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PUBLISHER'S NOTE

The second issue of SCITECH, the scientific and technical half-yearly journal of the college is now in your hand. Apart from formulating and implementing innovative strategies for imparting scientific and technical education in the field of engineering, the college intends to direct its dynamic energy to some other extra - activities that are creative as well as relevant to the field of engineering. The publication of SCITECH is an example.

From this issue onwards, a separate space for readers, Readers' Page, has been included in the journal so that we may be in constant touch with our readers.

The articles contained in this journal are naturally directed towards scientific and technical education and research as far as practicable. The publication committee of the journal would always like to welcome and appreciate articles from concerned academicians and experts with a view to move further towards the envisaged aims and objectives of the journal. All the readers including you are therefore requested to render your valuable suggestions and comments on the publication of this issue at present and on other issues in future so that the committee can proceed further towards its objectives with the desired level of momentum.

The publication committee deeply apologizes for the delay of the publication of this issue of the journal. The publication was delayed due to several factors including the collection of articles and advertisements. We will attempt to publish its coming issues on time.

Finally, the publication committee is bound to make it clear that the ideas and information contained in this journal are the writers' own and it does not assume any responsibility for the adverse effect (if any) resulting from them.

CONTENTS

1.	The Advent of Modern Measurement Standard - Ishwori Man Pradhan	1
2.	Options for Passive Cooling and Solar Heating of Building in Nepal - Donn Treeë	4
3.	Treatment to Pier Well of Trishuli Bridge - D.N. Yadav & Deepak Jha	14
4.	Earthquake Resistant Design & Construction : Basic Concepts - J.K. Bothara	21
5.	An Inexpensive Source of Energy : Wastage from Biomass & Residues - Sarita Poudyal	25
6.	Drinking Water Quality and Implication on Human Health - Dr. N.C. Saxena	31
7.	Improved Management for Food Self Sufficiency - Dr. K.R. Sharma	37
8.	Effectiveness of Sub-surface Drainage for Stabilization of Landuse - T.L. Adhikari	40
9.	EST Engineering - Ram N. Khanal	53

THE ADVENT OF MODERN MEASUREMENT STANDARD

Ishwari Man Pradhan*

For the development of science and technology as well as trade and industry in a country, a measurement system standardized on the basis of scientific units is indispensable. The latest units of measurement for such a system are of mks or SI system. Nepal adopted this system by enacting the Standard Weights and Measures Act 2025. She had in fact taken it up two years ago, for then, while introducing the new series of coins with aluminium in the lower denominations, necessitated by rising cost of coinage metals, the weights of the coins were designated in grams instead of earlier tola and grain.

The act decreed SI units as Nepal's units of measurement, fixed the ratio of old units to these, the modalities of maintaining the standards and authorized HMG to enforce them in phases. It took HMG more than twenty years to enforce them throughout the Kingdom in the field of weights and measures, replacing the old *manapathi* system. The land measure still continues to be in *ropani* and *bigha* for practical reasons. However, the practice of quoting the prices of gold and silver in tola is already not legal and should be discontinued.

Obviously, it is enactment of this kind which sets the pace of adoption of new system. The metric system came into being by a resolution of the national assembly in France in the wake of the French revolution when the French were inspired to radically rationalize their weights and measures system. Accordingly, they declared multiples and submultiples in decimalised steps

for all units which greatly facilitated computations. Also they called for creation of prototypes of standard meter and kilogram which were fixed respectively as ten millionth of the quadrant meridian passing through Paris, and the mass of one thousand cubic centimeters of water at 0° celsius.

These were accepted gradually by other countries, the Foot Pound Second System was prevalent in British held territories. In 1876, an international conference on weights and Measures was held. It decided to create International Bureau of Weights and Measures to be located at Sevres near Paris and to charge it with the standard prototypes. The conference was called Conference General des Poids et Measures (CGPM) and was to be held periodically to review and refine the Metric System.

An interesting case of refinement was the removal of anomaly in respect of the standard of second. The second was originally defined as 1/86400th of the solar day which is the interval between meridians of two consecutive days. As clocks grew in number and accuracy, it was discovered that the duration of solar day in fact varies. The standard solar day was then taken as the average of the days of the year 1900. As the science of optics advanced, it was felt that this standard is unsuitable and the most constant duration must be selected. That of course is the radiation of an excited atom as one of its electron changes orbit. The standard of second was therefore defined as the duration of 9 192 631 770 periods of the radiation corresponding to the transition between the two hyperfine

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levels of the ground state of caesium-133 atom (XII CGPM 1967).

Another refinement concerns the meter. The prototype of the meter kept at Sevres was found to differ from ten millionth of the meridian quadrant passing through Paris. It was felt better to relate it to radiation wave length. The standard of meter was therefore defined as 1650 763.73 wavelengths in vacuum of the radiation corresponding to the transition between the energy levels $2p_{10}$ and $5d_5$ of the Krypton-86 atom (XI CGPM 1960). It was subsequently related to wave length of light in vacuum.

In 1954, the conference felt that the standards so far addressed only the weights and measures; it can very well be made to serve all aspects of contemporary technology by adopting the mks system and adding standards for ampere (in terms of electromagnetism in place of Gaussian electrostatic standard), Kelvin (giving the thermodynamic scale of temperature), Candela (as the unit of luminosity) and Mole (quantity of matter). Two supplementary units of the radian and the steradians were also included. The seven primary units with the supplementary units form a coherent system of standards and were designated as standard Internationale des Units of SI in short.

We shall now review the FPS system because it was in a way prevalent in Nepal prior to SI.

Foot (in some places cubit) was the earliest unit man used. The British institutionalized it into Imperial System by creating prototypes of standard yard (3 feet), pound and gallon and placing them in custody of Board of Trade. (In old times the standard foot was that of the pharaoh or the chief, causing confusion and strife). The focus was on weights and

measures of everyday trade. Allowed errors were decreed according to the class of transaction (for gold and silver weightments, the errors should be much less than for serial weightments). By bringing in definiteness and clarity, the British were successful in rearing FPS system into all pervasive scientific system. It prevailed throughout the British held territories satisfactorily. Even now it is in use in U.S.A., Canada and Australia.

There was an anomaly because of the acceptance of the use of pound as the force unit also. The poundal and the pound weight were later introduced but the latter necessitated the introduction of *slug* as another unit of mass. The same anomaly arose with kilogram force. The adoption of Newton for force finally did it away.

In India the British had the prototype of "Seer" made, and placed in custody of the Assay master of Bombay Mint. The seer equals 80 tolas. The India mints made rupee coins of 1 tola a piece. 1 tola is made equal to 180 grains and 7000 grains make 1 pound avoirdupois. Because of rigid weight checking done on silver coins (sterling silver i.e. $11/12$ pure silver) and close weight tolerance, the rupee coin was used as weight piece for weighting gold and silver. This practice has since been discontinued. The British used troy ounce for precious weightments but this ounce is different from avoirdupois ounce of $1/16$ pound. And 3 troy ounces equal 8 tolas.

The Nepalese also used tola called mohar tola, this being $19/20$ of Indian tola which they called company tola in the name of East India Company. Tola as such comes from the Sanskrit word for comparison. Mohar tola was the nominal weight of Nepalese rupee also. Being of 171 grains. 18 mohar tolas made 1 pao and 4 paos, 1 seer. 3 seers

or 12 paos made one dharni. In India the pao meaning one quarter of a seer was equal to 20 tolas naturally. 40 seers made 1 maand. However the maand in usage had different values in different places. So also in Nepal, the Pokhara seer was equal to 2 paos.

Until the adoption of mks system, Nepalese official decree regarding weights and measures called "Khota Chellan" of Rana days read something like this;

8 Barley beads (regular shaped) make	1 angul
12 Angul make	1 Bitta
2 Bittas make	1Haat
2 Haats make	1 Gaj = 1 yard.
10 Pinches make	1 Muthi
100 Lals (red seeds) make	1 company tola
10 Muthis make	1 Mana
2 Manas make	1 Kuruwa
18 Mohar tolas make	1 Pao
4 Kuruwas make	1 Pathi
4 Paos make	1 Seer
3 Seers make	1 Dharni.

N.B. : The pathi in usage was found to closely approximate and so was official made equal to 1 Imperial Gallon.

Interesting but unsuitable for scientific works !

With the adoption of SI system all confusion ended (also in India where it was enforced in 1956). The British enforced it in all transactions since 1975 thus ending the FPS system altogether.

Lastly a few words on maintaining of standards. This implies what is called maintaining of "Traceability" to international standard by creating a hierarchy of standards within the country and systematic calibrations. The classes of standards are Primary, Secondary and Reference.

The calibration for the checking of Weights and Measures used in the markets is done with the help of

Reference Standard. This falls within the domain of legal Metrology (Science of Measurement).

The Reference Standard is the one used in calibrating the instruments used for actual measurement such as Proof Strength in Alcohol testing and Proof Stress in material testing. The reference Standards are calibrated against the secondary Standards. The Primary Standard is to be used very sparingly to calibrate the secondary standards. There again has to be one national standard for each primary unit.

Not all countries can afford to have all the standards of all levels in every unit. What most countries do to maintain Traceability to the international standard is to get their required standards tested in the neighboring country which has got that standard recently calibrated and traced to international standard.

Nepal has already the national standard for kilogram calibrated against the international standard and was originally in the custody of Chief Inspector of Weights and Measures. It is now with Bureau of Standards and Weights and Measures. This is beside the other hurls of standards in other desired units such as volume (necessary for administration of legal metrology), voltage which are being used for calibration and test purposes and are traceable to international standard.



OPTIONS FOR PASSIVE COOLING AND SOLAR HEATING OF BUILDINGS IN NEPAL

Donn Treese*

INTRODUCTION

One of the primary functions of a building is to provide thermal protection and comfort for its inhabitants. Throughout history man has struggled to provide suitable shelter with available materials in various climatic regions where he has chosen to live. And, to a large degree, vernacular designs of indigenous architecture in many parts of the world show great ingenuity in adapting local materials to local climatic needs providing functional, affordable, thermally comfortable, viable buildings for living and working.

However, in this century, with the development of electricity and mechanical conditioning equipment, building designers have tended to disregard the climatic conditions and rely on the mechanical engineer to provide suitable interior environment. This lack of sensitivity to the local prevailing climate means that buildings need larger and larger mechanical systems to rectify the extra heating or cooling loads created by poor bioclimatic design. As a result, modern buildings are either not as comfortable as their historic counterparts even though there have been great advances in building materials technology and construction procedures, or they achieve their comfort levels through huge inputs of expensive and limited energy sources. Or, as we find in Nepal, buildings maintain unsatisfactory thermal environments inside during the hot and cold seasons.

Although traditional Greek housing was often capable of maintaining temperatures under 30 degrees C throughout the summer by indigenous design strategies, present housing construction results in temperatures over 35 degrees C through insensitivity to sun position and strength, to the liabilities and assets of outside temperature conditions, and to the potentials of ventilation and radiant cooling.¹

Here we have a building construction dating back 2500 years being more comfortable than modern buildings built in the same location in spite of the advances we have made in materials, science, design, etc. Sadly, however, this is not an isolated incident but a representative example of what is happening on a global scale throughout much of the "developed" and "developing" world. The ancient, traditional and vernacular design and construction procedures provide living environments which are considerably more comfortable, affordable and practical than newer buildings.

In this paper we will take a brief continuing education course covering the basic dynamics of human comfort, climatic parameters, and building materials physics. These factors will furnish the framework for improved building design to provide enhanced thermal comfort and thus reduced energy consumption in buildings.

¹ Loftness, V. et al. "The Design for Cooling Energy Conservation and Incorporation of Passive Cooling Systems for the Lykovrissi Solar Community in Greece" *Passive Cooling: Conference Proceedings*. ed. A. Bowen. International Solar Energy Society. 1981. p 51.

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PHYSIOLOGY 101 : HUMAN COMFORT AND WORK PRODUCTIVITY

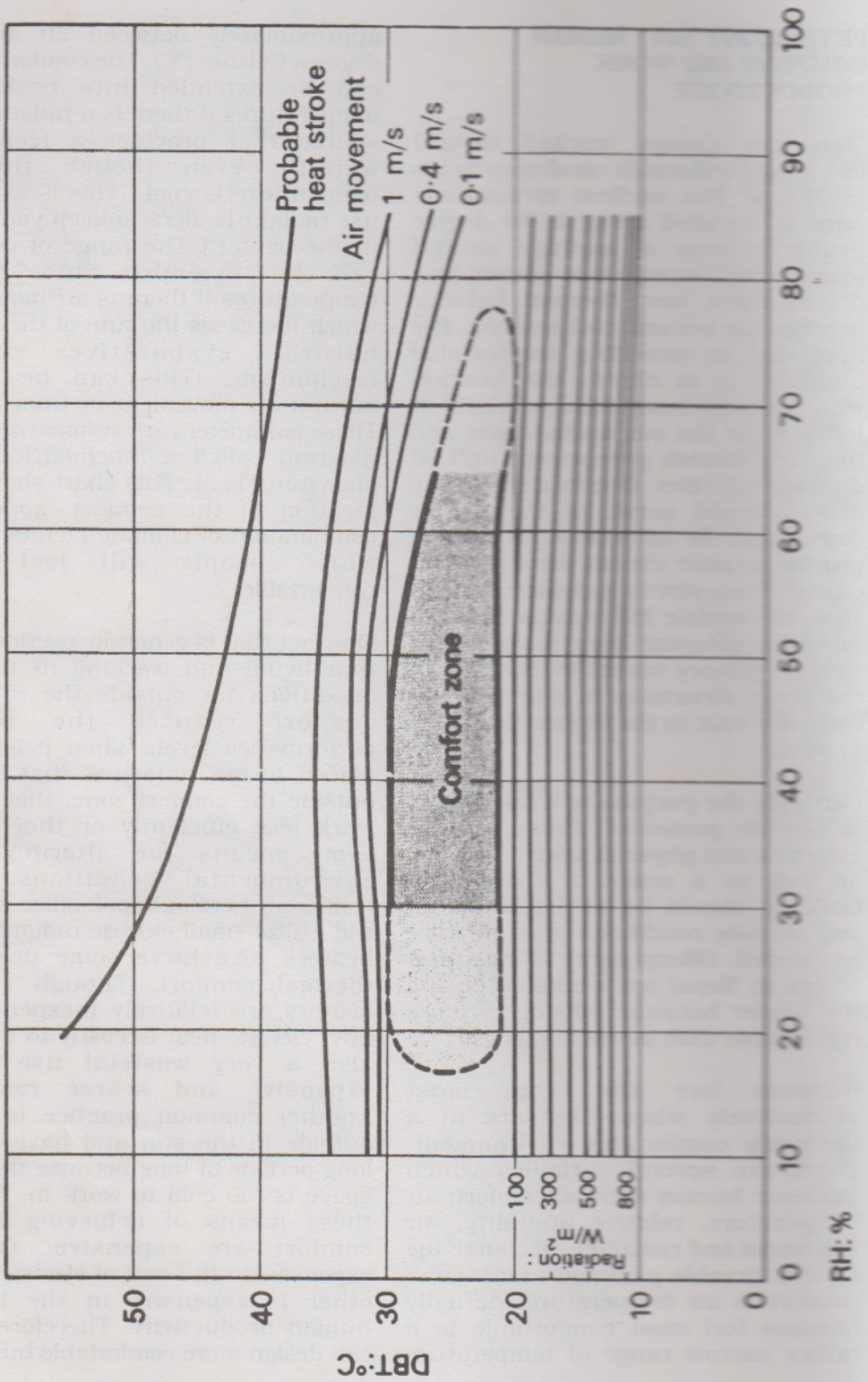
Man has always worked toward providing comfortable conditions in his buildings. The earliest civilizations were all located along a 20 degree isotherm (area of average annual temperature) because this climatic area provided the best thermal balance between the hot and cool seasons. The first step in providing comfortable buildings is to choose the location with the most comfortable climate. In India, both the old maharajahs and the early British government utilized dual capital cities. One location on the plains would serve as the winter capital and the hill station city would provide a cooler climate for a summer capital. From strictly a climatic point of view, the middle hill regions of Nepal provide a pleasant living environment with a tendency toward overheating in the lower elevations in summer and excessive cold in the higher elevations in winter.

