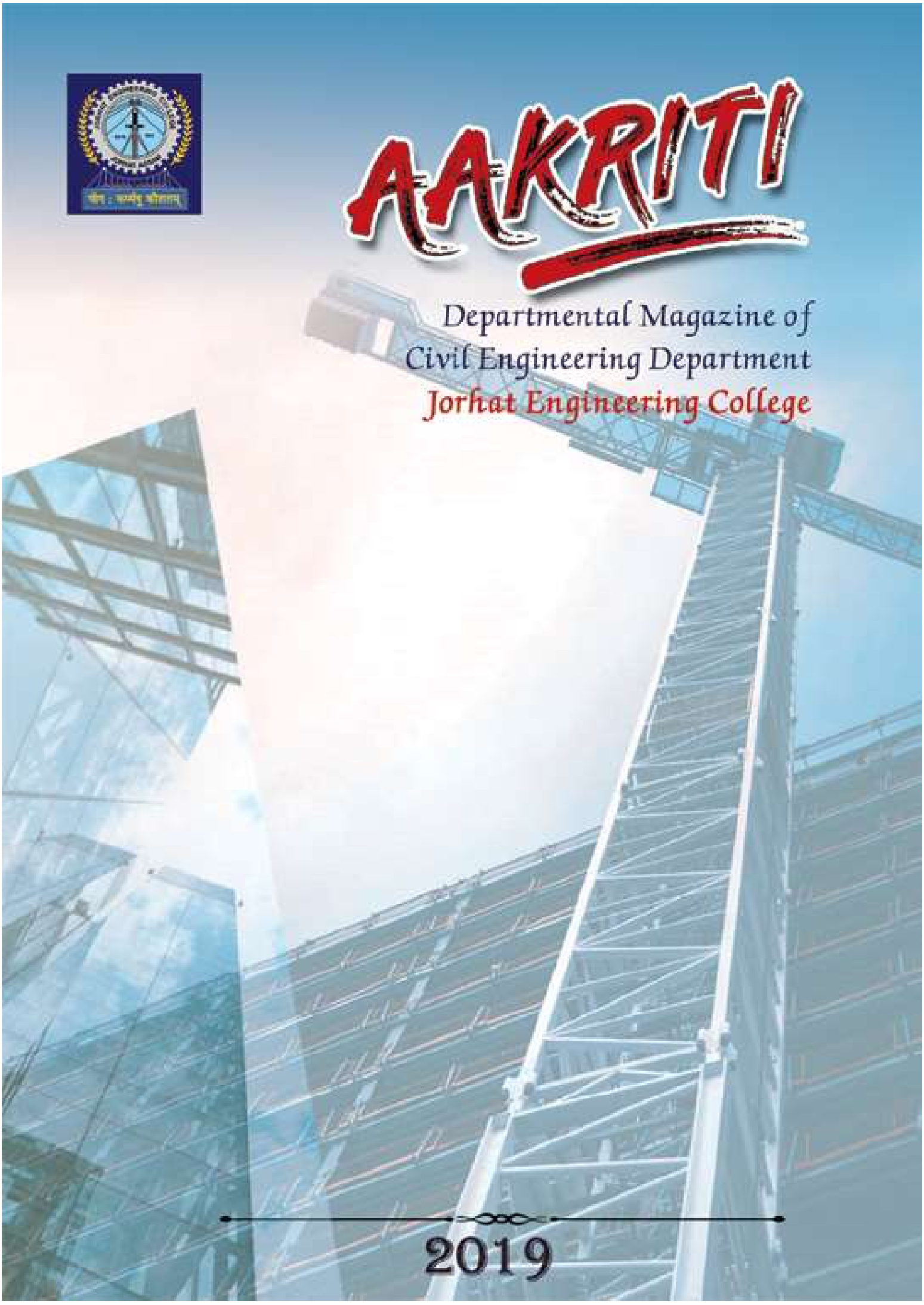

AAKRITI

Departmental Magazine of
Civil Engineering Department
Jorhat Engineering College

2019

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Aakriti

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বিভাগীয় সংগীত
(DEPARTMENTAL ANTHEM)

সুৰ আৰু কথা ঃ ড° অৰূপ কুমাৰ শর্মা
প্রাক্তন ছাত্র, অসামৰিক অভিযান্ত্রিক বিভাগ,
যোৰহাট অভিযান্ত্রিক মহাবিদ্যালয়

ঊনৈচশ যাঠিৰ শুভলগনত
পূৰ ভাৰতৰ যোৰহাট চহৰত
মংগলধ্বনিৰে বাজি উঠিছিল
প্রগতিৰথৰ সংকেত ঘণ্টা,
অভিযান্ত্রিক সাধনাত নামিছিল
অসামৰিক শত অভিযন্তা।

মহাকাশৰ ন-প্রযুক্তিৰে
ধৰাৰ বুকু জৰীপ কৰি
প্রগতিৰ নক্সা আঁকো,
দুর্বল মাটিও সবল কৰি
পাহাৰ নদীৰ বাধা নেওচি
পৰিবহণৰ সাজো সাঁকো
যুগমীয়া হয় যাতে
অভিনৱতাৰ এই যাত্রা
আমি অসামৰিক অভিযন্তা।

দূৰদর্শী চিন্তাধাৰাৰে
আন্তঃগাঁথনি সজাই
কত কিযে নির্মাণ কৰোঁ
বলিয়া বানৰ দুর্যোগ নাশি
জলসম্পদ প্রয়োগেৰে –
সেউজীয়া পথাৰ গঢ়োঁ,
সুন্দৰ নিৰাপদ
পৰিবেশৰ আমি স্রষ্টা
আমি অসামৰিক অভিযন্তা।।

Vision of the department

Development of quality human resources for sustainable industrial and societal growth through excellence in technical education and research.

Mission of the department

- To impart quality technical education at UG, PG and PhD levels through good academic support facilities.
- To provide an environment conducive to innovation and creativity, group work and entrepreneurial leadership.
- To develop a system for effective interactions among industries, academia, alumni and other stakeholders.
- To provide a platform for need based research with special focus on regional development.

Dr.(Mrs) Reeta Sarmah
Principal
Jorhat Engineering College
Jorhat-785007

MESSAGE OF GOODWILL

"AAKRITI" is something which has a definite form or shape. The department of Civil engineering has taken an appreciable step choosing the beautiful name "AAKRITI" because the civil engineering itself serves for planning, designing, building and transforming into final "AAKAR". The contents of "AAKRITI" will definitely be able to enchant the readers and associated stakeholders and it will turn into "AAKRISTA" in subsequent days.

Finally, I like to offer my thanks to the Head of Civil Engineering Department and the publication committee for sincere effort to bring out this issue in an innovative way.

Dr. Prasanna Kumar Khaund
Professor and Head of The Department
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MESSAGE FROM THE DESK OF THE HEAD OF THE DEPARTMENT

This is a proud moment for me for the maiden issue of our Civil Engineering Departmental magazine, "AAKRITI". A departmental magazine is a must for showcasing the departmental achievements before the stakeholders and I hope this maiden issue will set a tradition in this regard. I offer my thanks to the editorial board for taking the pain of giving a shape to this magazine, which will set as a benchmark for future.

I am also thankful to each faculty and students who are directly or indirectly involved in framing the maiden issue.

From the

Editorial Board

This is a proud moment for the members of this board to be a part of the process of bringing out the maiden issue of the departmental magazine, ***Aakriti.***

The conceptualization of this magazine was an organic process involving all members of the JEC Civil Family- faculty members, staff and students alike. The name itself was product of brainstorming of all the stakeholders. The cover design was a sole effort of the most important stakeholders, the students. As the most promising part of the department, students put their heart into this maiden venture and made the content vibrant with their budding contribution.

The editorial board acknowledges with gratitude, the cooperation of the faculty members and student community, in the process of bringing out the maiden issue of *Aakriti*. The board also conveys heartfelt thanks to the contributors of this volume.

The editorial board hopes that the readers will point out the inadvertent omissions and make the future ventures even better.

Department of Civil Engineering :

An Overview

The department of civil engineering is the department with which Jorhat Engineering College was started in 1960. The intake of the department at present is 75. Presently department has seven Laboratories — Hydraulics, Concrete, Soil Mechanics, Environmental Engineering, Transportation Engineering, Computational, Geology & Remote Sensing laboratory, Structural and Vibration laboratory. The department has its own Library enriched by updated books on all disciplines. In 2013 the department started its sole P.G. course in "Design of Civil Engineering Structures". The various heads who led the department from the front is as tabulated here:

Name	**Tenure**
Late Prof S D Phukan	1962-1976
Late Prof P K Bora	1976-1982
Late Prof S D Phukan	1982-1988
Prof. Rajagopalan Ayyaswamy	1988-1995
Prof. Deheswar Deka	1995-2000
Prof. Bibeka Nanda Choudhury	2001-2013
Prof. Prasanna Kumar Khaund	2013-present

Civil engineering dept has rendered consultancy services to central and state government departments such as PWD, Irrigation, Water resources Dept, MES, Indian Air Force, Indian N. F. Railways railway in addition to PSUs like ONGC, OIL, IOC, AAI, Power Grid Corporation among others. The department acted as State Technical Agency (STA) for Assam, Arunachal Pradesh, Nagaland for PMGSY under NRRDA, Govt of India for the states of Arunachal Pradesh and Nagaland since 2001. It has rendered its services for quality control of NRHM's hospital buildings and also to the World Bank funded Neer Nirmal Poriyojana under PHED(Assam). The department has organized more than ten one week trainings for engineers working for PMJSY schemes. This department has been arranging technical talks, short term programmes from time to time in its effort to provide continuing education to the engineers of Assam and north eastern India, Industry towards technical education in general.

In December in Dec 21-22, 2018 the department arranged the ***1st International Conference on Infrastructure Development*** (ICID-2018),which was the first of its kind for the college.

The department has so far organized three short term courses under AICTE-NEQIP,

(i) Recent Advances In Civil Engineering, 27-32 August, 2018

(ii) Recent Advances In Civil Engineering, 8-12 Dec.2015

(iii)Disaster Management, 9th-13th January, 2015

The department has organized numerous technical talks in recent past under the funding of TEQIP-II by leading lights for the benefit of UG students.

(i) One day talk on *Finding Fulfilment in Life* by Prof Devdas Menon, IIT Madras, 1st Sept, 2018

(ii) One day talk on *Problems and Prospects of Inland Water transport in Assam,* by Musfikur Rahman, Joint Director, Inland Water Transport, Assam, 18th August, 2018

(iii) One day talk on *Planning Design and Construction of Bridges and Culverts*, by Mr. BhudebSarma, AEE, PWD, 11th August, 2018

(iv) One day talk *on Alternative Building Materials and Technology* by Dr. Sanjay Deuri, Scientist CSIR, NEIST , Jorhat with departmental resource persons, 9th June, 2018

(v) Two Days talk on *River Erosion Control With Special Reference To North East India,*by Prof Arup Kumar Sarma with departmental resource person, IIT Guwahati, 1-2 June, 2018

(vi) Talk on *Overview of a Building Construction Project* by Experts from Oil India Limited, Duliajan, covering part of syllabus for 5th Semester Students

(vii) Talk on *Planning and Implementation of Construction work in E&P Industry* by Experts from Oil India Limited, Duliajan, covering part of syllabus for 7th Semester Students

In addition to these depart organized one day talks with faculty members as resource persons. Some of these talks are: *Advanced Surveying and Intelligent Transportation System", Alternative building materials and Technology, Earthquake Engineering: Codal Provisions and Practices, River Erosion Control with special reference to North East India.*

CONTENTS

TEACHERS' CORNER

TEACHERS' CORNER

ELECTRICAL RESISTIVITY TEST: AN EASY, FAST AND ECONOMIC ALTERNATIVE TO CONVENTIONAL DIRECT METHODS OF SUB-SOIL INVESTIGATION

Mr. Rituparna Goswami
Assistant Professor
Civil Engineering Department
Jorhat Engineering College

As Civil Engineers, we all are aware of the fact that Sub-Soil Investigation work is an essential pre-requisite for any kind of infrastructural development work. The most common practice in this regard is conducting direct exploration of the sub-soil at the site of proposed construction by physically exposing the sub-surface up to the desired depth. The whole process also includes conducting of field tests at various depths wherever applicable, as well as collecting of disturbed and undisturbed sample of different layers of the sub-soil for onward laboratory testing. Without divulging into details about the procedure of the field tests, one thing can be said that most of these tests are devised to estimate the in-situ density and thus the strength of sandy deposits below the ground surface. The most popular and common types of such field tests are Standard Penetration Test and Dynamic Cone Penetration Test. The necessity of conducting in-situ estimation of strength of sandy deposit using these field tests has arrived from the fact that undisturbed sampling of such soil is next to impossible and disturbed sand sample has no use other than serving identification purpose. However some other field tests are used to estimate the in-situ strength of cohesive deposit, namely Static Cone penetration Test.

This conventional practice of SSI, that is discussed so far; however gets challenged at some sites and situations due to logistical as well as time and financial constrains. To elaborate on this comment; let us take a situation of construction of RCC bridge over a waterway on a proposed extension of roadway in a hilly terrain. As the situation suggests, the possibility of conducting direct exploration using light weight, easily maneuverable wash boring set-up will be highly unlikely. In a hilly terrain; presence of fragmented rock, sand stone etc. within the sub-soil; make it impenetrable using wash boring technique. Also, since the access to the site via roadway is only in the proposal state;

hence the option of transporting lorry mounted heavy drilling rigs etc., capable of exposing such hard sub-soil; does not arise. In addition, such exercises are expensive and time consuming, which may also not be viable financially or otherwise. This type of situation demands out-of-the box solutions. One such option is to employ indirect techniques of Sub-Soil Investigation at the site and then use the available correlations of the properties thus evaluated with the strength (bearing capacity) of the explored sub-soil layers.

The basic operating principle of the two most common types of indirect methods of SSI is that the sub-soil is sounded from the ground surface without physically exposing it by means of propagating electrical current or artificially generated seismic waves in to it. Accordingly the two methods are called Electrical Resistivity Method and Seismic Refraction Method respectively. The Seismic refraction method is normally used for sounding for mineral deposits at very great depths below the ground surface, and hence is beyond the scope Geotechnical Engineering. Rather, this technique is more useful for geological exploration of deep earth.

The more relevant type of indirect sounding method that can be used to explore the immediate sub-soil, with an engineering perspective is the electrical Resistivity method. In this method, electric current is made to flow below the ground through a pair of current electrodes by creating potential difference between two potential electrodes, all spread over the ground; connected by a closed circuit with a battery source. The depth of flow of current below the ground is roughly equal to half the distance between current electrodes, spread over the ground. Thus by increasing the spread of the current electrodes, the current can be made to flow through deeper and deeper strata gradually. By recording the magnitude of current (I) and the corresponding potential difference (E) for each spread of electrodes; the corresponding resistance (R= E/I), and hence the Resistivity offered by the sub-soil layer (through which the current is flowing) may be estimated. Resistivity of any material is defined as resistance between opposite faces of a unit cube of that material, expressed in Ohms-m. Resistivity is a unique property of any soil/rock layers, that is directly related to the degree of compactness of the layered deposit. Compactness again defines the in-situ strength of any layer, especially granular soil and/or rock deposits. This fact is exploited to arrive at a correlation between the Resistivity value recorded for any underlying layer and the composition of that layer, i.e.; the type of soil/rock the layer is composed of. Once the type and composition of any layer is established, its in-situ strength in terms of bearing capacity can easily be estimated using any of the correlating system as is applicable.

There are three different patterns of spreading the potential and current electrodes over the ground to explore the sub-soil, namely Warner Arrangement, Lee Arrangement and Schlumburger Arrangement as illustrated in the figure below. Out of these three, the

Schlumberger one is the simplest and more reliable, and hence is popularly adopted for Sub-surface exploration.

In the Schlumberger type of arrangement, the spacing between potential electrodes is kept at a fixed distance apart and the current electrodes' spacing is gradually increased to probe deeper and deeper strata.

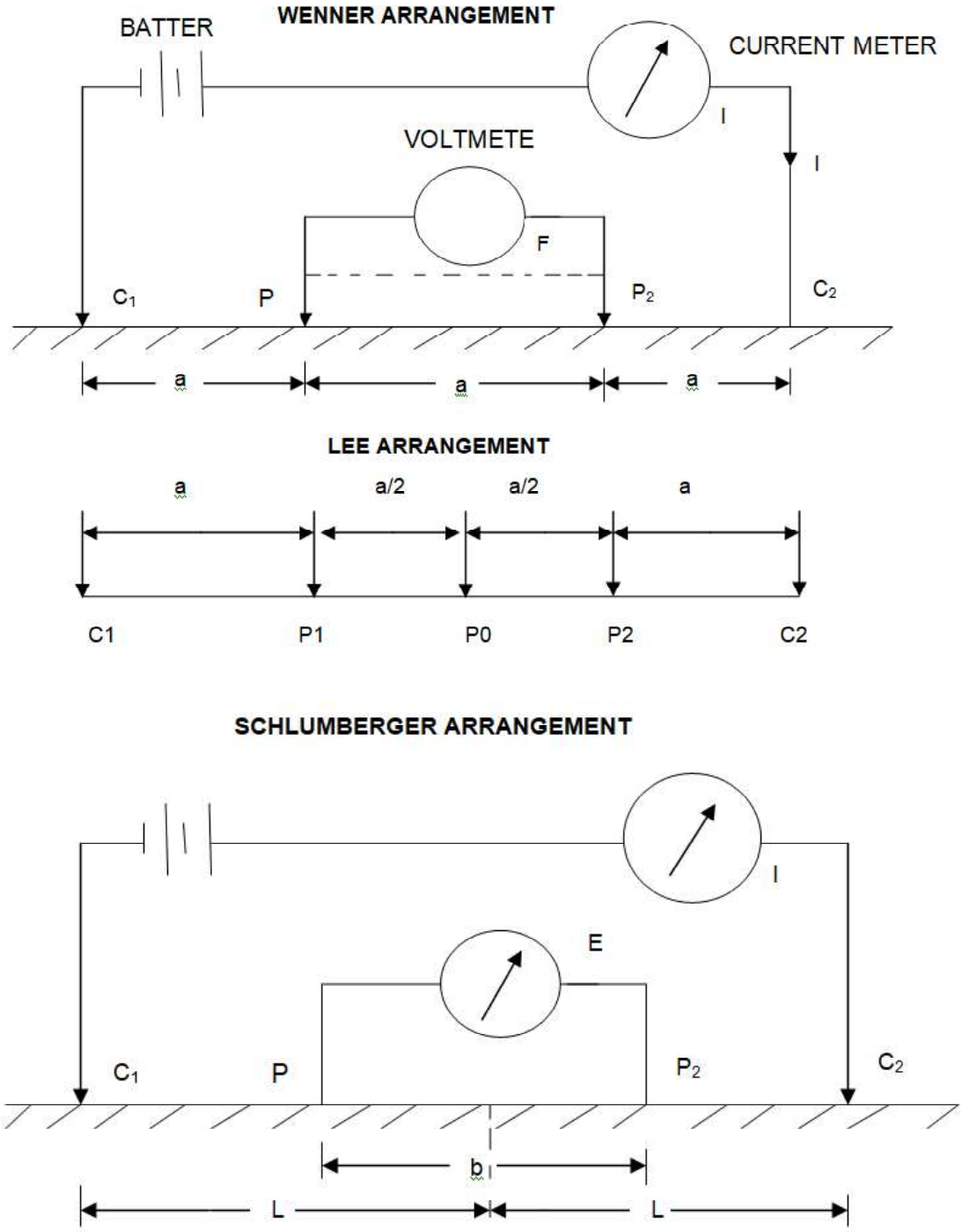

Fig. 1: Schematic Diagrams of Placement of Electrodes for different Test arrangements

The value of resistivity (ρ), expressed in ohm-m, while using the Schlumberger arrangement of electrode spacing, can be calculated as under;

Resistivity (ρ) = $\pi.B \times [(L/B)\,2 - ¼].R$

Where, L: - Distance of each current electrode from the centre of spread (varying), in meter.

B: - Spacing between potential electrodes (constant), in meter.

& R: - Resistance in the circuit, in ohms = E/I

Also, E: - Potential drop across the circuit, in Volts.

& I: - Corresponding current circulating in the circuit, in Amps.

In this set-up, normally the value of 'B' is kept equal to 1m and the value of 'L' is kept increasing from 2m onward so as to attain a probing depth of roughly 0.5L below the existing ground surface. Once the depth wise Resistivity of the Sub-Soil layers that is sounded for, is obtained and recorded; these values are correlated with the tentative soil/rock types encountered at corresponding depths. For this purpose, established correlation table as presented in I.S. 1892, 1979 (Appendix B, Cl. B-2.1.2) is generally adopted. The values are reproduced as under for ready reference.

Table 1: Range of Resistivity values for different Soil/Rock layers

MATERIAL	MEAN RESISTIVITY, in Ohm.m
Limestone (Marble)	10^{12}
Quartz	10^{10}
Rock salt	10^{6} – 10^{7}
Granite	5000 – 10^{6}
Sandstone	35 – 4000
Moraines	8 – 4000
Limestone	120 – 400
Clays	1 – 120

After the depth wise soil profiling is established, the corresponding presumptive bearing capacity of the different layers/types of the sub-soil encountered up to the desired depth can be estimated from IR standard Code of Practice for the Design of Sub-Structures

and Foundations of Bridges, 2nd Rev., 2013 (Table 6). This way, a lump-sum estimate of the load carrying capacity of any sub-structure, proposed to be laid at a given depth below existing ground level; can be made by taking the av. of the presumptive bearing capacity of all the sub-soil layers lying below the foundation within its significant depth.

