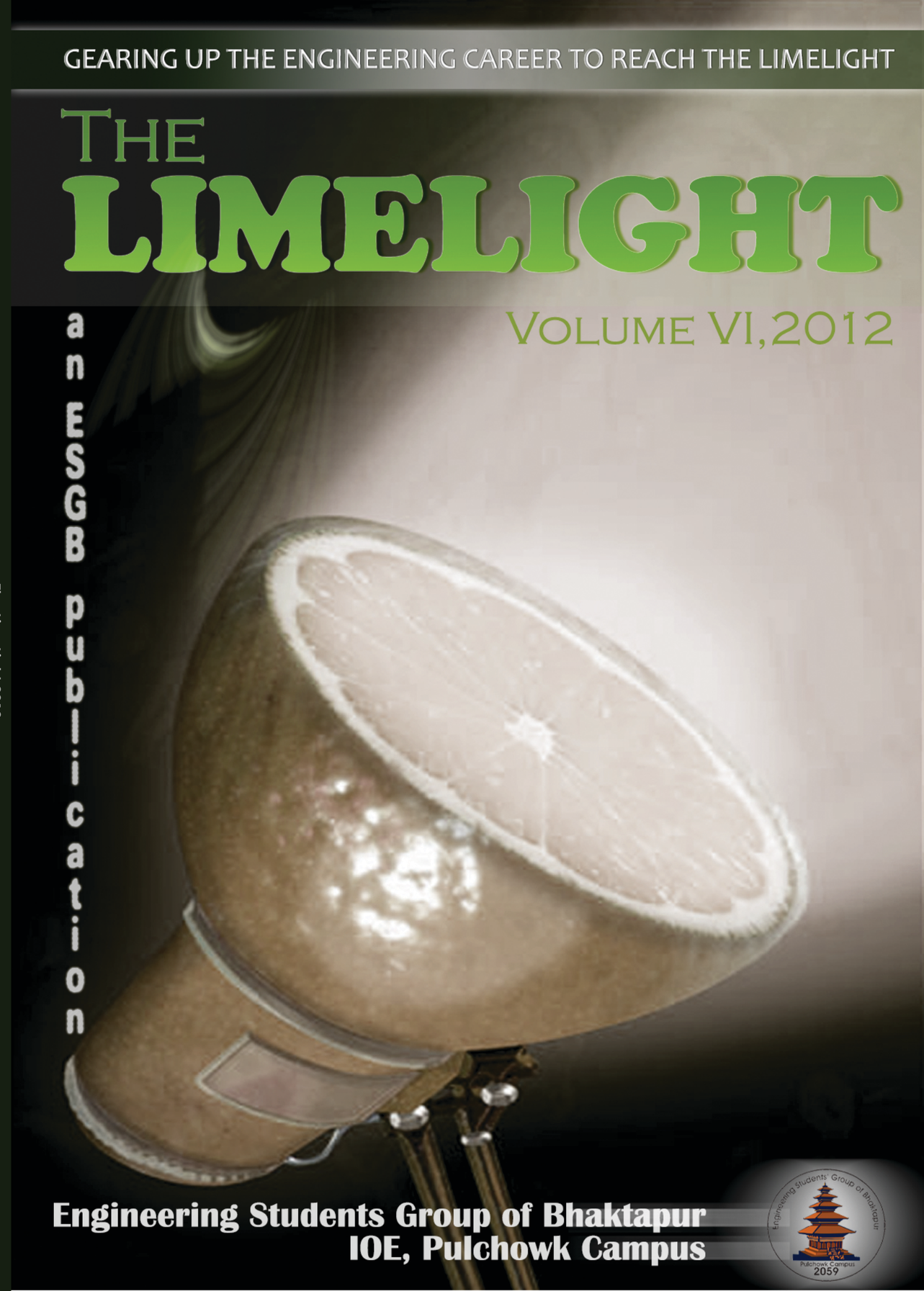
The LimeLight 2012

GEARING UP THE ENGINEERING CAREER TO REACH THE LIMELIGHT

THE LIMELIGHT

VOLUME VI,2012

an ESGB publication



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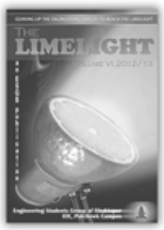
The LIMELIGHT

Editorial

6th Edition, 2012



THE LIMELIGHT TEAM

Vow to be valiant
Resolve to be radiant
Determine to be dynamic
Strive to be sincere
Aspire to be attuned

World is dynamic and everything changes with time. In this sense, change is inevitable and we ought to move with it. Therefore we need to pace with the dynamic world and grab each opportunity that comes for us.

"Scientist investigates that which already is
Engineers create that which has never been" – Albert Einstein

So, "The Limelight", the technical journal makes effort to portray engineering field, its possibilities and challenges and bridge the gap between the engineering and non-engineering field. The Limelight is not just for engineers but our effort seeks the direction to transfuse the engineering knowledge to layman.

Continuity gives us roots, change gives us branches and letting us stretch makes us grow and reach new heights. Thus, despite obscured obstacles, we are back with new spirit with our technical journal "The Limelight". This is the sixth volume of "The Limelight" and there is an immense amount of pride and pressure at its release. At this blissful moment, we must salute everyone who has directly and indirectly helped us accomplish this mission. Without their support and feedback, releasing this magazine would have been an endless abyss for us. We would like to shower our heartiest gratitude to all our sponsors and well wishers.

We have tried to make this issue perfect, flawless and to live up to the expectation of readers but it is bound to be erroneous. With full effort, we present "The Limelight VI" that we think will prove to be candle in darkness. Finally, we would like to mention that we are always expecting your precious comments, creative criticism and suggestions for the betterment of this journal and enhance its significance in the future

Don't Watch the Clock, do what it does. Keep Moving!

The Limelight 2012 Team

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Date: 2069-9-15

Message from the Dean

I am happy to write few words in this magazine- " The LIMELIGHT", an organ of students' group of Bhaktapur (ESGB), IOE, Central campus, Pulchowk.

I feel very happy that ESGB is publishing in a periodic way this publication containing different articles of teachers and students. I believe, such publications are the platform for dissemination of creative achievements of teachers and students of engineering discipline.

Our concern is the prosperous Nepal and this is possible only with increasing productivity through capable and competent work force. Institute of engineering (IOE) is, therefore, striving to produce brains who can contribute to the economic growth of Nepal. I believe, our students through ESGB and this publication shall carryover this mission of IOE eventually contributing to the national development process.

The effort of the LIMELIGHT-publication of ESGB is appreciating in this regards.

Institute of Engineering
Office of the Dean

Prof. Dr. (Er.) Bharat R. Pahari
[B.E.(civil), M.Sc. engg (Building), Ph.D.(quality of Engg Edu), Post Doc.(Quality Mgmt.)]

DEAN

TRIBHVAN UNIVERSITY

INSTITUTE OF ENGINEERING

PULCHOWK CAMPUS

PULCHOWK , LALITPUR

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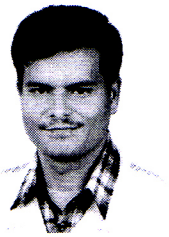
MESSAGE FROM CAMPUS CHIEF



It is a matter of a great pleasure to learn that the member of Engineering students' Group of Bhaktapur ESGB of this campus is publishing the sixth volume of technical journal "The Limelight".

As the world is surging towards knowledge, economy, present day professionals, especially the youngsters are thirsty for knowledge, innovative daring to dream & daring to excel. In this context, the continuous effort made by ESGB is really appreciable.

I wish ESGB to succeed in their quest for providing the opportunity to all that are interested and enlighten some hidden talent. I extend my heartfelt congratulation to all members of ESGB editorial board of the magazine for their success.

With Best Wishes!

Dr. Arbind kumar Mishra
Campus Chief
Pulchowk Campus

त्रिभुवन विश्वविद्यालय
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पुल्चोक ,ललितपुर

च. नं. मितिः-

Date: 2069-9-15

MESSAGE FROM FSU PRESIDENT

It is a pleasure to express few words on the occasion of publication of sixth volume of annual technical magazine "The LimeLight" by Engineering Students' Group of Bhaktapur(ESGB), IOE Pulchowk Campus. The effort of ESGB for the publication of this magazine is highly appreciable and would like to congratulate the team of the magazine for their success. The magazine will be very helpful for the technical students and professionals.

Lastly, I would like to congratulate and thank ESGB. And Free Student's Union always encourages the students to publish such types of magazine in future also.

With Best Wishes!

Prakash Sapkota
President
Free Students' Union
Pulchowk Campus

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THE LIMELIGHT
PULCHOWK CAMPUS

ACKNOWLEDGEMENT

Our team is very grateful to our seniors of ESGB who took the initiation in formation of Engineering Students' Group of Bhaktapur (ESGB). ESGB has become one of the best knowledge sharing and experience gaining platform for us.

We would like to express our deepest gratitude to all the seniors , friends and well wishers who has guided us in every step and event of ESGB including the publication of "The Limelight 2012" with their valuable suggestions. Without their constant encouragement, support and guidance we could have never completed our quest.

Our humble appreciation is towards the Executive Committee of 'Engineering Students' Group of Bhaktapur' (ESGB), without whose untiring efforts and support, we would have never been able to achieve this success. The Limelight 2012 team is thankful to all the professors, teachers, students and writers who contributed their resourceful technical articles and research works. Without their support we wouldn't have succeeded in fulfilling our aim.

We would like to express our sincere gratitude to all the business, educational and social enterprises for advertising in our magazine. This has been the main financial backbone for our publication.

We would like to thank Mr. Tulsi Lal Basukala, Er. Romas James Hada and Shiva Prasad Bala for their motivating words and effective guidance in the path to our success.

Last but never the least, we would like to thank everyone who has helped and supported us in any means for this publication.

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Seismic Performance Evaluation of a Reinforced Concrete Arch Bridge

Dr. Rajan Suwal[1] and Jeena Dangol[2]
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Abstract:

The entire Himalayan belt, because of its active tectonic movement, is seismically active causing high risk of earthquake in that region. Nepal lies at the very central part of the active Himalayan belt and therefore is vulnerable to disastrous earthquakes. Hence it would be imprudent to ignore the effects of earthquake on the infrastructures. The main purpose of this research is to analyze the seismic response of a reinforced concrete arch bridge. The dynamic characteristics of the study bridge under earthquake loading will be obtained by response spectrum analysis and time history analysis using structural analysis program SAP2000.

Introduction

The arch is one of the oldest structures known to man. Historically, the Romans perfected the arch bridge. No matter what the design is, all arch bridges share one common trait that is the ability to support an immense amount of weight. Almost everything that is built to take great pressure is curved, such as the hull of a submarine. Its structural properties allow arch to support such large amount of weight. The forces on an arch bridge extend outward and downward, a condition called compression. That is why arch bridges must be built using materials that take compressive loads well. In an arch bridge the main structural system supporting the deck is a curve member (or members), higher vertically at its center than its ends, acting almost entirely in compression with its compressive load being maintained by thrust against immovable supports called abutments.

Arch bridges utilizing a single arch must have spandrel columns. These columns help to transfer weight to the arch as well as to act as a connector between the bridge deck and the arch. Mainly three types of arches are used in practice: three-hinged, two hinged and fixed arch. Without hinges, arch ribs extend continuously from skewback to skewback and are fixed at skewbacks so no rotation can occur and thus the bridge is called a fixed arch. There can be two or three hinges in an arch. The three-hinged arch has hinges at the center and at the skewbacks, and the two-hinged arch has hinges only at the skewbacks. These hinges permit the transfer of the main compressive loads from one section of arch rib to another or to the abutments without transfer of bending movements. Hinges at the skewbacks simplify only the abutment design, but hinges at the crown and the skewbacks simplify the design of the arch rib as well as the abutments, eliminate stresses due to temperature changes, and allow the arch to tolerate minor movements of its abutments. The two hinged arch uses hinged bearings which allow rotation. The only forces generated at the bearings are horizontal and vertical forces.

Arch bridges are mainly suitable where we can find hard rock on both sides of abutment and where piers cannot be provided at mid. These bridges can be economically used for large spans. Arch bridges are generally constructed at stable rock site and have not experienced much seismic disturbance in the past. However, this does not give credit to be safe in extreme earthquakes.

Main defects in arch Bridges

Common defects of Main Arch Rib and Transverse Beams

a) Deficiency of Stiffness

Calculation model is unreasonably simplified, ignoring spatial effect or multi arch effect, thus producing calculation results different from actual stress status. The structure with deficiency cannot bear increasingly heavy loads and cracks under long-term loading.

b) Unreliable Transverse Connection

Because of weak transverse connection due to design or bad construction quality, arch ribs cannot adequately distribute loads transversely. It results in differential displacement between ribs under overloading, damaging transverse beams and consequently accelerating the failure of arch ribs.

c) Bad Workmanship in Construction

Concrete cracks due to shrinkage of concrete, heat of hydration, inadequate curing or poor treatment for construction joint. When arch ribs are constructed in segments and if concrete pouring is not dense in the joints, local concrete stress at this position increases extensively and concrete cracks under loading.

d) Overloaded Operation

Frequent overloads and speeding vehicles produce high stresses in bridges. Furthermore overloading brings about large distortion of arch ribs, cracks on transverse beams, disruption of structural sholeness and structural damage or even collapse.

Common defects of Column and Bent Cap

a) Differential Displacement of Ribs

Because of weak transverse connection, differential displacement occurs on each of ribs under deviated loading or temperature variation. The differential displacement of ribs means differential settlement of columns and bent caps.

b) Weak Connection Detailing

Since columns are cast in situ after ribs are constructed, structural integrity is less than if the whole structure were cast in situ. This results in reduction of the strength and rigidity of the connections and causes structural damage.

Common defects of Bridge Deck Slab

a) Small Section

Longitudinal and transverse cracks occur on thin section of slab with insufficient reinforcement cover. Such damages generally take place on deck slabs close to expansion joints.

b) Bad Quality of Joint construction

Poor concrete pouring quality reduces the rigidity of joints and structural integrity. If the joints are damaged, deck slabs bear load separately, which results in cracks in slabs that finally extend to deck pavement.

c) Deck Slab Transversely Placed

Damage mostly occurs on arch bridges with deck slab transversely placed.

Common defects of Abutment and foundation

a) Differential Settlement

Differential settlement leads to horizontal, vertical and rotational displacement of abutment. Because of differential settlement, tension stress in abutment brings about tension damage. Moreover, multiple-arch action, foundation yielding and unbalanced earth pressure also gives rise to abutment displacement and settlement.

b) Temperature Effect

An abutment is a huge mass concrete cast at the same time. After pouring, temperature of inside concrete is much higher than the outside due to heat of hydration. The temperature difference results in cracks on concrete surface.

Seismic Damages to Reinforced Concrete Arch Bridges

Nearly 1600 bridges suffered extensive damage in the Wenchuan Earthquake (M 8) that occurred in China in 2008. Several reinforced concrete and stone masonry arch bridges were damaged in the earthquake.

Kazhuhiko Kawashima et al. (2009) prepared a reconnaissance report on the damages to bridges during the earthquake and also presented their possible damage mechanisms. Investigations showed that collapse of most bridges resulted from the failure of reinforced concrete structural members. Important structural members and joints such as lateral beam-column connections and pile caps and slant-leg joints were insufficiently reinforced to form plastic hinges. Insufficient ductility capacity of the members and joints further exacerbated the damage leading to collapse.

A rigid frame RC arch bridge named Xiaoyudong Bridge received great damage in Wenchuan earthquake. Hao et al. (2008) reported that the bridge collapsed due to fault displacement. Kenji Kosa et al. (2011) also performed damage analysis of the bridge and made comparisons between the results from pushover analysis with the actual failure conditions from field survey.

A two span RC bridge named Jingtianaba Bridge also collapsed in the earthquake. The middle piers first toppled in the longitudinal direction, followed by the collapse of the two main arches. Kazhuhiko Kawashima et al. (2009) mentioned in their report that the excessive response displacement of the arches in the longitudinal direction resulted in failure of the mid pier as well as the arch ribs.

Another two hinged arch RC bridge named Hongdong Bridge of Mianzhu district completely collapsed in the earthquake. Similarly, Jinhua Bridge, a RC arch bridge with box shaped ribs showed extensive cracks on the side walls of abutment and shear cracks at the support of the deck at the arch crown.

There were a number of short span arch bridges which suffered damage for example, Caishenmiao Bridge in Qingchuan. A large number of stone masonry arch bridges also suffered damage.

Fig: Failure of Slant leg due to insufficient amount of reinforcement to form plastic hinge (Xiaoyudong Bridge, 2008, Wenchuan Earthquake)

Fig: Flexural and shear failure at connection of pile cap, slant legs and vertical piers due to local buckling of main bars (Xiaoyudong Bridge, 2008, Wenchuan Earthquake)

Fig: Tilt of pile and collapse of decks (Xiaoyudong Bridge, 2008, Wenchuan Earthquake)

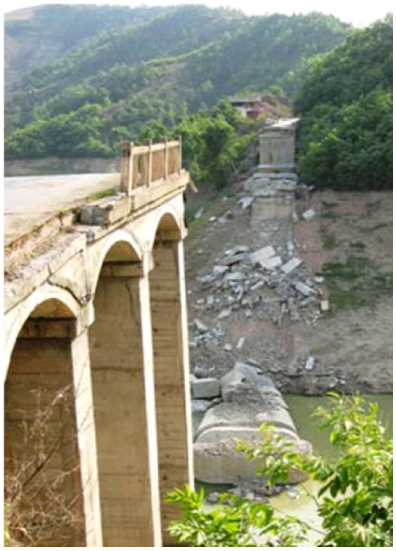

Fig: Collapse of Jintianba Bridge (2008, Wenchuan Earthquake)

Fig: Completely collapsed Hongdong Bridge (2008, Wenchuan Earthquake)

Fig: Cracks on side walls at an abutment, Jinhua Bridge (2008, Wenchuan Earthquake)

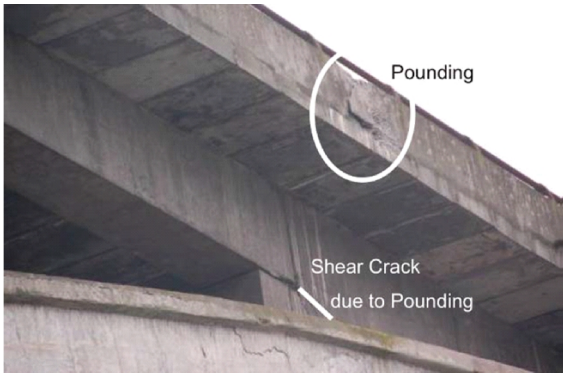

Fig: Shear cracks at the support of deck at arch crown due to ponding, Jinhua Bridge (2008, Wenchuan Earthquake)

Studies and Researches related to Seismic Performance of Arch Bridges

Giovanna Zanardo, Carlo Pellegrino, Carlo Bobisut and Claudio Modena (2004) evaluated the static and seismic performance of three existing short span RC bridge in Italy under non-uniform seismic displacements, before and after seismic interventions. Non-uniform support movement causes more damage to arch bridges than to straight bridges (Hao, 1993). Hao (1993, 1994) has investigated the effects of differential foundation movements on arch bridge responses.

Kazuhiko Kawashima and Atsushi Mizoguti presented on their paper the seismic performance of a RC arch bridge under a strong ground motion developed in the 1995 Hyogo-Ken Nanbu earthquake. It was found from the analysis that Kobe type ground motion induces large compression force, which is about double the design axial force and even some tension force in the arch rib. Large vertical response acceleration and displacement are induced by the lateral excitation due to significant mode coupling between lateral and vertical modes. The vertical excitation contributes to the axial force and bending moment in the arch rib. Thus, it is important to consider the vertical excitation in the design of arch bridge.

Trausti Hannesson presented in his thesis report the response of a concrete arch bridge to seismic loading which was not designed for seismic loading. Response spectrum analysis was performed on the isolated bridge and compared to the response of the original bridge. Non-linear time history analysis was performed using ten artificial time histories and the response compared to linear response spectrum analysis. It was concluded that the most critical structural elements in the bridge are the short spandrel columns which can be effectively protected by designing an appropriate isolation systems. The arch response is only slightly improved by the seismic isolation.

Near field ground motion

Ground motion in near field zone is characterized by strong, coherent long period pulses and is strongly influenced by the rupture mechanism, the rupture direction relative to site as well as possible permanent ground displacement at the site resulting from tectonic movement. Depending upon the first two factors, ground motion in the near fault zone can exhibit the phenomena of “forward directivity”, “neutral directivity” or “backward directivity”. Depending upon the last factor, ground motions close to the rupture surface may contain a significant permanent displacement, which is termed “fling-step” (Bray and Rodriguez 2004).

Forward directivity effects occur when the fault rupture propagates towards the site at a velocity that is almost as large as shear wave velocity and the direction of slip on the fault is aligned with the site. Forward Directivity Ground Motion (FDGMs) typically contain very few long period, high intensity ground motion pulses that are best observed on displacement and velocity time histories than on accelerations (Andrian Rodriguez-Marek). Backward directivity effects occur when a site is located at one end of the fault and rupture propagates away from the site. Neutral directivity occurs for sites located off to the side of the fault rupture surface when the rupture is neither predominantly towards nor away from the site (Bray and Rodriguez 2004).

Fling step is the static component of near-fault ground motion and is characterized by a ramp-like step in the displacement time history and a one-sided pulse in the velocigram. Pulses from fling-step have different characteristics than forward-directivity pulses. Whereas forward-directivity is a dynamic phenomenon that produces no permanent ground displacement and hence two sided velocity pulses, fling-step is a result of a permanent ground displacement that generates one sided velocity pulses. Fling effects are independent of epicenter location and are generally longer period than corresponding directivity effects. They decay rapidly with distance “d” from the fault (i.e. they attenuate proportionally to $1/d^2$). Furthermore these effects are important only for surface ruptures say less than about 5 km from the fault trace (Mirko Corigliano 2007).

The 2008 Wenchuan, China earthquake exposed the seismic vulnerability of several reinforced concrete arch bridges. A four span rigid frame arch bridge named Xiaoyudong bridge situated close to the fault was severely damaged in the earthquake. Since the 1994 Northridge earthquake and 1999 Chi-chi earthquake, many researchers have studied the characteristics of near-fault earthquake and seismic performance of the structure under such earthquake.

Wen Jun Gao, Guang Wu Tang and Yi Da Kong investigated the nonlinear response of a typical reinforced concrete rib arch bridge to near-fault ground motions recorded in 2008 Wenchuan earthquake. Results showed that significant seismic damage may occur, maximum demands were higher for near-fault records having forward directive than far-fault motions, and the rotational capacity of rib plastic hinge is not enough for the large compression force of arch rib. While backward-directivity motions, typically do not exhibit pulse-type motions, only have medium seismic damage to the arch bridge.

Adrian Rodriguez-Marek and William Cofer (2007) performed non-linear seismic evaluation of three concrete bridges under both forward directivity and non-FD ground motion. It was found that significant seismic damage may occur if the structural response is in tune with the velocity pulse of the FDGM. The response of bridges to FDGMs is highly dependent upon the period of velocity pulse. If this period is close to one of the bridge fundamental periods, significant damage can occur during a few cycles of motion.

Tsutomu Usami, Zhihao Lu, Hanbin Ge and Takeshi studied the inelastic behaviour of steel arch bridge subjected to strong ground motion. The steel arch bridge investigated in the study demonstrated satisfactory seismic performance under longitudinal earthquake excitation and performance was insufficient when subjected to transverse earthquake excitation. Hence it was concluded that the transverse direction of steel arch bridge is more dangerous than the longitudinal direction under earthquake and therefore, the behavior of this direction should be paid more attention.

Similarly, Mirko Corigliano (2007) in his doctoral thesis proposed a simplified approach, both in longitudinal and transversal directions, for studying the seismic

response of deep tunnels in near fault conditions. Erol Kalkan and Sashi K. Kunnath (2006) investigated the effects of fling step and forward directivity on the seismic response of steel moment frames. In the study, fling step effects were considered in several ways. Results from the study indicated that neat-fault records with fling can be more damaging than far-fault records.

Bridge modeling

When modeling an arch bridge, it is acceptable to model the arch using straight-line elements and a plane frame model. Based on the previous researches, it has been found that ten elements will yield acceptable results. Micheal Chajes in his research "Load Rating of Arch Bridge" used ten straight-line bridge elements having a unit width to model an arch bridge in STAADpro. If the arch is of varying thickness, the line segments should be modeled as tapered elements.

Trausti Hanneson in his thesis "Seismic Analysis and Design of Concrete Arch Bridge", created a 3-D model of concrete arch bridge in SAP2000. Beam elements were used to model the structural elements. The arch was divided into 150 elements, columns into maximum length 1m and the bridge deck into elements of maximum length 2m. The number of elements was determined from the considerations of modal analysis.

Since large axial variations of axial force occur in the arch rib, it is important to consider the non-linear interaction of axial force and flexural moment (Kazuhiko Kawashima and Atsushi Mizoguti). They idealized the deck and vertical members by linear beam elements. Because of unavailability of a reliable analytical model to take into account of the large axial force variation, only flexural non-linearity was considered in the analysis, i.e. the arch rib was idealized by flexural non-linear beam elements with Takeda type hysteretic behavior.

The study bridge (Chobhar arch bridge) is located in Chobhar, 9 km southeast of Kathmandu. Chobhar is known for the Chobhar gorge, which is linked with the origin of the Kathmandu valley, through which all the water of the valley drains. The bridge links Chobhar of Kirtipur to Sainbu of Lalitpur. It is a reinforced concrete two-hinged arch bridge with three numbers of arch ribs. Another suspension bridge over the gorge, which is more than 100 years old, is not in use now.

In this thesis, a three-dimensional finite element model of the study bridge has been created using 386 joints and 440 members in SAP2000. A series of non-linear time history analysis will be carried out using at least five strong ground motions so as to analyze the seismic performance of the bridge to near filed ground motion.

References:

Abdul Quadir Bhatti (2009), Seismic vulnerability of historical arch type bridge structures in Italy.

Andrian Rodriguez-Marek and William Cofer (2007), Dynamic response of bridges to near-fault, forward directivity ground motions.

Ch. A. Maniatakis, L. M. Taflampasa and C. C. Spyrakos (2008), Identification of near-fault earthquake record characteristics, 14 WCEE China.

Erol Kalkan and sachi K. Kunnath (2006), Effects of fling step and forward directivity on seismic response of buildings, Earthquake Spectra Vol. 22 367-390.

Giovanna Zanardo, cario Pellegrino, Carlo Bobisut and Claudio Modena (2004), Performance Evaluation o f short span reinforced concrete arch bridge, Journal of Bridge Engineering ASCE.

J.F. Jia and J.P. Ou (2008), Seismic analyses of long-span cable-stayed bridges subjected to near-fault pulse type ground motions, 14 WCEE China.

Kazuhiko Kawashima and Atsushi Mizoguti, Seismic response of a reinforced concrete arch bridge.

Kawashima K., Takahashi Y., Ge H., Wu Z. and Zhang J. (2009), Reconnaissance report on damage of bridges in 2008 Wenchuan China earthquake, Journal of earthquake Engineering Vol. 13,pp 956-998.

Ke Chen and Jianyong Song, Survey and analysis of the main defects in reinforced concrete ribbed arch bridges.

Ke Chen, Fei Yu, Huicheng Pan and Lei Wang (2011), Cause analysis of structural deterioration of reinforced concrete rib arch bridges.

Kenji Kosa, Zhongqi Shi, Jiandong Zhang and Hideki Shimizu (2011), Damage analysis of Xiaoyudong Bridge affected by Wenchuan earthquake China, Journal of Structural Engineering Vol.57A.

