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Indian Society of Earthquake Science

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Earthquake precursors utilizing surface temperature anomalies over the probable zones of earthquake occurrences :

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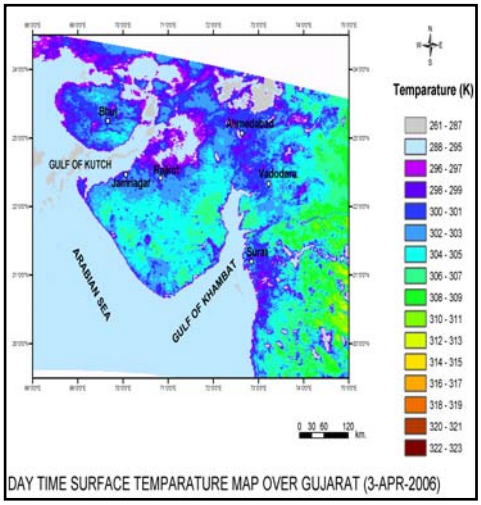
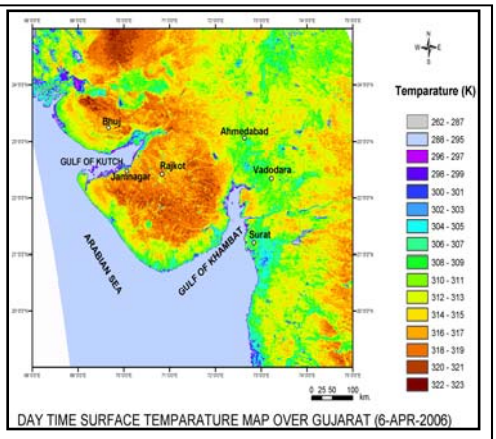
An earthquake is a sudden readjustment of the earth masses, causing relative motion of blocks of rock with characteristic times (less than an hour, and, in practice, much shorter). Seismic waves are mostly the only form of propagation through the earth's interior which is not severely damped after a short distance. At most subduction zones seismicity involves very large earthquakes characterized by a thrust faulting mechanism, expressing the overriding of the subducting land/ oceanic plate by the other plate.

The study of thermal precursors before an impending earthquake is possible due to the fact that a few days before the occurrence of an earthquake, the average temperature of the area keeps increasing.



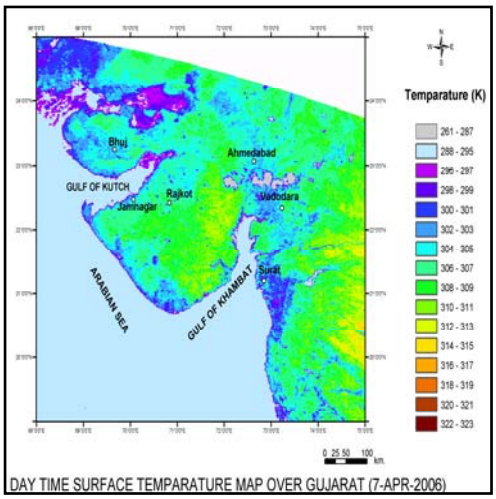
DAY TIME SURFACE TEMPARATURE MAP OVER GUJARAT (3-APR-2006)



DAY TIME SURFACE TEMPARATURE MAP OVER GUJARAT (6-APR-2006)

The surface temperature anomaly patterns over the Bhuj region have been generated using NOAA thermal IR data during March-April, 2006. Three imageries (one before, one on the date of earthquake/tremor and one after the earthquake/tremor) have been processed and analyzed.

Surface temperature patterns have been generated over Gujarat for six days during the occurrences of tremors, and utilized the same for demarcation of change in surface temperature as a precursor to impending earthquakes. A sharp change in the surface temperature patterns could be observed in this whole region and more so near Bhuj region just before the occurrences (on April 6, 2006) of such mild tremors during 3-7 April, 2006. However, a sharp decrease of surface temperature could be observed after the occurrences of such tremors . (**Continued in page 2**)



DAY TIME SURFACE TEMPARATURE MAP OVER GUJARAT (7-APR-2006)

From the President's Desk

The 1st issue of ISES has already been rolled out in Feb 2012. Though the content of the issue were mostly on the activity of ISR, nonetheless an effort was made in such an endeavor to publish a newsletter for the benefit of the members. However, this issue will focus all corners of society 's framework with special reference to individual members' contributions.

It is heartening to see that members are interacting and contributions have started pouring in slowly. On this occasion, I take the privilege to convey my sincere thanks to all the members for their kind co-operation and sincere support to continue the newsletter ahead.