All said and done, however; since this method only yields rough estimate of load carrying capacity of any foundation, without taking into consideration the effects of foundation characteristics and also soil characteristics; hence it has to be practiced in most unavoidable circumstances only. Also, the bearing capacity estimated from this method is only corresponds to shear failure only and settlement calculation has to be made separately. ❖

HYDROLOGIC MODEL INEVITABLE FOR DATA-SCARCE REGION

Mr. Pulendra Dutta
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Jorhat Engineering College

The natural flowing watercourse is usually termed as a "River". It normally originates in hill or mountain, traverses several kilometers and finally merges into an ocean, sea, lake or another river. Rivers are found on every continent and on nearly every kind of land. Some flow all year round whereas the others flow seasonally or during wet years. "Nile", the world's longest river travels through several countries. Even the Brahmaputra is a transboundary river which travels through three countries viz. China, India and Bangladesh. Thus the river basin encompasses huge area consisting of variety of features on the ground. As such, the study of a river basin should essentially incorporate all components such as engineering, hydro-meteorological, social, ecological etc. within its boundary. This would lead to proper estimation of parameters required for water resources management.

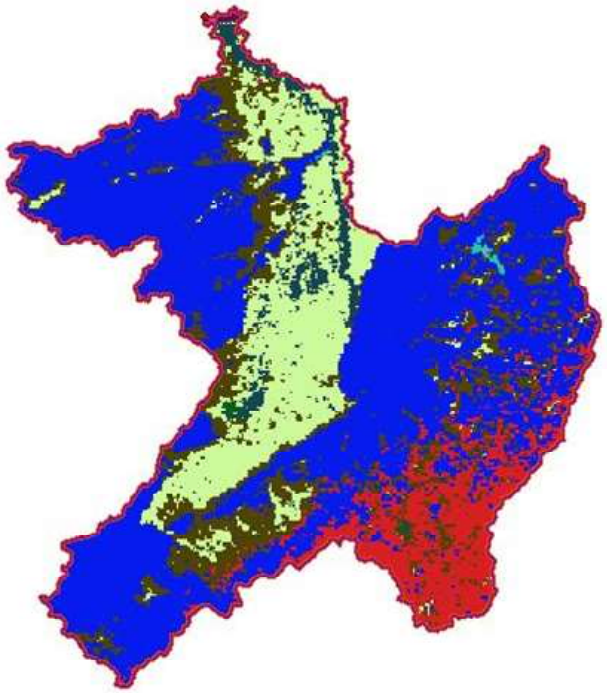

Fig 1. Dhansiri River Basin

Water resources are the sources of water that are potentially useful to humans. It is important because it is needed for life to exist. Many uses of water include agricultural, industrial, household, recreational and environmental activities. Water resource management is the activity of planning, developing, distributing and managing the optimum use of water resources. Ideally, water resource management planning has regard to all the competing demands for water and seeks to allocate water on an equitable basis to satisfy all uses and demands.

Understanding the basin hydrology is an important aspect of river basin management. Efforts should be made to have a comprehensive management policy of river so as to achieve utmost utilization of the natural water resources. The development of river management policy of a river basin essentially requires the hydro-climatic variables which include weather data, discharge data, water quality parameters, sediment parameters etc. But the challenge of water resource schemes lies in obtaining accurate ground observations. Although the hydrological models can serve this purpose, they require adequately accurate climate (temperature, rainfall, evaporation, etc.) input information. Out of all the weather components, rainfall is the main driving variable to widely impact the results of hydro-climatologic studies. The planning of water resource schemes depends on rainfall characteristics especially the variability and trend as well as a reliable rainfall intensity-duration-frequency (IDF) relationships. In large parts of the world, however, the observed precipitation records are often scarce, discontinuous and frequently contain discrepancies, particularly in the developing and under-developed countries. In cases longer records are available in certain gauge observations; they fail to provide a reliable spatial depiction. Even proper records of other parameters such as hydrology, hydraulics and basin characteristics are hardly obtained in most of the countries.

In the event of non-availability of ground records of basin parameters, the hydrological model can advantageously be used to provide the information helping to plan and design the water resources schemes. This is possible through the use of satellite-based input data available at several global sources. The satellite data can be fed into watershed model which would provide the output information regarding discharge, sediment, water quality etc. Due to the advancement of computer software, a lot of tools are presently available to model a river basin. Some of these tools are SWAT (Soil and Water Assessment Tool), VIC (Variable Infiltration Capacity) model, HEC-RAS (Hydrologic Engineering Centre—River Analysis System). These tools are made much capable to provide the information required for river basin management schemes. In the absence of the observed records, these hydrologic models can at least provide the science-based elements helping water resources managers. ❖

HYDRO-POWER POTENTIAL IN INDIA WITH A SPECIAL REFERENCE TO NORTH-EAST

Dr. P. K.Khaund
Professor & Head
Civil Engineering Department

Water resources are sources of water which can be potentially used for agricultural, industrial, power generation, domestic use, environmental and recreational activities. 97% of the total global water is saline water. Out of 3% of the fresh water available on the earth, 69% of it is in ice and glaciers and 30% is groundwater and all lakes, rivers and swamps combined only 0.3% of total freshwater.

India has about 4% of world's freshwater resources ranking it among the top ten water rich countries. Despite this, due to climate change and rapid growth of population leads India a 'water stressed region' with current utilisable fresh water standing at 1122 cubic metre per year and per capita compared to international standards of 1700 cu.m. It is expected that in future India will be declared as 'water scarce region' if utilisable fresh water come down to below 1000 cu.m per year per capita.

India, with a geographical area of about 329 M.ha, is a land of many mountains and rivers. Physiographically, India may be divided into seven well defined regions. These are:

i. The Northern Mountains comprising the mighty Himalayan ranges;
ii. The Great Plains traversed by the Indus, Ganga and Brahmaputra river systems;
iii. The Central Highlands, consisting of a wide belt of hills running east-west between the Great Plains and the deccan plateau;
iv. The Peninsular Plateaus;
v. The East Coast, a belt of land of about 100-130 km wide, bordering the Bay of Bengal;
vi. The West Coast, a narrow belt of land of about 10-25 km wide, bordering the Arabian Sea;

vii. The islands, comprising the coral islands of Lakshadweep in Arabian Sea and Andaman and Nicobar group of islands in the Bay of Bengal.

As per the annual report (2013-2014), CWC, the water resources potential of India, which occurs as a natural runoff in the rivers is about 1869 Billion Cubic Meters (BCM). It constitutes a little over 4% of the total river flows of the world. However, due to various constraints of topography and uneven distribution over space and time, only about 1121 BCM of the total annual water potential can be put to beneficial use. This can be achieved through 690 BCM of utilizable surface water and 431 BCM through ground water. The ultimate irrigation potential of the country is estimated as 139.9 m ha. out of which irrigation potential from major and medium irrigation projects is assessed as 58.47 m ha.

For the purpose of planning and development, the entire country has been divided into different river basins as shown in the Table 1 below:

Table 1: Different river basins of India

River basins	Catchment area (km^2)	Average annual potential (km^3)	Utilisable surface water resources (km^3)
Indus up to boarder	321289	73.31	46.00
Ganga	861452	525.02	250.00
Brahmaputra, Barak & others	194413	585	24
Godavari	312812	110.54	76.3
Krishna	258948	78.12	58.0
Cauvery	81155	21.36	19.00
Subernarekha	29196	12.37	6.81
Mahanadi	141589	66.88	49.99
Pennar	55213	6.32	6.82
Mahi	34842	11.02	3.10
Sabarmati	21674	3.81	1.93
Narmada	98796	45.64	34.50
Tapi	65145	14.88	14.50
WFR from Tapi to Tadri	55940	87.41	11.94
WFR from Tadri to Kanyakumari	56177	113.53	24.27
EFR between Mahanadi & Pennar	86643	22.52	13.11
EFR between Pennar & Kanyakumari	100139	16.46	16.73
WFR of Kutch & Saurashtra including Luni	321851	15.10	14.98
Minor Rivers draining into Myanmar & Bangladesh	36202	31.0	Not applicable
Total		**1869.35**	**690.31**

Hydro Power Scenario in India:

The first hydroelectric power station implemented in India was Sidrapong at Darjeeling and was completed in 1897 and is still in operation. India is the 7th largest producer of hydroelectric power in the world and ranking 3rd worldwide in the total numbers of dams. India's hydro power potential is estimated at 84,000 MW at 60% load factor. In 2014-2015, the total amount of hydro power generated in India is 129 x 10^6 MWH. As on 31st March 2016, India's installed utility scale hydroelectric capacity was 42,783 MW or 14.35% of its total utility power generation capacity. Additional smaller hydro power units with a capacity of 4274 MW have been installed.

As per assessment made by CEA, future estimated installed capacity in coming years in India would be 1, 48,700 MW. Out of which 33,832 MW from Indus basin, 20,711 MW from Ganga basin, 4152 MW from Central India river system, 9430 MW from Western flowing rivers of Southern India, 14,511Mw from Eastern flowing rivers of South India and 66,065 MW from Brahmaputra basin. In addition, 56 nos. of pumped storage projects have also been identified with probable installed capacities of 94,000 Mw. Additional 6782 MW has been estimated from all small, mini and micro schemes and thereby total estimated hydro power in India will be 2,50,000MW. The major dams presently generating hydro power in India are tabulated in Table 2.

Hydro Power potential in North-East India:

The North-Eastern (N-E) Region, comprising Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura has a huge hydro potential. According to the estimates prepared by NEEPCO, the north-eastern region has the potential of about 58971 MW hydro power i.e. almost 40% of the country's total hydro potential; but out of this only less than 2% (1095MW) has so far been harnessed. As per the report status of hydroelectric power potential listed by Central Electricity Authority (CEA) out of the total capacity of 58971MW, only 4029 MW has been tapped, which amounts to less than 7%.

Among the NE states Arunachal Pradesh is the richest in hydroelectric power potential. In fact with an estimate of 27000 MW the state ranks first in the country in terms of hydroelectric power potential. The state also has the highest number of high head mini and micro hydel projects in India. The state has 37 power plants ranging from 5KW to 4500 KW with a total installed capacity of 23.8 MW and firm power of 16.5 MW. Another 21 project with total installed capacity of 76.25 MW are in different stages of implementation.

Table 2: Hydro Power in India

Sl.No.	Dam	River	Height	Length	Type	Storage capacity	Catchment area	Power Generated
1.	Tehri dam (Tallest dam in India)	Bhagirathi, Uttarakhand	260.5 m	575 m	Earth and rock fill	4.0 km^3	52 km^2 (surface area)	i. Tehri dam & hydropower = 1000MW ii. Kotesha Hyd. Elect. Plant = 400MW iii. Pumped storage = 1000MW Total = 2400MW
2.	Bhakra Nangal	Sutlej river (Himachal Pradesh)	226.0 m	520 m	concrete gravity dam	9.34 BCM Gobin Sagar Reservoir(2^{nd} largest in India)	168.35 km2	i. 5-units x108 = 540MW ii. 5-units x157 = 785MW Total = 1325 MW
3.	Koyna Dam	Koyna Maharashtra	103.33m	807.1m	Rubble concrete	2.8 MCM	891.78 km2	1st stage = 280MW, 2nd stage= 320MW Dam foot = 2 x 20 =40MW 3rd stage= 320MW, 4th stage =1000MW Total = 1960 MW
4.	Srisailam Dam	Krishna (Telangana)	145 m	512 m	Concrete gravity dam	6048 MCM	206,040 km2	Turbine left=6x150=900MW Turbine right = 7x110 = 770 MW Total = 1670 MW

5.	Nathpa Jhakri dam	Sutlej river (Himachal Pradesh)	67.5 m	185 m	Concrete gravity dam	3430 MCM		6-units x 250 MW = 1500 MW
6.	Sardar Sarovar Dam	Narmada (Gujarat)	163 m	1210 m	Concrete gravity dam	9500 MCM	88,000 km2	1450 MW
7.	Indira Sagar Dam	Narmada (Madhya Pradesh)	92 m	653 m	Concrete gravity dam	12000 MCM		8-units x 125MW = 1000MW
8.	Hirakud Dam (Longest dam)	Mahanadi Orissa	60.96 m	25.8 km	Composite structure of earth,concrete concrete and masonry dam	5896 MCM	83,400 km2	347.5 MW
9.	Nagarjuna Sagar dam	Krishna Andhra Pradesh	124 m	1550 m	Masonry dam	11560 MCM	215,000 km2	816 MW
10.	Idukki dam	Periyar (Kerela)	168 m	366 m	Concrete arch dam	1996 MCM	649.3 km2	780 MW

Ranganadi Hydel Power project with a total installed capacity of 405 MW, Kameng Hydro Electric Power Project (600MW), Subansiri Hydro Electric Power Project (4500 MW), Siang Hydro Electric Power Project (2000MW) and Damwe Hydro Electric Power Project (600MW), are the important projects in the state under NEEPCO, Brahmaputra Board and Central Water Commission.

Assam has also huge potential for development of the power sector based on hydel power. But there exists a big gap between availability and demand for power in the state. Assam accounted for only a small fraction i.e. 0.16 per cent of the total generation of electricity in the country during 2000-2001. On the contrary, consumption of power in the state has been increasing in the recent years. The installed capacity of power has remained the same at 574.4 MW since 1997-98 till date. The power generation in the state has gradually declined from the year 1996-97 and this downward trend continued till 2002-2003. The ASEB has six installed projects with the total installed capacity of 574 MW against the peak demand of 621 MW. The power supply position in the state is expected to improve considerably in the coming years with the materialization of projects under the state sector like Borgolai Thermal Power project (120 MW), Karbi Langpi Project (100 MW) and Amguri Combined Cycle Gas Based project (90 MW). In the Central sector, NEEPCO has installed and commissioned Kopili HEP (250 MW) and Kathalguri Gas Based Power Project (291 MW). NEEPCO is currently taking up construction of Kopili 2nd stage (25 MW) and it plans to take up the Lower Kopili (150 MW).

The state of Manipur having plenty of hydropower potential (about 2000 MW) but still, Manipur is a power deficit state and majority of the power requirement is imported from external sources. Manipur, at present has two small hydro projects and twenty-two diesel projects with a total installed capacity of about 10 MW and the total power availability, including share of power from central sector, is about 48 MW only. Against this, the peak demand is estimated to be approximately 129 MW; there is shortage of more than 50 per cent of the total requirement. Under the central sector, there is one hydel project – Loktak HEP with installed capacity of 105 MW.

Although Meghalaya is rich in thermal plant due to the availability of coal; still Meghalaya has a total of five installed projects (hydel) with total installed capacity of 185.20 MW. Against the total installed capacity, the peak requirement is 94 MW Thus, at present, there is no shortage of power in Meghalaya. Accordingly, to meet the requirement of the state as well as for selling to other states, Laiska Hydro Electric Power project of 54 MW has been proposed under the state plan.

Despite having a rich potential in hydro, Mizoram is also not having its own

power generation worth mentioning. At present, there are 22 isolated diesel power stations installed capacity of 26.14MW scattered at various places and 9 mini/micro hydel stations with capacity of 8.25MW in operation against the restricted peak load demand of more than 110 MW.

In Nagaland, out of requirement of 42 MW of power, Micro hydel stations and diesel stations generate 4.26 MW. Therefore the whole requirement of power is purchased from central sector projects like NHPC and NEEPCO. The allocation from NHPC and NEEPCO for Nagaland is only 25 MW. To meet up the demand, presently the Department of power, Nagaland, has taken up a 24 MW heavy fuel based Thermal Power station at Dimapur besides preparing for a 120MW multipurpose hydel power project at Dikhu and a mega HEP (around 300MW) at Tizu-Zingki.

Sikkim, with its hilly landscape and amazing terrain with high current river system, has a huge hydro power potential. With the liberalized power policy Sikkim is poised to gain in a big way. With the opening of this sector for private developers, Sikkim can look forward for developing and exploiting its huge hydro power potential, which has been assessed to 8000 MW peak with a firm base of 3000 MW. At present the total installed capacity under Energy and Power Department is 35.70 MW generated from 12 micro, mini and small power houses.

In Tripura, the power and energy scenario is not satisfactory. At present, the state has a total of five installed projects under the state sector (two hydel, two thermal and a diesel) with total installed capacity of 85.35 MW. Under the Central Sector, NEEPCO has commissioned the 84 MW Agartala Gas Turbine Project and are going to set up some other thermal projects.

Conclusion:

Development of the Northeast is receiving priority attention of the Government of India as a vital link in the development of economic relations with neighboring countries, especially in the context of the 'Look East Policy'. All the states should take attention to the proper utilisation of hydel power potential. But simultaneously sufficient measures should be taken thinking the probable disaster at downstream. All hydel power stations should be eco-friendly. Although there is a lot of dispute on undergoing Subansiri project at Garukamukh, but care should be at downstream of Subansiri River as the river bank soils are quite sandy in nature and easily erodible. During release of water after three for running years there is a possibility of severe erosion at downstream if proper measures are not taken. Possibility of structural failure of the dam is very low as it is designed considering seismic accelerating coefficient of 0.5. Design has been checked by different expert committee at different level. Instead of protest against the dam, there

should be a demand for more power share for Assam and more protective measures at downstream. We must accept in modern age that, "No power, no development". ❖

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HYPERLOOP AS A MODE OF TRANSPORTATION

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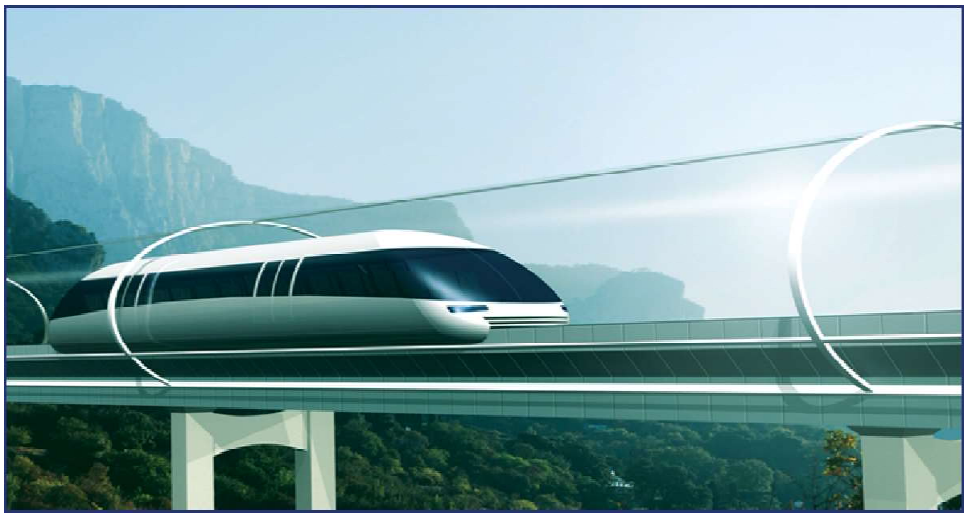
Introduction



Hyperloop is a very new concept of transportation. Hyperloop is a 5th generation medium of transportation. It could see passengers travelling at over 700 miles an hour in floating pod which races along inside giant low-pressure tubes, either above or below ground. Many companies are working on its development.

There are two big differences between Hyperloop and traditional rail. Firstly, the pods carrying passengers travel through tubes or tunnels from which most of the air has been removed to reduce friction. This should allow the pods to travel at up to 750 miles per hour.

Secondly, rather than using wheels like a train or car, the pods are designed to float on air skis, using the same basic idea as an air hockey table, or use magnetic levitation to reduce friction.

Supporters argue that Hyperloop could be cheaper and faster than train or car travel, and cheaper and less polluting than air travel. They claim that it's also quicker and cheaper to build than traditional high-speed rail. Hyperloop could therefore be used to take the pressure off gridlocked roads, making travel between cities easier, and potentially unlocking major economic benefits as a result. A number of different

companies are working to turn the idea into a functioning commercial system.

Hyperloop technology is still in development even though the basic concept has been around for many years. At the moment, the earliest any Hyperloop is likely to be up and running is 2020 but most services are expected to be later, as trials of the technology are still in their early stages.

Where will Hyperloop services run?

It's still not clear where Hyperloops will actually be established but a number of companies have sketched out routes in the US, Europe, and elsewhere. Potential routes include New York to Washington DC, Pune to Mumbai, Kansas City to St Louis, Bratislava to Brno, Vijaywada and Amaravati, and many more.

History of Hyperloop

The idea of using low-pressure or vacuum tubes as part of a transport system has a long heritage. The Crystal Palace pneumatic railway used air pressure to push a wagon uphill (and a vacuum to drag it back down) way back in Victorian south London in 1864. Similar systems using pneumatic tubes to send mail and packages between buildings have been in use since the late nineteenth century, and can still be seen in supermarkets and banks to move money around today.

One clear predecessor of the Hyperloop is the 'vactrain' concept developed by Robert Goddard early in the twentieth century; since then, many similar ideas have been proposed without much success.

However, it was entrepreneur Elon Musk who really reignited interest in the concept with his 'Hyperloop Alpha' paper in August 2013, which set out how a modern system would work — and how much it would cost.

