

# Analysis of Soil Nature and Soil Texture Class of Common Bricks of Kathmandu Valley

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## Abstract

Bricks are widely used construction material, 25% of material is bricks in construction. In Nepal about 3.2 billion bricks produced and consumed annually. There are 800 brick kilns in operation throughout the country. Brick kilns are predominantly found in the Kathmandu Valley and in the flat land of the Terai. There are approximately 110 brick kilns operating within the Kathmandu Valley with 15 at Kathmandu district, 33 at Lalitpur district and 62 at Bhaktapur district. This research explores the computational and experimental investigation of soil nature and soil textural class to determine the soil nature and soil texture class required for brick making soil. Smearing test and ball test was performed to determine the nature of soil and the soil texture class was determined by sedimentation test with the help of soil textural triangle. The soil nature required for brick making soil was found to be uniform type that is plastic clayey type and the soil texture class was found to be of clay loam, sandy clay loam and sandy loam type at Kathmandu district. Likewise, loam type at Lalitpur district and loam, silty loam, clay loam and sandy loam type at Bhaktapur district.

## Keywords

brick making soil – soil texture class – nature of soil

## 1. Introduction

Bricks are widely used in construction as a material, According to Gawatre [1], 25% of material is bricks in construction. The primary use of bricks has been for wall coverings over the years and somewhere for load bearing purpose, but they can be used for decorative purposes as well. Historically, the common brick has been molded from clay and fired in a kiln. Brick is one of the most commonly used building materials in Nepal[2]. About 3.2 billion bricks are produced and consumed annually [3]. There are 800 brick kilns in operation throughout the country [3]. According to FNBI [4], the brick production sector is a huge part of the economy in Nepal with investment in the sector estimated at USD 36 million. Brick kilns are dominantly found in the Kathmandu Valley and in the flat land of the Terai. There are approximately 110 brick kilns operating within the Kathmandu Valley alone with 15 kiln at Kathmandu district, 62 at Bhaktapur district and 33 at Lalitpur district [3]. There are various factors that affects the strength of bricks like composition brick

making material that includes brick making soil nature and its soil textural class, preparation of clay and blending of ingredients,nature of molding adopted,care taken in drying and stacking of raw or green bricks,type of kiln used including type of fuel and its feeding,burning and cooling processes [5]. The brick making soil nature can be determined by smearing and ball test and the soil texture class can be determined by positioning result obtained from sedimentation test on soil texture triangle [6].

## 2. Methodology

### 2.1 Sampling and Data Collection

The methodology was based on experimental research. For determining the sample size, a simplified equation for calculation for number of samples with confidence interval 95% and precision level  $e$  is given by [7]:

$$S = \frac{N}{1 + N \cdot e^2}$$

Where,

S= Number of Samples, N= Population Size, e = Precision Level Substituting, e = 10%. From the relation the sample size was found to be 52.3 from population size of 110 brick kiln. Hence the number of sample brick kiln taken was 53 which was obtained by assuming 10% of error. By random sampling the brick making soil sample was collected from 40 different brick kiln of Kathmandu, Bhaktapur and Lalitpur district as sample soil from the calculated sample. Smearing test, Ball test and Sedimentation test were performed on the soil sample to determine the nature and soil texture class of brick making soil.

### 2.2 Sample collection

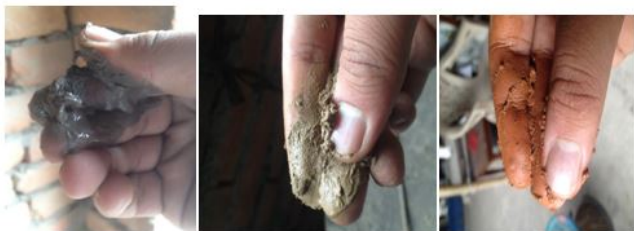
Brick making soil was collected from 40 different brick kiln. Figure 1 shows images of some samples of soil from different brick kiln.



**Figure 1:** sample collection

### 2.3 Smearing Test

Some loose soil from the brick making soil was taken and an appropriate amount of water was added into it in order to make a sticky paste. After the soil was saturated with water, the soil paste was mixed by hand. It was tried to make a ball with this soil. The moist ball was rolled in the hand enough so that the ball was dried out a little bit. A little bit of the soil was pinched out with the thumb and the index finger and smeared on the thumb by the index finger at one go as shown in figure 2.



