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Retour vers le futur : apprendre du passé et innover pour le futur

Sonam Wangchuk

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Retour vers le futur

apprendre du passé et innover pour le futur

mémoire du

Diplôme de Spécialisation et d'Approfondissement

Sonam Wangchuk Ingénieur, Inde

Architecture de Terre

DSA Terre 2008-2010

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Retour vers le futur

apprendre du passé et innover pour le futur

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Avant Propos

Ce mémoire est destiné aux habitants des Himalayas et du Ladakh , autant que pour le diplôme de DSA du CRAterre

Je suis vraiment reconnaissant à toute l'équipe du CRAterre de m'avoir accepté dans ce cours alors que j'arrivais du Ladakh avec pas plus de 3 mots de français en poche. J'ai commencé à l'apprendre en suivant les cours. Ceci pour vous dire que mon niveau de français est loin d'être suffisant pour rédiger un mémoire. Comme je ne voulais pas l'écrire en anglais pour une université française , alors j'ai choisi la «voie du milieu», avec un langage que les gens du monde entier peuvent comprendre, sans l'usage de mots... la langue des images.

Cette histoire vous sera contée principalement avec des images, et juste l'essentiel avec des mots. Comme dit un proverbe: «une simple image peut parfois en dire plus que 10 000 mots. En plus, je pense que cette façon sera également utile pour les habitants de l'Himalaya, où, d'un kilomètre à l'autre, les gens peuvent parler des langues différentes.

Foreword

This memoir is meant as much for the people in Ladakh and the Himalayas as for the Diplome de DSA at CRATerre.

I am thankful to CRAterre that they accepted me in the DSA course even though I came from Ladakh with only a few words of French. I learnt the language during the course. So of course my French is not strong enough to write a whole thesis. And somehow I did not want to write a memoire for a French University in English either. Therefore I have chosen a middle path – a Language that most people in this world understand without words... the language of images.

This story is told mainly in images with only the essential text in words. As the saying goes an image says what a ten thousand words cannot. I thought this would be equally helpful for our people in the Himalayas where we speak different tongue after every few miles and very few can read anyway.

Acknowledgement

Du fond du cœur, je tiens à remercier tout particulièrement:

- la grande famille du CRAterre, pour m'avoir supporté avec mes difficultés de langage et mes différences culturelles, et, de la part de la terre, je la remercie, pour l'immense service qu'elle lui rend et dont j'ai beaucoup profité,
- Philippe Garnier pour son soutien et sa patience avec moi,
- mes amis Serge Maini et Robert Celaire, qui m'ont conduit vers le CRAterre
- Lily avec ses 85 ans, Colette, Marie Annick et jusqu'à Gwen, avec ses 9 ans, pour avoir guidé mes premiers pas en français,
- Christiane Mordelet, qui a répondu à toutes mes questions et qui m'a aidé dans la traduction de ce mémoire,
- tous ceux qui m'ont accueilli durant mon "pèlerinage de terre ",
- les Ladakhis, qui ont de si grandes attentes de ce matériau.

I want to convey my heartfelt thanks:

To the whole CRAterre family for being so supportive despite my problems of language and culture, and for generally doing such great service to the earth.

To Philippe Garnier for his support and for his patience with me.

To my friends Serge Maini and Robert Celaire for leading me to CRAterre

To 85 year old Lily, Colette, Marie Annick and nine year old Gwen for helping me with my French and

To Christiane Mordelet, for bearing with all my questions and helping translate this memoire ...

To all the people who hosted me during my pilgrimage,

To the people of Ladakh who shared their wisdom and who have great expectations from the earth.

Résumé

Le Ladakh est une région située à l'extrême nord de l'Inde. Historiquement, c'était un royaume comme le Tibet, le Sikkim, et le Bouthan, et il est souvent appelé «Petit Tibet». De nos jours, il est devenu une minuscule minorité de l'Inde, où les gens ont une culture et un langage totalement différent du reste du sous-continent indien . Situé à une altitude moyenne de 3500 m, au cœur des montagnes de l'Himalaya, c'est un désert de haute altitude, où les températures hivernales peuvent plonger jusqu'à -30° C, mais abrité de la pluie comme de la neige par l'immense arc himalayen, et de ce fait, la moyenne des précipitations n'y excède pas les 90 mm par an.

C'est une région, où, de nos jours encore, la quasi-totalité des gens vivent dans des habitations à base de terre. Où les gens connaissent et réapprennent la valeur et l'art de vivre dans un tel habitat, peut-être parce que la terre est la seule réponse parfaitement adaptée aux conditions climatiques locales. Comme le Ladakh est situé à des centaines de kilomètres aux fins fonds des hautes montagnes, le coût des transports de tous les matériaux est très élevé, tant sur le plan économique que écologique, du fait de l' augmentation des prix de l'énergie, mais aussi des enjeux environnementaux dans un écosystème si fragile.

Néanmoins, c'est aussi un endroit où le ''progrès'' moderne a déjà pénétré, et la rencontre avec les modes de vie urbains, les médias, le cinéma, a contribué à donner aux gens un sentiment d'infériorité vis à vis de leurs belles habitations traditionnelles.

Les riches se sont déjà tournés vers le ciment, les toits en tôle, et même les briques de terre cuite importées d'Inde à travers les routes de l'Himalaya. Ces pressions ont amené les gens à délaisser les voies traditionnelles qui suivaient la sagesse et les savoir-faire des anciens, et qui n'auraient nécessité que quelques petites touches de modernité pour leur redonner plus d'élégance et de pertinence. Mais nous avons un longue tradition de sentiment d'infériorité envers tout ce qui provient du Ladakh et une tentation aveugle pour tout ce qui vient de l'extérieur.

De nos jours, le Ladakh est à la croisée des chemins par rapport à sa culture constructive. C'est une des minorités climatique du monde où on peut ressentir simultanément la morsure du froid et la brûlure du soleil, et c'est si froid, si haut, si sec, qu'il y a peu de places dans le monde qui pourraient nous donner un modèle ''tout fait'' à imiter.

C'est pourquoi j'ai pensé entreprendre un pèlerinage dans le temps et dans l'espace, pour rencontrer d'autres cultures et vivre d'autres expériences, depuis la simplicité du monde traditionnel himalayen jusqu'à ''l'efficacité'' du monde contemporain. C'est aussi un voyage à l'intérieur de soi-même, et plus j'apprends de ce monde complexe moderne, plus j'ai de l'admiration pour les choses simples et ingénieuses. De ce fait je ressens la nécessité d'être capable de choisir le meilleur de ces 2 mondes.

Comme nous ne sommes qu'une minuscule minorité de 300 000 habitants, perdue dans une vaste nation de 1,2 milliards d'individus, le gouvernement indien n'a pas fait beaucoup d'efforts pour y mettre à jour les technologies et les sciences modernes qui auraient pu permettre d'améliorer les techniques traditionnelles, ni pour éduquer les habitants et les techniciens, pour les aider à construire des maisons durables et sures qui respectent l'environnement. En l'absence de telles contraintes , les gens ont pris toute liberté pour ''copier-coller'' aveuglément l'usage de ces matériaux inconnus comme le béton armé.

Ainsi le Ladakh va continuer à faire le lit des désastres de toutes sortes. Nous vivons sous la menace constante des tremblements de terre comme nous résidons sur cette jeune chaine agitée qu'est l'Himalaya. En fait, la plupart des gens vit dans la vallée de l'Indus, qui se trouve être aussi la zone de contact entre les plaques indienne et eurasienne.

Le tremblement de terre de 2006, au Cachemire, qui a fait 50 000 victimes, a amené ce risque à nos portes – En fait l'épicentre n'était, à peu près, que à 200 km de la frontière du Ladakh.

Puis les brusques coulées de boue de l'été 2010 au Ladakh ont emporté près de 1500 maisons et fait près de 700 victimes. Une des conséquences malheureuses de cette tragédie, et qui pourrait bien en appeler d'autres dans cette région , est que les gens, comme les médias et les bureaucrates ont commencé à blâmer l'utilisation de la terre comme matériau de construction et à la rendre responsable de ces dommages, malgré le fait que les dommages avaient plus à voir avec le choix du site pour la maison que de son matériau de construction. En effet, là où les maisons avaient été construites sur les trajets des coulées, même des immeubles en béton ont été emportés, et là où le site avait été choisi plus judicieusement, les habitations en terre ont résisté même aux inondations.

Dans tous les cas, l'éventualité de telles catastrophes pose la question de la sécurité des constructions au Ladakh, et des voix commencent à s'élever pour trouver des réponses.

Enfin, le Ladakh est aussi un endroit qui rencontre une autre calamité naturelle, mais sa régularité ne fait pas la une des journaux car le nombre des victimes est peu important: il s'agit des températures glaciales enregistrées chaque hiver, descendant jusqu'à –30°C ou – 40 °C dans certains endroits. Bien sûr il existe d'autres endroits sur la Terre où les gens doivent faire face à des températures similaires, mais dans ce désert de haute altitude, il faut y ajouter l'extrême faiblesse des ressources naturelles en énergie: la plupart des gens ne disposent d'aucune ressource si ce n 'est quelques maigres paniers de bouses (de vache) pour affronter ces conditions extrêmes.

A la lumière de ces catastrophes naturelles, j'ai dirigé mon étude vers les tendances "modernes" de construction au Ladakh et les stratégies adoptées (ou le manque de stratégie). J'ai étudié comment on a pu s'égarer ainsi, et même, refuser de tirer les leçons de nos erreurs que ces récentes calamités ont mis en lumière.

Pour tirer les leçons du passé, j'ai analysé et étudié les vieilles forteresses millénaires et les monastères dont le paysage ladakhi est paré et j'ai tenté d'explorer les sagesses des anciens, qui, en dépit de leurs si faibles ressources, avaient apporté un grand soin pour se protéger de ces dangers

Et cela m'a conduit dans un voyage beaucoup plus grand, que j'appelle mon "pèlerinage de terre", qui m'a amené à aller à la rencontre, tant du monde des anciens que du monde "moderne". Ici, je veux partager avec vous ces connaissances glanées le long des chemins de l'Himalaya, depuis Leh jusqu'en Himachal Pradesh, du Népal au Tibet, du Sikkim au Bouthan, où sont pratiquées les techniques traditionnelles du pisé. Ce pèlerinage m'a amené à étudier les techniques de terre contemporaines du monde "moderne", là où la terre est réappropriée comme un matériau de luxe et écologique. J'ai étudié et comparé les rendements et les empruntes carbone du pisé sur différents continents, depuis Auroville en Inde jusqu'à David Easton en Amérique du Nord, Earth-Structures en Australie et Martin Rauch en Europe.

Pour finir, je vous présente une idée qui commence à germer avec toutes ces découvertes, de lancer un mouvement en faveur d'une architecture sure, durable, et d'un coût abordable, pour tout l'arc himalayen. Ici, je vais étayer les innovations que nous avons mises en œuvre au Ladakh, pour justement, faire des choses plus simples, moins chères et plus écologiques. Je vais aussi raconter l ' histoire du travail d'une nouvelle entreprise de constructions en terre, que j'ai lancée, pour fournir aux gens des constructions en terre, abordables, chauffées au solaire, résistantes aux tremblements de terre et aux inondations. C'est une initiative où, d'une part les gens recevront un service de qualité, pour un prix correct, et en même temps, des jeunes apprendront un travail créatif, où leurs revenus proviendront de l'innovation et des techniques, plutôt qu'en accablant les clients. Ce sera aussi un moyen de redonner à la terre les honneurs qu'elle mérite comme matériau de construction.

Je terminerais avec quelques conclusions et recommandations pour les acteurs du développement dans des régions comme le Ladakh.

Summery

Ladakh is a region in the northernmost part of India. Historically one of the Himalayan kingdoms along with Tibet, Sikkim and Bhutan, it is often called Little Tibet. Today it is a microscopic minority in India where people have a language and culture very different from the rest of India. Located 3500 m above sea level and deep in the Himalayan mountains, it is a high altitude desert in the Himalayan rain-shadow where temperatures go down to –30° C and the average annual precipitation is only 90 mm.

It is also a region where still almost the whole population lives in some form of earth building. Where people know and are re-learning the art and value of living in earth houses. Earth is also perhaps the only solution because it is perfectly suited for the local climatic conditions. Since Ladakh lies hundreds of kilometers deep into the Himalayan mountains., the cost of transporting any other form of industrial construction materials is extremely high - both economically as well as ecologically, given the rising energy prices and the environmental concerns in the sensitive Himalayas.

Yet it is also a region where the so called modern trends are making inroads. The exposure to big cities, media and cinema is making people feel uncomfortable and inferior in their own beautiful dwellings.

The rich are already moving towards concrete structures, iron roofs and some even to fired bricks imported from across the Himalayas. These pressures have lead people to move away from the traditional ways which were based on ancient wisdom and experience and needed only a touch of modernity to make them even more refined and relevant. Myths abound the common public opinion about everything Ladakhi based on strong feelings of inferiority about themselves and blind appreciation on everything from outside.

Today Ladakh is at a crossroad in its construction culture. It is a climatic minority where one could have a frost bite and sunburn at the same time. It is so cold, high and dry that there are very few places in the world that can give us a good model to emulate.

So I thought of going on a pilgrimage to learn from our own past and from the world. To meet other cultures and experiences form the simplicities of the traditional world in the Himalayas to the efficiencies of the contemporary world. It is also a journey within. The more I learnt about the complex and modern ways the more I respected the simple. Hence I saw a need to be able to choose the best of both the worlds.

Being a microscopic minority of 300,000 people in a vast nation of 1.2 billion, the Indian government also has made no efforts to actually use modern science and technology to improve upon the traditional ways, or to educate people and the technicians to build safe and sustainable houses in Ladakh. In the absence of such efforts people take the liberties play with blindly copy the use of new unknown materials like reinforced cement concrete.

And therefore Ladakh continues to be a hot bed for disasters of many kinds. We have always faced the threat of earthquakes, being in the shaky young mountains of Himalayas — in fact most of the population lives on the Indus river which geologically also happens to be the suture line of the Indian and the Eurasian plates.

The Kashmir earthquake of 2006 which killed 50,000 people brings this possibility right to our doorsteps— in fact the epicenter was hardly 200 kilometers away from Ladakh's border.

Then the totally unexpected flash floods of 2010 in Leh damaged roughly 1,500 houses and killed around 700 people. An unfortunate outcome of this that could spell another kind of disaster for the region was that the people as well as the media and the bureaucracy started blaming earth as a building material for the massive flood damages. This was despite the fact that the damage had more to do with site selection than with building material. Where the houses were built on the flood path even concrete houses were washed away together with the earth built ones and where sites were better chosen even the earth houses withstood the splashes.

In any case these disaster possibilities together still pose a big question mark on the safety of the current buildings in Ladakh and people are clamoring to find answers.

Finally Ladakh is a region that faces yet another calamity of nature, but with such regularity that it does not make news and the death toll is also rather low. And this is the extreme cold temperatures every winter, touching – 30C to -40 C in some places. Of course there are other places in the world that face similar temperatures but the difference is that due to the extreme scarcity of any forms of natural energy resources in this high altitude desert, most rural people are armed with nothing but a few baskets of cow-dung to face this extremity of climate.

In the light of these threats my study looks at the emerging 'modern' trends in construction in Ladakh and the strategies adopted (or the lack of them), to deal with such threats of nature. It documents how we have gone astray and even refused to learn from our mistakes that the recent calamities have clearly exposed.

In order to learn from the past I then document and analyze the millennia old forts and monasteries that dot the Ladakhi landscape and try to explore the wisdom of our ancestors who took great precautions against the above challenges, despite incredibly limited resources.

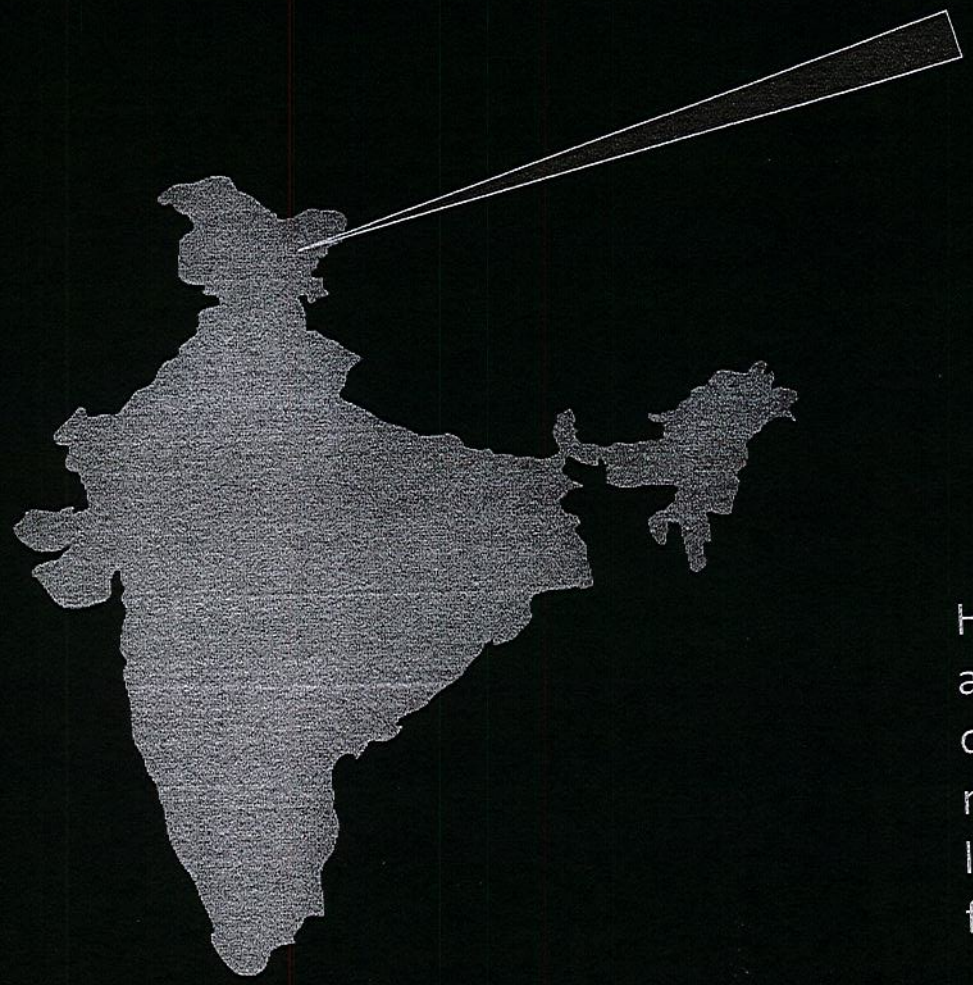
This leads me to a bigger journey which I call my 'Earth Pilgrimages' and which took me to visit different parts of the ancient as well as the modern world. Here I share my learnings from my travels through the length of the Himalayas from Leh to Himachal Pradesh, Nepal, Tibet, Sikkim and Bhutan where traditional rammed earth is practiced . The pilgrimage then takes me to learn from the contemporary world where modernized earth techniques are seeing resurgence as an elite and exclusive luxury of the elite. I study and compare the productivity and carbon foot print of rammed earth on different continents from Auroville in India, David Easton's REW in North America, Earth Structures in Australia and Martin Rauch in Europe.

And finally I present an initiative that I started with these learnings to start a movement for safe, affordable and sustainable housing for all in the Himalayas. Here I document the innovations we carried out in Ladakh to make things simpler cheaper and greener. I also document the work of a new earth construction enterprise that I helped launch to provide people with affordable earth houses that are solar heated, earthquake safe and flood resistant. This is an initiative where the public gets quality service at affordable prices while the youth get a creative means of employment, and their income comes from innovation and use of technology rather than by taxing the clients. This is also an attempt to bring back the glory that earth deserves as a building material.

The document ends with some conclusions and recommendation for the various stakeholders in the development of a region like Ladakh.

Introduction

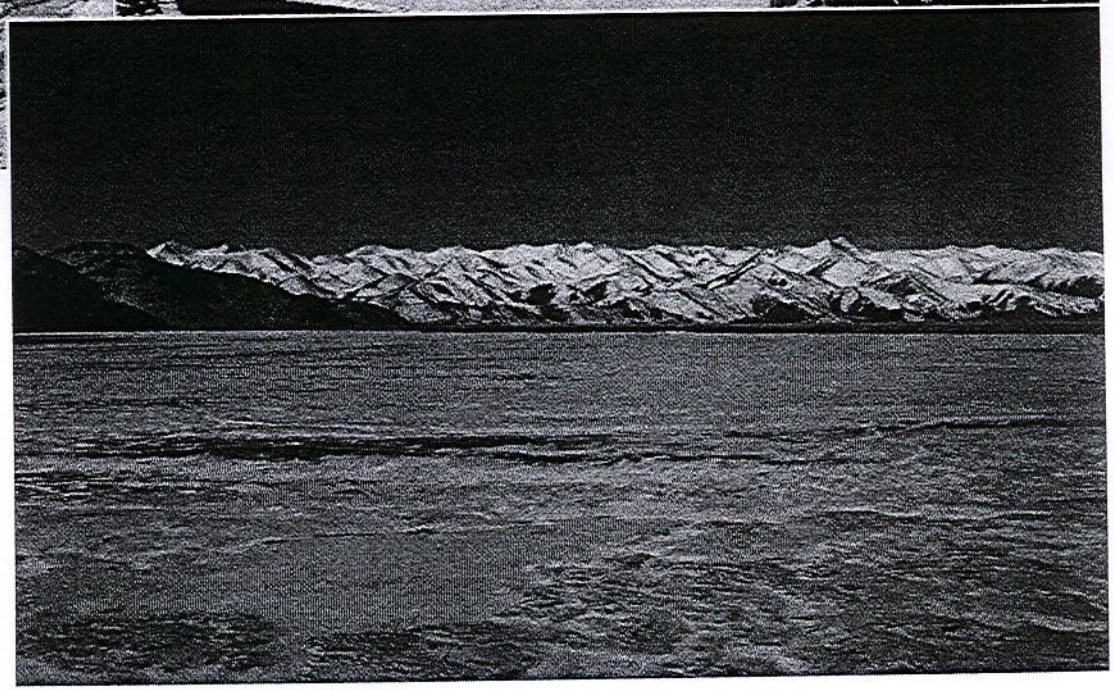
LADAKH



Northernmost region in India, Jammu & Kashmir State

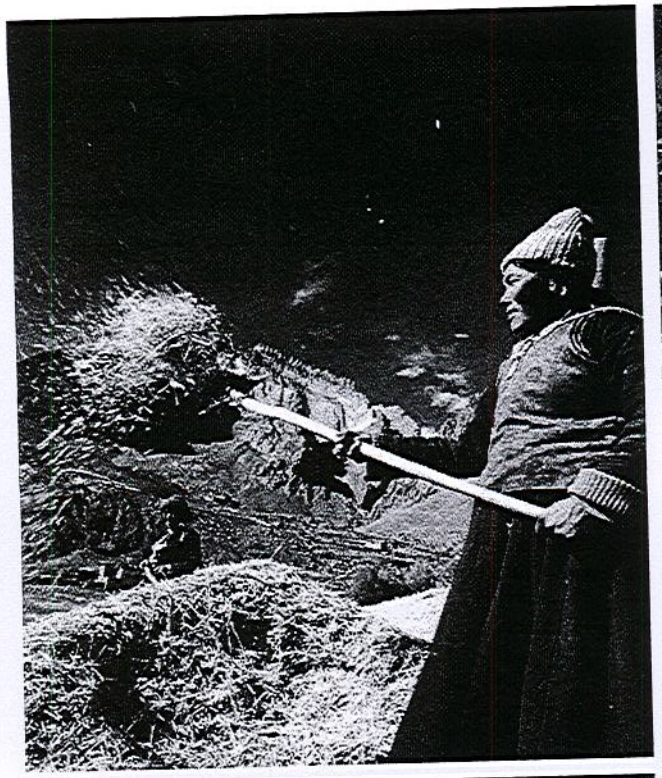
Historically one of the Himalayan kingdoms along with Tibet, Sikkim and Bhutan, it is often called Little Tibet. Today it is a microscopic minority in India with a language, culture and climate very different from the rest of India.

