Ten days Faculty Internship Program Report

I, Mrs. Rajashri Narayanrao Kulkarni (Asst Professor, DBRAIT, Port Blair) completed my 10 days (3rd June – 12th June 2019) faculty internship in the field of "Liquefaction Assessment of Sands" under the guidance of Prof. Sireesh Saride (Civil Engineering, IIT Hyderabad). This internship report focuses on the work experience that I have gathered as an Internee.

Introduction to Liquefaction

Liquefaction is a phenomenon in which the strength and stiffness of a soil is reduced by earthquake shaking or other rapid loading. Soil liquefaction occurs when a saturated or partially saturated soil substantially loses strength and stiffness in response to an applied stress such as shaking during an earthquake or other sudden change in stress condition, in which material that is ordinarily a solid behaves like a liquid. Liquefaction and related phenomena have been responsible for tremendous amounts of damage in historical earthquakes around the world.

Due to liquefaction there is increase in pore water pressure during undrained shearing causes a reduction in effective stress which in turns reduces the shear strength of soil. The pore pressure generated due to liquefaction is often released through sand or water boils. The soil behaves more like a viscous fluid and heavy structures and light structure may float or damaged or collapse.

On the first day of my internship Prof Sireesh sir introduce me with P.hD. scholar Ms Prinkya and she explained me about liquefaction, what are the different parameters are responsible and shown me the Advanced and electronically controlled cyclic Triaxial Apparatus by using which one can determine the dynamic properties of soil responsible for liquefaction of soils. Next five days she explains me the different test carried out on soil sample and procedure to find out dynamic properties of soil which are given below.

1. **Laboratory tests**

Laboratory tests are usually performed on relatively small specimens that are assumed to be representative of a larger body of soil. The specimens are tested as elements (i.e., they are subjected to uniform initial stresses and uniform changes in stress or strain conditions).
The ability of laboratory tests to provide accurate measurements of soil properties depends on their ability to replicate the initial conditions and loading conditions of the problem of interest. No laboratory test can represent all possible stress and strain paths with general rotation of principal stress axes; consequently, different tests will be most suitable for different problems.

2. **Sampling**

Elements tests are performed on soil specimens. For problem involving the response of soils to be placed as fills, specimens can be constructed from bulk or disturbed samples by simulating the compaction process as closely as possible in the laboratory. Tests on existing soils can be performed on undisturbed or reconstituted specimens. However, in many instances the results will be different between these tests because of differences in soil fabric between natural and reconstituted soil specimens, even when densities and applied stresses are similar.

3. Cyclic Triaxial test

The cyclic triaxial test has been commonly used test for measurement of dynamic soil properties at high strain levels. In the triaxial test, a cylindrical specimen is placed between top and bottom loading platens and surrounded by a thin rubber membrane. The specimen is subjected to a radial stress, usually applied pneumatically, and an axial stress. By virtue of these boundary conditions, the principal stresses in the specimen are always vertical and horizontal.

The difference between the axial stress and the radial stress is called the deviator stress. In the cyclic triaxial test, the deviator stress is applied cyclically either under stress-controlled conditions (typically by pneumatic or hydraulic loaders), or under strain-controlled conditions (by servohydraulic or mechanical loaders). Cyclic triaxial tests are most commonly performed with the radial stress held constant and the axial stress cycled at a frequency of about 1Hz .

As with the static traixial test, the cyclic test can be performed under isotropically consolidated conditions, thereby producing the stress paths the cyclic deviator stress and total stress path for an isotropically consolidated specimen. Isotropically consolidated tests are commonly used to represent level-ground sites where no initial shear stresses exist on horizontal planes. The test begins with zero shear stress and the deviator stress is initially increased. Since the axial stress is then greater than the radial stress, the major and minor principal stress axes are vertical and horizontal respectively. After the deviator stress reaches its maximum value it decreases and approaches a value of zero. Just before it reaches point zero, the major principal stress axis is still vertical, but it rotates instantaneously to horizontal as point zero is passed and the deviator becomes negative. At point zero, no shear stress exists on the specimen. This process of stress reversal repeats itself throughout the test, with instantaneous rotations of the principal stress axes occurring every time the deviator stress passes through zero.

In some cases, the cell pressure is also applied cyclically. By decreasing (or increasing) the cell pressure by the same amount that the deviator stress is increased (or decreased) by, the Mohr circle can be made to expand and contract about a constant centre point. The resulting stress path will then oscillate vertically, much like that shown for the case of vertically propagating s-waves.

