was highly susceptible for excessive settlement, squeezing out, and loss of strength under seismic forces. The most susceptible profiles had the following type of soils:

- Very Loose to Medium Dense Silty and Silty Fine to Fine Sand;
- Very Soft to Soft Clay; and
- Artificially Fills of Uncontrolled Loose Fills.

For the above type of soils susceptibility increases many folds when these soils are below ground water (fully saturated condition). Even seasonal variation in ground water level can also affect the structural stability under seismic forces. In case of Alaskan earthquake nearly 10-M thick strong topsoil slid down into sea due to presence of a small layer (less than 10 cms thick) of silt soil that "liquefied" under seismic action. Even after nearly 50 to 100-M lateral movement of the soil many building were intact inferring site soil profile plays a very significant role in the stability of the structure under seismic conditions.

Well-established data is available which indicates and provides general potential for soil's susceptibility under seismic forces of different earthquake intensities. Using this information along with other aspects of the building design conditions it is possible to identify if the specific site has any seismic susceptible conditions. Hence based on the susceptibility, appropriate foundation must be selected for the new buildings. In case of preexisting buildings it is more difficult to minimize the seismic susceptible of the building as nothing much can be done for the site soil conditions and to the already provided foundation.

In summary, for general guidelines it can be stated that the building stability under seismic conditions or during earthquakes depends on the three major items – nature of soil, type of foundation, and rigidity and redistribution capacity of the superstructure members (columns, beams, shear walls, etc.) In earthquake prone area, each of these factors has critical control over the structural behavior during an earthquake.

## Activities - April - June 2004

### LECTURES

Dr. K.S. Ramakrishna, Vasudhaika Trades & Technology Pvt. Ltd, Chennai delivered a lecture on "Current Piling Practice" on May 12, 2004 at IIT Chennai. He presented advanced methods in bored piling and driven piling procedures.

### OTHER ACTIVITIES

Mr. Ranganathan, Laboratory Assitant retired from Soil Mechanics Laboratory of Anna University, was presented a memento of appreciation for his selfless services to the conduct of many lectures and other functions conducted by the chapter at Anna University.

Dr. K.S. Ramakrishna, Vasudhaika Trades & Technology Pvt. Ltd, Chennai delivering the lecture on "Current Piling Practice"

### Nature of Soil

Most dangerous type of soil under a foundation or general area from earthquakes are "Silts" and "Silty Fine – Medium Sands" in very loose to medium dense state with ground water. These soils have high potential for "Liquefaction" when subjected to seismic forces. Under seismic forces ground water in voids/ pores of the soil will be subjected to rapid cyclic forces leading to rapid increase in pressure of the water in the soil pores. This increased water pressure will try to dissipate by moving upward or sideward leading to migration of soil particles leading to fluid behavior of the soil. Weakened foundation soil will lead to excessive settlement or complete failure of soil under foundations leading to significant settlement of the structure or tilting of the structure. In extreme cases during earthquakes, water fountains were seen to spring out of ground when the pore pressure exceeds the soils downward weight.

In case thick layers of very soft to soft clay soils are present at shallow depths then the soil will squeeze out of the ground outside the structure leading to loss of support under the structure. In many cases (San Francisco earthquake) it was also identified that the magnitude of the earthquake forces increased many folds in the areas with thick layers of loose sands, silts and very soft clay soils. This was identified as the one of the major reason for failure of large number of buildings in the San Francisco Bay Area.

Most stable foundation stratum from earthquake point of view i.e. the one which minimizes the earthquake force effects to structure is "Hard Rock" or at least "Non Liquefiable" strata of high in-situ density and strength. In the Chennai region some of the major areas with low potential for large settlements and foundation failures are St Thomas Mount, Pallavaram, Nanganallur, Tambaram (rocky formation is present at shallow depth), other areas like parts of Mylapore, parts of George Town, Avadi (dense to very dense sand soil or very stiff to hard clay profile present in these areas).

Some of the major areas of very high potential for large settlements and foundation failures are Pallikarni marsh area due to presence of large thickness of very soft clay (at least 5-M thick), parts of area close to the Adyar river, East of Saidapet, and some areas close to Central Railway Station.

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## Growth of Geotechnical Wisdom

Continued from page 3 **Seismic Vulnerability .....**

### Type of Foundation

Shallow foundations (load bearing walls, isolated column footings, strip rafts, rafts, etc.) supported on the above-mentioned soils will be significantly damaged by earthquake forces as soils under these foundations become "transitionally" weak during earthquake. Deep foundations (piles, caissons, etc.) supported on to "Hard Strata or Non-Susceptible Soils" below the layers of these potentially liquefiable soils will be least affected if these piles were structurally designed to take the lateral forces from earthquakes.

### Rigidity and Redistribution Capacity of Superstructure Elements

Above the foundation, super structure must be rigidly interconnected in all the directions to allow redistribution of the forces through out the columns and beams without distress. In case the columns are not rigidly interconnected to each other, and if each column moves differently with respect to near by columns then the structure will crack and fail due to differential movement of different part of the building. It is also most important to make sure that there are no large cantilever parts (columns on one side of the slab type) in the building. Also, "Floating" columns must be completely avoided in the buildings.

Section of the audience at the Lecture "Current Piling Practice" by Dr. K.S. Ramakrishna, Vasudhaika Trades & Technology Pvt. Ltd, Chennai on May 12, 2004



Dr. Swami Saran, Emeritus Professor, IIT-Roorkee, will deliver the 27th IGS Annual Lecture at IGC - Warangal (17-19 Dec.) 2004. Topic of the Annual Lecture is "Some Engineering Aspects of Reinforced Earth"

Another critical aspect of the structure is the column - vertical load-carrying members of the building to foundation. Typically the column L/D (length to least width) ratio is large from earthquake force point of view. The high L/D ratio will provide flexibility to the column to bend in different curve shapes depending the earthquake force direction and magnitude, and frequency. During this bending action columns (which are generally not designed for bending) will break leading to complete structural collapse. This type of large L/D ratio arises in case of buildings with stilt floors where columns will be present without any walls. The L/D ratio of columns can be reduced by increasing the least column width or by reducing the column's effective length by providing continuous lintel level and sill level beams integrated into the columns. In addition, these integrated sill and lintel level beams with columns in each floor along with roof level beams will reduce the free column length (L) available for bending thus reduces the bending stresses in the columns. In addition, these continuous lintel and sill level beams will also provide paths for redistribution of the forces between columns and provide breaks for crack propagation in walls.

From now on owners, builders and engineers must give greater importance to the structural safety and accordingly increase the structural strength, structural rigidity and capacity to transfer the earthquake forces without failure.

The above points can be summarized as below:

1. Give proper respect and consideration to soil type under foundations.
2. Design the foundation elements to counter lateral loads apart from vertical loads.
3. In each floor, the columns must be inter-connected with each other by sill level and lintel level continuous beams. This will reduce L/D ratio.
4. Maintain the quality of concrete and steel.

It is necessary to remember that designing and constructing a structure to resist earthquake does not guarantee 100% protection as nature is such each earthquake is unique with special conditions that affect the buildings differently. These precautions will help to reduce the human loss if not the full building by preventing quick and immediate collapse of the building in the worst case.

It must be clearly stated "Earthquakes do not kill people only Improperly Designed and Improperly Built Buildings will kill people during earthquakes."

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Seminar Workshop - Geosynthetics India 2004, IGS, Delhi Chapter, Oct. 27-30, 2004. Limited number of registration forms available with IGS Chennai Chapter. Contact Secretary

We are on the web - [www.igschennai.org](http://www.igschennai.org)