Certainly the purpose of a building is to provide protection (from weather extremes and physical safety), privacy, as well as a sense of space. The building should be an improvement over outside conditions or it may not be needed. (Many rural schools and offices in Nepal work outside during the winter because outside is more comfortable than inside buildings.)

Humans live and work most productively when they are in a thermally comfortable environment. There are several variables which influence human thermal comfort: air temperature, relative humidity, air movement and radiation. Of course the most noticeable parameter on human comfort is air temperature. Actually humans feel most comfortable in a rather narrow range of temperature

approximately between 20 and 30 degrees Celsius ($^{\circ}\text{C}$). The comfort range can be extended into cooler air temperatures if there is a radiant heat source that provides a feeling of warmth, even though the air temperature is cool. (This is why you use radiant heaters to keep you warm in the winter.) The range of comfort can be extended into higher temperatures if there is air movement which increases the rate of the body's natural evaporative cooling mechanism. (This can be either natural air movement or from a fan.) These parameters are summarized on a diagram called a *Bioclimatic Chart* shown in Fig. 1. This chart shows the location of the *comfort zone*, the combination of climatic factors within which people will feel most comfortable.

One fact that is generally overlooked is that living and working in thermal conditions far outside the range of comfort reduces the human performance level. When people are placed in environments that are far outside the comfort zone, they either work less efficiently or they utilize some means for altering their environmental conditions. Very commonly here in Nepal, office workers will utilize small electric radiant space heaters to achieve some degree of thermal comfort. Though radiant heaters are relatively inexpensive to buy, electric heat is costly to use and also a very wasteful use of an expensive and scarce resource. Another common practice is to sit outside in the sun and have tea for long periods of time because the office space is too cold to work in. Both of these means of achieving human comfort are expensive. One is expensive in the cost of electricity, the other is expensive in the loss of human productivity. Therefore, if we can design more comfortable buildings,



we would also provide more energy efficient buildings and increase human productivity and comfort.

CLIMATOLOGY 101 : OBSERVING THE SUNSHINE AND THE OTHER ELEMENTS

Although most buildings are built with total disregard to solar orientation, we do live in a very ordered universe, the understanding of which will help us in designing comfortable, energy efficient buildings. The sun follows a very predictable path in the sky throughout the year. In fact, sun dials have been made which will show the month, day and time of the day during the year. This regular path of the sun generally is from east to west each day as the earth revolves around on its axis. Since the earth is tilted on its axis in relation to the sun, it causes the sun to shine more intently in different locations during the year. In the winter time (in the northern hemisphere) the sun rises in the southeast and follows a rather low path through the southern sky on its way to setting in the southwest. During the summer, the sun rises in the northeast and follows a path high over head setting in the northwest.

From an understanding of the sun path, we can realize why the southern exposure of a building is the most important for collecting solar energy when you want it to heat the building in the cool winter season. On the other hand, the single most important surface of a building when it comes to staying cool in the summer is the roof because it is receiving the greatest intensity of solar radiation. The east and west walls of a building are next in significance as far as the amount of solar radiation falling on them when you do not want it during the hot summer season. Therefore if you want to catch solar heat when you desire it

in the cool winter season you need to orient your building in such a way that the longer side of the building is facing the south and the north. The shorter east and west walls will then have smaller surface area in relation to the whole building and will add less solar heat to the building in the summer time when you don't want that additional heat. The south side of the building will be the larger side and will provide a greater surface area for collecting solar heat when you want it in the winter time. It is generally important to insulate the roof for improved thermal comfort in both the hot and the cool seasons. In the summer the roof is the surface of the building receiving the most heat (which you don't want) and insulative building materials will reduce the flow of heat into the building from the roof. In the winter when you want to catch the south sun, you also want to retain as much of that heat that you have collected as possible and roof insulation will help to do that.

In choosing a site to build on we should remember the importance of solar orientation. The south slopes of mountains will provide more winter sunshine than the north slopes where the sun may shine for a very short period during some winter days. Also adjacent mountains can block the sun to our advantage (if it blocks some of the low northeast and northwest sun in the summer) or to our disadvantage (if the hills block the low southeast and southwest winter sun).

Another climatic factor to consider is wind. We need to be aware of wind direction and velocity at different times during the year. During the hot season (especially the warm humid monsoon season in this part of the world) we may desire the air movement the natural wind provides and would want to orient our building (and space our

One additional principle that is useful for cooling is the effectiveness of evaporation of water in cooling. This is our own body's method for cooling when overheating is a problem. When water evaporates it utilizes heat energy to evaporate the water. The action of using the heat to produce the work of evaporation causes a cooling effect because the heat has been used up in the work of evaporating the water.

PASSIVE DESIGN 101: PUTTING IT ALL TOGETHER

With all of this information as a background we need to assemble the information together and arrive at some basic design options for solar heating (to provide increased warmth in the cold winter months) and passive cooling (utilizing natural principles of cooling to keep houses cooler in the hot season). We will start by looking at some basic building blocks of passive design.

ORIENTATION

As mentioned previously, proper orientation to sun and wind is essential to enhance natural heating and cooling processes. A properly solar oriented house will stay warmer in the winter and will also be cooler in the summer. The Greeks realized this 2500 years ago and oriented the street patterns of their new cities so the houses would all have a good southern exposure and a limited east-west exposure. (This would also be good for Nepal to implement in areas of new construction.) The building should then be elongated in the east-west direction (approximately a 1:1.3 aspect ratio [width to length ratio]) with major rooms to be heated on the southern side of the building.

DIRECT, INDIRECT AND ISOLATED GAIN

When you consider the collection of solar radiation for passive heating there are three general ways to collect this heat. These are called direct, indirect and isolated solar gains. *Direct solar gain* is when you allow the sun to come directly into the building through clear glazing or through an open door or wall opening. Again, this works best on the south side of the building. *Indirect solar gain* is when heat is collected on the outside surface and allowed to flow into the building either by conduction through the wall or by convection. Here the sun is not heating the inside directly with sun rays coming inside, but by heating the outside of the wall through which heat is then transmitted to the inside. One example of this is the *Trombe wall*. A Trombe wall is a heavy weight south facing black surfaced wall that is covered with clear glazing. This wall acts as a solar panel to collect the radiant heat from the sun. The mass of the Trombe wall holds the heat as thermal storage and the heat slowly flows through the wall by conduction then into the room. *Isolated solar gain* is the technique of collecting and storing solar heat away from the building and then utilizing this heat when required. This separation from the building allows a greater degree of flexibility in using the heat when desired and keeping it away when the outside sol-air temperature (combination of air temperature and solar radiation) is too warm already and no additional heat is desired.

WARM FEET / COOL HEAD

Since heat rises and coolness drops, when possible, it is best to design your passive system in such a way that coolness is coming from above (a cool roof) and heat is coming from below (a

warm floor). Having warm feet and a cool head will do much to keep us comfortable in any season.

COOLING OPTIONS

Though the sun is a great provider of warmth for winter heating, there is not a similar easily available cooling source for summer. However, there are still some moderately useful options for cooling which include (besides orientation already mentioned): evaporation of water, air movement, shading, re-radiation to the cool night sky, and thermal coolth storage.

Evaporation of water is one of nature's most effective means of cooling. For use as space cooling, evaporative desert coolers are common on parts of the Terai. These utilize evaporation of water that is circulated over a grass mat. Air is drawn through the mat and forced into the living space by a fan. As the dry air passes over the moist grass mat water is evaporated into the air and this process lowers the dry bulb temperature of the air. Though effective in low humidity, the addition of moisture to the air can sometimes cause unpleasantly high humidity inside the living space. (Recently developed two stage evaporative coolers are able to provide increased cooling efficiency even lowering the inside air below the wet bulb temperature.) Another use of evaporative cooling is to cool the roof area of a house and allow this coolness to flow through the roof slab by conduction and cool the living space by convection. With roof surface evaporative cooling there is no increase in moisture inside the building. This technique has been tried by the author in the hot dry season in Delhi and found to be very effective. The major problem was the lack of water available which can be a common problem in a hot-dry area. The method used was to cover the flat

roof with burlap bags and wet the area three times a day. In a hot dry climate like the Terai in May, a roof area can evaporate 10 liters of water /M² /day which is a considerable amount of water for a dry region. The small 4 X 8 meter roof area of the author's house in Delhi could evaporate 320 liters of water a day; over half the amount of water that was coming to our three storey building which housed three families.

As mentioned previously, the comfort zone within which a person will feel thermally comfortable can be increased by the inclusion of air movement. By increasing ventilation from outside (in moderately warm climates) or increasing the movement of internal air by a ceiling fan, interior comfort can be increased. This is why ceiling fans are found and are effective for increasing comfort in warm climates.

One very helpful means of reducing the amount of heat flowing through the fabric of a building is to first reduce the amount of heat that is striking the outside of the building. Shading of the building, and especially shading of window openings is helpful in reducing the solar load on a building and thus lowering the heat that is transmitted inside. The design and optimization of sun shades for windows can easily be done following solar charts for the latitude and orientation of your building. This will allow the designer to optimize the summer shading of windows while allowing the maximum sunlight to penetrate for heating in the winter season when the daytime sun is lower in the sky. Trees are a good natural and beautiful source of shading and also blocking or directing natural air movement in the micro-climatic area around a building. Coniferous trees with continuous foliage, like evergreen trees, are especially useful on the north side of a

building since they keep their foliage all year long and can help to block cool winter winds coming from the north. Because their foliage comes close to the ground they are also useful on the east and west exposures of a building to block the low angle summer sun in the morning and evening. For the south side of buildings deciduous trees are more useful. Some varieties of these trees will have their full foliage during the summer when shading is needed and then lose their leaves for the cold season allowing more sunlight to pass through them to strike the building.

Just as much of the heat striking a building comes as radiation from the sun, the re-radiation of heat from the building to a cool night sky can be an effective means of cooling a building. Especially in climatic regions that have low humidity and clear, cloudless skies at night, much heat will escape from a building to the "cool sink" of space. To utilize this cooling source it is necessary to have sufficient thermal mass in the roof to absorb the heat from the sun during the daytime and then allow it to be re-radiated to the night sky before allowing the heat to flow through the roof to the interior of the building.

Just as we have talked about thermal storage of warmth for heating in the winter, it is also possible to store *coolth* to be used when needed. This can be coolth that has been collected during the night or even cooling for summer than has been collected in the winter. There are some projects which have stored snow and ice collected in the winter for summer cooling, but we will consider a more economical alternative for Nepal. One very large thermal storage source can be found right under foot. The ground provides a huge thermal mass that can be utilized. Depending upon soil type and

composition, a depth of about two meters into the ground will provide an ideal thermal storage location. At this depth, the ground temperature fluctuates very little keeping close to the average temperature for the year. However, its small fluctuations provide the warmest ground temperature in winter and the coolest temperature in summer because it takes about six months for the effect of the thermal change to move through two meters of soil. This means that an earth tube (or small tunnel) located two meters underground could provide a cooling source for the summer and also a heating source for the winter. If summer temperatures average (day and night) about 30°C and winter temperatures average about 10°C, an earth tube may be able to provide air into a building at around 20°C which approaches a comfortable temperature for summer or winter. The author is currently consulting on a project proposing the use of an earth cooling tube in conjunction with an evaporative cooling tower for a lower altitude location in Nepal. If this project is actually completed a report will be given on the effectiveness of this technique.

HIMALAYAN CASE STUDIES

The author is not familiar with any specific passively designed buildings in Nepal. Case studies of several solar passive buildings in the western Himalayas have been compiled by Sanjay Prakash in Delhi. His book, *Solar Architecture and Earth Construction in the Northwest Himalaya* is listed in the bibliography of this article. Examples are given of schools, hostels, community buildings, etc. in Leh, Ladakh and the Spiti region of Himachal Pradesh, North India. These are cold high altitude areas like the higher regions of the Himalayas in Nepal. The sample buildings and

proposed designs with computer generated thermal projections, show that passive solar heating is a viable option for improved thermal comfort in Asia's high altitude areas.

Possibly this article will be an impetus for discussion and dissemination of passive solar information in Nepal. It is my hope that I could find out about passive buildings already constructed in Nepal and that this information would help begin a passive movement among building designers in this country.

CONCLUSION

Though the middle hill regions of Nepal generally provide a mild and pleasant climate, there is a need for improved thermal comfort in buildings in various

parts of the country during different parts of the year. Generally, heating is desired in the cold season at high altitudes and cooling in the hot season at lower altitudes. With a proper understanding of the natural processes involved, much can be done through natural means with little or no electricity to greatly improve the thermal comfort inside building. Properly done, these passive techniques can increase thermal comfort while reducing energy consumption in buildings. This paper has attempted to provide a broad background for the whole area of passive solar architecture. Future articles in this Solar Section will address these topics individually in more detail.



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TREATMENT TO PIER WELL OF TRISHULI BRIDGE

D.N. Yadav*
Deepak Jha

SYNOPSIS

The sloping phyllite rocky strata encountered above anticipated maximum scour depth hindered the sinking of the pier-well on Dhading side. High velocity of flow, appreciable design-discharge, deep water depth, presence of big quartzite boulders, and limited type and capacity of equipment available made further sinking economically unfeasible. Foreseeing the impossibility of the lowering the well in such strata, the design had to be modified by providing anchors to resist pull with suitable bed protection works to check the deepening of the scour.

This paper deals with an assessment of the rock mass rating of the existing rocky strata. The design calculation and provision of anchoring and protection works recommended for completion of the works.

INTRODUCTION

Trishuli bridge is located at a distance of 70 Km. along Prithvi Highway from Kathmandu in Dhading District of Bagmati Zone. It bridges over the Trishuli river and links the Prithvi Highway with Dhading Besi, the District Head Quarter through District Road.

The bridge is a 110m long single lane bridge consisting of two steel trusses each 24.4m end span and one 60.96m intermediate span resting on steel frame connected to RCC piers and abutments. Based on geotechnical report Feb. 1988, all four foundations (Two piers and Two abutments) were designed to have isolated RCC footing resting on underlying rocky strata erroneously interpreted contrary to the aforesaid report.

The construction-contract was awarded and the foundation-work of the two abutments were executed. The excavation was continued for the foundation of the pier on Malekhu

side. Boulders mixed with sand strata was seen to exist up to 6m depth in place of expected rocky strata. Confirmatory boring in April 1990 revealed the presence of a boulderly strata upto 15m depth at the locations of both the pier foundations. Foundation-design of the piers was revised in September 1990 and deep well foundation with adequate well curb was adopted.