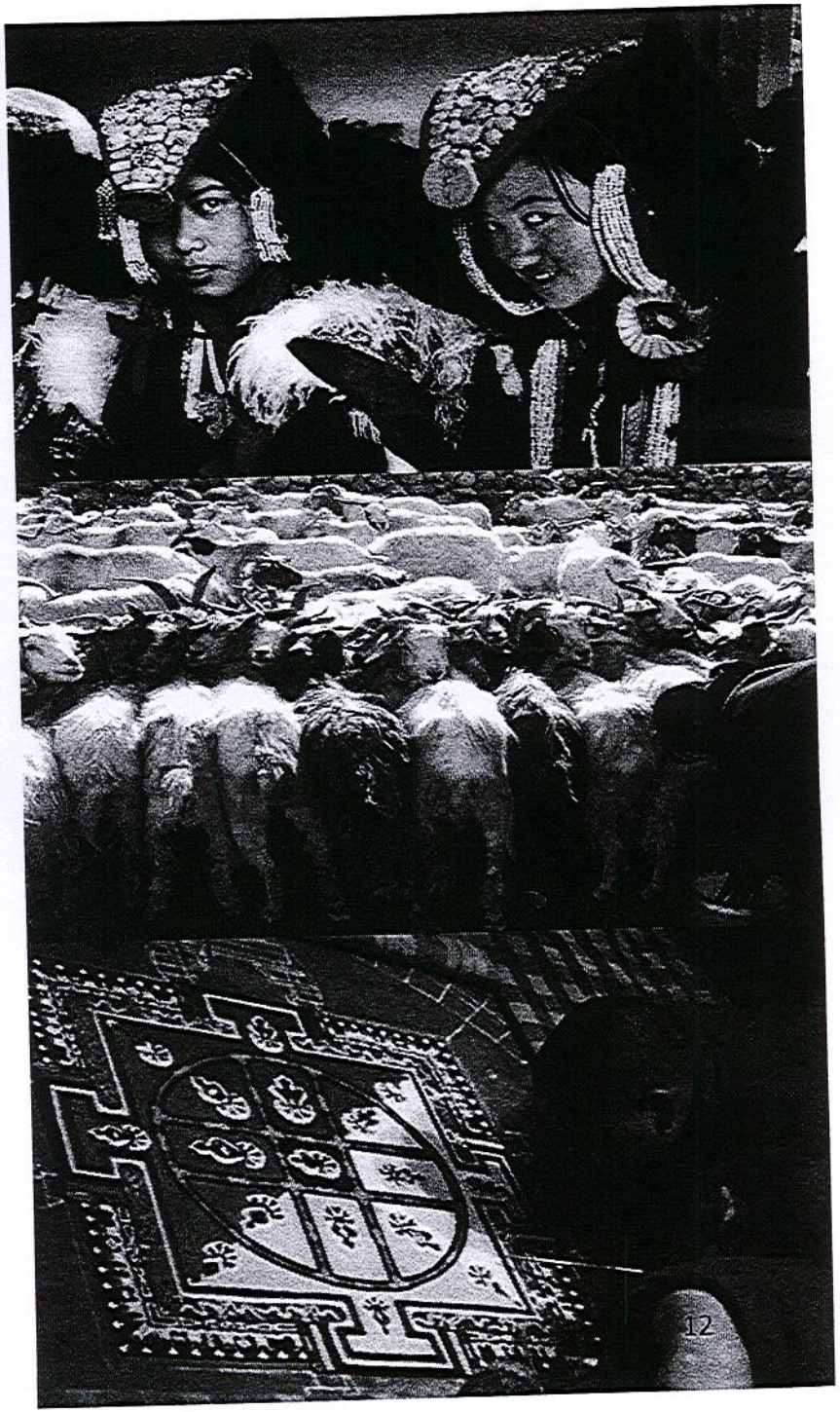
Ladakh

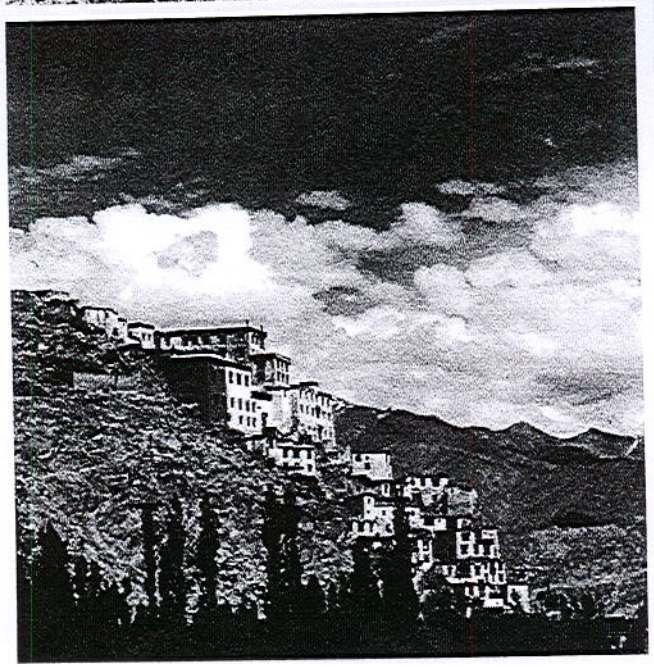


Cold, high and dry

Being in the Himalayan rain shadow Ladakh receives an average precipitation of only 90mm per year. Habitations are located from 3,000 to 4,000 m of altitude. Temperatures in winter may dip down to – 30° C.







And yet over centuries people not only survived, but a rich culture of art architecture and nature friendly lifestyle flourished.

A Rich Construction Culture...
...is being fast forgotten

In traditional Ladakhi construction culture site selection played a very important role. To begin with all villages in Ladakh are located on a stream that finally leads into the Indus river. While these streams were the source of life, yet people never built anywhere close to the stream or the river. The villages were always perched on a rocky hill usually facing south. This meant that the people were safe from flashfloods and at the same time the cultivable land below was spared for farming. The height and the view also gave them protection from invaders.

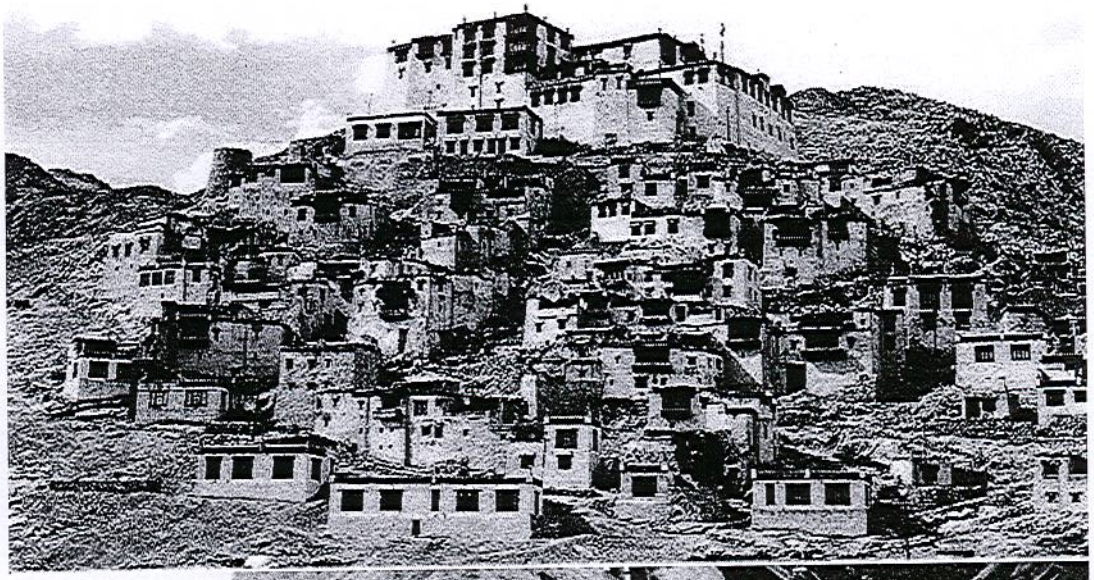
Now it is understood that building on the rocky slopes is also better against earthquakes compared to the soft alluvial deposits in the valley.

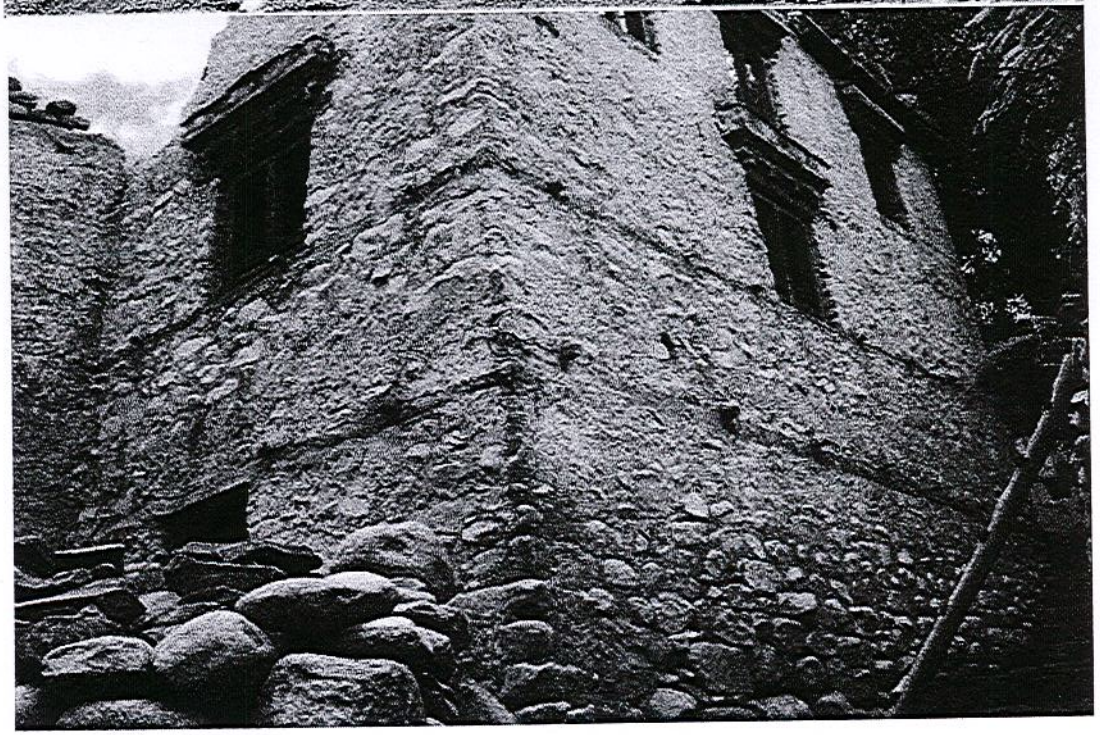
Apart from site selection most houses would also have anti-seismic tie bands at various levels .

Wall thickness was another way our ancestors dealt with several issues of safe housing. The wall thickness in old houses used to range from 50 cm to 100 cm. This gave them stability in earthquakes, as well as the insulation to withstand the extremely cold winters. Interestingly earth walls at one meter thickness have U values close to modern national standards in many countries.

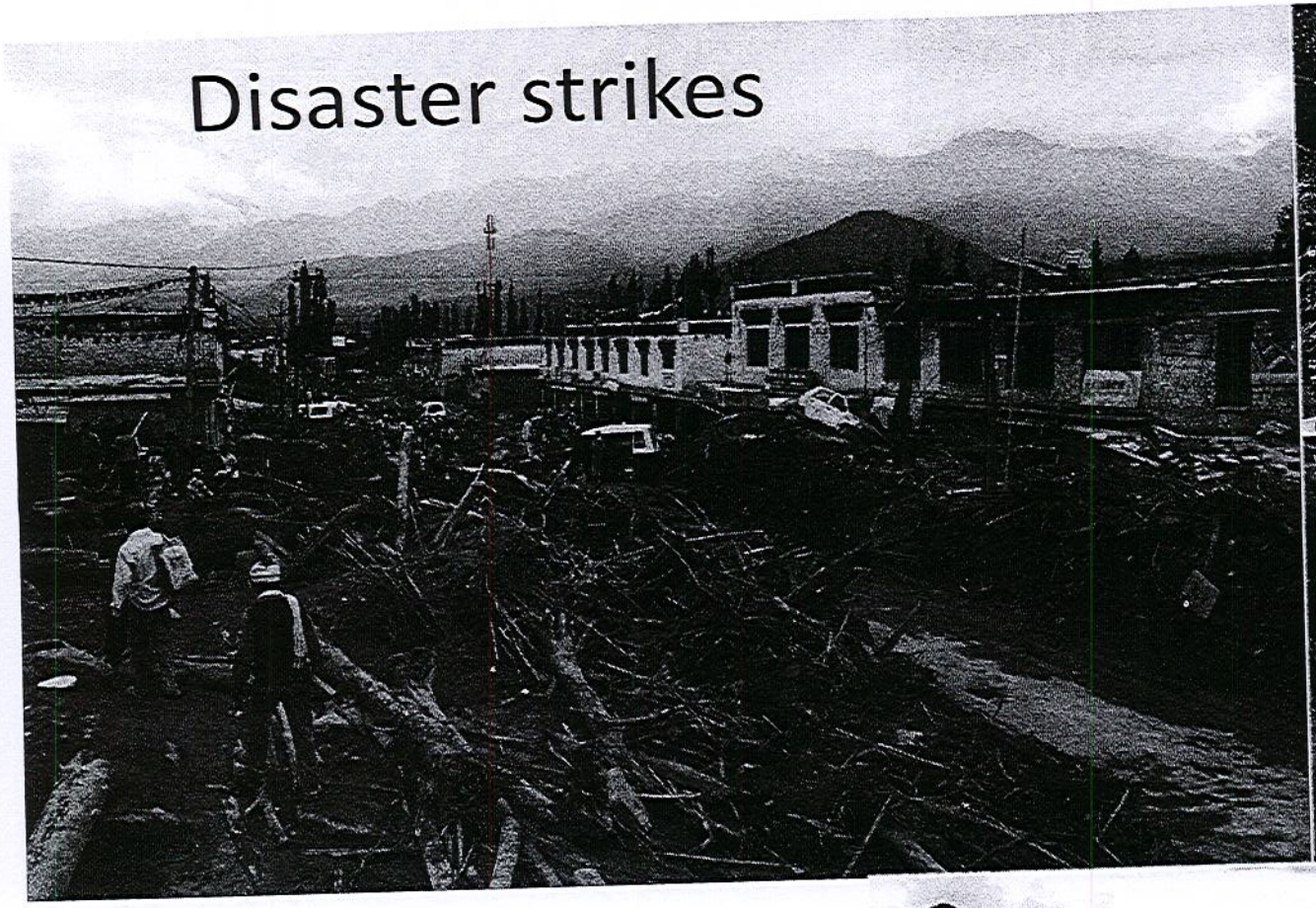
South facing slopes gave them the warmth of the sun all winter, although it was only after the advent of glass that this could be used in a real sense . Yet it was a great tradition to be on the enclosed terrace called '*yaps*' specially built for basking in the sun in winters. Many Ladakhi folk songs from centuries ago start with few lines in praise of the sun and the glory of how it shines on the village and brings warmth to all.

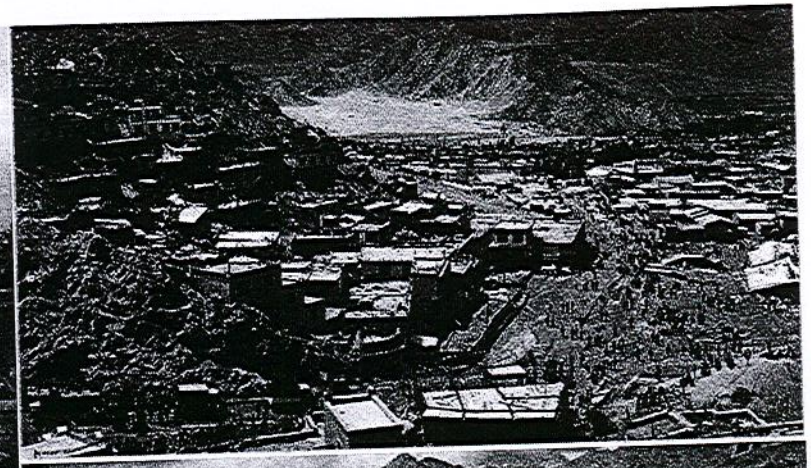
However in the 'modern' times people are fast forgetting the ancient wisdom... unfortunately not without consequences...

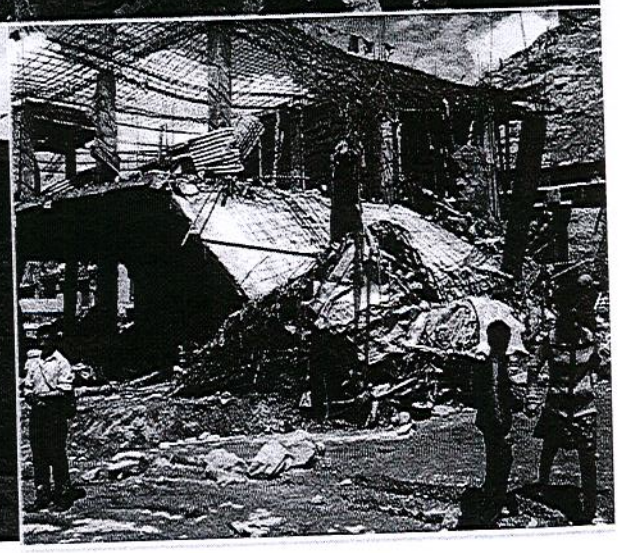




Disaster strikes





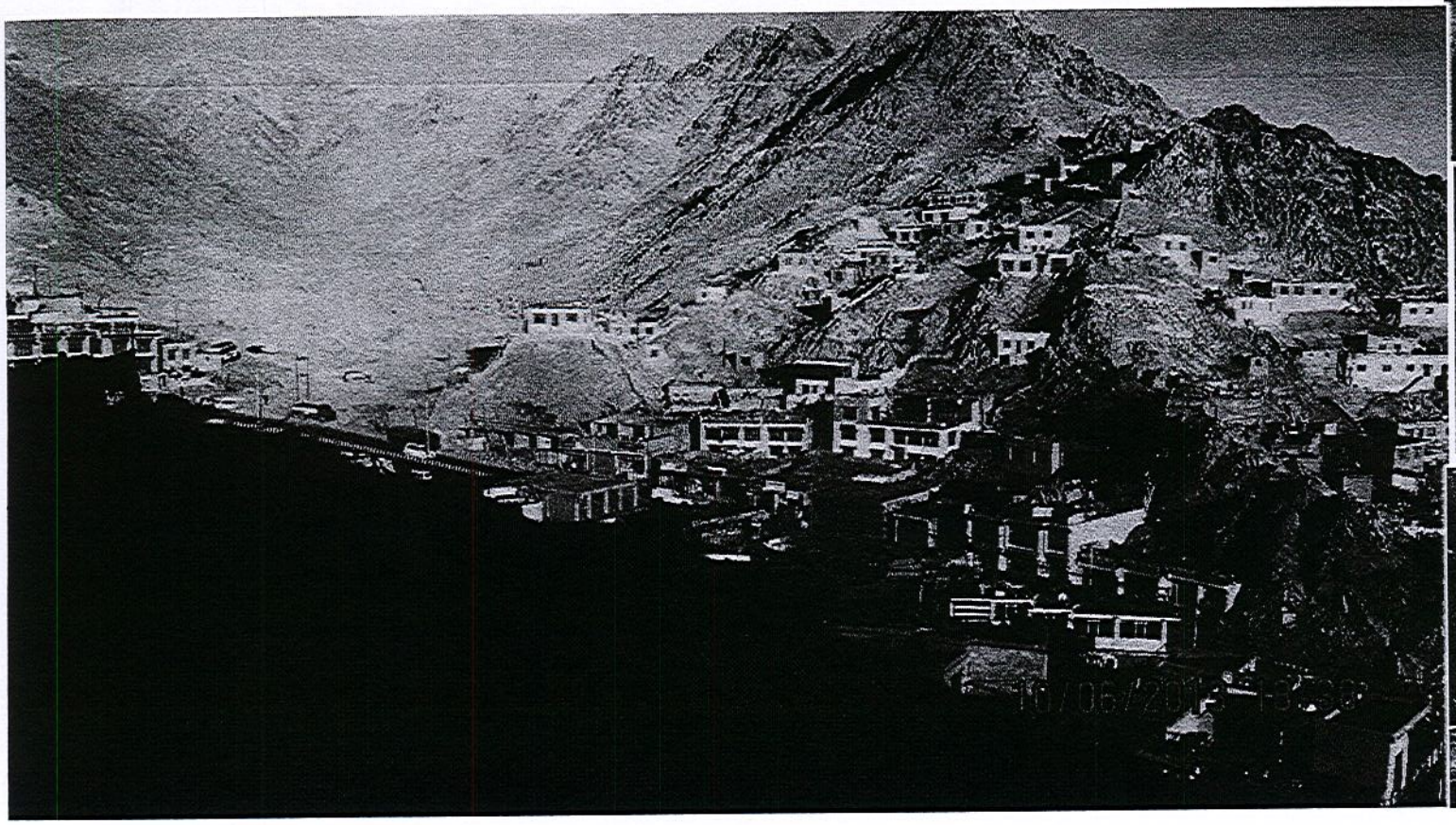


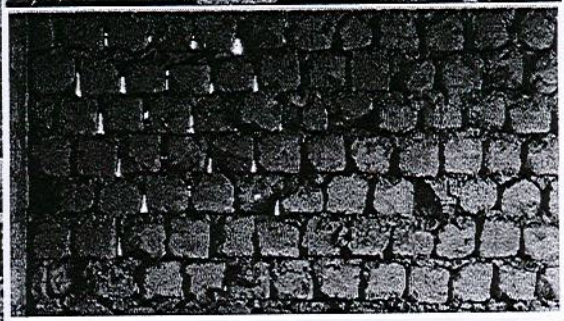
Over the years due to unsound policies of a distant government that did not understand nor respect local traditions, people slowly forgot the ancient wisdom and started building in unsafe ways with unknown materials and right in the flood paths. This was mainly due to the pressures of urban migration triggered by an unsustainable development concept. And in 2010 nature punished us severely when a flash-flood caused the destruction of some 1,500 houses and the death of roughly 700 people.

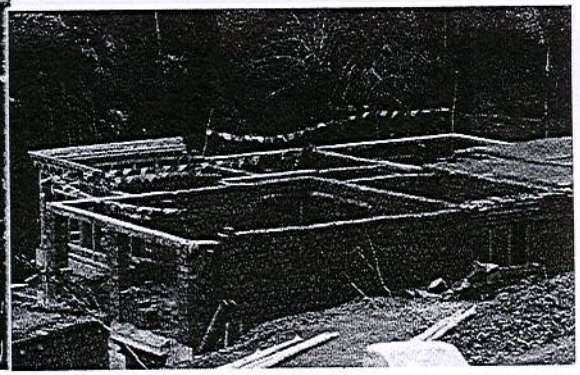
Some people ignorantly blamed the earth buildings and advocated for concrete. But it was for anybody to see that where the flashflood hit hard even concrete stood no chance and where it was mild even mud houses withstood the splashes. But it was clear that the best way to deal with flashfloods was... to avoid it.

Life as usual again...

Past Perfect, but if Present Continuous.... then... Future Tense







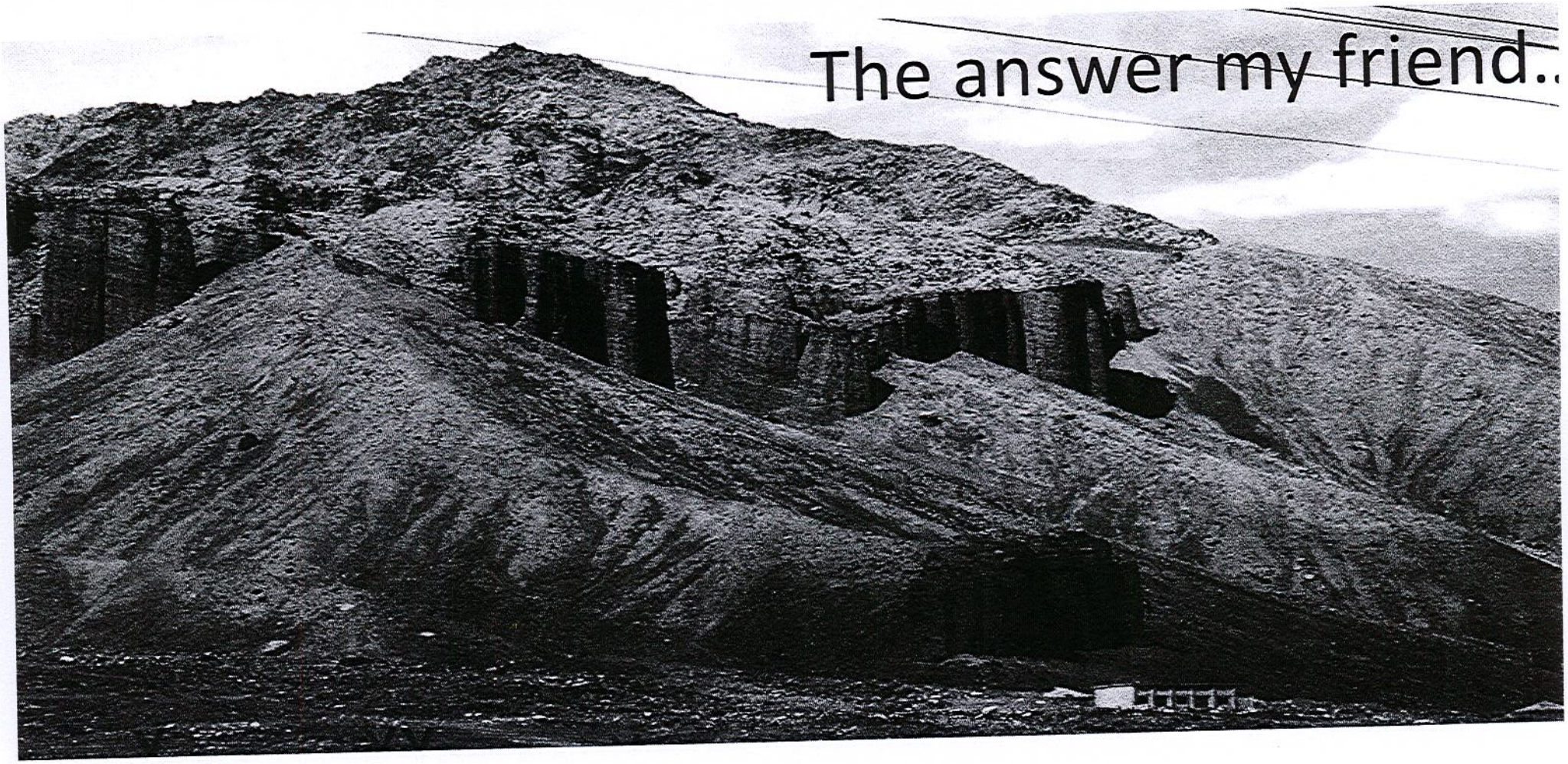
Just two years after the floods people are once again building in the same flood paths. Similarly the Kashmir earthquake of 2006 also seems to have not taught much. Although it killed 50,000 people and was right at our doorsteps — in fact the epicenter was hardly 200 kilometers away from Ladakh's border.