Kirty Tiwari (2011), Time history analysis of cable stayed bridge subjected to near fault pulse type g r o u n d motion.

Mirko Corigliano (2007), Seismic response of deep tunnels in near-fault conditions, Research Doctorate in Geotechnical Engineering, pp. 30-39.

Wen Jun Gao, Guang Wu Tang and Yi Da Kong (2011), Failure mechanism of reinforced concrete rib arch bridge under near fault earthquakes, Journal of applied Mechanics and Materials Vols. 90- 93.

Fast Track Mere Illusion - Neither "Fast" Nor Suitable

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Even in 21st century, it takes more than 6/7 hours to reach Pathlaiya in Tarai from Kathmandu, a distance of under 70 kilometers as the crow flies. Before Mugling on Prithvi Highway was connected with Narayangarh on East West Highway, it was an arduous trip of, sort of, a whole day winding up and down steep hills. Although, Pathlaiya lies due south from Kathmandu, people now have to take a detour of over 100 km to Mungling, due west, and then retrace almost the same distance back from Narayangarh, heading east, to reach Pathlaiya. In this backdrop, people have been exploring possibility of shaving off the distance, and, also, time from such trips since some time.

Tunnel Highway to Hetauda

At one point in time, people were embroiled in a debate about connecting Hetauda from Kathmandu through a set of tunnels. Besides tunneling being exorbitantly costly (due to fragile geology of Nepal's "young mountain"), it would have "served" as a veritable death trap, as plying the vehicles being used in Nepal's roads now, would have resulted in asphyxiation of the passengers by the carbon monoxide, spewed by these vehicles, in the tunnels; proving that the idea is a product of "tunnel vision." Then the powers to be decided to build, a so called, fast track road, after a feasibility study was completed on the auspices of Asian Development Bank.

Will Fast Track be "Fast"?

Now people are busy talking about fast track; forgetting (or failing to understand) that it will not be fast in reality. The design speed of this road is stated to be 80 kilometer per hour (km/h); 50 km/h in mountainous terrain. Maglev (magnetic levitation)[1] train is the newest form of surface transport mode, the highest recorded speed of which is 581 km/h. In China, the trip from Shanghai to the airport – a distance of 30 km – is covered in just 7 minutes 20 seconds, achieving a top speed of 431 km/h (268 mph), averaging 250 km/h. High speed trains have already been in use since a long time in many countries; bullet train's best average speed is 262 km/h in Japan. Similarly, train to Lhasa travel at 160 km/h on the plain, slowing down to 120 km/h when it reaches the Qinghai-Tibet section.

Therefore, with faster and more cost effective technology already becoming available in our own neighborhood, it isn't prudent to go for a technology that is not really fast, in the name of fast track. Nepal should use the most cost effective technology and mode of mass rapid transportation (MRT) system from amongst array of modes now in use in the world. The cost effectiveness should be measured in terms of life cycle cost, including net of positive and negative externalities of the mode and technology (including carbon emission and its local negative externalities in terms of adverse impact on health).

In view of this an attempt is being made in this article to evaluate electric train from Kathmandu to Tarai and the so called fast track and assess which mode will be best suited from the perspective of the macro economy and the commuters.

Fuel Efficiency

Even if Nepal had been endowed with a large mineral reserve of fossil fuel, it would have made economic sense to switch to rail transport instead of wheel based transport as, according to a 1995 U.S. Government estimate, the energy cost of carrying one ton of freight a distance of one kilometer averages 337 kJ for water, 221 kJ for rail, 2,000 kJ for trucks[2]. Therefore, it demonstrates downright lack of vision for Nepal to be dependent on fossil fuel for wheel based transport when (a) she doesn't produce a drop of fossil fuel and (b) it costs just 11 percent of fuel cost of wheel based transport for train service – a saving of 89% in fuel cost. By going for train using fossil fuel Nepal could have put MRT in place and also saved 89% on fuel cost; resulting in commensurate reduction in losses suffered by Nepal Oil Corporation (NOC) as well as reduction of balance of trade and balance of payment deficit (also stemming unnecessary drain on foreign currency).

Moreover, for Nepal, the best policy is to use energy sources for transport other than fossil fuel. In other words, in the interest of self reliance too, a country like Nepal should have gone for transportation mode that is not dependent on fossil fuel which has to be transported from aboard. That is, the best mode of MRT for Nepal is electric train service; weaning Nepal away from dependency on imported fossil fuel (a firm step towards self reliance) and also availing transport service to the users at substantially lower cost (as energy cost of rail is one-ninth of wheel based transport). With the new technology of regenerative braking system becoming available, electric train can, further, be operated at lower energy cost.

It is estimated that the vehicles currently plying in Kathmandu-Pathalaiya route use about 10,000 kiloliters (kl) fuel each month (120,000 kl annually); and growing steadily. With the construction of fast track, the current fuel consumption will be reduced by 35% (in present route) – a reduction of 42,000 kl in a year. However, if electric train is to be built, the fossil fuel consumption of 120,000 kl will completely be eliminated thereby stemming drain on foreign exchange to that extent and, consequently also reducing loss suffered by NOC as well as balance of trade and balance of payment deficits of the country.

Besides, as petroleum product is a strategic commodity and any unfriendly act on the part of our neighbor have had crippling effect and the dependency has proven to

be fatal. The trade embargo and blockade of transit imposed by India in late 80s succeeded in bringing Nepal's economy to a grinding halt. From this perspective too, Nepal's transport policy needs to be focused on self sufficiency; especially when Nepal has high potential for electricity generation.

Carbon Offset

If Nepal's consumption of fossil fuel is to go down by 120,000 kl each year, as mentioned above, then Nepal will succeed in curtailing its emission of greenhouse gases (GHGs) by 321,000 tons in a year; as 1 liter diesel emits about 2.68 kg of carbon dioxide.[3]By trading this quantum of carbon offset at the median rate of US$ 10/ ton, Nepal could earn US $ 3.2 million which is equivalent to Rs 240 million at the exchange rate of Rs 75/USD. In such a scenario it isn't wise to be building more roads dependent on fossil fuel and polluting more. Even at local level, the pollutants emitted by fossil fuel guzzling vehicles aversely impact people's health; resulting in unnecessary medical expense and even absenteeism from work – reducing national productivity.

Capital cost

It has recently been reported that the fast track will cost about Rs 56 billion. However, according to the feasibility study and preliminary design prepared by Oriental Consultants Co. Ltd. in association with ITECO, for ADB, the cost of 4-lane "North South Fast Track Project" is Rs 69.11 billion, at the conversion rate of Rs 75/USD, as detailed below:

Cost estimate in million USD

	Foreign	Local	Total
Civil works	330.3	373.	703.3
Equipment	2.6	.5	3.1
Land	0	25.6	25.6
Consultancy	11.3	37.6	48.9
Subtotal	344.2	436.7	780.9
Physical contingency	17.1	21.5	38.6
Price contingency	17.3	84.7	102
Grand Total	**378.6**	**542.9**	**921.5**

On the other hand, in accordance with a study conducted by Messrs Shankar Nath Rimal and Birendra Keshari Pokhrel, renowned engineers, it costs only about Rs 18.46 billion to build electric train connecting Kathmandu with Tarai. Moreover, investment of Rs 69 billion is for the construction of just the road while Rs 18.46 billion spent on electric train is inclusive of track and the rolling stock to run on it. In this backdrop it doesn't make sense for Nepal to chose "fast" track instead of electric train.

For a country like Nepal, investing Rs 69 billion just to build the road can in no case be deemed prudent when at just Rs 18.46 billion electric train service (inclusive of track and engines and bogeys to run on it) can be instituted. Nepal, instead, should invest the saving of Rs 50 billion in setting up electric train service in other areas.

Geological Encroachment – land use

The fast track is envisaged to have 4 lanes that will be 21 meters broad; as lesser number of lanes will slow down the traffic – defeating the very purpose. But encroachment of this scale in the hilly terrain is inadvisable in view of high potential for landslides that will be triggered by explosion undertaken to build the road. Whereas electric train will need only 11 meter. Besides, capacity enhancement in future will only be possible by increasing the number of lanes; entailing further increases in the land requirement from 21 meter to 30 meter. This will be needed every 10 years. But in the case of electric train capacity enhancement will simply mean increasing frequency of the train service, adding bogeys on existing engines and eventually addition number of trains; two tracks will easily serve for more than 100 years.

Passenger Fare

The fast track has been deemed feasible on the condition that passengers continue to pay same fare as now, although service providers will be able to save substantially on fuel consumption, vehicle wear and tear, etc. Whereas, electric train will cost just about one-third of current bus fare. Therefore, from the perspective of passengers and cargo, electric train is better mode of MRT than fast track.

Facilities to Commuters

In the case of electric train there will be no need to disrupt travel for amenities like visits to restaurants and rest rooms. Additionally internet service can be availed by installing wireless in the passenger compartments. These will not be possible in the fast track.

Urbanization

With the opening of just a track of a future highway, people start building houses and shops along the alignment which results in unplanned urbanization with resultant constraints like lack of necessary services and amenities. In the case of electric train, urbanization can be pre-planned in and around train stations. The likely alignment of fast track has already been ravaged by speculative land prices which should not be allowed to go out of hand.

Accident

Upon completion of the fast track due to high probability of haphazard urbanization coupled with driver error, accident rate (and fatalities) will also sky rocket. However, in the case of electric train, with no haphazard urbanization possible, chances of accidents could easily be controlled. And driver error could be reduced in the case of electric trains with automation and remote control.

Commute time

Presently, cargo to Nepal is being transported part of the way in trains and some part in container trucks; entailing loading and unloading in a number of places (defined as transfer cost) and also requiring additional time (transport of a tanker of petroleum product from Raxaul to Amlekhgunj – a distance of about 25 km – takes about 20 hours). With electric train, cargo can directly be transported to Kathmandu, for example, from Kolkata or Mumbai, thereby avoiding transfer time and cost.

Conclusion

Transportation is not merely wheel based surface transport. Transportation is rather moving cargo and passengers from one place to other. The mode could be water based like ships. In surface transport, besides wheel based, it could be train and it even could be suspended in the air from cable like ropeway, cable car

etc. Moreover, as Nepal enjoys high competitive/ comparative advantage due to the potential for electricity generation in huge quantum, the best mode of transport for Nepal is electric train, ropeway, cable car etc. and even in the case of wheel based mode, she should opt for electric vehicles (including bikes) and even hybrid cars, instead of conventional fossil fuel guzzlers. Unfortunately for Nepal, the policy makers and bureaucrats are unable to see beyond their collective noses and every time a reference is made to transportation, they start digging up roads. However, it has been amply demonstrated above that electric train is the best mode of MRT for Nepal, instead of so called "fast" track.

Moreover, as the policy makers are already talking of train service in north-south highways, Prithvi highway, east west highway, and even connecting Kathmandu with Khasa in Tibet by train, it doesn't make sense at all to be digging one more road in the name of "fast" track which is not fast in reality. Besides, from the perspective of fuel economy, carbon trading potential, capital cost, geological encroachment, passenger service and fare (including for cargo), travel time, planned urbanization along the alignment, possibility of reduced accident rate, etc. fast track isn't appropriate for Nepal.

We are building a "new" Nepal and, if a transportation mode expected to be fast isn't fast, then an oxymoron as such doesn't deserve to be built in the new Nepal. We should rather go for electric train.

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References

[1]It is a system of transportation that suspends, guides and propels vehicles, predominantly trains, using magnetic levitation from a very large number of magnets for lift and propulsion. This method has the potential to be faster, quieter and smoother than wheeled mass transit systems. The power needed for levitation is usually not a particularly large percentage of the overall consumption; most of the power used is needed to overcome air drag, as with any other high speed train.
[2] http://en.wikipedia.org/wiki/Truck
[3] http://www.ipcc-nggip.iges.or.jp/EFDB/find_ef.php

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Modern Trend in Earthquake Resident Design (ERD) of Buildings and Detailings

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Abstract:
Most of the multi-storied buildings in Nepal are constructed with reinforced concrete (RC). It is necessary to improve ductility of the buildings so that the major damages occur during an earthquake can be minimized and sudden collapse can be prevented. Design of structures in earthquake prone areas should be based on the principles of earthquake resistant design (ERD). Detailing of RC structures is necessary to supplement ERD. Different relevant codes should be referred and followed as appropriate. Designer should understand that one of the main reasons behind many of the structural failures during earthquakes is lack of detailing. This paper attempts to clarify relevant clauses of ductile detailing codes. The minimum concrete grade and limitation on the use of different grades of steel are specified in these codes. The role of the joints in buildings is to transfer loads from a superstructure to the foundation and they should remain intact during an earthquake to prevent catastrophic collapse. There are many factors responsible for strengthening members and joints. Hooks, spacing and development length of rebars, concrete cover, percentage of rebars, lapping etc are the major design consideration in ductile detailing of members and joints. Recommended measures for achieving ductile design of earthquake resistant buildings are briefly explained in this paper.

1. INTRODUCTION

Now-a-days Reinforced cement Concrete (RCC) is most widely used construction material in Nepal for many types of civil engineering structures . It is an extremely plastic and mouldable material which accurately reflects the shape, texture and finish of the surface against which it is cast.

There are different types of structures such as dams, barrages, hydropower structures, bridges, reservoirs, buildings and so on. Most of them are reinforced concrete structures. In this paper, the author attempts to explain ductile detailing of RC buildings.

Design of a building is a multidisciplinary task involving inputs from various fields like architectural, structural, sanitary, electrical engineering. First of all, an architect defines the shape of a building as per functioning requirement, aesthetics and environment. For economy and structural efficiency, the architect has to consult a structural engineer. The finalization of the architectural planning and requirements should be followed by detailed structural design. Structural design decides the sizes of the members like beam, column and rebars arrangements.

Structural design is the combination of three main steps, viz. analysis, design and detailing. Analysis of the structure is based on certain assumptions and resulting stresses are used for detailed design of rebars. Detailing should be done properly in order to function the structure as per assumptions made before analysis. Detailing is one of the major steps in structural design. In fact, no structure will complete without detailing.

Principles of Earthquake Resistant Building

There were several major and moderate earthquakes in Nepal. Therefore, every building structure is expected to experience moderate to major earthquakes during its life period.

Design of building structure should follow the principles of earthquake resistant design. A well designed earthquake resistant building should be able to:

1. Resist minor earthquake without damage
2. Resist moderate earthquake without structural damage but with some non-structural damage
3. Resist major earthquake without collapse but with some structural as well as non-structural damage.

In many structures, it is expected that structural damage caused by even major earthquake could be limited to repairable limit of damage due to proper detailing. This is however, depends upon a number of factors, including the type of construction selected for the structure, building configuration etc. In approaching architectural and structural design, perhaps the most important attribute an architect or engineer can develop in good judgment. The ability to understand structural system behavior, develop workable details, use appropriable building materials and keep building elements together during an earthquake so that they will act as a unit to resist seismic forces is crucial for achieving philosophy of ERD.

To acquire the principles of earthquake resistance building, detailing in the design process and its implementation in the construction must be done strictly. Any changes in structural components whether major or minor should be pre-informed to designer before making any modifications.

Failure of the Structures

It is not easy to generalized common causes of failures of structural elements during earthquakes since the type

provided for the utilization of garages or shops whereas upper stories have heavy partitions. Also, in simple thinking, beams are provided in mid landing of staircases for strengthening. Such type of structures causes short column effect, which attracts very many stresses during earthquake.

Failure may be because of poor quality in construction with inferior or inappropriate materials and poor supervision. The construction materials used in the structure is steel, cement, aggregates, water etc. that contribute to strength requirement. Supervising engineers should be as capable as designers so that the later should not miss anything.

Even in well designed structures, due to different behavior of soil strata, damage during severe earthquakes has been observed caused by the settlement of foundation soil. Design of foundation in major structures should be carried out based on soil investigation. But owner of each and every residential building could not able to provide soil investigation data because of cost involvement in soil investigation. Then, structure is designed based on the assumption of bearing capacity by soil nature and vicinity soil investigation if available. Nature of soil may vary from one foundation to another in the same building. So it is very difficult to accomplish appropriate foundation design, which may lead to failure of the structure.

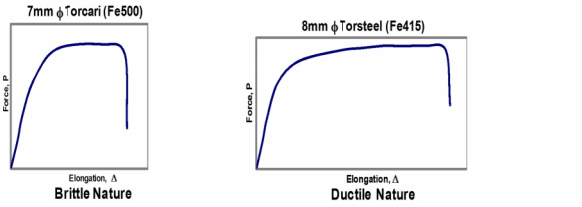
Codes related to earthquake resistant building

As time passes, additional different codes are available to overcome the shortcomings in past codes. Some of the Indian Standard (IS) and Nepal Standard (NS) codes related to seismic design and ductile detailing is as follows:

1. IS: 1893:2002 (PART 1), Criteria for earthquake resistant design of structures
2. NBC 105:1994, Seismic design of building in Nepal
3. NS 500:2058, Seismic design of building in Nepal
4. IS 4326:1993, Earthquake resistant design and construction of buildings
5. IS 13920:1993, Ductile Detailing of RC Structure subjected to seismic forces
6. NS 501:2058, Ductile Detailing of RC Structure subjected to seismic forces

NS 501: 2058 ductile detailing of RC structure subjected to seismic forces is referred from IS 13920:1993. The code incorporates a number of important provisions, which were not covered in IS 4326:1993. Significant changes have been incorporated in this code. The requirements for detailing of longitudinal reinforcement at joint faces, splices, and anchorage requirements in beams have been explained more explicitly. In this code, use of material has been specified. It is mentioned that from clause 5.2 of IS 13920:1993, for more than 3-storey buildings, minimum grade of concrete shall be M20. In designing of multi-story buildings it demands higher grade of concrete to lower the size of the member and to lessen the development length. Again as per clause 5.3, steel reinforcement exceeding Fe 415 grade should not be used. However, amendment published on March 2002 allows use of higher grade of steel (TMT bar) more than Fe 415, which states that, "However, high strength deformed steel bars, produced by the thermo-mechanical treatment process of grades Fe500 having elongation more than 14.5 percent and conforming to other requirements of IS 1786:1985 may also be used for the reinforcement".

As per this clause higher grade steel other than TMT such as Torcari (Fe 500) cannot be used for the seismic resistant building because of brittle in nature. This may be elaborated from the graphs.



In above graph, flatter area under curve denotes ductility behavior of Torcari (Fe 500) and Torsteel (Fe 415). Though design flexural strength is about the same, the post crack behavior is totally different. Torcari steel has less area under the curve after yield whereas Torsteel has more area under the curve, i.e. Torcari (Fe 500) has less ductility than low grade Torsteel (Fe 415). Ductility in rebars is essential to avoid the sudden collapse of buildings during a major earthquake.

Detailing

The main function of detailing is to provide proper action and interaction by each structural member such as foundation, column, beam and slab. Any design is not said to complete without detailing of joints and other structural members.

Every structural element is strengthened completely by detailing as per design requirement. The floor loads of slab will be distributed to beam through slab-beam joints and thus accumulated floor loads will be distributed to the columns through beam-column joints. Column loads will be transferred finally to the foundation through column-footing joints. Thus, each and every member is connected with joints. If joints do not perform well due to lack of detailing, forces cannot transfer from one member to another during intense earthquake shaking even though each individual member has adequate strength.

#Special confining reinforcement calculation:

The area of ties (A_{sh}) in circular column shall not be less than

$$= 0.09\ S\ D_k\ f_{ck}/f_y(A_g/A_k-1)$$

where, S= pitch of ties

D_k = Outside diameter of core of spiral or hoops

f_{ck} = Characteristic compressive strength of concrete

f_y = yield stress of hoop or spiral

A_g = gross area of column

A_k = area of concrete core ($pi/4\ D_k^2$)

The area of ties (A_{sh}) in rectangular column shall not be less than

$$.= 0.18\ S\ h\ f_{ck}/f_y(A_g/A_k-1)$$

where, h = longer dimension of column measured to outer face of hoops

A_k = area of concrete core measured to outside of hoops

This calculated spacing shall not exceed ¼ of minimum member dimension but need not be less than 75mm nor more than 100mm.

***Development length of rebars for different grades of concrete and steel:**

Equating the limit of bond in bar and tensile forces,

$\pi \phi L_d \tau_{bd} = \pi/4\, \phi^2 \sigma_s$ i.e., $L_d = (\sigma_s / 4\tau_{bd})\, \phi$

Developedment Length, L_d in terms of ϕ

Improper detailing and Preventive measures

SN	Improper detailing	Preventive measures
1	Insufficient hook in lateral ties and stirrups	Provide 10 times diameter of lateral ties or stirrups or 75mm whichever is greater in 45°
2	Insufficient numbers of stirrups in beam	Provide maximum spacing of stirrup over a length of beam of twice times effective depth (2d) at less than or equal to d/4 and at d/2 for rest middle part.
3	Insufficient numbers of ties in column	#Special confining reinforcement shall be provided at each ends of column. This distance shall be greater of larger dimension of the member, 1/6 th of clear span and 450 mm.
4	Lack of hoops in beam-column joint	Even it is difficult to provide ties in joint practically, it is necessary to provide ties through the joint at the column ends and minimum half of confinement bars in joint at beam framing in all vertical faces.
5	Improper place of beam bar in column joint	Longitudinal bars of beam shall be provide inside the longitudinal bars of column.
6	Lack of stirrups or hoops in lap of longitudinal bar	Provide maximum spacing of stirrups or hoops at lap not more than 150mm.
7	Lack of sufficient development length	*Provide anchorage length of both the top and bottom bars of the beam, beyond the inner face of the column, equal to development length in tension.
8	Short column effect	Sometimes, there is significant variation significant variation in stiffness along its height due to presence of bracing, a mezzanine floor or a RCC wall on either sides of the column. In such cases, special confining reinforcement shall be provided over the full height of column.
9	Lack of bar of local stresses	When secondary beam are rested on main beam, local stress will be developed on main beam. Provide minimum of two extra bars beneath the secondary beam along the direction of main beam.
10	Lap of main bar in improper places	Provide lap of main bar in point of contraflexure of column. Generally it exists in mid half height of column. In the case of beam, provide lap in the place of minimum stresses developed section. It is better to provide lap at center of top bar and 1/3 to ¼ th beam span of bottom bar. Not more than half of bars are lapped at a section.
11	Lack of proper amount of reinforcement	In slab, provide 0.15 % of total cross sectional area for mild steel and 0.12 % for high strength deformed bar. In beams, minimum tension reinforcement shall be, Ast=0.85bd/fy and maximum not more than 0.04bd. In columns, minimum longitudinal reinforcement shall be 0.8 % of the cross sectional area and not more than maximum of 6%. But to avoid congestion of bar, provide not more than 4 % in general.

12	Lack of concrete cover	Concrete cover shall be provide sufficient so that developed stresses will uniform around the bar and air moisture does not attack in the bar. Minimum clear cover shall be provide 15mm, 25mm, 40mm and 50mm for slab, beam, column and foundation respectively. Provide 25mm or twice the diameter of bar whichever is greater at the end of each bar.
13	Lack of linkage between hoops and stirrups with longitudinal bar	All hoops of the column and stirrups of beam must be linked with longitudinal bars of the member. Otherwise provided spacing does not mean at all, because of mixed cement slurry and fine sand will be replaced inside the gap and shear cannot transfer to longitudinal bars.

Concrete grade, f_{ck}	Steel grade , fy					
	Fe250		Fe415		Fe500	
	Mild Steel		Deformed bar (Tor Steel)		TMT	
	Tension	Compn.	Tension	Compn.	Tension	Compn.
M15	54 ϕ	44 ϕ	56 ϕ	45 ϕ	68 ϕ	54 ϕ
M20	45 ϕ	36 ϕ	47 ϕ	38 ϕ	57 ϕ	45 ϕ
M25	39 ϕ	31 ϕ	40 ϕ	32 ϕ	49 ϕ	29 ϕ

Conclusions:

Design of structures in earthquake prone areas should be based on the principles of earthquake resistant design (ERD). Detailing of RC structures is necessary to supplement ERD. It is necessary to improve ductility of the buildings so that the major damages occur during an earthquake can be minimized and sudden collapse can be prevented.

References:

1. *IS 1893 (Part 1):2002 - Criteria for earthquake resistant design of structures*
2. *NBC 105 : 1994 - Seismic Design of Buildings in Nepal*
3. *NS : 500 - 2058 - NBC: Seismic Design of Buildings in Nepal*
4. *IS 4326 : 1993- Earthquake Resistant Design and Construction of Buildings*
5. *IS 13920 : 1993 - Ductile Detailing of RC Structures Subjected to Seismic Forces*
6. *NS : 501- 2058 - Ductile Detailing of RC Structure Subjected to Seismic Forces*
7. *IS 456 : 2000 - Plain and Reinforced Concrete*
8. *Earthquake Tips- C.V.R. Murty, BMTPC, IIT,Kanpur*
9. *Manual of Seismic Design – James L. Stratta, Pearson Education*
10. *Structural Design of Multi-Storeyed Buildings – U. H. Varyani, SAP Pvt. Ltd.*
11. *Protection Against Earthquakes – Dharam V. Mallick, SAP Pvt. Ltd.*
12. *12. Reinforced Concrete Structures – Park,R & Paulay,T, Wiley-Interscience, New York*

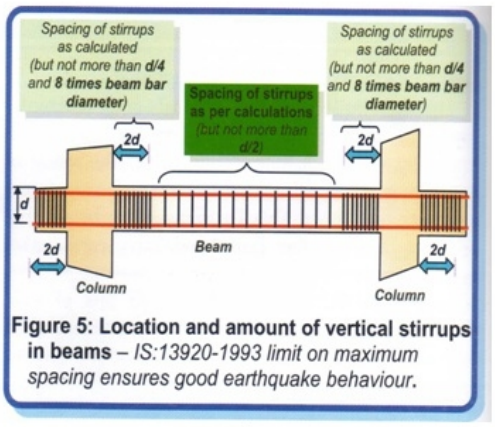


Figure 5: Location and amount of vertical stirrups in beams – *IS:13920-1993 limit on maximum spacing ensures good earthquake behaviour.*

FIG. 1 vertical stirrups in beam

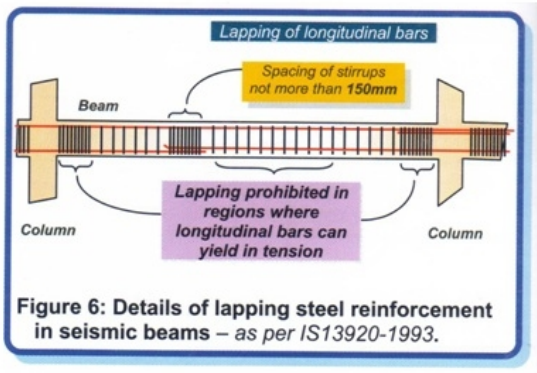
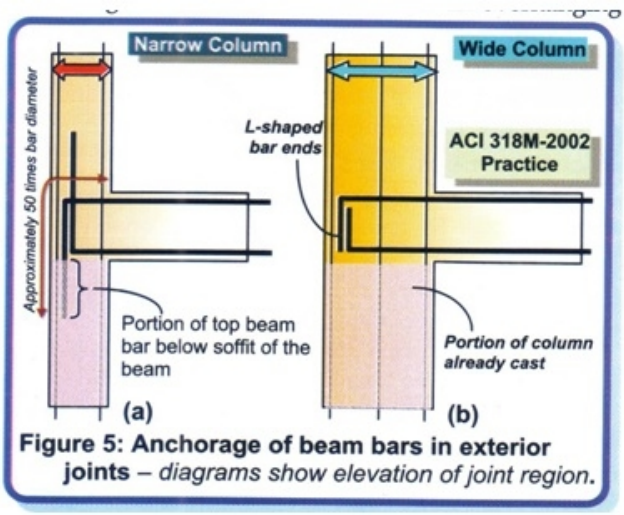


Figure 6: Details of lapping steel reinforcement in seismic beams – *as per IS13920-1993.*

FIG. 2 Lapping steel reinforcement in beam



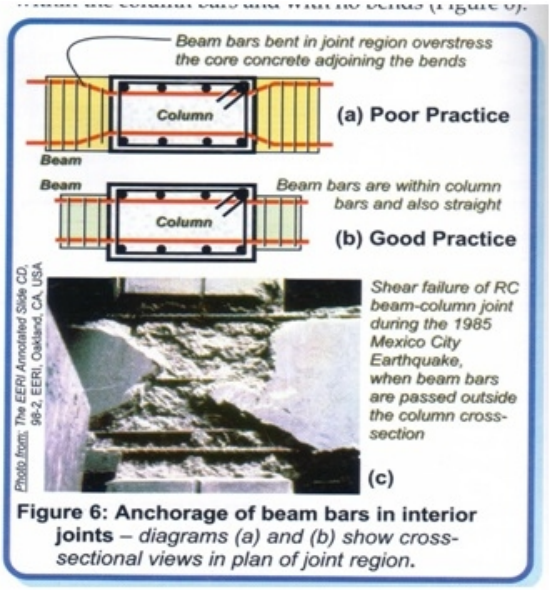


FIG. 3 Anchorage of beam bars in exterior joint

FIG. 4 Anchorage of beam bars in interior joints

- **Height of Confinement Zone: larger of D, h_c/6 or 600 mm**
- **Spacing of ties in CZ: ≤ D/4 but ≥75 mm and ≤ 100 mm**
- **Spacing of ties in Lap Zone: ≤ D/2 and ≤ 100 mm**
- **Spacing of ties in rest : ≤ D/2**

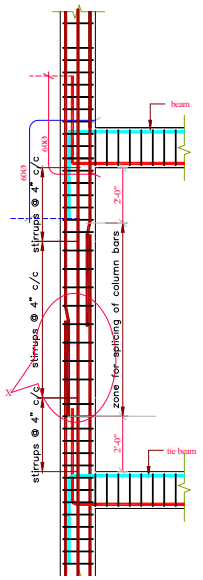


FIG5: COLUMN-DETAILING

FIG 6 :Beam-column joint of side frame

FIG. 7 :Secondary beam joint

Earthquake and Kathmandu Valley

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Earthquakes, floods and landslides are major natural disasters for Nepal. We are facing these disasters from many centuries. In the scenario of Kathmandu valley, earthquake is the most prominent and probable natural disaster in the near future.