Foundation-work of both the piers was taken up according to the revised design. The pier well on Malekhu side was sunk to the designed level but difficulty was experienced in sinking the other pier well on Dhading side in Feb. 1992 when sinking was just 3m below the bed level. Confirmatory boring in March 1992 revealed the presence of a rocky strata at the depth of 3.6m. Rock-fragments recovered from dredge-hole were studied in June 1992 to access rock mass rating and on-site details were also analyzed to rest the well on the strata. It was essential to sink the well further by 4m for stability. Considerable sinking effort was made by chiseling under water drilling and blasting, deployment of

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divers and kentledge to sink the well by 4m in rock. Tilts and shifts were regularly checked and maintained within limits.

Well curb suffered little damage during the sinking as it was adequately reinforced with steel plate. Rocky strata was met with at 3.6m depth on Dhading side but it was non-existent on Malekhu side of the well indicating its sloping trend. Complete dewatering and pneumatic sinking were out of question. Rock specimens recovered from different depths were inspected and tested during further sink (*2* acting of well curb was confirmed with divers in final position. Design-calculations were made to ascertain the number and position of anchors. Also garlanding the well with blocks was recommended to prevent scour.

SALIENT FEATURES

a. Hydrological Features

Design discharge	- 6667 cumecs
Mean velocity	- 8m/sec Normal
Silt factor	- 16 (Anticipated max.)
Lowest bed level	- 346.79m
Scour level	- 344.86m
Scour level	- 336.53m
Design HFL	- 353.19m (1988)
Actual HFL	- 355.69m (1993)
Common water level	- 348.40m

b. Geotechnical Features

Type of rock	: Phyllite minimum comp. strengths : 006.0Mpa
Top level of rocky strata on Dhading side of the pier well	: 343.19m
Level of rocky strata on Malekhu side of the pier well	: Non-existent.
Angle of internal friction	: 40°
submerged density	: 12KN/m ²
Ratio of subgrade reaction	: 001.0
Angle of friction between well and surrounding strata	: 022.5°

C. FEATURES OF WELL

External diameter	- 006.0m
Thickness of steining	- 001.0m
Cap-top level	- 349.9m
Depth of embedment on Dhading side	- 003.19m
Height of well curb	- 001.69m
Depth of embedment on Malekhu side	- 000.0m
Founding level	- 340.0m

ROCK - CHARACTERISTICS

To ascertain characteristics of rock in rocky strata, study was made as per IRC:78-1983 in June 1992. Drilled core specimens and samples recovered from cap rock were tested. Final result is as under :

S.No.	Characteristics	Condition/Value	Rating No.
i.	Uniaxial compressive strength	85kpa	+ 7
ii.	Core sample quality	RQD 60 percent, fair	+ 13
iii.	Joint spacing	0.2 to 1.0m, thin to medium	+ 20
iv.	Joint Conditions	smooth surface	+ 6
v.	Ground water condition	Moist	+ 7
vi.	Influence of joint orientation	Favorable	- 2
		Total	+ 51

RMR rating based on Geomechanics Classification Systems works out to 51, hence rock is assessed Fair. Soundness, Hardness and massiveness of rocks recovered from below cap rock enhanced as observed in Feb. 1993. RMR rating is therefore quite high at founding level.

ANALYSIS

Sinking was stopped at RL 340.0m. Soil-strata consisted of boulderly sand from LBL to 3.6m depth underlain by rocky strata on Dhading side and boulderly sand from LBL to RL340.0m. on Malekhu side of the well. Depth of embedment in rock is 3.19m on Dhading side which is expected to decrease uniformly to 0 on Malekhu side. Diverse as well as grab-operator confirmed presence of such sloping nature beyond RL 343.19m. Rock specimens were observed to possess slight to fair weathering, good texture and high hardness. Point load tests on six specimens yielded minimum compressive strength 6.0Mpa. Artesian water did not exist. Ground water was free from sulphate.

The phyllite rocky strata having RMR value over 51 and other favorable characteristics is considered suitable for foundation. IRC:78-1983 specifies minimum grip below anticipated maximum scour level = $1/3$ rd maximum depth of scour in erodible strata. Also extent of square seating and embedment in rock is dependent on method of construction, quality and profile of rock. Rock possessing allowable compressive strength 2.0Mpa to 0.6Mpa is considered soft.

Embedment in bed rock varying from 1.5 to 4.0m is sand, lime and silt stones having unconfined strength from 3.3 to 57.5Mpa has been found sufficient for 768m long Narmada bridge as reported in Ref.3.

Embedment in hard rock is 3.0m in bridge over river Krishna as reported in Ref. 7.

Abutment and pier wells rest on hard and soft rock strata without embedment as reported in Ref. 5.

Founding level of pier well is kept above maximum anticipated scour level and embedment in weathered rock up to 3m has been found sufficient as reported in Ref. 6.

Rock with more than 60% core recovery is satisfactory against erosion from factors like current velocity, size of material above rocky strata, frequency and duration of medium size floods as reported in Ref. 6.

Rock in this case, possesses allowable compressive strength over 2.0Mpa with 3 factor of safety and hence it is hard rock. Seating in such a rock at founding level is governing criteria but not the gearing capacity, provision of 3.19m embedment in rock on Dhading side and almost zero in Malekhu side is considered sufficient for such a compression well. Also sufficient square seating of well is essential to avoid deep seated failure. The rock is considered suitable for anchoring to provide against pull, transitional and rotational displacement.

Analysis based on limited geotechnical data made available by the project, reliability of the data and unauthoritative experience/skill in this field might lead to inadequate provisions. concentration of flow round the pier, unexpected nature of location and extend of scour-hole obliquity of flow, debris in flow etc. let to provision of heavy bed protection works. Extent of scour, size of blocks and configuration of protection work were figured out keeping in view the pertinent salient features as reported in Ref. 11.

DESIGN

The pier is founded at RL 340.0m whereas the RL of maximum anticipated depth of scour is 336.53m. The well is embedded in hard rock but the depth of embedment varies from 3.19m to 0m. It is therefore, essential to check the stability of the well.

Resort is taken to IRC:45-1972 and the other relevant literature to check stability is based on Elastic Theory. Embedment-Depth is considered more or less 0.5 times the external diameter of the well. Soil surrounding the well is non-cohesive.

These conditions are investigated :

Condition - I Without protection, plum concrete fill and anchors.

Condition - II With protection, plum concrete fill and anchors.

Condition I

HFL considered during the design stage was RL 353.19m which increased to RL 355.69m as per the observation made by the Trishuli bridge project in July 1993 after the completion of the foundation work. The pier withstood all the forces effectively without any detrimental effect. Sketch 1 shows various details.

Loads and forces on the well are as under .

Dead loads

Weight from superstructure	=	72.5
Live load reactions	=	65.5
Weight of pier and cap	=	62.5
Weight of well and cap	=	624.0
Buoyancy	=	- 237.0
Net vertical weight (W)	=	587.0t

Live load forces,
Live load reactions = 65.5t

Lateral load forces Moment at base

In traffic direction	Hxx	Myy
Water current forces	76.00	875.77
Braking force	17.25	287.2
Tilt and shift	-	122.9
Total	93.25t	1285.87tm

In current Direction Hyy Mxx
Water current forces 82.0t 944.9tm
Wind and seismic forces are not considered.

Resultant lateral forces at scour level - 124.17t

Resultant moment at base - 595.7tm

Area at base - 28.27m²

Section modulus - 21.21m³

Projected width L - 6.0m

Grip length - 3.19m

Design calculations are shown in appendix I. Tabular values as reported in Reference 9 are used for quick calculation.

Results of Appendix - I show that :

Criterion of Elastic State is partially complied with and the tension created at the base is high.

The well is therefore unstable. Appropriate measures must be provided.

Condition II

The expected extent of the scour, the volume of bed the material removed and the diameter of equivalent sphere to withstand current velocity as stated in appendix II require extensive protection works. Overall shape of the scour - hole would be oval in plan. Its shape for provision of projection - works is recommend semi-circular on U/S side and elliptical on D/S side.

provision of RCC precast concrete blocks filled with plum concrete and connected together with wire-ropes is recommended over an area of about 30.0 $\times$ 20m around the well. Top of the block should flush with LBL 346.79m. This measure will prevent the scour-deepening.

The area of the tension - zone is estimated 1.75m² and the tensile force to be taken care of is about 6.0t. One rock anchor made of 25mm dia tor steel reinforcing bar properly placed and grouted in rock below and adequately bonded in bottom plug has been reported to take 5.8t safe load. Considering factors such as depth of water in well, inadequate bond in bottom-plug concrete, limitation in working space and site conditions to perform drilling and grouting with cement sand slurry, availability of suitable machines, urgency of works, reliability of anchors, etc. 15.no. anchors with high factor of safety were recommended.

The holes were drilled 3.0 to 5.0m below the sump mostly in the upstream half portion of the well to provide anchors. This measure will resist the tension and provide against displacement. The design-calculations are shown in Appendix - II. The plum concrete filling would increase the base frictional resistance.

With protection, the plum concrete and anchors loads and forces are ascertained as shown below:

$$\text{Downward Load } W = 587 + 117 = 704\text{t}$$

Lateral load forces	Moment at base	
<u>In Traffic Direction</u>	<u>Hxx</u>	<u>Myy</u>
Water current forces	62.00	881.64
Braking forces	7.25	342.24
Moment due to Tilt and shift		122.70
Total	79.25t	1346.58tm

<u>In current direction</u>	<u>Hyy</u>	<u>Mxx</u>
Total	48.00t	682.60tm

Resultant lateral forces at the scour level = 92.65t

Resultant Moment at base = 1510.00tm
results of Appendix - II show that:

- Criterion of Elastic State are fully complied with
- Tension Developed at base is acceptable

The well is stable. The cutting edge of the well was seated uniformly on the rock by sending the divers with pneumatic tools to cut the uneven surface, to remove the fractured rocks and to carry out light blasting to remove the loose rocks. It was confirmed that the cutting edge touched the rock in almost 85 percent of its circumferential length. The anchors would resist about 103.0t lateral force on 70% reliability. The sketches 2, 3 and 4 show the details of adopted measures.

CONCLUSIONS

- The rocky strata at such a shallow depth could not be located either in the initial boring in 1988 or in the confirmatory boring in 1990. The strata was located when there was a problem in sinking supplemented with further boring in 1992. This is not an unusual case in the history of boring. Sufficient no. of confirmatory borings at the designated locations of the foundation should be done.
- Provisions of anchors, increasing the dead weight of the well with the plum concrete bed protection-works may be adopted to make the shallow foundations safe. Enormous cost in erecting cofferdam, dewatering, cumbersome excavation in boulderly strata is normally required for the bridge foundations and the delay in the completion of the work can be

avoided if such measures are adopted judiciously. hence rigorous analysis may be omitted for the hard rock.

The pressure at the founding level is quite below the allowable value and

□□□

Acknowledgments

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Appendix - I

Condition- 1

Loads and forces are stated in Section 5, Condition - I

Given angle of internal friction	= 40°,	k = 0.532
Coefficient C_2	= 0.067,	Moment of inertia $I = 85.7 \text{ m}^4$
$a = 0.839a_2$	= 0.414	$m = 1.0$
Coefficient C_3	= 1.59	$r = 1-2$
		Coefficient $r = 9.54$

Criteria - I

$$M/r (1 + a_1 a_2) - a_1 W = -267.13 < 124.17t \text{ (O.K.)}$$

$$M/r (1 - a_1 a_2) + a_1 W = 601.6 > 124.17t \text{ (O.K.)}$$

Criteria - II

$$mm/1 = 18.63$$

$$\text{Coefficient } k_p = 12.7, k_a = 0.184, (r k_p - k_a) = 15.1, 18.63 > 15.1 \text{ (not O.K.)}$$

Criteria - III

$$\text{Coefficient } p = 167.26, B = 6.0m$$

$$\text{Pressure on foundation} = + 70.746/\text{m}^2 \text{ (0.707MPa), } - 44.1t/\text{m}^2 \text{ (0.441mPa)}$$

Appendix - II

Bed Protection works

Angle of internal friction = 40°, Void in boulder = 30%

Maximum velocity = 11.3m/sec, Depth of flow = 9.5m

Diameter of obstruction to flow = 4.30m

Diameter of sediment = 100.00mm

Particle Froude No. = 11.41, Coefficient $d_s = 8.50m$

Volume of material removed = 1200.00cum. Size of unit = 21.00m

Extend of the scour both on U/S and d/s sides = 32.5m

Anchors

Torsteel reinforcing bars 5.0 to 8.0m length, 25mm dia. were carefully placed preferably in vertical position in 40.0mm dia drill-holes. They were grouted using grout pump with cement sand slurry. Bottom plug was done after completion of anchor works. Total 15 No. anchors were recommended.

Condition - II

In this case, $k = 1.03$, $C2 = 0.15$, $C3 = 0.96$
 $l = 197.7\text{m}^4$, $r = 5.7$, $p = 264.9$ and $Kp - Ka = 12.6$, $r = 1.2$

Criteria - I

$$M/r (1 + a_1 a_2) - a_1 W = (-) 233.84 < 92.65 \text{ O.K.}$$

$$M/r (1 - a_1 a_2) + a_1 W = 763.6 > 92.65 \text{ O.K.}$$

Criteria - II

$$m M/I = 7.64 < 3(kp - ka) = 15.12 \text{ O.K.}$$

Criteria - III

Measures on foundation = $+ 43.5 \text{ t/m}^2$ (0.435MPa), $- 2.3\text{t/m}^2$ (0.023 MPa)

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EARTHQUAKE RESISTANT DESIGN AND CONSTRUCTION : BASIC CONCEPTS

Jitendra Kumar Bothara*

ABSTRACT

Numerous active faults traversing Nepal and its periphery make it highly vulnerable to earthquake hazard. It has been hit by four lethal earthquakes of different magnitudes which have caused more than 11000 casualties. 1934 Nepal-Bihar earthquake alone caused more than 8000 life loss in Nepalese territory. Big earthquakes of magnitude of 8 or even more on Richter Scale are expected in Nepal and its periphery of 150 km from its boundary. This is concluded by recent study conducted for Hazard Mapping and Risk Assessment of seismic zonation of Nepal.

Of course, earthquakes cannot be prevented but loss of life and property and disruption of community's social and economic fabric due to it can be minimized. Studies show that about 75% of fatalities and major property loss attributed to earthquakes are caused by the collapse of the buildings. The studies also show that major causes of building failure are wrong site selection, inferior construction material, poor workmanship and construction practices. Just by constructing earthquake resistant buildings, which require very minor additional investment, major life and property loss can be prevented. Design and construction of an earthquake resistant building requires a thorough understanding of the concepts behind it. This paper attempts to highlight the basic concepts behind earthquake resistant design and construction.

INTRODUCTION

Quality of construction is generally governed by local availability of construction material and technology, local climate, socio-economic factors and so on. Load bearing buildings with material such as clay, stone, brick, and framed buildings with timber, bamboo, reinforced concrete (RC) are prevalent in Nepal. Timber framed building are being absolute due to scarcity of timber where as RC framed building are gaining popularity, specially in urban areas. What ever be the structural system or material, appropriate seismic strengthening methods need to be incorporated in design and implemented in field for earthquake resistance. The method of strengthening naturally depends primarily on structural system and

materials used for the construction of building and secondarily on the technology that is feasible and economic. The paper presents basic concepts of effective earthquake resistant construction of masonry and reinforced concrete buildings.