NEWS / EVENTS

- GERMI will organise the Annual Convention of Indian Geophysical Union in coordination with PDPU and ISR, Gujrat during 29-31 Oct 2012, at PDPU, Gandhinagar (www.igu.in).
- Post Seminar IGU Workshop on Magneto-Tellurics is scheduled on 1-3 Nov 2012.
- Dr.B K Rastogi,DG ISR is elected Fellow of Gujrat Science Academy. Also as a Member Programm Advisory Committee of DST, Delhi.

Inside this issue:

Evaluation of Liquefaction Potential through Triaxial Cyclic Tests

Yet another cap has been added to Geo-Technical Lab of ISR for measurement of soil properties for Seismic Microzonation, Foundation Designing and Engineering Geological aspects.

A state-of-the -art Triaxial Testing Machine developed by M/s HEICO, New Delhi has been installed in the Geotechnical Lab, at ISR which became functional since Dec 2011. The purpose of this machine is to ascertain the shear strength of the sample and determine the relationships between stresses and strains. The advantage of Triaxial test is in the re-creation of real conditions: the failure plane is no longer conditioned by the apparatus itself, but develops along the plane possessing lesser resistance within the sample. The control of drainage and pore pressure allows to study the effect of fluids on the mechanical properties of the solids within the sample. The Triaxial test also allows radial strain of the sample under load, a feature not present in other tests.

This machine is used in evaluation of shear parameters like Cohesion and Angle of Friction for a particular soil sample. It is one of the most sophisticated and automatic machine, ever made by M/s HEICO, New Delhi. By the help of this machine, it is possible to estimate the Liquefaction Potential of the soil sample. The Shear Stresses and Axial Strain acting on the soil sample at particular amplitude of each cycle can also be

Fig. 1 (A) shows the Triaxial Testing Machine at ISR (Geotechnical Lab), while **Fig. 1 (B)** shows the key components of Testing Machine.

Fig 1 (A) Triaxial Cyclic Testing Machine

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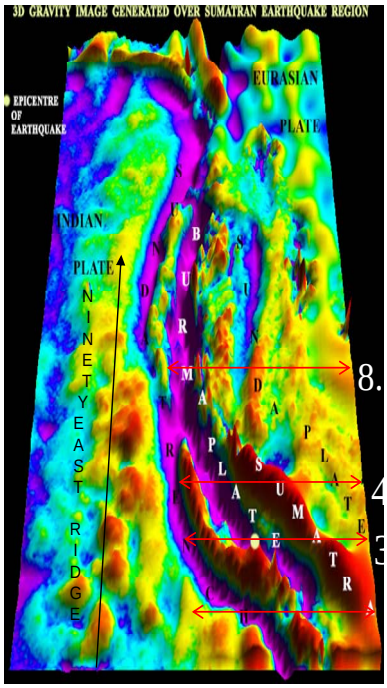
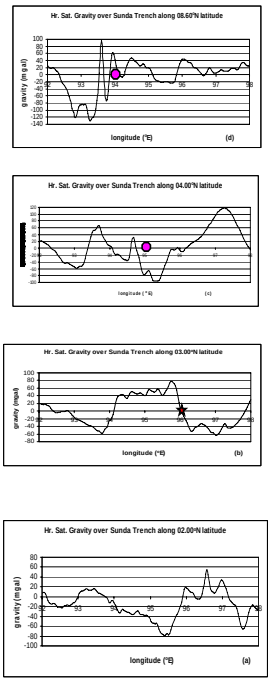
Studying the changes in high resolution satellite gravity over the Sumatran earthquake region with reference to the severe earthquake on 26th Dec., 2004



High resolution satellite gravity image over Sumatran earthquake region

Sources (Altimeters) : Geosat GM, ERS-1/2, Seasat, TOPEX



Profiles generated over the epicenter and the aftershocks regions show a drastic changes in the gravity patterns which is conspicuously absent in other profiles far away from the epicenter/aftershock regions.

A 3D high resolution gravity image has been generated and superimposed over the tectonic map over the Ninety East Ridge and the Sumatran earthquake region. Variation in the gravity field can, therefore, be utilized as a predictor of seismic behavior.

The most frequent sample diameter used for triaxial testing is 38.1 mm. Also, other diameters like 50 mm, 70 mm and 100 mm can be used. The Triaxial cell is a water-tight container with hydraulic connections at the base and a sliding load piston in the top, with a soil sample at the center enclosed within a thin membrane, covered by porous stones in the top and bottom. Confining (Cell) and Back pressures are continuously applied to the Triaxial cell with a series of increments (Fig. 1B). Cyclic Dynamic test is performed for Sandy soils, while Static test is performed for Clayey/ Silty soils. In conclusion we recall the traditional volume change using Graduated Burettes fitted to a drainage line.