In his Hyperloop Alpha paper, Musk set out the case for a service running between Los Angeles and San Francisco, which would be cheaper and faster than a proposed high-speed rail link. He argued that his Hyperloop could be safer, faster, more affordable, weather-proof, self-powering and less disruptive to people living along the route.

Working of a Hyperloop tube

The basic idea of Hyperloop as envisioned by Musk is that the passenger pods or capsules travel through a tube, either above or below ground. To reduce friction, most but not all of the air is removed from the tubes by pumps.

Overcoming air resistance is one of the biggest uses of energy in high speed travel. Airliners climb to high altitudes to travel through less dense air; in order to create a similar effect at ground level, Hyperloop encloses the capsules in a reduced-pressure tube, effectively allowing the trains to travel at airplane speeds while still on the ground.

In Musk's model, the pressure of the air inside the Hyperloop tube is about one-sixth the pressure of the atmosphere on Mars (a notable comparison as Mars is another of Musk's interests). This means an operating pressure of 100 Pascals, which reduces the drag force of the air by 1,000 times relative to sea level conditions, and would be equivalent to flying above 150,000 feet.

Hyperloop capsules

The Hyperloop capsules in Musk's model float above the tube's surface on a set of 28 air-bearing skis, similar to the way that the puck floats just above the table on an air hockey game. One major difference is that it is the pod, not the track that generates the air cushion in order to keep the tube as simple and cheap as possible. Other versions of Hyperloop use magnetic levitation rather than air skis to keep the passenger pods above the tracks.

Difference between a Hyperloop & High-speed trains

Supporters argue that Hyperloop is significantly better than high-speed rail. It is lower cost and more energy efficient because, among other things, the track doesn't need to provide power to the pods continuously and, because the pods can leave every 30 seconds, it's more like an on-demand service. It's also potentially two or three times faster than even high-speed rail.

Will Hyperloop be a success?

There are well-funded companies racing to be the first to deliver a working service but, despite their optimistic timescales, these projects are still very much in the pilot and experimental stages. Going from short test routes to hundreds of kilometres of track is a big jump that none of these firms has made yet.

If the technology is still in development, that's also very true of the business models to support it. The success of Hyperloop will vary depending on the destinations, local economics, and geography. Trying to build a new line overland across England, for example, can prove an expensive and complicated business which can take many years.In other countries where land is cheaper or where routes can travel through less populated

areas, it may be easier to get services up and running faster.

Capacity is another issue. It's not clear that Hyperloop can do a better job of moving a large number of people than other mass transit options. Critics argue that lots of pods will be required to achieve the same passenger numbers as more traditional rail, which uses much bigger carriages. And there are many engineering hurdles to overcome, like building the tubes strong enough to deal with the stresses of carrying the high-speed pods, and finding energy- and cost-efficient ways to keep them operating at low pressure.

Moving from a successful test to a full commercial deployment is a big jump, and passenger trials are still to come. Assuming that consumers are happy being zoomed around in these tubes, finding the right price for the service will be vital, too.

Right now Hyperloop is at an experimental stage, even if the companies involved are very keen to talk about its potential. ❖

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LIVING CONCRETE A FRANKENSTEIN MATERIAL

Dr. Mrinal Kumar Dutta
Associate Professor

Scientists have used bacteria to create a sustainable concrete that is alive and can even reproduce that may help reduce the environmental impact of the construction industry. Scientists at the University of Colorado, Boulder have created this "living concrete", The concrete is a mixture of gelatin, sand, and cyanobacteria. The resulting structure was able to regenerate itself three times after researchers cut it apart, does look like a Frankenstein material. Scientists used photosynthetic bacteria called *Synechococcus*, a type of cyanobacteria. This has the advantage of not needing any special carbon source to produce carbonate, since it gets what it needs by pulling carbon dioxide out of the air.

Forming carbonate is a slow process, and the cyanobacteria is not playing any structural role for a while after they are mixed with sand. So to keep the material together long enough for the carbonate to form, gelatin is mixed with the bacteria and suspended sand in the mixture. This is enough to maintain simple structures for long enough that the cyanobacteria could start forming carbonates. As long as the mixture was kept at an ambient humidity of 50 percent or more, the gelatin would absorb enough water to maintain a hydrogel that supported bacterial life for at least a week. The metabolic activity of the cyanobacteria could also be adjusted via the temperature. Photosynthetic bacteria also give the concrete another unusual feature: a green color.

Colonies of cyanobacteria is inoculating into a solution of sand and gelatin. The calcium carbonates churned out by the microbes mineralize the gelatin which binds together with sand. Some of the cyanobacteria can be pulling out of one structure and can be use them to inoculate a new one and could be continue the process through at least three generations of structures.

Making of cement and concrete alone need for roads, bridges, buildings and other structures generates nearly 6 per cent of the world's annual emissions of greenhouse gas - carbon dioxide. Minerals in the new material are deposited by cyanobacteria, a common class of microbes that capture energy from sunlight through photosynthesis.

Under the right conditions, these green microbes absorb carbon dioxide gas to help them grow and make calcium carbonate – the main ingredient of limestone and cement. Additionally, such concretes would remove carbon dioxide from the air, not pump it back out and under a range of humidity conditions, the concretes have about the same strength as the mortar used by contractors today.

By incorporating biology into concrete, helps concrete that can heal its own cracks. A major advantage of the new material, its creators say, is that instead of adding bacteria to regular concrete — an inhospitable environment — their process is oriented around bacteria: enlisting them to build the concrete, and keeping them alive so they make more later on. The new concrete represents a new and exciting class of low-carbon, designer construction materials.

The blocks also have the advantage of being made from a variety of common materials. Most concrete requires virgin sand that comes from rivers, lakes and oceans, which is running short worldwide, largely because of the enormous demand for concrete. The new living material is not so picky not restricted into using some particular kind of sand, but could be use waste materials like ground glass or recycled concrete.

Additionally, such concretes would remove carbon dioxide from the air, not pump it back out and under a range of humidity conditions, the concretes have about the same strength as the mortar used by contractors today.

Researchers are working to make the material more practical by making the concrete stronger; increasing the bacteria's resistance to dehydration; reconfiguring the materials so they can be flat-packed and easily assembled, like slabs of drywall; and finding a different kind of cyanobacteria that doesn't require the addition of a gel. ❖

RESPONSE REDUCTION MECHANISM IN STRUCTURES

Dr. (Mrs.) Nayanmoni Chetia
Assistant Professor

Many of us were fascinated by the idea of houses on wheels in our childhood. It was mere a wild imagination in those days. But today, there are houses with wheels! Anyway, the wheels or bearings are not meant for movement from one place to another, but for reduction of responses.

Cost effective protection of present day buildings against earthquake, wind or other disturbances is an important issue in an era of tight economic policies. The trend towards more slender, lighter, flexible and architecturally more daring structures along with recent advances in material science and Engineering has resulted in popularity of damping as a useful means of controlling vibrations or vibration related effects. Lateral forces caused by natural phenomenon are random process in magnitude and direction in both time and space domains. Over the past few years, world has seen huge earthquake damages leading to loss of lives and properties. At higher altitudes, wind load is major point of concern. Some forms of structural systems or changes can be implemented to reduce the responses. These system involves the principle of absorbing or reflecting the energy which otherwise would have transmitted in the structure itself. During an earthquake, the major problem is from the horizontal forces on building. Conventional Civil Engineering structures were designed on the basis of two main criteria, strength and rigidity. The strength was related to damageability or ultimate limit state assuring that force level developed in structure remains in elastic range or in limited plastic deformation. The rigidity was related to serviceability limit state for which the structural displacements must remain in some limits. Along with the above two, the ductile demand must be added which serve as the shock absorber in the building. The various code based methods for seismic design are lateral strength based design, Displacement or ductility based design, Capacity based design and of late Energy based design.

Structural response control for seismic loads, also known as earthquake protection system aims at the modification of the dynamic interaction between structure and earthquake ground motion, in order to minimize the structural damage and to control the structural response. The family of earthquake protective system includes passive, active and hybrid control. The control of a structure is tried from two different approaches,

either by the modification of the dynamic characteristics or the modification of the energy absorption capacity of the structure. In the first case the structural period is shifted away from the predominant period of the seismic input, thus avoiding risk of resonance occurrence. Isolation is effective only for a limited range of frequencies of structures. Acceleration response for a structure for some earthquake can be reduced, but at the same time response of the same building for some other earthquake may be increased. In the other approach, the capacity of the structure to absorb energy is enhanced through appropriate devices, which reduces damage to the structure. Both the approaches are widely used in response reduction process.

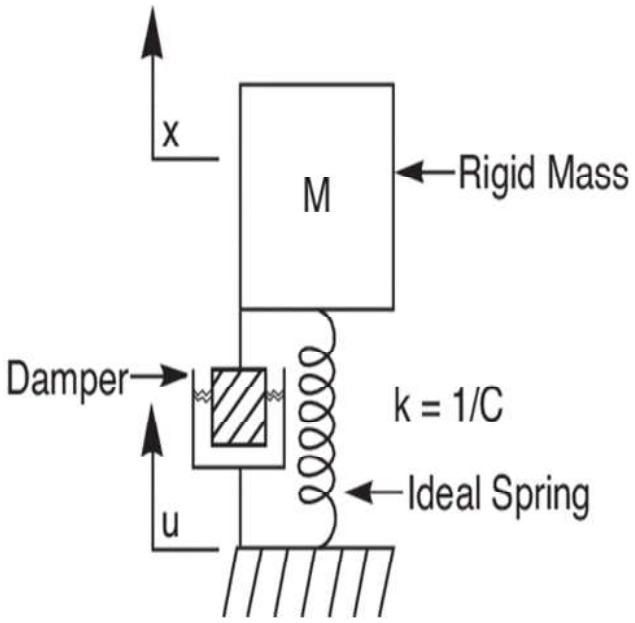

Fig 1. Passive Damper

Passive dampers have significant application to buildings, bridges and industrial plants normally use mechanical devices, fluids to reduce vibrations. It also uses viscoelastic materials where kinetic energy is converted into heat. Some more examples are Tuned mass damper and Tuned liquid mass dampers, metallic dampers, friction dampers, lead injection dampers, lead rubber dampers etc.

Active damper uses outside power in the form of electronically controlled sensors in a closed loop to counter the vibrations and oscillations. In these systems mechanical devices are incorporated into the buildings which actively participate in the dynamic behaviour of the building in response to the input during the earthquake ground motion. The structure's characteristics are modified according to seismic input to the building. They keep accelerations, displacements and forces below specific bounds in order to reduce the damage in case of a strong earthquake.

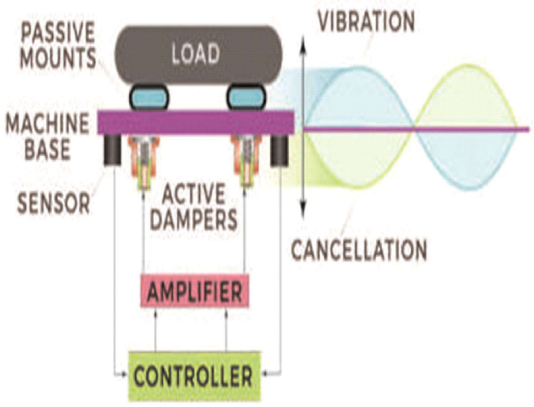

Fig 2. Active Damper

Energy dissipation can be done using base isolation which separates the superstructure from the base resting on shaking ground. The isolators work in a similar way to car suspension, which allows a car to travel over rough ground without the occupants of the car getting thrown around. Normally increasing ductility of the building or increasing the elastic strength of the structure is the most conventional method of handling seismic demand. Base isolation takes an opposite approach, i.e. to reduce the seismic demand instead of increasing the capacity.

Fig 3. LA City Hall, base isolated building

The response of the structure is modified such that the ground below is capable of moving without transmitting minimal or no motion to the structure above. The requirements for installation of a base isolation system is that building be able to move horizontally relative to the ground, usually at least 100 mm.The most common configuration is to install a diaphragm immediately above the isolators.

If the building has a basement then the options are to install the isolators at the top, bottom or mid-height of the basements columns and walls. The various advantages

of a base isolation system includes reduction in seismic demand, lesser displacement, reduction in peak acceleration transmitted to the superstructure, protection of integrity of internal structures, lesser ductile detailing requirement etc. But this system is not suitable for high rise buildings and for buildings on soft soils. Also base isolation cannot be applied partially to structures unlike other retrofitting schemes. More over a base isolated building is decoupled from the soil by isolators resulting lower support stiffness, may make the building more susceptible to wind induced motion. Normally used isolation components are elastomeric isolators such as lead rubber bearing, low/high damping rubber bearings and sliding isolators like resilient friction systems or friction pendulum systems. Sliding isolators can be provided with or without recentering capacity.

Fig 4. Base isolation with elastomeric bearings

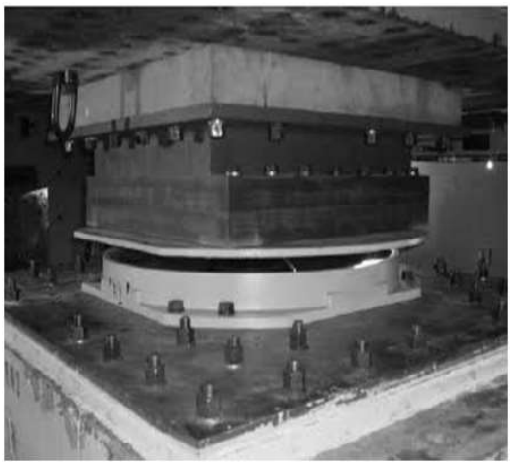

Fig 5. Base isolation with sliding system

Friction pendulum bearing works on the principle of simple pendulum. It has a re-centering capability. They contain a sliding plate and due to geometry, each horizontal displacement is associated with a vertical displacement too. The potential energy, stored by the superstructure, which has been pushed to the top, automatically results in

recentering the bearing into the neutral position. Structure on wheels, Benicia Martinez Bridge, California is one of the largest bridge to get retrofitted by this method.

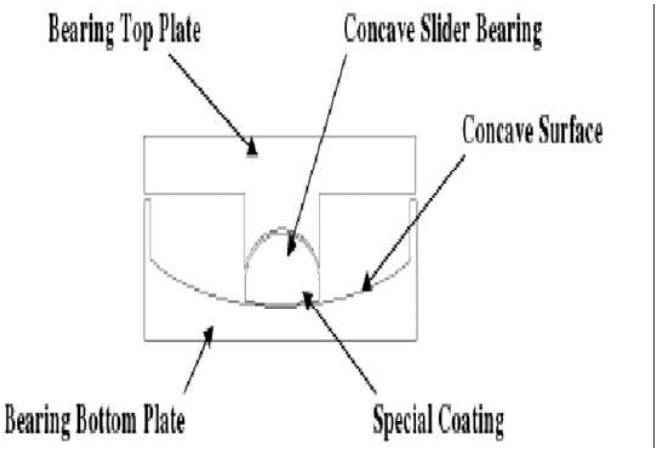

Fig 6. Friction pendulum bearing

One of the common type of control is a Tuned Mass Damper, used both as active and passive control device or harmonic absorber. It is a device mounted in structures comprising of mass and spring attached to reduce the amplitude of mechanical vibration and can prevent damage, discomfort, outright structural failure. It is used in power transmission, automobiles, and tall buildings.

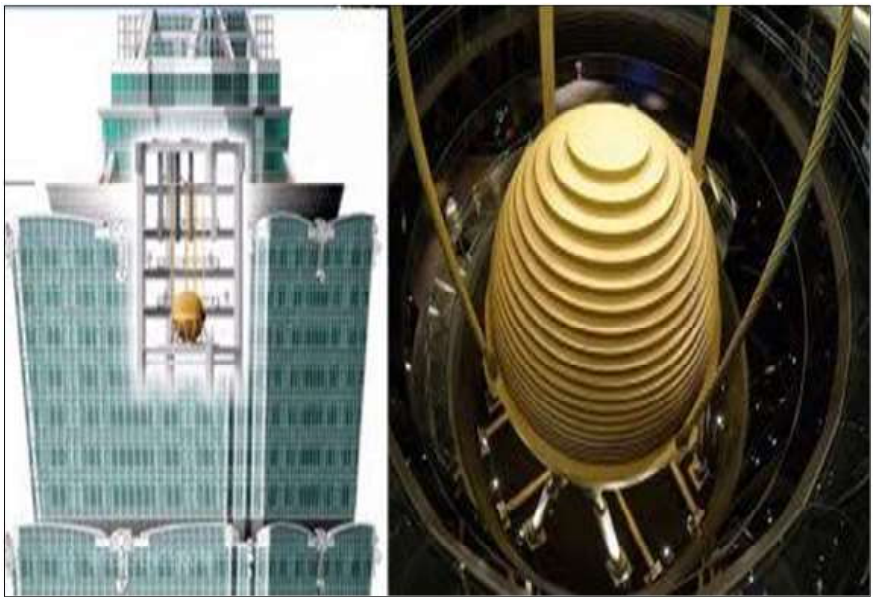

Fig 7. Tuned Mass damper

In viscous dampers by using viscous fluid inside a cylinder, energy is dissipated. Energy is absorbed by silicone-based fluid passing between piston-cylinder arrangements. Due to ease of installation, adaptability and coordination with other members also diversity in their sizes, viscous dampers have many applications in designing and retrofitting.

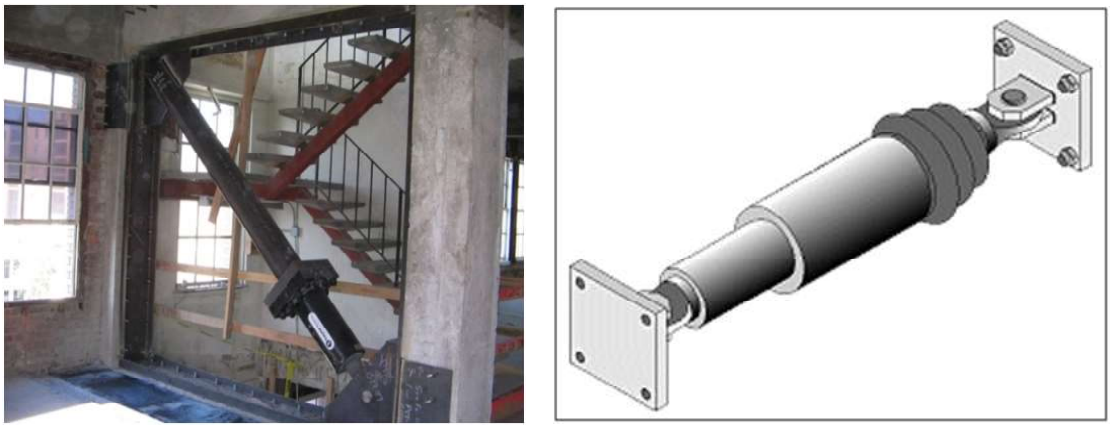

Fig 8. Viscous Damper

Penguin Vibration Damper another type of friction damper of passive type and can be used to create necessary damping for flexible structures, such as bending steel frame or to provide effective damping to structures. PVD damper is designed for installation in places where displacement can generate necessary damping such as installation of metal skeleton brace or concrete moment frame.

Fig 9. Penguin Vibration Damper (PVD)

Another important type of passive control is Elasto-plastic damper or X plate dampers. They are thin metallic plates of X or V shape and consist of single or group of plates and are made up of mild steel or copper material having different thickness. The mechanism of dissipating the energy of X plate damper is more effective during the earthquake by absorbing input energy of the structure.

Use of seismic control systems has increased but choosing best damper and installing it into a building is very important for reducing response of structures. The controlling devices reduce damage significantly by increasing the structural safety, serviceability and prevent the building from collapse during the earthquake. ❖

SEISMIC RE-QUALIFICATION OF FOUNDATIONS

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Introduction

Earthquakes have occurred for millions of years and will continue in the future as they have in the past. The destruction caused by the earthquake depends on the density of the population, infrastructure available in that area and on the proximity of strong ground motion. It is impossible to prevent earthquakes from occurring, but it is possible to mitigate the effects of strong earthquake shaking to reduce loss of life, injuries, and damages. When an earthquake occurs, seismic waves radiate away from the source and travel rapidly through the earth's crust. When these waves reach the ground surface, they produce shaking that may last from seconds to minutes. The strength and duration of shaking at a particular site depends on the size and location of the earthquake and on the characteristics of the site. At sites near the source of a large earthquake, ground shaking can cause tremendous damage.

Earthquake geotechnical engineering is relatively a new subject and is constantly making progress in the recent decades through research in different areas. Structures built earlier, in accordance with pre design codes, are generally vulnerable to seismic effect due to then construction technologies, materials availability etc. While the state of the art understanding could be incorporated in new construction projects, there are several important structures like hospitals, bridges, power plants etc. that were built much earlier which did not benefit from the better understanding. Therefore, re-examining the structures designed and built earlier has become essential in the light of the new and hopefully better understanding of seismic resistant design philosophies. Extent of earthquake damage to built environment (structures) depends not only on the details of the structure but also on the ground on which the structure is built. It is well established that geotechnical aspects, i.e., soil can be a major contributor to damages to the built environment. It is therefore important to consider various geotechnical structures. Taking into account the recent earthquake experiences, for example 2001 Bhuj, 2010 Chile, 2011 Tohoku

earthquake, 2011 Sikkim earthquake, 2015 Nepal earthquake, re-examining the geotechnical structures, designed and built earlier, with the aid of new and better understanding concepts is very important for re-qualifying their seismic safety. If a structure is observed to be not qualified in the process of seismic re-qualification, measures need to be adopted for improving their seismic performance which is termed as seismic strengthening or retrofitting or rehabilitation.