CONCEPTS

The basic concepts are:

- The goal of earthquake resistant design and construction is only to have a fail-safe structure not a earthquake proof one i.e. damages during an earthquake is acceptable but not collapse.
- Earthquake force is not imposed by some external agent as it is an inertial force which depends on the weight of the building and acceleration of earthquake imposed by ground shaking on the structure. So, more the self weight more will be the earthquake force.

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- The earthquake resistant buildings are designed for much lower level of acceleration than that of any actually recorded one. The situation is quite contrary to the approach made in codes for other loads like imposed, live loads, impact effects, and pressure due to wind, water or earth. In all such cases the specified loads are usually higher than the actual one. Thus, design approach for earthquake is very different. In fact, it is based on probability of infrequent occurrence of large lethal earthquakes, energy absorption capacity and ductility of structure and its components.

While defining earthquake load for a building, the level of resistant is based on a concept of an acceptable risk. The objectives are:

- to resist minor earthquake and frequent earthquakes in life span of a building without any damage i.e., all parts of the building must remain elastic and the deflections should be small so that even the non-structural elements such as glass panels and partition walls remain undamaged.
- to resist moderate earthquakes which may be expected once in the life span of the structure without significant structural damage i.e., the structure may be allowed to under go yielding at some sections resulting in energy absorption in inelastic deformation. Even after an earthquake the building should be functionally efficient.
- to resist major or severe earthquake without major failure or collapse of structural frame work of the building or its components and maintain life safety.

Actually speaking, designing a building without any damage during moderate level of earthquake will be unacceptable because of economic reasons.

- Large earthquakes cause violent ground shaking, with simultaneous components in horizontal and vertical direction and are accompanied by rocking, twisting, and distortion of ground. The ground movement set-up forces in the structural elements of any building attached to the ground giving rise to complex stresses and deformation which cause disintegration of building components. It leads to significant damage or collapse of the building. So the major goal of designing and constructing a building should be to maintain its integrity and the building should behave like a box during severe shaking so that it will help in its survival.

- It is well established that the configuration of a building, size, plan and elevation shape, height, mass distribution, and so on has an important influence on its performance in a earthquake. Experience has shown that a building will have the maximum chances of survival in an earthquake if :

- it is symmetrical in plan and elevation
- it is without large offsets in plan and elevation
- small in plan and not elongated in plan and elevation
- the load bearing members such as walls and columns are uniformly distributed in plan
- the load bearing members are continuous, without offsets from roof to foundation i.e. load path is straight

- columns and beams are co-axial without offsets
 - large columns and small beams in plan are preferable
 - no principal members change sections suddenly
 - the structure is continuous (redundant) and monolithic as possible
 - good construction material is properly used.
- In moment resisting framed buildings columns should be stronger than beams. The logic is, it will compel formation of plastic hinge in beams rather than in columns. During severe earthquakes even if the beams fail it will be local type of failure compared to column failure which may lead to global type of failure.
- It has already been explained that the structures are designed for much lower level of earthquake force than that is actually generated because of economic reasons. Now, for survival of structure total reliance is placed upon its energy absorption capacity and ductility. For ductile behavior of the structure all the brittle mode of failures such as shear failure, anchorage failure, buckling failure, rocking effect and so on are to be suppressed by proper detailing, strengthening of structural members in shear.
- To have strong column - weak beam and strengthening of structural members in shear rather than in flexure (ending) Capacity Design Approach is preferred.
- Rigid floors or roof i.e. cast in situ RC slab or braced flexible floors help in better redistribution of horizontal force among horizontal force resisting members and in boxing of building. If pre-cast RC elements are used for floor or roof, a topping of RC should be provided over it.
- The behavior of buildings during past earthquakes exemplifies the adverse effects of soft soil condition. Even during 1934 Nepal-Bihar earthquake it was generally found that structures built on soft soil such as in Sanagaun and Bhaktapur suffered severe damage compared to similar buildings of Kirtipur. So during its design of a building such effects should be well considered.
- Considering the importance of the building and facilities in the post-earthquake scenario and consequences in case of their failures such as hospitals, schools, fire brigades, water towers and tanks, large halls such as cinema halls, assembly halls, communication facilities, structures containing hazardous materials are designed for earthquakes of longer return period. Higher level of earthquake force is considered so that these would be functional even after a severe earthquake.
- At last, it should be well remembered that a structure behaves as it is constructed not as it is designed. The random vibration associated with an earthquake subject structure to large scale field test. As a result, poor construction collapse, weak ones suffer damage to a large extent, strong ones get away minor damage and exceptionally sound constructions remain intact. Since all parts of the structure are shaken, weak links cannot escape damage. They fail first and lead to over stressing of stronger parts there by compelling them to failure.

SUMMARY AND CONCLUSION

- Earthquake is not an externally applied load like other loads.
- The present design approach against earthquake is based on fail-safe concepts.
- Assumed earthquake force in design is much lower than actually generated. For safety under severe shocks, the structure must possess adequate ductility.
- Building configuration, size, plane and elevation shapes, height, mass distribution and construction materials play an influential role in the seismic performance.
- Important buildings should be designed for higher earthquake force to reduce seismic risk.
- Foundation soil plays multidimensional role in seismic behavior of building so it needs due consideration.
- To avoid weakness in a structure, detailing in design must be thorough and quality of construction should be maintained high to avoid the creation of weak spots.



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AN INEXPENSIVE SOURCE OF ENERGY : WASTAGE FROM BIOMASS AND RESIDUES

Sarita Poudyal*

INTRODUCTION

Utilization of agricultural residue as a source of energy is one of the very common and simple processes, but has a remarkable variation depending on the level of development of the country. Many of the developing countries have their basic needs of energy, which are fulfilled by the Biomass; as fuel-wood, animal waste or the crop residues. But in highly developed countries only a small fraction of such energy has been utilized. So the variation may be from 1% in developed countries to 80% in developing countries.

The wastage from Biomass i.e. agriculture and Agro-Industry provides an inexpensive source of energy and effectively low sulphure content fuel; having reducing chances of

environmental pollution. Extensive utilization of these will compete with the demand of food; and which are concerning with extensive utilization of biomass wastes.

To meet with the growing demand of energy, some traditional resources of energy are being used which are

- Plantation of high energy value crops. e.g. sugar and starchy crops, fast growing trees etc.
- Utilization of aquatic plants, oils and hydrocarbon crops.
- Getting energy from rural and municipal sewage and solid wastes.

Given below is the simple sheet flow diagram of biomass conversion:

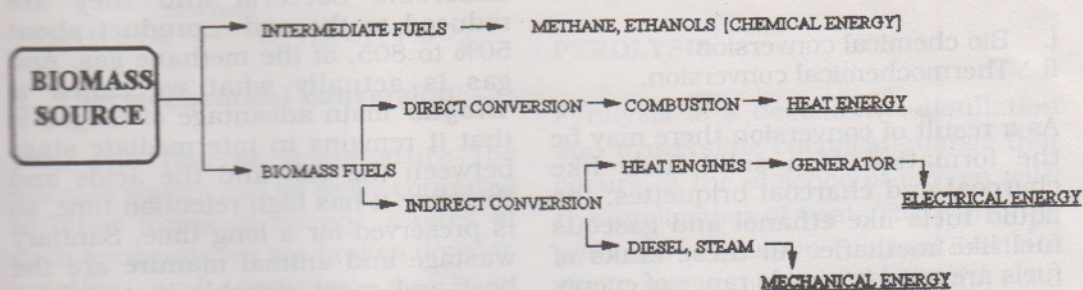
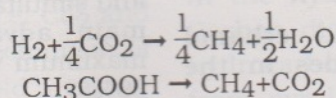


Fig. 1: Conversion of biomass into different kinds of convenient fuels.



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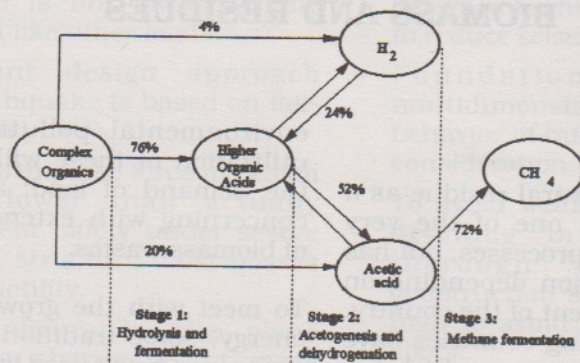


Fig. 2: Steps in the anaerobic fermentation process, with enter flow represented as percent COD.

Above diagram shows that each and every kind of energy conservation is possible from Biomass conversion. Namely chemical energy. Heat energy, Electrical energy and Mechanical energy.

The energy conversion from the biomass can be mainly divided into two different kinds.

- Bio chemical conversion
- Thermochemical conversion.

As a result of conversion there may be the formation of a solid fuels like charcoal and charcoal briquettes; the liquid fuels like ethanol and gaseous fuel like methane. All these kinds of fuels are used in a wide range of energy conversion devices, to satisfy the different kinds of energy needs.

i. Bio chemical conversion

Anaerobic digestion and ethanol fermentation both includes in the biochemical conversion.

Anaerobic biochemical process occurs

with the decay of organic solids which is then converted to methane, hydrogen sulphide and hydrogen gas. The organic solids converts into their soluble salt by the enzymatic action and hydrolysis into their soluble salt are then converted into short chain acids and alcohols and oxygen present in these acids and salts are used by anaerobic bacteria and they are reduced to the end - product about 50% to 80%, of the methane gas. And gas is actually what we called is '**Biogas**'. main advantage of Biogas is that it remains in intermediate stage between the salt and the acids and therefore it has high retention time, so is preserved for a long time. Sanitary wastage and animal manure are the best and most suitable material for ANAEROBIC DIGESTION.

Thus the anaerobic digestion is of the effective device for pollution control and simultaneous supply of energy. Its main advantage is that it used maximum water content Biomass i.e. 99%.

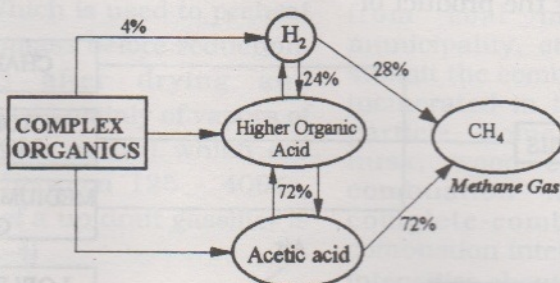
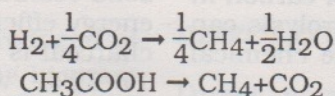
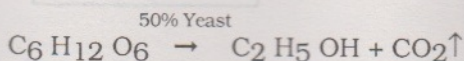


Fig. Anaerobic fermentation process.

The biogas formation is available even in a small units. The residue that comes from biogas formation has a fertilizer value and can be used for crop production.

Ethanol formation is another type of biochemical process; where the cane sugar are converted to ethanol without a significant loss of energy.



ii. Thermochemical conversion

With the rise of temperature the biomass wastes can be easily converted to other forms of energy. wastes at such temperatures are broken down to smaller and complex units of molecular which may be the gases, liquids or including some solid products combustion actually means a complete oxidation of carbon to carbon dioxide and water. i.e. CO_2 and H_2O . So the controlled mechanism of this simple process can yield a variety of fuels. The mechanism can be controlled by a limited supply of

oxygen a specific combination of temperature, pressure and various type of catalyst which can carry out a partial break down in the conversion process.

The are different kinds of thermochemical approaches in biomass. Such as *Pyrolysis; Gasification; Combustion and Biomass Liquification*.

PYROLYSIS

Pyrolysis is a destructive distillation and irreversible chemical change that occurs in the absence of oxygen with the application of heat. Therefore, the pyrolysis process in Biomass leads to the formation of gases, liquid and solid residue.

The component of the gas i.e. Pyrogas in the hydrogen, carbon monoxide. Carbon dioxide, methane and other hydrocarbons. The liquids result out from pyrolysis are methanol, acetic acid acetone, water and tar.

The solid residue consists of carbon in the form of charcoal. So pyrolysis can be concerned as a valuable chemical and industrial feed-stock.

Now a days numerous technologies have been developed for the product of

solid residue by pyrolysis. Where the energy efficiency for the production of charcoal is supposed to be in order of 17-29% while theoretically the efficiency is as high as 40% could be achieved.

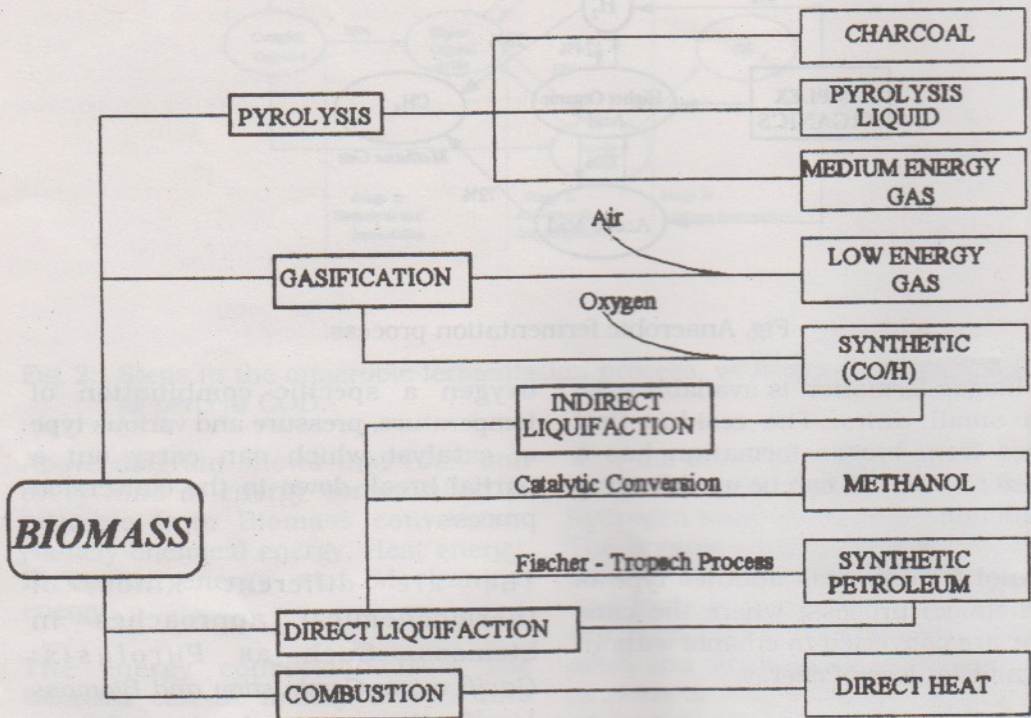


Fig. 2: Thermo - Chemical biomass conversion processes.

GASIFICATION

The process of changing of biomass-waste lower or medium range energy gas with the use of oxidant is called gasification.

When the gasification is done with the limited supply of air then the process is called *air gasification*. The air gasification is one of the *partial combustion* of biomass and the process is very simple cheap and reliable.

Only one draw back of air-gassifier is that, it produces the gas which has low calorific value because it is diluted with Nitrogen. Therefore, gas has no economical value.