The stone masonry walls above illustrates a common problem with masonry in Ladakh. The stones are too short for proper bond. There are no through wall bond stones to hold the two sides together.

Adobe masonry is in no better state either. The way the bricks are laid in header courses alone and without mortar in the vertical joints is dangerous. This not only makes the walls week for earthquakes but is also a thermal disaster.

The (mis) use of concrete is most pathetic. Load bearing beams are often laid on unreinforced columns made of stacked hollow blocks. This could act like a trap in an earthquake. Ladakh has been recently upgraded to the Zone V or the most dangerous zone in the earthquake zoning system of India.

The answer my friend..



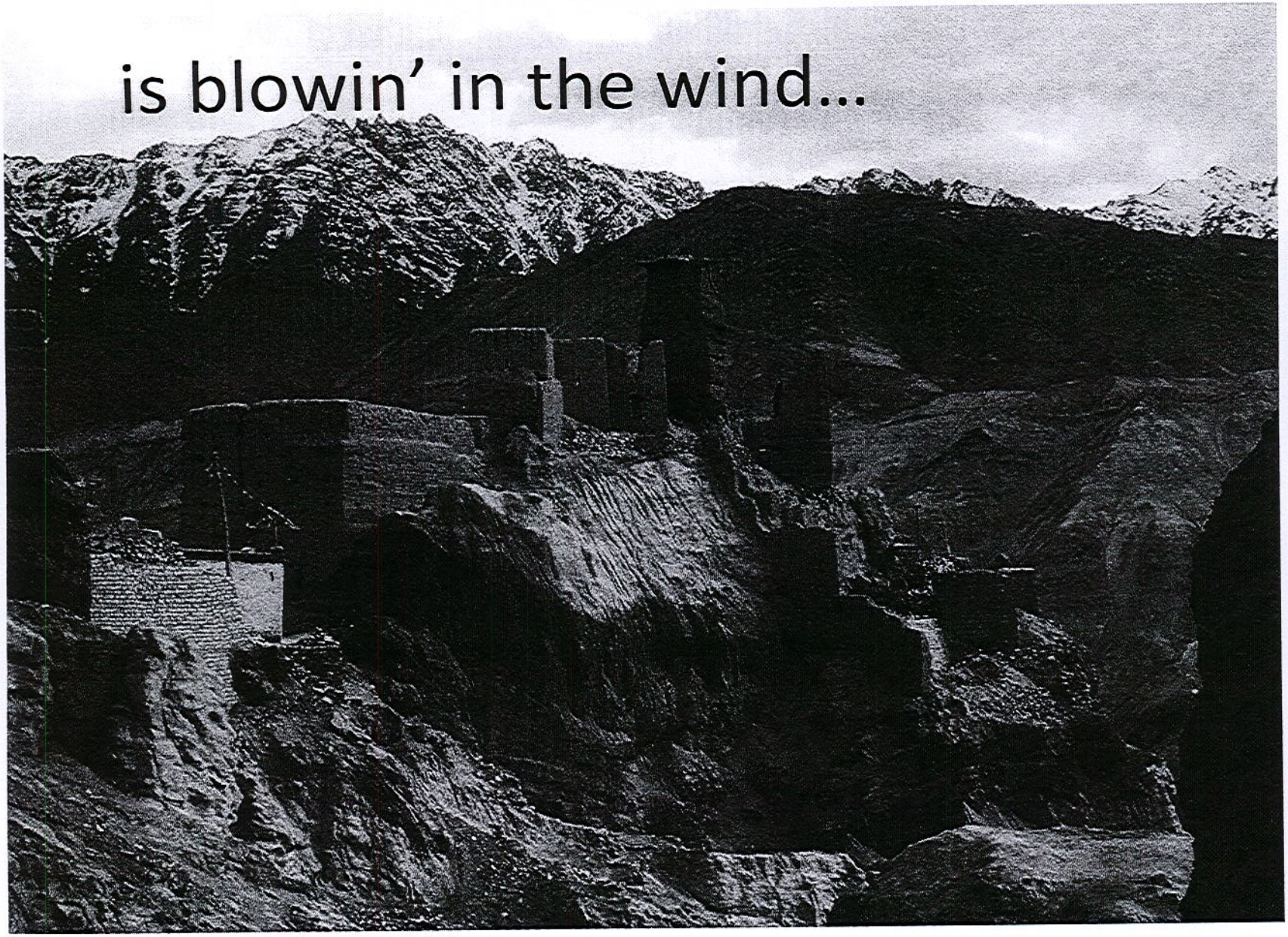
The Problem:

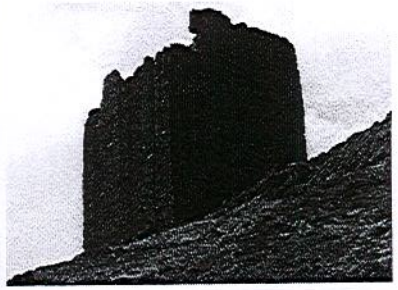
Today Ladakh is at a crossroads in its construction culture. Cement is definitely not the solution for ecological and economical reasons,. At 3,500 m altitude with winter temperatures touching – 30° C, it is actually a curse for our people and the planet.

In my search for the ideal building materials for Ladakh I found that stone is becoming very scarce and expensive in the city areas, and it also has very p insulation capacities. In any case random rubble masonry is now considered unsafe from seismic point of view. Soil tests in many villages showed that soil is too sandy for Adobe bricks. Out of 20 villages surveyed only 3 had enough clay content for adobe mud bricks. Most villages had less than 15 % fir grains below 0.075 mm (75 microns) i.e. very low binding capacity. Usually about 40% fines with a good clay content is good for adobe. Shey village whi has suitable clayey silt deposits and supplies most of the adobe used in Leh city is becoming an environmental and agricultural disaster and the suitable soil is already almost exhausted.

Yet the answer still seems to be blowing in the wind... for one look at the surrounding mountains gives us many clues.

is blowin' in the wind...





Rammed earth which uses more sandy soil with a minimum amount of clay seems to be the answer in these circumstances, as can also be seen from the many historical monuments that dot the Ladakhi landscape. For some reason the technique got lost even though the abandoned walls from up to 1,000 years have done extremely well despite being left exposed to the vagaries of nature. Hence it would be worthwhile to study how our ancestors built and what they mixed to improve the otherwise poor sandy soils to make the walls last so long.

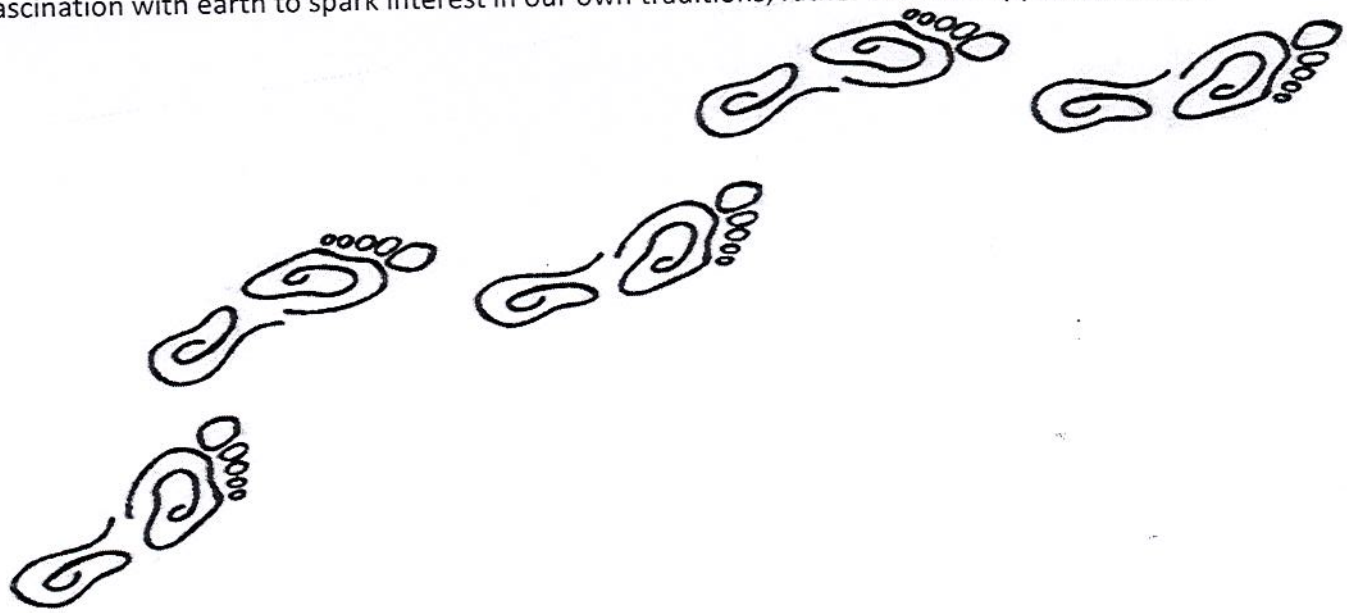
MY EARTH PILGRIMAGE

Learning from the past and the present

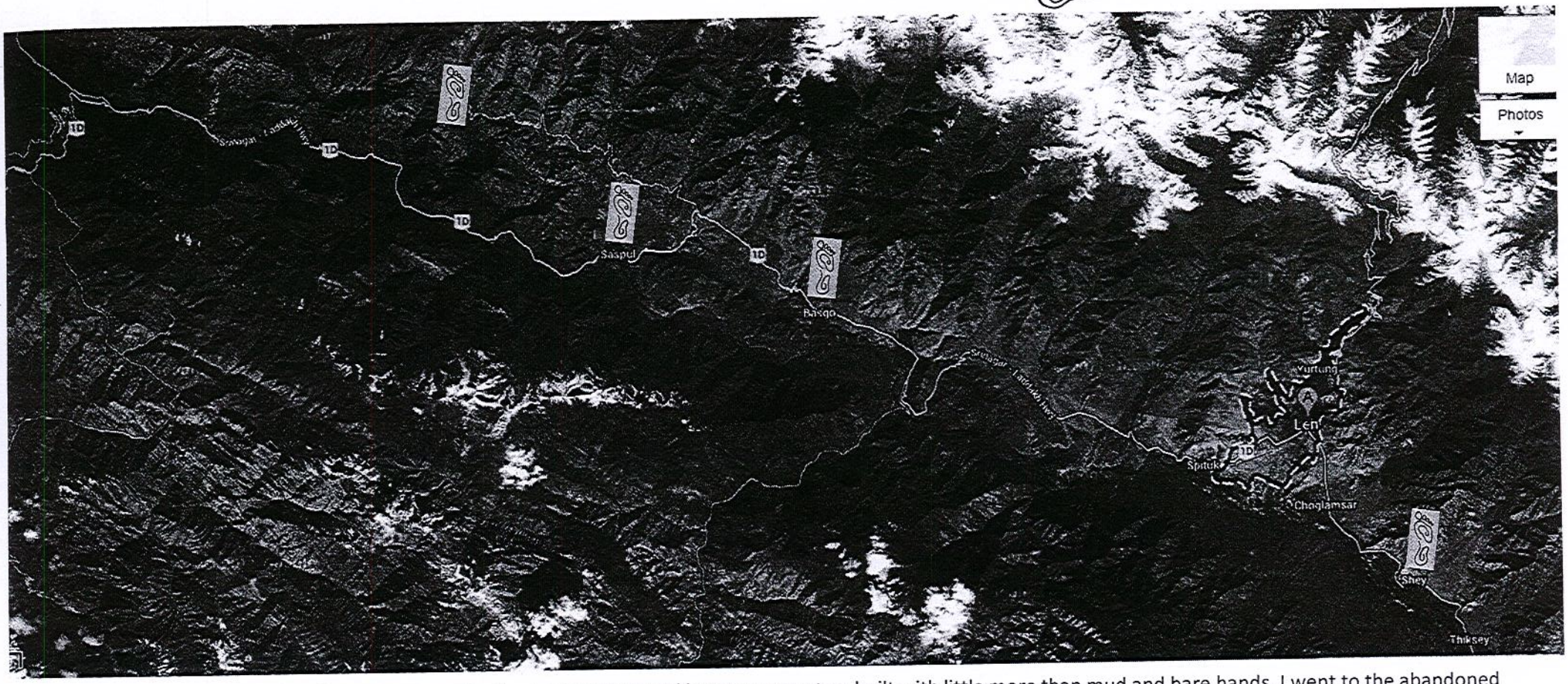
So I set out on this pilgrimage to learn more about earth. First within Ladakh to learn from what our ancestors had done. Then in the neighboring Himalayan states, and kingdoms… from Spiti in Himachal Pradesh to Mugu in trans-Himalayan Nepal, Gyelthang in Tibet to Lachen in Sikkim and Paro in Bhutan, in order to understand the living practice of traditional rammed earth. The methods used are simple and practical. Only problem is that the people in these very regions do not value it and look for trends set by the big cities and the west.

So finally I travel to different continents in the western world where rammed earth has become a fashion statement and is built in a highly mechanised way. This took me to David Easton in North America, Earth-structures team in Australia, and of course CRAterre and other enterprises in Europe.

Here was a chance to make use of the western fascination with earth to spark interest in our own traditions, rather than the opposite, which is normally the case.



Earth Pilgrimage within Ladakh...

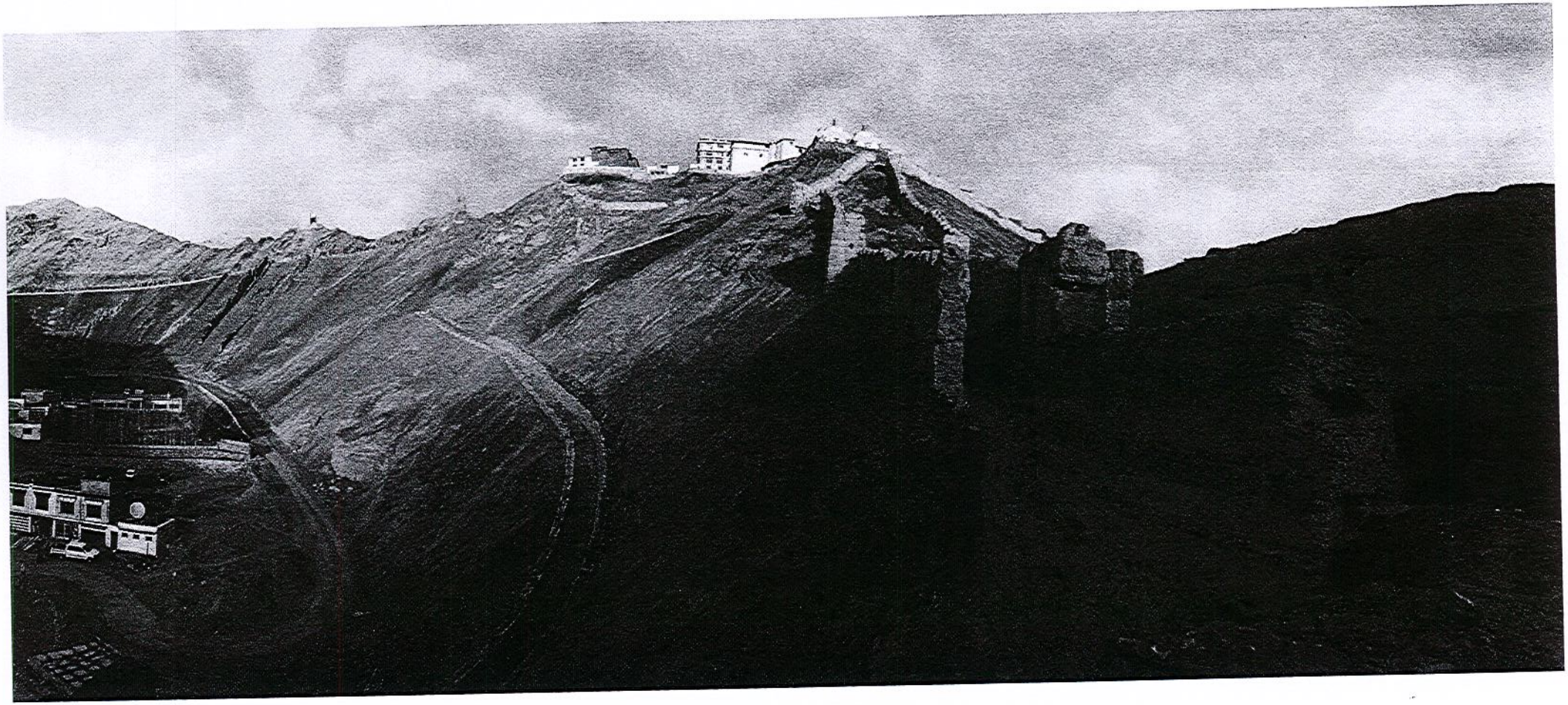


So first of all I set out to rediscover my own heritage. To understand how our ancestors built with little more than mud and bare hands. I went to the abandoned forts at Tingmosgang, Saspol, Basgo and Shey in Ladakh. These walls have been left exposed to rain, snow, freeze and thaw for up to 800 years... and yet they stand majestically. Nature could not do much harm to them but yes people (and invaders) took away the doors, windows and even the roofs for the precious wood in them but still they stand.

Since all of these walls had no protection form rain and snow for hundreds of years and since other conditions were similar it may indicate that the soil mix they used for the walls and the type of ramming they did and the density they achieved could have played and important role in their conservation.

I studied little samples of these walls in the CRAterre laboratory, to work backwards and understand what made these champion walls stand while others fell.

The forts of Tingmosgang



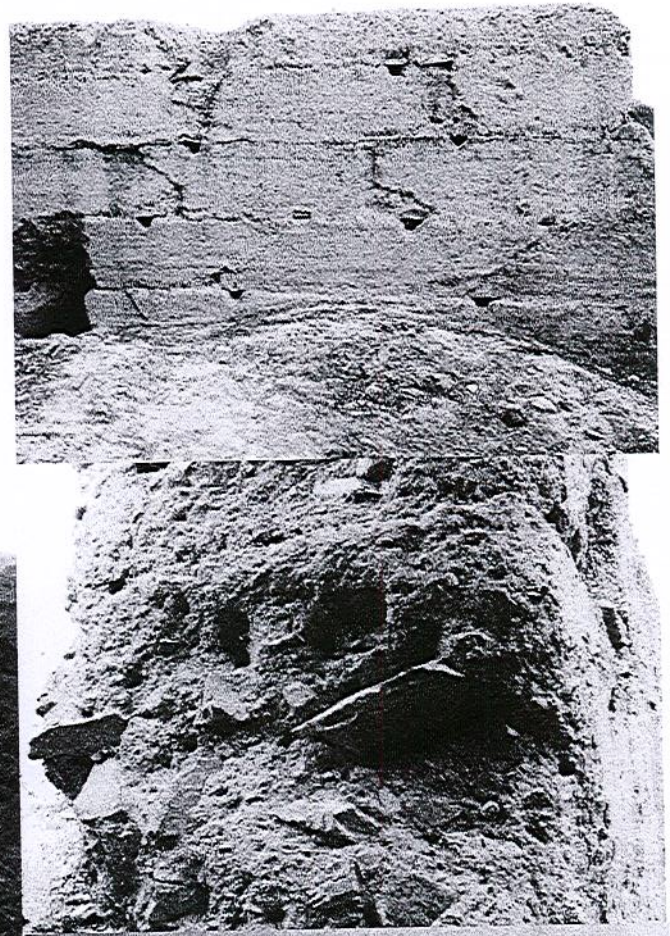
Tingmosgang

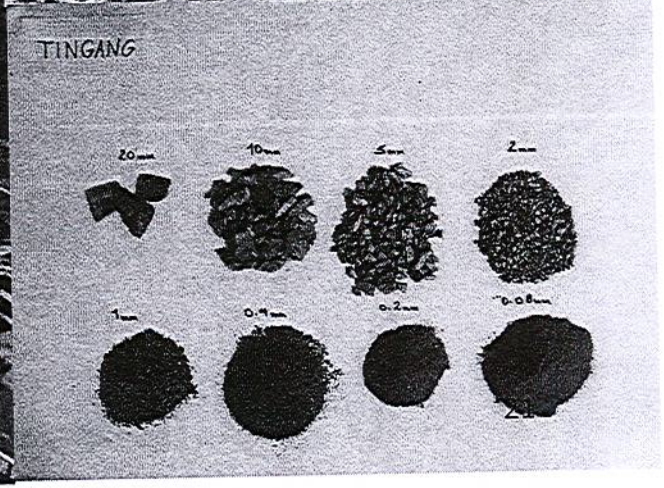
Tingmosgang lies at a distance of about 92 Kms west of the Leh. This castle was built at the time when Gragpa Bum, the 18th king of the Ladakhi dynasty, was ruling over Sham. About 500 years have elapsed since its construction.

The walls were 100 cm to 80 cm wide, and the height of each filling of the formwork roughly 80 cm. Largest grain size was roughly 20 cm rocks. The soil was very gravely and seemed have been collected from the same hill side. It actually seemed more like packed earth than rammed earth.

Wall Sample density: 2.15 Kg/l

Further Lab test results of the soil analysis are yet to come.





The Fort of Saspol

The Fort of Saspol

Saspol fort lies on a plateau above the village of sapol, 61 Kms from Leh city. Very little is known to historians about this Fort/palace. It is four stories high and the walls are of roughly one meter thick.

It seemed lightly packed as in packed earth. There were no lift marks of ramming, it was all uniform.

Layers are reinforced with branches of sed shrub(colutea mesantha)

The local soil was very sandy but the source of the purple clay mixed was 300 m away.

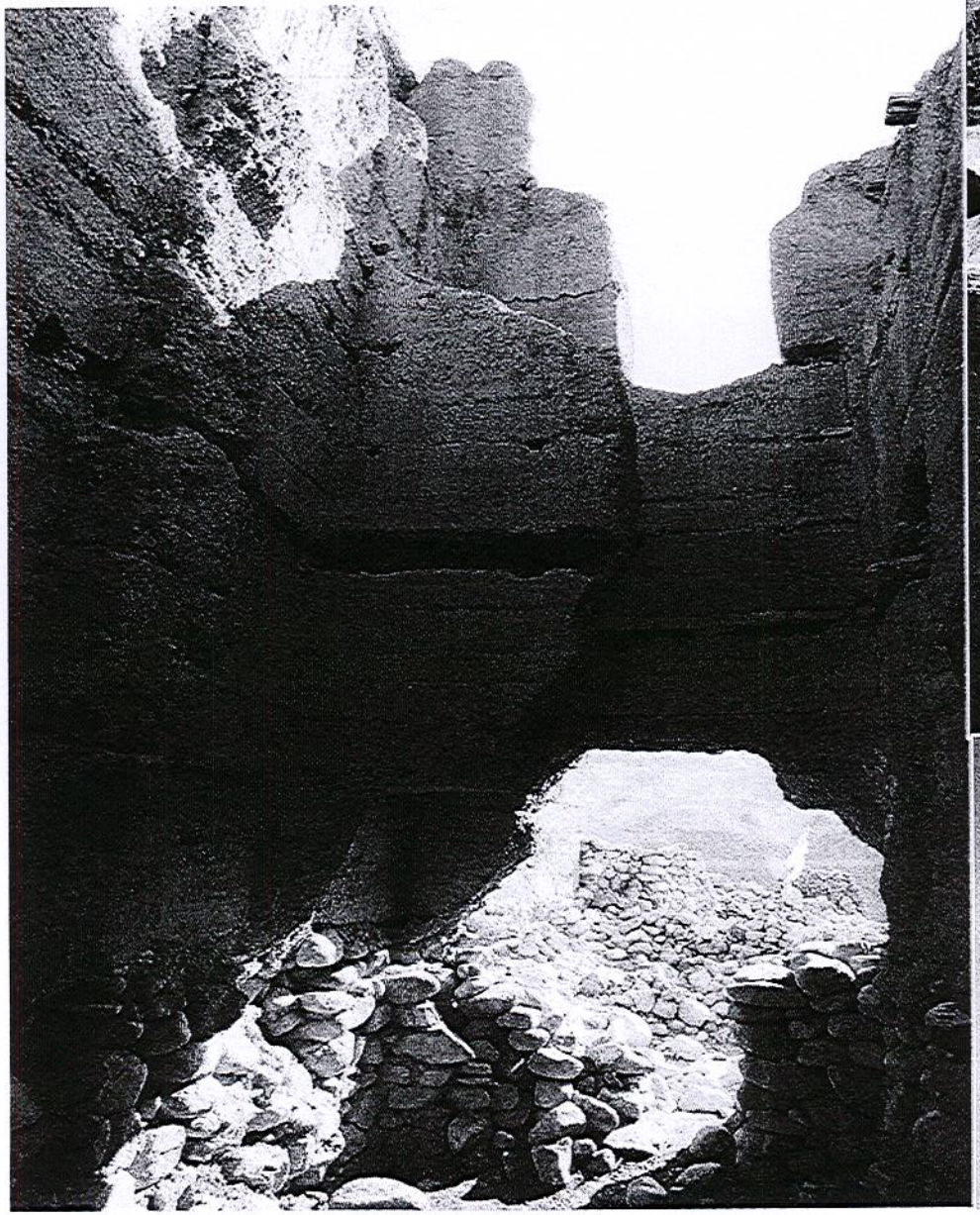
The formwork heights varied from 80 to 100 cm.