Factors Affecting the Damages of Foundation

The damages due to dynamic loading of geotechnical structures like foundations are affected by ground amplification and soil liquefaction. One of the most dramatic causes of damage to structures during earthquakes has been the development of liquefaction in deposits of loose and saturated sand. Vibration due to the earthquake causes settlement of the ground surface and the development of high pore-water pressure results into upward flow of water, which often turns the sand into a liquefied condition. The *effects of soil* liquefaction on the built environment can be extremely *damaging.* It is important to analyze the site response and liquefaction potential to understand the comprehensive impact of these two effects on the response of the structures under seismic loading. Although the effects of liquefaction have been long understood, it was more thoroughly brought to the attention of engineers after the 1964 Niigata earthquake and 1964 Alaska earthquake.

Studies on Seismic Requalification

The studies on seismic requalification of structures are conducted by different researchers. Showa Bridge failed during Kobe earthquake. Damala et al. (2017) conducted the seismic re-qualification of Saraighat Bridge over river Brahmaputra supported by well foundation. Krishna et al. (2014) summarizes various steps which are required to be considered for seismic re-qualification of geotechnical structures and is shown in Fig. 1. Expected earthquake motion parameters (PGA, magnitude and/or ground motion at the bedrock level etc.), local soil conditions, built details of structure like foundation details, structural load, any distress/deformation condition etc. are to be considered for requalification studies. Ground response and liquefaction analysis are to be carried out. Seismic analysis of the structure is to be carried out using the results obtained from the earlier stages.

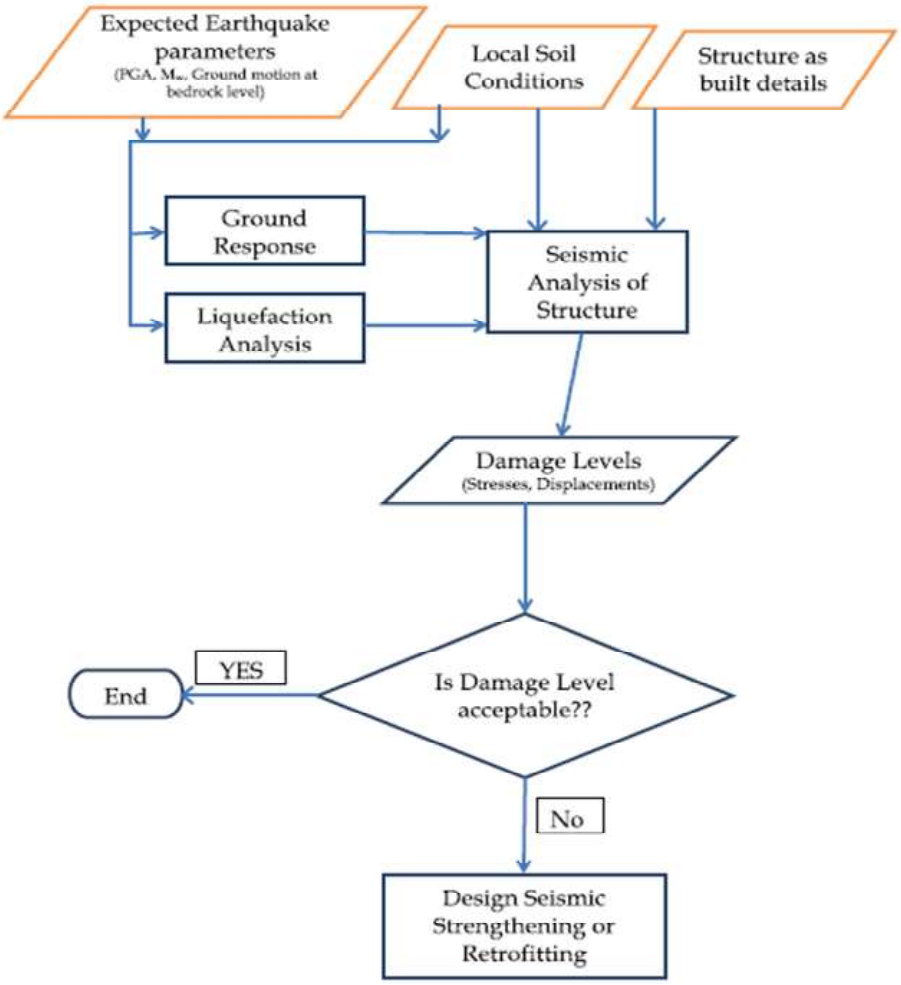

Fig 1. Seismic requalification procedure (after Krishna et al., 2014)

Case Study of Seismic Requalification of Dhansiri River Bridge

There are a number of bridges in Assam on the national highways which were built much before the understanding of the term liquefaction. Therefore, it is questionable if the bridges were safely designed. Dhansiri River Bridge is a relatively major river crossing Road Bridge in a high seismic zone situated in North Eastern part of India in the vicinity of the Himalayan faults, was built and opened for the traffic in the year 1964, just at the time of the initial understanding of seismic liquefaction has evolved. It is, therefore, necessary to carry out a seismic requalification study of this important bridge. Emte and Bhattacharjee (2019) conducted seismic requalification studies of Dhansiri River Bridge.

Standard Penetration Test (SPT) is conducted near the vicinity of the bridge to collect the geotechnical data. Standard penetration resistances (*N* values) and soil samples are collected over 1 m interval up to a depth of 24 m. Data obtained from field and laboratory tests (e.g. unit weights, relative densities, shear wave velocities, etc.) are used for calculating the input parameters of the soil model.

It is found that the soil stratigraphy of the bridge site consists of loose to medium density sand layers over 24 metres of depth with a clay layer at a depth of 5 m from the surface. The shear wave velocities for all layers are estimated (Maheswari et al. 2008) from the observed standard penetration resistance. The bore log of the geotechnical investigation showing different soil properties and respective *N* values is shown in Table1.

Using the data obtained from the field investigation and laboratory tests, site response analysis is carried out in Open System for Earthquake Engineering Simulations (OpenSees) finite-element analysis software framework. A multi-layered single column of soil is modeled in 2D with periodic boundary conditions to emulate a 1D analysis and is subjected to an earthquake excitation at the base (Fig. 2).

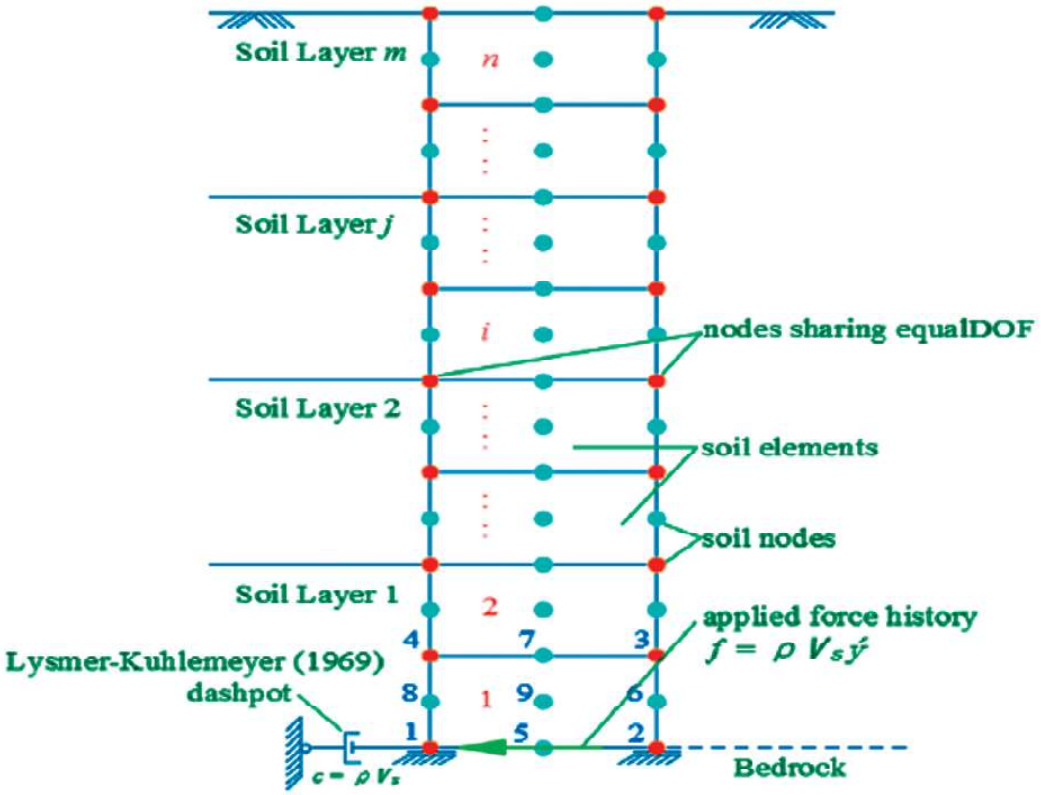

Fig. 2. Schematic representation of the site response model (After Emte and Bhattacharjee, 2019)

Table 1. Typical soil borehole and laboratory tests data for the bridge site

Depth (m)	SoilType	Relative density, D_r(%)	SPT-N values	Saturated soil mass density, ρ_{sat}(kg/m^3)	Shear wave velocity, V_s (m/s)	Friction angle, Ø (°)	Cohesion, c(kPa)
1	Medium Sand	53	8	1640	178.8	33.5	-
2	Medium Sand	42	6	1500	164.0	32	-
3	Medium Sand	64	13	1810	206.9	35	-
4	Loose Sand	23	2	1440	117.8	31	-
5	Clay	—	3	2690	133.1	0	37
6	Medium Sand	52	7	1640	171.8	33.5	-
7	Medium Sand	46	10	1570	191.2	33.5	-
8	Medium Sand	53	8	1590	178.8	33.5	-
9	Medium Sand	49	15	1630	216.1	33.5	-
10	Loose Sand	28	6	1320	164.0	31	-
11	Medium Sand	36	6	1460	164.0	32	-
12	Medium Sand	45	10	1610	191.3	32	-
13	Medium Sand	37	8	1520	178.8	32	-
14	Medium Sand	41	9	1550	185.3	32	-
15	Medium Sand	41	10	1540	191.3	32	-
16	Medium Sand	46	18	1580	228.3	33.5	-
17	Medium Sand	46	16	1600	220.3	33.5	-
18	Loose Sand	35	10	1460	191.3	31	-
19	Medium Sand	40	10	1520	191.3	32	-
20	Medium Sand	41	14	1600	211.7	32	-
21	Medium Sand	60	25	1910	252.0	35	-
22	Medium Sand	57	24	1610	248.9	35	-
23	Medium Sand	52	25	1590	252.0	33.5	-
24	Medium Sand	56	29	1820	263.5	35	-

The response of the well foundation subjected to Sikkim and Loma Prieta earthquake in terms of bending moment and relative displacements are shown in Fig. 3. The maximum bending moments are 435 kNm and 1300 kNm under Loma Prieta and Sikkim earthquake respectively. The moment capacity of the well is determined (Rai et. Al. 2006) and the ultimate moment of resistance of the well section is calculated to be 225 MNm. But the maximum bending moment is 1300 kNm. Hence, it can be concluded that the well is safe under the considered loads and the applied input motion.

Conclusions

The seismic requalification studies of foundation of old important structures are essential. The case study on seismic requalification on Dhansiri River Bridge ensures the safety of the structure.

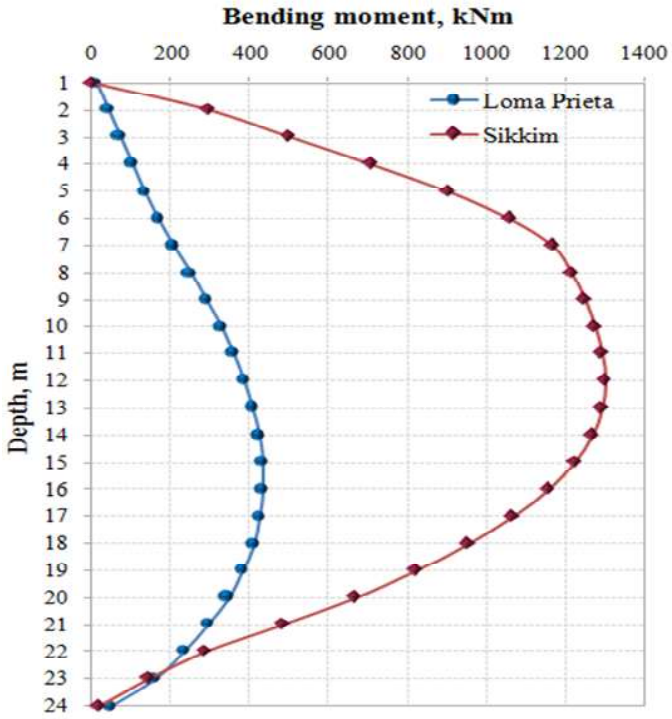

FIG. 3 Variation of bending moment along the depth of the well for the two different earthquakes

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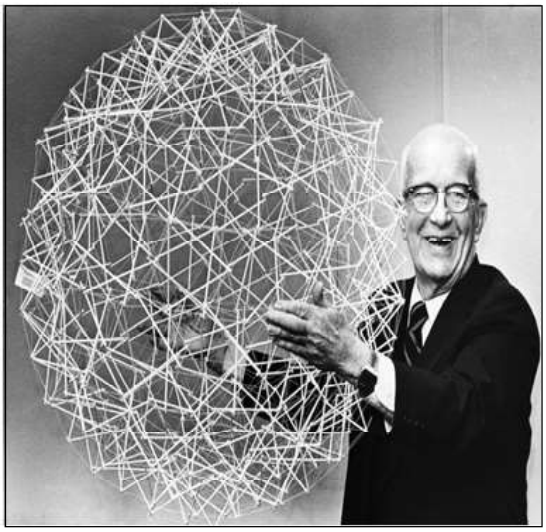
TENSEGRITY STRUCTURES AND ITS APPLICATIONS

Abhigna Divyaprakash Bhatt
Assistant Professor

Tensegrity is a portmanteau of 'tension + integrity'. Buckminster Fuller was the one who first coined this phrase in his 1962 patent application. But the construction of the first true Tensegrity structure is however attributed to the artist Kenneth Snelson who created his Xpiece sculpture (*Fig1 (a)*) in 1948.In his patent, Snelson describes Tensegrity as a "class of structures possessing, what may be termed discontinuous compression, continuous tension characteristics." This discontinuity was also recognized by Buckminster Fuller (*Fig1 (b)*) in his patent description, when he stated that "*the structure will become small islands in a sea of tension*."



(a) April 18, 1979, R. Buckminster Fuller holds up a Tensegrity sphere.

(b) "X-piece" made by Kenneth Snelson in the winter of 1948.

Figure 1: (a) Fuller and (b) Snelson's Sculptures.

Most of our houses and other man-made structures are 'compressionegrities', their integrity lies with the continuity of compression from the highest brick in the Empire State Building to the lowest block of granite, the compression runs in an unbroken line from element to element. We have thought of our bodies in the same way the skeleton is a stack of bones, like a stack of checkers a continuous compression structure with the individual muscles hanging off each bone to move it. But every classroom skeleton you

have ever seen is wired together, in the actual skeleton the bones float in a sea of soft-tissue. A model of leg tensegrity can be shown from *Fig 2*.

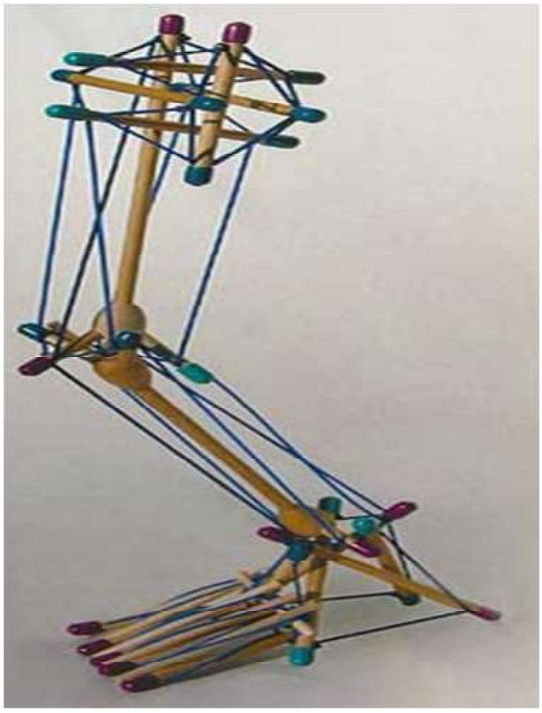


Fig 2: Leg model tensegrity

Applications

Tensegrity Structures are Similar to musculo-skeletal systems of highly successful land-based animals. *Cats*- which can jump several meters in height without causing damage to their structure, *Cheetahs*- which can achieve maximum speeds of over 60 mph, their musculo-skeletal systems are made up of rigid links (bones) which are connected by tensile elements (tendons) with contractive elements (muscle fibers) in series.

Fig 3. Basic structure used as a house hold furniture

The tensile elements maintain the integrity of the form and store energy, making it possible to sustain large impact forces and transfer energy from one bound to the next. Due to this architectural equivalence, it is likely that tensegrity structures can provide a suitable basis for locomotion. Dynamics allow for the storage and release of energy which facilitates locomotion. Tensegrity structures also provide benefits in terms of weight and strength-to-weight ratio which make them useful in bridges, towers, roofs etc.

Fig 4. The Kurilpa Bridge in Brisbane, Australia. It is the world's largest Tensegrity bridge, which was opened on the 4th of October 2009

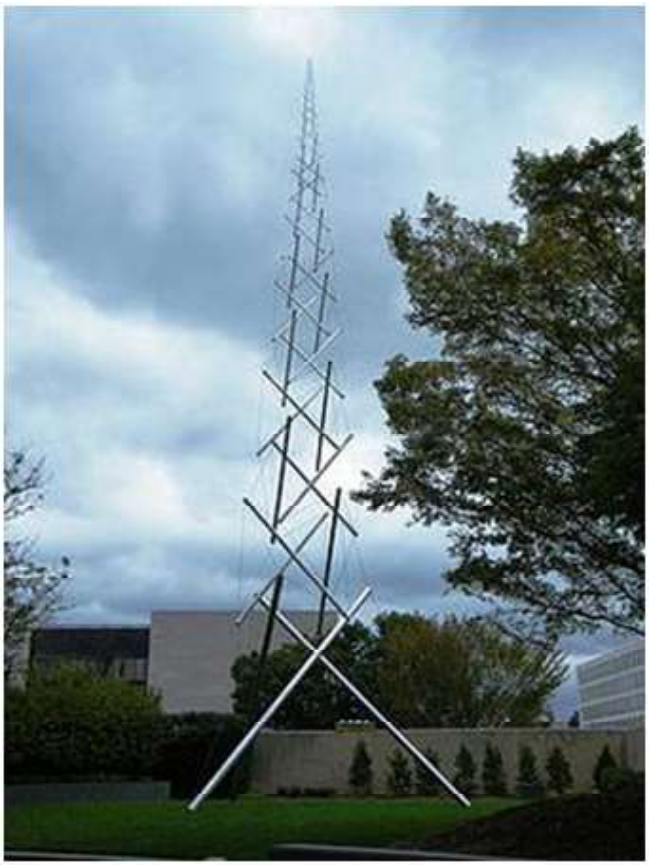


Fig 4. Needle Tower - A public artwork by American sculptor Kenneth Snelson located outside of the Hirshhorn Museum and Sculpture Garden in Washington, D.C., United States

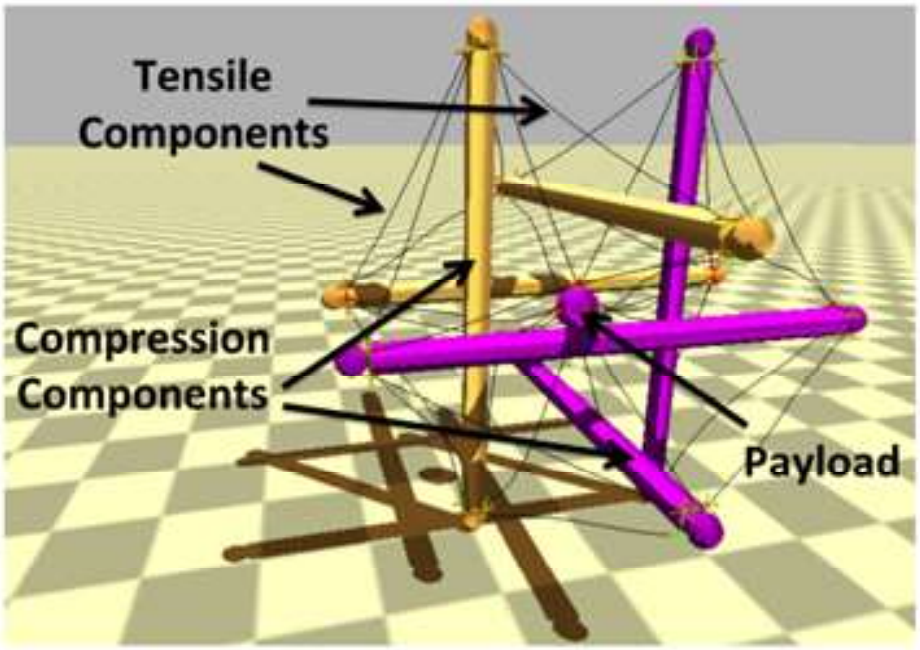


Fig 5. The *"Super Ball Bot"*, under development at *NASA Ames*, is a robotic exoskeleton designed to land on the surface of Titan without a parachute or airbag. The robot, created by Vytas SunSpiral and Adrian Agogino, can then roll about the surface by adjusting its shape

Summing it up, Tensegrity structures are easy to transport as they are deployable. It is difficult to get closed form solution due to its complex geometry. It can be used as robots for locomotion as they can loco mote on any terrain. It provides benefits of high strength to weight ratio and easy storage and release of energy. It has a wide Future Scope of Work. ❖

THE ROYAL'S RAIN WATER HARVESTING SYSTEM

Prasanty Borah
Assistant Professor

Rajasthan, a state in the western part of India, is the land of beautiful palaces, forts, deserts and lakes. I had the privilege to visit this part of the country last January and I must say it was one of the most memorable one. I have always been fascinated by majestic structures, their symmetry and the engineering behind those structures and this state was a store house of all my fascination. Apart from the majestic structures, the thing that fascinated me the most was their different rain water harvesting systems. As we know Rajasthan is an arid region, rain water harvesting was considered to be sacred duty by the kings and netizens of Rajasthan and they build various modes of rains water harvesting systems such as stepwells, tankas, paars, khadins, jhalaras and so on.