But despite of atmospheric air gassifier. The oxygen gassifier using pure oxygen - produces the gas which has high energy content. Thus has high calorific value. But this is highly expensive process because of the demand of expensive oxygen gas plant.

In a gassifier the air is introduced at the bottom of the bed of the biomass in a hearth; and the gas produced in the hearth is usually with low temperature. Which is used to preheat and dry the biomass before reduction. The products after drying and preheating consists mainly of vapors of liquids (water oils or tar) which are condensed in between 125 - 400≤c. Simple outline of a up draft gassifier is given below (fig.-4)

DIRECT COMBUSTION

Direct combustion of biomass is carried out for high demands of coals. A large number of wastes 1.2 wastes from coal mine, wastes from municipality, etc. ate the organic to submit the combustion. These are also incinerated in thidized beds of sand particle. Some examples and Rice husk, wood chips of 2cm≥. The combustion is thidized bed is complete-combustion and high combustion intensities. Which has the intensities about upto 500kg/m-m².

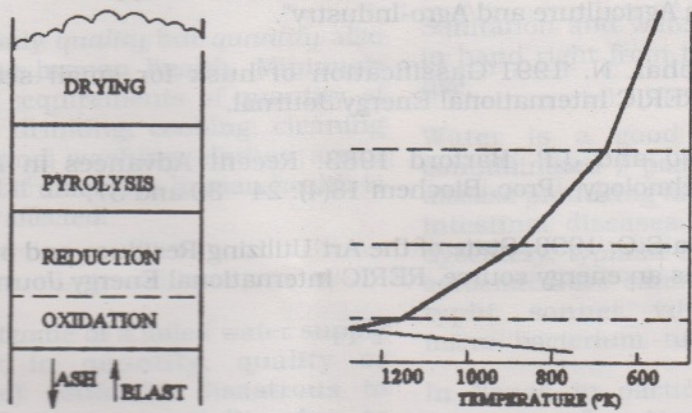


Fig. 4: Processes Occurring in Gasification reactions with Corresponding temperature profile.

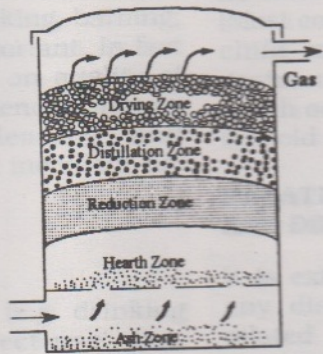


Figure-5 : Schematic of an Updraft Gasifier.

CONCLUSION

On the observation and from above discussion a rapid development of the technologies for the Biomass-conversion of agricultural and agro-industrial wastes are needed. The methods to diversity the biomass resource base has to be made in

conjunction with the use of developing and emerging technologies of conversion.

The emphasis must be given to the more efficient equipment and technologies for energy utilization.

□□□

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Fig. 4: Processes Occurring in Gasification reactions with Corresponding temperature profile.

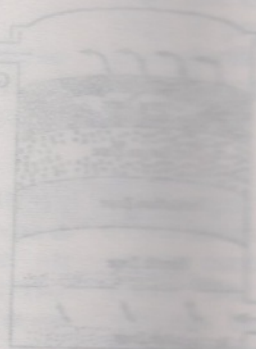


Figure 5: Schematic of an Updraft Gasifier.

DRINKING WATER QUALITY AND IMPLICATION ON HUMAN HEALTH

Dr. Naresh Chandra Saxena*

The topic 'Drinking Water Quality and Implication on Human Health' can be conveniently studied by using *kipling's* seven serving couples - what and what not, why and why not, when and when not, where and where - not, who and who-not, whom and whom-not and how and how-not. The following norms are also implied in the study.

Norm-1

It is not only *quality* but *quantity* also affects the human health. Minimum standard requirements of quantity of water for drinking, cooking, cleaning bathing and washing clothes are a must and if deficiency human health is adversely affected.

Norm-2

Worst outcome of a failed water supply (whether in quantity, quality or otherwise) could be disastrous to human beings - mortality due to epidemics.

Norm-3

Quality of drinking water alone is not sufficient but that of cooking, bathing, sanitation is equally important. In fact human health depends on quality of 'Water for personal hygiene (drinking, cooking, bathing, cleaning and washing clothes etc. all included; i.e. household uses.

Norm-4

Water is of 'direct-use' (e.g. drinking purposes) and 'Indirect-use' (i.e.

bathing, cooking, sanitation and washing clothes etc.) Direct-use water must have higher and better quality standards than Indirect-use and hence there could be separate supplies to the consumers. However, it is neither financially nor functionally feasible to have either separate quality standards or supplies.

Norm-5

Sanitation and water supply go hand in hand right from treatment till final use.

Water is a good carrier and in contaminated / polluted state carries disease producing bacteria and usually intestinal diseases such as cholera, dysentery, typhoid etc. Drinking water epidemics are caused by salmonella-typhi, sonnei, vibro-cholerae and micro- bacterium -tuberculosis.

In Nepal, in particular, inadequate access to safe water supplies combined with sanitation conditions, domestic and personal hygiene practices are the factors preventing improvement of health conditions. The leading illness in almost all districts are diarrhoea (Most common cause for under 5 years child mortality each year), severe gastroenteritis and cholera epidemic which occur each year. Hepatitis A and typhoid are on the rise.

RELATIONSHIP BETWEEN DISEASE AND DRINKING WATER

It is extremely difficult to prove that any disease outbreak is due to or related to drinking water. To find the exact reason(s) of the disease outbreak requires exhaustive clinical, epidemiological and laboratory studies

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over a long period. Disease manifesting period is very long. Even though some relationship has been mentioned from the old times of hippocrates in indicating marshy places with fevers, scientific explanations were lacking. Attempts have been made to prove drinking water connection by compiling the findings of several scientists and medical authorities who have done their research/investigation in different countries for years. Following are the concluding remarks with brief description :

It is confirmed by scientific observations worldwide that cholera is a water-borne disease and only effective means of cholera control is to require a *protected* water supply for all household uses.

Reports from USA and Libya confirmed the outbreak of gastrointestinal illness-*giardiasis*-attributed to *giardia-lambia* where drinking water was the source of infection. Outbreak of gastrointestinal illness is also caused by a virus serologically related to *norwalk* virus and termed *viral-gastroenteritis*. The average daily consumption of one or more glasses of water is strongly associated with this disease, that is drinking water is a source of illness.

Reports from India and Libya epidemic of viral hepatitis was water borne and also virus causing epidemic might be another human hepatitis virus whose mode of transmission be fecal-oral.

Outbreaks of enteric disease in Sweden *campylobacter enteritis* caused by *campylobacter-jefuni* usually resulted from ingestion of improperly cooked food, unpasteurized milk and drinking water. Municipal water, somehow got into water mains, was implicated as the vehicle of transmission.

Legionellosis (leading to pneumonia)-a pulmonary disease- outbreaks in Italy, were commonly associated with cooling towers, evaporative condensers, shower heads and tap water caused by a pulmonary pathogen *legionella-pneumophila*. The study revealed that the pathogen is frequently found in water storage/distribution systems and taps or showers.

Mycobacterium-xenopi is another pulmonary pathogen causing pulmonary disease that is frequently isolated from tap water, especially hot water taps. It is similar to *legionella-pneumophila* in that it is found in incoming water mains and it survives well at 45 C.

In all pulmonary disease cases level of contamination is important because not only compromised individuals but healthy individuals were also susceptible to infection.

HOW WATER AFFECTS DISEASES HENCE HEALTH

Water affects diseases and consequently human health in many ways. For example, *sparganosis* is the infection of subcutaneous tissue caused by the larvae of a tapeworm of the genus *spirometra*. Swimming larvae are usually consumed by a microscopic crustacean of the genus *cyclops*. The drinking of untreated water that contains *cyclops* usually results in the migration of the larvae through the intestinal wall and into the subcutaneous tissue.

Two types of particulates can occur in tap water and stimulate microbial regrowth. These particulates are the result of corrosion and particulates in the raw source water not removed by treatment. Stimulated microbial regrowth appeared to be related to surface areas of particulates, rather than the organic nutrients that may

be in or on the particles. In low-usage residential area, the particulate-associated coliforms may not be detected when sampling from taps. Also, pipe corrosion changes quality of water and makes it *dangerous* for drinking and other purposes besides imparting colour, odour and taste. Hard and soft water produce corrosion and corrosion related disease. Soft water dissolves lead and becomes dangerous to health.

Human beings are also responsible for some epidemics discharges of patients (suffering from diseases) when somehow enter water, bacteria are further carried and spread to public causing spread of diseases. Most important water borne bacteria responsible for such diseases are *S. typhi*, *S. paratyphi*, *shigella* dysentrial and *vibrio cholera*. The feco-oral infections are worldwide where fecal material from one person enters the mouth of the other. Feco-oral infections are transmitted by water borne route (particularly in epidemics), contaminated food, utensils, hands and even clothes. Most common diseases due to feco-oral infections - cholera, typhoid and diarrhoea - are prevalent among poor and young children causing widespread malnutrition and heavy burden on health services.

High nitrate concentrations encourage the formation of *nitrosamines* which may increase the incidence of gastric cancer. Nitrites and amines both commonly occur in food and may combine to form nitrosamines in the stomach. This reaction is encouraged by nitrate concentrations in water of 50 to 100 mg/litre (as nitrate). The implications for water supply planning are obvious.

The question, why an engineer is in the centre of a complex discipline with

a variety of issues, is itself complex. First of all an engineer is not *traditionally* trained for environmental health problems for the poor in developing countries. On the medical side, diseases of the poor in hot climates are very different from the diseases of the rich in temperate climates and the engineer *must understand* these diseases to do the job properly. The economic scene is also radically different and the engineer, in a developing country, must have a fundamental grasp of the economic climate in which he has to work. Social and Institutional problems are of utmost importance and It is necessary that projects are designed in the full knowledge of the institutional and social context in which they will be carried out.

A high degree of interdisciplinary collaboration is, therefore, necessary requiring the participation of engineers, doctors, biologists, economists, anthropologists and others. At the same time, broad range of skills and abilities shall be needed to do the needful.

An engineer, in order to apply engineering methods for improving community health, must understand

- (i) community health
- (ii) infectious diseases which are the principal causes of ill health in developing countries
- (iii) how to modify human environment so as to prevent or reduce the *transmission* of infectious diseases
- (iv) classification of infectious diseases according to environment which he can change rather than conventional generic or biological taxonomy classifying according to the nature of pathogens - the organisms which cause them.

Water-virology (study of viruses in water) is a recent phenomenon, progress has been rapid and knowledge continues to accumulate apace worldwide. The importance of virus related diseases is because antibiotics are *ineffective* against virus and the treatment when necessary is only supportive - an important medical consequence. Many viruses are resistant to both environmental stress and disinfection. The characteristics of viruses which cause problems in the supply of drinking water therefore are :

- (i) their resistance to inactivation and disinfection,
- (ii) their lack of correlation with established bacterial indicators of fecal pollution, and
- (iii) their ability to infect at low concentrations.

The problems are enhanced by a lack of simple test for the presence of pathogens, and also by the frequent absence of clear epidemiological evidence of their presence in contaminated drinking waters.

The spread of virus is *typical* and is determined by the 'minimum-infective dose' (i.e. number required to establish an infection) which could be as little as one virus particle in a susceptible person. This contrasts with the several thousands required in many bacterial diseases. If the dose can be so small then it implies that any level of viral contamination in drinking water must present some risk, i.e. it is reasonably certain that waters in which viruses can be demonstrated can cause infection.

For the future, it can be hoped that the epidemiological relationship between virus levels in potable water supplies and any resulting infection

within the community will be fully understood, thus leading to a rational basis for setting limits on the concentration of virus in water.

CONTROL

It is a pertinent question as to who is responsible for water-health system. While three governing bodies-legislature, executive and judiciary have their own role, media cannot be ruled out. Political commitment or will should give rise to meaningful policies because ad hoc control mechanisms do more harm than good. Policies are translated into plans and programmes creating necessary awareness in the masses. Education, community participation together with responsibilities are among the control parameters.

Water-supply planners are mostly aware of most of the problems but they tend to forget. Progress in new fields of water supply must precede introduction of legal controls and standards but legislative authorities seem to adopt a wait and see attitude. Financial cut backs do not help. Authorities are reluctant to spend money on any subject *not vital* and may confine to activities solely dictated by legislation.

Water industry must work with medical authorities to understand health effects better. In case of possible contamination/pollution water authorities should warn district administrators and health authorities and should ensure protection / treatment / solution of the problem.

People at the receiving end are not supposed to be responsible for hazard free water supply, even though community participation is desired now-a-days. There is a limit upto which people can be involved but

because of their limited skill and training, wholesome water-supply will remain doubtful.

DRINKING WATER CHEMISTRY AND HEALTH

The health problems related to chemical, as opposed to microbiological composition of water are different in the sense that chemistry of water can lead to diseases which are not infectious and are prevented simply by adding deficient chemical or removing harmful chemical. Water chemistry and disease may be considered under three headings : the absence of necessary chemicals, the excess of harmful organics and the excess of harmful inorganics.

The absence of Iodine and fluoride is discussed as follows. There seems to be some relationship between water softness and cardiovascular disease i.e. populations using *hard water* (containing carbonates and sulphates of calcium and magnesium) have a lower incidence of cardiovascular disease.

In general, it is suggested that the presence of THMS (*trihalomethanes*-especially chloroform) and most other organic pollutants in drinking water is of *negligible* public health importance. Even though some organic compounds are either *toxic* or *carcinogenic* (cancer producing). They occur in very small concentration (less than 1 microgram/litre) and do not have any specific health effects.

Inorganic chemicals are more harmful than organic ones. A number of *metallic ions* (e.g. antimony, arsenic, boron, lead, tin, mercury etc.) cause metabolic disturbances by upsetting the production and function of certain enzymes or to cause toxic effects.

A typical problem is effect of salt in ground water (chlorides and sulphates) which makes it unpalatable and so leading people to use surface water which is likely to be bacteriologically polluted. High doses of these salts make water laxative. High intake of sodium (usually sodium chloride) is linked with high blood pressure. Some details follow :

Lead-poisoning - lead and soluble salts of lead cause poisoning. Regular use of water with greater than 0.3 to 0.5 ppm lead leads to lead poisoning. It is also caused when a person is exposed to dust of lead or its compounds or fumes of hot lead. According to IS-4312-1967, "when lead and lead compounds are taken for considerable length of time in small doses specially in case of oxides and carbonates, chronic lead poisoning is observed" Only a fraction of ingested dose is excreted and the remainder is left in tissues, mainly in bones, until finally the amount retained in the body produces toxic symptoms. In fact lead is a cumulative poison. Chronic lead poisoning causes pain in abdomen, constipation, loss of appetite and thirst etc. Since lead pipes and lead joints in water distribution introduce lead, they are not used in water-supply these days. According to US standards lead less than 0.05 mg/litre is safe for drinking water.

Goitre - is a disease caused due to *shortage of Iodine* in water. If water is derived from underground limestone regions, there is always a deficiency of Iodine in water. Some Iodine must be added to water artificially.

Mottled enamel or staining of teeth- is a disease of teeth and is more pronounced in growing children. It is due to presence of excessive (more than 1.5 ppm) *fluorides* in water. It is important to note that shortage (less

than 1ppm) of fluorides is also harmful to good teeth development. Best range for fluorides in water which is harmless and desirable is 1 to 1.5 ppm (or less than 0.8 to 1.7 mg/litre, US standard). Fluoride concentrations over 4 mg/litre cause stiffness and pain in joints and skeletal deformities.