Earthquake and plate tectonics

Earthquake is one of the most natural disastrous phenomena experienced with a sudden vibration of ground which is termed as "strong ground motion". Earthquakes may occur as a result of tectonic activities, volcanic activities, landslides and rock falls, rock bursting, nuclear explosions and more. In the history of Nepal, earthquakes were caused by the tectonic activities. Nepal is located in a boundary between two colliding tectonic plates (Indo-Australian and Eurasian plates: the first plate is sliding under another) which is known as a "subduction zone". This zone is world's most seismically vulnerable and active regions.

Bihlam et al. (1995) studied the slip rate (the speed of one plate sliding under another) of the Indo-Australian plate in the subduction zone on different parts of Himalaya region. Some great earthquakes in the past from this zone are Assam 1897 (Mw 8.1), Kangra 1905 (Mw 8.0) and Bihar 1934 (Mw 8.3). The authors focused their study of slip rate mainly for Nepal and found that the slip rate of western Nepal (between Eastern Nepal and Kumaun region of India) is very low compare to other parts of Nepal. Khatri (1987) also mentioned about absence of earthquake occurrences in the western part Nepal for last 200 years. The author named this region as a "central gap" and predicted a great earthquake in the near future. Correa-Mora et al. (2008) discussed about the accumulation of elastic stain energy of rock due to locking action (negligible or no slip rate) of the plates. Usually, the locking action of the plates occurs when smooth slipping (or sliding) of the plate is obstructed and results in the accumulation of stain energy. When the accumulated strain energy of the rock exceeds its resiliency, rupture (or failure) of rock (or plate) occurs with release of tremendous amount of seismic energy. Most parts of the seismic energy are released in terms of seismic waves which propagate in all directions and cause vibration of interior and exterior of the earth. After realizing these facts, it seems that Kathmandu valley which is located near to the "central gap" is vulnerable from probable future great earthquakes.

Geology of Kathmandu valley

Kathmandu valley, situated over thick fluvio-lacustrine sediment, is mainly composed of clay and slit deposited by "Paleo-Kathmandu Lake" during Pliocene and Pleistocene age. A layer of coarse sand and gravel is found between the fluvio-lacustrine sediment and bedrock. The thickness of the sediment is found up to 457 m in the borehole at Harisiddhi, south- eastern part of Lalitpur and 550 m in Bhrikutimandap, Kathmandu (Piya 2004). The thickness of loose sediment over the bedrock in Kathmandu valley is sufficient enough to amplify the amplitude of seismic waves causing intense ground motion. During earthquake of Bihar 1934, Kathmandu valley experienced severe damage compared to Bihar area. Although Kathmandu valley is far from the epicenter of that earthquake, the damages in most part of the area were due to the condition of local geology (Pandey and Molnar, 1988; Bihlam et al., 1995).

Effects of Earthquake on the Kathmandu valley

Liquefaction is a phenomenon which is defined as the transformation from solid state of soil to a liquid state as a consequence of increased pore pressure and reduced effective stress caused by the vibration of soil particles (Castro 1987). Liquefaction occurs in saturated sandy and silty soil where spaces between individual particles are completely filled with water and the water exerts pressure on the soil particles. In simple words, the shear stress of the soil becomes very low (tends to zero) during liquefaction of soil. Earthquake shaking (cyclic loading) causes the water pressure to increase and decrease shear stress of soil.

A well known example of liquefaction was observed in Nigata, Japan. On June 16, 1964 the land of Japan was struck by 7.5 magnitude earthquake whose epicenter was 35 miles far from Nigata (Seed and Idriss, 1982). At that time maximum ground acceleration was recorded to be 0.16 g which triggered the liquefaction phenomena. The consequence of this effect resulted in the formation of sand boiling and ground failure. The foundation of the most of the structures tilted and settled in the ground up to 3 feet.

In the context of Kathmandu valley, the presence of silty and sandy soil at shallow depth, high ground water table and probable occurrence of strong earthquake make the valley a susceptible place for liquefaction (Piya 2004). Neupane and Suzuki (2011) also studied liquefaction potential of Kathmandu valley after analyzing data of 22 boreholes around Singhadurbar, Maharajgunj, Jamal and Naxal areas. The authors assumed ground acceleration of 0.3 g and earthquake of magnitude of 8. They concluded that Kathmandu valley has a high potential of liquefaction from a strong earthquake and major governing factor is water table at the shallow depth.

So, Kathmandu valley is prone to the future great earthquakes possibly originating from the "central gap" in the western Nepal. In addition, the presence of unconsolidated loose soil of the valley might result in the severe ground failure by the liquefaction. Current practice of building apartments and tall buildings in such loose soil, and haphazard urbanization might also add severity in the future disasters. In order to reduce the risk from the future disaster, concerned authority should

- monitor the built high rise buildings, permit building construction after studying the soil condition, comply everybody to use building codes, organize programs for general public to teach methods of safeguarding lives during an earthquake, make plans for post disaster management which includes search and rescue operation, emergency evacuation, health and other services to people etc, and more.

References

Bilham, R., Bodin, P. & Jackson, M. (1995). Entertaining a great Earthquake in western Nepal: Historic inactivity and geodetic tests for the present state of strain. *Journal of Nepal Geological Society*, 11 (1), 73-78.

Castro, G. (1987). On the behavior of soils during earthquakes - Liquefaction. *Soil dynamics and liquefaction*, A.S. Cakmak (ed.), Elsevier Science Pub., Amsterdam, 169-204.

Correa-Mora, F., DeMets, C., Cabral-Cano, E., Marquez-Azua, B. & Diaz-Molina, O. (2008). Interplate coupling and transient slip along the subduction interface beneath Oaxaca, Mexico. *Geophysics Journal International.*

Khattri, K. N., (1987). Great earthquakes, seismicity gaps and potential for earthquake disaster along the Himalaya Plate boundary. *Tectonophysics*, 138, 79-92.

Neupane, R. & Suzuki, K. (2011). Research report of Department of Civil and Environmental Engineering. *Saitama University,* Japan, 37, 9-16.

Pandey, M., R. & Molnar, P. (1988). The distribution of intensity of the Bihar-Nepal Earthquake of 15 January 1934 and bounds on the extent of the rupture zone. *Journal of Nepal Geological Society,* 5, 22-44.

Piya, B., K. (2004). Generation of a Geological database for the Liquefaction hazard assessment in Kathmandu Valley. *Master's thesis, International Institute for Geo-information Science and Earth Observation,* Enschede, The Netherlands.

Seed, H., B., & Idriss, I., M. (1982). Ground motions and soil liquefaction during earthquakes. *Earthquake Engineering Research Institute*, Berkeley, CA, 134.

Energy Efficiency in Traditional Residences of Kathmandu

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Abstract:
The modern energy efficiency and thermal conditions in building need to revive and refine from old principles and examples. The traditional residential buildings of Kathmandu valley do not have artificial system of heating and cooling in the past. The success of any architectural design depends upon its ability to deliver thermal comfort to the inhabitants of the building. These residences built with traditional form, technology, skill and natural material show a distinct relationship with respect to geography, religion, culture, tradition and climatology of the valley. The traditional residential buildings in harmony with nature have better thermal comfort and lesser need for energy as compared to present practices.

The paper focuses factors that influence energy efficiency and thermal comfort of such building with respect to site planning, vertical planning, building form and material and construction technology. These effects had been studied in selected case study of traditional residential buildings from Patan and Kirtipur of Kathmandu valley. The study focuses to analyze the vertical space planning, mud architecture, thick construction, life style etc. The study focus to answer the questions like; what are the characteristics of materials, technology and building forms of traditional house of Kathmandu for energy efficiency and thermal comfort for long period in the past? How can be traditional knowledge inform modern building for the greater thermal comfort and energy efficiency? This paper is expected to elucidate traditional measures energy conservation observed in residential architecture of Kathmandu with its merit.

Keywords: traditional residential building, energy efficiency, temperature, thermal performance

1. INTRODUCTION

The first human built shelters designed with respect to the thermal comfort and climatic elements- sun, wind, rain and snow. From the experiences of thousands of years, it is clear that planning and building designing had been guided by several factors like geographical, geological, social, cultural, economical, climatologically etc. In historical time, the traditional houses usually did not have artificial systems of heating or cooling. A few hundred years ago when the techniques were developed, then people have studied the climatic influence with scientific measurement. Climatic factors played an important role in the growth of our civilizations. Throughout history, humans have been seeking to adapt and have developed different energy efficient building forms.

Traditional architecture in any place, as observed today, is not the result of a one-time effort but culmination of hundreds of years of experimentation to understand to response to a particular situation through trial and error. These shelter forms have an important attribute of making its inmates comfortable in extreme climatic conditions. Overall a harmonious balance between built form, climate and lifestyle was achieved. The design and planning responded well with respect to geography, tradition, climatology and passive solar architecture. That is why; the most of traditional houses were developed with energy efficiency and the thermal comfort in different climate of Arab countries, India and Nepal. So the study focuses to analyze thermal performance with energy efficiency in traditional residences and compare with modern residences of Kathmandu

2. METHODOLOGY

2.1. Study of thermal performance in traditional and modern residences of Kathmandu

In order to study the practical use of energy efficiency and thermal comfort in traditional residential buildings of Kathmandu, a sample of fourteen residences in Patan and Kirtipur of the Kathmandu valley have been considered. Of these, data from five have been reviewed in this paper. The three modern residential building in traditional settlement of Patan and Kathmandu have been considered to compare with traditional residential buildings. The indoor and outdoor temperature of the residences was collected and monitored for four season summer, winter, autumn and spring manually. Nearly thirty days of temperature was recorded in each season with the ordinary room thermometer. The temperature was recorded three times a day; at seven in the morning, two o' clock in the day and ten in evening from ground floor to attic vertically. The study of temperature reading is to focus to read the max and min temperature in each space during twenty four hours of a day in different seasons of a year.

3. CASE STUDIES

3.1 Traditional residential building

Before going into case study, a brief description of the traditional residential architecture of Kathmandu needs to be given. The most prominent characteristic of any traditional building in Kathmandu is thick external wall having small openings, which reduce transfer of heat. The plan of the building is square or rectangular and symmetrical in shape around courtyard or street. Rooms are arranged around the street or courtyard. Material of construction is sun burnt brick, burnt brick, tile stone,

mud and wood. Mostly the four-storied residence is attached type oriented to court or street. The vertical spatial planning allocate with utility rooms in heavy ground floor (Chheli), bedrooms in first floor (Chotan), living room and bed in second floor (Matan) and kitchen and dining and in attic (Baiga). The plan incorporated along with staircase and dormer window (Makpwa) or cat's hole (Bhau pwa) in slope roof for ventilation. Two rooms in first floor are separated by central wall. In second floor, living room and bed are separated by central post and wooden partition of two bays. The living room with large window admits low sun light in winter and cool breeze in summer.

The building has exposed brick façade which is red in color and rough texture. The uneven number of window is placed in each storey. Central window of living fitted with glazed and timber shutters. A large projection of slope roof acts as effective shading device during summer and also protects from driving monsoon rain. The external exposed brick wall consists of 60 cm in thickness. The thick multilayer wall of pakki apa (Burnt Red brick), kachi apa (sun dried brick) and mud plaster placed from outside to inside in external walls. The foundation of structure built of natural stones. Mud or tile flooring with wooden plank is supported by wooden joist in all floors. In attic, slope roof of clay tiles constructed with well-compacted mud supported by wooden planks and joists. Normally floor height is less than seven feet. Ground floor and attic is not use during night time. This type of residences is provided with no artificial heating and cooling system. Still occupants enjoy good thermal comfort.

3.2 Modern residential buildings

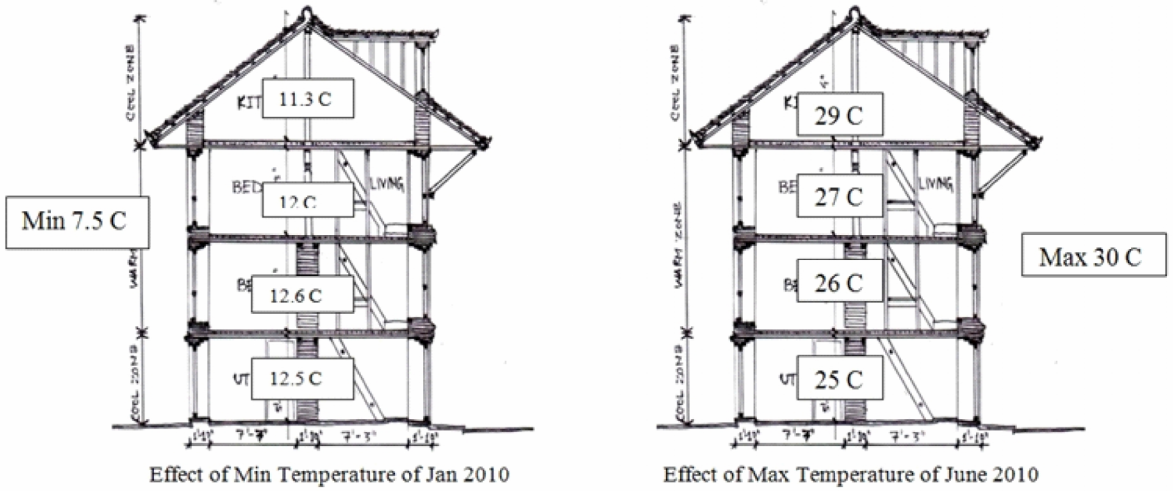
In this study, modern buildings were selected in old traditional settlement where traditional buildings were built in the past. So plan of the building is simple, square or rectangular. All external and internal walls were constructed with burnt brick with cement mortar. The external wall thickness is max 23 cm (9") and the internal walls are 11 cm thick. Roof, slab, column and beam are constructed with homogenous RCC material with frame structure. Floors and flat roof is cement punning finish on the top. Medium size openings are provided with single glazed shutter. Material of construction is burnt brick, RCC, metal and wood. The most prominent characteristic of this type of building in Kathmandu is thin external wall and roof which transfer heat faster than wall and roof of traditional residence. Normally floor height is more than eight feet. The interior of rooms is finished with cement plaster. Two to three feet projection of flat roof protects from driving monsoon rain but not acts as effective shading device during summer. Normally all floors and attic is use during day and night time.

4. ANALYSIS OF DATA

4.1. Data of Traditional residences

(Due to paucity of space, only data of two traditional and two modern residential building is presented here.)

4.1.1 Residence of D. B. Maharjan, Dev Dhoka, Kirtipur, Kathmandu



Effect of Min Temperature of Jan 2010 | Effect of Max Temperature of June 2010

DATA ANALYSIS OF JUNE 2010 (Jestha 2067)

Residence: Dan Bahadur Maharjan Address: Devdhoka, Ward No. 2, Kirtipur

TEMPERATURE

	TIME	OUTDOOR	INDOOR				DIFFERENCE	
			I	II	III	IV	*MAX*	*MIN*
MIN	700	*22.2 C*	*23.13*	*23.9*	*24.23*	*23.43*	2.03	0.93
MAX	1400	*30.4*	*25.37*	*26*	*27.33*	*29.23*	5.03	1.17
		$T_{0\,Max}$	T_1	T_2	T_3	T_4		

LIMELIGHT

DATA ANALYSIS OF JANUARY 2010 (MAGH 2066)

Residence: Dan Bahadur Maharjan Address: Devdhoka, Ward No. 2, Kirtipur

	TIME	OUTDOOR	INDOOR				DIFFERENCE	
			I	II	III	IV	MAX	MIN
MIN	700	7.47 C	12.47	12.6	12	11.3	5.13	3.83
MAX	1400	21.97 c	15.23 c	15.30 c	16.73 c	17.67 c	6.74	4.3

4.1.2. Residence of S. Maharjan, 193, Subahal, Patan, Lalitpur

DATA ANALYSIS OF JAN 2010 (MAGH 2066)

Residence: Sanjaya Maharjan Address: 193, Subahal, Ward No.8, Patan

TEMPERATURE

	TIME	OUTDOOR	INDOOR				DIFFERENCE	
			I	II	III	IV	MAX	MIN
MIN	700	9.17	11.23	12.17	11.83	11.83	3	2.06
MAX	1400	16.33	13.17	14.89	15	14.78	3.16	1.33
		$T_{0\,Min}$	T_1	T_2	T_3	T_4		

DATA ANALYSIS OF JUNE 2010 (Jestha 2067)

Residence: Sanjaya Maharjan Address: 193, Subahal, Ward No.8, Patan

TEMPERATURE

	TIME	OUTDOOR	INDOOR				DIFFERENCE	
			I	II	III	IV	MAX	MIN
MIN	700	25.4	23.14	24.88	25.45	25.62	2.26	0.22
MAX	1400	29.18	24.35	26.08	27.6	27.97	4.83	1.21
		T_0	T_1	T_2	T_3	T_4		

4.2. Data of Modern residences

4.2.1 Residence of R.M. Shrestha, Kobahal-9, Patan, Lalitpur

DATA ANALYSIS OF JUNE 2010 (JESTHA 2067)

Residence: Rudra M Shrestha Address: Kobahal-9, Patan Modern residence

	TIME	OUTDOOR	INDOOR				DIFFERENCE	
			I	II	III	IV	MAX	MIN
MIN	700	23.62	24.27	25.27	26.02	25.43	2.4	0.65
MAX	1400	26.03	25.24	26.2	27.93	27.81	1.9	0.79

DATA ANALYSIS OF JAN 2011 (POUSH 2067)

Residence: Rudra M Shrestha Address: Kobahal-9, Patan Modern residence

	TIME	OUTDOOR	INDOOR				DIFFERENCE	
			I	II	III	IV	MAX	MIN
MIN	700	6.98	9.45	10.45	10	10.83	3.85	2.47
MAX	1400	10.72	10.2	11.6	10.97	11.82	1.1	0.52

4.2.1Residence of P. Tandukar, 22 La 5, Konti, Patan, Lalitpur

DATA ANALYSIS OF DEC 2010 (POUSH 2067)

Residence: Purna Tandukar Address: 22La5,Konti, Patan

Modern residence(Banglamukhi sahakari)

	TIME	OUTDOOR	INDOOR				DIFFERENCE	
			I	II	III	IV	MAX	MIN
MIN	700	12.64	11.14	11.62	11.9	12.58	1.5	0.06
MAX	1400	16.9	12.18	12.86	13.06	15.22	4.72	1.68
		T_0	T_1	T_2	T_3	T_4		

DATA ANALYSIS OF AUG 2010 (BHADRA 2067)

Residence: Purna Tandukar Address: 22La5,Konti, Patan

Modern residence(Banglamukhi sahakari)

	TIME	OUTDOOR	INDOOR				DIFFERENCE	
			I	II	III	IV	MAX	MIN
MIN	700	24.42	23.52	24	24	24.82	0.9	0.4
MAX	1400	26.5	24.1	24.58	25.02	26.24	2.4	0.26
		T_0	T_1	T_2	T_3	T_4		

5. INFERENCES

5.1 Less effect of outdoor environment

In observation of temp graph, during summer and winter external environment less effect directly in indoor environment in traditional residences whereas external environment effect directly in indoor environment in modern residences. The temperature difference is less between outdoor and indoor spaces in modern residences whereas the temperature difference is more between outdoor and indoor living spaces of traditional residences. During summer, in one of the traditional residences recorded mean max outdoor temperature 30.5 C which create indoor temp nearly max 26 C to 27 C in living spaces for short period (5 hrs) in day time. The indoor temperature is two to five degree Celsius lesser than outdoor in traditional residences which falls under comfort range. This temperature does not exceed the overheating (< 26 C) so do not need of any energy for cooling till this temp except in attic. But in modern residences, the indoor temperature is up to nearly two degree less or more than outdoor for long time (> 10 hrs) which need energy for cooling during day time (> 26 C).

Same way, the indoor temperature is three to four degree more than outdoor temperature during day time in winter in traditional residence (15-17 C) which falls under comfort ranges so no need of energy for heating. But during morning and night time, the recorded mean min outdoor temperature nearly 7 C create indoor temp nearly 12 C which demand less energy to heat for thermal comfort for short time. But in modern residences, the indoor temperature is nearly 10-13 C during day time. During morning and evening, indoor temperature less than 12 C which needs more energy for heating during day and night time for long time to creates comfort thermal condition.

5.2 Less energy demand

The volume air of any space directly demands energy to create comfort thermal condition during extreme cold and hot season. A big room requires more heating or cooling energy to create comfort thermal condition than small room. The size and height of a room of traditional residence is smaller than a room of modern residences. Normally the volume of a bed room of traditional buildings is nearly 15 cubic metre (2.4x3.3x2) where as the volume of a bed room of modern buildings is minimum 29 cubic metre (3x3.6x2.7).Volume of spaces of traditional building is nearly two times less than modern building which

demand less energy to heat and cool in traditional building compare to modern building.

5.3 Max use of thermal mass

In traditional residential building of Kathmandu, mud based materials like burnt brick, sunburn brick, mud mortar, mud tile, mud plaster were used with thick construction in roof, wall and floor. This type of materials with thick structure provides a large thermal mass. This mass store heat or cool for long time which effectively attenuate the external ambient conditions. So in observation of temp graphs during summer and winter, external environment was less effect directly in indoor environment in traditional residences. This type of thermal mass is not used in modern residential building nowadays. That is why the temperature difference is less between outdoor and indoor spaces in modern residences. So rooms in traditional building demand either no or less energy to heat and cool compare to modern building.

6. CONCLUSION

Following conclusions are drawn from the study presented herein with respect to energy efficiency and thermal comfort of traditional residential buildings of Kathmandu:

(i) The max use of thermal mass minimizes outdoor thermal effect in indoor and provides better degree of thermal comfort in residential buildings.
(ii) It also minimizes energy demand to create thermal comfort in residential buildings.
(iii) Volume of each spaces of a building should be less which need less energy to heat and cool as in traditional residential building.
(iv) The design system with natural materials and construction technology has been effectively used to achieve energy efficiency in traditional buildings whereas this has not been as effective in modern houses.
(v) The technology used in traditional residential buildings of Kathmandu much more addressed for energy efficiency and thermal comfort.

REFERENCES

1. S R Tiwari, 1988 "Tired Temples of Nepal", Mrs. S Tiwari, Kathmandu, Nepal
2. S Giovanni, 1982,"Building today in a historical context: Bhaktapur, Nepal" Ratna Pustak Bhandar Kathmandu, Nepal
3. W Korn, 1977,"The traditional architecture of the Katmandu valley" Ratna Pustak Bhandar Kathmandu, Nepal
4. Y.K.Parajuli, Dr.K.Sturzbecher, Dr. S. Amatya 1986, "Experiences in preservation and restoration of in a medieval town"-Bhaktapur development Project

Creativity is all about hard work

Mikkel Frost
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Stale

Over the last decade, the word creative has totally lost its value. Since the term has been both misused and overused it has become a virtually meaningless cliché. Creative is something everybody wants to be – or it's something people outside of the arts want to be around. Creative is one of the most commonly-used words in job applications as applicants know that every employer wants creative people. If all job applications were true, most people on the planet would be creative. Creative has become so cool that it is actually not cool at all. When you hear people or companies say that they are creative you can be sure that they are not – they just want to be.

1st prize competition - Experimentarium in Hellerup in Denmark - Cebra Architects

Hard work

Some clients believe that talented architects are creative around the clock. They think that their creativity is like a river of ideas and brilliant thoughts in which they can fill their bucket at will. To a certain extent this is true. Truly creative people get good ideas, but only rarely at gun point. Most of the time you don´t just get an idea – you build it. It does happen that lightening strikes and that the artist is filled with inexplicable divine inspiration, but let´s be honest: most of the time it's all about hard work. In this sense creative people are just hard working people who won´t settle for the ordinary.

From time to time, we actually meet clients who´ll spend 15 minutes describing their commission before ending their presentation by asking, "So, what´s your take on this – what should it look like?". In these situations, it would be great if we could verbally supply a finished blueprint, and we´d definitely make a lot more money that way. But this is not how it works. Most commissions are complex and even the most skilled architect has to analyze and digest the parameters and challenges it presents before a creative design can be achieved. This fact is closely related to the notorious problem of billing. When a client is presented with a simple plan – maybe even a single piece of paper – he´ll often wonder why he has to pay so much for it. The thing is that he doesn´t see all the work it took to get there. He doesn´t know that the bin is overflowing with discarded plans and proposals that led to the one solution in front of him. He doesn´t expect creativity to be hard work.

An education House for science in Bjerringbro, Denmark - Cebra Architects

Stealing

Creativity is linked to innovation, which is another word that has been known to turn many people's stomachs. There is an idea that creativity leads to innovation and innovation is obviously about inventing new things – new never-been-seen-before things. We´ve managed to stay in touch with our local architectural school and have had the pleasure of both teaching and attending critiques from time to time. During these sessions, it is clear that the students expect themselves to be creative and innovative – and so they should. However, and this is where it gets interesting, some students – especially freshmen – feel that they have to invent everything from scratch. That studying the works of great architects is like cheating. Imagine a writer who refused to read novels or a composer who refused to listen to music so no one could accuse him of not being original! Paul McCartney is supposed to have said that "everybody steals, but the good ones only steal from the best" and this is the essence of most creativity.