The machine at ISR was started in the month of Dec 2011 for testing of soil samples for Seismic Microzonation projects. Some samples from 100 m depth boreholes of Dholera SIR were tested for evaluation of Liquefaction Potential. The machine is very useful in defining the Load v/s Deformation curves and is also useful in determination of Axial Strain, Pore Pressure Change, Consolidation Index, Volume Change, Effective Stress, etc. For present ongoing study of **"Seismic Microzonation of Ahmedabad city"** the undisturbed soil samples from 3.0 m to 30.0 m depth will be tested and the results generated will be used for evaluation of Liquefaction Potential for Ahmedabad city. Fig. 2 shows some sample graphs for Dholera SIR soil samples.

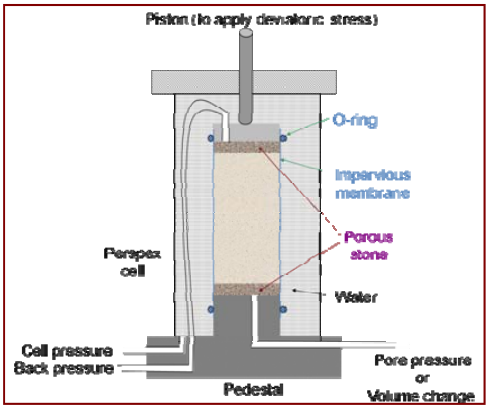


Fig 1B . Key components of Triaxial Cyclic Testing Machine

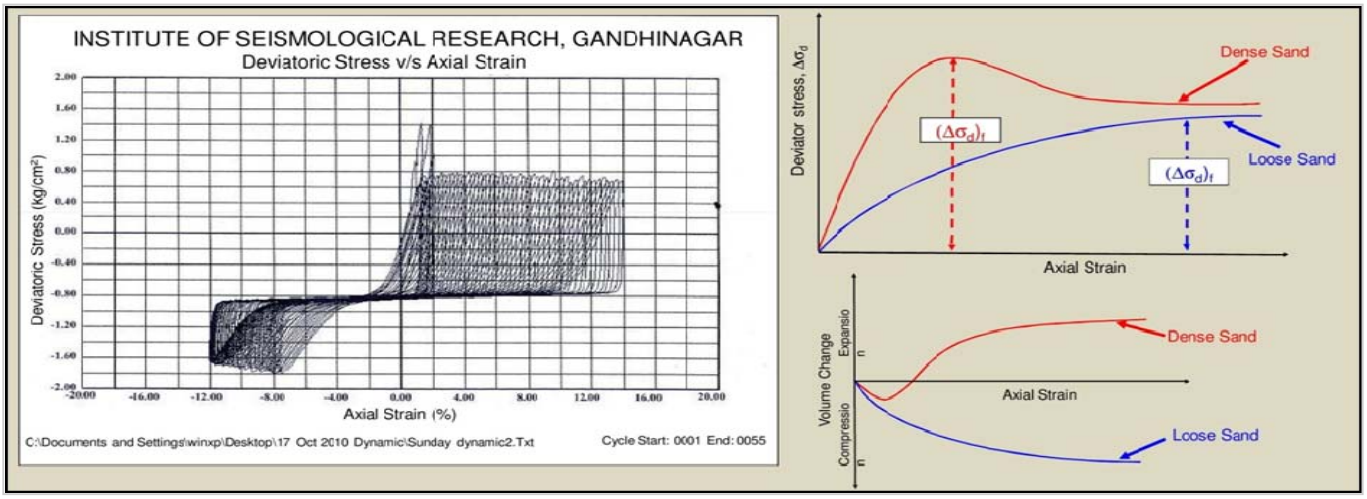
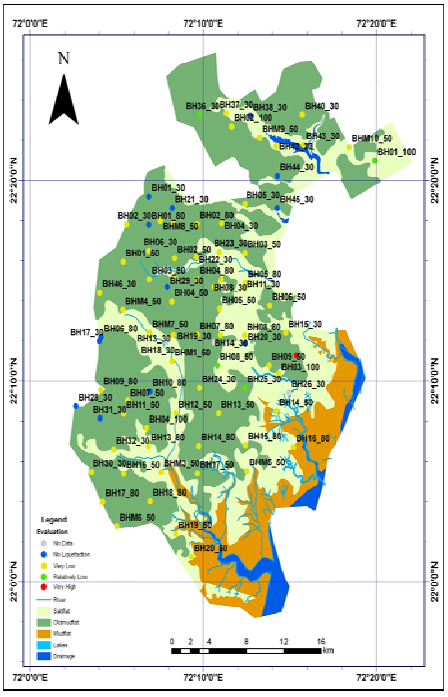