IRON RELATED

Excess iron in water is very harmful for blood pressure patients. Iron is usually associated with manganese having same ill effects as Iron.

Presence of Iron in water should be less than 0.3 mg/litre and of manganese less than 0.05 mg/litre according to US standards.

Nitrate Concentration - Nitrate concentrations are tending to increase sporadically in surface and ground water due to more intensive agricultural practices (nitrogenous fertilizers etc.) and the increase in population upstream of water supply intakes.

The risk is infantile methaemoglobinaemia (a serious blood condition) which affects young bottle-fed babies and which can be fatal if the baby is not supplied with low nitrate water. Babies are susceptible in the range 50 to 100 mg/litre (as nitrate) There is justification in the policy that water authorities may warn district administrative and health authorities where nitrate concentrations in water supply exceed 50 mg/litre and to ensure that babies are provided with alternative supplies of water if nitrate concentrations in water supply should exceed 100 mg/litre. (Nitrates are reduced in the body to nitrites causing serious blood condition).

High nitrate concentrations (50 to 100 mg/litre as nitrate) also encourage formation of nitrosamines which may increase the incidence of gastric cancer.



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IMPROVED MANAGEMENT FOR FOOD SELF SUFFICIENCY

Dr. K. R. Sharma*

Worldwide, 69% of the freshwater is used for agriculture, 23% for industry and 8% for domestic use. For Nepal, domestic and industrial water uses account only for 4% and 1% respectively and 9% of the total water use is in the irrigation sector. Projected figures for population indicate that the present population of about 19 million in the country will increase to 35 million by 2025. With this increase in population, the demand for water for drinking, agriculture, industry, power generation and other uses will continue to increase in the future. The water requirements for hydropower generation are difficult to estimate, however, all large-scale hydropower generation plants require large quantities of water. The increased demand for water for different sectors will have to be met by proper planning and the lion's share presently proportioned to irrigation will have to be reduced to a level as low as to the global average.

With this scenario of the water demand, the food production and demand outlook should be reviewed. Nepal as a whole is a food deficit country and it is projected that a two-fold increase in food production will be required in the country by the year 2025. For several reason the rate of increase in food production is less than anticipated. First, the area actually irrigated is much less, the cropping intensities are low. Secondly, large areas continue to be planted to traditional low-yielding varieties. Also, the appropriate management technologies are not easily available. We are badly managed even in producing and distributing chemical

fertilizers.

So far as the resource use and food supply situation is concerned, the country is at a cross road and the question arises whether we should continue buying food or improve our management? Naturally the answer is that we should improve the management system.

We therefore should now have a vision for improving our management. How are we going to do this? Where shall we start? What will be our implementation approach? Are we really committed for improvement? These are some of the questions the politicians and the planners should ponder.

Coming back to the growing demand for water and the country's food supply situation, it is for sure our reliance on irrigation are increasing. As we can not expect to have more share of water in irrigation at the cost of power generation, industrial use and domestic supplies, the only alternative left before us is again to improve our management - this time the management of our water resources. In other words, we have to produce more food grains with the less use of irrigation water.

Little is known about water management requirement or about the effects of water shortage on food grain crops. Due to limited water supply in the source of many irrigation systems, especially in the non-rainy seasons, expansion of irrigated areas in existing irrigation system must come from savings derived from good water management. For this water efficient technologies already developed by

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researchers and farmers could be very useful. The prevailing trends of building physical infrastructures rather than doing the more difficult training of system personnel and of farmers need to be adjusted. The following approaches of producing food-grain should be considered :

The first one is the physical infrastructure approach. This requires the establishment of irrigation system facilities. The approach focuses on converting rainfed land to irrigated one and the rehabilitation of existing irrigation facilities. This helps in extracting the potential of land and water resources. As most of the easily tappable water sources have almost been diverted, the need is to go for more expensive sites. In a cash poor country like ours this option is relatively less feasible.

The second approach is through the selection of genetic varieties and improved cultivation techniques at the field level. For example, the irrigated rice and wheat yield potentials can be increased by 30 to 40%. This is the biological approach to increasing agricultural production. There is tremendous potential in this aspect.

Another approach is the improvement of irrigation system management costing a nominal amount as operation and maintenance expenses per hectare per year. It can result increased output of about 1.5 ton per hectare per year. This is the irrigation management approach for growing more food.

Given these approaches, a combination of the three approaches is required for meeting future food needs of the country. Among the three, management is the most indigenous portion of the whole technology in the entire process and certainly we can achieve a lot by improving our management.

Technology, professionals and farmers are the prominent factors and they should be made to go hand-in-hand for a good managerial approach. To start with we need a management revolution for the irrigation sector and gradually this should encompass the whole agricultural sector for the increased agricultural production. In our neighboring countries the green revolution was in fact a management revolution for the agricultural sector. Production inputs management like improved seeds, fertilizer, pest control and water was introduced as a package there. As a result, China and India are self sufficient in their food grains requirement.

Usually, obtaining a reliable water supply from the system is a major problem and farmers have limited freedom in on-farm water management until the water supply situation is solved first. This issue so far has not been adequately addressed.

In the Agriculture Perspective Plan (APP) which the Government has approved much emphasis has been given to the exploitation of our ground water reserve. There are reports indicating that 90% of the Terai area under cultivation can be irrigated by ground water. The shallow tubewells are taken as the remedy of our outstanding problems. If this is taken as a breakthrough one shallow tubewell will have to be installed at an interval of every 164 m. If this should be implemented, questions can arise regarding its sustainability in terms of technicalities in the indiscriminate use of ground water, the availability of the pumps and other equipment in the country as well as the operation and maintenance costs that will be incurred.

The best approach would have been to go for balanced use of both surface

water and ground water. This will avoid the overuse of ground water which can be used as an insurance against droughts and dry spells. Moreover, a clear and sustainable ground water right should be established by the state before developing the irrigation infrastructure. Installation of tubewells incompatible with the water right and local management capacities is bound to create conflicts among the users on one hand and between the beneficiaries and the agencies on the other.

Questions have been arising on the sustainability of our irrigation systems which have been already developed. This is the outcome of the dependency syndrome created due to the lack of farmer participation during the system planning and development. Clear and recognized management responsibility and authority is lacking. For an efficient management adequate financial and human resources are essential and this aspect has been overlooked. Accountability for management should commensurate with incentives. This should be on an institutional basis rather than on the individualistic approach that is generally followed.

In a wider scale our production systems and irrigation infrastructures are under performing because of the issues raised above. Over and over again capital investments have been made in various forms of rehabilitation and maintenance as a remedy to the problems. Farmer participation, capability build up, generation and mobilization of resources have come as slogans without giving due regard to local management. In the name of people's 'participation' much is expected from poor farmers. Have we ever analyzed, how long a farmer is engaged in his farm to make the living

of his family? What time and money can he really contribute to the agency sponsored local participation? How capable is he and how far can he improve? Do farmers perceive the problems the same way the agencies perceive? What will be the processes to make the farmers' association viable ones? These are some of the questions the planners should take into account while establishing a sustainable management continuum.

The policy makers should sometimes imagine themselves as farmers. Consider, for an example, an irrigation system. The farmers are told by the Government officials that management of the system is to be turned over to them. The Government will rehabilitate the system and they too have to shoulder the expenses. The farmer is not fully convinced because he does not have faith on the Government officials. In such a situation what is required is a convincing answer. The farmer will have water supply to the system and to his farm during the time of need. He will be asked to pay water fees provided he gets water in his fields and equity will be maintained to avoid disputes. Improved water allocation and distribution in the supply canals could improve water use efficiency in the system as well as water distribution equity among farmers. In most irrigation systems, however, management improvements can be made by avoiding inadequacies in terms of design and institutional building.



EFFECTIVENESS OF SUB-SURFACE DRAINAGE FOR STABILIZATION OF LANDUSE**

(A CASE STUDY OF LANDSLIDE AT KM 83+600 OF ARNIKO HIGHWAY, NEPAL)

T. L. Adhikari*

SYNOPSIS

In this paper, a case study has been presented to highlight the effectiveness and importance of surface, near-surface and deep subsurface drainage for the stabilization of active landslide at km 83 + 600 of Arniko Highway. The calendar of landslide covering an area of about 3 hectares, indicate its triggering due to indiscriminate realignment of washed out section road in 1987, design in 1990, construction in 1992/1993, intensive maintenance in 1993 and normal routine maintenance since 1994. Extension of the applied methodology for investigations, monitoring, analysis, design as well as cost effective stabilization techniques might prove useful for treatment of similar instabilities in the Himalayan range.

ABBREVIATIONS

- AHRP - Arniko Highway Rehabilitation Project
ARE - Assistant Resident Engineer
CHRP - Charnawati Rehabilitation Project
DOR - Department of Roads
GLOF - Glacier Lake Outburst Flood
GWT - Ground Water Table
HDP - High Density Polyethylene
ICB - International Competitive Bidding
RE - Resident Engineer
RFRP - Road Flood Rehabilitation Project
SDC - Swiss Development Cooperation
IDA - International Development Agency
etc.

INTRODUCTION

The landslide area at km 83 + 600 of Arniko Highway is among ten most severe spots treated under IDA funded road flood rehabilitation project. The landslide covered an area of approximately 3 hectares most of which used to be cultivated paddy field. The landslide before treatment was in a stage of moderate activity.

Arniko highway is generally aligned along the right bank of Sunkosi river. Sunkosi corridor is characterized by numerous instabilities, landslides, gully erosions, debris flows, fan depositions and other transient morphological features. Sunkosi river is known from frequent occurrence of devastating flood events and GLOF's. Major flood incidence were observed in 1964 and 1981.

The landslide area considered in this paper falls under stretch km 82 + 600 to km 83 + 700 where a substantial length of highway was washed out. Subsequent to the devastation in July 1987, the sector of Arniko highway between Lamosangu (km81) to Barhabise (km 7) was under taken by royal Nepalese army for emergency reopening of road as a crisis management operation. The 1.5 km road stretch was realigned further up beyond the eroded bank. The realignment of road was in the form of full cut realignment passing along marginally stable colluvial slope. The stretch is characterized by saturation, high round water table and acute ground water activity. Following the realignment of highway, the landslide area propagated further uphill side

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finally affecting an area of about 3 hectares. The composition of debris is made up of angular boulders of phyllite and schistose phyllite with silty matrice.

Emergency reopening of road was completed in 1988. Preliminary reconnaissance surveys, investigations and conceptual schemes for treatment of the instabilities was carried out under assistance of SDC in 1989 in connection with Arniko highway rehabilitation project, master plan studies. Further investigations, studies, design, construction and monitoring works were undertaken under IDA funded road flood rehabilitation project between 1990 and 1994. The paper mostly deals with activities undertaken during the road flood rehabilitation project.

INVESTIGATIONS

Various investigations including geophysical and subsurface exploration as well as producing piezometric monitoring were conducted at the site in order to obtain information necessary for subsequent analyses and stabilization designs. The activities are succinctly described in the following paragraphs.

ENGINEERING GEOLOGICAL STUDY

Engineering geological survey was carried out under AHRP studies in 1989. The survey was based on the base line traverse between Dhulikhel (km 30) to Kodari (km 114) with necessary extension using meridian compasses and topofils, where required. The field survey was limited to a band of 50 m on either side of road centre line.

Detailed engineering geological study was made in connection with RFRP studies. The survey was based on

control and detailed topographical map prepared under the project.

GEOPHYSICAL STUDY

Geophysical survey was conducted using two different approached: Electrical resistivity method and Seismic refraction method. A number of lines were surveyed.

The interpretation of the geophysical data was carried out using manual as well as computerized approaches. The calibrations of such data was made through correlation study with the bore log prepared during AHRP studies. The profiles obtained from geophysical study are depicted in Fig. 5. Two layers of soil were interpreted.

GEOTECHNICAL STUDY

Geotechnical study to characterize rock and strength and other parameters was carried out to some extent during the AHRP studies. Some additional geotechnical investigations at field as well as at laboratory was necessary to acquire necessary data for design conceptualization, option study and detailed design purpose.

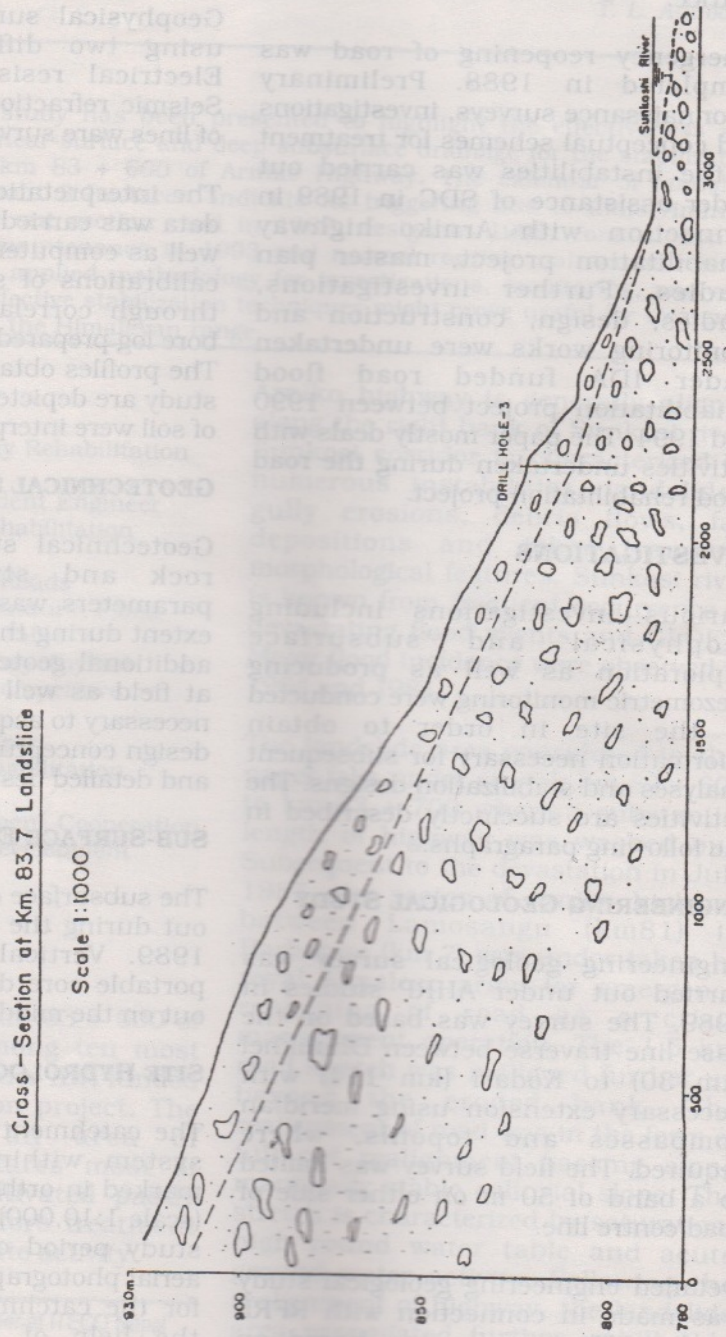
SUB-SURFACE EXPLORATION

The subsurface exploration was carried out during the AHRP study period in 1989. Vertical core drilling using portable core drilling rig was carried out on the middle of the landslide.