Most of the time creating something is about putting the right parts together. Just like doing a collage or welding metal scraps together like Robert Jacobsen. Almost any work of art – poetry, music or architecture – is a collection of memories combined and used in a new way. Even the Sydney Opera House, which is probably one of the most striking architectural inventions ever, gained its inspiration from somewhere else. Utzon never hid the fact that he stole, or if you prefer borrowed, the Mayan

concept of plateaus he saw in the Mexican jungle and turned them into his own architecture. In short, no invention is made from nothing and creativity is strongly linked to knowledge and experience.

1st prize competition 'Isbjerget'/residence - in Aarhus in Denmark - Cebra Architects

1st. prize competition - Design Kindergarden in Kolding in Denmark - Cebra Architects

Wizardry

Most people would agree that the greatest artists are born with special talents. On the other hand, if we forget about the genius of rare people like Mozart or Picasso, creativity is something that can be learned or at least developed. This doesn´t mean that everybody can become a great architect, but most people can become a good one. Creativity is not only a gift – it is also a mindset and to some extent a working method.

As already mentioned, most innovation is the result of hard, unceasing work. In our office, we never settle for the first idea we get. In the end, we might return to that first intuitive pitch but not before we've been through numerous different schemes, and we will keep questioning the durability of a concept right up to the deadline. Some refer to this method as a kind of architectural Darwinism. We bring ideas to life but only the fittest will survive – or mutate to do so. Architects who become easily pleased with their ideas – and this is a common trap that even the best can fall into – often miss out on realizing the full potential of their work. A creative person will keep trying to improve the thing he is doing. The composer Gershwin said, "I don't need more time, I need a deadline!" Without a time frame, we´ll go on improving our work forever.

Often outsiders ask us why we always have to pull all-nighters at the end of a deadline, "Couldn't you just start earlier?". In their minds architecture is like cutting firewood. The thing is – and this can be learned – that a creative process is about continual reworking and mass murdering your darlings. Most creativity can be compared with Hogwarts: partly magic but mostly practice.

Planning/competition - Gellerup - Cebra Architects

Tomfoolery

CEBRA has designed quite a few schools for both children and young adults. Through this, we´ve met numerous teachers, students and their parents, and we often hear them talk about the creative subjects. By this, people mean everything related to subjects such as music and painting. There is a deep-rooted presumption that creativity is basically just fooling around with bongo drums and paints. However, we must realize that much of what surrounds us is the result of creativity. And this is also true of the negative aspects of modern life, such as the highly destructive atom bomb. When thought of in this way, we can see that creativity is not just related to certain disciplines. Whenever human capability expands, it is usually a result of creativity. This was the case when Ford revolutionized production methods so cars could be produced quickly and therefore more cheaply. It was the case when John Pemberton invented Coca Cola and it was the case when the Wright brothers finally realized Leonardo da Vinci's principles of aviation. There is really no difference between a Picasso and an iPhone. They are both proof of human creativity. The reason that creativity can be applied in every field is because it is basically a working method. It is a process during which designers, poets or scientists keep questioning their work and results and revising habits and traditions. This is the very core of architectural development: we try every day to do new and better things. Not because architecture itself is creative, but because creative architects keep trying.

Reference

-http://monicalangelund-blog.blogspot.com/2012/02/creativity-is-all-about-hard-work.html

Node Relocation Techniques for Delaunay Nodes

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Abstract:
Delaunay graphs have been used in CAD/CAM, sensor network and geographic information systems. We have investigated the reliability properties of nodes in Delaunay graphs. For measuring the reliability, we formulated the concept of roaming-region for nodes. A node v with large roaming-region r(v) such that v is positioned near the center of r(v) is identified as a reliable node. We developed algorithms for constructing roaming-regions and presented an implementation of the proposed algorithm in the Java programming language.

1. INTRODUCTION

A network or graph consists of a set of nodes V and a set of edges E. An edge E connects two nodes in V. Such a network is usually denoted as G(V,E). The term vertex is also used to indicate node. Similarly, the term link is used to indicate edge. A class of simple networks used extensively in sensor networks and geographical information systems is the planar network. It is noted that a network is called planar if it can be drawn in the plane without intersecting edges. Delaunay triangulation, relative neighborhood graph and Gabriel graph are examples of widely used planar network. One of the main reasons for the popularity of planar graphs in application areas is the fact that the size of a planar graph (number of edges) is not large. In fact, in a planar graph the number of vertices and the number of edges are linearly related. Furthermore, the data structure for representing planar graphs is much simpler and can be updated quickly.

In this paper we have considered the reliability properties of planar network when nodes of the networks are allowed to change slightly in their neighborhood. Broadly speaking, a node in a network is called reliable if the connectivity of the network does not change if the node moves slightly from the initial position. In particular, we investigated the reliability properties of nodes in a Delaunay triangulation.

We first formulated the notion of roaming-region for a node of Delaunay triangulation. We showed that as long as a node remains within its roaming-region, the underlying Delaunay network does not change.

We presented an $O(n^2)$ time algorithm for computing the roaming-region of a node in Delaunay triangulations.

2 Problem Formulations

Consider a set of nine nodes 'S' as shown in Figure 2.1a. The Delaunay triangulation of these nodes is shown in Figure 2.1b. If we move a node slightly then it is (a) a set of nine nodes (b) Delaunay triangulation Figure 2.1: Illustrating Delaunay triangulation very likely that the Delaunay triangulation of 'S' will not change. On the other hand if we continue to move a point significantly further from its initial position then the resulting Delaunay triangulation changes.

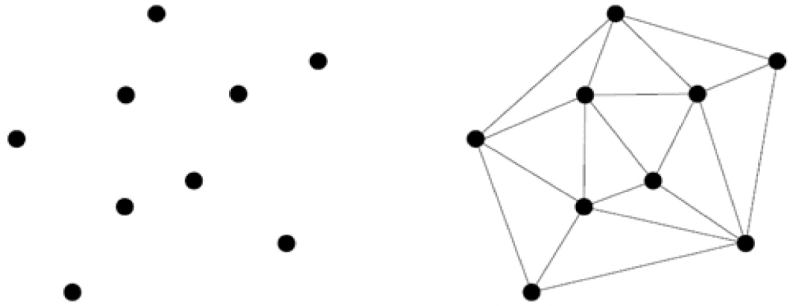

Figure 2.1: Illustrating Delaunay Triangulation

This change of Delaunay triangulation is shown in Figure 2.2. In Figure 2.2, initially node v_0 is connected directly to v_1, v_2, v_3 and v_4. When v_0 is moved to new position as shown in the figure, it will be connected to one more node which is v_5. Figure 2.2; Illustrating the change of triangulation by node movement to determine the connected region for a node such that the Delaunay triangulation remains the same no matter where the node is placed in the region. To formulate this problem formally we extend the free-region concept for unit disk graph.

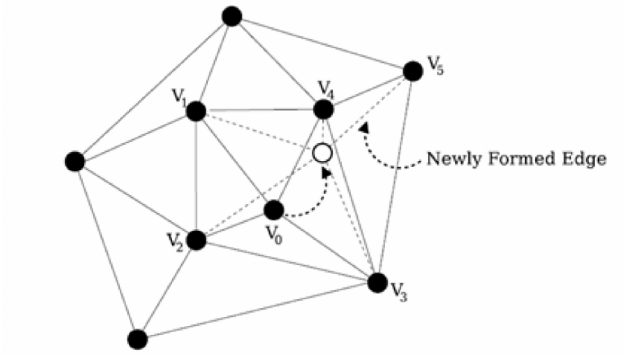

Fig. 2.2 Illustrating the change of triangulation by node movement

Definition 2.1 Consider the Delaunay triangulation of a set 'S' of points in the plane. The roaming-region of a node v_i is the maximal region Rm(i) in the proximity of v_i such that the Delaunay triangulation does not change when v_i is moved to any point within Rm(i). An example of a roaming region is shown in Figure 2.3.

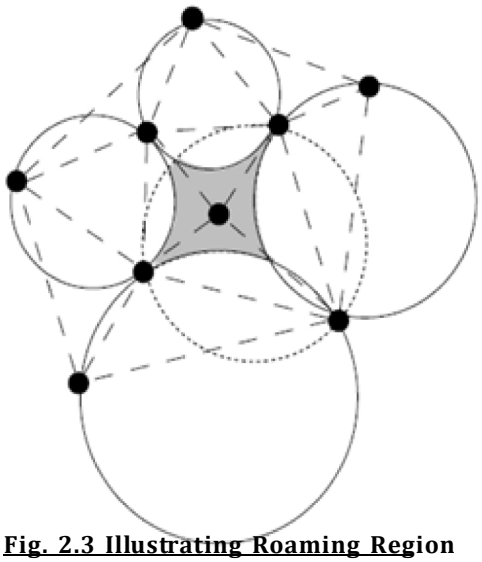

Fig. 2.3 Illustrating Roaming Region

*3.*1 Roaming Region for Internal Nodes

Before developing methods for computing roaming regions we recall one of the key properties of Delaunay triangulation which states that the circum-circle of any triangle of a Delaunay Triangulation is empty, i.e. the circum-circle does not contain any other node of the triangulation. This property is called "empty-circle property". Our method of computing roaming region of a node is based on the use of set intersection and set differences of circum-circles of carefully selected triangles (both Delaunay and non-Delaunay) in the proximity of the candidate node. For this purpose we start with the characterization of *radial* and *lateral* triangles for a given node v_i as follows.

Definition 3.1 *Consider a candidate Delaunay node vi. Let t_1, t_2, t_3, … , t_k be the triangles incident on v_i. If the degree of v_i is k then there are k incident triangles. The triangles sharing the sides of incident triangles opposite to v_i are the radial triangles of v_i. In Figure 3.5, radial triangles for node v_i are shown shaded grey.*

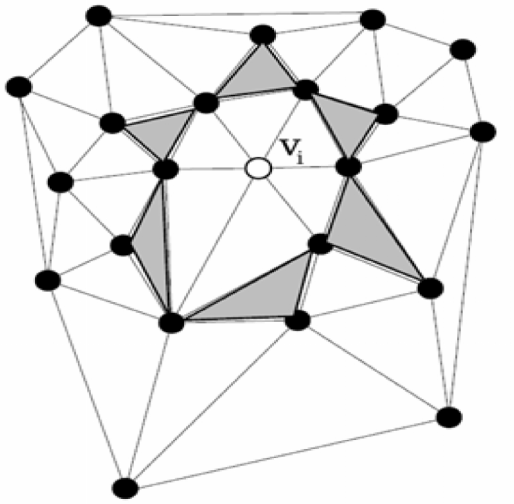

Fig. 3.5 Illustrating radial triangles for deep internal node v_i

The notion of lateral triangles is captured by considering consecutive incident triangles $t_i t_{i+1}$ for a candidate node v_i. Lateral triangles as conceptualized below are not Delaunay triangles. Figure 3.6 shows two of the lateral triangles for a Delaunay node v_i.

Definition 3.5 *Let t_1, t_2, t_3, …, tk be the triangles incident on node vi such that they are ordered angularly around v_i. A pair of consecutive incident triangles $t_i t_{i+1}$ form a quadrilateral $v_i v_p v_q v_r$. The non-Delaunay triangle $v_p v_q v_r$ is a lateral triangle for vertex v_i. In Figure 3.6, only two out of six possible lateral triangles are shown.*

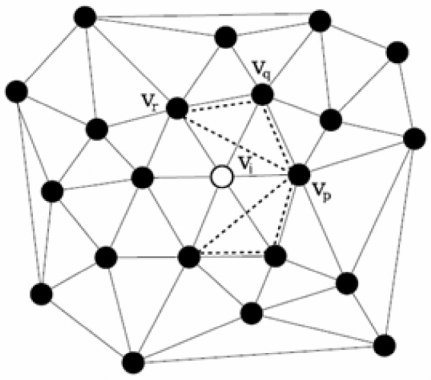

Figure 3.6: Illustrating lateral triangles for deep v_i

Radial Roaming Region: Let R_1, R_2, R_3, …, Rn be radial disks of v0. Let v_1, v_2, v_3, …, v_m be the neighboring nodes of v0. Let D_{max} be the convex-hull area of the point sites including v0 and neighbor nodes v_1, v_2, v_3, …, v_m. Then, the radial roaming region of v_i is:

$$\textit{Radial Roaming Region} = RR(i) = Dmax - R_1 - R_2, \dots, R_n \ (i)$$

In Figure 3.7, radial circum-circles R_1, R_2, R_3 and R_4 are drawn with respect to delaunay triangles D_1, D_2, D_3 and D_4 respectively. In this scenario, Delaunay triangles D_1, D_2, D_3 and D_4 are radial triangles of v_0. To compute a free roaming region for a node v_i, considering the radial circum circles is not enough. So, we also need to consider another concept of Lateral circum-circles. Radial circum-circles and Lateral circum-circles are shown in Figure 3.7 and Figure 3.8 (dotted circles) respectively.

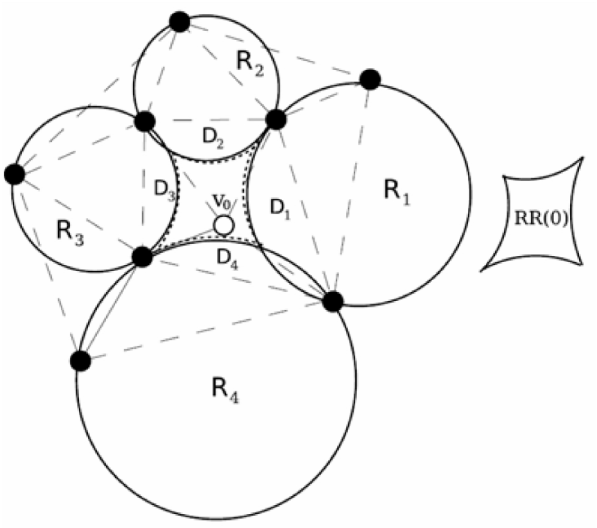

Figure 3.7: Illustrating radial roaming region for v_0

Lateral Roaming Region: Let L_1, L_2, L_3, …, L_k be the lateral disks of v_i. Then lateral roaming region LR(i) for node v_i is given by

Lateral Roaming Region = LR(i) = Â"(L_1,L_2,L_3, …, L_k) (ii)

The intersection of radial roaming region RR(i) and lateral roaming region LR(i) precisely gives the roaming region R(i) for node v_i as follows.

R(i) = Â"(LR(i),RR(i)) (iii)

The formation of radial roaming region RR(0) for node v_0 is elaborated in Figure 3.7. The radial disks are drawn with circles and the convex-hull regions chopped by radial disks are shown on the right side of the figure. Similarly, the formation of lateral roaming region LR(0) for node v_0 is elaborated in Figure 3.8.

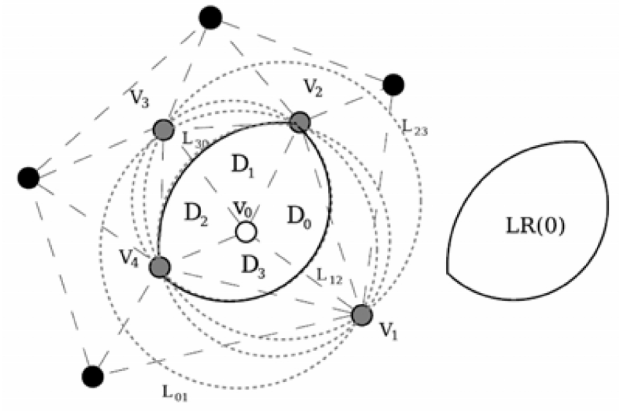

Figure 3.8: Illustrating radial roaming region for v_0

The lateral disks are drawn with dotted circles and their intersection LR(0) is shown on the right side of the figure. The overlay of lateral roaming region LR(0) and radial roaming region RR(0) is shown in Figure 3.9. The intersection of LR(0) and RR(0) gives the roaming region R(0) as shown on the right side of the figure.

The algorithm for computing the roaming regions for internal nodes is sketched below:

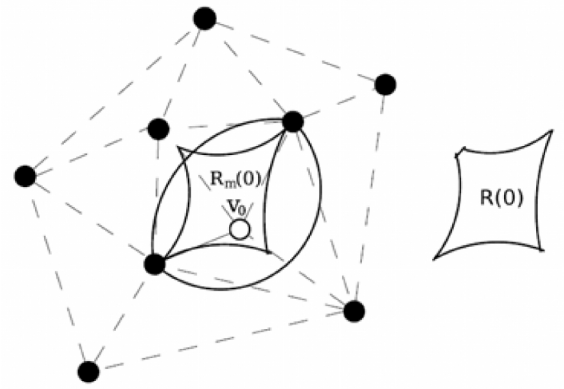

Figure 3.9: Illustrating formation of roaming region R(0)

Roaming Region Algorithm for Internal Nodes

Input: (i) Delaunay Triangulation DT (ii) Interior node v_i
Output: Roaming region R(i) for v_i

Algorithm 1 Roaming Region for Internal Node

1: a. Determine all the neighboring nodes v_1, v_2 …, v_m of v_i in DT
b. Let D_{max} be the convex-hull area of the point sites including v_i and neighboring nodes v_1, v_2,…, v_m
2: (i) Determine the radial triangles t_1, t_2, …, t_k for v_i
(ii) Compute radial disks R_1, R_2,… , R_k corresponding to t_1, t_2, …, t_k
3: Determine RR(i) = D_{max} - R_1 - R_2 ... - R_k
4: Identify lateral disks L_1, L_2, …, L_p for vertex v_i
5: Compute LR(i) =Â"(L_1, L_2, … , L_p)
6: Determine and output R(i) = Â"(LR(i), RR(i))

Theorem 3.1 *The roaming region for deep-internal node v_i in a Delaunay triangulation DT can be computed in $O(n^2)$ time, where n is the number of nodes in DT.*

Proof. We assume that the given Delaunay triangulation is available in a doubly-connected edge list data structure. Step 1 can be done in $O(d(v_i))$ time by following the edge list incident on v_i, where $d(v_i)$ is the degree of node v_i. Since the number of edges in a DT are linearly related to the number of vertices n, $d(v_i)$ = n. Hence, Step 1 and Step 2 take O(n). Once radial triangles around v_i are available, radial disks can be determined in O(n) time. By navigating the doubly connected edge list data structure, lateral triangles of v_i can be determined in O(n) time. Finally, the intersection of lateral disks and the intersection of LR(i) and RR(i) can be done in $O(n^2)$ time in a straightforward manner.

3.4 Roaming Regions for External Nodes

While roaming regions for internal nodes are always finite and bounded, the corresponding roaming regions for external nodes could be both bounded and unbounded. It is interesting to identify the cases where the roaming region for an external node is bounded. Consider the case in which the number of convex-hull edges is at least five as shown in Figure 3.10. Let v_i be the candidate external node for which we want to identify the roaming region. We re-label the nodes as the convex-hull boundary, in counterclockwise traversal as v_{i-2}, v_{i-1}, vi, v_{i+1}, v_{i+2}, …. We further denote the convex-hull edges as $e_{i-2} = (v_{i-1}, v_{i-2})$, $e_{i-1} = (v_i, v_{i-1})$, ei = (v_i , v_{i+1}), $e_{i+1} = (v_{i+1}, v_{i+2})$ ..... If the extension of edges

e_{i+1} and e_{i-2} meet at point q_i then the roaming region will be bounded and inside the union of triangle $T_i = (v_{i-1},q_i,v_{i+1})$ and the convex-hull region of the whole point sites.

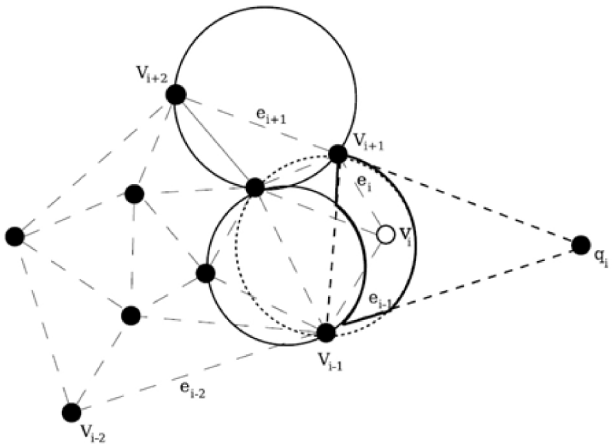

Figure 3.10: Illustrating bounded roaming region for an external node v_i

On the other hand, if the extension of edges e_{i-2} and e_{i+1} diverge as shown in Figure 3.11, then the roaming region could be unbounded for certain distribution of nodes. In order to come up with the algorithm for capturing roaming regions for external nodes we need to identify all the cases for which the roaming regions are finite. Once such cases are properly identified, it would be straightforward to extend the algorithm for internal nodes to the nodes on the convex-hull-boundary.

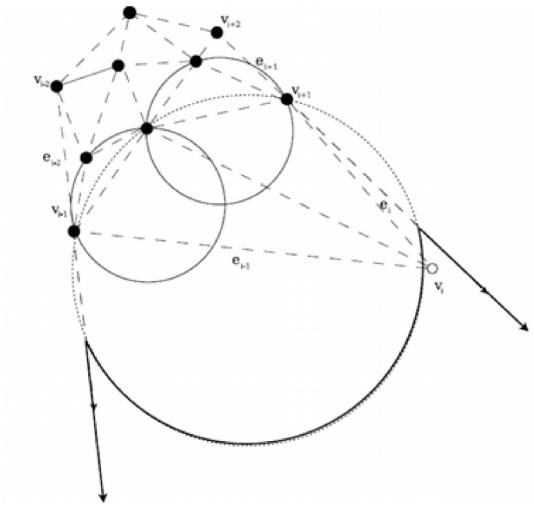

Figure 3.11: Illustrating unbounded roaming region for an external node v_i

CONCLUSION

We reviewed well known algorithms for computing Delaunay triangulation of point sites in two dimensions. The properties of Delaunay triangulation were examined for capturing the proximity properties of point sites. We introduced the problem of computing roaming regions for nodes of Delaunay triangulation. To capture the roaming region of Delaunay nodes we formulated the notions of lateral roaming region and radial roaming region. We showed that the roaming region is precisely given by the intersection of radial roaming region and lateral roaming region. This characterization led us to the development of an efficient algorithm for computing the roaming region of a Delaunay node.

Several further investigations can be performed by extending the concepts introduced in this paper. An interesting problem would be to develop an algorithm for identifying nodes with maximum reliability.

REFERENCES

1. *K. Q. Brown. Voronoi diagrams from convex hulls. Information Processing Letters, 9(5):223–228, 1979.*
2. *L. Paul Chew. Constrained delaunay triangulation. Algorithmica, pages 97–108, 1989.*
3. *Vedat Coskun. Relocating sensor nodes to maximize cumulative connected coverage in wireless sensor networks. Sensors, 8, 2008.*
4. *B. N. Delaunay. Sur la sphre vide: Izv. akad. nauk sssr. RNauk SSSR, Otdel. Mat. Est. Nauk, 7:793–800, 1934.*
5. *Marc van Krevel. Mark Overmars Mark de Berg, Otfried Cheong. Computational Geometry: Algorithms and Applications. Springer-Verlag, 2008.*
6. *Jan B. Pedersen N. Rongratana, Laxmi Gewali. Estimating the free region of a sensor node. JCMCC, 74:53–64, 2010.*
7. *Henry Selvaraj Navin Rongratana, Laxmi Gewali. Characterizing free-regions of sensor nodes. International Conference on Systems Engineering, pages 375–379, 2008.*
8. *J. O'Rourke. Computational Geometry in C. Cambridge University Press, 1998.*
9. *Jim Ruppert. A delaunay reûnement algorithm for quality 2-dimensional mesh generation. NASA Ames Research Center, 1993.*

NODE FILTERING AND FACE ROUTING FOR SENSOR NETWORK

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Abstract:
- *Efficient Algorithms for identifying Redundant Sensor Nodes*
- *New Technique for Filtering Redundant Nodes in Sensor Network*
- *Reliable Algorithm for Message Routing Forwarding*

1. Introduction

Development of efficient algorithms and protocols for sensor network application has attracted the interest of many researchers since the last 10 years. Sensor networks have been applied to solve problems in many areas of science and engineering that include robotics, emergency response, environmental monitoring, remote sensing, manufacturing, and law enforcement. A sensor network is formed by wirelessly connecting sensor nodes which are distributed on two dimensional surface or embedded on some equipment or gadgets. A sensor node is essentially a small electrical device containing (i) small amount of memory, (ii) low capacity processing unit, (iii) a radio communication component with range between 50 meter to 300 meters, and (iv) some sensing component for measuring physical quantities such as temperature, pressure, humidity, etc. Nodes within the transmission range can exchange information wirelessly. Nodes outside the transmission range can communicate by establishing a sequence of in-range intermediate nodes between them. This kind of establishing in-range intermediate nodes between two distinct nodes is called routing.

Computation in sensor network is much different than in traditional wired network. In sensor network, there is no centralized control for communication. Communication and computation is preferred to be done locally in distributed manner. Each node only knows the position of itself and its in-range neighbors. A node can explore the presence of other nearby nodes by exchanging information between k-hop neighbors, where k is usually 1, 2, or 3. Computing global properties of the sensor network that include connectivity, clustering, and coverage by exploring upto k-hop neighbors (for small k) are the most challenging problems in this emerging area of computer science and engineering. Some good progress has been made for performing routing and clustering in recent years and there are a wealth of fertile problems to pursue further research.

In this paper, we examine the use of planar graphs for developing routing algorithms in sensor network. In particular, we consider the application of Gabriel Graph(GG), Relative Neighborhood Graph(RNG), and Delaunay Triangulation(DT) for determining communication routes in sensor network.

A graph G consists of a set of nodes V and a set of edges E. It is usually denoted as G(V,E). Each edge E connects the two vertices in a graph. The edge can be directed as well as undirected. A graph is called planar if it has no intersecting edges. A sensor is a device that measures a physical quantity and converts it into a signal which can be read by an observer. If two or more sensor nodes are connected, then it is called sensor network. A sensor network consists of distributed sensors to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, humidity and to pass their data through the network to the main location.

There are different ways to transmit message from one sensor node to another in a sensor network. One of the most popular method is called flooding in which a sensor node transmits its message containing destination to its neighbor nodes. The other nodes re-transmit these message to their respective neighbors till the message is conveyed to destination. We can also transmit message from one node to another using Greedy forward routing, Face routing, and Hybrid greedy forward face routing.

Greedy forward routing tries to bring the message closer to the destination in each step using only local information. In this case, each node forwards the message to the neighbor that has shortest distance to the destination. The process is repeated till the message is delivered. Face routing is routing along the face of the graph. The next node is determined by traversing the boundary of the face that intersects the line joining source and target node. Hybrid greedy forward face routing is the combination of Greedy routing and Face routing. Greedy forwarding can lead into a dead end, where there is no neighbor closer to the destination. Then, face routing helps to recover from the situation and find a path to another node, where greedy forwarding can be resumed. This process of using both Greedy routing and Face routing is called Hybrid greedy forward face routing. Sensor networks can be represented by a planar graph. Some of the widely used planar graphs are Gabriel Graph, Relative Neighborhood Graph, Unit Disk Graph, Delaunay triangulation, and Restricted Delaunay Graph. The main advantage of using these type of graph is that the size of a graph will not be large (edges are almost linear to number of vertices). We can represent these planar graphs in a Doubly Connected Edge List(DCEL) data structure. It is a data structure in which each edge is divided into two half edges pointing in opposite direction. It consists of a record for each face, vertex and half-edge.