Although the stress path of such a traixial test can be made to match that induced by a vertically propagating s-wave, the principal stresses in the triaxial test remain constrained to the vertical and horizontal direction rather than rotating continuously as caused by the s-wave.

The stresses and strains measured in the cyclic triaxial test can be used to compute the shear modulus and damping ratio. The cyclic triaxial test allows stresses to be applied uniformly, although stress concentrations can exist at the cap and base, and allows drainage condition sot be accurately controlled (when the effects of membrane penetration are mitigated). It requires only minor modification of standard triaxial testing equipment. On the other hand, the cyclic triaxial test cannot model stress conditions that exist in most actual seismic wave propagation problems.

On fourth and fifth day of workshop I and Ms. Prinkya performed one test on sand sample and see how the cyclic traixaial test performed and I observed different patterns and loops during the test. Next few days I referred different literature form referred journal on case study of Liquefaction occurred due to earthquake at Bhuj in 2004 and how the failure of different dam in the rejoin of Kachh occurred due to liquefaction after earthquake.

During the literature review me and Prof. Sireesh dicussed on various aspects and problem that are facing in Port Blair, Andaman and Nicobar Island; as Island is coming under zone V which is frequently experiences earthquake. Also how the liquefaction assessment is required for Andaman and Nicobar Island after 2004 Tusanami as there is no too much research and study had been conducted till time. Following are few literature reviewed relevant to Gujrat Earthquake;

1. **Geotechnical Aspects and ground response studies in Bhuj earthquake India**, *by T.G. Sitaram and L. Govind Raju,* ***Geotechnical and Geological Engineering 22: 439–455, 2004.***
   In this paper, the ground response studies at a site in Ahmedabad City along with bservations of geotechnical aspects such as ground cracking, sand volcanoes and liquefaction of soils associated with the Bhuj earthquake are discussed.
2. **Back Analysis of Cahng dam section in the Kachchh region of Gujrat,** *By G.L. Sivakumar Babu, Amit Srivastva, ,****Proceedings of the 17th International Conference on Soil Mechanics and Geotechnical Engineering 2004.***
   In the present study, a typical Chang dam sections located in the vicinity of epicenter is considered for the back analysis using dynamic numerical analysis with the help of commercially available software FLAC 5.0. The software has the capacity to model advanced non-linear constitutive material behavior under dynamic loading along with the pore pressure generation capabilities. The results of the back analysis of the dam section indicated that the presence of liquefiable soil beneath the foundation not only caused large deformation but also modified the failure pattern i.e. from slope to a base type failure, the feature which was also observed during field investigations.
3. **Analysis of stability of earthen dams in kachchh region, Gujarat, India** , *by G.L. Sivakumar Babu ⁎, Amit Srivastava 1, V. Sahana ,* ***Engineering Geology 94 (2007)***
   In this study, it is demonstrated that the probabilistic approach when used in conjunction with deterministic approach helps in providing a rational solution for quantification of safety of the dam and in the estimation of risk associated with the dam construction.
4. **Numerical Analysis of Failure of Rudramatha Dam Section During 26th January, 2001, Bhuj Earthquake,** *by Amit Srivastava,* ***Recent Advances in Geotechnical Earthquake engineering and Soil dynamic, 2010***
   In the present study, a typical Rudramata dam sections located in the Kachchh region is considered for the failure analysis using fully coupled nonlinear dynamic numerical code FLAC 5.0 with pore pressure generation capabilities under dynamic loadings. The analysis is performed using the acceleration – time history record of the Bhuj earthquake developed by Iyengar and Raghukanth (2006) involving analytical procedures. The results of the analysis of the dam section indicated that the presence of liquefiable soil beneath the foundation not only caused large deformation but also

modified the failure pattern i.e. from slope to a base type failure, the feature which was also observed during field reconnaissance.

I successfully completed 10 days faculty internship program in IITH. I express my sincere thanks to my internship guide Prof Sireesh Saride (Civil Engineering, IIT Hyderabad) for providing me the valuable guidance, support, supervision and useful suggestions throughout my internship work. A grateful acknowledgement also goes to TEQIP III for giving me this opportunity. It has been a great learning opportunity for me as well as my professional and research carrier. I also express my sincere thanks to Andaman and Nicobar Administration and Principal DBRAIT, Port Blair for allowing me to avail internship opportunity under TEQIP III. I am also thankful to the Authority of IIT Hyderabad for providing laboratory, library and other facility. I would also like to thank to Ms. Prinkya (PhD Scholar) for her invaluable suggestion, helpful discussion and never ending support with lab work in a very positive environment.

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