SITE HYDROLOGY

The catchment area for the drainage system within the landslide was marked in orthophoto contoured map (scale 1:10,000) prepared during AHRP study period on the basis of stereo aerial photographs. The characteristics for the catchment was studied with the help of orthophotomaps and

Fig. 5: LANDSLIDE AT Km 83+600
SEISMIC REFRACTION PROFILE



Cross - Section at Km. 83.7 Landslide

Scale 1:1000

helicopter photography (scale approx. 1:2,000) prepared in 1989. The data related to temperature, rainfall etc. were taken from the nearest meteorological stations at Barhabise, Chautara and Thokarpa. The data for infiltration, interception etc. were judged on the basis of catchment characteristics.

TOPOGRAPHICAL SURVEY

The base line traversing between Dhulikhel (km 30) to Kodari (km 114) was carried out in 1989 in connection with AHRP studies. The traverse was established to achieve an accuracy of third order geodetic control work. The same network was applied for the preparation of orthophotomap (Scale 1:10,000) of the entire road corridor including that for Lamosangu-Jiri road. Further topographical survey under RFRP in 1990 was based on the traverse net established earlier.

In addition to the topographic detailing a number of cross sections and profiles were also surveyed for the purpose of stability analyses and stabilization design.

LANDUSE PATTERN

The land-use pattern was required for catchment characterization as well as for assessment of land acquisition needs. The summary of the land use pattern is as shown below:

Irrigated paddy terraces	-	30%
Dry cropping terraces	-	30%
Barren landslide	-	25%
Thin forest	-	10%
Gullies	-	5%

ANALYSIS

Manual as well as computerized techniques were applied for the stability analysis of the landslide slope.

Simplified models such as infinite talus slopes, Hoek and Bray chart solutions etc. were applied for rapid assessment of severity of the slope stability and for judging of sensitivity with ground water table condition. No deformation and seismic analyses were carried out as low cost solutions were encouraged.

BACK ANALYSIS OF SLOPE

Exact determination of effective soil strength parameters in-situ was difficult using small scale laboratory apparatus. The friction angles determined on disturbed and sieved (below 4.75mm size) sample indicated much smaller values of soil friction angles than those apparent in the field. The soil classification on the basis of sieve analysis was found to be sandy gravel to sandy-silty-gravel. The field assessment of friction angle was found close to that of angular gravel. In order to overcome the incompatibility, back analysis using field safety factor of 1.0 was carried out to reassess the soil strength parameters at field condition through iterative approach with softwares for most probable GWT conditions.

The results from back analysis were in conformity with the parameters of angular gravel and therefore these values were used for the stabilization designs.

SENSITIVITY OF SLOPE STABILITY

Having arrived at the acceptable values of effective soil strength parameters, four types of sensitivity analysis were carried out to assess the behavior of slope under various conditions. Such analyses were carried out with respect to variation in soil strength parameters, variation in ground water table, forces attributed by the proposed support structures such as anchors and effect of flattening. The sensitivity analyses are briefly presented below:

Sensitivity of Slope Stability with Variation in Soil Strength Parameters

As discussed earlier, the soil strength parameters from different assessment techniques were quite different. It was therefore necessary to assess the effect of such variation in the stability factor to the existing slope. The results from this exercise are tabulated below:

Soil Friction Angle (deg)	Factor of Safety of a Probable Slip Surface
40.0	1.29
37.5	1.18
35.0	1.08
32.5	0.98
30.0	0.89
27.5	0.80
25.0	0.72

Sensitivity of Slope Stability with Variation in Ground Water Table

For the purpose of sensitivity analysis with ground water table, variation of ground water table was made from ground surface to depth of 10 m. The result from the sensitivity analysis are as depicted below :

Depth of Piezometric Level (m)	Factor of Safety of Probable Slip Surface
- 1.0	0.697
- 2.5	0.874
- 5.0	1.136
- 7.5	1.350
10.0	1.497

Sensitivity of Slope Stability with Variation in Support Anchors

Considering the possibility of use of anchored structures for the stabilization of the landslide, the sensitivity was studied. For the purpose to this analysis, existing ground water table was considered to start with factor of safety of 1.0 KN/m² of the landslide surface. The results of

this sensitivity exercise are tabulated in the following chart .

Anchorage Intensity kN/m ²	Factor of Safety for a Probable Slip Surface
0	1.00
4.8	1.10
9.1	1.20
13.0	1.30
16.7	1.40
20.0	1.50

Sensitivity of Slope Stability with Flattening of Slope

Considering the possibility of application of slope flattening by cutting of head and raising of toe, this analysis was carried out. For the purpose of this sensitivity analysis variation of slope from 35° to 25° was considered. The results are given in the list below :

Slope Angle (deg)	Factor of Safety for a Probable Slip Surface
35.0	0.93
32.5	1.02
30.0	1.12
37.5	1.25
25.0	1.39

DESIGN

DESIGN PARAMETERS/CRITERIA

Considering the massive volume of the landslide area, stabilization of all parts of it with high safety factor becomes unaffordable and economically unviable. Therefore, the criteria/parameters were chosen only to improve the existing stability condition marginally i.e. f.o.s. 1.2. Then, through the application of intensive bio-engineering, it was believed that the measures would ultimately provide necessary anchorage to the soil mass through root anchorage. Another assumption was that, through use of

proper drainage, environment favorable for consolidation of loose soil material in the landslide will be created, which will enhance the soil strength parameters. The following parameters/criteria were generally followed for the design of the stabilization measures :

Parameters

Soil Friction Angle	: 33°
Soil Cohesion	: 0 KN/m ²
Soil Unit Weight	: 16.25KN/m ³ saturated
	: 10.5 KN/m ³ submerged
Permeability of Soil	: 0.579 mm/sec
Soil Classification	: GP

Criteria

Factors of safety against sliding 1.20 (Lower value chosen as improvement in slope stability was the main objective).

OPTION STUDIES

For the improvement of the slope stability, following options were considered :

Option A - Trimming, catch drain, french drains, horizontal

drains, toe wall, surface cum deep drainage at side ditch and bio-engineering.

Option B - Trimming, catch drain, french drain, anchored walls, gravity wall, surface-cum-deep drainage at side ditch and bioengineering.

Option C - Removal of all slid and potentially sliding material and minor retaining wall at toe.

Technical Comparison

Option A basically deals with the factor responsible for the destabilization and further propagation of the landslide and intends to reduce the driving forces to increase safety factor.

Option B basically intends to resist the soil mass by providing some anchorage force thus increasing the nominator in the safety factor formula.

Option C intends to reduce the mass of sliding material and to reduce slope of the landslide area by removal of head and raising of the toe with minor gravity structures.

A comparison chart between the three options is briefly depicted below :

	Option A	Option B	Option C
MERITS	- Easier installation - Use of local material - Easy to install monitoring tool - Lowers ground water table - Easy to monitor - Further maintenance possible - Dissipates pore pressure - Creates condition for rapid consolidation - Creates water free root zone for better growth of vegetation	- Ensures better safety factor - No need to monitor piezometer	- No need of drilling technology - No need to monitor - Low cost solution
DEMERITS	- Involves horizontal drilling - Some of the drainage pipes may be squeezed/choked during movement of soil mass	- Sophisticated monitoring tools - Involves sophisticated drilling, installation and grouting process. - Some of anchors may fall - Difficult to replace anchors - Use of foreign material - Difficult to monitor	- Lower safety factor usually not adequate - Due to lack of drainage, growth of vegetation is difficult - Condition for consolidation of soil mass not present.

Cost Comparison

The costs based on prevailing rates of items of construction are as depicted below :

- Option A** - NRs. 7.67 million with safety factor > 1.20
- Option B** - NRs. 10.50 million with safety factor > 1.20
- Option C** - NRs. 5.20 million with safety factor > 1.20

Based on the above technical and cost comparison, Option A was selected for detailed design.

DESIGN DETAILS

Detailed design was carried out for the most preferred stabilization option. The layout of various stabilization measures are depicted in Fig. 6.

Surface Water Management

Surface run-off management was made using catch drains at the top of the landslide area, top channels of network of french drains within the landslide and with side drain and pipe culvert at road level. The drainage channel sections were designed to deliver expected discharge of 10 year return period. The catch drain was designed with masonry lining to outfall at the rocky stable gully to the south approximately 300 m from the landslide area.

Near-Surface Drainage

Near-surface drainage was designed at the landslide area using french drains of depth between 1.5m. The density of the french drain network was designed to create a dry layer of 1.0 m below ground surface at active part of the landslide. The materials used for french drains were geotextile, HDP perforated pipes, filter gravel, cobbles and rubble stones (refer Fig. 7 for typical sections of french drains).

Deep Subsurface Drainage

Deep drainage was managed by use of deep drilled horizontal drains. This work involves drilling of drill holes at upward angle upto a depth of 20-25 m with use of casings where necessary using Cassagrande C6 crawler mounted drilling rig or Lumesa Mounty portable drilling rig, insertion of perforated HDP pipe 63 mm dia. wrapped with geotextile mesh, outlet arrangement upto nearest drains etc.

Minor Structural Support

Such measures were designed at the toe area of the landslide. The supports were in the form of gabion retaining wall at hillside of road, stone masonry support for french drains outlet and some stone pitching works.

Bioengineering works

The landslide area was subdivided into two zones for application of bioengineering. The toe area near road was applied with intensive measures while the rest of the landslide was applied with extensive measures with the following definitions :

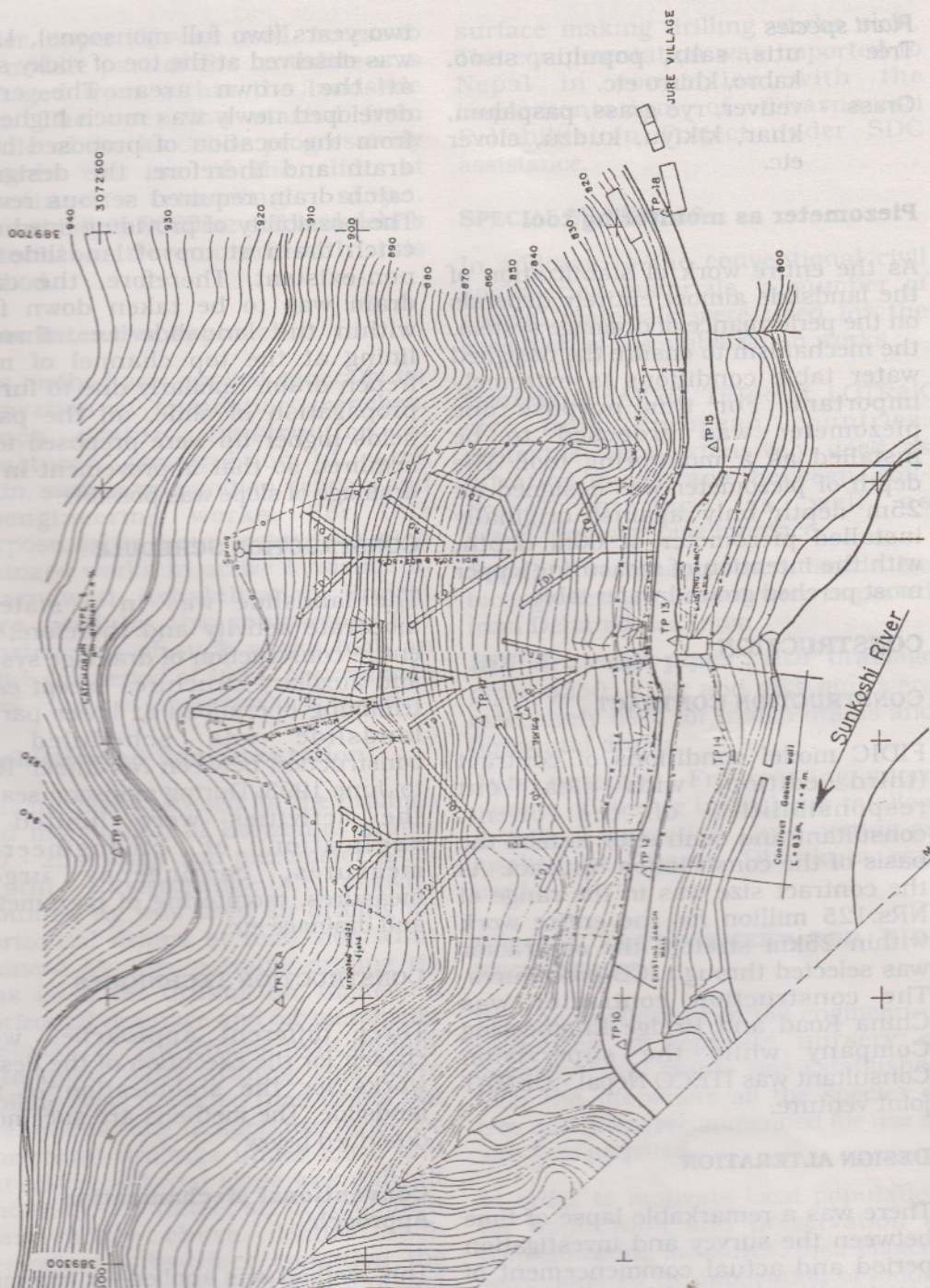
Intensive measures :

- Terracing 1 - 2 m width
- Brush matting
- Grass plantation @ 18 slips/m²
- Tree plantation @ 1 tree/m²
- Stone arches for slopes > 34°
- Gabion netting
- Edge rounding upto 2 m width
- Top soil spreading
- Palisades with bamboo stakes
- Resealing with 25gm/m² tree and grass seeds

Extensive measures

- Grass plantation @ 5 slips/m²
- Tree plantation @ 1 tree/m²
- Residing with @ 2 gm/m² tree and grass seeds
- Palisades with bamboo stakes

Fig. 6: LANDSLIDE AT Km 83+600
STABILIZATION MEASURES



Plant species

- Tree - utis, salix, populus, sisoo, kabro, khirro etc.
Grass - vetiver, rye grass, paspalum, khar, kikiyu, kudzu, clover etc.

Piezometer as monitoring tool

As the entire work of stabilization of the landslide almost entirely depends on the performance of drainage system, the mechanism to ensure the designed water table conditions is extremely important. For this purpose one piezometer was proposed to be installed as a monitoring tool. The depth of piezometer was designed for 25m depth only against originally installed piezometer of 60m depth, with the intention of measuring upper most perched ground water table.

CONSTRUCTION

CONSTRUCTION CONTRACT

FIDIC model conditions of contract (third edition) with clear cut responsibilities of the client, consultant and contractor formed the basis of the construction contract. As the contract size was in the range of NRs.125 million for the entire work within 25km stretch, the contractor was selected through ICB procedures. The construction contractor was China Road and Bridge Engineering Company while the supervision Consultant was ITECO Nepal - CEMAT joint venture.

DESIGN ALTERATION

There was a remarkable lapse of time between the survey and investigation period and actual commencement of construction due to delays in bidding, evaluations and awarding of contract, a typical symptom of third world countries. During this period of almost

two years (two full monsoons), 1.5 m was observed at the toe of rocky slope at the crown area. The crown developed newly was much higher up from the location of proposed catch drain and therefore, the design of catch drain required serious review. The possibility of providing lined rigid catch drain at top of landslide was non-existent. Therefore, the catch drain was to be taken down from within the landslide i.e., through lining at the top channel of main french drain. Similarly due to further propagation of slide, all the paddy fields higher up were proposed to be acquired so that improvement in the drainage of slope was possible.