In this paper, we are mainly concerned about filtering of nodes for routing in sensor network. We basically try to identify redundant nodes present on a network so that we can eliminate these nodes and make the routing path more effective and efficient.

3.1 Compressing Equivalent Nodes

Consider a set of nodes S= {p0, p1, p2, . . . , pn-1} used for face routing in sensor network. Two nodes close to each other are called equivalent if their transmission range cover the same sub-set of nodes. Recall that all nodes are assumed to have identical transmission range which is taken, without loss of generality, as 1. We can illustrate the notion of equivalent nodes with specific example. In Figure 3.1, the transmission disks of two nodes p5 and p6 are shown with dashed circle. This shows that nodes p5 and p6 covers the identical set of nodes p1, p2, p3, p4, p7 and p8.

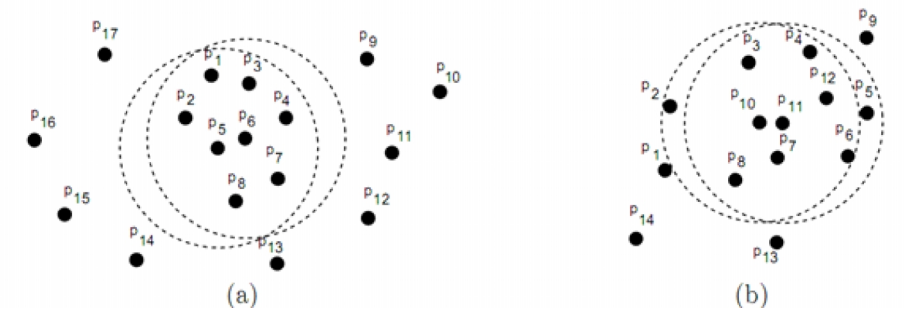


Figure 3.1: Illustrating Equivalent nodes p5 and p6

On the right-side of Figure 3.1, two nodes p10 and p11 are shown which are not equivalent even though they are very close to each other. There can be many nodes equivalent to each other in some rare distribution that contains clustered nodes in some pocket region. This is illustrated in Figure 3.2.

Figure 3.2a is a distribution of sensor nodes where there are five distinctly visible clusters sub-sets of nodes. The clusters that cover identical nodes are highlighted by drawing circles for their range in Figure 3.2b. It is observed in Figure 3.2b that circles in a group cover the same set of nodes.

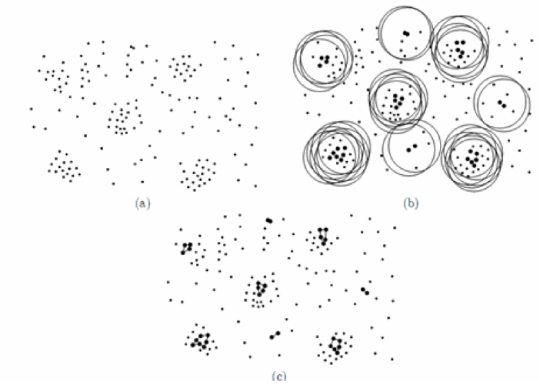
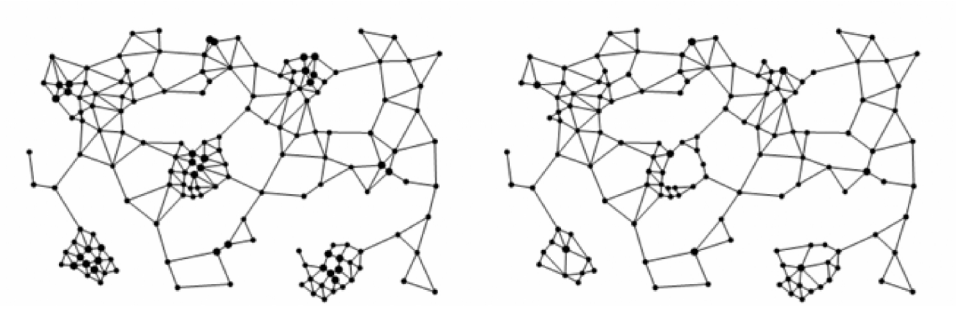


Figure 3.2: Illustrating Clusters of Equivalent nodes

Definition 3.1.1. *(Compressed Gabriel Graph) Consider a Gabriel Graph G(V,E)of a set of sensor nodes. Let 1,C2,...,Ck be the set of equivalent nodes in G(V,E). The nodes in V not in the equivalent sets are referred to as background nodes and the set of these nodes is denoted by VB. The set of nodes obtained adding to VB exactly one member from each equivalent set is the compressed set of node VC. The resulting Gabriel graph of VC, denoted by GC(VC,EC), is the compressed Gabriel graph. Figure 3.3 shows the original Gabriel graph and its compressed version for indicated transmission range.*

Lemma 3.1.1*. If background nodes vi and vk are connected in Gabriel graph G(V,E), then they are also connected in the compressed Gabriel graph GC(VC,EC).*



(a) ***(b)***

Figure 3.3: Illustrating Gabriel Graph and its compressed version

Proof: Consider any route R connecting node vi to vk that passes through a cluster Cj . Let ve and vt be the nodes in the background and in R that are closest to the cluster Cj (Figure 3.4).

Let vj be the representative node in Cj . Since ve and vt are connected to same nodes in Cj , they are also connected to vj by the “special path” (ve, vj ,vt) shown by dashed segments.

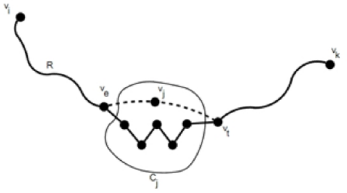


Figure 3.4: Illustrating a Proof of Lemma 3.1.1

3.2 Solo-Faced Chains

A segment can be viewed to consist of two half-edges. A gabriel graph in which edges are splitted into two half-edges is shown in Figure 3.5b. Let {e1,e2,....,e15} be the edges of a gabriel graph. The half-edges of ei are denoted by ei' and ei'' . Note that ei' and ei'' are twin half-edges of each other and they are directed reverse to each other.

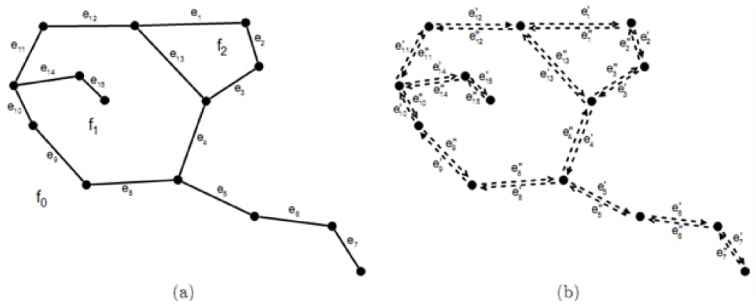


Figure 3.5: Gabriel graph showing edges and its equivalent half edge

Definition 3.2.1. An edge ei is called solo-faced edge if the twin half-edges of ei, i.e. ei' and ei'' are incident on the same face. In Figure 3.5a, there are three faces f0,f1, and f2 in the gabriel graph. Edge e15 is a solo-faced edge since e15' and e15'' are incident on the same face f1. Similarly e5 is a solo-faced edge as e5' and e5'' are incident on the same face f0. On the other hand, e4 is not solo-faced as e4' and e4'' are incident on faces f0 and f1, respectively.

Definition 3.2.2. (Maximal Solo-Faced Chain) A sequence consecutive solo-faced edges is referred to as solo-faced chain. A solo-faced chain that is not contained in any other solo-faced chain is called maximal solo-faced chain. In Figure 3.5 there are two maximal solo-faced chain which are e7e6e5 and e15e14. Some gabriel graphs could have many maximal solo-faced chain. A gabriel graph with five maximal solo-faced chains is shown in Figure 3.6.

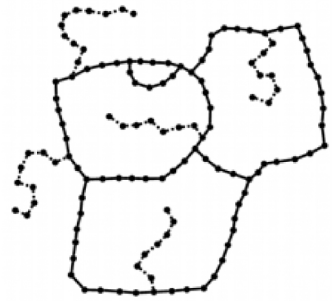


Figure 3.6: Illustrating Solo-Faced Chains

Remark 3.2.1. Now onward, unless otherwise stated, the term solo-faced chain w be used to indicate maximal solo-faced chain.

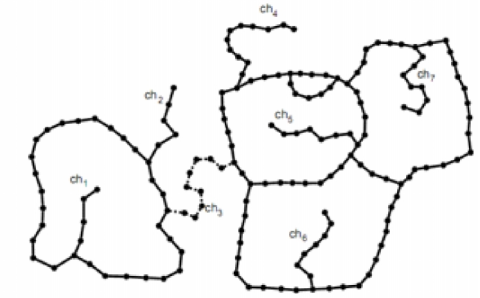


Figure 3.7: Illustrating Bridge Solo-Faced Chain (ch3-drawn dashed)

Definition 3.2.3. (Bridge Solo-Faced Chain) Solo-faced chains can be distinguish into two types: Bridge type and Non-Bridge type. If the removal of a solo-fa chain ch1 from the gabriel graph breaks the graph into two onnected component then ch1 is called bridge solo-faced chain. In Figure 3.7, there are seven solo-fa chains. Among them only one is a bridge solo-faced chain which is drawn by dash edges.

Definition 3.2.4. (External Solo-Faced Chains and External Components) Figure 3.8 shows five clusters of nodes A,B,C,D and E. These clusters contain many interconnected nodes and solo-faced chains. Let ch1,ch2,ch3 and ch4 be the four bridge solo-faced chains connecting these five clusters of nodes. These five clusters of nodes and their bridge solo-faced chains can also be represented in tree structure as shown in Figure 3.9.

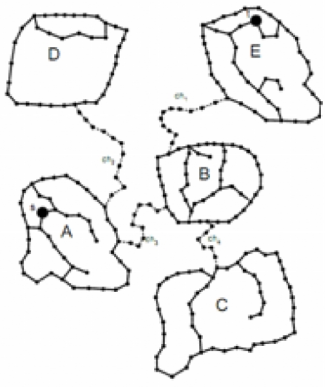


Figure 3.8: Illustrating clusters of nodes connected by Bridge Solo-Faced Chains

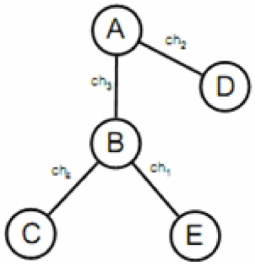


Figure 3.9: Tree representation of Bridge Solo-Faced Chains

Let s and t be the source and target node present inside clusters A and E respectively. From Figure 3.9, we can see that the actual path to travel from source node to target node is A -> ch3 -> B -> ch1 -> E. Only ch3 and ch1 are the two bridge solo-faced chains that lie in the path from A to E. All other bridge solo-faced chains that don't lie in the path are called external solo-faced chains. There are components and external solo-faced chains as shown in Figure 3.11.

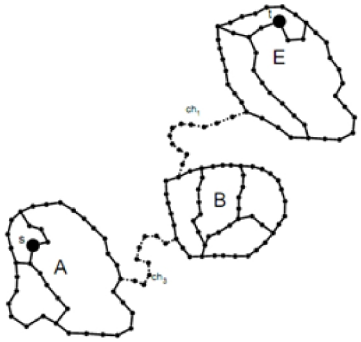


Figure 3.11: Illustrating cluster of nodes after removing External-Components and External Solo-Faced Chains

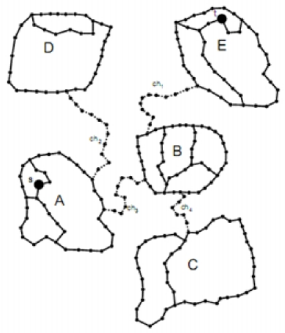


Figure 3.10: Illustrating cluster of nodes without Non Bridge Solo-Faced Chains

3.3 Extracting Biconnected Cluster

We could use the depth first search based on connected component recognition algorithm to extract biconnected clusters. However, Gabriel graph is a planar graph and a much simpler algorithm can be designed to extract biconnected components. To describe such a simpler algorithm, it is necessary to use the doubly connected edge list (dcel) data structure for representing planar graph which is described next.

3.3.1 Planar Graph

A graph G(V,E) is called planar if it can be drawn on a plane without intersecting edges.

3.3.2 Planar Straight Line Graph

A planar straight line graph is a planar graph containing all straight edges. They are mostly used to represent maps. Figure 3.12 shows a planar straight line graph containing five vertices and five edges.

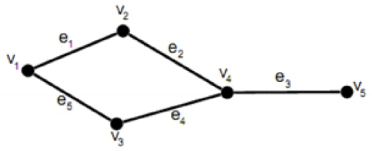


Figure 3.12: Illustrating Planar Straight Line Graph (PSLG)

3.3.3 Doubly Connected Edge List (DCEL)

Double Connected Edge List is a data structure for representing planar straight line graph. It was originally suggested by Preparata and Muller in 1978 for the representation of 3D convex polyhedra [10]. In DCEL, each edge is viewed as a pair of twin half-edges pointing in opposite direction. Figure 3.13 shows a doubly
connected edge list data structure containing five vertices, ten half edges and two faces.

A DCEL consists of record for each half edge, face, and vertex. Each half edge record consists of a twin edge, a previous edge, a next edge, an incident face, and a source vertex. The face record consists of a bounding half edge and vertex record consists of a incident edge, and its co-ordinates.

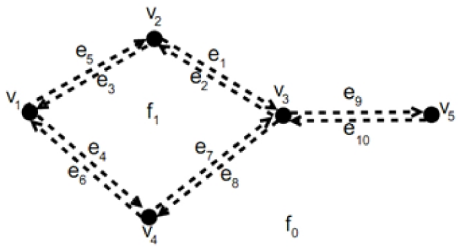


Figure 3.13: Illustrating Doubly Connected Edge List data structure

3.3.4 Degree of Vertices

The degree of vertex v is defined as total number of edges incident to that vertex. Let V={v1,v2,v3,v4,v5,v6} be the total vertices and E={e1,e2,e3,e4,e5} be the total edges present in a graph G(V,E) as shown in Figure 3.14(a). Vertex v3 has degree three because three edges are incident to it. Similarly, vertex v6 and v5 have degree one and two respectively. Figure 3.14(b) shows the edges splitted into two half edges for representing it in Doubly Connected Edge List data structure. An algorithm to detect vertices of degree one is described in algorithm 5.

Figure 3.14: Graph showing edges and its equivalent half edge

Algorithm 5 Detect vertices of degree one
1: **if** vi.getIncidentEdge().getTwin().getNext()==vi.getIncidentEdge() **then**
2: return true.
3: else
4: return false.
5: **end if**

Figure 3.14: Graph showing edges and its equivalent half edge

3.3.5 Removal of Floating Chains

Floating chains have at least one vertex with degree one. Figure 3.15 shows a floating chain e3,e4,e5. In this chain, vertex v6 has degree one and hence this node is removed from the graph. After the removal of vertex v6 and edge e5, vertex v5 becomes the another node with degree one. These nodes are removed from the graph one after another until we don't find any vertex with degree one. We also need to consider if the vertex node is source or target because these nodes shouldn't be removed from the graph. The concept of doubly connected edge list data structure is used to remove floating chains from the graph as shown in Figure 3.15(b).

Algorithm 6 Removing Floating chain
1: Vertex v1,vc
2: HalfEdge e1,e2
3: vc ! vi
4: **while** vc = s or t and deg(vc) == 1 **do**
5: v1 ! vc
6: e1 ! v1.getIncidentHalfEdge()
7: e2 ! e1.getTwin()
8: vc ! e2.getStartNode()
9: e2.getPrev().setNext(e1.getNext())
10: vc.setIncidentHalfEdge(e1.getNext())
11: remove v1, e1, e2 from the graph
12: **end while**

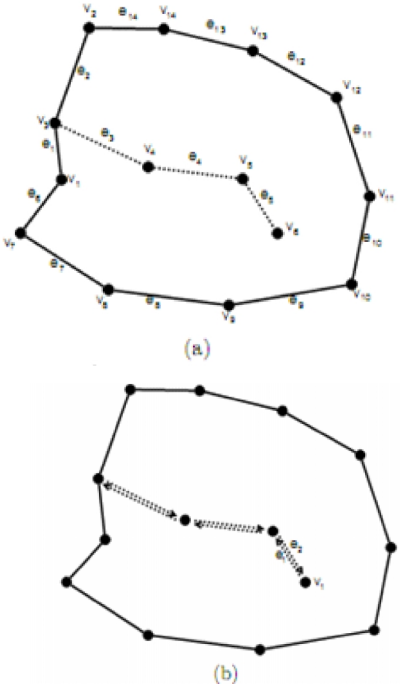


Figure 3.15: Graph showing floating chains.

We assume that the given gabriel graph G(V,E) contains no floating chain. If there are floating chains, then we can use Algorithm 6 in Section 3.3.5 to remove them. A graph G(V,E) is called biconnected if there are two distinct paths between any pair of vertices in G(V,E). A biconnected graph remains connected even if some of its vertices are removed. Figure 3.16(a) is a biconnected graph because any two pair of vertices have at least two distinct paths. Figure 3.16(b) is not a biconnected graph because vertex v1 and v4 doesn't have two distinct paths.

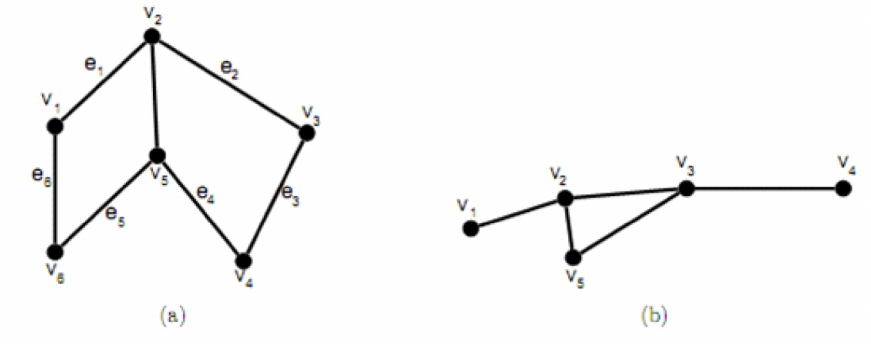


Figure 3.16: Illustrating biconnected graph

In a connected gabriel graph G(V,E) without floating chain, there could be many biconnected components and bridge chains as shown in Figure 3.17. A dcel representation of G(V,E) is shown in Figure 3.18.

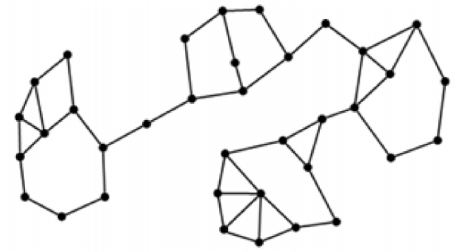


Figure 3.17: Illustrating biconnected components and bridge chains

Figure 3.18: DCEL representation of biconnected components and bridge chains

Figure 3.19: Illustrating transition half-edge

Definition 3.3.1. A half-edge ei is called transition half-edge if it satisfies the following conditions.
i) Half-edge ei is in bridge-chain.
ii) Let ej=ei.next.twin, then ej .face is not same as ei.face

Algorithm 7 describes an algorithm to determine transition half edge. This transition half edge is used for finding bi-connected graph in Algorithm 8. Figure 3.19(b) is used for implementing Algorithm 8. Algorithm 9 describes the procedure to remove external components and external solo-faced chains from the graph.

Algorithm 7 Find all Transition Half Edge
1: **for** each edge ei in bridge solo-faced chain **do**
2: **if** ei.getNext().getTwin().hasMainFace()==false **then**
3: add ei to transition edge list
4: **end if**
5: **end for**

Algorithm 8 Find Bi-Connected graph from transition edge
1: transition edge ei
2: half edge e1,e2,ec
3: e1 ! ei
4: e2 ! e1.getNext()
5: **if** e2.getNext().getTwin().hasMainFace()==true **then**
6: ec=e2.getNext().getTwin().getNext()
7: **else**
8: ec=e2.getNext()
9: **end if**
10: Edgelist el
11: el.add(e2)
12: **while** ec = e2 **do**
13: el.add(ec)
14: **if** ec.getNext().getTwin().hasMainFace()==true **then**
15: ec=ec.getNext().getTwin().getNext()
16: **else**
17: ec=ec.getNext()
18: **end if**
19: **end while**
20: create a polygon p using all the edges of edge list el
21: **for** each edge e1i present in graph **do**
22: **if** e1i is present inside p **then**
23: el.add(e1i)
24: **end if**
25: **end for**
26: output el as total edges of one bi-connected graph obtained from transition edge ei

Algorithm 9 Remove External Solo-Faced Chains and External Components from graph
1: label each edges of a bi-connected graph by a tree that has pointer to other trees.
2: use transition half-edge to find connection between two trees
3: find the tree present in source and target
4: use depth first search to find the path from source to target.
5: delete all bridge solo-faced chains that doesn't lie in the path
6: delete all vertices and edges that doesn't have tree that lie in the path.

Observation and Conclusion

We show all the experimental results that we obtained by running e program. Table 5.1a and 5.1b shows the random nodes and their respective ranges ken for the experiment. Table 5.1a shows the total nodes and their ranges when they are partially connected and Table 5.1b shows the total nodes when they are completely connected.

Nodes	Range
200	104
300	87
400	75
500	66
700	60

(a)

Nodes	Range
200	238
300	192
400	156
500	133
600	116

(b)

Table 5.1: Nodes and their range

We drew gabriel graph with the above nodes and tested it in different ranges. We found out that the equivalent nodes varied with range of nodes. Table 5.2a nd 5.2b shows the results obtained when the graph was partially and completely connected respectively. The equivalent node got reduced by 12.28% when nodes were partially connected. On the other hand, the equivalent nodes got reduced by 5.17% hen the nodes were completely connected. This shows that equivalent nodes were mostly found when nodes have small range.

Total Nodes	Range	Total Eq. Groups	Total Eq. Nodes	Total Nodes after removing Eq. Nodes	% change
200	104	25	55	170	15
300	87	35	76	259	13.67
400	75	38	85	353	11.75
500	66	55	115	440	12
700	60	54	117	637	9

(a)

Total Nodes	Range	Total Eq. Groups	Total Eq. Nodes	Total Nodes after removing Eq. Nodes	% change
200	238	12	26	186	7
300	192	9	18	291	3
400	156	20	40	380	5
500	133	22	47	475	5
600	116	29	64	565	5.83

(b)

Table 5.2: Total changes in equivalent nodes

We also counted the total hubs used while routing from source node to target node under different routing conditions. We experimented it with greedy, face and hybrid routing and calculated the total hubs present before and after removing equivalent nodes. We also tested it when the external components were removed from the graph. Table 5.3 gives all the details that we calculated when the graph was partially connected. Table 5.3a gives the changes in hubs when we used greedy routing. Similarly, Table 5.3b and 5.3c gives all the details about changes obtained while using face and hybrid routing respectively. We can see that most of the nodes got stuck when we used greedy routing on partially connected graph. One of the most significant result can be seen on Table 5.3b and 5.3c where we can see that the total hubs reduced a lot during face and hybrid routing respectively. Table 5.4 shows the total change in hubs when different routing algorithms were used before and after removing equivalent nodes and external segments on completely connected graph. Table 5.4a, 5.4b and 5.4c shows the changes obtained when greedy, face and hybrid routing were used. The table shows that there weren't significant improvement when the nodes were completely connected.

From Table 5.3 and 5.4, we can see that more number of equivalent nodes, solo-faced chains and bi-connected components were found on partially connected graph. Hence, we can conclude that our algorithm is mostly suitable for partially connected graph. From this paper, we found out that there are lots of redundant nodes present when we connect nodes using different planar graphs. We can filter out the unnecessary nodes by finding out equivalent nodes, solo-faced chains and bi-connected components and we found it to be more effective when nodes were partially connected.

Total Nodes	Range	Total hubs present		
		Before Removing Eq. Nodes	After Removing Eq. Nodes	After Removing External Segments
200	104	11(S)	11(S)	11(S)
300	87	3(S)	3(S)	3(S)
400	75	0(S)	0(S)	0(S)
500	66	2(S)	2(S)	2(S)
700	60	1(S)	1(S)	1(S)

(a)

Total Nodes	Range	Total hubs present		
		Before Removing Eq. Nodes	After Removing Eq. Nodes	After Removing External Segments
200	104	51	46	42
300	87	782	726	446
400	75	800	713	402
500	66	1044	938	436
700	60	386	350	209

(b)

Total Nodes	Range	Total hubs present		
		Before Removing Eq. Nodes	After Removing Eq. Nodes	After Removing External Segments
200	104	37	32	32
300	87	289	273	165
400	75	180	165	88
500	66	1443	1493	431
700	60	437	389	243

(c)

Table 5.3: Total changes in hubs (partially connected graph)

Total Nodes	Range	Total hubs present		
		Before Removing Eq. Nodes	After Removing Eq. Nodes	After Removing External Segments
200	238	23	23	23
300	192	27	27	27
400	156	31	31	31
500	133	35	33	33
600	116	31	28	28

(a)

Total Nodes	Range	Total hubs present		
		Before Removing Eq. Nodes	After Removing Eq. Nodes	After Removing External Segments
200	238	35	34	34
300	192	32	32	32
400	156	39	38	38
500	133	42	40	40
600	116	45	39	39

(b)

Total Nodes	Range	Total hubs present		
		Before Removing Eq. Nodes	After Removing Eq. Nodes	After Removing External Segments
200	238	23	23	23
300	192	27	27	27
400	156	31	31	31
500	133	35	33	33
600	116	31	28	28

(c)

Table 5.4: Total changes in hubs (completely connected graph)

References

[1] Delaunay triangulation. http://en.wikipedia.org/wiki/Delaunay_triangulation.

[2] Fortune's algorithm. http://en.wikipedia.org/wiki/Fortune%27s_algorithm.

[3] Java (programming language). http://en.wikipedia.org/wiki/Java_%28programming_language%29.

[4] A visual implementation of fortune's voronoi algorithm. http://www.diku.dk/jemmesider/studerende/duff/Fortune/

[5] Voronoi diagram. http://en.wikipedia.org/wiki/Voronoi_diagram.

Lowering of Groundwater Table in Kathmandu Valley and Its Replenishment

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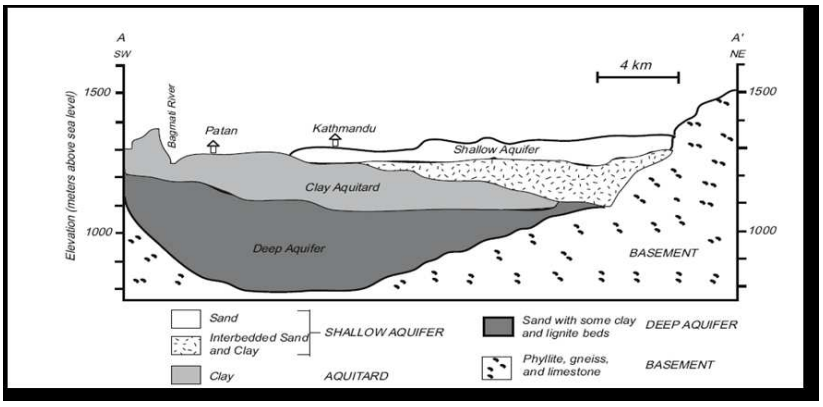
Abstract:

Over drafting of ground water in Kathmandu valley has reached its proximity thereby lowering the ground water table by about 2.5m/year (Shrestha, 2000). Large scale urbanization and consequent concretization, depletion of vegetation cover, heavy demand for the use of static ground water sources, little recharge of groundwater, high demand for drinking and industrial purposes, etc. are the triggering factors responsible for the declining water level. Nepal has a high urbanization phenomenon; it has been observed in Nepal from the 1970s onward, showing one of the highest rates in Asia and Pacific (ADB/ ICIMOD, 2006). The average contribution of ground water remains close to 50% of the total water supply in Kathmandu valley (Jha, 1997; Sah, 2001; Khatiwada et al., 2002; ENPHO, 2004) prohibiting a heavy amount of precipitation to infiltrate and replenish the ground water. Infiltration depends on vegetation cover, slope, soil composition, depth to the water table, the presence or absence of confining beds and other factors. The critical recharge areas of Kathmandu valley are diminishing due anthropogenic activities. Increasing anthropogenic activities in Kathmandu valley, the main urban centre of Nepal, have mounted heavy stresses on ground water quantity and quality. The shortage of groundwater is more pronounced due to urbanization and limited open areas available for recharge of ground water. The source of replenishment of the over drafted resource may be undoubtedly the precipitation. The haphazard construction practice and over-pouring population in Kathmandu valley has raised the water demand in urban areas and the outskirts too but the unavailability of perennial surface resources has enhanced the pressure over groundwater in order to fulfill domestic, industrial and institutional demand. Artificial recharge and rainwater harvesting may collaborate in the replenishment during torrential precipitation.