Fig 2. Representative graphs of sample testing for Dholera SIR in TCT Machine



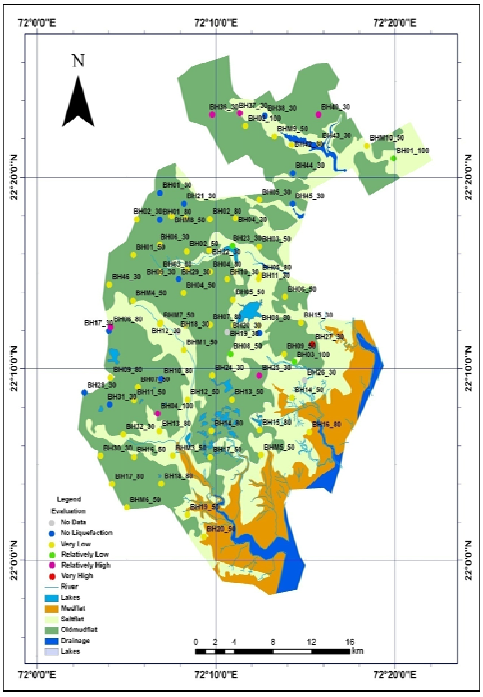


Fig 3. (A): Liquefaction Potential Map (Local EQ @ Actual GWL)

Fig 3. (B) Liquefaction Potential Map (Local EQ @ Zero GWL)

Evaluation of Liquefaction Potential for Dholera SIR was estimated using practical (Triaxial Tests) and theoretical (Japanese Road Assoc. Method, 2002) techniques. Liquefaction potential analysis was carried out in 87 boreholes (40 boreholes of 30 m, 27 boreholes of 50 m, 16 boreholes of 80 m and 4 boreholes of 100 m depth) using the two scenario earthquakes, i.e., Local & Far type for the pre-monsoon and monsoon period (i.e., water level at surface). GIS based maps were prepared for each borehole with respect to their liquefaction evaluation (see **Figs. 3 (A) & (B)**).

The analysis for liquefaction potential assessment was based on the geology, sub-surface geology, seismic history and geotechnical characteristics of soil as collected. Calculation of liquefaction potential for Dholera SIR is presented into two sets ((i) Local EQ at Actual GWL & (ii) Local EQ at Zero GWL. About 95% of Dholera SIR falls in the "**Very Low**" category, excluding S of Rahatalav village (BH27_30) in the eastern part of Dholera SIR, which shows "**Very High**" category for "Local Earthquake" scenario.

Raison d'être

To promote the cause of advanced study and exchange of ideas amongst the seismologists by discussion on subjects of interests in the field of Earthquake Science by organizing meetings, conferences, seminars, symposia, annual lecture programs etc.

To strengthen the level and dissemination of Earthquake Science by preparation and publication of teaching and training material and publishing research bulletins, journals, memoirs, monographs etc. and to synergize co-ordination of research and investigation in all disciplines related to Earthquake Science.

To execute research projects with the national and international collaborations and conductive to the objects of the Society in above mentioned and other objects for the benefit of its members with no profit motive

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Miscellaneous news

Geological Investigations of any possible fault near Jaitapur Nuclear Power plant site, North of Ratnagiri :

A team of 30 geologists / geophysicists from ISR, NGRI, GSI, ONGC, AMD, NPCIL, IITb, and NIOT visited in and around Jaitapur Nuclear Power Plant site to investigate the possibility of existence of any fault and possibility of any Neo-tectonic activity.

A paper was published in current science mentioning that beneath Decan Trap a fault may activate to produce a large earthquake as happened at Koyna M6.3 (50 km away) and at Latur (M6.2 ,400km away).

A subsurface fault can be detected by geophysical surveys which are underway. However, any surface indication of any subsurface fault and its Neo-tectonics were to be assessed in the field on the basis of GSI work report of the area. Two days thorough checking of the area did not reveal any such features.

A 50 km long NNW lineament close to the coast appears to have shifted some rivers / streams courses. The most prominent feature, 8 km south of the plant site, was thoroughly investigated. It was found to be caused due to formation of sand dune due to human intervention in last 50 / 100 years as evidenced by historical data. Sand samples have been collected and are being dated to confirm it.

As there is no Neo-tectonic activity in the area, it is recommended to go ahead unless any fault is detected within 5 km of the site by geophysical survey.

Registration for 'Federation of Indian Geosciences' Associations (FIGA) has been filed on 29th March, 2011 at Hyderabad. The following nine associations have given their consent to be part of FIGA.

1. Geological Society of India, Bangalore
2. Indian Geophysical Union, Hyderabad
3. Association of Hydrologists of India, Visakhapatnam
4. Paleobotanical Society, Lucknow
5. Indian Geologists Association, Chandigarh
6. Indian Society of Applied Geochemists, Hyderabad
7. Association of Exploration Geophysicists, Hyderabad
8. The Palaeontological Society of India, Lucknow
9. Indian Society of Earthquake Science, Gandhinagar

ISES at a glance

- **First General body meeting of ISES is scheduled at 0800 hrs on 30th Oct 2012 at ISR.**
- **A total of 110 members are on roll of ISES.**