CONSTRUCTION SCHEDULE

The landslide was in a state of moderate activity and therefore, the entire construction of drainage system and auxiliary structures except earth trimming operations at lower part of landslide was scheduled for construction between November 1992 to June 1993. During monsoon season the activities were limited to application of bioengineering measures, contingency urgent measures, monitoring of piezometers and drainage etc.

CONSTRUCTION TECHNIQUES

Three different approaches were chosen for the execution of the design works for the stabilization of the landslide. The methods are succinctly described below :

Conventional Mechanization Approach

This method was applied for trimming and removal of soil and debris material from the lowermost humped section of the landslide. For this purpose heavy equipment like dozers (2), excavator,

loader, tipper (6) were used. Access to the middle part of the landslide was managed from within the landslide area. The operation started from middle of the landslide progressively towards the toe of the slide at redefined trimming slope. Approximately 8000m³ soil and debris material was removed with this method.

Labor Intensive Approach

This method was applied generally for excavation of foundation trenches, french drains, construction of structures, construction of catch drain, surface preparation, fencing and bioengineering works. For this purpose, labor group trained for such drainage works in active landslide in Charnawati Rehabilitation Project were used by the contractor. The construction of such works took an entire dry period of 1993. Approximate involvement of laborers was 6000md.

Sophisticated Equipmentation

This method was used for the drillings and installation of horizontal drains (20 - 25m long) and piezometer (25m depth). Cassadrange C6 crawler mounted rig was used for drilling for horizontal drains at road side while Lumesa Mounty portable drilling rig was used for drilling for higher-up horizontal drainage and for piezometer installation. The drilling were initially attempted with drilling rigs (core drilling type) imported from China but the applicability of such machines for horizontal drillings under loose and saturated colluvial slope was difficult and therefore, former set of equipment was finally chose. Under such geological subsurface condition the output of Cassagrande C6 was upto 3 holes in a day whereas that of Lumesa Mounty was one hole per day average. Casings were almost always necessary upto a depth of 10m from ground

surface making drilling works slow. The equipmentation was imported to Nepal in connection with the implementation of Charnawati Rehabilitation Project under SDC assistance.

SPECIAL MATERIALS

In addition to the conventional civil engineering materials, a number of special materials were used for the execution of the stabilization works :

Geotextile : AKZO, TERRAM, LOTRAK etc. from European countries, geotextile were extensively used as filtration membrane between soil-gravel interface as well as gravel/drainage pipe interface.

Seeds : various types of seeds fro bioengineering purpose were imported from Deharadoon, India.

HDP drainage pipes : HDP drainage pipes $\phi 250$, $\phi 160$ and $\phi 63$ mm were extensively used for french drains and horizontal drains.

Jute netting : Fro creating micro climate of steeper bare slopes to allow growth of vegetation. Jute netting as applied at Dharan Dhankuta was used.

SPECIAL ARRANGEMENT FOR BIO-ENGINEERING

For the application of bio-engineering measures, a separate nursery of capacity 5000 plants was established near the site where all the species of tree and grass recommended for use at site were prepared.

In order to motivate local population for application and preservation of bioengineering measures, their choices were honored by application of fodder species upto 15% of the total number of plants to be applied in the landslide area.

QUALITY AND COST CONTROL

The drainage measures applied in the landslide needs intensive supervision at field level but the need for quality control is quite limited. The only materials other than local material were geotextile, HDP pipes, GI wires and a limited quantity of cement and seeds for bio-engineering purpose. The quality of geotextile and HDP pipes was approved on the basis of manufacturer's test certifications. Limited laboratory tests were carried out for GI wire, cement and concrete, while field tests were made for seeds. Although there was some alteration on the original design and some contingency works during monsoon season, the actual cost of landslide stabilization work was well within 10% for most of the landslides under the project (Refer fig. 8 for status of landslide immediately after construction).

POST CONSTRUCTION ACTIVITIES

In case of landslide stabilization works, the activities during post construction period were much more intensive than those for conventional civil engineering structures.

INTENSIVE MAINTENANCE DURING FIRST MONSOON

As an usual case for landslide stabilization, intensive maintenance was applied during the first monsoon period. this was necessary as the factor of safety against sliding on each part of the landslide was chosen lower than normally specified value of 1.50 for soil slope.

The arrangement during monsoon period consisted of the following :

- One supervisor full time to monitor each part of landslide daily to

detect and report any distresses, tension cracks, movements, slips, breaching of drains, saturated patches etc. who used to report of ARE directly.

- One group of laborers (strength 4 nos.) to attend immediate works such as connection of saturated areas to drains using gravel packs and drainage pipes, stone pitching works immediately after slip occurrence, reinstatement of breached drains, bracing and support of local humps and bulges, biotechnical measures at a active areas such as wattle fences, brush wattles, brush wood checkdams (palisades), brush layers etc.
- One group of bioengineering laborers (strength 2 nos.) to apply bioengineering measures immediately after slip reinstatement.
- Weekly monitoring by ARE for any incidences or impending dangers within the landslide area. More frequently in case of heavy precipitation of prolonged duration of saturation.

Drainage Monitoring

During the entire period of monsoon season subsequent to construction, biweekly monitoring were carried out for the following :

- Piezometric level monitoring using indigenous "fox whistle" and measuring tape.
- Discharge monitoring of all horizontal drainage holes using stop clock and bucket/measuring cylinders.
- Discharge monitoring of french drains using stop clock and bucket/measuring cylinders.

The results of such monitoring are as given below :

- Max. ground water discharge from french drains MD2 - 3.500 lit/sec, MD3 - 3.50 lt./sec.
- Max. ground water discharge from horizontal drain A-2ml/sec, B-126 ml/sec, C-28 ml/sec D-10ml/sec, E-160ml/sec, F-96ml/sec, G-0ml/sec, H-184 ml/sec.
- Piezometric depth from ground surface PZ-5.99 - 10.65m.

INITIAL DISTRESSES

Based on the visual monitoring reports the following were the initial distresses during first monsoon after construction.

- Light bulging of gabion retaining wall at front face.
- Some tension cracks and humps within the landslide area.
- Crackings at top lining of french drains at a number of places.
- Superficial slips at steeper ground surfaces
- Light tilting in steep battered walls. The gabion walls at toe of landslide were rear stepped type with steep front batter of 1H:10V.

Such initial distresses are usual in freshly treated landslides during first monsoon period which should be further monitored for progressive deterioration, if any.

FINAL ASSESSMENT

Final assessment of the landslide area was made during handing over of works from the contractor to client in 1994 monsoon period. The final

- Needs replacement/addition of plant materials where the growth is not satisfactory.
- Needs regular sealing of cracks at top lined part of french drains.
- Condition of structures and drains generally found acceptable.

Similar was the remark for other six landslide areas undertaken within RFRP project.

CONCLUSION

The following conclusion are made from the case study of landslide at km 83 + 600 of Arniko highway. The conclusions might be extended for stabilization of similar landslides in the Himalayan range.

1. French drains and horizontal drains are highly effective for landslide areas where saturation/ground water table is observed right upto the ground surface.
2. Both types of subsurface drains are highly effective to drain out ground water.
3. Drainage techniques for stabilization are much more cost effective compared to support structures such as anchors.
4. Drainage technique may attribute better factors of safety than conventional trimming and flattening of slopes.

5. Estimate of cost of such measures in moderately active landslide areas are well within acceptable ranges of 10%.
6. The success for stabilization of all seven landslides under the project indicate that the level of confidence in stabilization of landslides using such measures is generally acceptable.
7. Use of steep-battered rear-stepped gabion walls should be avoided as the rate of success is rather low.

□□□

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** This article is adopted from a paper presented to a seminar organized by Nepal Engineering College on Feb. 2, 1996.

Background Information

The teaching of English in Nepal started with the early Rana regime influenced by the British-rule in India. It has now occupied an important status in Nepalese education. From the decade of 1960's onwards the literature - based approach in the teaching of English has been more or less shifted to the language - based one. As in Dr. Malla's words, it was an attempt to point out "an awareness of the nature of the basic problems of teaching English as foreign language."¹ The New Education System Plan (NESP) also positively accepted this approach.

The need of English language teaching (ELT) is very great in Nepal. Without this language at present it is impossible to acquire modern science and technology and without modern scientific and technical know - how the development of the country itself remains seriously affected. The teaching of English has to be more efficient, effective and useful to its learners for a number of reasons.

In spite of several efforts towards improving the teaching of English from the 1960's, no satisfactory results have yet been noted. The teaching of this language has remained still chaotic in real practices. It is very essential to improve ELT situations for learners who need English language skills for specific purposes. The ELT situations at the technical institutes including

the engineering ones in Nepal cannot remain as an exception to this reality.

The purpose of the present article is to make an attempt to highlight on some basic concepts on which the teaching of this language at the engineering institutes in Nepal should be based.

ESP Approach

English language teachers today need to adopt increased specialization in teaching because of the increased demand of English language for particular needs and the rapid advancement in linguistics and educational psychology. Our knowledge regarding different styles and registers of language and our increased need for more and more specialized approach to teaching/learning have brought into existence the concept of ESP (English for specific purposes).

Although it is very difficult to pin point the concept of ESP, the term as used here, refers to "closely matching teaching content to learner requirements."¹ In this approach learners' needs and purposes for learning the language are of major concern. This approach to language teaching is basically learning - centered and is therefore based on the learners' reason and purpose for learning the language in addition to its base rooted on the principles of learning process. In other words, this approach is purpose - specific and need - based. Moreover, this approach is concerned mainly with the profession - oriented groups of learners who need English for their specific purposes.

¹ Kamal P. Malla (1977) : "English at the Undergraduate Level", English in Nepalese Education, Ratna Pustak Bhandar, Kathmandu, P. 1.

* Mr. Khanal is Asst. Professor in Language & Communication Dept., nec.

¹ Jo McDonough (1984) "Preface," ESP in Perspective, Collins ELT, London, P. ii.

ESP approach in fact is the first attempt towards developing a scientific system in the process of language teaching.

EST Approach

ESP approach demands an objective study of the specific aspects of language use in subject specific domains before attempting to devise the specific language teaching methodology.

ESP teachers, who are at the same time the curriculum planners are bound to be aware of the naked truth that they need to train themselves in the preliminary knowledge of the specific disciplines of their pupils. Without taking up this task willingly they can neither assist their students to understand their specific language needs nor can they help them to learn the specific aspects of the language used in their specific disciplines. This fact is more relevant and vivid in the field of science and technology which is growing very fast.

The vast and ever-growing world of science and technology has compelled the ESP concept to grow more and more and to come with a newer approach called EST (English for Science and Technology) approach. This approach is widely accepted and practiced in the field of language teaching/learning these days.

The major goal of the students in the field of engineering is to acquire modern science and technology related to their specific fields of study through English. English is a source language for them to carry on their study at present and to update their learning in the future. They also need this language in their occupations after they have completed their study. The teaching of English at the engineering institute in Nepal should be based on EST approach as far as practicable.

EST Engineering

In the modern context of Nepal it is very essential to learn English language in a specialized way in order to effectively learn scientific and technical skills and ideas. The focus on teaching English in a scientific/specific way for learning engineering courses at the engineering colleges is highly desirable. In the present context of the country, English language has occupied such a status that without its use the entire process of engineering communication breaks down. With the lack of adequate skills of this language the engineering brilliance of the engineers can remain seriously hampered.

Needless to express that teaching of English in the engineering institutes in Nepal should be more specialized and should be based on specific brand of EST i.e. on ESP approach which is specific to the field of engineering. This newer EST approach can be termed as EST Engineering.

EST approach has thus become an important field covering many specialized areas and sub-areas according to the changing demands today. Modern aspects of this approach such as EST Engineering has been inspiring a number of research in many specific areas such as needs-analysis, curriculum development, teaching methodology, resource development, teacher preparation and evaluation procedures.

The time has now come for the English teachers at the engineering colleges in Nepal when they need to make their maximum efforts to understand how the engineering students and teachers at the colleges communicate their ideas in English. For this they are in need of formulating a large body

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drawing teachers from both engineering and EST fields with a view to promote interaction and co-operation as far as possible. Such an effort can bring EST Engineering approach into grand success. Only then we can step unto other approaches such as English for specific engineering purpose approaches. All the specialized approaches are based on the needs of the learners.

Relevance of Needs Identification at the Engineering Colleges

As the field of engineering education in Nepal is very popular as well as very expensive, the teaching/learning atmosphere prevalent there demands our sincere but timely attention in establishing the need, relevance or importance of teaching English for the engineering purposes. The students in the field of engineering need this language for a number of reasons : they need it to listen to the lectures, and to consult their text-books, reference books and even journals. They also need English to appear in their tests and examinations. The engineering students therefore need to have a good command in the skills of the specific variety of English language for their academic activities. They need these skills even in future for updating their engineering ideas and skills when they take up their engineering business.

Researches have shown that the engineering students like to improve their English language background for their engineering purposes although they seem to treat the English classes with some dislike. The researches have also shown that the engineering students are well aware of the reality that they need relevant English language skills for their academic as well as professional careers. The traditional theoretical ELT approach

which emphasizes on teaching English as a compulsory subject must be improved as soon as possible as this approach emphasizes on teaching English language rules followed by irrelevant but heavy exercises. To speak the truth, this approach has come to a failure with the wastage of time and money. The emphasis should be therefore on teaching specific aspects of English language use relevant to engineering activities. In other words, we should stop compelling our students to study English as a subject. Rather, we should encourage them to learn English language for their practical purposes. Only then the students will be more and more motivated to the teaching of English language courses. Our teaching should always result into the real learning of the students. This is the reason why the students' need must not be thought up but it should be all the time studied and enlisted with a view to motivate the learners in the teaching.

It is very essential to identify the real need of the learners in English in the engineering field of education on linguistic as well as pedagogic levels otherwise teaching of English can hinder not assist them to move forward into their major track. The needs of the learners can be identified through a research using data collecting instruments such as questionnaires, interview schemes and student evaluation tests. ESP experts related to the field of engineering can also be requested to collaborate for this purpose.

Conclusion

Teaching of English in the field of engineering in Nepal should be based on several factors such as purpose of teaching English, needs of the learners, learner motivation, learners'

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Conclusion

Teaching of English in the field of engineering in Nepal should be based on several factors such as purpose of teaching English, needs of the learners, learner motivation, learners'

problems, teaching / learning atmosphere including methodology, resources and evaluation procedures. Teacher preparation with the acceptance of the new approach in the teaching must also be equally considered.

A curriculum developed taking all these factors into account can really be effective and fruitful. It should not be forgotten that the process of developing a curriculum is never ending as it takes into account the changing needs of the learners.

Modern linguistic and psychological trend which has been focusing on the learning - centered language teaching

programs can never be disregarded from the field of engineering education in Nepal. This type of program is different from the traditional ones as it is a collaborative effort between the real teachers and learners. The modern concept i.e. the teaching of English for specific purpose is a commonly used concept almost everywhere in the world today. The emergence of this concept in a more specific and pragmatic way in the field of engineering in Nepal can really serve as a guideline even in the vague ELT environment prevalent there at present. Teaching of English must be more specific as far as possible.

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