Introduction

Kathmandu valley has average humidity of 75% with heavy concentration of precipitation during June to August as a result of Southeast monsoon winds (HMGN, 1969). Bagmati river system is the largest contributing river system for Kathmandu valley with respect to surface and groundwater scenario. The landform of Kathmandu valley constitutes alluvial and flood plains along the rivers and slightly more elevated river terraces (Thapa et al.). Kathmandu valley occupies an intermixed basin containing up to 550m of Pliocene-Quaternary fluvio-lacustrine sediments (Sah, 2001). Upper unconfined aquifer of late Quaternary sand up to 20m thick overlies an aquitard of black clay with peat and lignite bands (Sah, 2001). The aquitard is well developed on the western side of the valley, where it is up to 200m thick. Beneath the aquitard is a sequence of Pliocence sand and gravel beds, intercalated with clay, peat and lignite (Sah, 2001). These sand and gravel beds collectively comprise a deeper, confined aquifer, which provides and important water supply to the central urban area of Kathmandu (Sah, 2001). Recharge to the upper aquifer is from direct infiltration of monsoonal rain and from stream flow on the North and East of the basin (Sah, 2001). The basin has the superficial outlet through the gorge of Bagmati River in the Southwest (Jha et al., 1997). Kathmandu valley occupies about
327 Km² of 664 Km² surface watershed areas in central Nepal with average altitude of 1350m above mean sea level (Pradhanang et al., 2011). Annual precipitation in the valley is around 1755mm, 80% of which is from monsoon rain that spans from June to September (Pandey et al.,2010). Recharge to the region's main aquifer has been variously reported to be 15million m³/yr (Binnie et al., on the North and East



Cross section through the Kathmandu Valley, with vertical exaggeration, adapted from Jha et al.1997 and Creswell et al. 2001

LIMELIGHT

of the basin (Sah, 2001). The basin has the superficial outlet through the gorge of Bagmati River in the Southwest (Jha et al., 1997). Kathmandu valley occupies about 327 Km^2 of 664 Km^2 surface watershed areas in central Nepal with average altitude of 1350m above mean sea level (Pradhanang et al., 2011). Annual precipitation in the valley is around 1755mm, 80% of which is from monsoon rain that spans from June to September (Pandey et al., 2010). Recharge to the region's main aquifer has been variously reported to be 15million m^3/yr (Binnie et al., 1989) to less than 5 million m^3/yr (Gautam and Rao, 1991). Recharge to the deep aquifer, however, is suggested to be less than 80000 m^3/yr (Gautam and Rao, 1991).

Water Table Variation:

In general on a regional scale, the predevelopment water table closely follows the form of the topographic surface (Hitchon, 1969; King, 1892; Meinzer, 1923; Meneley, 1963; Toth, 1963; Wisler and Brater, 1959). The form of the predevelopment water table is normally a "subdued replica" of the land surface (Tolman, 1937; Freeze and Cherry, 1979; Hubbert, 1940). Most of the changes in water table altitude in humid to sub humid regions are the result of changes in land surface altitude with increasing altitude (Williams, T.A. et al., 1989). Gravity is the force that moves ground water which generally means it moves downward. There's about 4.1-19.7% of annual precipitation that replenishes groundwater in semi-arid regions (Sah, 2001).The depletion of ground water is taken as a first indicator of water scarcity (Sah and Indu, 2004).). Widespread silty lacustrine deposits that are usually fine grained control groundwater recharge for shallow aquifers in the valley meanwhile the aquifers are inter-bedded with the impermeable clay and prevent easy access of percolating rainwater to the aquifers (Pradhanang et al., 2011). The drop in pumping water level from 9m to 68m in Kathmandu valley over a few years signalizes an alarming situation (Metcalf and Eddy, 2000). The sustainable withdrawal of Kathmandu valley in the area of around 500 Km^2; is designated as 26.3 million liters a day (Stanley, 1994) but current rate of abstraction is around 58.6 million liters a day (Metcalf, 2000) so the overexploitation is found to be more than 60%. Kathmandu valley faces annual growth rate of urbanization as 4.5% (ADB, 1998) and the built up area had grown up to 134% in 2006 since 1984 (Bhandari, 2010) so the pressure over groundwater is increasing in alarming way. The diminishing scenario of paddy rice plantation and converting the cultivable land into built up areas in Kathmandu valley has led to fall in groundwater table.

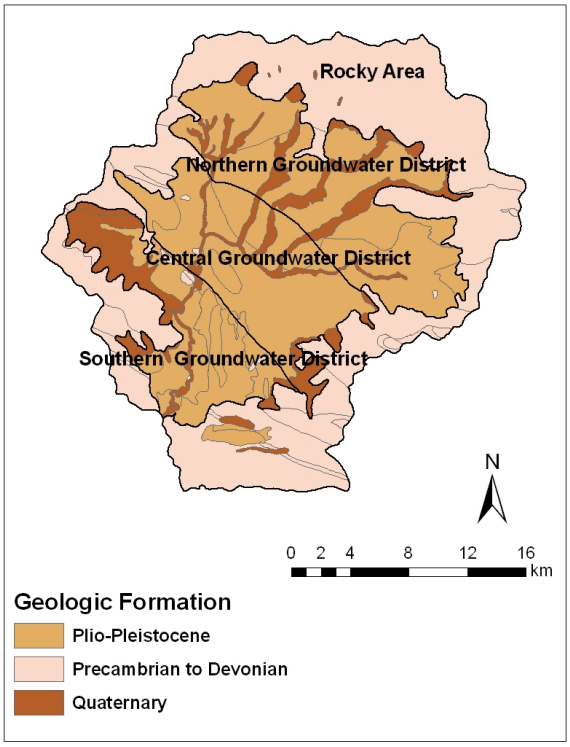
Replenishment of groundwater in Kathmandu Valley:

Recharge occurs both naturally through water cycle and anthropogenic processes i.e. artificial ground water recharge where rainwater or reclaimed water is routed to the subsurface (Shah, 2001). Recharge may be from precipitation over the demarcation, large roof areas from where rainwater can be collected and diverted for recharge, canals from large reservoirs from which water can be made available for recharge, natural streams from which surplus water can be diverted for recharge, properly treated municipal and industrial wastewater and "in-situ" precipitation, etc. Infiltration capacity of soil is an important factor that governs the rate of saturation of the vadose zone. Sustainability is the balance stage of drafting and recharge so it is important to take the account of water budget in specific areas in order to replenish. Prevention of clogging of soil pores may be performed by periodical removing of the mud-cake and dicing or scraping of the surface layer, installation of a filter on the surface, the permeability of which is lower than that of the natural strata, addition of organic matter or chemicals to the uppermost layer, cultivation of grasses and providing inverted filter consisting of infiltration pits/trenches are very effective. Groundwater recharge occurs on vadose zone below plant roots and often expressed as a flux to the water table surface (Sah, 2001). Based on the hydrological formation of various characteristics including river deposits and others, the Kathmandu Valley is divided into three groundwater zones or districts: northern zone, central zone and southern groundwater zones (JICA, 1990). The northern groundwater zone covers Bansbari, Dhobi khola, Gokarna, Manohar, Bhaktapur and some principal water supply wells of NWSC are situated in this area. In this zone, the upper deposits are composed of unconsolidated highly permeable materials, which are about 60 m thick and form the main aquifer in the valley. This yields large amounts of water (up to 40 l/s in tests) (Sah, 2001). Northern groundwater zone has a comparatively good recharging capacity. The central groundwater zone includes the core city area and most part of Kathmandu and Lalitpur Municipalities. Impermeable stiff black clay, sometimes up to 200 m thick, is found here along with lignite deposits (Sah, 2001). Beneath this layer, there are unconsolidated coarse sediment deposits of low permeability. Marsh methane gas is found throughout the groundwater stored in this area; existence of soluble methane gas indicates stagnant aquifer condition (Sah, 2001). The recharging capacity is low due to stiff impermeable layer. According to dating analysis, age of gas well water is about 28,000 years (Shah, 2001). The confined groundwater is probably non-chargeable stagnant. Most of the private wells are located in the central district of the valley and are drawing basically fossil water, the quality of which is not good (HMG/ IUCN, 1995). The southern groundwater zone is located in the geological line between Kirtipur. Godavari and the southern hills; thick impermeable clay formation and low permeable base gravel are found extensively (Sah, 2001) with poor development of aquifer.

Artificial recharge could be employed in order to replenish the exploited ground water during monsoon as monsoon constitutes more than 80% of total precipitation in Kathmandu valley by either of techniques viz. spreading method, vertical or lateral recharge shafts, injection wells, induced recharge and improved land and watershed management (contour bounding, contour trenching, bench terracing, gully plugging, etc.). However, even when recharge is taking place, replenishment by downward percolation of meteoric water shows high inter-annual variability and is a complex physical process that is difficult to evaluate (Learner,

1990; Simners et al., 1992). Although urbanization may reduce direct infiltration of rainfall because of large impermeable area created, recharge below cities is often far higher than pre-urban levels (Morris et al., 1994; BGS, 1995). In many shallow groundwater regions; such as wetlands and lowlands in river valleys, a high groundwater table and significant hydraulic gradients between the saturated zone and the root zone lead to continuous supply of groundwater to the root zone (Chen Xi and Hu Qi, 2004).

Sub surface reservoirs are very attractive and technically feasible alternatives for storing surplus monsoon run off (CGWB, MoWR, India, 2000). The sub surface geological formations may be considered as "warehouse" for storing water that come from sources located on the land surface, besides suitable lithological condition, other considerations for creating sub surface storages are favorable geological structures and physiographic units, whose dimensions and shape will allow retention of substantial volume of water in porous and permeable formation (CGWB, MoWR, India, 2000). The subsurface storages have advantages of being free from the adverse effects like inundation of large surface area, loss of cultivable land, displacement of local population, substantial evaporation losses and sensitivity to earthquakes along with the beneficial influence on existing ground water regime (CGWB, MoWR, India, 2000).



Kathmandy Valley showing geological formation and ground water districts (Pradhanang et al., 2011)

Conclusion

The drawdown of ground water table claims the declination of stream base flows, wetlands with consequent damage of ecosystem and downstream users and land subsidence along with surface structures. The haphazard construction practice and the concentration of population over small areas put further pressure on ground water so the water table is lowered abruptly in Kathmandu valley. The northern recharge district is the only capable recharge zone and rest of the zones has not remarkable contribution over replenishment of over-drafted ground water. Artificial impounding reservoirs and seepage allowing concretization may help in smaller extent but sustainability is never expected because of more than 60% overexploitation. Kathmandu suffers from severe water scarcity during dry season and the ultimate resource is the groundwater. Rain water harvesting from each household, if made mandatory by the municipalities; during monsoon season to ground or collecting tank may reduce the overburden. The rate of urbanization may be controlled by decentralization so that the population density may be lowered in Kathmandu and its surrounding municipals. In the semi-arid areas of the world groundwater table lowering rate is 1m/yr but Kathmandu valley has 2.5m/yr; showing one of the world's adverse scenario. So this may convert Kathmandu valley into an arid zone soon. Many parts of Kathmandu valley have lost the top soil due to quarrying for brick manufacture so that formation of impervious strata could be seen reducing the infiltration rate. The vegetative cover loss is another key factor governing the poor infiltration rate in Kathmandu valley. Inundated Kathmandu valley could be seen during monsoon days so the water if managed and allowed to seep during monsoon may replenish the groundwater table in its position.

References:

1. ADB (1998), TAR: NEP 31620, pp. 1-2.
2. ADB/ICIMOD (International Centre for Integrated Mountain Development). (2006). Preparing the Kathmandu valley water supply, sewerage and urban development project. Technical assistance report. Project no: 34304.
3. BGS (British Geological Survey) (2001). Groundwater Quality: Nepal, pp. 1-2.
4. Bhamdari, S. (2010). Urban Change Monitoring Using GIS and Remote Sensing in Kathmandu Valley, Nepal. pp. iv, 1-4.
5. CGWB (Central Ground Water Board) (2000), Ministry of Water resources, India. Guide on Artificial Recharge to Ground Water, Chapter 11.
6. Department of Ecology, Washington State (1986). Ground Water Resource Protection Handbook, Chapter 2.
7. Fetter, C. W. (1988). Applied Hydrogeology. Prentice Hall, Upper Saddle River, New Jersey. Freeze, R.A., Cherry, J.A. (1979). Groundwater. Prentice-Hall, Inc. New Jersey, pp. 604.

Building with Earth

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1.History and introduction

Earth buildings have probably been around for over 10000 years, from the moment humans left the principle of hunting and gathering patterns. The earliest shelters using earth were indeed the outgrowths of temporary, seasonal shelters made of brush and wood. The oldest remains found so far are the ruins of Jericho, estimated at over 9000 -years old. In a grave at Mastaba in Egypt there are traces of 5000 –years- old cast earth blocks. Archaeologists have found similar 3000 –year- old construction techniques in Pakistan. Indeed, as you can see, brick coming form mud brick, has been part of man's history for several thousands of years: since prehistoric man began experimenting with dried mud and tried to solve the problems inherent in the material. The mud was slow drying, shrunk dramatically when eventually did so and cracked easily afterwards. It was discovered that mixing the mud with straw, shaping the combined materials into manageable blocks, and leaving the result to dry in the sun lessened these problems.

This teaching of making sun -dried brick, or adobe, dates from around 5000 B C. It was known in Europe, South America, the Middle East, India, Africa and Asia and is still used in some regions of the world such as the remote parts of the Middle East, where wood and other materials are not available for firing bricks.

In the Old Testament, references are made to earth blocks made with straw: one of the pharaohs give orders that the children of Israel should not be given straw to make their blocks.

Because of its abundance, earth has been used for most of the architecture without architects. There are many historical examples of pure earth towns from Jericho to Timbuctoo, including temples, churches and places. Both the tower of Babylon and the Great Wall of China were partly constructed of earth.
In the first part of the Roman Republic sun dried brick faced with stucco was the most popular method of building, especially for private houses because of its low cost.

In both Peru and Chile, the Inca Indians knew of these building techniques long before the Europeans came, for example the Mexican pueblo is the result of a well-developed earth block technique.

In the mean time, although sun-dried block performed tolerably well as a building material, its limitations became increasingly apparent. To build more complex structures people looked for changes and improvements to the earth –products. For 4000 years, people discovered that if they burn the clay-products they have much better performance properties: they become more water resistant, have a more regular shape etc. These techniques occurred with higher civilization levels and travelled around the world with the cultures that adapted it. They are used till nowadays in the regions that possess the fuel to burn the clay.

Earth building can be found in most cultural periods in history: although in Europe they are less common beyond the 11th century, the technique flourishes again from the end of the 18th century and continued till the late 19th century. The method received a particularly strong following in Denmark, England and Germany. After the Second World War, earth building became popular again in some countries: village destroyed by the fighting in Russia were rebuilt with rammed earth techniques. In Germany, around 10000 houses of this period survive. Most people although since then see mud buildings as a very poor or very rich building material: for the verywith, or for the very rich who can afford to pay the labor intensive techniques.

As told before, the interest in the sun dried bricks never disappeared and the techniques are still used all over the world. In Europe, in the last few years, a fresh wave of interest is seen in earth houses. There are project programmers in France; universities in France and Germany have professional training courses for engineers and architects; Denmark has a long tradition in earth construction. In the southern states of the USA a whole group of contractors is now specialize in earth building. In many countries over the world earth building never disappeared and will never do, because it is the only local (and thus cheap available) building material. For example in Yemen, they still build towns and houses in earth: the house can get several storeys high and build in their hundreds; they create the atmosphere of a mud Manhattan.

2.Soil, the basic material:

Physically, solid is nothing more than a compound matter made up of solids, water and air. It is produced by a combination of actions: the breaking down of rocks by weathering, the interaction of dissolved silicates (present in the parent rock) with various soluble salts of form the clay minerals and the decomposition of vegetable and plant matter.
The depth of soil varies in general but if you make a vertical cut, you will see that it is made up of layers. These layers vary in depth, color and texture and there can be many of them. A typical profile can be divided in three parts topsoil (containing large quantities of organic matter) subsoil (containing little or no organic matter) and bedrock (may or may not be broken down into lumps).

3.Few main guidelines for building with earth:
Earth for building should contain as little humus as possible and should therefore come from the subsoil layers. The topsoil layer contains too much organic matter that will continue to decompose and change, this is also not opportune for the stabilizers used for construction nowadays. This topsoil which therefore always should be removed is often indentified by its dark colour and by its musty smell, accentuated when the soil is damp or warm.

Earth has good insulation properties but will require extra insulation in cold climates. One of the most important advantages of this material, compared to modern materials like concrete or steel, is its big heat capacity. In this way, it is an ideal instrument in reaching comfort in most climates without (for with less) consuming energy.

Because of the large amounts of mud needed for one building, the extraction of it can include some environmental impacts: this can cause serious damage to the nature if it happens on a large scale. So, it may be better to keep it on a small scale. The Egyptian architect Hassan Fathy turns the wells in fishing pools or they can serve to gather drinking water.

Sometimes stabilization methods are used to make the soil resistant to the environmental impact next to possibilities like cement cladding or finishing paintings. Stabilization\ methods in combination with compaction have best results; however it can be used on uncompacted soils as well. Stabilization means the mixing of the soil with one of these: cement, lime, pozzolanas and bitumen. The first three have about the same reaction on the soil: they improve the strength under both wet and dry conditions but have the disadvantage they have to be used in large amounts to work efficiently. The other method, bitumen, only improves strength against water. However, in most cases, no stabilizers are needed because good architecture (for example overhanging roofs) and good mixing of soil will prevent a lot of problems.

Mud has great advantage as environmental friendly material because it is completely recyclable as long as no stabilizers are used. Building with earth also includes the access to large amount of water on the production site; this can be a major problem in the future because water is scarce raw material in the world.

As we know, mud is a product that is not good resistant to water, so we have to take precautions. For example an overhanging roof and a good base foundation are indispensable.

The questions everyone working with earth as a building materials has, are these:
a) Where can I find the right soil?
b) How can I be sure this is the right Soil?
c) What is the right soil anyway?

a) The answer to the first question: Where to find the right soil?
Although a satisfactory soil may not be present in the immediate area of the construction project, soils suitable for adobe brick making are found in almost all countries. To avoid hauling soil for long distances, you can try to find the satisfactory composition of earth by blending soils from close-by sites. In this way, you will need soil areas rich in clay, sand or silt. The identification of past geological processes will help you in locating particular soil types: stream beds often contain clay, silt and in the proportions that make good bricks (including the suitable grain size) dry lake beds are often rich in clay, flood plain deposits will supply fine sands and silts, clay can often be found in earth originally formed under water (under the marine border) and so on.

One of the best ways to find satisfactory soil is to look at the existing earthen structures in the immediate area. Usually previous builders (of traditional houses) have indentified good soils by trial and error methods. The location of the soil supply areas for the existing building should be determined and made topic for further investigation.

In western countries, there is a lot known about the underground of most places nearby cities so there are more possibilities to find the right soil combination not far away, preferably on the building site. In the developing countries, it is a common knowledge to find the best soil in the neighbourhood as it is one of the main reasons to found a city.

b) The answer to the second question: Is this the right soil?
So, we have to make a soil classification system that shows you which types of soil you can use for building purposes. By looking at the composition of soils, you can also discover how you have to change the characteristics of the soil available in the neighbourhood of the building site. In that way, it becomes the best performance for the job.
Soils are composed, in varying proportions depending on the soil type, of four grades of particle size: gravel, sand, silt and clay in descending size.

Gravel	60.00 to 2.00 mm	100.00 to 2.00 mm
Sand	2.00 to 0.06 mm	2.00 to 0.08mm
Silt	0.06 to 0.002mm	0.08 to 0.002 mm
Clay	less than 0.002 mm	Less than 0.002 mm

(There are some differences in the grading, left one is the British Standard Grading, and right one is the American Society Testing Materials Grading)

Also the shape of the soil particles is important in determining mechanical stability: these may be rounded, angular, plate like or fibrous. The combination of shape and size determines the stability under dry conditions.

Gravel, sand and silt are made of different size particles of rock and they form the stable body of a soil. They retain the same size when wet or dry (a slight exception should be made in the case of silt, which sometimes swells a little when wet and will hold together when wet and compact). To be used in building, each of them needs to be mixed with an additional materials acting as a binder, in this case clay.

Clay has a quite different particle size than the others; it acts as a binder in most soils and is characterized by its stickiness when damp and by its hardness when dry. Unlike other grain sizes, it is generally unstable: it swells when wet and shrinks when dry, which often results in

cracking. The minute particles of clay are only visible under microscope: each particle is coated by a film of water held by surface tension. It is this water that binds each particle to its neighbors. Even when the clay is extremely dry, the particles are still strongly bonded together by tiny points of water, and it is the tension in the water that gives the dry material its strength (adhesion and cohesion).

c) The answer to the last question: What is the right soil? It is more about the tests to do before building with that soil (in this way it refers to the next point):
When the potential soil supply source has been selected, representative samples must be prepared. The number of samples is determined by the size of the project because the soil composition can change vary rapidly across an area or as one digs deeper. The methods of soil analysis can be divided in descending order of accuracy and increasing simplicity from detailed laboratory test to field laboratory tests. The last ones are the most common in the regions that use soil building techniques frequently. Although they use almost no equipment, the importance of it should not be underestimated!
There are short explanations of the most appropriate and common tests; Maybe, they seem a bit simple but they are the reality in a lot of countries in the world nowadays.

4. Earth as loose materials
'From earth you have come, to earth you shall return'
Some different names for various uses of earth in buildings:

Word	**Used in**
Adobe	Mexico, southeast USA, Spain
Bauge	France
Cajon	Spain
Chika	Ethiopia
Cob	England and Gambia
Jalous	Sudan
Kachi	Nepal
Kacha	India
Nogging	England
Pise	Isreal, USA, Zimbabwe and France
Sod (Soddys)	USA, Nebraska and Knasas
Swish	Ghana
Tapia	Africa, Australia and Zimbabwe
Terioni	Mexico
Torchi	France
Tubali	Nigeria and West Africa
Wattle and daub	England

Some different names for various uses of earth in buildings:

Earth used as building materials is often given different names. Scenically referred to as loam, it is a mixture of clay, silt (very fine sand) sand and sometimes larger aggregates like gravel of stones.

When speaking of handmade unburned bricks, the terms ' mud bricks" or "adobes" are usually employed. When speaking of compressed unburned bricks, the term "soil blocks" is used. When compacted within a formwork, it is called "rammed earth."

'Loose materials' is a collective name for fine particle materials that have originated form mineral and organic, decomposed products from animals and plants. In the larger lifecycle, these return to a solid form such as rock. During this process, loose materials with a large organic content can form a foundation for the creation of coal or oil. A wide spectrum of raw materials, within these states of continuous degradation and regeneration has been used throughout mankind's history for building construction.

References

- Material for architects and builder, Arthur R. Lyons
- Principal lectures in building material and CAD . school of built environment , DE montfort university ,Leicester .UK
- Mud: the potential of earth -based material for third world housing. Anil Agarwal
- Earth construction handbook ,the building material earth in modern architecture , Gernot Minke
- Handbook for building homes of earth ,lyle A. wolfskill et al.,Texas A&M university
- The ecology of building materials .Bjorn Berge

- Principal lectures in building material and CAD . school of built environment , DE montfort university ,Leicester .UK
- Mud: the potential of earth -based material for third world housing. Anil Agarwal
- Earth construction handbook ,the building material earth in modern architecture , Gernot Minke
- Handbook for building homes of earth ,lyle A. wolfskill et al.,Texas A&M university
- The ecology of building materials .Bjorn Berge

Aquasif - Ceramic Silver Treated Filter

Cheap and Best Household Water Treatment System

Anil Prajapati

The initial ceramic filter for water treatment system had started in Nepal since 1987 AD by Hari Govinda Prajapati. He is a small- scale entrepreneur who lives and works in Bhaktapur, Thimi, a pottery community about 30 minutes outside of Kathmandu city. He is the owner and managing director of Madhyapur Clay Crafts. That ceramic filter contained candle for filtering mechanism. In Aquasif, candles are replaced by filter disk which has filtering capacity up to 4 lit/hr. Madhyapur Clay Crafts is producing Aquasifs since 2005 with the technical support of Village Forward, an US based NGO.

Figure 1 Aquasif- Silver treated Water Filter

Mr. Prajapati has worked in this sector and given training to many people outside and inside the Kathmandu valley. People now are conscious in the health sector. Even rotary clubs, schools, and also in the rural area of the Nepal, the technology had been used and the demand of the filter has been increasing.

Combustible material is mixed with clay, and then fired in kiln for the filter disks. It is then immersed in a dilute silver solution. Completed filters are then tested to ensure proper flow rate and bacteria deactivation for more than 24 hours. It has capacity of 18 liters.

The ceramic silver treated filter system is one of the most effective and inexpensive method to purify the drinking water. It can be locally manufactured, easy to use and clean, low cost technology, and kills all the harmful bacteria. Laboratory test have indicated that this filters removes 99.9 % of E-coli and other harmful bacteria. Thus, it would be more beneficial for the health consciousness of the people. It also helps for the minimization of the waterborne diseases since many people die of waterborne disease like diarrhea, cholera, typhoid, jaundice etc in the monsoon season of the country

In Nepal about 40,000 children below the age of five die every year due to lack of sanitation or say due to water borne diseases. In 2009, more than 200 people have died of diarrhea epidemic (within an interval of few months) in the western parts of Nepal in the districts of Jajarkot, Rukum, Dailekh, Salyan, Dang and Rolpa (these are the remote districts of Nepal). Epidemiology and Disease Control Division of Nepal said that hazardous and contaminated water was identified as a major cause of the epidemic. In every summer season, many people are affected by epidemic diseases caused by contaminated water in rural area of Nepal. If people use the ceramic silver treated filter which is cheap and more effective for water purifying, we can reduce the waterborne diseases in Nepal.

In the Nepalese market there are several types of modern water filters available such as reverse osmosis, Ultra violet treatment, mineral water filters etc. These are expensive and the rural population can not afford them. Similar candle filter (stainless steel container, about 18 liters capacity) in the local market cost about Rs. 2000. However, the ceramic filter under discussion is highly effective even though it is of simple technology. The main ceramic silver treated disk is made only in Madhyapur Clay Crafts, Thimi, Bhaktapur and other parts of the filter

Figure 2 Aquasif and other Filters Comparison on various bases

(mainly the receptacles, filter holders and lids) are being manufactured in nine different places in Nepal. The beauty of this filter is that it can be manufactured locally and also in remote districts with some training. It will create jobs in the remote rural community and protect the health from water borne diseases. Moreover, it is a low cost filter costing about Rs.350/- to Rs.600/- per filter (US$.5 to 8.). Such low cost high value filters need to be popularized in the rural areas of Nepal and other developing countries.