Fig.1. Jaigarh Fort

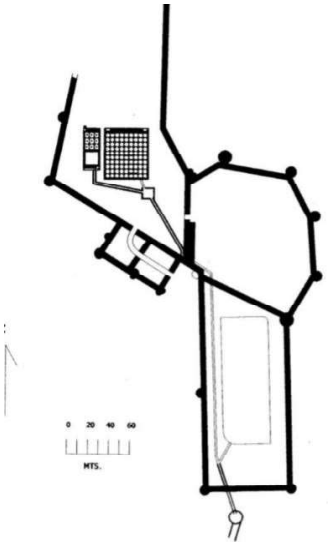


Fig.2.Plan of the Jaigarh Fort showing the hydraulic system

My first stop in this beautiful state was the pink city of India, Jaipur. This city is a gateway to beautiful palaces and majestic forts. Jaigarh fort, built by Raja Sawai Jai Singh II, is one of the finest examples of traditional rain water harvesting system of India. It was based on the principles of rainwater harvesting and water conservation.

The whole mechanism of the system is comprised of collecting rainwater through aqueducts and carrying it to storage tank with the facility of cleaning the water and its storage in tanks which are provided with the technique of conservation of water having least pollution; it became operational due to gravitational

force/gravity. It mainly consists of three hydraulic systems; one is major and others are minor. The Major hydraulic system is an integrated water engineering and conservation, which can be divided into three parts:

Fig.3.Water Channels outside the Fort

First, the water channels outside the fort which is a network of aqueducts encircling the three hills of varied contours to tap the rolling down water on the slopes of hills and carry it to the masonry rivulet which in turn brings so collected water to the inlet duct of the fort to feed the water reservoir and tanks inside the fort, aqueducts got originated 3.5 kms far on the south of Jaigarh fort where it encircles the hill of high altitude forming an irregular rectangular following the contour of hill. It gathers the whole water as rain downpours on this hill and then channels it into a single duct, which carries the water towards north.

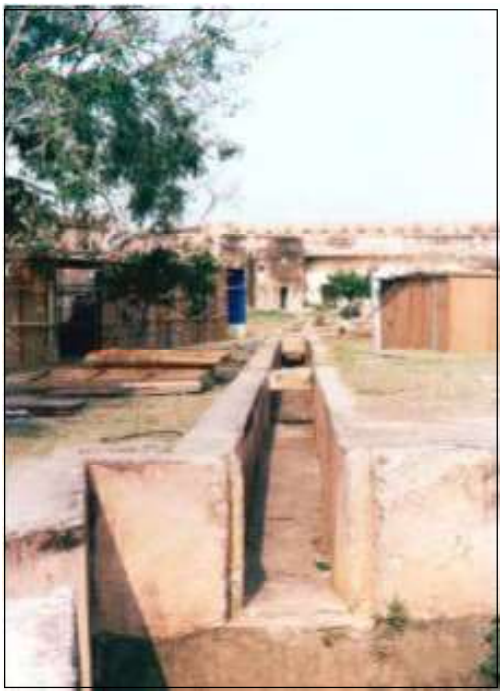


Fig.4. Distributary Aqueducts

Second, the water channels inside the Fort forms a network of distributary aqueducts. The underground duct, which carries water form masonry rivulet existing outside the fort, enters into the fort and runs as an open duct diagonally towards northwest and then, it goes subterranean. From this point it branches off into two subterranean channels i.e. eastern and western/main channel. Eastern subterranean channel carries water to feed a very huge open tank existing in this southern courtyard. At the entry point in the southern fortified wall, the open duct has a depth of 1.85 meters while it goes ahead, its depth become less and it is 1 meter at the other point where it goes subterranean. Such a depth at entry point is for two reasons- one to check the flow of debris and wreckage ahead and second to provide security by not allowing anybody to cross it since it remained filled with water because of depth.

Fig.5.Reservoir Roof perforated with nine holes

Lastly, the major hydraulic system of the Jaigarh fort is an elaborate system which consists of adequate facility to store water in four well designed strategically located water reservoirs in different parts of the fort. There exist four reservoirs inside the fort, out of them, two are in the shape of open reservoir, one finished rather completed with technique to approach water while other an unfinished huge reservoir. The remaining two are the storage tanks, one of great dimension are covered with roof while the other is covered with a perforated roof to lift water from holes. This system is still functioning properly and if you ever visit Jaigarh fort have a glass of water from their filter. Another interesting fact about this reservoir is that that the royal treasures were kept in this reservoir which was directly connected to the amber palace and access to this reservoir was reserved only for the king.

Just few kilometers from the Jaigarh palace, there is a step wells by the name Panna Meena Ka Kund near the Amer Palace. It was constructed with the purpose of water harvesting during the monsoon season.

After pink city it was the turn for the city of lakes, Udaipur. Udaipur is a beautiful city surrounded by enchanting lakes on all sides. The magnificent view of the City Palace by the lake Picchola was simply marvelous. This city has faced water scarcity from the time its inception, due to its geographical location**.** The locals gave us a brief insight into the lake system of the city. The rulers who ruled the city built an array of artificial lakes to ensure regular water supply for their subjects. The lakes of the city being interconnected forming a lake system which supports and sustains the groundwater recharge, water availability for drinking, agriculture, industries and is a

Fig.6. Panna Meena Ka Kund

source of employment through tourism. The lake system has three main lakes in its upper catchment area, six lakes within its municipal boundary and one lake in the downstream. The Udaipur Lake System can be divided into the following categories:

Fig.7. Lake Pichhola

- ❖ Upper lakes: Lake Badi, Chhota Madar & Bada Madar
- ❖ City Lakes: Lake Pichola, Fateh Sagar Lake, Swaroop Sagar Lake, Rang Sagar, Kumharia Talab, Goverdhan Sagar.
- ❖ Downstream Lake: Udaisagar Lake

In recent times, the condition of the lakes deteriorated sharply mainly due to unregulated and rapid commercialization escalated the inflow of pollutants. The water level of the lakes is also decreasing. Adequate measures are opted by both the government and the resident of the city to revive the dying water bodies. Hence it is evident that the people residing in this part of the country are doing their best to harvest water in whichever way they could for the future generations.

Fig.8. Fatehsagar Lake

There was so much knowledge to devour from two beautiful cities that one visit is not enough. Their culture, heritage, magnificent forts and palaces, beautiful lakes and desert are all spellbinding. My visit to these two beautiful cities was enriching from the perspective of a tourist as well as a civil engineer. ❖

WHY I CHOOSE TO BE AN ENGINEER?

Er. Baharul Hussain
Assistant Professor

The moment when humans first start building small roofs using leaves and branches of trees to keep themselves warm and safe, when human starts using stone as tool to do daily works, the same moment of human history can be called as the first to follow the path of engineering. Humans are no different from other animals of this earth when there is a question of food, shelter and area (Property). It is very common in animals that they fight for their food, for their area of dominance. Being the sons/daughters most ruthless mother of all, Mother Nature, humans needed to fight for survival at first. These fights, wars demands more and more innovations as human life is at stake. Hence all the engineering knowledge humans can innovate or gather were used for defence purpose. But with time humans start living in a less violent society and there starts the need for engineering for common civil people. Thus starts the Civil Engineering. At later stage we got the other branches of engineering as per our necessity.

A schematic drawing of pyramid.
(Source: https://medium.com/@asya_shkuro/great-pyramid-of-giza-mystical-experience-that-changed-life-of-napoleon-bonaparte-9adcd910e0d9)

Being a civil engineer of 21st century, it always blows me away whenever I look at some of the landmark monuments of past centuries.

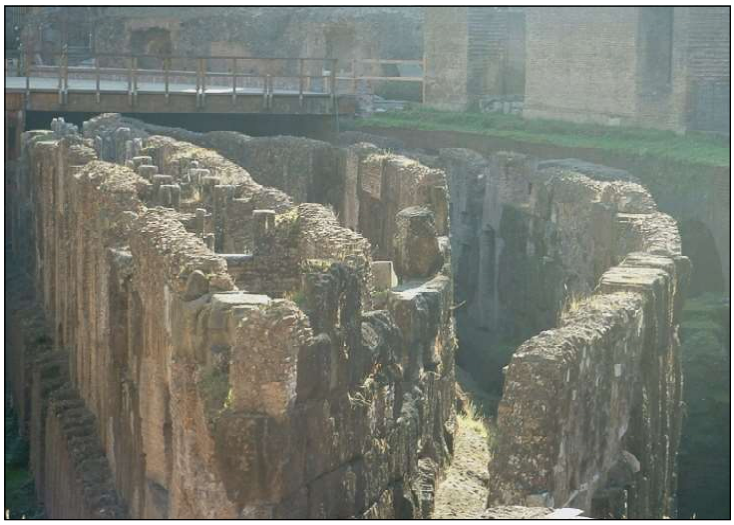
It always puzzles me, whenever I try to think about the level of engineering knowledge people have used when great pyramids of Egypt were constructed nearly 2000 years before birth of Christ. People have carried 20-80 tons of limestone blocks to a height as

high as 137 m without the use of any modern machineries. The pyramids were so precise that the average error of the four bases is of about only 58 mm. Interestingly all pyramids are not just a pile of stones, it is a structure with properly designed chambers.

***The Colosseum** (Source: https://en.wikipedia.org/wiki/Colosseum#/media/File:Colosseum_in_Rome,_Italy_-_April_2007.jpg)*

I cannot imagine the engineering hurdles romans have faced when they have constructed the Colosseum. A multi-storey stadium which can hold estimated 50,000 to 80,000 spectators, which was used for gladiator contests and public spectacles such as mock sea battles, animal hunts, re-enactments of famous battles and dramas based on Classical mythology.

The cross section of the Colosseum shows how majestic it was when romans were in there golden period. The extent of vision, planning and designing is just outstanding. As civil engineer we can feel the level of precision in execution which is extraordinary. The colosseum has two-level underground network of tunnels and cages beneath the arena where gladiators and animals were held before contests began. Eighty vertical shafts provided instant access to the arena for caged animals and scenery pieces concealed underneath. Larger hinged platforms, called *hegmata*, provided access for elephants and large animals. During mock sea battles though these interconnected network of tunnels the whole arena was filled with water. It is hard to believe, the extent of engineering achievements romans had achieved almost 2000 years ago.



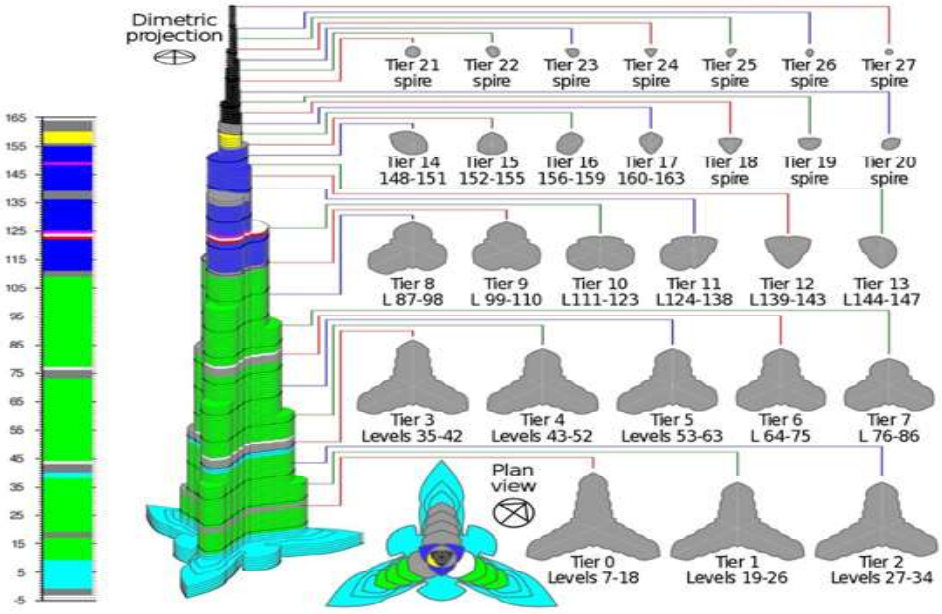
Detail of Hypogeum (Source: https://en.wikipedia.org/wiki/Colosseum#/media/File:Colloseum-hypogeum-detail.jpg)

Coming back to India we find Tajmahal, Red

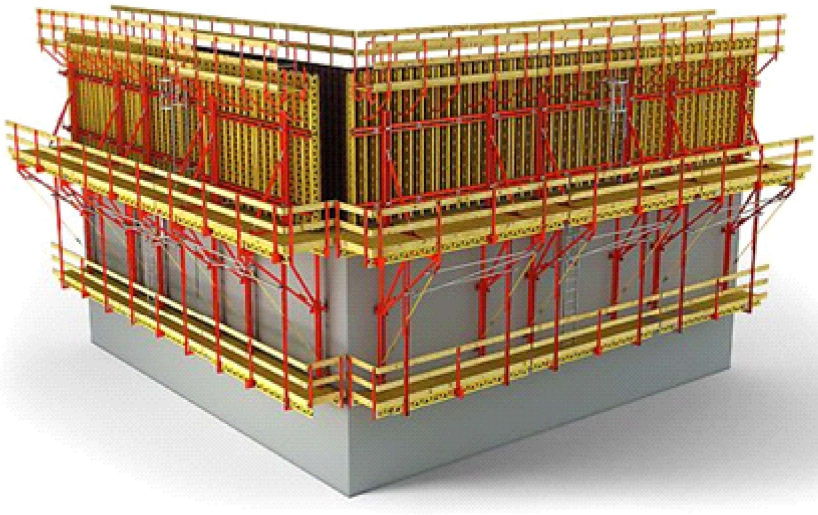
Fort, Ajanta Cave and many more. All these historic structures shows the journey of engineering from the beginning of evolution. Though all the examples given above are from history, the human kind is able to continue its engineering legacy. Civil engineers have constructed some massive, state of the art structures which can challenge and change the way we human think or imagine. The height civil engineers have achieved can really make one pause for a moment and made them think how it is possible.

Burj Khalifa (Source: https://en.wikipedia.org/wiki/Burj_Khalifa#/media/File:Burj_Khalifa.jpg)

One of such example is the Burj Khalifa which astonished me every time I look at it. The structure was constructed over a 152 friction piles of 50 m depth. This is the tallest building in world having total height of the building is 0.828 km. For construction of this building structural engineers Bill Baker and his team has developed a new hexagonal buttress core system which can be made as high as 828 m. For such kind of building only designing is not the only challenge. The proper execution without any error is must. The hexagonal core of the building acts as the spinal cord of the building which was constructed by a jump formwork technique. This technique can build a solid core system without any joint. Other than that while the construction of this building concrete needed to be pumper to a height as high as 800 m, which t self is a big challenge.



Schematic representation of Burj Khalifa. (Source: https://www.som.com/projects/burj_khalifa__structural_engineering#tab_photos3



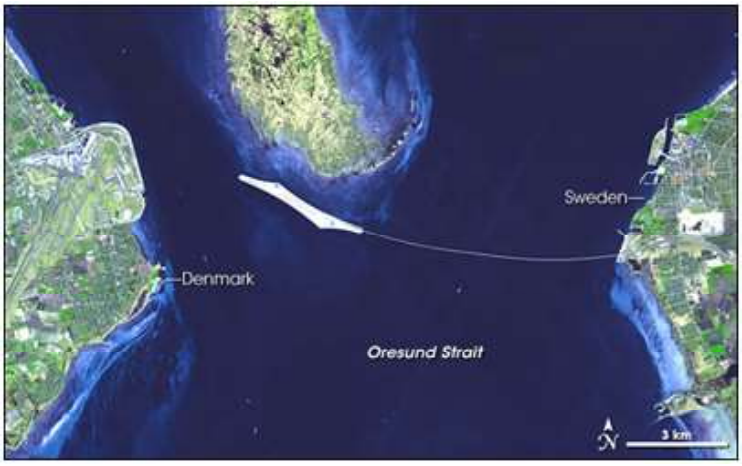
Schematic representation of Jump Formwork. *(**Source: https://www.peri.com/en/products/civil-engineering-solutions/climbing-systems/cb-climbing-formwork.html)***

Leaning Tower of Dubai (Source: https://en.wikipedia.org/wiki/Capital_Gate#/media/File:Capital_Gate.jpg)

Leaning Tower of Pisa (Source: https://en.wikipedia.org/wiki/]Leaning_Tower_of_Pisa#/media/File:The_Leaning_Tower_of_Pisa_SB.jpeg)

We all have heard about leaning tower of Pisa. That is more of an engineering failure than an achievements. Because the leaning was not intentional. But what if we make an intentionally leaning building. This has been done in Dubai, The Capital Tower

of Dubai. The building is 160 m tall and was designed to incline 18° West. The structure rest over 490 piles to withstand dead load of the structure as well as very high lateral loads due to wind load. The wind speed in Dubai can reach upto 130 kmph. Earthquake load or seismic load is not that critical for Dubai as it is spread over an area which is seismologically very stable. The whole structure was built around a concrete core, which was constructed with the jump form method.



Satellite view of the bridge (Source: https://en.wikipedia.org/

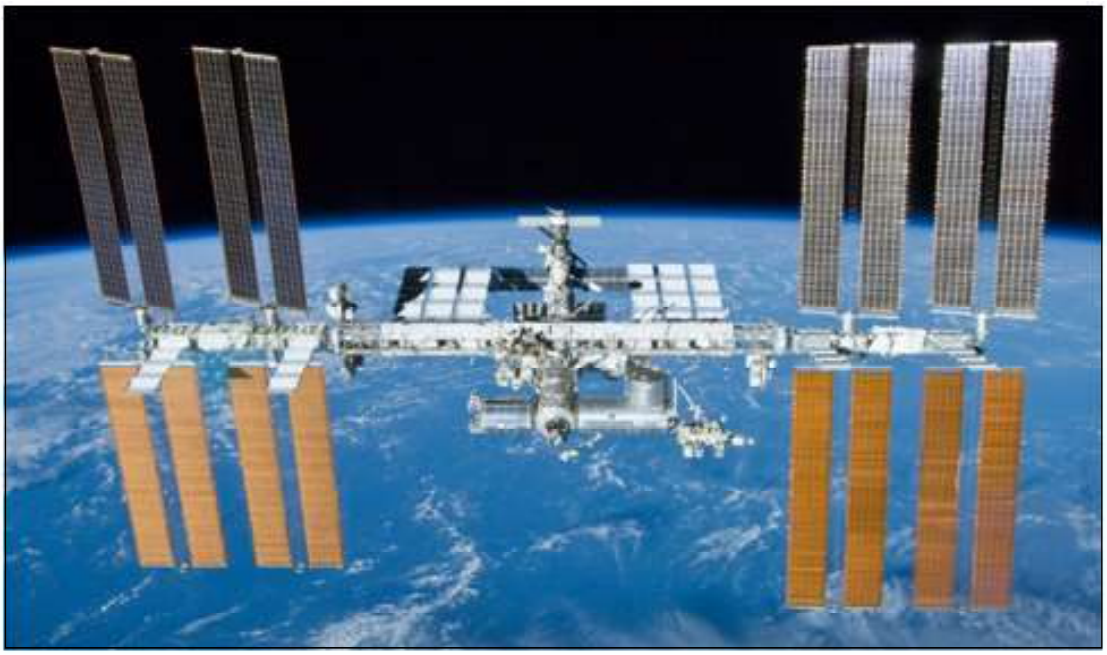
If we talk about bridges there are some impossible bridges, which has already been constructed by civil engineers. If I talk about the Öresund Bridge between Denmark and Sweden, having a total length of 7.84 km, width 23.5 m and height 204 m. This bridge is a cable stayed double Decker Bridge. This bridge is accompanied with a tunnel underneath the ocean and a man mage island. The tunnel segments were pre-casted and then brought to the site and then submerged into the sea. The whole tunnel was constructed peace by peace.