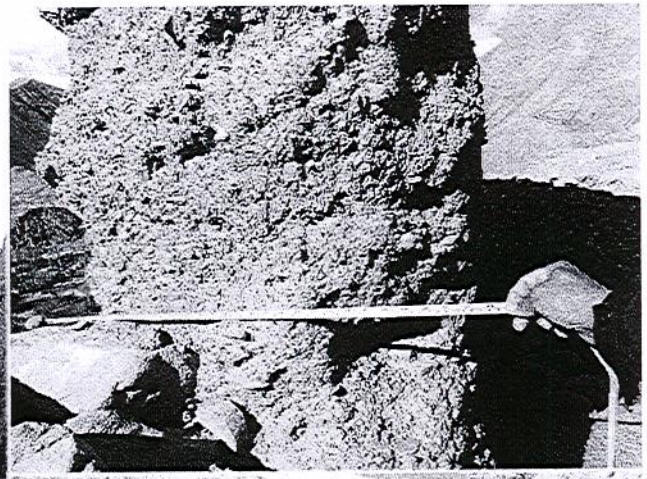
Wall thickness: 85 to 95 cm,

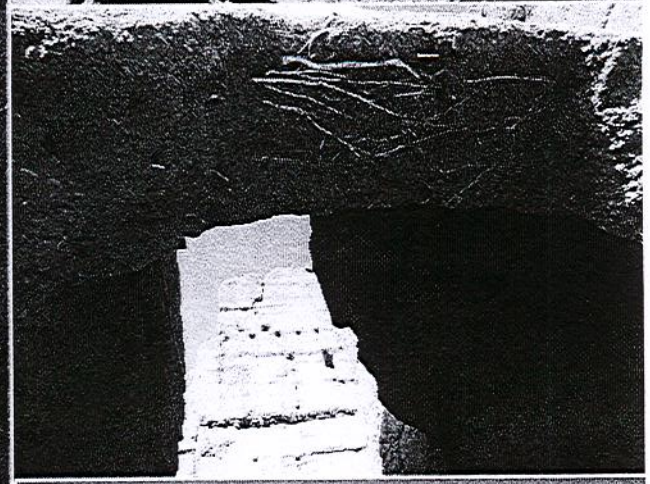
Largest grain size: 7 cm.

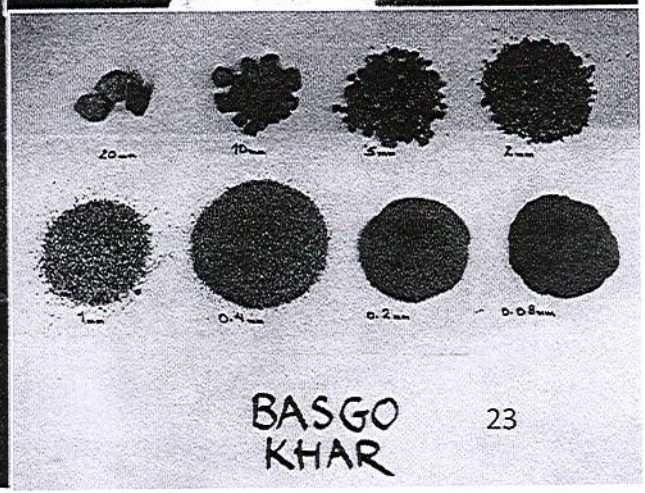
Wall sample density: 2.2 Kg/l

Further Lab test results of the soil analysis yet to come.

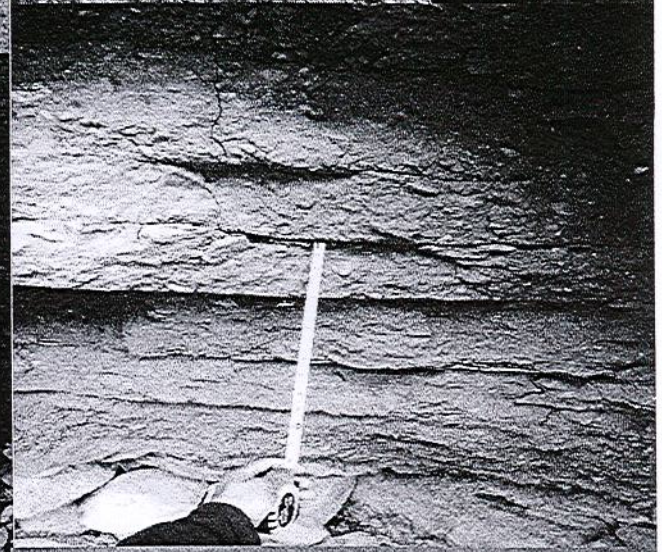


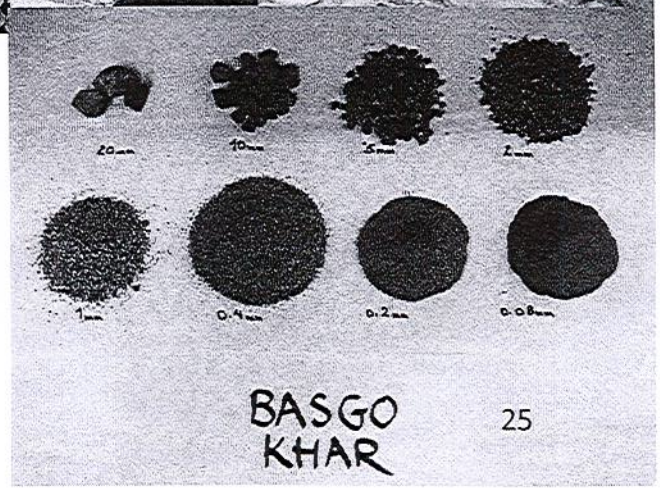






The Basgo Palace





Basgo Castle

The site at Basgo consists of four distinct structures, three temples and a fort. The fort (Basgo Rabtan Lhartsekhar Castle) was built first and is the only structure made from rammed earth. Basgo was the capital of Ladakh before 1357, and it is possible that the castle dates from that period.

Unlike previous two, at Basgo the walls were really hard rammed and the density was very high.

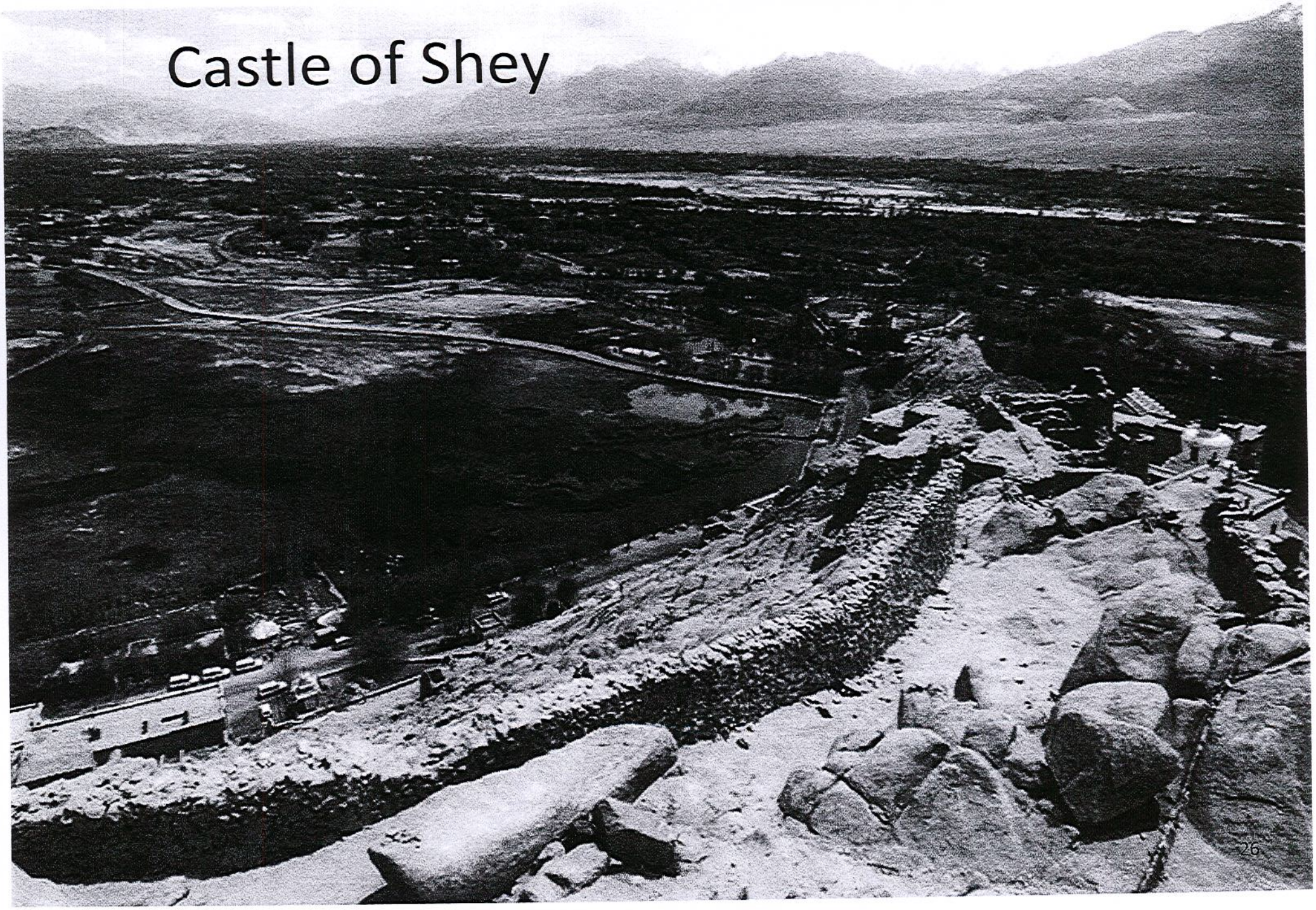
The lifts could be seen and they were 8 cm each. Wall thickness was 120cm,

height of formwork was 80 cm, length of formwork 3 m

Wall sample density: 2.3 Kg/l

Further Lab test results of the soil analysis yet to come.

Castle of Shey



Shey Castle

Shey was the first capital of Ladakh and remained so until 1550, when the kingdom was consolidated and power moved to Leh.

All that currently remains is a length of rammed earth wall, founded on bedrock and extending up from the road to the current monastery. It was also well rammed like in Basgo but the soil was very silty.

The marks of erosion along the lift marks are very visible.

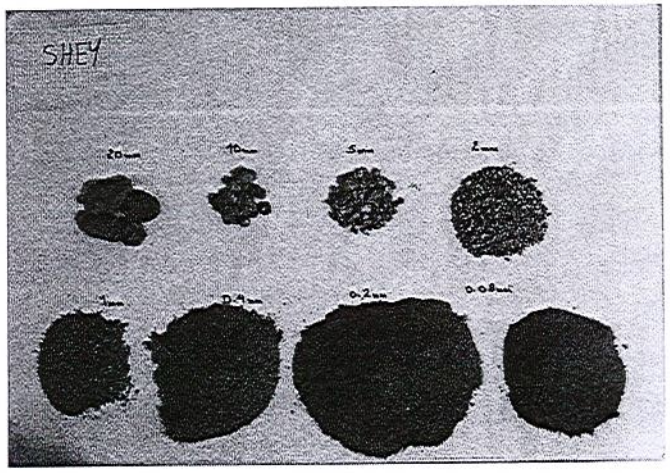
Formwork height was 80 cm, wall width 1 m.

Ramming lift heights were 8cm,

Wall sample density: 2.0 Kg/l

More lab results are awaited.

Further Lab test results of the soil analysis yet to come.



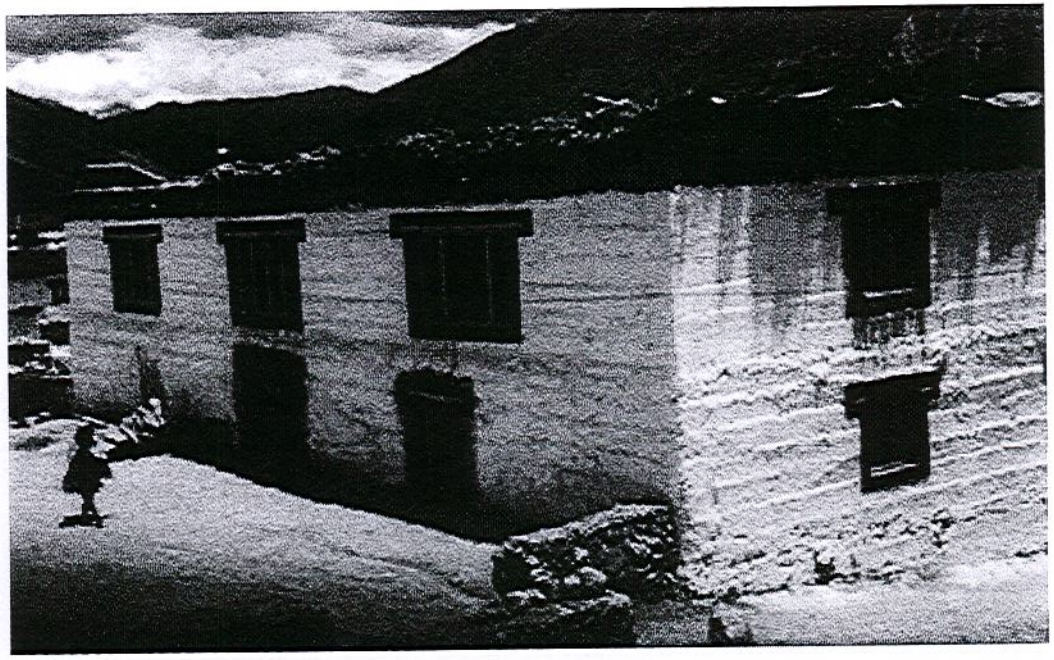
EARTH PILGRIMAGE IN HIMALAYAS

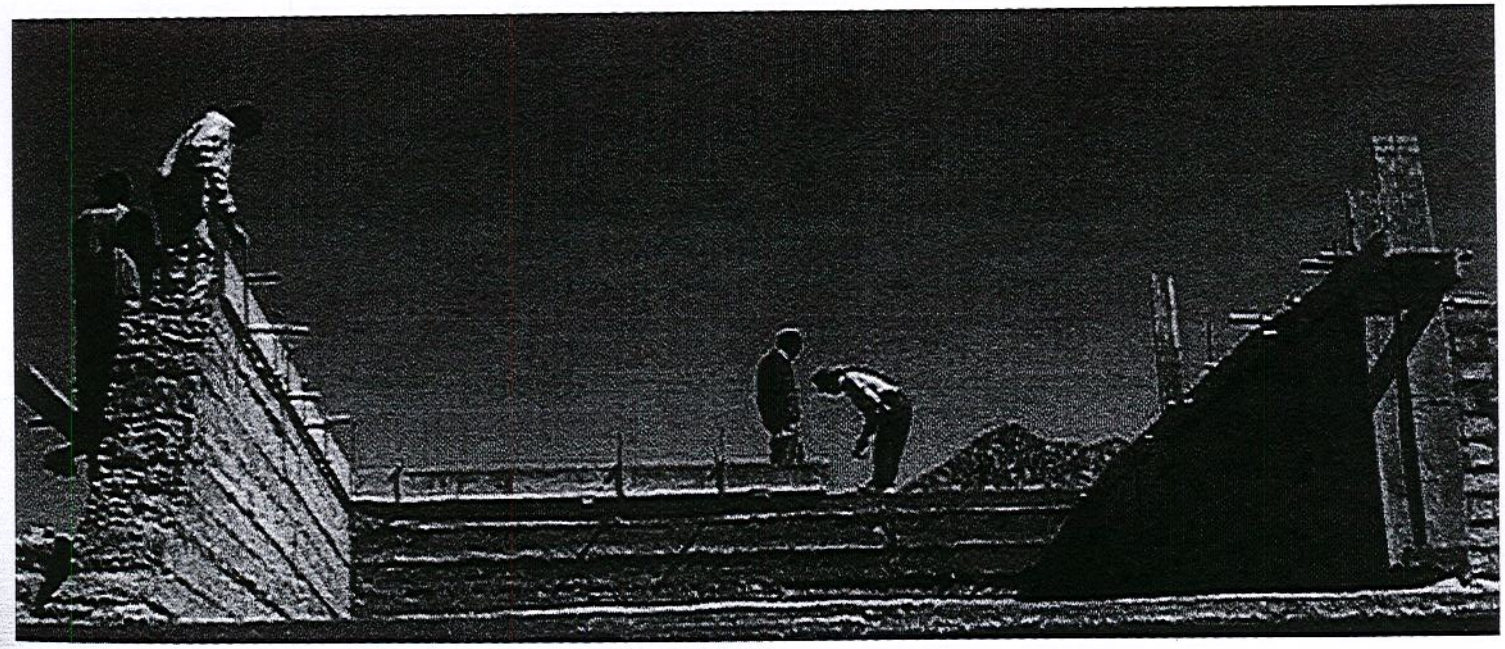
Although rammed earth technique was lost in Ladakh, it is still practiced in many parts of Himalaya as the principal building technique. Therefore I carried on my pilgrimage to other parts of Himalayas starting with Spiti in the neighbouring state of Himachal Pradesh. At different time I went also to Mugu in the trans-Himalayan part of Nepal and Lachen in Sikkim and Paro in Bhutan. I also travelled to Tibet in China where rammed earth is a great traditions. I tried to look at the technique as well as the social processes around it. For example in most places rammed earth houses are built as a community activity with all the villagers coming together in turns to whoever needs a house built.

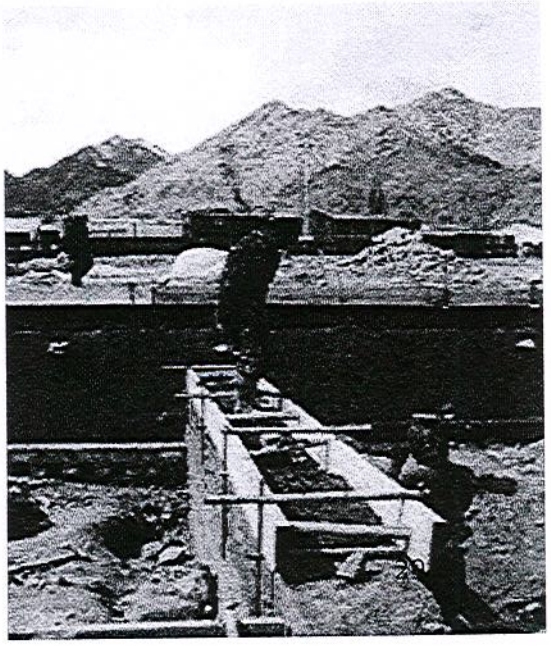
It is often accompanied by community songs specially conceived to follow the rhythm of ramming.

Spiti

- Spiti and many parts of Ladakh shared this technique of what might be called packed earth. The soil mix which is normally gravely sand with little clay content is packed with feet and only lightly beaten with a wooden hammer. The product is lighter than normal rammed earth and therefore more insulating. Often there are some shrinkage cracks in the wall but they are not structural and are covered by the plaster. Some houses just whitewash over the rammed walls and do not use plaster.
- The soil was mostly gravely,
- Wall thickness was 40cm and formwork height 25cm.
- 7 people built one round of roughly 35m length in a day of 8 hours.
- Productivity: 0.06m^3/person/hr

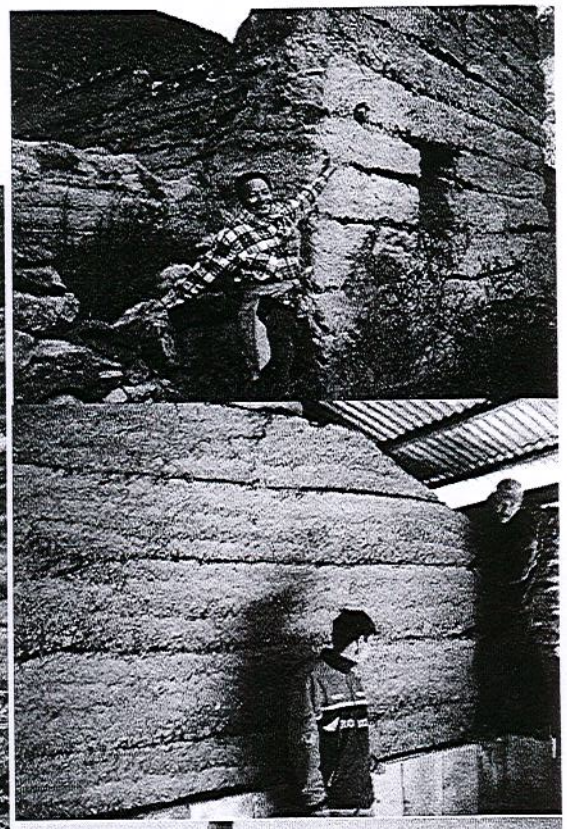


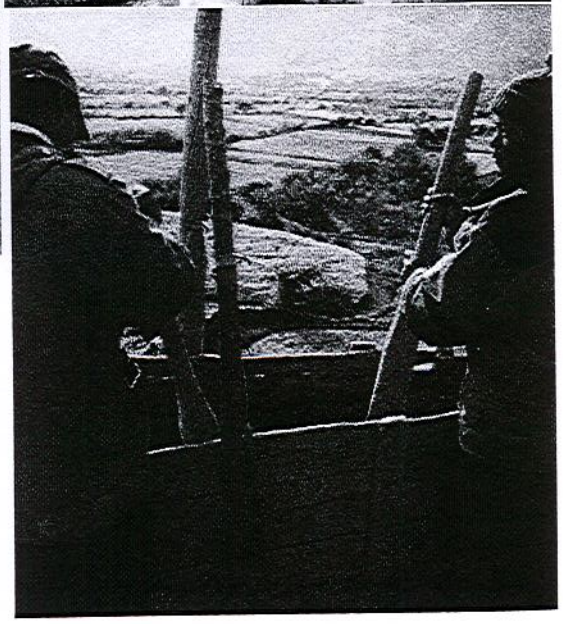




Mugu Nepal

Trans-Himalayan Tibetan part in Nepal





Kimri is a village at around 3,400m of altitude in the remote Mugu district of Nepal. Kimri is inhabited by people of Tibetan ethnicity and their language, culture and construction techniques are closer to Tibet than to the rest of Nepal. There were centuries old ruins of rammed earth temples and current village monastery and most houses were all built with rammed earth and they had just built a primary school using this technique.

The soil is quiet suitable for rammed earth with enough clay content.

The formwork used was 40 cm high and the wall thickness was 45 cm.

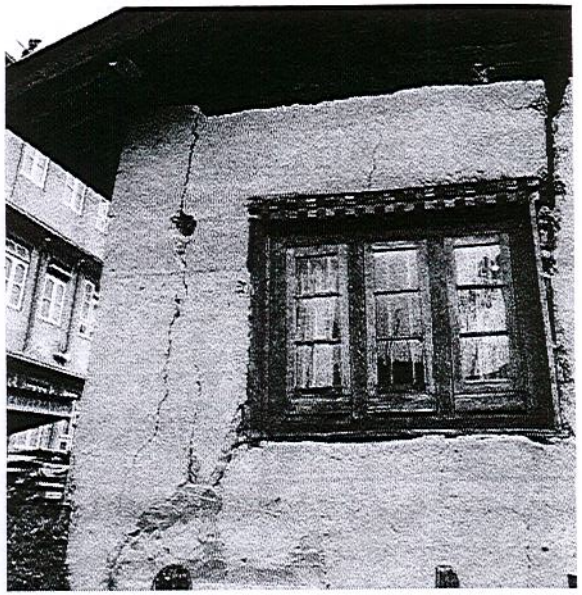
It was difficult to measure productivity as it was built by volunteers with random timings.