Village Forward has been assisting for training, quality controlling and extension of filter production sites in various part of Nepal. The filter disk is patented in USA. Most of these filters are being sold through the local NGOs, women groups, local clubs, rotary clubs, co-operative societies and pottery stores. The silver treated filter disks works for two years and these filters has to be replaced after 2 years of using. The filters are tested in laboratory of Village Forward in the USA and the local laboratories namely ENPHO (Environment and Public Health organization) and NESS (Nepal Environmental and Scientific Service), Kathmandu, Nepal.

Several teams of researchers such as from MIT, USA, preparing for their Degree thesis had come to Nepal and worked together with Mr. Prajapati in developing this filter.

Neo - Marxist Urban Theory

Kailash Suwal

The subsequent development of urban sociology **in the 1970s and 1980s was strongly influenced by Marxist theory**. Marxism is more than an academic theory intended to increase understanding, it has also been seen as a programme of political action to intervene in history and bring about the ideal new society of the future, and in this respect it is unlike most other sociological theories. Academic Marxist theory (of which there are many versions) should not be confused with what is sometimes called 'pub Marxism'; even Marx said of himself, 'I am not a Marxist'. Marxists argue that many of the problems and inequalities of society derive from the nature of the economic system underpinning it. In particular the development of modern industrial capitalism as had emerged in the nineteenth century is often cited as the root of the evil. Basically Marx saw only two classes – the capitalist (bourgeoisie), i.e. the owner of the production and factories, and the workers (proletariat), the producers – which he saw as having a fundamental conflict of interest. Until it was resolved by revolution there would always be problem in society. Simply seeking to change the nature of the built environment was seen as superficial. As mentioned, the planners are thus seen by Marx's followers as 'lackeys of the bourgeoisie' tinkering with the superstructure. **Marx describe the economic base of the society as the substructure, and above it is the superstructure, which consists of the social and cultural institutions, the built environment and everything else which makes up our civilization.**

Marxian theory is strongly determinist in that it says that the superstructure takes the form it does in order to facilitate the continuance and maintenance of the 'social relations' and 'means of production' which enable the capitalist class to get the most work out of their workers at the lowest wages possible. Therefore, for example, it was argued there was little point in carrying out improvements to the built environment if people could not afford to benefit from them. If their wages were too low (because of the structure of the society) they would simply move elsewhere rather than pay higher rents for improved property. **As Engels, Marx's colleague, said, 'you don't solve the housing problem, you only move it; alluding to the fact that there would always be slums until people had the means to afford better housing. The solution was there to deal with cause rather than the effect: to change society rather than the built environment.** Marx believed that society could be transformed only by adopting a socialist mode of production in which the private ownership of capital and indeed of all private property was abolished. If people owned the system and were running it themselves (on the principle 'from each according to his ability and to each according to his need') no one would be poor again: indeed, there would ultimately be no need for money and profit in a truly socialist state. But, as we have now seen in Eastern Europe, it is easier said than done, because of human nature. Followers of Marx believed that the revolution was too important to be left to the workers**.** There had to be an elite cadre, the party leaders, who would take the initiative in creating the new society. Like any elite group, in time they lost touch with the people and pursued their own interests at their expense, without even the measure of accountability that democracy gives.

Reference

-www.Town planning. Com
-Town planning (magazine)

Engineering Education-Global Trend and Our Practice

-Madhukar Basnet

After the completion of BE, I couldn't decide on what further study course to catch up? When the field work is to be handled, it requires more of administrative parts than technical one. Almost of the designs are copied and pasted in many fields. Moreover, there are many masters from transportation engineering working in water resource field, many water resource masters working in road. It seems very mismatching between our course and field requirement. It is best proven by the performance of our so called distinction holders in their real field of work. Hence is the ranking of TU in the world as 5234th. Moreover, many of our seniors seem still in confusion about their real desire. Certainly, we are working but very few are satisfied in national and international level. Questions of ranking and performance have become commonplace in a world that increasingly emphasizes the knowledge economy, which has, in turn, put added pressures on nation states and resulted in a growing proclivity on their part towards ranking. No university from Nepal was even included in a 2011 study to determine the best 200 universities in Asia. And a forthcoming study by the Asian Development Bank reveals Nepal's higher education performance is among the lowest even in South Asia. A multitude of factors are responsible for this poor performance. Higher education is still an elite system in terms of access and participation, with a gross enrolment rate of less than 10%. In engineering, graduation rate was 44% at bachelor and 55% at master's level.

As most of us dream to have high profile like the celebrity we observe day to day, we lack such core knowledge. Many of us imagine foreign country as our heavenly platform to get the dream, but reality is just opposite. Exemplifying with reference to common destination university of Nepalese Students- South Dakota State University of USA, it ranks 194th in USA national level and not included within best 500 in international rank. It signs our potential.

The technology changes within seconds but our syllabus changes only after decades. From my recent experience in hydropower, I had hardly heard about the chemicals, materials and their handling procedures during BE. It is also sure that the government is aiming to bulge the power generation. But none is concerned to produce capable human resource for the target. Today's latest trend in international market is to modify the syllabus according to the research and engineering findings as soon as possible so that the human product from university immediately can give the required performance in the field. Hence our education has fallen among the poorest and we are obliged to seek opportunity away from the nation which again is not the solution. Now, I think, we must have such university or research center which synchronizes with the recent technology. Let's think to contribute for this.

Biofuel: Prospect and Possibility in Nepal

Anita Prajapati

1. Introduction

Biofuels are the fuels derived from biomass or waste feedstock, also known as agro fuel. It is one of the renewable sources of energy that has not been prominently exploited. The fuel derived its energy from biological carbon fixation. Carbon fixation is the reduction of inorganic carbon (carbon dioxide) to organic compounds by living organisms. Biofuel can be solid biomass, liquid fuels or various biogases. Solid biofuels include wood, sawdust, grass trimmings, domestic refuse, charcoal, agricultural waste, non-food energy crops, and dried manure. Liquid biofuel include Ethanol, biodiesel, vegetable oil, syngas, bioethers, and biogas. Fossil fuel is not considered as biofuel even though it has its origin in ancient carbon fixation.

Bio-fuels can be extracted from locally available resources or plant materials like algae, corn, soy, sugarcane, Jatropha, rapeseed, animal fats and cellulose. Biofuels can be classified as advance biofuel and conventional biofuel according to the technologies used to produce them and their respective maturity. Advanced biofuel comprise different emerging and novel conversion technologies, 50% lifecycle greenhouse –gas reduction is to be achieved. Conventional biofuel include well established technologies that are producing biofuel on a commercial scale today.

In Nepal, biofuel is refers mainly to bioethanol and biodiesel. Bioethanol is an alcohol made by fermentation, mostly from carbohydrates produced in sugar or starch crops such as corn or sugarcane. Cellulosic biomass, derived from non-food sources such as trees and grasses, is also being developed as a feedstock for ethanol production. Ethanol can be used as a fuel for vehicles in its pure form, but it is usually used as a gasoline additive to increase octane and improve vehicle emissions. Bioethanol is widely used in the USA and in Brazil. Current plant design does not provide for converting the lignin portion of plant raw materials to fuel components by fermentation. Biodiesel is made from vegetable oils and animal fats. Biodiesel can be used as a fuel for vehicles in its pure form, but it is usually used as a diesel additive to reduce levels of particulates, carbon monoxide, and hydrocarbons from diesel-powered vehicles. Biodiesel is produced from oils or fats using trans-esterification and is the most common biofuel in Europe.

In principle, biofuels are a way of reducing greenhouse gas emissions compared to conventional transport fuels. Burning the fuels releases carbon dioxide; but growing the plants absorbs a comparable amount of the gas from the atmosphere. However, energy is used in farming and processing the crops, and this can make biofuels as polluting as petroleum-based fuels, depending on what is grown and how it is treated.

2. World Scenario

In 2010 worldwide biofuel production reached 105 billion liters (28 billion gallons US), up 17% from 2009, and biofuels provided 2.7% of the world's fuels for road transport, a contribution largely made up of ethanol and biodiesel. Global ethanol fuel production reached 86 billion liters (23 billion gallons US) in 2010, with the United States and Brazil as the world's top producers, accounting together for 90% of global production. The world's largest biodiesel producer is the European Union, accounting for 53% of all biodiesel production in 2010. As of 2011, mandates for blending biofuels exist in 31 countries at the national level and in 29 states/provinces. According to the International Energy Agency, biofuels have the potential to meet more than a quarter of world demand for transportation fuels by 2050.

Brazil leads the world in production and use, making about 16 billion litres per year of ethanol from its sugarcane industry. Sixty percent of new cars can run on a fuel mix which includes 85% ethanol.

3. National Scenario

Government of Nepal has announced Biofuel Programme (Jaibik Indhan Karyakram) in the fiscal year 2065/66 (2008/09), to be implemented through AEPC, for the promotion of biofuel. Different activities have been launched for its promotion. Basically, Jatropha produced biodiesel has been taken in consideration for the biofuel promotion. This is in response to the issues like environmental degradation, loss of country's economy for importing fossil fuel, energy crisis and oil shortage due to unpredictable price fluctuations in international markets. The plantations have been carried out mainly in districts of Surkhet, Makwanpur, Kailali, Birgunj, Dharan, Rupandehi and Nuwakot under AEPC. Pilot project is being carried out at Tanahun. Under District Energy and Environment Unit/Section (DEEUs) six districts have been identified, for the first phase, which are Lamjung, Okhaldunga, Makwanpur, Chitwan, Dhading and Gorkha

According to the research, performed by the Alternative Energy Promotion center (AEPC), the highest percentage of oil content (i.e.58.57%) is found with genotype collected from Dadeldhura district at 1150 masl (meter above sea level). This is the highest oil content ever reported in the seeds from naturally growing population of Jatropha curcas in Nepal. AEPC have established "Germplasm Garden" in Darechok VDC, Chumlingtar, Chitwan. The total potential of ethanol production, at present is about 20,000 kL/year and the biggest sugar mill is having the production capacity of about 30kL/day.

Various organizations, Local government agencies, NGOs Private Companies Micro-finance institutes, Community groups are working for the promotion of biofuel.

Draft of Bio-Fuel Promotion Policy

The government of Nepal has prepared the draft of "Bio-Fuel Policy and Work Plan -2068" to provide guideline, to identify policy, institutionalize and find the legal base for the promotion of the bio-fuel in Nepal.

4. Problems

There are few problems technically; engines can generally cope with the new fuels. But current technologies limit production, because only certain parts of specific plants can be used. The big hope is the so-called second-generation of biofuels, which will process the cellulose found in many plants. This should lead to far more efficient production using a much greater range of plants and plant waste.

As in case of Nepal, even though the GoN decided to go for blending 10% ethanol in the petrol in 2002, but this didn't came into implementation due to various reasons. However, both the ethanol and biodiesel have good potential in Nepal.

Some issues on bio-fuel energy

- Lack of adequate exploration and implementation of other viable renewable energies; such as bio-diesel, ethanol.
- Lack of concept of commercially developing drumstick (biodiesel plant) as an alternative to petroleum products. Plantation of bio-fuel plants like Khirro- Kadam is not emphasized for bio-energy.
- Lack of development of technology of growing plants related with bio energy
- Lack of awareness about the multi-benefits of biofuel
- Lack of initiatives regarding the production of biofuel

The above issues are to be solved for the development of bio-fuel energy in Nepal.

5. Conclusion

Nepal is totally dependent on imports of petroleum products for its energy requirement. More than 50% of merchandise export is spent in importing petroleum products. The oil import in Nepal increase by 15.34% annually, the figure is highest among the South Asian countries. Thus it can be predicted that Nepal is dangerously becoming dependent on oil imports for energy requirement. At this prospect, the promotion of locally available biofuel energy is highly sought. The future of Nepal energy requirement depends seriously on how the issue is raised and policy implemented.

With the increasing trend in consumption of fossil fuel, oil price hikes, concern over greenhouse gas emissions from fossil fuels, and support from government subsidies, the concern over this fuel as renewable fuel is increasing. Biofuel from Jatropha is steadily gaining popularity in Nepal. It has the multi benefits like drought-resistant perennial shrub growing well in marginal/poor soil, easier to grow and relatively quick that produce seeds for 50years. Oil on extraction can be combusted as fuel without being refined or can be converted into biodiesel. It burns with clear smoke-free flame, tested successfully as fuel for simple diesel engine. The oil is also an insecticidal. But there are number of issues being raised, that needs to be considered to have these benefits to be counted. There are numbers of government and private sectors working on this sector to explore this new renewable energy so as to make it easily accessible. Serious assessment on the production, extraction and promotion of biofuel energy is in fervent need. The policy needs to be implemented from the grass root level and the subsidy mechanism for the use of technology and energy itself should be without any complexities.

References

· *http://en.wikipedia.org/wiki/Biofuel*

· *http://www.myrepublica.com/portal/index.php?action=news_details&news_id=37125*

·*AEPC e-newsletter 19th ,20th and 21st volume 2011*

·*BBC News/ science nature/ quick guide: biofuel*

·*An Overview of Biofuel Programme by Mr. Nawa Raj Dhakal and Mr. Nirpesh Dhakal*

·*Biodiesel from Jatropha: Scenario of Nepal by Manish Karn*

·*World Energy Outlook 2011; IEA*

·*ERSF Report*

Face Recognition Using Error Back Propagation Neural Network

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Abstract: *Face recognition is an emerging biometric method used for recognizing a person based on the features of a person's face. As none of the face recognition techniques used till date provide a robust solution to all situations many research works have been put on to it. This paper presents a face recognition technique, in which a neural network is trained with error back propagation technique with single hidden layer. Here 15 images of Yale database are used and the recognition ratio of the subject is determined. The neural network is trained using the mean faces and target faces of each subject. The advantage of this technique is high recognition ratio, less computational requirements, better processing speed and less network complexity.* ©

Keywords *– Face recognition, error back propagation, gradient descent rule, neural network.*

I. INTRODUCTION

Face recognition has been an important research subject in the pattern recognition field mainly due to ever increasing security demands and its potential commercial and law enforcement applications. The last decade has shown dramatic progress in this area, with emphasis on such applications as human-computer interaction (HCI), biometric analysis, content-based coding of images and videos, and surveillance. [1]

An Artificial Neural Network (ANN), usually called neural network (NN), is a mathematical model or computational model that is inspired by the structure and/or functional aspects of biological neural networks. A neural network consists of an interconnected group of artificial neurons, and it processes information using a connectionist approach to computation. In most cases an ANN is an adaptive system that changes its structure based on external or internal informational data that flows through the network during the learning phase.

This paper gives a Neural Network based algorithm for efficient and robust face recognition. Here, a holistic approach is used for face recognition in which the whole face of the person is taken as the input data. This technique uses the concept of mean image which tries to encompass all the features of the subject's images on database. The only pre-processing of the training images on the data base is the computation of mean image. The mean image of a subject is provided as an input to the neural network and the network trains itself based on the target image of the subject. After, the network has been trained the weight vectors for individual subjects are stored in database and based on the weight vectors in the database recognition of any new test image is performed.

II. SUPERVISED LEARNING

There are three major learning techniques of a neural network, each corresponds to a different way of learning. These are supervised learning, unsupervised learning and reinforcement learning. In this paper we will mainly focus on the gradient descent technique and error back propagation techniques under supervised learning methods.

Error back propagation networks or Multilayer perceptrons are types of supervised learning artificial neural network consisting of feed forward networks with distinct input, output and hidden layers. The units function basically like perceptrons, except that the transition (output) rule and the weight update (learning) mechanisms are more complex. There may be any number of hidden layers, and any number of hidden units in any given hidden layer. In feed forward activation, units of the first hidden layer compute their activation and output values and pass these on to the next layer, andso on until the output units will have produced the network's actual response to the current input presented to the input layer.

Once activation is fed forward all the way to the output units, the network's response is compared to the desired output which accompanies the training pattern. There are two types of error. The first error is the error at the output layer, which can be computed directly. The second type of error is the error at the hidden layers, which cannot be computed directly since there is no available information as to the desired outputs of the hidden layers.

Essentially, the error at the output layer is used to compute for the error at the hidden layer immediately preceding the output layer. Once this is computed, this is used in turn to compute for the error of the next hidden layer immediately preceding the last hidden layer. This is done sequentially until the error at the very first hidden layer is computed, which is *generalized Delta Rule*.

Error back propagation learning Algorithm, also called, Generalized Delta learning uses the gradient decent algorithm since the activation functions used are differential. Gradient descent means that the parameter vector is updated along the negative gradient direction of the MSE.

The sigmoid function, also called the sigmoidal curve (von Seggern 2007, p. 148) or logistic function, is the function:

$$y=\frac{1}{1+e^{\wedge}(-x)}$$

A nice property of sigmoid function is

$$\frac{\partial \sigma}{\partial x} = \sigma(x)[1-\sigma(x)]$$

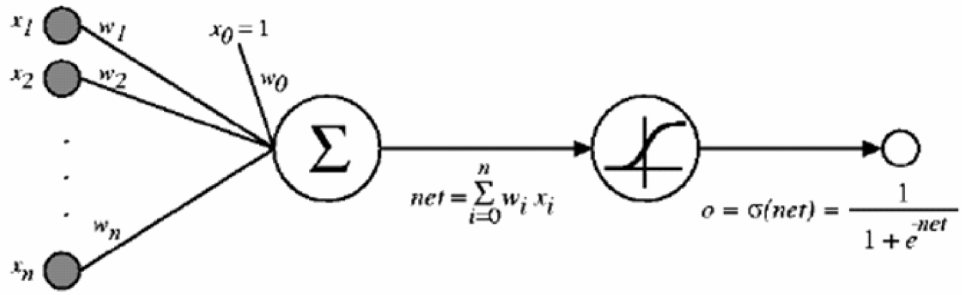
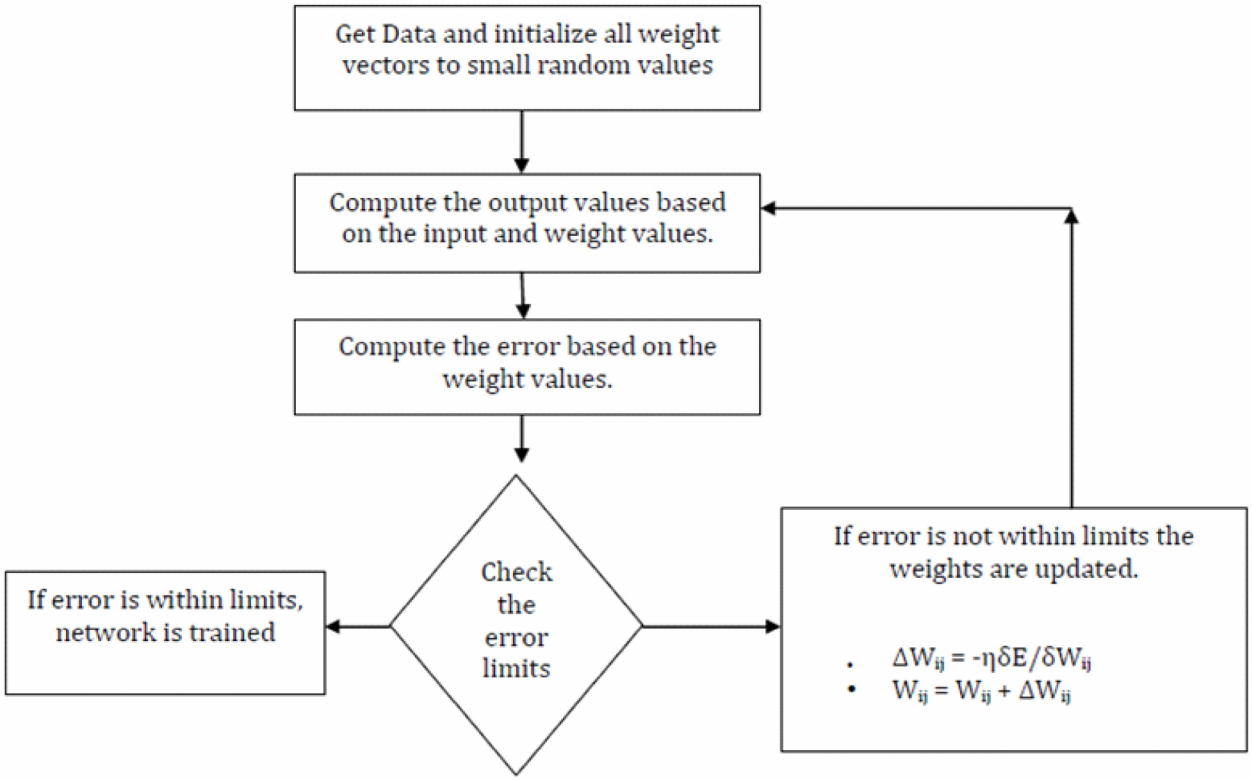


Figure 1: A Feed forward Network with Sigmoid Unit

The Gradient Descent Algorithm for training the networks



Back Propagation Network with Sigmoid Units

Error Back Propagation Algorithm for training networks

1. Initialize all weights to small random number1

Until the error condition is not satisfied

2. Input the training example to the network and compute the network outputs.
3. For each output unit k, the local gradient (′) is defined as
4. $\delta_k \leftarrow o_k(1 - o_k)(t_k - o_k)$
5. Local gradient points towards required changes in synaptic weights. The gradient is actually is the product of the corresponding error signal for that neuron and the derivate of the associated activation function.

6. For each hidden unit h

$$\delta_h \leftarrow o_h(1 - o_h) \sum_{k \in outputs} w_{h,k}\delta_k$$

7. Update each network weight wij

$$w_{i,j} \leftarrow w_{i,j} + \Delta w_{i,j}$$

Where,

$$\Delta w_{i,j} = \eta \delta_j x_{i,j}$$

Where,

The back propagation algorithm provides an 'approximation' to the trajectory in weight space computed by the method of steepest descent. The smaller the learning rate parameter · , the smaller the changes to the synaptic weights in the network will be from one iteration to the next, and the smoother will be the trajectory in weight space. This improvement, however, is attained at the cost of a slower rate of learning. If, on the other hand, if the learning rate parameter is too large in order to speed up the rate of learning, the resulting large changes in the synaptic weights assume such a form that the network may become unstable (i.e. oscillatory). A simple method of increasing the rate of increasing the rate of

learning yet avoiding the danger of instability is to modify the delta rule by including a momentum term as

$$\Delta w_n = -\eta \frac{\partial E}{\partial w} + \alpha \Delta w_{n-1}$$

where, ± is the momentum constant and 0 < ± < . Suffix *n* denotes nth learning cycle of the weight. This is generalized delta rule the special case is delta rule when ± = 0 .
The addition of momentum term smoothes weight updating and tends to resist erratic weight changes due to gradient noise or high spatial frequencies in the error surface. However, the addition of momentum term does not always seem to speed up training: it is more or less application dependent.

III. METHODOLOGY

Firstly, face images of Yale database has been selected as the training and target images. 11 images of 15 candidates have been selected and these images have the following general features:
„h Uniform illumination conditions.
„h White color plain background.
„h Faces in front and upright position
„h Images in grayscale and in same resolution.

The images of each of the subject are then classified as training images and target images. The training images consists of 10 set of images shot in various facial expressions and the target image is the image shot with normal expression. From the training images, the mean image of each of the subject is computed. The mean image consists of the major features of all the facial expressions of the subject. To encompass all the features of the images and for further mathematical operation on the images the mean image and the target image are then converted to double data type using MATLAB functions. In doing so, the images do not lose their original properties but the pixel-wise data type converts to double from default int type.
The mean images and the target image are then passed on to the feed forward back propagation neural network for obtaining the training weights for each of the subject. The network architecture used consists of three distinct layers, input, hidden and output layer. Unlike, the regular back propagation technique, which assigns weight to the connection between the nodes, here we assign the weight values to the nodes themselves. The network architecture used is shown in figure 2:

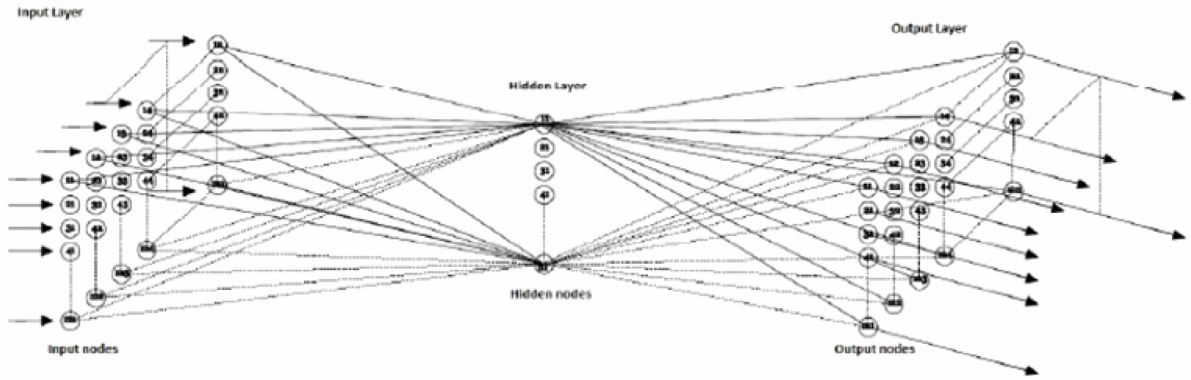


Figure 2: Network Architecture used in training Neural Network

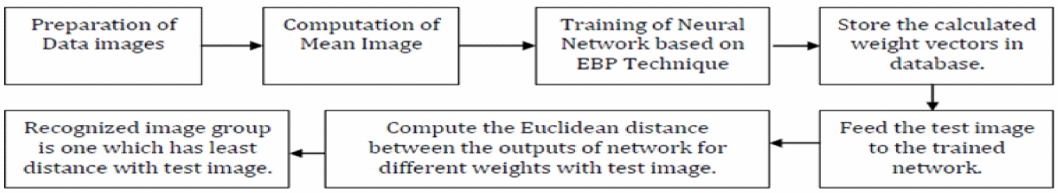


Figure 3: Block Diagram of the working methodology

1 Before training there will be Selection and Preparation of Training Data.
A neural network is useless if it only sees one example of a matching input/output pair. It cannot infer the characteristics of the input data for which you are looking for from only one example; rather, many examples are required. This is analogous to a child learning the difference between (say) different types of animals - the child will need to see several examples of each to be able to classify an arbitrary animal. It is the same with neural networks. The best training procedure is to compile a wide range of examples (for more complex problems, more examples are required) which exhibit all the different characteristics you are interested in.

Figure 4: Training Image of a subject from Yale Database

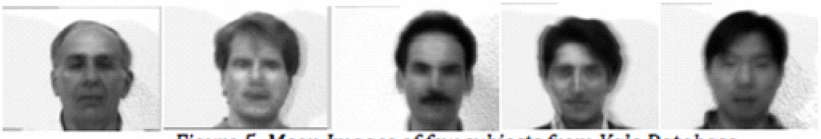


Figure 5: Mean Images of few subjects from Yale Database

Figure 6: Target Images of few subjects from Yale Database

Figure 7: Output Images of few subjects from network

The image recognition of a test image after the neural network has been trained is based on the Euclidean distance between the input test image and the outputs as per the various weights of different subjects. Euclidean distance is a general dissimilarity measure which measures the dissimilarity between two points. Mathematically, the Euclidean distance between point's p and q is the length of the line segment connecting them. The Euclidean distance between the test image and the output of the neural network with different weight values is computed, the test image is then said to belong to the same group of images which has the minimum distance with the test image.