Bogibeel Bridge during its construction. ***(Source: https://www.nbmcw.com/tech-articles/roads-and-pavements/39668-bogibeel-rail-cum-road-bridge.html)***

Even in Assam the Bogibeel Bridge which connects connecting Dhemaji and Dibrugarh Districts of Assam is of total 4.94 km. It is a steel and concrete double decker bridge. The fact which astonished me is that each span of the bridge is prefabricated and then slide over the piers of the bridge. Each span is of 1700 metric tons and the pulling force required was equivalent to pulling 26 Airbus A380 with maximum take-off weight over 650 tons, put together without any wheels.

So far what engineering community has achieved is discussed. But we must plan for the future. As we are moving forward we are facing new and more dangerous threats. Environment degradation is one of the most dangerous threat we are facing right now. Engineers are already aware of the fact that if some innovative and effective solution is not found out very soon then human kind is going to suffer a lot. Engineers are now working to develop more sustainable solutions to our problems. Solar panel, wind turbine, wave energy harvesting, find better use of waste materials, developing materials with low carbon footprint, developing techniques to harvest more and more renewable energy and many more.

Recently US has established a new space command to tackle military space operation. Humans are continuously trying to expand its knowledge about space and universe. In near future human might start living in outer space like International space station as well in some other planet. Being a follower of science I cannot neglect the fact



International Space Station.

(Source: https://en.wikipedia.org/wiki/International_Space_Station#/media/File:International_Space_Station_after_undocking_of_STS-132.jpg)

that humans might start to live in other planets in future. Considering these situations a completely new horizon of engineering will start. Construction of habitable structures in outer space will be a new challenge. The structures will be self-sufficient where provisions of generation of energy, disposal of waste, recycling of material and growing food for dwellers will be present. These are not some content of sci-fi movie. Humans have already achieved it and using it in International space station. As human and civil engineer we should let our imaginations fly high.

It is said that, necessity is the mother of invention. We are facing new problems everyday of our life. But we are not standing still, we are working day and night to solve our problems with better, sustainable solutions. This is the moto of the engineering community as a whole. This is why I choose to be an engineer. ❖

WHY *VAASTU* IN ASTU SYLLABUS?

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1. Preamble

Principle of Vaastu Shastra has been included by Assam Science and Technological University (ASTU) as a topic in the subject "Building Construction and Planning" (subject code CE181304) under 3rd Semester Undergraduate Course in Civil Engineering.

2. Objective of this write-up

One thing must be made clear in the outset that there is no such written document named *Vaastu shastra* in Ancient India unlike other *shastra* such as the *Kautilya's Arthashastra*. The content of the so called *Vaastu Shastra* are picked up from ancient treaties such as *Puranas*, *Samhitas*, *Sutras.* The first book came out on *Vaastu* was the *Samargana Sutrdhara* written by Ram Raz in around 13th century[1]. However, with the advent of Hindu nationalism, a new found pride in old came into force and this subject is reintroduced in the name of a *Shastra*.

But when this is to be studied under a technical course of a technical university the content of the course has to be scrutinized. In this write-up, effort will be taken to look into one particular belief in *Vaastu* and to examine the same in the light of present advancement of science and technology and to see whether it is still relevant.

3. Dishadhipati in *Vaastu belief*

In *Vaastu*, certain gods are believed to be presiding over certain directions. In planning of a residential house with *Vaastu*, a particular room, depending on its use, is to be placed in a direction to get the blessings of that god. Fig.1 shows the *Vaastu* beliefs and how plan for different rooms are done using the principle.

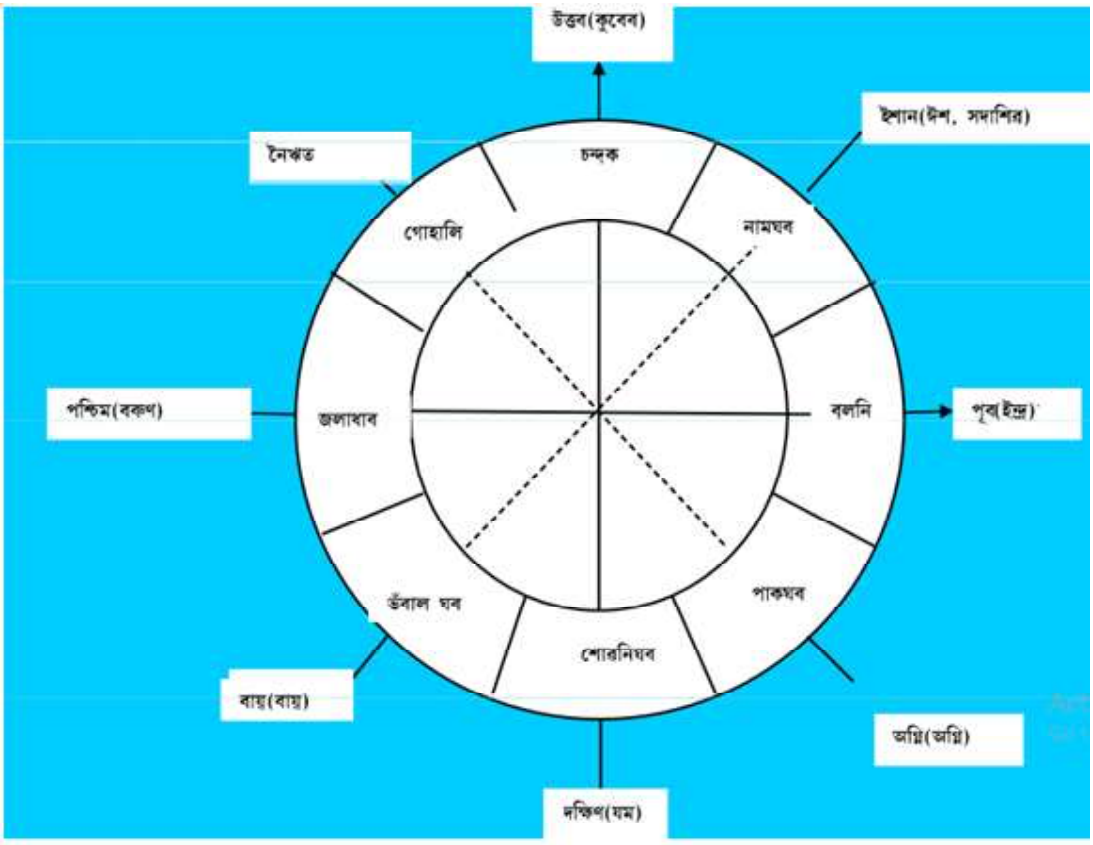

Fig. 1 Placement of rooms by *Vaastu* as per reigning gods
(As per *Arthashastra*)

1. Vaayu in South-West Direction

In this write-up, the wind direction is taken into scrutiny. According to *Vaastu Shastra,* the South-West side is supposed to be presided by *Vaayu*, the wind god. Generally speaking, wind comes with monsoon and South-West monsoon is the prevalent monsoon in India. It appears to be logical to attribute this direction to Vaayu(even if the concept of god is overlooked). However, this assumption is not valid for all places. A modern scientific document called Wind-Rose diagram shows the prevalent wind direction. This document is carefully prepared to determine prevalent wind direction for a particular place over the years. The Air force stations keep a record of the wind directions of the respective places and makes available for public. One such website is *www.mesonet.agron.iastate.edu/sites/windrose.phtml*. To illustrate this, two representative windrose diagrams are presented in Fig. 2-3. Whereas Fig. 2 is for Jorhat, Fig 3 is for Hyderabad.

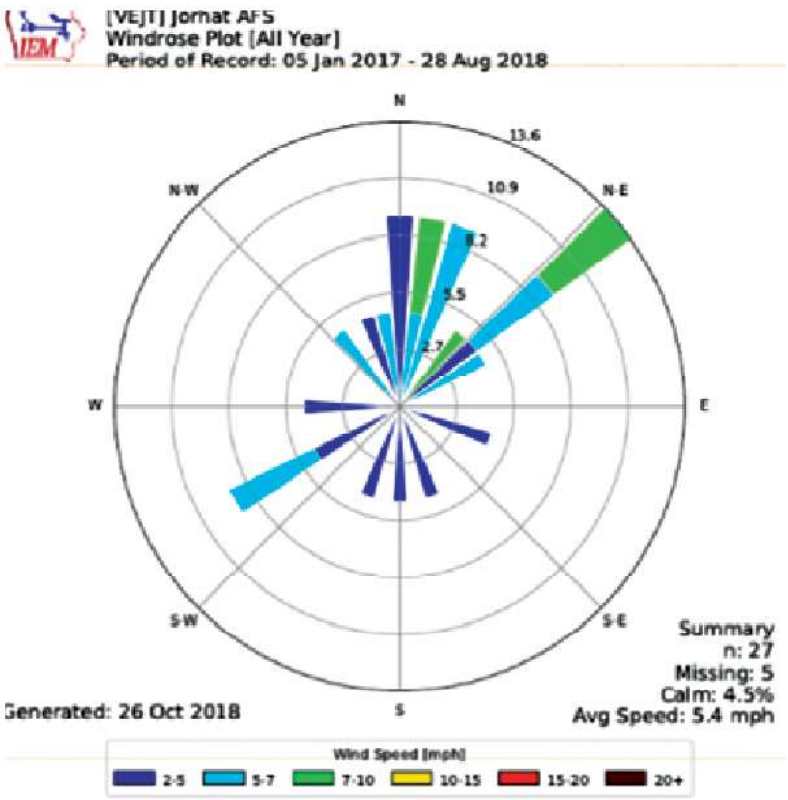

Fig. 2 Wind rose diagram of Jorhat [2]

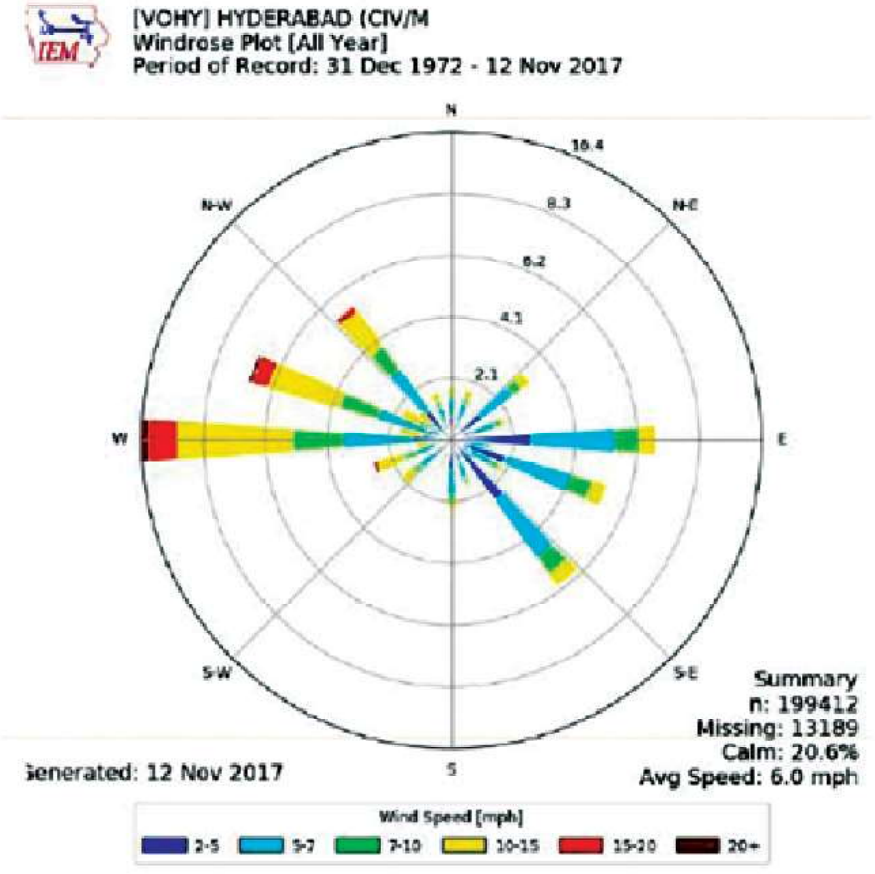

Fig. 3 Wind rose diagram of Hyderabad [2]

It is clear from Fig. 2 and Fig. 3 that prevalent wind direction is nowhere near South-West. In fact, in case of Jorhat, it is North-East.

With this example it can be easily said that the one of the very basic belief *Vaastu Shastra* is found on wrong notion.

1. Conclusion

In this write-up attempt has been made to see the reason behind a Vaastu Principle in the light of scientific understanding. It may be concluded that belief without proof must not be propagated in the name of technical topics under a science and technology university.

Post Script: The reference for the subject "Building Construction and Planning" under ASTU contains no reference for *Principles of Vaastu Shastra.* It is but natural for the subject experts not to include any as there is actually no respectable reference under the heading *Vasstu Shastra.* ❖

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2. *https://mesonet.agron.iastate.edu/sites/windrose.phtml*

INDUSTRY EXPERIENCE OF STUDENTS

1. Summer Internship at NRL

Nibedita Doley

B.E 7th Semester

The Numaligarh Refinery is located at Morangi, Golaghat district, Assam in India is a refinery owned by Numaligarh Refinery Limited, a joint venture between Bharat Petroleum (61.65%), Oil India (26%) and Govt of Assam (12.35%). In the training programme, first we were trained about Fire and Safety management which is an important tool for ensuring safety in refinery. We were informed about Personal Protective Equipments (PPE) which are used at work site to reduce risk of dangerous occurrences during a hazard. PPE includes boiler suit, safety shoe, and safety helmet. Basically, there are two categories in civil department, namely Civil Maintenance Department and Project Department. Insulation, refractory, painting, housekeeping etc. are supervised by the civil maintenance department. We were given a full refinery tour by the civil maintenance department. Then, paintings in the interior wall of the tanks were shown to us. We came to know about the types of paints, primers used there and steps to be taken during painting job is done. Also, they showed us different types of insulating materials that are used in insulation works and existing hot and cold insulation in the pipelines. Moreover, we were taken to the construction site of new refinery gate and new CSIF office building. We were given the estimates, drawings of the work to study and we saw reinforcement bindings of column, slab and casting of slab and using of vibrating tool during casting. Later on, we were assigned a survey project where we need to locate the OWS pits in the refinery and roughly calculate the distances between them. Finally, we made a map of the refinery and located the pits by using suitable scale. ❖

2. Summer Internship at Irrigation Department, Govt. of Assam

Supriya Borah

Civil Engg. 7th Semester

An internship enables us to gain first-hand exposure of working in the real world. It also allows us to harness the skills, knowledge and theoretical practice that we have learnt in our college. Internship is a major part in the learning process. So, I along with a few of my classmates undertook a one month summer internship at Irrigation Department, Guwahati Division (Ulubari). Irrigation is a branch of Civil Engineering which deals with artificial supply of water to the fields to get the best crop output qualitywise as well as quantitywise. Irrigation department designs, constructs, operates and maintains the irrigation schemes. During our internship programme, at first a revision was done about the irrigations schemes, types, canal diversion headworks etc. Also we were shown some designs and estimates of the department. After knowing the basics of design works, we visited some sites of minor schemes. Mainly, we visited some electrical lift irrigation schemes which have been working from almost six years. There we saw how water is lifted from a suitable location of a river with the help of electrically operated machines. Some storage were there where water is stored for further use. The lifted water is then distributed to the crop fields with the help of specially designed canal system to meet the water requirements of crops. Thus irrigation helps in production of good quality crops and provides the basic infrastructure for the growth of economy. Undergoing the internship programme, we came to know the real life aspects of the irrigation system and our theoretical knowledge was enhanced. ❖

3. Summer Internship Experience at PHED, Govt. of Assam

Siddharth Borah

Civil Engg.7th Sem

One of the major experiences recommended during our time as an undergraduate is doing an internship. I together with few of my classmates undertook a one month summer internship at Public Health Engineering Department, Jorhat Division. Public Health is the branch of engineering which deals with water supply and sanitation works. Its main goal is to enhance quality of life of the people by ensuring sustainable safe drinking water and sanitation facilities and services along with promoting hygiene practices according to their choices and affordability. On 26th of June, 2019 we were taken to Neer-Nirmal Pariyojana Water Treatment Plant, based near the bank of river Brahmaputra, in the ghats of Nimati, Jorhat,Assam. It was a water treatment plant with a capacity of 28.2 MLD. Initially, traces of arsenic and many toxic substances were found in water table of the area. Therefore the proposal of Neer Nirmal Pariyojna came in play where only surface water is taken as the source. We were given a detailed idea of the various features of the project and about the various components of the water treatment plant. We then visited The Greater Titabor Pipe Water Supply Scheme(Zone II). Our main purpose for the visit was to be familiar with the environment and to get practical knowledge of water treatment plant components. Next we visited the Bongal Pukhuri PWSS which supplies water to various areas of Jorhat using ground water as the source. We also visited the Swach Bharat Mission Office. The objective of the mission is to achieve an open defecation free India. In Assam more than 88% works have been completed under the Swachh Bharat Mission. Twin pit Technology is commonly used under SBM for construction of toilet in several areas. Finally we visited the District Level Laboratory and conducted various tests on water samples to check for contamination. The water sample collected should not be contaminated by outer environment. The branch carries out tests on water samples collected from various localities and certify it for use in day to day life. The summer training was a great learning experience. Our theoretical knowledge was enhanced through practical medium. We came to know the real life aspects of the water treatement units and their individual functionings.

Also the officials and engineers involved in the site were quite co-operating and they understood the essence of our practical knowledge requirement. So I would advise everyone to take the opportunity to do an internship even if it is not necessarily in the field that you wish to work in as it enhances our practical knowledge and gives us a clear understanding of the situation and how it is dealt with. ❖

4. Summer Training IIT GHY

Darshana Devi, Maitry Phukan, Mayurakshee Kakoti, Rajdeep Dhar, Mrigakshi Bania

Civil Engg.7th Sem

The topic entitled "A critical review of hydrographs in hilly terrain" consists of a brief description of hydrology and precipitation for reference purpose. This project, at its base in IIT Guwahati is an original piece of work carried out by us under the guidance of Dr. Arup Kumar Sarma.

Measurement of rainfall, rain gauge and its types has also been discussed. We studied the factors that influence the hydrograph shape and volume, base flow separation, and had a detailed review of hyetograph and effective rainfall. From effective rainfall hydrograph, we found out the direct runoff hydrograph. Unit hydrograph of a complex storm was studied and flood analysis of the Garbhanga watershed area was done by synthetic hydrograph method. The hydrograph characteristics are the effective rainfall duration, the peak direct runoff rate, the basin lag time. The length of Garbanga area has been calculated using centroidal distance h/3. From these relationships, five characteristics of a required unit hydrograph for a given effective rainfall duration may be calculated, the peak discharge for unit watershed area, the basin lag, the base time, and the widths of the unit hydrograph at 50% and 75% of the peak discharge. As we have done a case study in the Garbhanga catchment area, we have found out cumulative 24 hour precipitation values. We have also studied coir erosion control net which has water holding capacity, erosion control, and provision for growth of vegetation. The stage and discharge curve is established with the data provided. Channel discharge is measured across a drainage channel according to manning's formulae, stage is measured by taking interval of 50 cm ranging from 0 to 0.95m as 0.95 m was the provided depth of channel based on which we have also done a C- pogramme to find out the stage discharge curve as shown further in the report. With the given data of channel width, depth range, rugosity coefficient concentration, bed slope; the area of channel, wetted perimeter, hydraulic mean depth, velocity of channel and finally the discharge is found out. The 24 hour precipitation value is taken from the month of june of which the maximum rainfall value is taken. Then using the reduction

equation, we found out the resulting precipitation for the corresponding 2 hr rainfall. We find the intensity of effective rainfall. In the synthetic hydrograph method, basin lag is taken out, the distance along the main water course from the gauging station to a point opposite to the watershed centroid in kilometer is calculated, for the corresponding C_t and C_p; t_p,t_r, T_b, Q_{ps} are found out. D.R.H for 5 cm rainfall excess for peak discharges are found out separately. It is also done by superposition method to cross verify as well as to compare the discharges with respect to base time. D.R.H and U.H. for 2 hour with 5 hour excess rainfall is found out. D.R.H and U.H. found from rainfall excess of E.R.H with the corresponding peak discharges.