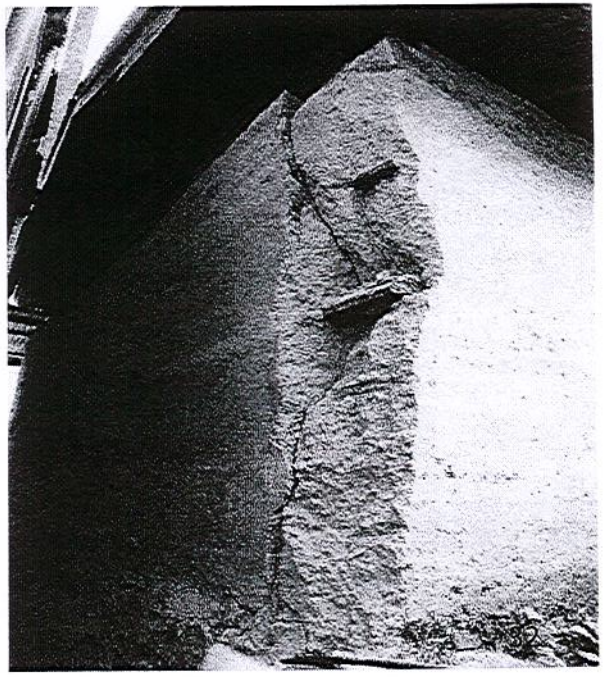
Tibet

Tibet has a great tradition of rammed earth from millennia. Most monasteries and forts are made of rammed earth. The sandy soils found in most places adapts very well to the technique. During my visit there were no current buildings happening as it was not yet the season for construction. Therefore I took the information and the photographs from my friend Yeshi Gyetsa of Gyethang region situated at 3,400 m of altitude.

The community gets together to take turns to help those needing a house built. The double headed wooden rammer is a part of the belongings of a household and the volunteers come with their own rammers at the site. Ramming is accompanied by songs and the ramming takes the form of a sort of dance.

They have a very special way of installing the formwork. Long beams of 7 to 8 m are installed in pits on the two sides of the new wall to be constructed. These poles stay put during the whole construction process and support the planks of the formwork in all the courses. All it takes is binding the upper side of the poles with ropes or wires, just above the formwork. Again it was not possible to obtain any reliable information on productivity as it is an organic community activity and I was not there to observe.





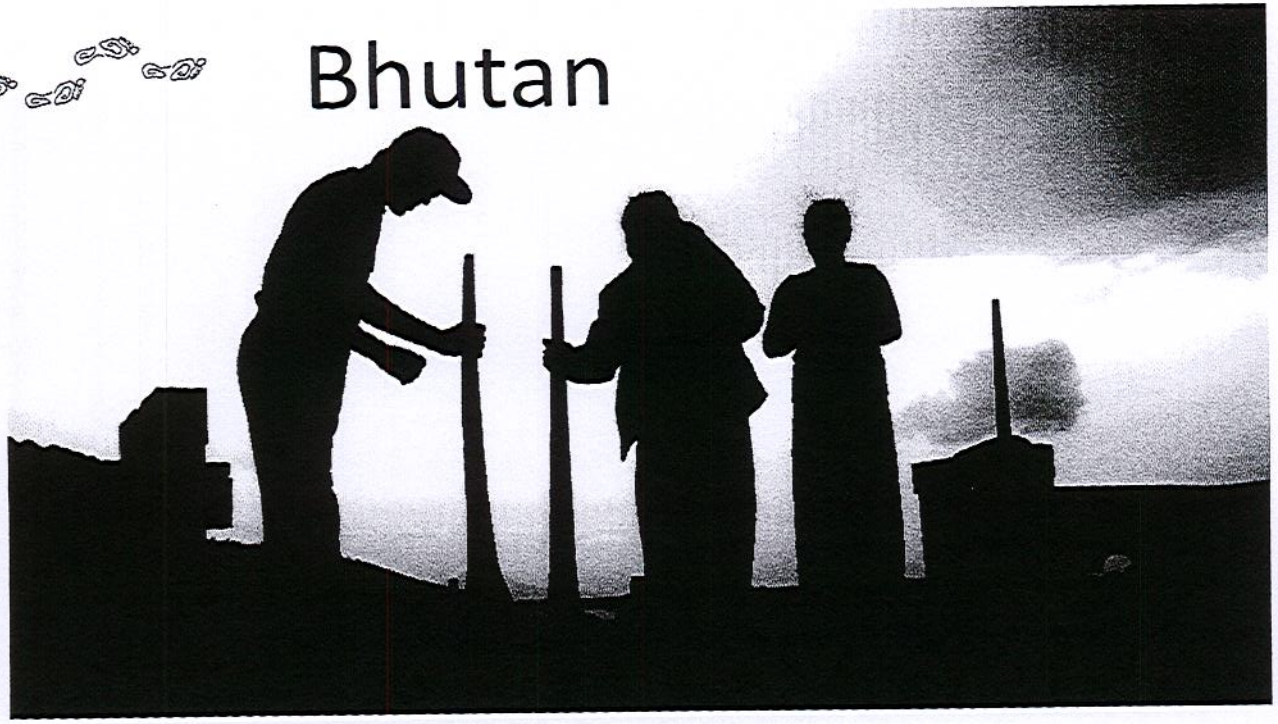
Sikkim

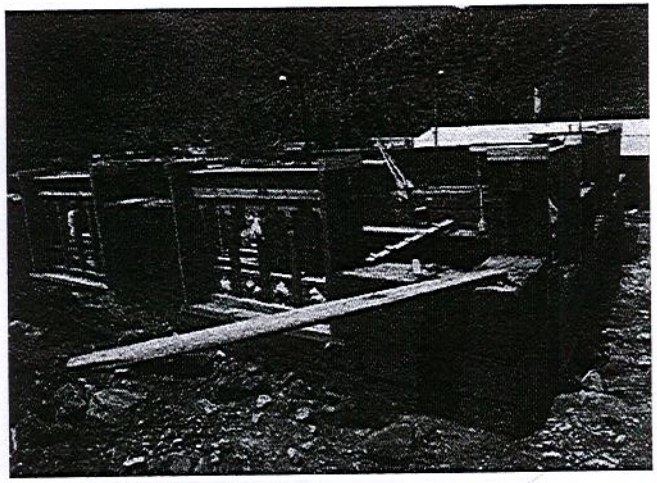
A sad story

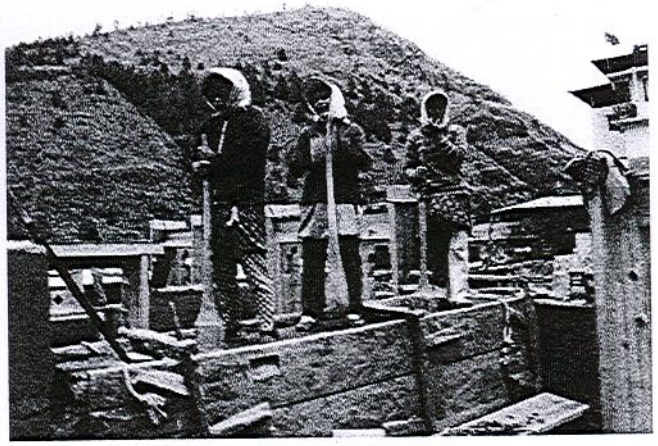
Sikkim was an independent kingdom till 1972 and then it became a part of India as one of its states. The demography and the culture changed in a big way since then but the remote villages of Lachen and Lachung in upper Sikkim are still considered somewhat original. However my visit in 2011 was a sad one to see that tratditional construction practices are all nearly dead in Lachen and Lachung. People have all moved to 'modern' concrete houses as can be seen in the picture. The rammed earth house in the foreground was damaged in the earthquake and the owners abandoned it for the concrete house in the background. There were no new traditional earth buildings built in Lachen area in the past 10 years.

Moreover the earthquake in 2011 damaged many of the remaining traditional house as also the concrete ones. The main damage in traditional rammed earth houses was mainly the corners that split. Therefore Sikkim present good lessons particularly for corner reinforcements and tie beams.

Bhutan







Rammed earth is the principal building technique in most parts of Bhutan. It is an interesting example for the other Himalayan regions like Ladakh because Bhutan has significant rains and yet that does not seem to deter them from continuing their earth traditions. However it is also true that in the recent years the younger generation had started looking down upon earth as a poor man's material. Most fortunately for them Aman Resorts one of the best high-end resort chains in the world recently built a chain of resorts in Bhutan using contemporary rammed earth while still maintaining the traditional architectural features. The locals tell me that this has done a lot in reviving the image of this technic. At present the government is making an effort to standardise the technic.

Traditional rammed earth building process is a community activity in Bhutan with many villagers joining hand. The men take care of the formwork installation while women do the ramming and there is always a song that is sung to go with the rhythm of ramming. On this site near the road from Paro to Thimpu the soil was rather clayey and there were several cracks in the walls but plasters cover them up.

The form work was 50 cm high and 3.5m long, wall width was 50 cm.

EARTH PILGRIMAGE TO CONTEMPORARY WORLD

South Asia

buildaur

I met Mr. Dharmesh Jadeja of Buildaur. They have been building in rammed earth for many years in Auroville international town near Pondicherry. Rammed earth is generating a lot of interest among both the international residents of Auroville and the Indian elite outside. During my visit Buildaur had just got and request from the famous Indian actor Kamal Hasan to build his house in Chennai.

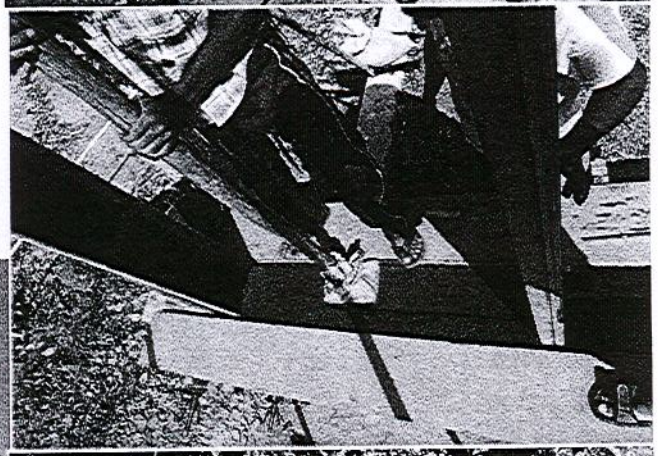
They use a modern from work that owes its origins to REW USA and CRAterre.

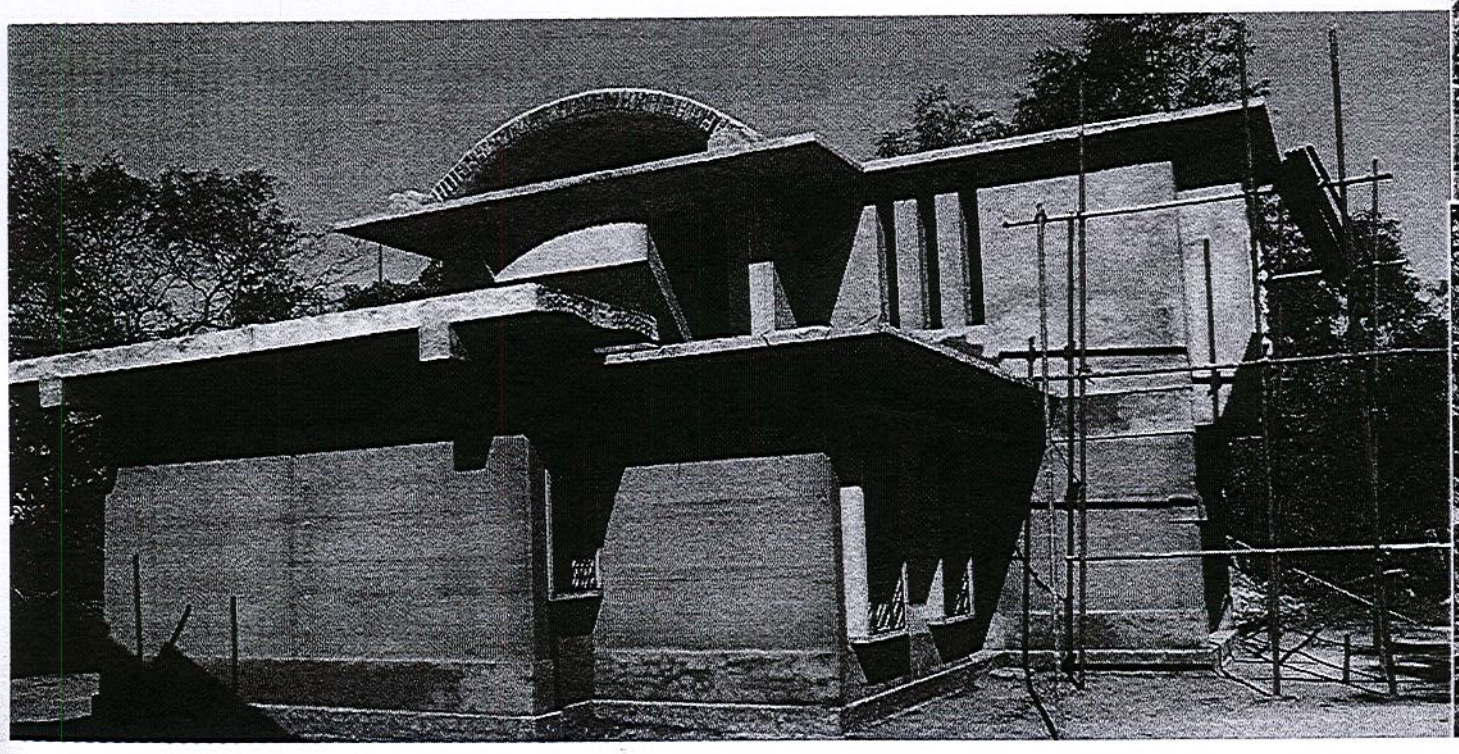
All processes are manual, they use no machines whatsoever.

All walls are stabilised with 6% cement.

Productivity: 1.2 m^3 with 8 workers per day i.e. 0.02 m^3/person hr.

Diesel fuel consumption: 0 lit/m^3





North America

RAMMED EARTHWORKS USA

I met Mr. David Easton in Napa Valley California, who is one of the pioneers in rammed earth technology in the world.

They build almost always with cement stabilisation of 5 to 8%

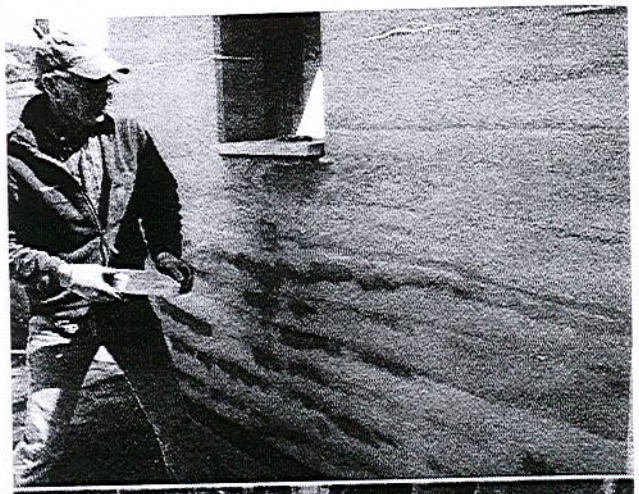
For bigger projects they use an auger type soil mixer with automatic feeder and conveyor belts for soil delivery,

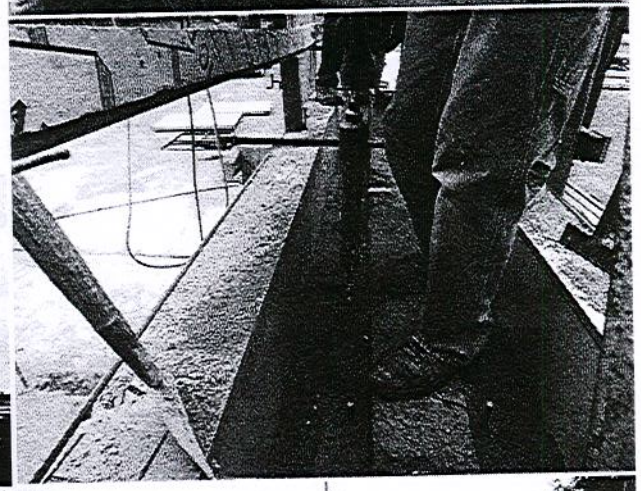
Productivity estimate: average 19 m^3 per day with 10 workers i.e. 0.24 m^3/person hr.

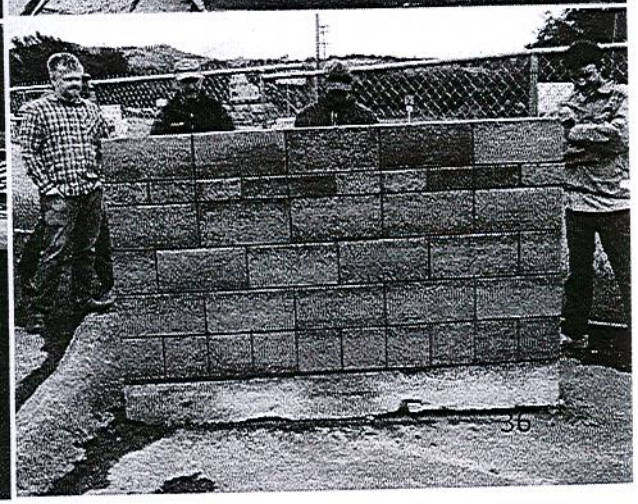
Diesel fuel use estimate : 3 lit/m^3

Due to the use of more efficient machines for mixing and delivery their efficiency is much better than others who use the bobcat for all purposes.

But sadly due to the economic crisis, David was moving away from rammed earth and towards what he calls rammed earth blocks (see pic) which are a form of compressed earth block.







Australia

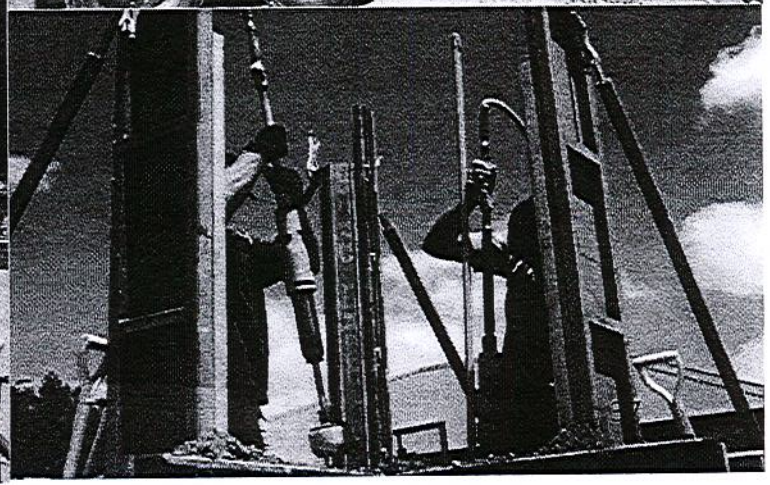
EARTH STRUCTURES

Earth Structures is one of Australia's major rammed earth companies. I met Mr. Scot Kinsmore on a site in Torquay.

Like all others in Australia they use only cement stabilised rammed earth with 6 to 8% cement to achieve a compressive strength of 12 to 18 Mpa.

Productivity: average 3m^3 per day with 4 persons i.e. 0.093 m^3/person hr

Diesel fuel use estimate : 6.7 lit/m^3

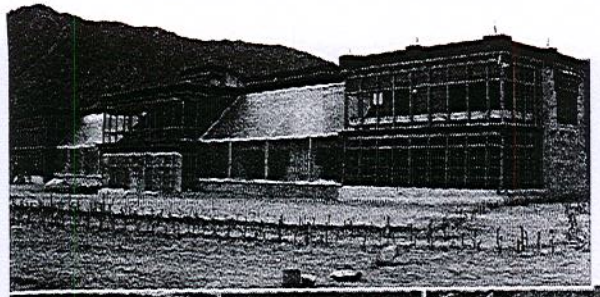


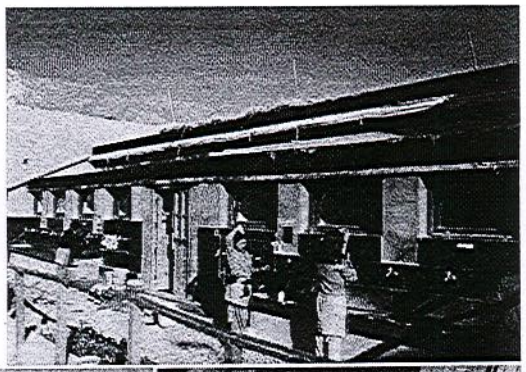
Solutions for Lab

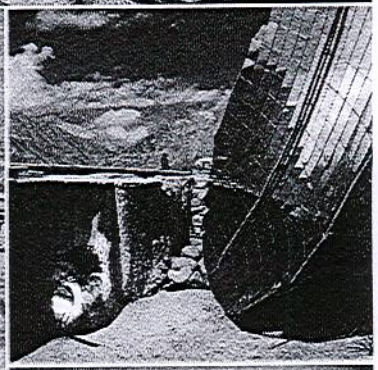
SECMOL Campus

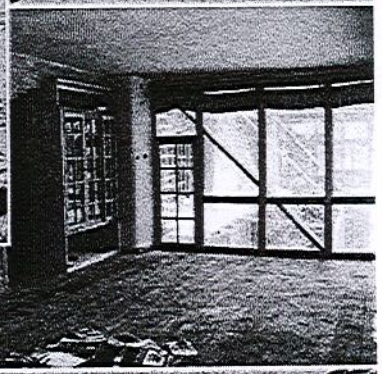
Best of both the worlds

Where traditions meet the modern
Sun meets the Earth



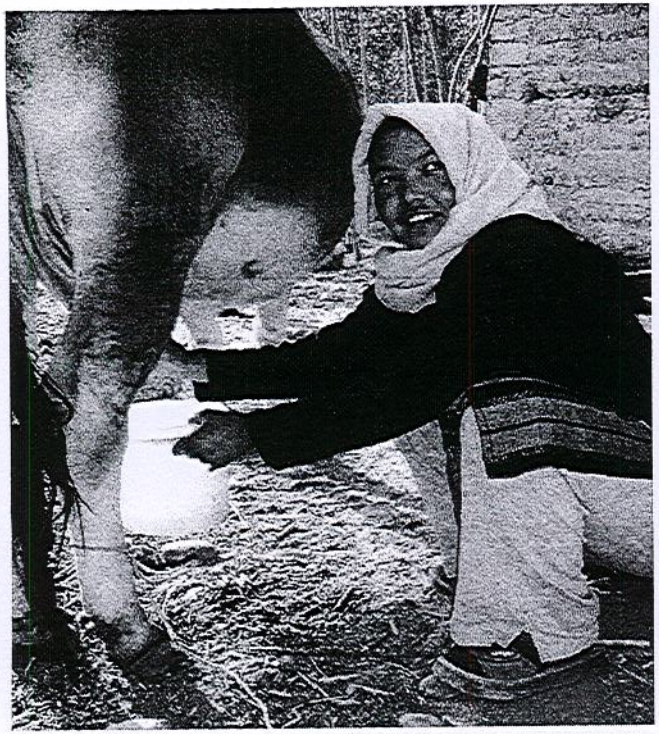


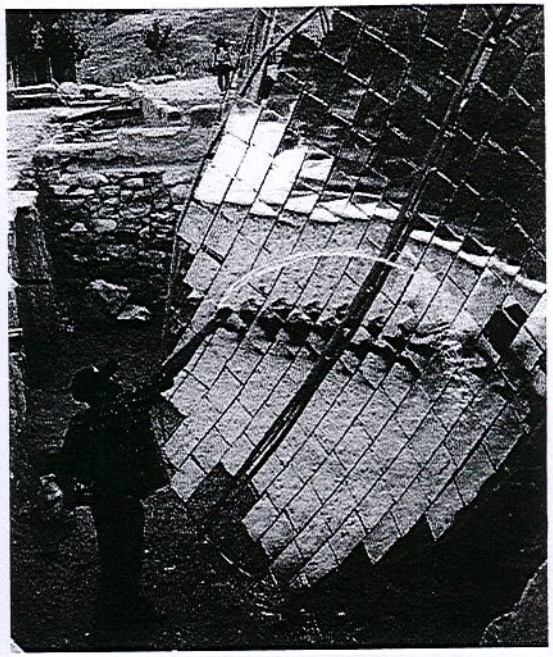




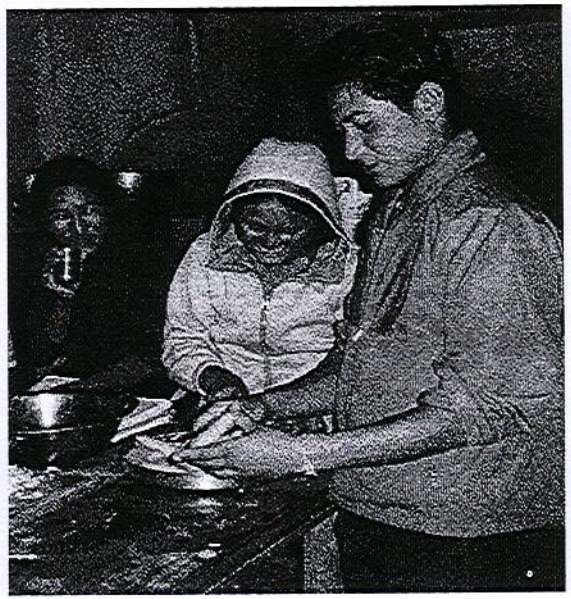
At SECMOL alternative campus we have tried to make the three precious resources of the universe meet... the sun, the earth and the human. To show that when human ingenuity meets with a material like earth and an energy source like the sun, both of which are abundantly available to all – rich or poor, man can live comfortably without harming others.