IV. EXPERIMENTAL RESULTS

The input images each of 320 x 243 pixels are the input data sets, where each pixel acts as an individual data set. The only hidden layer consists of 'n' number of nodes and the exact number of nodes required may vary as per the learning rate, initial guesses of weights and the selection of the number of nodes and proper learning rate is kind of 'black art', you never exactly know what's the right combination. On testing with 12 of the test subjects, with 11 different test images of each of the subject the accuracy of this network was found to be 80%, which can be considered as fair bit of accuracy as the processing time once the network has been trained is fairly low.

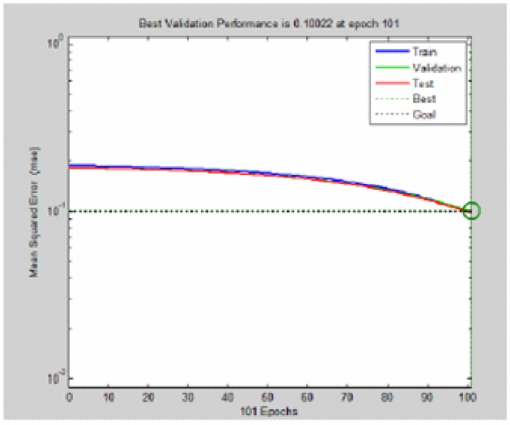


Figure 8: Performance graph of the network

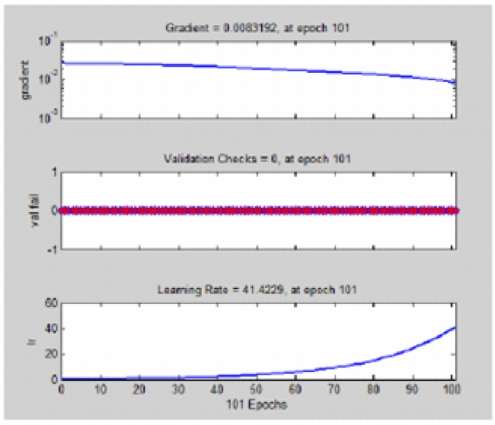


Figure 9: Decrease of error gradient and variation of learning rate in every epoch.

After training the network for all the 15 test subjects, the system was found to have a recognition ratio of almost 80% for all the test subjects. It was also found that the training speed of the network can be fairly increased by the use of adaptive learning rates.

V. CONCLUSION

This system is well suited for low-cost, real time hardware implementations with few pre processing of the image. The accuracy of this system can be highly improved with the use of the face filter and image pre-processing. Although, face recognition using SOM are majorly popular, this technique can parallel the accuracy of SOM based techniques and commercial implementation of such system may be feasible in future.

REFERENCES

*[1] A. Abdallah, M. Abou El-Nasr, and A. Lynn Abbott, "**A New Face Detection Technique using 2D DCT and Self Organizing Feature Map**" in Proc. of World Academy of Science, Engineering and Technology, Vol. 21, May 2007, pp. 15-19.*

*[2] P.Latha, Dr.L.Ganesan & Dr.S.Annadurai, **"Face recognition using neural networks"** in Signal Processing: An International Journal (SPIJ) Volume (3) : Issue (5)*

*[3] Jawad Nagi, Syed Khaleel Ahmed & Farrukh Nagi, "**A MATLAB based Face Recognition System using Image Processing and Neural Networks**".*

*[4] Santaji Ghorpade, Jayshree Ghorpade, Shamla Mantri, Dhanaji Ghorpade, "**NEURAL NETWORKS FOR FACE RECOGNITION USING SOM**" in IJCST Vol. 1, Iss ue 2, December 2010.*

Community based Rural Electrification

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General Background

Nepal, a small land locked South Asian country surrounded by two Asian giants China and India, is second richest country in terms of water resources after Brazil and has boon of high hydropower potential. Nepal is bestowed with about 6000 perennial rivers and rivulets flow with annual average runoff of 225 billion m^3 thereby providing huge hydro power potential. Out of theoretical potential of 83000MW, 43000MW is said to be economic viable in present context. In spite of its small economy and comparatively low economic progress than its neighboring countries it is trying its best to move up in the development scale for which planned harnessing of its hydro energy is going to play the lead role. To reach the development in every nook and corner of Nepal, Rural electrification has an important role to play and is also major challenge due to its geographical diversity. Hydropower Development policy 2001 has planned a strategy to extend hydropower services to the rural economy from the perspective of socio equity with the realization of the fact, development of power sector having a direct concern with agricultural and industrial development, is a pre-requisite. This small country has very low per capita energy consumption the main reason being poverty. Around 30% population of Nepal is still below poverty line maximum of which belongs to rural background. Despite having enormous potential only 50% population has access to grid electricity and only about 10% of rural population has access to electricity. So most of the rural community is still dependent on traditional fuel sources like firewood, charcoal, agricultural residues and animal dung which are uneconomical, unhealthy as well as hampers the environment.

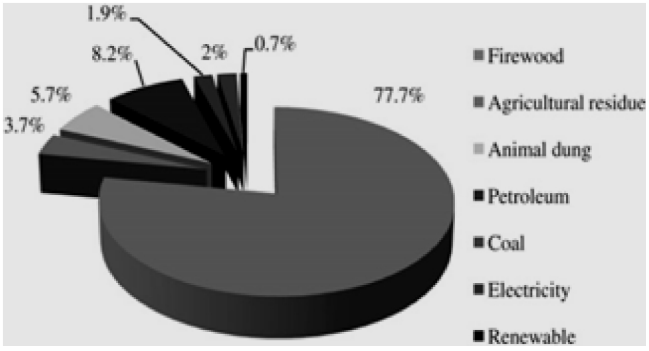

Figure 1:Energy consumption in 2008/09 by source type.

Rural Electrification and Community Based Rural Electrification Concepts

Rural electrification brings electrical power to rural and remote areas which is used not only for lighting and household purposes, but it also allows for mechanization of many farming operations, such as threshing, milking, and hoisting grain for storage. In areas facing labor shortages, this allows for greater productivity at reduced cost.

National Water Plan 2005 targets to achieve the per capita electricity consumption of over 400KWh by year 2027. But the case here is very disheartening. By end of year 2009 only about 1.5% (661MW) out of economically and technically feasible hydropower potential has been exploited which is very unevenly distributed between urban and rural areas. With majority of population (70%) residing on rural areas, rural electrification has become one of the main strategies to increase the per capita energy consumption. Rural Electrification in Nepal has been implemented through Nepal electricity Authority (NEA), Grant Projects (ADB, Word Bank, etc), Alternative Energy Promotion Center (AEPC) and Community Electricity Users Cooperative.

One of the various approaches of rural electrification is by National Grid Extension. But there occur various economical and technical drawbacks for both NEA and Rural community in rural grid extension under direct control of NEA. Also private entrepreneurship for rural electrification has proved to be unsuccessful in many cases internationally. Hence, an alternative 'third way' approaches: decentralized delivery by local cooperatives.

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The formation of local cooperatives to increase rural electricity access is not new. The majority of rural USA was electriûed in this manner during the 1930s, 1940s and 1950s. In the mid-1930s 90% of rural homes lacked electricity. By 1953, over 90% of the USA's farms had electricity. Local Cooperatives are democratically governed businesses that are motivated by socially orientated goals of local development that is closely regulated by their consumers. Hence, local cooperatives offer an attractive alternative to (the often ineffective) public sector management or principally profit-motivated private sector involvement.

Its decentralized implementation approach also extends significant advantages. Decentralization is thought to 'significantly improve and even shape efforts to expand access to modern energy services, particularly for poor rural women and men' by facilitating 'the active involvement of local actors in development processes, which can help to scale up energy service delivery to

the poor'.(UNDP 2009). Community Based Rural Electrification is also successfully implemented in Bangladesh under Rural Electrification Board (REB). The REB works with rural communities to establish local electrical cooperatives known as Palli Bidyut Samities (PBSs) that develop and distribute electricity. REB has successfully increased electricity access in rural parts of the country and is regarded 'by many as one of the most successful rural electrification programs within developing countries' (UNDP 2009).

Community Based Rural Electrification in Nepal

There are lots of hindrances due to which electrification of rural areas is often under shadow in Nepal and several constraints significantly restricted NEA's progress in rural electrification. In Nepal, electrification and security of national property. This approach has increased the transparency of electrification process, localized the decision making and widened the space for dialogue on rural electrification issues. Electricity theft due to lack of regular and close monitor by NEA has been released and this has helped to decrease the technical losses and also created favorable environment for respectful life.

Community based rural electrification (CBREs) has been able to provided cheaper electricity and services to the community consumer groups on their own doorstep and hence increased the consciousness towards rural and social development. CBRE has created a new creative relationship between state, private sector and community. More than 200 CBREOs have been approved

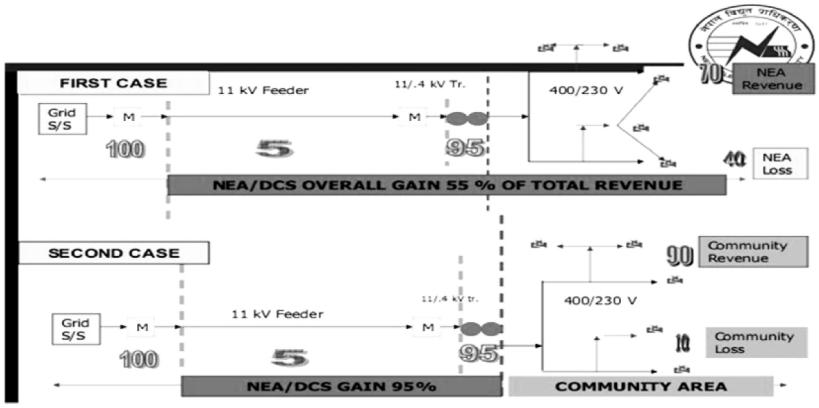

Figure 2:Economic benefit from CBRE over conventional method

projects are no longer seen as technical interventions alone. Practitioners and critics conclude that 'electricity if targeted at the poor alone' would not be a realistic approach. This is often because the poor alone cannot risk the heavy financial investments that are required to build and maintain an electrical system. In addition, the lack of proper feasibility studies, quick assessments, and non-participation of the beneficiaries has led to failures in some cases. While at the same time, Nepal has successfully implemented community-based organizations (CBO's) for local social services and public goods, such as forestry committees, water supply, irrigation and sanitation working groups, mothers' associations, micro hydro electric group and dairy cooperatives. Hence following the international success of CBRE and internal success of CBO's, it was thought that CBO-led grid extensions could also be successful. Community Based rural electrification (CBRE) is the approach of electrification of rural areas under active involvement of community by forming cooperative organization. CBRE is demand driven bottom up approach in which the consumers' group selects suitable scheme for them instead of conventional RE schemes. Government of Nepal (GoN) provides 80% fund of estimated cost through Nepal Electricity Authority (NEA) and 20% is financed by community by share capitalization. 80% fund released to NEA by GoN and 20% community contribution is kept in "Community RE fund". The scheme is physically launched only after the total fund for its completion is secured.

The 20% community contribution in CBRE has developed the sense of ownership thereby increasing the safety in 42 districts of Nepal lightning up more than 135000 households and providing clean energy to hundreds of small scale rural industries.

CBROs are also involved in providing technical trainings to its members that has enhanced the technical capability in rural community. Services of CBROs are based on same locality so any kind of problems is quickly taken care of, thus increasing the effectiveness of service. Customer's satisfaction has increased and level of service is also progressing with time. With the implication of CBREOs, consumer numbers has increased in average from 40% - 200% and average distribution loss is reduced to 12% from 30% - 70% in various areas which is very positive result. Average monthly consumption has gone up from 18KWh to 35 KWh and revenue has increased 200% than earlier recovered. CBREOs have also created local employment opportunities and the technical trainees are also emigrating for more employment opportunities with promising future career.

The CBRE to grid electricity has been particularly successful where the cooperative has also worked at improving the productive uses of electricity and the capacity of its members to pay for electrical appliances and invest in new business. For example South Lalitpur Rural Electricity Cooperative (SLREC) is providing loan with minimum interest rate to its members to buy Electrical grass cutter. The main profession of that area being animal husbandry, electrical grass cutter has helped them to save their time by manual grass cutting and thus providing time for other jobs as well as

increasing the income. In the many places Milk Chilling factory is also established for storing and preventing milk for degrading. This has motivated locals to invest more on their ongoing animal husbandry firmand expand their business. CBROs have also invested in developing lift irrigation in places where farms are in high hills and this has reduced dependency on rain for irrigation. Along with these, electrical ropeway for transportation, FM station, telecommunication, and small scale rural industries are also powered by electricity from CBROs. This has highly promoted the living standard of locals. Some cooperatives have been able to generate 'substantial' surpluses from the management of local grid services. Surrounding infrastructures such as roads and existing commercial activity has played important role in developing productive uses.

Conclusion

Rural Electrification particularly can never be a project for high economical benefit but with proper mobilization of local communities it can benefit social aspects from energy consumption to infrastructure development. Today, rural electrification cannot just be included under electrical engineering but it is also part of social engineering. Traditional RE practices under public or private management possess high risk potential which has repelled investment on this sector but Cooperative concept has started a new wave of rural electrification and has significantly reduced its losses and community participation has increased potential of success. Community based rural electrification has not only electrified the rural community but it has also helped to create a community of mutual cooperation for social development.

Refrences

1. *Community Rural Electrification , An experience in Nepal- Ram Chandra Pandey, NEA*
2. *The Value of Cooperatives in Rural Electrification- Annabel Yadoo, Heather Cruickshank, Engineering Depatment , University of Cambridge*
3. *Rural Electrification- An Experience from Nepal – Dilli Prasad Ghimire, NACEUN*
4. *en.wikipedia.org/wiki/Rural_electrification*
5. *National Water Plan 2005, Nepal*
6. *Rural Electrification Policy 2006, Nepal*
7. *http://naceun.org.np/*

Low Power Electronics

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The world is undoubtedly run by electronics today. Electronics, once a darling of scientific research and weapon design, has percolated into the very fabric of society. We are increasingly reliant on faster and newer, 'take where you go' technology, mobile phones, tablets and laptops. This necessitates more efficient electronic circuits since power drain is a bane on any kind of mobile device's effectivity. So, with the proliferation of mobile devices, power considerations have started to shape the designs of digital circuits to a large extent. This article aims to provide the readers with a brief overview of the power consumption of modern digital electronics technology and the methods that are in use to curb power losses.

Device power parameters:
There are many ways to define and measure power consumption. Common specifications include MIPS/watt, mA/MHz, low-power run-mode current consumption, and sleep-mode current consumption. When devices are in 'active standby', mobile devices should use very little power. Some power loss is inevitable, since the CMOS(Complementary Metal Oxide Semiconductor) technology used by devices today have intrinsic power loss characteristics. These loss, however, may be minimized by proper hardware and software optimization.

Power consumption of digital devices:
Any digital device acts like a switch. The transition from lower level '0' stage to '1' stage or vice versa consumes power, known as dynamic power consumption. In idle state also, the device draws power i.e. static power consumption (due to sub-threshold leakage currents). For devices working on low frequencies, static power contributes more to the overall power consumption whereas for high frequency devices, the dynamic power losses are more prominent.
The major reasons for power consumption in CMOS Circuit are as follows:

1. Dynamic or switching current
   Due to charging and discharging of parasitic capacitances
2. Short circuit or direct path losses
   Due to shorting of Vcc and ground during switching transition
3. Leakage currents
   Due to reverse bias diode leakage and sub threshold conduction
4. Static currents

The power consumption equation of a CMOS device is given by,
Power = Capacitance x Frequency x Voltage^2

From the equation, we see that the power consumption may be decreased by:

- Reducing parasitic capacitance in the device
- Reducing frequency of operation
- Decreasing the operational voltage of the device

One or more of these methods are combined in modern devices to minimize power losses. Some practical methods of achieving this are explained below

Eliminating Parasitic Peripherals/clock gating

Since many microcontrollers come out of reset with peripherals enabled, disabling unused peripherals will save a significant amount of power. Often, this is simply a matter of clock gating; turning off the clock to a peripheral will completely eliminate its power consumption. In some situations, though, a more sinister power sink lurks in the bowels of peripherals, a.k.a., quiescent current.

In applications that demand deep sleep and maximize every nanoampere, the peripherals' quiescent-current consumption becomes vital. Analog peripherals such as comparators and analog-to-digital converters (ADCs) are good examples where clock gating alone won't suffice when powering down the peripheral.

3.11 Analog Comparator (ACMP) Electricals

Table 15. Analog Comparator Electrical Specifications

C	Characteristic	Symbol	Min	Typical	Max	Unit
D	Supply voltage	V_{DD}	1.8	—	3.6	V
P	Supply current (active)	I_{DDAC}	—	20	35	µA
D	Analog input voltage	V_{AIN}	V_{SS} – 0.3	—	V_{DD}	V
P	Analog input offset voltage	V_{AIO}	—	20	40	mV
C	Analog comparator hysteresis	V_H	3.0	9.0	15.0	mV
P	Analog input leakage current	I_{ALKG}	—	—	1.0	µA
C	Analog comparator initialization delay	t_{AINIT}	—	—	1.0	µs

1. This excerpt from Freescale's MC9S08QE32 datasheet for the analog comparator peripheral illustrates how leaving the comparator on isn't a good idea.

Configuring Unused I/O

Unused I/O can be a major source of unwanted power consumption if it's left configured as an input. In standard CMOS logic, power consumption occurs only when switching states from on to off and vice versa. Floating inputs will cause unintentional switching. The best way to handle unused I/O is to set it as an output when power must be saved, i.e., in a power-down or low-power run mode.

From a board-level perspective, it's important to consider the lowest power state of the circuit connected to the pin. For example, if the pin is pulled up or down externally, set the output to the value corresponding to VDD or ground, respectively.

Remember, in this scenario unused I/O isn't limited to the I/O that's never used. Any time a peripheral or a set of I/O isn't necessary, it can be reconfigured as an output on-the-fly. This is generally a good idea when entering a low-power mode of operation that works with limited functionality. Dedicated analog inputs must be treated carefully at the board level, as they can be input-only pins with input impedances in the tens of kilohms.

Run-Mode Clock Throttling

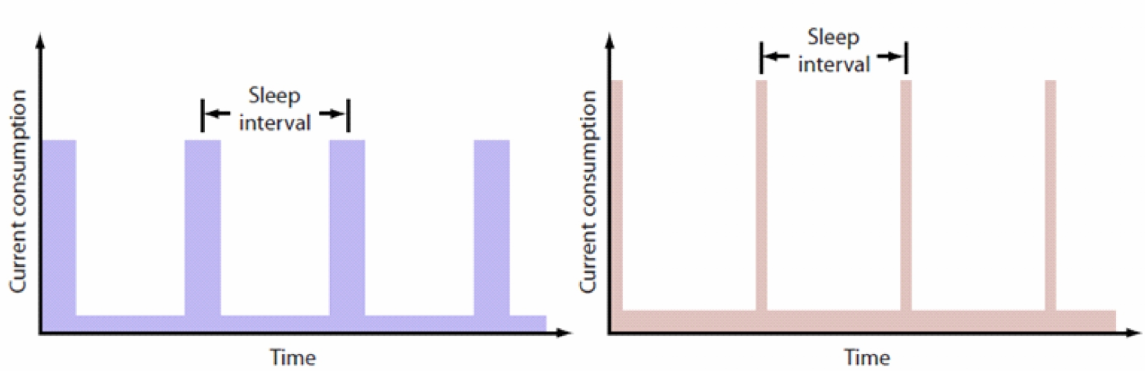
In applications featuring a device operating in active mode, where the CPU is enabled and processing for extended periods of time, it makes sense to carefully evaluate the performance/power tradeoff. For instance, low-power applications rarely require blazing-fast speed. Usually, the CPU performs some rudimentary calculations on data or manages peripheral interaction with the outside world. At times, the CPU needs to be on, but its role is limited. Here, lots of power can be saved by throttling its clock down to a level where it efficiently processes data without becoming idle.

PARAMETER		TEST CONDITIONS	T_A	V_{CC}	MIN	TYP	MAX	UNIT
$I_{AM,1\ MHz}$	Active mode (AM) current (1 MHz)	$f_{DCO} = f_{MCLK} = f_{SMCLK}$ = 1 MHz, f_{ACLK} = 32,768 Hz, Program executes in flash, BCSCTL1 = CALBC1_1MHz, DCOCTL = CALDCO_1MHz, CPUOFF = 0, SCG0 = 0, SCG1 = 0, OSCOFF = 0		2.2 V		200	250	µA
				3 V		300	350	
$I_{AM,1\ MHz}$	Active mode (AM) current (1 MHz)	$f_{DCO} = f_{MCLK} = f_{SMCLK}$ = 1 MHz, f_{ACLK} = 32,768 Hz, Program executes in RAM, BCSCTL1 = CALBC1_1MHz, DCOCTL = CALDCO_1MHz, CPUOFF = 0, SCG0 = 0, SCG1 = 0, OSCOFF = 0		2.2 V		160		µA
				3 V		260		
$I_{AM,4\ kHz}$	Active mode (AM) current (4 kHz)	$f_{MCLK} = f_{SMCLK}$ = f_{ACLK} = 32,768 Hz / 8 = 4,096 Hz, f_{DCO} = 0 Hz, Program executes in flash, SELMx = 11, SELS = 1, DIVMx = DIVSx = DIVAx = 11, CPUOFF = 0, SCG0 = 1, SCG1 = 0, OSCOFF = 0	-40°C to 85°C	2.2 V		2	5	µA
			105°C				6	
			-40°C to 85°C	3 V		3	7	
			105°C				9	
$I_{AM,100\ kHz}$	Active mode (AM) current (100 kHz)	$f_{MCLK} = f_{SMCLK} = f_{DCO(0,\ 0)} \approx$ 100 kHz, f_{ACLK} = 0 Hz, Program executes in flash, RSELx = 0, DCOx = 0, CPUOFF = 0, SCG0 = 0, SCG1 = 0, OSCOFF = 1	-40°C to 85°C	2.2 V		60	85	µA
			105°C				90	
			-40°C to 85°C	3 V		72	95	
			105°C				100	

2. This excerpt from Texas Instruments' MSP430F2132 datasheet lists the run-mode current for various CPU clock frequencies.

Taking Advantage of Bursty Operation

On the other side of the CPU throttling coin, bursty operation for processing and data acquisition offers another good opportunity to save power. The principle behind this technique involves minimizing the time in an active mode of operation. It may be unintuitive, but performing the tasks that consume lots of static current for a shorter period of time can be more power-efficient than doing so for a longer period of time at lower power. This applies equally well to CPU run modes and high-power peripherals such as ADCs.



3. Shown is the active-mode current consumption versus processing time for two hypothetical microcontrollers: an eight-bit CPU (a) and a 32-bit device (b).

The burst-mode principle for processing data can be elucidated further by comparing power consumption between 8-bit and 32-bit hypothetical devices. Both wake up with the same periodicity to acquire and process data. Because the 32-bit device (right) can complete the processing task faster, it's out of its high-power mode quicker when the sleep interval and data-to-process remains constant. Also, note the difference in the baseline power consumption, with the 8-bit device having the lower of the two. The area under the curve represents

total energy consumption. Therefore, the lower-power run-mode on the 8-bit device (left) isn't necessarily an advantage.

Low-power, low-frequency clock sources can be employed to manage sleep/wakeup cycles. Such a timer comes standard on most modern microcontrollers. If not available, then highly accurate and low-power 32.768-kHz watch crystals are an ideal substitute.

Multi core architecture

Multicore architecture have profound advantages when it comes to power consumption. As we saw earlier, the power consumption of a device depends on frequency to a large extent. Using Multicore technology, a single high frequency processor may be replaced by a no. of processor cores operating on lower frequency with the same performance throughput. Furthermore, by using multi-core processors, the signals have to travel smaller distances within the processor. This means the signal distortions are smaller, allowing the processor to operate on lower power signals. These advantages have made Multicore technology popular in mobile devices today.

Conclusion

These are the techniques modern designers have adopted to minimize power losses in modern electronics technology. Although these are the general techniques for curbing power losses, what we have to realize is that all power saving techniques are device specific and we have to take into account the operation frequency, performance threshold and practicality of the device when choosing one technique over the other.

References:

· *Managing Power Consumption in Silicon devices by Bo Karlsson & Jonas Svennebring,May 2011*

· *"The Benefits of Single-Cell MCU Operation" by Steve Diaper, Field Applications Engineer, Silicon Labs: http://low-powerdesign.com/silabs_diaper.htm*

· *"Reducing energy use with MCUs" by Isaac Leung, Electronic News July 6, 2011: http://www.electronicsnews.com.au/news/reducing-energy-use-with-mcus*

· *General data and specs for Freescale Semiconductor's S08QE Flexis 8-bit S08 Microcontrollers: http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=S08QE*

· *Datasheet for Freescale Semiconductor's MC9S08QE32 Microcontroller, Revision 7, September 2011: http://www.freescale.com/files/microcontrollers/doc/data_sheet/MC9S08QE32.pdf*

· *Datasheet for Texas Instruments' MSP430F21x2, Mixed Signal Microcontroller (MCU), NOVEMBER 2007–REVISED JANUARY 2012: http://www.ti.com/lit/ds/symlink/msp430f2132.pdf*

· *How Green Is Your MCU? by John Donovan, EE Times, 4/27/2011: http://www.eetimes.com/electronics-blogs/other/4215522/How-Green-Is-Your-MCU-*

Making Good Concrete

Compiled By: J.M Shrestha

The following points pertaining to materials and workmanship are important while making a good concrete.

1. **Cement**: Use fresh cement of approved quality. Store it properly to prevent deterioration.
2. **Aggregates**: Use well graded aggregates, free from silt, organic matter and other undesirable impurities.
3. **Water**: Use potable quality of water. It should be free from impurities and harmful ingredients. It should be within tolerable limits specified in the standards.
4. **Admixtures**: Use appropriate type of admixture in correct dosages. Trial mixes should be made, if necessary. Consult the manufacturer, if required.
5. **Batching**: Batching material by weight is preferable. If batched on volume basis, use measurement boxes in units of 35 liters which is the capacity of one 50 kg bag of cement. The cement should, in any case, be batch only by weight and preferably by whole bags. Correction for bulking of aggregates is necessary.
6. **Quantity of mixing water**: Use the minimum quantity of mixing water, consistency with the degree of workability required to enable easy placing and compaction of concrete.
7. **Mixing**: Use mixing machine. Avoid hand mixing. When it is unavoidable hand mixing should be done on an impervious plate-form. In the case of hand mixing, mix cement and sand first and then add aggregates.
8. **Transporting**: Avoid drying out, segregation and setting during transportation.
9. **Placing**: Place concrete in its final position before setting starts; avoid segregation of materials and disturbance of the forms; lay concrete in suitable layers without any break of continuity.
10. **Compaction**: Use internal, external vibrators; avoid over vibration.
11. **Finishing**: Finish after a little stiffening.
12. **Formwork**: Use formwork which is rigid and closely fitted, with sufficient strength to support the wet concrete. Check the formwork properly whether it is on exact required alignment as per drawings or not. Provide concrete cover blocks of proper sizes at the top, bottom and ends over the reinforcement bars.
13. **Reinforcement**: Make sure that the reinforcement used is free from loose rust, oil, paint, mud etc.
14. **Curing**: Keep concrete moist, preferably for 10 days minimum.

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