Similarly, for different sets of C_t and C_p, different values of peak discharges are found out. The synthetic hydrographs for the corresponding peak discharges have been drawn. It is a deterministic approach to find out whether the channels of the catchment area are flood prone or not, to check the dependency of channel discharges on the local parameters, to provide necessary drainage system designs accordingly ❖

5. Summer Internship at Indian Oil Corporation Ltd., Noonmati

Swapneel Sarma

Civil Engg.7th Sem

Guwahati Refinery was set up at Noonmati in Guwahati on 1st January 1962. Guwahati Refinery is the first Public Sector refinery of India and belongs to Indian Oil Corporation Limited. We were very fortunate to get selected for the summer internship in the month of July, 2019 at IOCL, Noonmati. The training took place for a duration of 30 days. At first we were taught about the "Fire and safety" rules to be observed within the refinery premises, it included the basic rules and regulations like - Smoking is strictly prohibited inside the refinery. Every person inside the campus should wear safety shoe and helmet etc. Next we were given a brief idea about the classification of fire namely- class A, B, C, D and E. We were introduced to the different branches of civil engineering in a refinery – (i) Civil maintenance (ii) Project department (iii) Engineering services and (iv) Contract cell. The jobs taken care of by civil maintenance are- Insulation, Refractory, Painting, Housekeeping, Building Maintenance, Storage Tank Maintenance, and Road Repair. We were given a tour around the refinery campus and shown the different units inside the premise. After all this we were assigned our project for the duration of the internship, we were instructed to do an in-depth plan study of a "SAND TRAP TO PROCESS DCU COKE CUTTING WATER IN ETP" and to a detailed estimation and analysis of the same. ❖

STUDENT PROJECT :

A SNAPSHOT…

A DETAILED STUDY OF SOIL CHARACTERISTICS BY THE ADDITION OF QUARRY (STONE) DUST

Maitry Phukan, Prasidhi Hazarika,
Debashis Borah, Suni Sonowal, Madhusmita Patir,
Guide: ***Arup Deka, Prasanty Borah***

Stone dust is a kind of solid waste material that is generated from stone crushing industry which is abundantly available. It is estimated that each crusher unit produces 15- 20% stone dust and the disposal of such wastes pose lots of geo- environmental hazards. The best way to eliminate these problems is to make use of such wastes. Keeping this in view, an experimental study was conducted on locally available soil by mixing it with stone dust.

The effect of distributed stone dust on Maximum Dry Density, Optimum Moisture Content, Liquid Limit has been discussed in this project. The percentage of stone dust by dry weight of soil was taken as 10%, 20%, 30%, and 40% by weight of the soil sample. The first series of tests were performed over soil, the second series over quarry dust and finally series of these tests were performed over various mix proportions of both soil and quarry dust.

It was observed that the optimum mix was obtained at 80% soil and 20% quarry dust mixture by weight. Mixing of soil with quarry dust also reduced the liquid limit effectively as the quantity of quarry dust increased. The below comparison chart (Fig 6.1)shows that as the quantity of quarry dust increases from 10% to 40%, there is a slight increase in the MDD value from 1.78g/cc to 1.83g/cc and the liquid limit decreases from 15.7% to 10%.

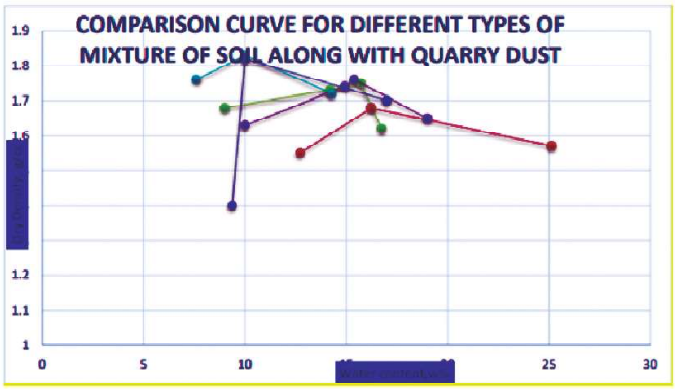

Fig 1. Comparison between different OMC & MDD curves of varying mixtures of soil and quarry dust.

The below comparison chart(Fig. 6.2) shows that as the quantity of quarry dust increases from 10% to 40%, there is a slight decrease from 15.96% to 11 %.

The concept of replacement of natural fine aggregates by quarry dust highlighted in the present investigation could improve the utilization of generated quarry dust, thus, reducing the requirement of land fill area and conserving the scarcely available natural sand sustainable development .This shall result in low waste generation by properly re-using it as a filling material. Re-using such wastes thus reduces cost making it much more economical. Also, it seems that the dry density increased with the addition of quarry dust with a significant decrease in the optimum moisture content. Hence, it has been observed that quarry dust proves to be a promising substitute for sand and can be used to improve the engineering properties of soil.

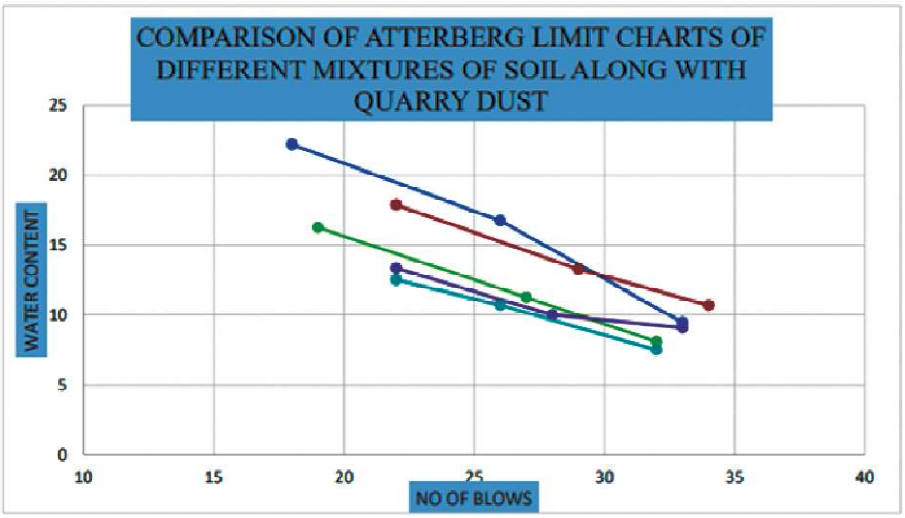

Fig 2. Comparison between different liquid limit curves of varying mixtures of soil and quarry dust. ❖

A PROJECT ON PERVIOUS CONCRETE PAVEMENT

Hussain Muhammad Ubaidullah, Arif Muhammad, Puja Hassam, Livi Chishi, Deba Prasad Choudhury

Guide: ***Mr. Rituparna Goswami and Mr. Koushik Kalita***

Pervious concrete (porous concrete, permeable concrete, no fines concrete and porous pavement) is a special type of concrete with a high porosity used for concrete flatwork applications that allows water from precipitation and other sources to pass directly through, thereby reducing the runoff from a site and allowing groundwater recharge. Pervious concrete can be used in a wide range of applications, although its primary use is in pavements which are in: residential roads, sidewalks and pathways, parking areas etc.

The aim of our project is to discuss various combination of pervious concrete with different aggregate size and water cement ratio. Three aggregate sizes 2.36-10mm, 10-20mm and different proportions of mix of both sizes are taken. Owing to its pozzolanic properties Ground granulated blast-furnace slag is used as a replacement for Portland cement in one mix. Water-cement ratio of 0.28, 0.32 and 0.35 were used for each aggregate size. The objective of this investigation is to study the effect of variation in aggregate size and water-cement ratio on pervious concrete performance in terms of strength and permeability. The experimental investigation was carried out to evaluate the density, compressive strength and permeability for each concrete mix. ❖

A STUDY OF SOLID WASTE MANAGEMENT IN JORHAT TOWN

Narzia Sultana Ahmed, Jahangir Alom, Jyotirmoy Talukdar, Bijon Bikash Borah, Nilnabh Sonowal, Madhurjya Goswami

Guide: ***Dr. Mrinal Kumar Dutta and Mr. Koushik Kalita***

Solid Waste Management (SWM) is an organised process of storage, collection, transportation, processing and disposal of solid refuse residuals in an engineered sanitary landfill. SWM is an integrated process comprising several collection methods, varied transportation equipment, storage, and recovery mechanism for recyclable material, reduction of waste volume and quantity and disposal in a designed sanitary landfill.

The present scenario of solid waste management in Jorhat town is studied in details. At first, the primary data is collected by conducting a household SWM survey, site visit, visual inspection and interaction with municipality workers. The secondary data is collected from the Jorhat Municipal Board office, Statistical office and other sources. The data mainly consists of waste generation and their characterization, collection and transportation. After analysing the data collected from the household survey and various other sources, gaps have been identified with Solid Waste Management Rules, 2016. A methodology has been provided for proper segregation and collection, effective transportation, processing and recycling of waste and finally scientific disposal of non-biodegradable waste. Many modern techniques are to be recommended for proper processing of biodegradable waste in Jorhat and finally, suggestions are to be provided for the modification of a proper landfill at Garmur as per the Solid Waste Management Rules, 2016 norms. ❖

A STUDY OF THE INFILTRATION RATES OF VARIOUS TYPES OF SOIL IN THE JORHAT ENGINEERING COLLEGE CAMPUS USING THE DOUBLE RING INFILTROMETER

Sabnam Parbin Laskar, Chandan Sarma, Baadshah Soleman Imran Rosul, Anurag Dutta, Supriya Borah, Himangshu Daimary,

Guide: ***Dr. P.K. Khaund, Mr. Utpal Ray***

Infiltration test is conducted in different types of soil within the college campus using the double ring infiltrometer. The main objective of the project is to determine the rate of infiltration at various locations against different saturation condition of the soil.

It has been observed that owing to rainfall, very little rate of infiltration is obtained in some locations and thus test is again carried out later to re-evaluate the infiltration rates. At each site, the infiltration rates are measured twice at different weather conditions and the variation of infiltration rates with moisture content of the soil is represented graphically.

Soil samples are also collected from the respective locations with the help of core cutter and various lab tests are also conducted to determine the dry density using the oven dry method. The liquid limit and the plastic limit tests are also conducted using cone penetrometer to classify the soil accordingly.

The infiltration test, thus helps us to determine how the rate of infiltration varies from place to place depending upon the type of soil and the soil properties. ❖

COMPARATIVE STUDY OF PERMEABLE CONCRETE AND ITS FEASIBILITY IN THE PRACTICAL FIELD

Priyam Pratim Pathak, Poppy Gohain, Nibedita Doley, Mriganka Kumar Das, Angshuman Baruah

Guide: ***Dr.Nayanmoni Chetia and Mr.Utpal Ray***

Evolution of technology has been the most significant with the evolution of mankind. Ever since the environment has started to deteriorate because of the carelessness of man, we are in search of solutions which help create environment friendly and cost effective ways to build and recreate pollution free environment for fitter survival. Such effective ways have been developed in the field of concrete technology and Permeable concrete is one such example. Permeable or pervious concrete is that concrete which primarily consists of coarse aggregates and less or no fine aggregates associated to the mix. It thus enhances the permeability of the concrete and become solution on civil works that can solve water clogging or water accumulation. If proper design is done with addition of admixtures and fillers it may even reduce the percentage of coarse aggregates to give some equivalent strength then we may say permeable concrete as a good solution. Our study revolves with its most efficient design to give proper strength and permeability to the concrete so that it can even be used to reduce floods to some extent and help refilling the groundwater table especially in regions where the water level is decreasing. Thus, permeable concrete stands to be a similar solution as the green concrete. ❖

DETAILED ANALYSIS OF G+2 RCC RESIDENTIAL BUILDING

Chinmoy kurmi, Bishal Dutta, Darshana Devi, Jablinson Timung, Ashique Akhtar

Guide: ***Gautam Hazarika and Pranjal Sarma***

The title of the project is "Detailed Analysis of G+2 RCC residential building". The entire analysis of the structure is mainly developed with the help of kanis method. The basic objective in structural analysis and design is to produce a structure capable of resisting all applied loads without failure during its intended life. Kani's method uses a method of iteration for statically indeterminate structures and can save a great deal of time compared to moment distribution method especially considering structures with a couple of storeys or more. It is much simpler and less time consuming method compared to other methods with less percentage of errors making the analysis safe ultimately enhancing the longevity of the structure. Since the northeastern region is highly prone to seismic catastrophes, therefore we cannot afford being inaccurate in our results.

Interestingly, the times are changing, and new methods with ease of calculation and accuracy are being developed with economy also being one of the main factors. This is the age of computers to take over almost everything. This also includes design in Civil Engineering. As the role of accuracy is important in calculations, we cannot think of a better option than involving computers in the mix. Everything from giving a preview of the structures to rectify any human errors to virtually checking the stability, the workload has been reduced drastically. Still a human mind has infinite capabilities. Hence the procedure has been progressed with manual approach, without the involvement of computers which can solve, design and analyse a structure. ❖

OPEN DUMPING OF MUNICIPAL SOLID WASTE (MSW): EFFECTS ON WATER QUALITY AND SOIL

Monish Sinha, Sanyukta Bora, Nishant Parasar, Mrigakshi Bania, Bensinle Magh, Achyut Dutta

Guide: ***Dr. Mrinal Kumar Dutta, Miss Joba Goswami***

Municipal Solid Waste Management has become one of the major problems in urban and semi-urban areas with rapid increase in the population and urbanization. Improper MSW disposal and management causes air, soil, and water pollution. Most of the dumping sites have been built without any sound engineering design such as engineered liners and leachate interception and collection system. Deteriorating soil quality and decrease in vegetation abundance are grave consequences of open waste dumping which have resulted in growing public concern. Indiscriminate dumping of wastes contaminates surface and ground water supplies and arise major health and safety issues. The main objective of this study therefore is to investigate the effects in water and soil due to dumping of solid waste and to find out the remedial measures so as to prevent water and soil contamination. The Study area is located in the southern part of Jorhat district of Assam between latitudes $26^0$75'N, longitudes $94^0$22' E & latitudes 26^0 74' N & longitudes 94^0 22' E. The residents have raised serious concerns about the disposal site due to foul smell and the menace of stray animals in the area. We have seen that the Tocklai River, Jorhat has been blocked over the years and the waste falling into river may be one of the causes. To study the extent of water contamination 9 sampling sites and for soil contamination 3 sampling sites were selected near the dumpsite from where the samples were taken with care. The samples oiwere analyzed for the different physico-chemical parameters like pH, Total hardness, Alkalinity, Chloride Content, Turbidity, Total dissolved solids, Do content, Iron content, etc as well as Heavy Metals according to the standard methods. If the test result exceeds permissible limits, then certain remedial measures would be suggested so as to prevent water and soil contamination. Although the concentrations of few contaminants exceed the permissible limits, water and soil quality represents a significant threat to public health. Urgent attention therefore, needs to be paid to the water supply from this region.

Fig 1: Snaps from dumping yard. ❖

SEISMIC VULNERABILITY IN THE FLOOD PLANES OF ASSAM

Nayan Jyoti Dutta, Rahul Dutta, Aktar Hussain, Abhishek Kumar Laskar, Lalnghatlien Darngawn

Guide: ***Dr. Atanu Kumar Dutta and Abhigna Sandeepkumar Bhatt***

The main objective of the project lies in the context of the present earthquake hazard scenario in Assam, which falls in the nation's most earthquake prone zone (Zone V). The flood plane is mostly inhabited by indigenous tribes. Places like Majuli (which is the world's largest river island) has the potential to be declared as world heritage place. This land being mostly alluvial in nature, and water table being very near, the soil liquefaction is a parameter which cannot be overlooked. The population use traditional stilted houses in this region which is again a typical housing typology not fully studied. So this is a project encapsulating both the structural and geotechnical aspects and the interaction thereon is highly desirable to asses the seismic vulnerability of these houses.

After completion of this project the expected outcome of this project will be that there will be a proper understanding of the seismic behaviour of traditional stilted houses in alluvial plane, which will lead towards devising appropriate structural solutions to remove vulnerability of these houses against probable earthquake. Also there could be suggestions in retrofitting existing houses of this typology. ❖

SOIL REINFORCEMENT USING BAMBOO

Sagarika gogoi, Anurag gogoi, Jyotismita das, Sringbili charangsa, Nokbe teron, Ruhinul Haque Choudhury

Guide: ***Dr. Arup bhattacharjee, Mr. Nihir boro and Ms. Marlina gowala***

The use of bamboo as reinforcement in Portland cement concrete has been studied extensively by the Clemson Agricultural College. Bamboo has been used as a building material globally by the human civilization since a very long period of time but after the Clemson study, its use as reinforcement has gained little attention. A study of the feasibility of using bamboo as the reinforcing material in precast concrete elements was conducted at the U. S. Army Engineer Waterways Experiment Station in1964. Ultimate strength design procedures, modified to take into account the characteristics of the bamboo reinforcement were used to estimate the ultimate load carrying capacity of the precast concrete elements with bamboo reinforcing. This study has been taken as a reference in the study conducted henceforth. The investigation of the use of bamboo as a complimentary material with steel in Reconstruction has been shown in this study with the economy, safety, convenience and durability of application of the particular idea. Since the use of bamboo in the ancient times for housing purposes, it has been diminishing in our world in the form of a building material in despite its rich properties, strength and economic advantages. There are several methods presented and deduced by universities and the U.S navy and has proven the validity of the use of bamboo in structural members such as columns and girders. Hence in this report, the methods are presented by the members of this group for the better strength and more applicable methods with the least compromise in strength. Methods that have been put forth in this report are not guaranteed to have the best outcomes or with any assurance of the maximum strength of a structure, the designs being presented are those which have been tested on software simulation for safe working load and failure analysis. This could be very helpful and have a very good breakthrough in the field of concrete designing with prominent economic benefits over steel (being used with it) and its benefits related to the reduction of carbon emission in the atmosphere, if methods like these are applied extensively and studies for the development of a code pertaining to concrete design with bamboo reinforcements can be brought forward for a better future of economical and eco-friendly RCC construction.

Need of the project

The implementation of various technologies used in the field of RCC construction have not been changed since the time steel in the form of reinforcement was introduced and codes were developed to use it in various conditions and in several manners in load bearing structural members. Whatever the reason being behind this trend is surely the immense strength of steel but for smaller structures, where little strength is required as compared the high-rise structures to tackle self-weight as well as the loads that amount to a huge magnitude because of numerous floors. The structures that are not meant to be put under loads of magnitudes this high can be built with an alternative of steel that can bear loads up to certain limits safely and is cheaper, easy to avail and eco-friendly. Bamboo happens to be such a material and can be replaced by steel in various parts of a structure. Bamboo can be used extensively in column design. It can also be coupled with steel in beams to tackle strength up to a certain limit where it has to be coupled with steel in doubly reinforced beams. Whenever it has to be put with steel, design principles involved with the setting of steel can be used when coupling bamboo with steel. The major reasons for putting forth the methods in the field of changing reinforcements to bamboo is its Carbon-absorbing property while it grows, so instead of emitting CO2, unlike steel, while it is in the stages of growing, it would absorb it. It will also help in reducing the self-weight of the structure.

Bamboo has a fibrous structure and can also absorb vibrations which can also be very helpful in low magnitude seismic shocks. A great deal of money is spent on projects where steel is bought for seismic proofing and putting them in between the walls for shock absorption, whereas bamboo is much more affordable and can be more easily cut according to the required cross-section and length thus saving the cost of cutting it with heavy machinery moreover, its fibrous structure with giving it an edge over steel in absorbing vibrations. ❖

SOIL REINFORCEMENT USING PLASTIC WASTES

Maitry Phukan, Prasidhi Hazarika, Debashis Borah, Suni Sonowal, Madhusmita Patir

Guide: ***Dr. Arup Bhattacharjee and Ms. Prasanty Borah***

It is observed that plastic wastes like the polyethylene bags, plastic bottles, plastic straw, etc tend to accumulate underground upon deposition. These entities are non-biodegradable and prove to be really dangerous when being exposed to the environment. So, is there a way by which the geotechnical properties of the soil can be studied in order to draw down a comparison between various types of plastic wastes and its impact on soil reinforcement?

We plan to test the optimum moisture content (OMC) vs maximum dry density (MDD) of the soil sample collected by the J.E.C lake by adding various proportions of plastic bottles, polythene bags of size lesser than 50 micron and polythene bags of size more than 50 microns, cutting the plastic into a constant dimension of 1.5cm x 0.5cm, thus, performing the standard proctor test for determination of MDD. We have mixed 0.1%, 0.2%, 0.3%, 0.4% & 0.5% of all the above mentioned plastic wastes by weight of the total soil sample and performed the test. We have also correlated the MDDs with the concentration of the each individual plastic type and intend to compare all the results upon completion of our project.

So far, we can come upon a conclusion that upon addition of plastic wastes into the soil, the soil has an increased strength as the MDD increases upon increasing the plastic concentration in the soil. But a point comes where the concentration of plastic exceeds the soil concentration and the interaction of soil and plastic results into a reversal of strength in the soil, and the MDD starts to decrease after a certain plastic concentration. The main reason is supposed to be the increase of plastic amount in the soil compared to the soil entities alone which leads to a decreased soil interaction, due to presence of plastic in excess amount. We have till now completed the analysis of plastic bottle interaction with the soil where the MDD graph showed reversal after 0.4% concentration (optimum concentration) by weight of the plastic strips. Hence, the correlation showed a continuous increase in the MDD till the optimum concentration beyond which it

decreased.

Further, we wish to complete our analysis with all the plastic wastes mentioned by performing various other geotechnical tests other than the standard proctor test, i.e the UCS test to check the shear properties of soil upon the addition of plastics as well. We also try to compare the effect of the roughness parameters of the one-time use plastic bags and the recyclable plastic bags in enhancing the strength properties of the soil.

Fig 1: Preparation of soil sample ❖

STUDY OF DIFFERENT PARAMETERS OF BACTERIAL CONCRETE

Sharmina Aktara Begum, Swapneel Sarma, Ayushman Rabha, Denis L. Gangte, Suman Debnath, Queen Konwar

Guide: ***Dr. Nayanmoni Chetia and Mr. Baharul Hussain***

Concrete is still one of the main materials used in the construction industry, from the foundation of buildings to the structure of bridges and underground parking lots. Traditional concrete has a flaw, it tends to crack when subjected to tension. Self-healing concrete could solve the problem of concrete structures deteriorating well before the end of their service life. The objective of our project is to compare the different parameters of bacterial concrete like compressive strength, split tensile strength, flexure strength etc. with that of a normal mix of concrete and drawing a conclusion on how the addition of bacteria in the concrete mix will affect the properties of concrete and also we will be checking the self-healing nature of bacterial concrete by forming some cracks in a beam by applying load and allowing it to heal.