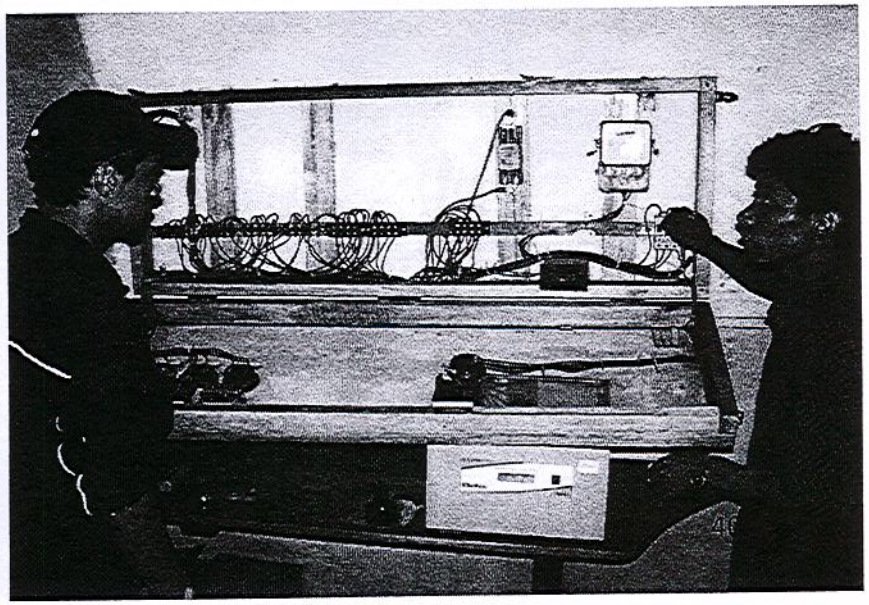
At this campus earth is the material and sun is the energy source for almost every thing from space heating to lighting, cooking, water heating, water lifting and so on. Solar green houses provide organic vegetables while the solar heated cowsheds and hen houses keep the animals warm and enhance productivity in winter.





The Campus is managed by the students themselves



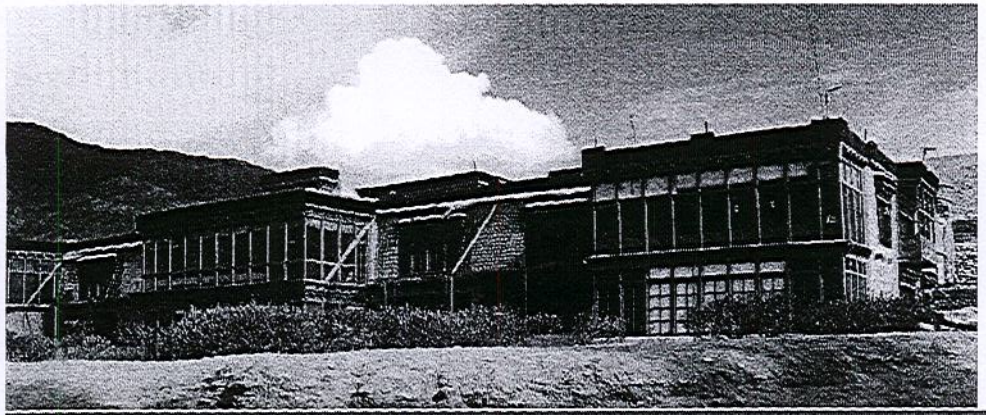


The Middle Path

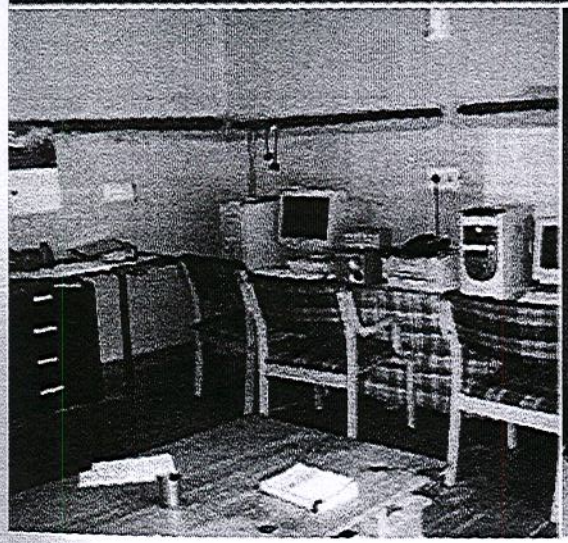
14° C is not very warm by international standards even if its feels less severe due to low humidity and mass in the Ladakhi air. But In Ladakh where winter temperatures drop to – 30° C and indoor temperature in the local houses drop down to below freezing, we consider 14° C a middle path where human comfort can meet harmony with nature.

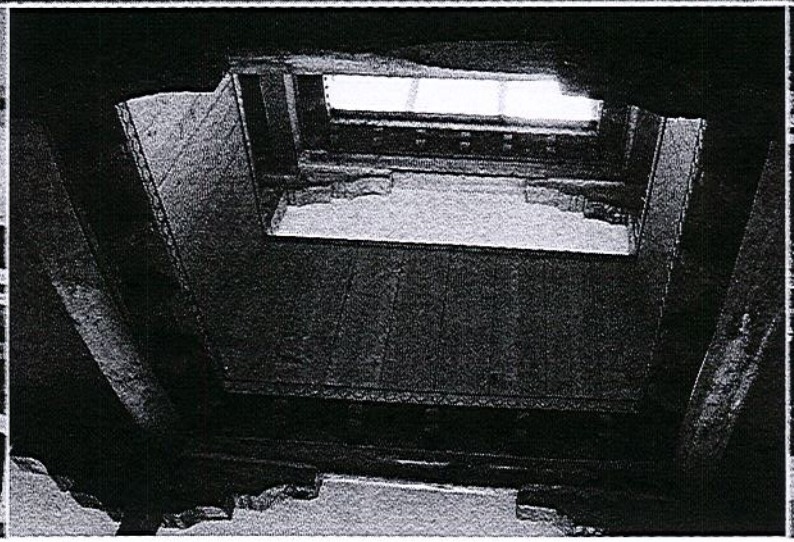
Average temperature during the day + 14 ºC

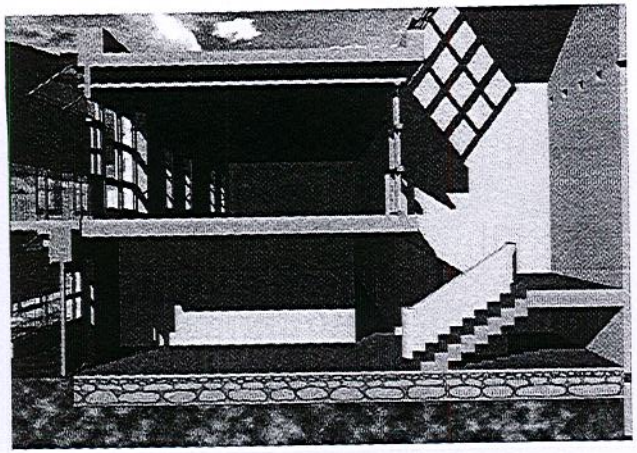
Minimum at night + 10 ºC



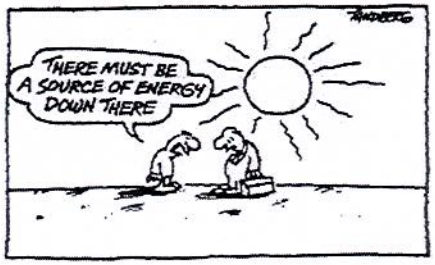
A happy blend of traditional and modern



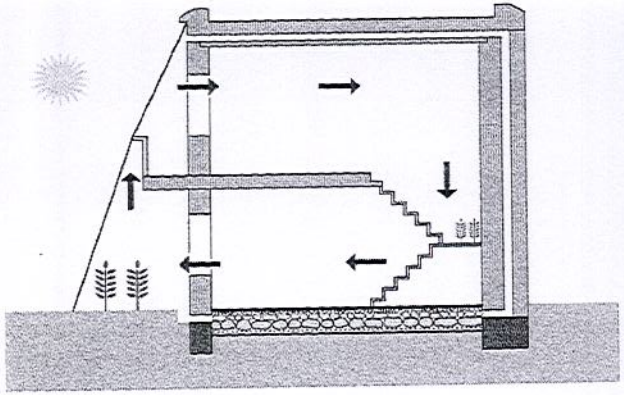


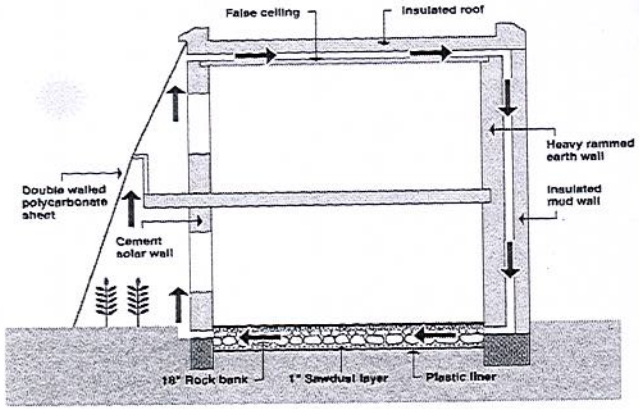


Let the sun shine



A Training Centre we built for the Indian army. Uses only solar heating in winter.



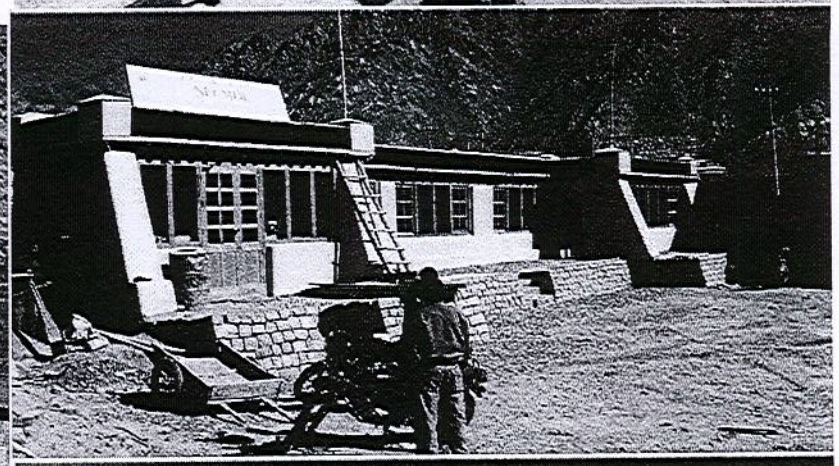


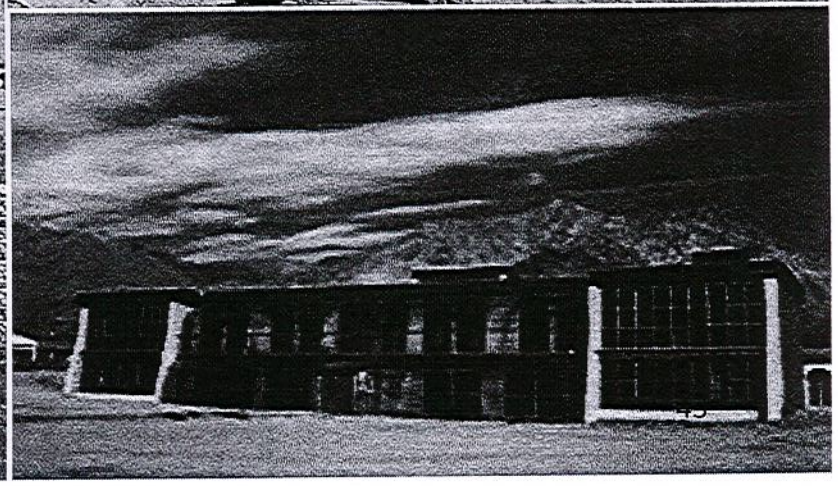
on the earth

Sharing the experience

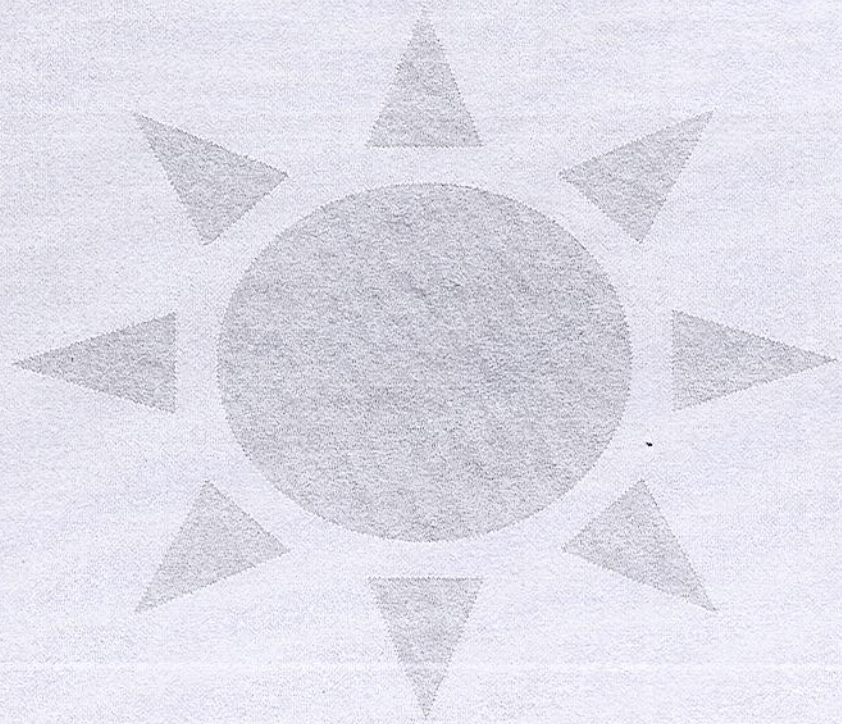
These buildings at our Campus evoked interest in the people in Ladakh and neighbouring countries. Schools in Ladakh, Nepal, Bhutan and even the Indian army approached us for such solar heated mud buildings. We built several such buildings but beyond a point it was not possible nor sustainable for an NGO to help because the primary goal of SECMOL was education reform.

This gave birth to a new innovative approach to promoting the earth. I started a small project to train young enthusiasts to launch small earth construction enterprises. And found innovative solutions to most of the issues facing earth construction in Ladakh, particularly in rammed earth. This was much more sustainable as it provided creative employment to the youth while providing a service to the community.





INNOVATIONS



to move the earth and the sun

Leh city covered in smoke of domestic heating on a December morning

and to save Leh city from the fires of hell…

A New Approach to move the earth and sun...

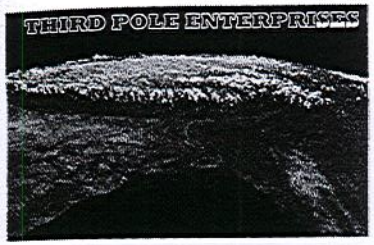
Shesyon Entrepreneurship Hub

Promoting earth is rather a tricky issue, especially in the developing world. People associate it with poverty and backwardness.
With due respect to the good feelings practices of the development person, I think the reality is that people have an urgent need almost a necessity to show that they are not poor. They have a need to be included among the tribe... the fear of being left out socially is as important as fear of hunger or shelter once the primary needs are met. I think this must be recognised as any other need or necessity like food, clothing and shelter, if we are to be successful in our projects.
Sometimes even those promoting earth do a lot of damage by promoting it as a low cost material for the poor. I am specially scared of development agencies who look at it as a means of low cost housing and often label it as that. Once that happens the stigma becomes even stronger and even the poor do not accept it. There fore it is important that such promotions happen at both ends of the economic spectrum...
Therefore in Ladakh I have tried to let the earth move by itself. Our strategy is to first promote a renaissance of the earth among the rich and influential which would then be followed by others as well.
The idea is also to put in place a system of execution that evokes a sense of pride among the population.
And for this, first of all I launched the **Shesyon Entrepreneurship Hub**:

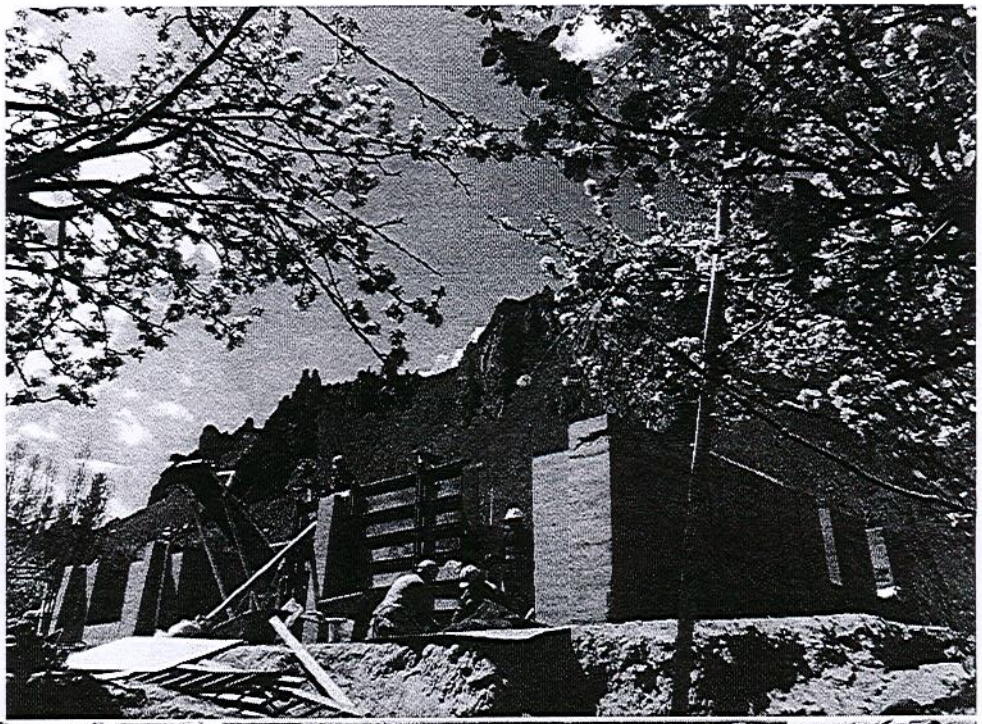
Shesyon Entrepreneurship Hub

The hub helps promote the entrepreneurships of young enthusiasts who are trained to build world class cotemporary earth houses and are continuously mentored. The idea is that the clients get a valuable service with all headaches taken away while Ladakhi youth get creative employment and ... the earth moves on its own without external funding and support as is often the case with development projects.
The first company is already launched and is called the '3rd Pole Enterprises', it aims to build world class solar heated modern rammed earth buildings. In future there might be other companies launched that use other suitable earth-construction technologies apart from rammed earth.
As a mechanism for sustainability for both the hub itself and the new companies it launches, Shesyon also makes financial investments in the new companies so that it is in its own interest that the companies are successful in every possible way.
In order to introduce the most efficient and cost effective techniques in Ladakh we observed the latest in contemporary rammed earth and adopted them, only after adapting them to our context.

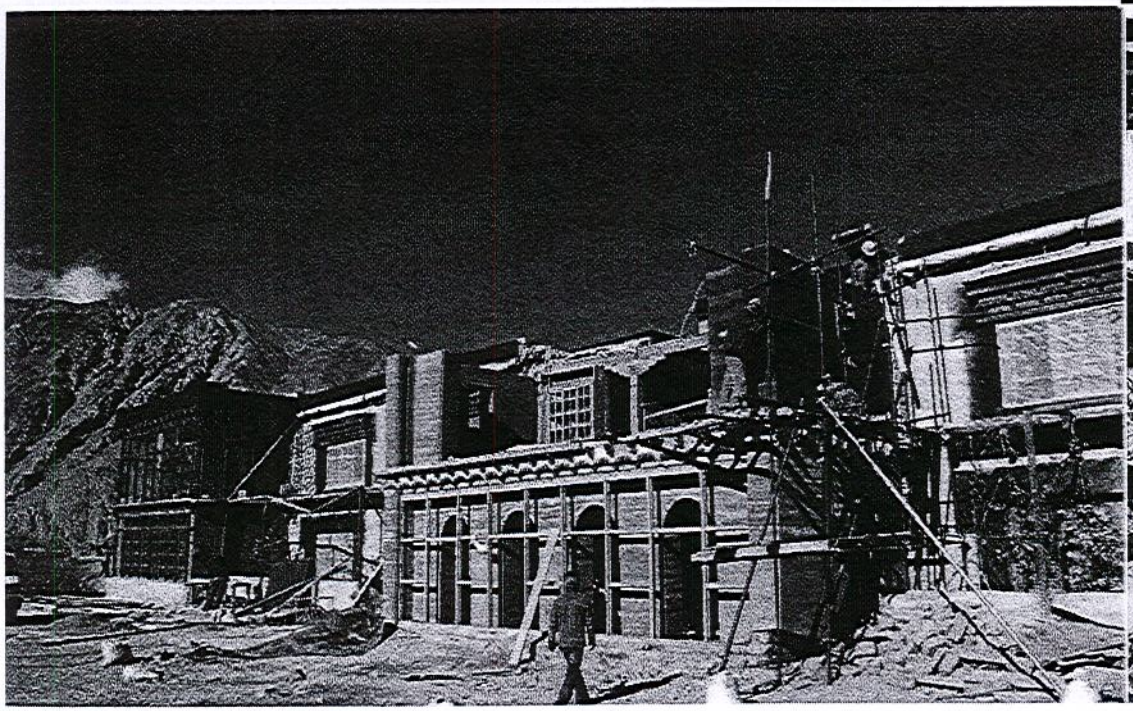
Whether it was the challenge of dealing with the unsuitable soils in Ladakh or deciding the extent mechnisation needed I made many experiments and had to find our own answers to all the problems...

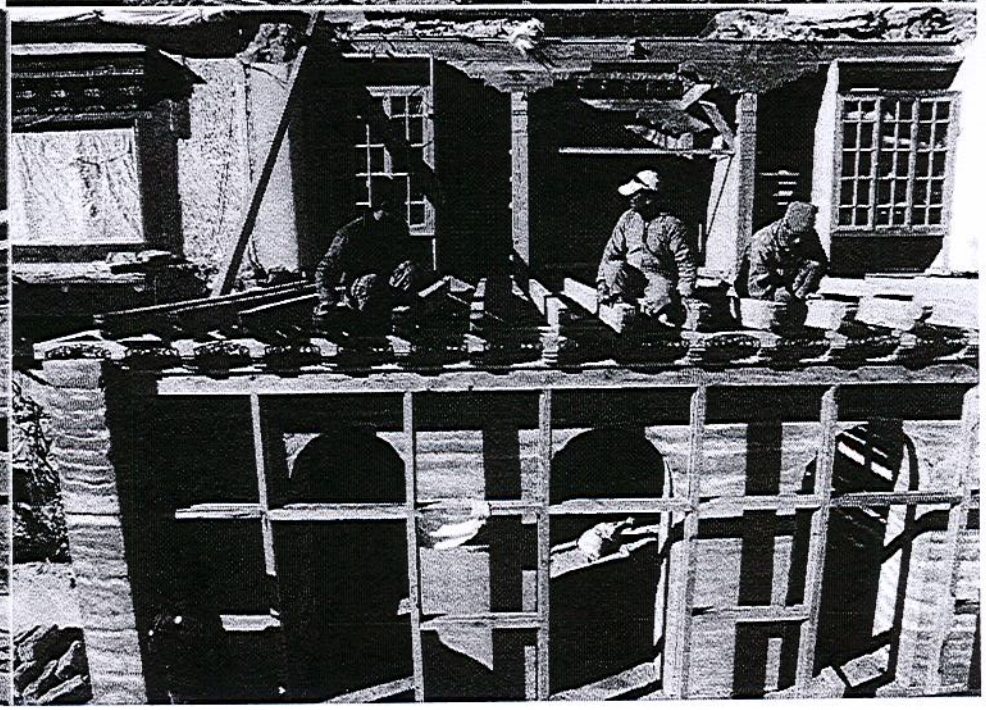


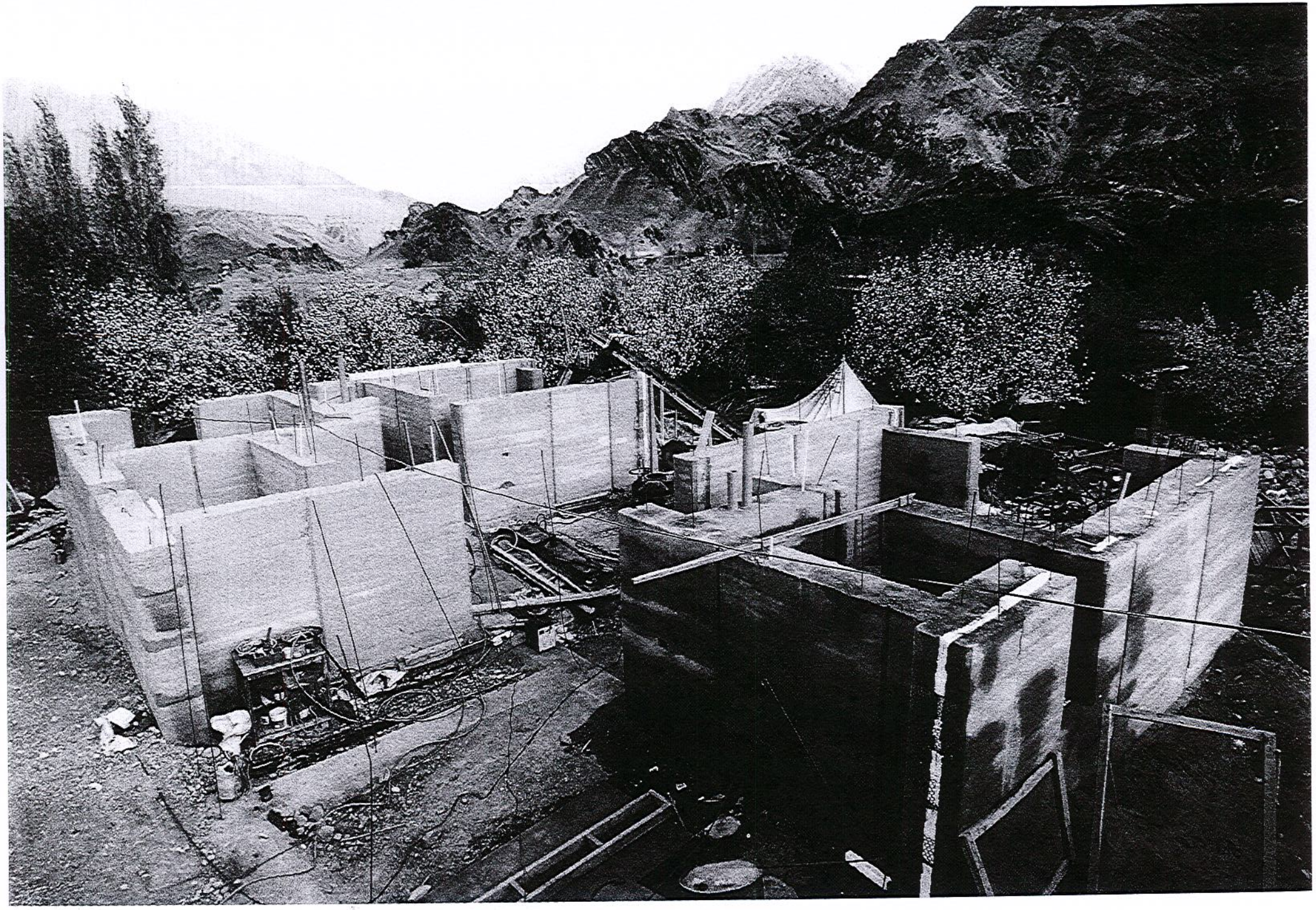
A company with a difference



With help from the Shesyon Entrepreneurship Hub this company was set up last year. Three projects have already started- one in Leh city, one in a village tourist resort and one at the SECMOL Campus. It tries to make an agreeable blend of traditional and modern architectural features. It uses mostly traditional materials but has tries to mechanise the processes as labour is in short supply in Ladakh. The houses this company builds are not costlier than normal houses that people presently build in Ladakh with stones, mud bricks and cement frame structures etc. This is because the company believes that its profits should come from innovation, mechanization and waste prevention and not so much from the pockets of the clients. However the difference will be that these houses will be earthquake and flood resistant and will not go below +15° **C** even in Ladakhi winters... of course heated only by solar energy.







The challenge of sandy soils 1

INNOVATIONS

Clay slurry technique to solve the sandy soil problem.

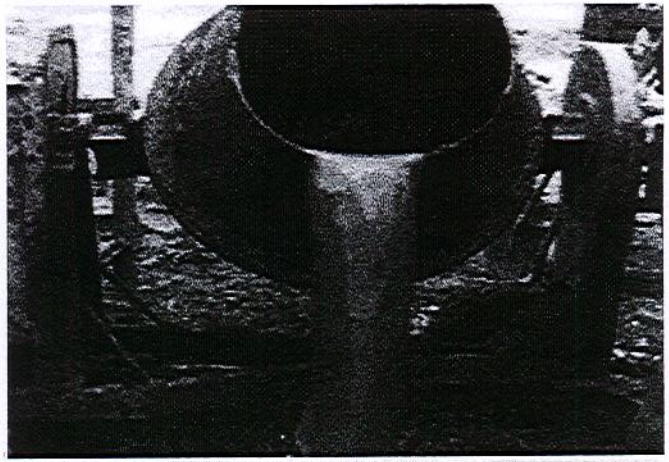
Rammed earth needs less of fines but In Ladakh the soil in most places is too sandy to be good for even rammed earth. 17 of the 20 villages surveyed had less than 17% fines below 0.08 mm and less that 2% of clay content. However there are also large deposits of silty clay in other parts with clay contents up to 80%. Due to the high clay content small amounts are sufficient for large quantities of poor soil, hence transportation is easy, yet it is hard to pulverize the clay lumps.

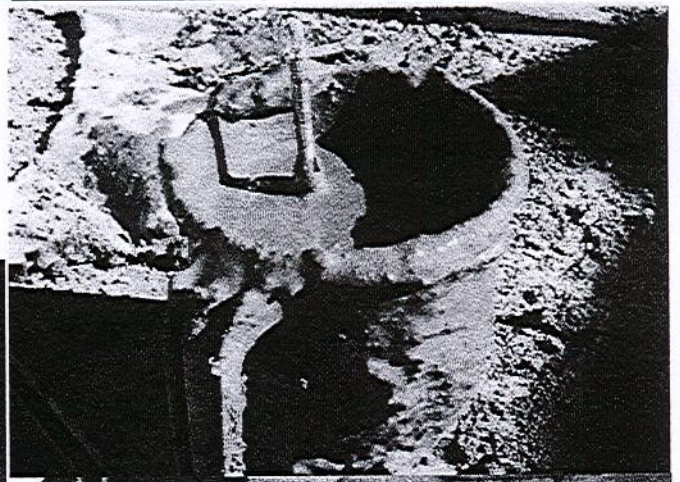
In 2009 during a project in Nepal with two impossible soils one nearly pure clay and the other pure sand I developed this technique of making the clay into a thin slip and then mixing this clayey slip in the soil instead of water. I carried out many tests and calculations to arrive at a right thickness of the slip so that it is not too thick to mix yet carries enough clay to bring up the clay content of a very sandy soil up to at least 8 %.

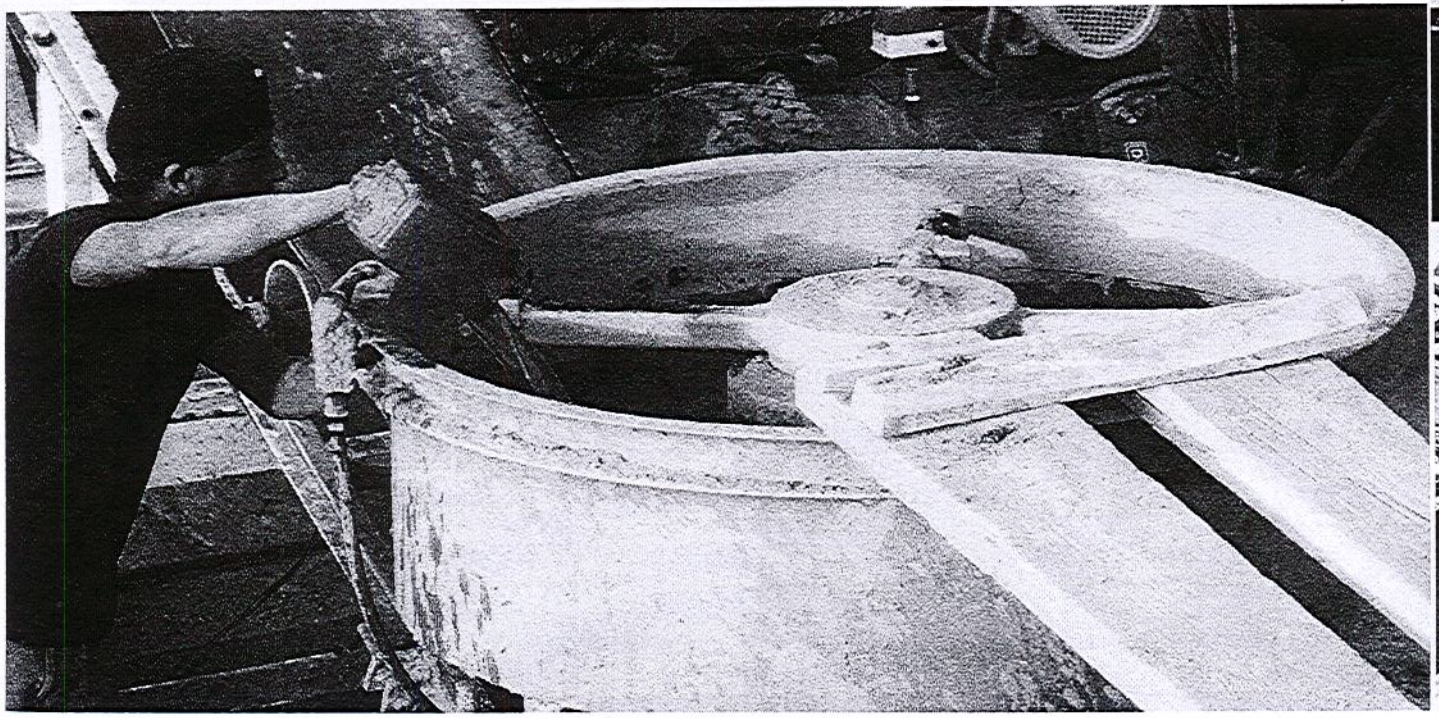
Limitations:

Since the soil in most places in Ladakh is too sandy , this works only with highly clayey material which is found in Basgo, Saspol, Spituk and few other places.

The soil mixing becomes very difficult for hand mixing. Hence this method is good only for machine mixing.







INNOVATIONS

Challenge of Sandy Soils 2

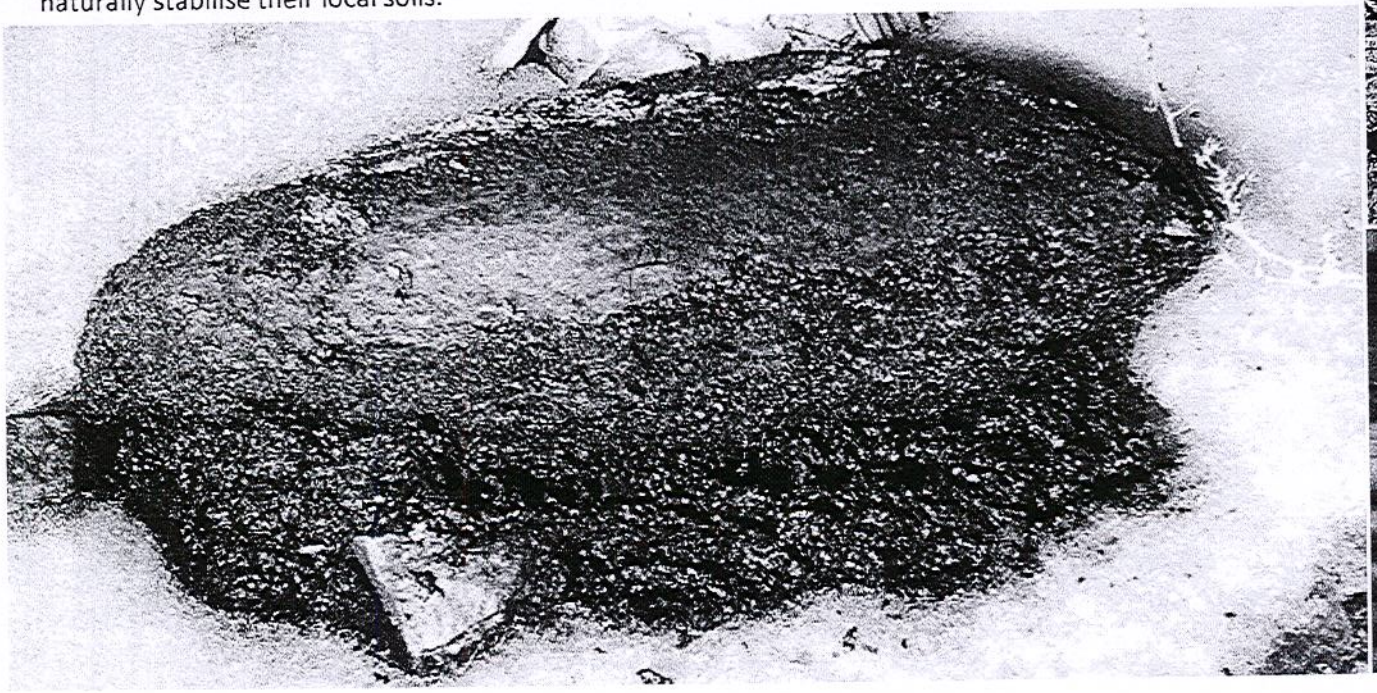
Freeze thaw technique to pulverise the pure clays.

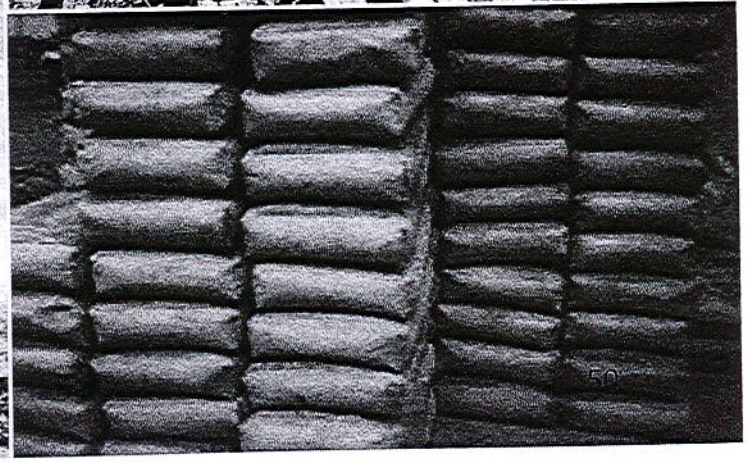
As mentioned in the previous section, the clay slip method has some limitations, such as it make the mixing very difficult and it limits the mixing proportion to a maximum of 8% clay. The other method normally used is pulverisation and it is an earth builders nightmare in terms of human labour and energy costs if done mechanically.

But in Ladakh and other cold countries we have a blessing. I observed that the same natural causes that makes rocks to become soil or turn good walls and plasters into dust, could for once... be put to our use.

The process is called freeze thaw when water seeps into the cracks of rocks or walls it freezes at night and expands... breaking the solid structure around then in the day it thaws and seeps even deeper and the cycle is repeated.

During the winter I wet the hard claystones several times and then nature takes care of the rest. By spring one gets a soft dry dust of clay ready to mix in the sandy soils in the proportion one desires. I propose to do this at a significant scale so that pure clay could be sold in bags just like cement bags. For soil stabilisation people could either buy portland cement when waterproofing is needed or buy this natural "cement" to naturally stabilise their local soils.





INNOVATIONS

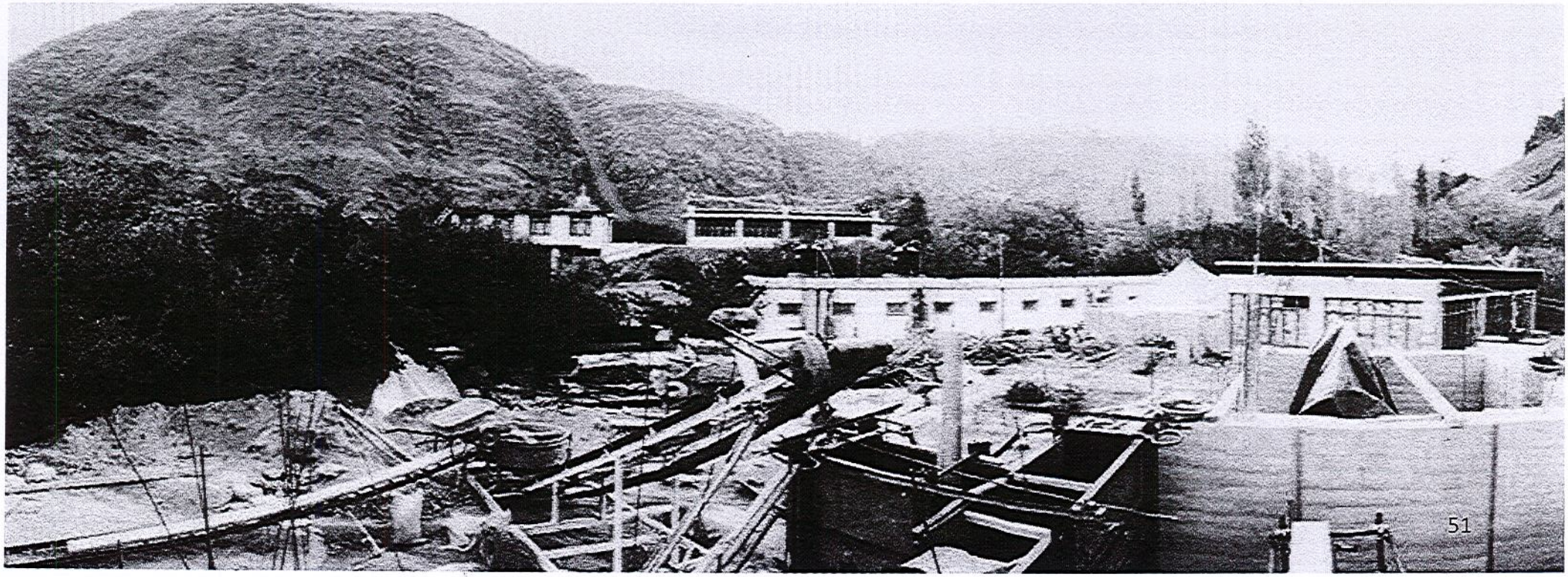
Wheelbarrow on rails

Among the various machines used and tested, this simple machine i.e. inclined plane proves to be the most efficient. Use of wheel barrows on planks was a good improvement in efficiency but it was risky, because for portability the planks had to be thin. This made it unwieldy for the worker when a loaded barrow had to climb a meter high in order to reach the pan mixer.

Therefore we developed this rail system which ensured that the two wheels always remain on track and reaches the right spot at the mixer top irrespective of the skills of the worker. Apart from climbs it is also good for the flat surfaces as it gives a clean and dirt free track. We have some times used this system to move soil from up to 14 meters away by joining four rails of 3.5 m each. The best part is that if needed, the rails can become regular ladders. We are working to make a similar system from the mixer to the top of the formwork in order to replace the powered conveyor belt.

Replaces: 2 workers

Limitation: The framework to support the rails has to be strong and well designed for safety and time saving.



Low Cost Pan Mixer

INNOVATIONS

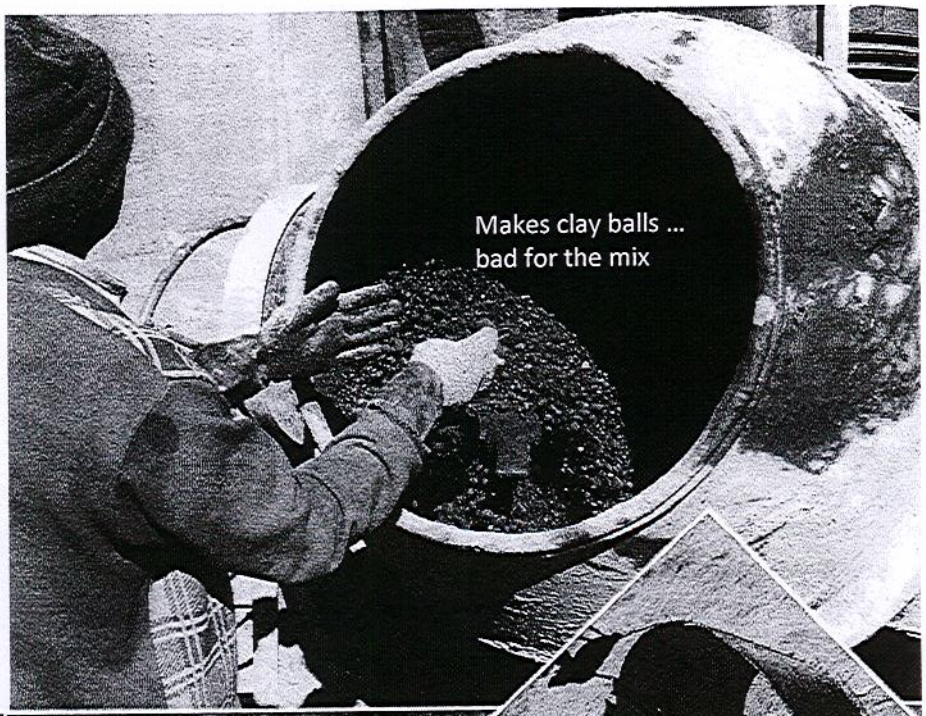
Most rammed earth builders a common complaint, that ordinary concrete mixers don't work for mixing soil for rammed earth or compressed earth blocks. The soil rolls into lots of balls as the mixer bucket rotates horizontal axis. This is especially serious when mixing cement to stabilise the soil as the cement gets concentrated in balls and prevents uniform distribution.

The big advantage of a concrete mixer is that they are mass-produced and are available every where at affordable prices. Where as planetary mixers which are recommended for soil mixing are very rare and an expensive piece of equipment.

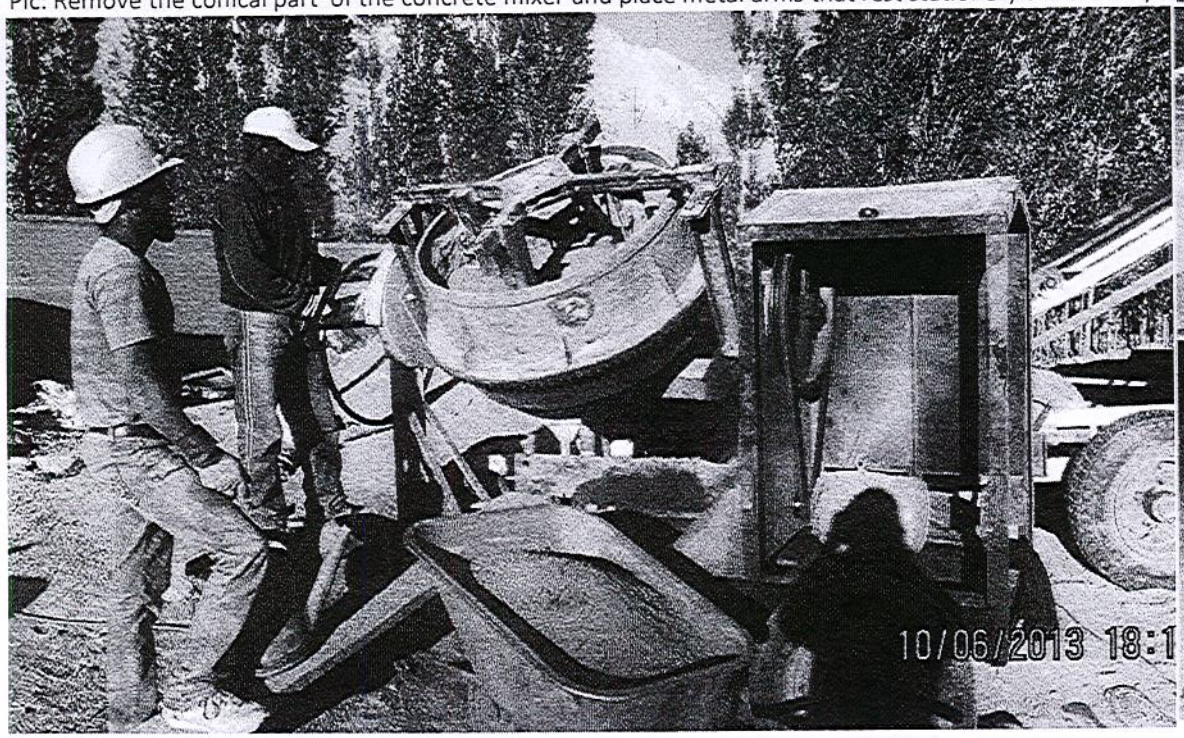
In keeping with the true Indian spirit of low-cost adaptations called 'Jugaad'we successfully modified two second-hand concrete mixers into wonderfully functional soil mixers. It cost us just Euro 75 extra to do that. Normally in India it costs roughly Eu. 1,000 for a concrete mixer and Eu. 3,000 for a pan mixer.