Fig 1: Preparation of bacterial concrete and the bacterial sample ❖

THICKNESS DESIGN OF DIFFERENT LAYERS OF FLEXIBLE PAVEMENT INCLUDING MIX DESIGN OF DBM

Siddharth Borah, Shresth Modi, Joshita Das, Ruplin Kropi and Mharhoni Y Yanthan

Guide: ***Mr. Rituparna Goswami and Mr. Koushik Kalita***

Design of flexible pavement by CBR method has always been one of the most important topics, for the Civil Engineers. One of the main advantage is the simplicity of conducting CBR test in laboratory as well as method of pavement design using simple design charts. However based on the local design requirements (such as traffic. climatic and other environmental factors) each country develop their own design chart. The CBR method of flexible pavement design was being extensively used in different countries of the world for quite a long period of time. In this project, main road of Jorhat Engineering College was taken. At the very beginning initial traffic survey was conducted. After this, the design traffic was calculated considering various factors as per IRC: 37-2012. By conducting soaked CBR test of subgrade, required thickness of different layer, and total thickness of the pavement was found out using CBR design plate of IRC: 37-2012. To limit cracking and rutting in the bituminous layers and non-bituminous layers, allowable strains were calculated from the Fatigue and Rutting models respectively as per IRC: 37-2012 and checked with the computed strains from IITPAVE software

In India, use of bitumen content has been prevalent since many years ago. Although these mixtures of bitumen and aggregate proved as a successful pavement material, they were not proportioned on the basis of any proper mix design criteria. As the knowledge regarding paving material expanded, the quest for more economical, functional and safer design criteria using an optimum bitumen content in bitumen macadam came to the forefront. To satisfy the mix design specification, numbers of method have been developed. The present study highlights this variability involved in the bitumen mix design process. In this project optimum bitumen content for DBM (Dense Bituminous Mecadam) Course is found out using Marshall Stability Test as per MORTH 5th revision 2013 and IRC: 37-2012. This study is based on Indian specifications, where mix design, like in many other countries, is performed in accordance with Marshall Method. ❖

STUDENTS' CORNER

INDIA-PAKISTAN "TECHNO-POLITICAL" CRISIS ON HYDROLOGICAL DATA

Chandan Sarma
6th Semester
Department of Civil Engineering

Since independence, the world has seen many phases of insecurities, wars, conflicts and strategic negotiation among both the neighbouring countries commonly named in contrast with each other as India and Pakistan. Both the countries have gone through numerous wars, military standoffs, nuclear conflicts and what not for matters involved like the sensitive Kashmir issues, cross border terrorism, religious dogmas, and for issues and allegations involved with the intelligence bureaus of both the nations (not to forget the Kulbhushan Yadav Case).

With so many conflicts and allegations of both the nations against each other, there has arisen a new "Techno-Political crisis" due to abrogation of the special status for the state of Jammu & Kashmir and bifurcation of the union territories in which the state of India has stepped back from sharing its hydrological data to Pakistan.

What exactly is the hydrological data exchange between the two countries?

Originating from the Tibetan Plateau in the vicinity of Mansoravar, Indus is one of the longest rivers in Asia and it plays a vital role as a lifeline to Pakistan. The river flows through Ladakh, the region of Kashmir towards the region of Hindukush ranges and then flows southerly covering the entire length of Pakistan. With some of the most complicated irrigation systems and with a crucial role in power production over the river, Indus forms the spine of Pakistan.

Along with Indus, Chenab and Jhelum are the other vital waterbodies of our neighbouring country whose origin also passes through India. Thus, Pakistan is highly dependent on the hydrological data supplied by India in order to have an eye on the characteristics change over these rivers.

The partition of the British India has brought about many issues and conflicts among both the countries and one among them being water distribution methodology of the Indus river system. Brokered by the World Bank in 1960 a famous treaty known as the "INDUS WATER TREATY" was formulated to bring about systematization in the

use of the water in Indus systems. This agreement under a negotiation of nine years brought about control in water division in six major rivers. Under this treaty, India got its control over Beas, Ravi, Sutlej, while Pakistan got its control over Indus, Chenab, and Jhelum. As, the river systems under which Pakistan got its control do not originate within the country, rather originates from either India or China, therefore the hydrological data of these rivers within the Indian territory plays a crucial role for Pakistan for its control and regulation of water, misunderstanding of which may lead to complete disaster in the country.

India, on humanitarian ground and as a friendly gesture under an agreement of 1989 started sharing its hydrological data of these rivers to Pakistan which helped the country to understand the annual runoff, maximum discharge, historical maximum flow, flood forecast, flood frequency. The agreement is renewed every year. But as of now, the government of India as decided not to renew its agreement of 1989 due to is continuous and heinous attack and false allegations over the Indian Territory. This decision of India has made Pakistan outcry accusing India to have unleashed the fifth-generation warfare using water as weapon, claiming New- Delhi to share the technical data and reports of the Sutlej river, failing of which would lead to floods as well as drought across the Islamic nation, affecting normal life and agriculture over the region. ❖

THE HEART OF BRAHMAPUTRA

Shivani Nath
B.Tech, 5th Semester

The pride of Assam, our identity and something which can never be taken away from us. Majuli, the largest river island of India that stands strong in the Brahmaputra. But today I don't want to sing its known facts nor want to come up with its general knowledge. I want to tell its unknown and untold story.

In the days of yore, the people of Majuli heard a loud voice from Brahmaputra. The unknown voice kept on repeating "Banhoti kathito, jopatote pachito". It meant 'you will get a piece of split from a bamboo and a basket from a bamboo grove'. The voice urged them to learn the skill and art of mask making and perhaps this is how, the culture, the prestige we cherish today, the masks of majuli became such an integral part of Assam and our identity. Majuli is the only place in the north east India where such an act of art exists.

The heritage, of Majuli apart from being the largest river island in India. Majuli is synonymous with the practice of Neo -Vaishnavite tradition and culture that has been nourished here with great love and devotion. Although the largest riverine island, perhaps in world too, it is slowly disappearing.

Sri Mahapurush Srimanta Shankardev was a visionary. His philosophies had transcended the boundaries of religion, shaped by his philosophies the 'Satras' ,which apart from being platform for religious discoveries are also centre for cultural and creative knowledge. He even wrote plays on the life of lord Krishna and performed to depict the character of the play. Earlier the masks were made of wood, clay, earth. Later bamboo were naturally quite light weight and the satras were the place where masks were made.

The voice of Brahmaputra finally laid to rest. At present all the satras don't practice the art of making masks. The art has been kept alive at 'Notun Chamaguri Satra'. The masks big, small reminds us of the childhood stories told by our grandmother, the stories of Mahabharata and Ramayana.

Masks are of three types –

1. Mukha (there are only face masks)
2. Lotakai Mukha (in these mask eyes and lips can be moved)

3. Bor Mukha (big in size cover the whole body)

The Satradhikar of Notun Chamoguri Satra , Hemchandra Goswami is a master craftsman. He has kept the art of mask making alive and thriving. Winner of national award, he also happens to be a great storyteller. Majuli is the only place in Assam where such a rich culture is beholden as a part of Assam and Assamese people

.This is our culture and pride. The heritage of Assam should be protected and spread across the whole world. It is our identity and no identity can be taken until we hold it firm. ❖

নতুন দিগন্ত

নচিবুদ্দিন আহমেদ
ষষ্ঠ ষাণ্মাসিক
চি - ৩৯/১৬

জীৱনটো যে
এটা মহাসংগ্রাম
এই জীৱন সংগ্রামত
কেতিয়াবা যুঁজি যুঁজি
পৰোঁ ভাগৰি।
নিৰাশাৰ ডাৱৰবোৰে
মন মোৰ ঘনে ঘনে
ধৰে আৱৰি।
সেয়েহে কেতিয়াবা মোৰ
মনৰ মাজত এনে ভাব হয়,
নিৰাশাৰ মাজত যেন
আশাৰ পোহৰ
বিচাৰি পাম
ডাৱৰবোৰ আঁতৰি যাব
আকাশখন পোহৰেৰে
উদ্ভাসিত হ'ব।
মোৰ ভাগৰুৱা মনটো
এক আশাৰ পোহৰত
উদ্ভাসিত হৈ
এক নতুন দিগন্তৰ
সূচনা হ'ব ❖

আলোড়ন

দীপজ্যোতি ভূঞা
তৃতীয় ষাণ্মাসিক

সহস্ৰজনৰ সহস্ৰ আলোড়ন,
সশস্ত্ৰ নহ'লেও বাকবন্ধী যুঁজৰ আগমন।

উৎপীড়ন যেন আজি পৰিণত এটি সুলভ শব্দত,
অভিমান স্বাভিমানৰ দগাত যেন স্বাভিমান আজি
পৰাজয়বশত।

উন্মত্ত জনতা, উত্তপ্ত আজি সমগ্ৰ পৰিবেশ,
ৰাঙলী নদীৰ পানীৰে আজি ৰক্তস্নানৰ সমাবেশ।

শোষণ নিৰ্যাতনে আজি সমগ্ৰ মানৱজাতিতে বান্ধিলে
জাল,
অন্যায়, অবিচাৰৰ জয়যাত্ৰাত আজি চৌদিশে বাজিছে
ধ্বংস শক্তিৰ খোল তাল।

আপোনপাহৰা মানৱ জাতি আজি জাগ্ৰত হ'বৰে হ'ল,
আজি মূকবধিৰ হৈ বহি থকা জনৰ সকলো জহি খহি
নিঃশেষ হ'ল। ❖

যান্ত্রিকতাৰ পৃথিৱী আৰু আমি

ঋষিৰাজ শাণ্ডিল্য,
তৃতীয় ষাণ্মাসিক
অসামৰিক অভিযান্ত্রিক বিভাগ

যান্ত্রিকতাৰ এই পৃথিৱীত ধোঁৱাবিহীন ইলেক্ট্রিক ট্রেইনত আমি পূর্ণ গতিৰে আগবাঢ়ি গৈ আছোঁ, এবাৰো পিছলৈ ভুমুকি মাৰিবৰ প্রয়োজন হোৱা নাই আমাৰ। মাথোঁ আগুৱাই গৈ আছোঁ। কিন্তু আমাৰ গন্তব্য স্থল আমাৰেই অৱগত নহয়। তথাপিতো উন্নতিৰ জখলাত আগবাঢ়িছোঁ। প্রতিদিনে বৈজ্ঞানিক ন ন আৱিষ্কাৰক স্বাগতম জনাই নিজকে যান্ত্রিকতাৰ পৃথিৱীৰ ছাবি দিয়া পুতলালৈ পৰিণত কৰিছোঁ। জন্মৰ পূর্বৰে পৰা আমাৰ ওপৰত ইমানকৈ কাৰিকৰী কৌশল প্রয়োগ কৰা হৈছে যে জন্ম গ্রহণ কৰা সময়ৰ পৰা এটি শিশু যান্ত্রিকতাৰ পৃথিৱীৰ অংশ হ'বলৈ বাধ্য হৈ পৰে। বিভিন্ন কাৰিকৰী বিদ্যা গ্রহণ কৰি এইসমূহ জগতৰ উন্নতিত প্রয়োগ কৰাৰ চিন্তাধাৰা কেতিয়াও নেতিবাচক হ'ব নোৱাৰে, আদিম যুগৰ সেই দিনৰ পৰা বর্তমানৰ একবিংশ শতিকাৰ বিজ্ঞানৰ যুগলৈ ৰূপান্তৰৰ যাত্রা নিশ্চয় ইতিবাচক। চমক সৃষ্টি কৰা বিজ্ঞানৰ ন ন আৱিষ্কাৰসমূহে আমাক যি উন্নতি প্রদান কৰিছে তাৰ বাবে বর্তমানৰ যান্ত্রিকতাৰ সমাজ সঁচাকৈয়ে শলাগৰ পাত্র।

কিন্তু এই যান্ত্রিকতাৰ পৃথিৱীত পুৱা শুই উঠাৰ পৰা ৰাতিৰ শয়ন পাটিলৈকে উদ্‌গতিৰ যি চিন্তাধাৰা তাৰ মাজতে যেন আমি কিবা এটা পাহৰি গৈছোঁ। ক্রমাৎ সকলো যেন হৈ পৰিছোঁ স্বার্থান্বেষী তথা স্বার্থপৰ। সূক্ষ্ম পর্যবেক্ষণ কৰিলে দেখা পোৱা যায় যে মানৱজাতিৰ উন্নতি যিটো হাৰত বাঢ়ি গৈছে, ঠিক তেনেদৰে অপৰাধৰ মাত্রাও বাঢ়ি গৈছে। আমি যেন হৈ পৰিছোঁ মূল্যবোধবিহীন। মনুষ্যত্বৰ বিকাশ যেন হেৰাই গৈছে আমাৰ পৰা, মূল্যবোধৰ দৈন্যতাত আমি হৈ পৰিছোঁ সততাহীন।

আমাৰ পৰিয়ালসমূহৰ সংস্কাৰৰ দিশটো পিছপৰি যোৱাটো যান্ত্রিকতাৰ কোপদৃষ্টি নহয় বুলিব নোৱাৰি। আমাৰ জ্যেষ্ঠসকলক যান্ত্রিকতাই এনেদৰেই গ্রাস কৰি দিছে, অর্থাৎ উন্নতিৰ জখলাত আগবাঢ়িবলৈ তেওঁলোকে আপ্রাণ প্রচেষ্টা কৰিছে, যাৰ বাবে নিজ সন্তানৰ প্রতি থকা সামান্য দায়িত্বখিনিও পাহৰি গৈছে। যাৰ বাবে শিশুসকল হৈ পৰিছে সংস্কাৰবিহীন। ছাত্র জীৱনত আমাৰ মাজত আমাৰ মাজত দেখা পোৱা গৈছে মূল্যবোধৰ দৈন্যতা।

যান্ত্রিকতাৰ আমাৰ সমাজখনে এনে এক সাম্প্রদায়িকতাৰ বীজ সিঁচি দিছে যাৰ বাবে আমি হৈ পৰিছোঁ ধর্মীয় অন্ধবিশ্বাসী। আমাৰ যুৱ প্রজন্মই পাহৰি গৈছোঁ জ্যেষ্ঠসকলক সন্মান কৰিবলৈ, সৰুক মৰম-স্নেহ কৰিবলৈ ইত্যাদি ইত্যাদি। মুঠৰ ওপৰত আমাৰ অভিভাৱকে শুদ্ধ বুলি ভবা উন্নতিৰ জখলাডালত আমাৰ অনিচ্ছাসত্ত্বেও তেওঁলোকৰ আনন্দৰ বাবে বগাব ধৰিছোঁ আৰু নিজকে যান্ত্রিকতাৰ পৃথিৱীৰ অংশ কৰিবলৈ আগবাঢ়িছোঁ। অভিভাৱকৰ দৌৰাত্ম্যত হেৰাই গৈছে নেকি আমাৰ ক্ষুদ্র ক্ষুদ্র সপোনবোৰ, ক্ষুদ্র আশাবোৰ? মুঠতে আমাৰ শিশুসকলৰ সোণালী শৈশৱ ভিডিঅ' গেম, লেপটপ আৰু দুখনমান কার্টুন চিৰিয়েলৰ মাজতে সীমাৱদ্ধ। এই যান্ত্রিকতাৰ ফলাফল কি সেয়া নিশ্চয় সকলোৰে জ্ঞাত, কিন্তু সকলো জানিও আমি ইয়াৰ বিৰোধিতা কৰিব নোৱাৰোঁ। কিয়নো পুৱাৰ পৰা নিশালৈকে আমি লোৱা যান্ত্রিকতাৰ পৃথিৱীৰ সহায়ে আমাৰ হাত ভৰি শিকলিৰে বান্ধি ৰাখিছে।

কৈশোৰ অৱস্থাত SMARTPHONE আৰু COMPUTERৰ অবিহনে আমাৰ জীৱন অচল হৈ INTERNETৰ সুবিধাৰ কথা আজিৰ পচুৱৈ সমাজক মই নক'লেও হ'ব। INTERNETৰ পৃথিৱীত আগবাঢ়ি গৈ আমি যথেষ্ট জ্ঞান আহৰণ কৰিছোঁ। কিন্তু আমি জানো জীৱনৰ মূল্যৱান সময়বোৰ ছচিয়েল

মেডিয়া (SOCIAL MEDIA) যেনে FACEBOOK, WHATSAPP, WECHAT, TWITTER ইত্যাদিতে অতিবাহিত কৰা নাই নে? আমাৰ প্ৰত্যেকৰে হাততে যৎপৰোনাস্তি তুলি দিছে একোটাকৈ স্মাৰ্টফোন। কিন্তু ইয়াৰ ব্যৱহাৰ আৰু ফলাফলৰ প্ৰতি কাৰো গুৰুত্ব নাই। ছাত্ৰ জীৱনটোত আমি যেন কেৱল অধ্যয়ন আৰু ইণ্টাৰনেটৰ মাজেৰেই দিনবোৰ অতিবাহিত কৰি দিছোঁ। আমাৰ মাজৰ পৰা হেৰাই গৈছে নেকি আমাৰ মাজত থকা সুপ্ত প্ৰতিভাবোৰ? MESSAGE লিখাৰ Short Languateয়ে পাহৰাই দিছে নেকি আমাক মাতৃভাষা লিখিবলৈ? সমাজত যেন আমি পঢ়াশুনা ছাত্ৰ-ছাত্ৰী হৈও সন্মুখৰ পৰা দুআষাৰ আমি জনা কথা এটাকে বিৱৰণ দিব পৰা নাই। ৰাতিপুৱাৰ পৰা টিউচন, কলেজ, কোচিং, প্ৰেমিক-প্ৰেমিকা এইবোৰৰ মাজত যেন আমি এখন তত্ত্বমূলক গ্ৰন্থ পঢ়াটো দূৰৰ কথা, পাহৰি গৈছোঁ যেন ৰাতিপুৱাই হকাৰে দি থৈ যোৱা ড্ৰয়িংৰুমৰ কোনোবা এটা চুকত পৰি থকা মাত্ৰ বাৰ পৃষ্ঠাজোৰা বাতৰি কাকতখন পঢ়িব। দেশৰ কি হৈছে, ক'ত উন্নতি হৈছে, ক'ত বানপানী হৈছে, বৰ্তমান ৰাজনৈতিক পৰিস্থিতি, সামাজিক, অৰ্থনৈতিক সমস্যাৰ বিষয়ে ভাবিবলৈ সময় নাই, কিন্তু অভিভাৱকৰ অৰ্থ হানি কৰি বৰ্তমানৰ AERISTOCRATIC পৃথিৱীৰ সৈতে ফেৰ মাৰিবলৈ অনাহক পাৰ্টিৰ নামত মাদক দ্ৰব্য সেৱন কৰিবলৈ আমাৰ সময় নিশ্চয় আছে। দেশৰ সমস্যা আজি আমাৰ দেশৰ নহয়। দেশৰ গৌৰৱো আমাৰ নহয়। কেৱল নিজক লৈয়ে যেন ব্যস্ত আমি সঁচাকৈ আমাৰ বাবে ছুপ্ৰিম পাৱাৰ সদৃশ যান্ত্ৰিকতাই বাৰু আমাক লৈ আহিল নেকি এনেকুৱা পৰ্যায়লৈ?? চাৰিওফালে দুৰ্নীতি, ভ্ৰষ্টাচাৰ, ধৰ্ষণ, লুণ্ঠন দেখিও কিয় নাইকিয়া হৈছে আমাৰ ইয়াৰ বিৰোধিতা কৰিবলৈ সময় তথা সৎসাহস? নে যান্ত্ৰিকতাৰ ROBOTICSৰ যুগত আমি আমাৰ বাহুবল কি আছিল পাহৰি গ'লোঁ।

ট্ৰেইনখনত সঁচাকৈয়ে আমি বহু বেগত আগবাঢ়ি আহি আছোঁ। মই কাকো থমকি ৰ'বলৈ কোৱা নাই। কিন্তু ইয়াৰ সমান্তৰালভাৱে আমি নোৱাৰোঁনে অলপ চিন্তা কৰিব? মনটোক আমি অলপ বহল দৃষ্টিভংগীৰে আগবঢ়াব নোৱাৰোঁনে? যান্ত্ৰিকতাৰ সুফলখিনি গ্ৰহণ কৰি কুফলবিলাক উপলব্ধি কৰিব নোৱাৰোঁনে?

এই কথা সত্য যে এই গতিত আজিৰ সভ্যতা গৈ থাকিলে আৰু কথাখিনি এতিয়াই উপলব্ধি নকৰিলে আজিৰ মনুষ্যত্ব, মূল্যবোধ আদিৰ দৈন্যৰ দৰে এদিন আমি স্বাৰ্থপৰ সমাজে পাহৰি যাব লাগিব আমাৰ কৰ্তব্য, আৱেগ, অনুভূতি, স্বাধীনতা। তেতিয়া জানো যান্ত্ৰিক পৃথিৱীৰ ন ন আৱিষ্কাৰে আমাক আমাৰ ধুনীয়া পৃথিৱীখন ঘূৰাই দিব পাৰিব?? পাৰিবনে? ❖

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