Replaces: 4 workers

Limitations: None

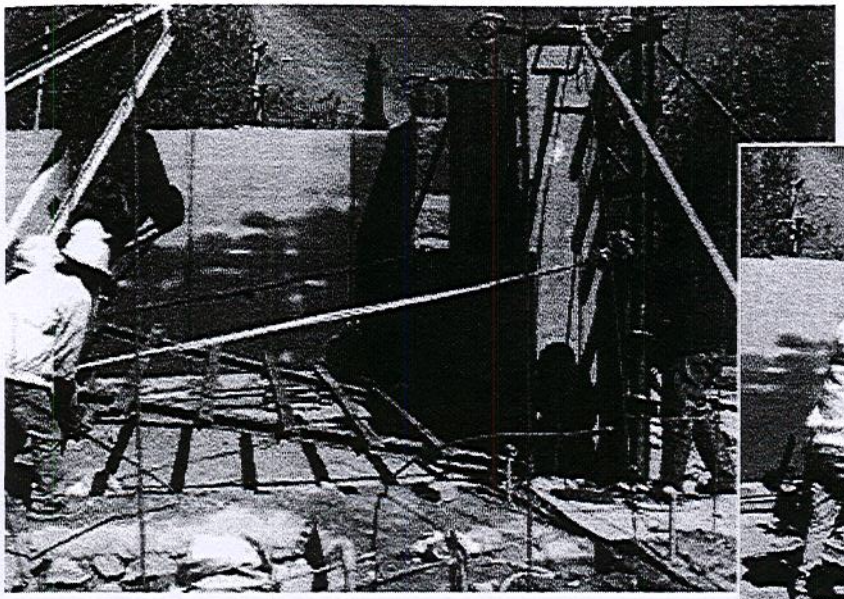


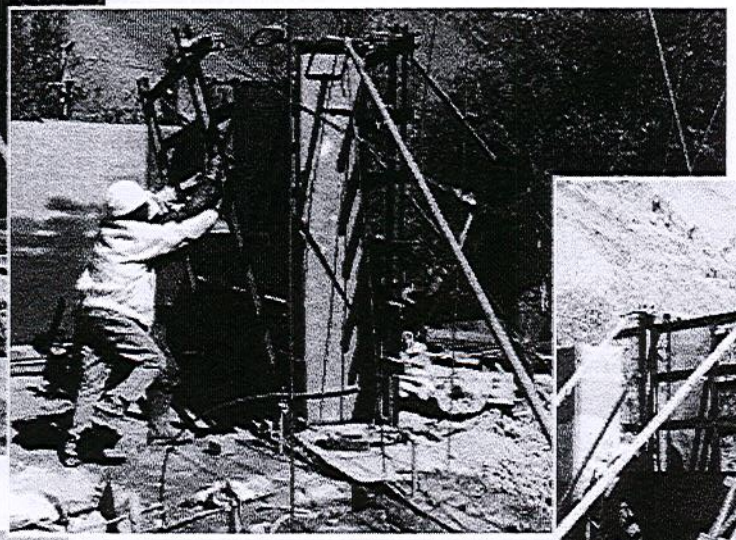
Pic: Remove the conical part of the concrete mixer and place metal arms that rest stationery on the body.

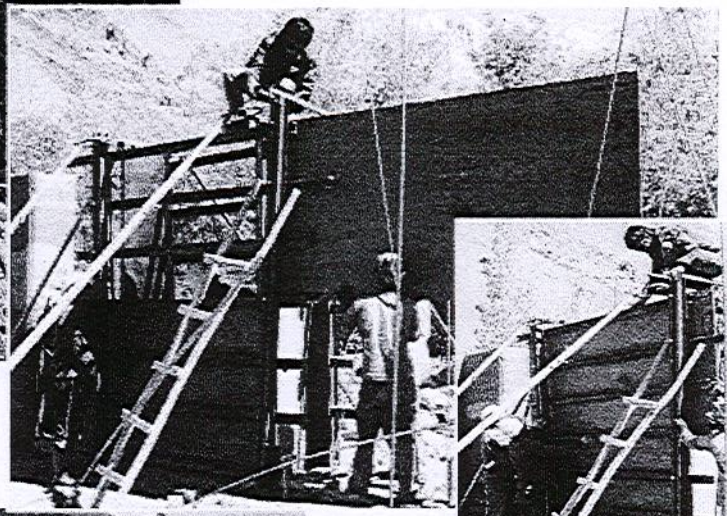


Fast Formwork

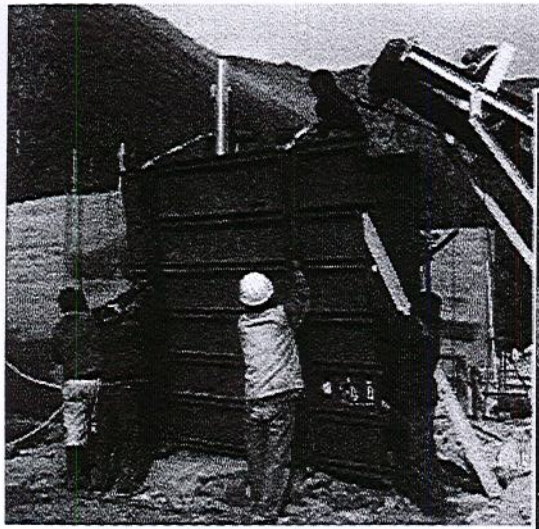
INNOVATIONS

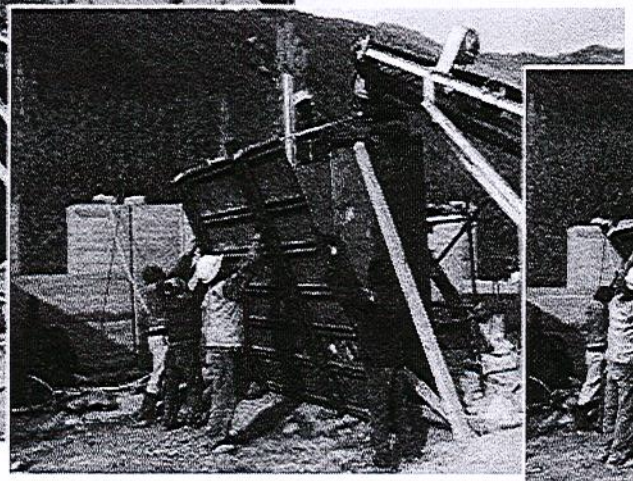


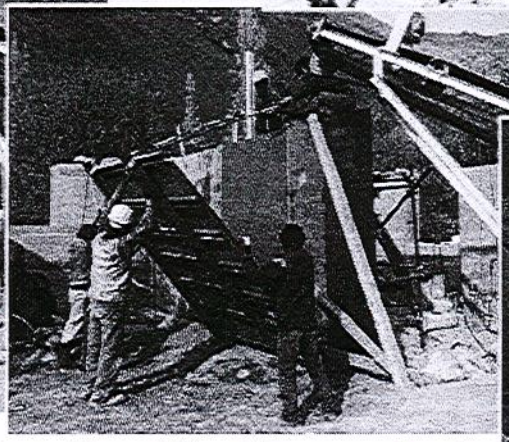


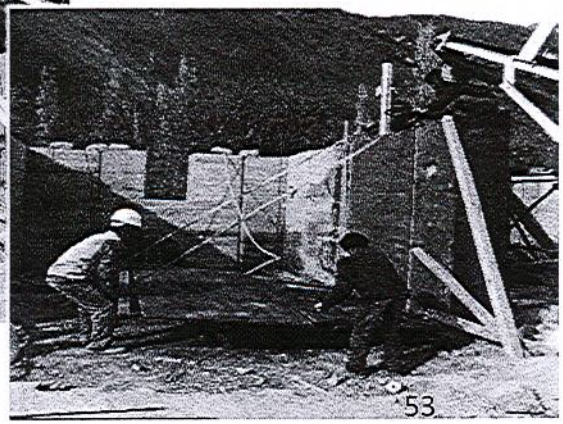


Mounting







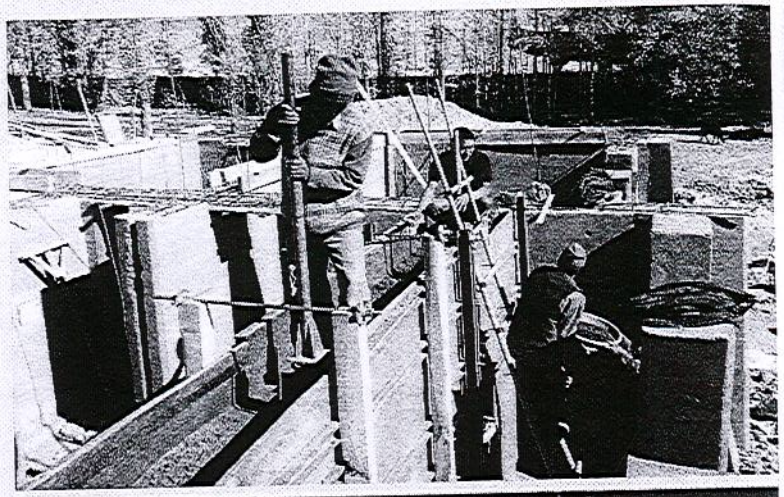


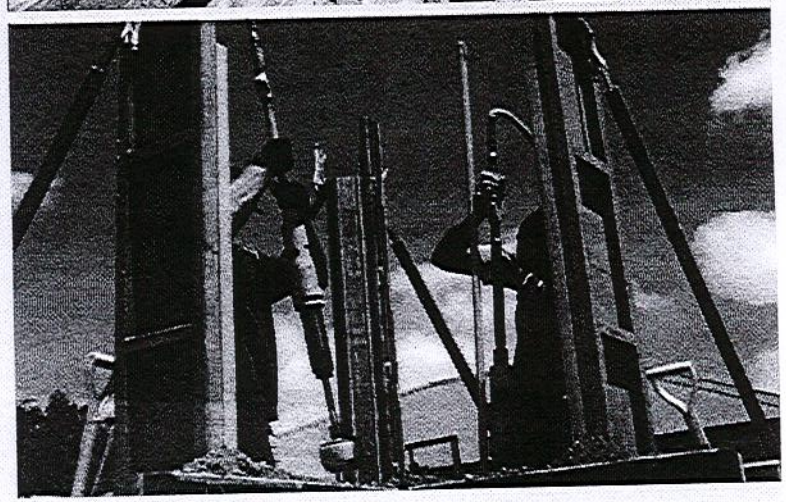
Dismounting

This enables quick mounting and dismounting of the formwork. It is easier to handle part by part if machines are not used. Laying formwork on floor and then pulling it up with ropes. This is safer and takes half the time of doing it piece by piece. We are now trying to do the same with a chain pulley so that both side can be pulled at the same time.

INNOVATIONS

Hand Ramming verses pneumatic ramming



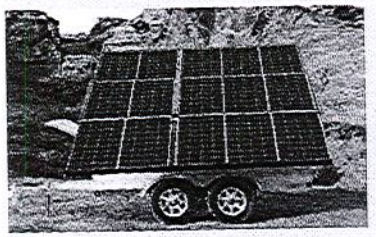


We have tested and compared different types of ramming, traditional and mechanised. But I found that of all the machines the pneumatic rammer (PR) is the least efficient in terms of number of workers it replaces for the cost of machines and energy consumed.

My studies show that the ramming speed is only doubled by a PR whereas the fuel energy consumed is infinitely more. Therefore theoretically one pneumatic rammer could be replaced by two manual rammers but practically speaking there might a third one might be needed for replacement if continuous ramming is desired. Therefore the PR only replaces two workers which compares very poorly to all the other mechanisation methods described earlier, especially if we take the energy costs into consideration. The compressor and the rammer itself are two of the most fragile machines with many moving parts. Therefore after testing various rammers I am convinced that it will be much economical and infinitely more ecological to replace the PR by two extra workers with extra allowances for their nutrition etc. I am doing a more scientific study to compare the cost of diesel fuel and the machine depreciation with the cost of hiring two extra workers in different economic contexts such as western industrialised countries and emerging economies such as India.

For the Ladakhi context I found that in order to make rammed earth more economical and ecological the brightest idea in mechanisation would be to use simple machines that have mechanical advantage but can work without fuel. The only powered machine that I found indispensible was the soil mixer machine because it replaces up to 4 people and does not consume much fuel/electricity. Therefore I am working on a system where:

the pan mixer is the only powered machine and it is powered by a portable solar photovoltaic trolley that also houses the battery bank and tool store for the site.



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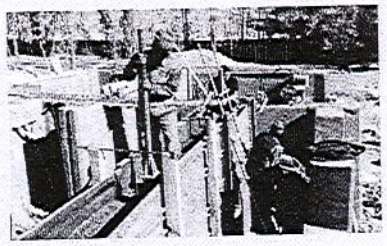

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Conclusions and Recommendations

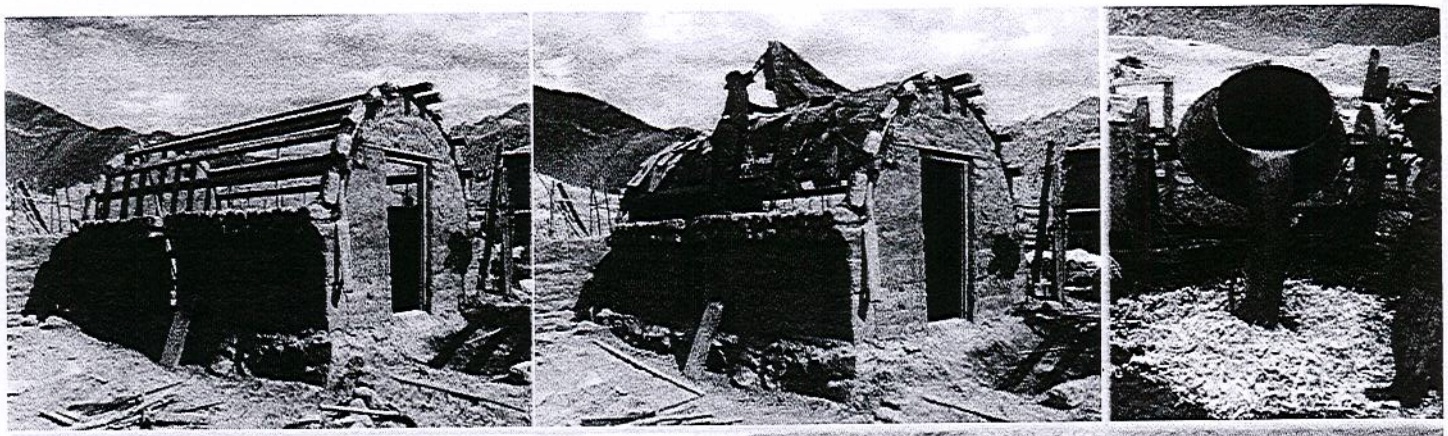
- **Revive and promote the Knowledge and skills of earth at every level**

- There is an urgent need to revive the knowledge and skills related to earth construction in Ladakh especially rammed earth which is found to be most suitable for the region currently.
- The Leh Polytechnic should establish a department dedicated to the study and dissemination of earth architecture. Technical support could be sought from international institutes like CRAterre,
- It is very important to present earth in a disaster resistant context threfore importance should be attached to this aspect also.
- The Building Centre in Leh managed by the Ladakh Ecological Development Group LEDeG needs to be revived with more focus towards disaster resistant earth construction systems.
- It is very important that the population looks at earth with respect and not as a poor mans material, therefore efforts should be made to introduce world class earth building systems among the rich and the elite.
- For this to happen we should put efficient systems in place such as construction companies that take care of all details, as is possible in other mainstream construction systems today.
- At the same time it is important that in the rural areas people do not have to depend on cash to have a good habitat, therefore efforts should also be made to revive the age-old tradition of community construction where the whole village would get together to build a family's new house,
- Apart from formal courses like in the Polytechnic organisations like LEDeG and SECMOL should organise short term trainings and workshops for the working professionals like engineers and architects, masons and workers.

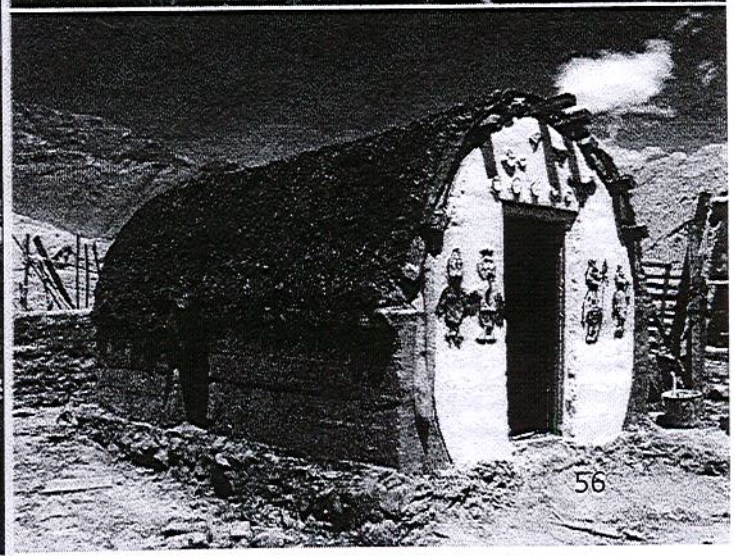
Utmost importance to prepare the younger generation for a cleaner tomorrow.

- Fun filled workshops should be organised for youth and children to understand and appreciate the earth as a friendly building material.
- Earth festivals on the lines of Grains d'Isere in France would be very popular in Ladakh.
- Since Ladakh has become one of the principal tourism destinations in India such festivals would raise awareness about earth nationally and internationally also.
- Earth promotion groups should be formed among the professionals and enthusiasts to go to the schools and promote earth among children.

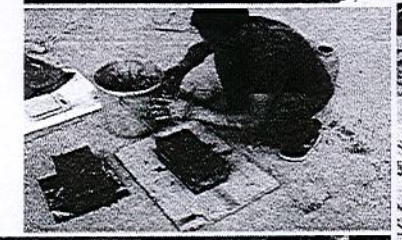
Fun-damental education

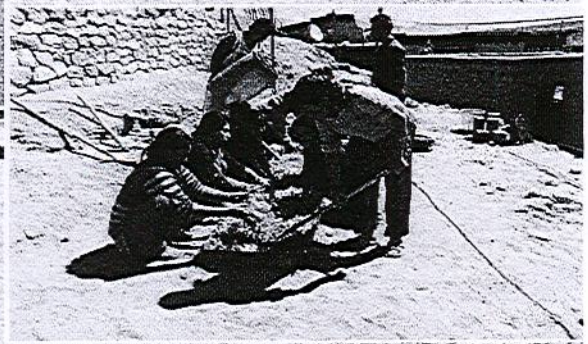


Students build a chicken house with projectile straw clay...



for a brighter tomorrow

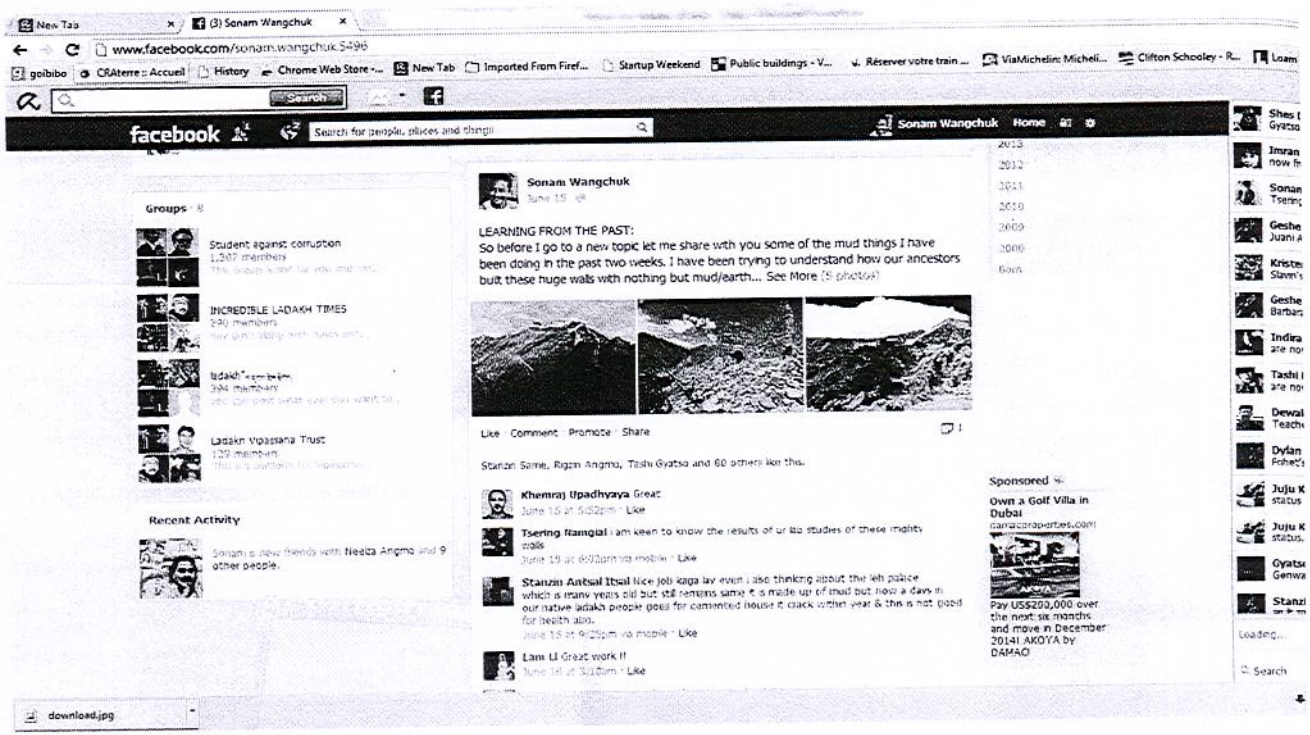




Leaving no stones unturned

It is most important that the younger generation grows respecting the earth and learning to play with it. Since traditional ways of doing that are breaking down new ways should be adapted and adopted. Earth festivals School visits, workshops, radio and TV programmes, and now social media have all become important ways to connect to the youth and keep them interested in the earth.

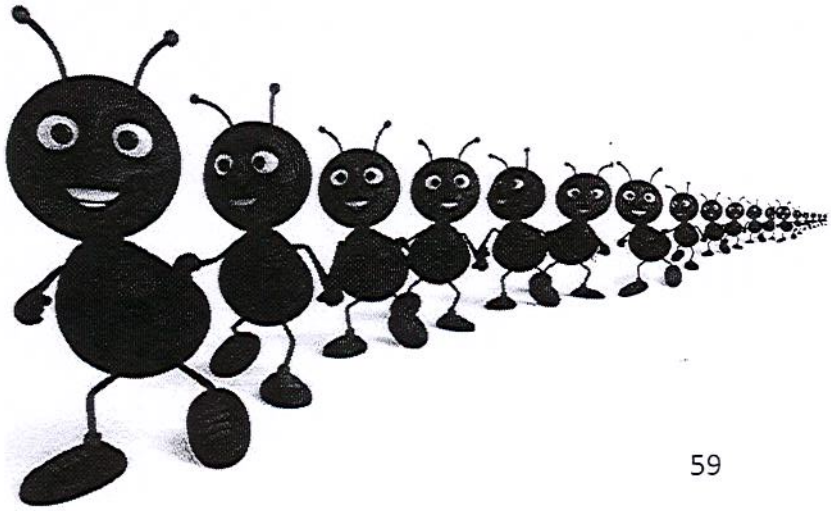
For some time I have been sharing my journey around earth with the youth of the Himalayas through different social media and it has bee a very satisfactory experience to see them start with a very skeptical outlook and end with curiosity and enthusiasm enough to bring them to courses and workshops.



Il faut être très poli avec la terre
Et avec le soleil

Il faut les remercier le matin en se réveillant (...)
Il ne faut pas les embêter ... les critiquer
Ils savent ce qu'ils ont à faire
le soleil et la terre
Alors il faut les laisser faire
ou bien ils sont capables de se fâcher
Et puis après
on est changé
En courge
En melon d eau
ou en pierre à briquet
Et on est bien avancé...

" Il faut que tout le monde soit poli avec le monde , ou alors il y a des guerres ... des épidémies , des tremblements de terre, des paquets de mer, des coups de fusil ...



Et de grosses méchantes fourmis rouges qui viennent

vous dévorer les pieds pendant qu on dort la nuit "

de Jacques Prevert , dans " histoires " Gallimard editeur