**Figure 2:** Smearing Test

The smearing was done as fine as possible. After the smearing, the soil that did not form a smooth and thin layer, then the soil was noted to be sandy. If the thin soil layer was shiny and evenly spread out over the thumb then the soil was noted to be plastic in nature. Consequently the thumb was let to dry out. After drying, the soil layer that fell off easily or could be removed then the soil was noted to be sandy or silty in nature with probably low plasticity. However the soil that stickened to the thumb and index finger after drying, was noted to be plastic in nature. Touch sensation type of examination was done during smearing test.

### 2.4 Ball Test

Ball test was mainly performed for getting a first feeling about the soils sand and clay proportion. A handful of soil was taken and some water was added in it. Water was added enough to make the soil moist and was made dough by hand. With the hand and fingers the soil and water was mixed thoroughly. After uniform mixing it was tried to make a handful ball out of the soil. The smoothness of the surface of the ball was observed. For plastic soils the surface was noted to be shiny and uniform. Likewise, For sandy soils the surface was noted to be dull and rough. Also with sandy soils it was difficult to make a round shaped ball.



**Figure 3:** Ball Test

### 2.5 Wet Ball Test

Immediately after the ball was reasonably well formed, the ball was dropped from a height of at least 1 meter. Alternatively the ball may be dropped from shoulder height with hands straight on the leveled and clean – preferably a concrete surface or a hard surface. The ball on the floor was observed. The ball that retained its

shape with little amount of deformation at the bottom only was noted to be plastic clayey in nature. However the ball that flattened out upon hitting the floor was noted to be sandy in nature.

### 2.6 Dry Ball Test

The tests was repeated by making balls and allowed it to dry them under atmosphere. The balls was cooled and the test was repeated. The ball that cracked into many pieces after contact with the floor was noted to be sandy in nature. However, the ball that broke into two to three pieces then the soil was noted to be clayey and plastic in nature.

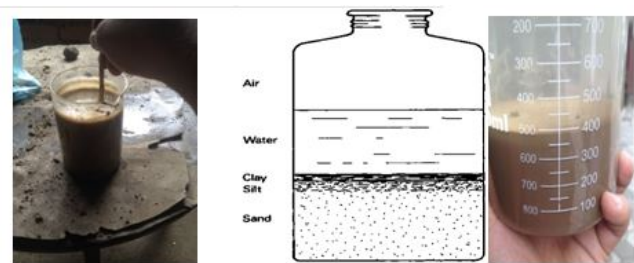
### 2.7 Sedimentation Test

This process is also known as ‘Bottle Test’ for determining the proportion of clay and sand particles in the soil. It also gives the idea of percentage mixture of sand and clay in the soil. One-fourth quantity of the glass beaker was filled with the required soil. Half teaspoonful of salt (to accelerate the deflocculation process) was added into the soil. Water was added to about 50% above the soil level. It was allowed for a few minutes till the water percolates to the bottom (there will be a distinct color difference between dry and wet soil). The soil and water mixture was stirred vigorously with a spoon for at least 2 minutes so that the color of the stirred material was uniform. The stirred slurry was poured into a measuring cylinder. The measuring cylinder was placed on a level platform and allowed it to stand for at least 12 hours or until the water became clear at the top. As soon as the water was cleared, there was distinct granulation layers which was represented the fineness/plasticity or coarseness/non-plasticity of the taken sample. Firstly the height of the bottom most visible layer which is classified as sand was measured and the percentage of sand was calculated. Secondly the topmost visible layer was measured which is classified as clay and the percentage of clay was calculated. The layers between the top (clay) and bottom (sand) was noted to be silt content of the soil sample. A representative soil mix of clay, silt and sand for good brick production is mentioned in table 1.

**Table 1:** Percentage content for good brick making soil

Elements	Percentage
Sand	20 to 45
Silt	25 to 45
Clay	20 to 35
Liquid Limit	25 to 38
Plasticity Index	7 to 16
Volumetric Shrinkage	15 to 25

Some experiment performed during the research are shown in figure 4.



**Figure 4:** Sedimentation Test

## 3. Result and Discussion

The result observed from smearing test, ball test and sedimentation test are listed below in the tabular form. Here table 2, table 3 and table 4 represents the result of brick making soil of Kathmandu, Bhaktapur and Lalitpur district respectively.

It was found that the brick making soil was of plastic clayey in nature from smearing and ball test. The soil texture class was found to be of loam, clay loam, sandy loam, sandy clay loam and silty loam by positioning the result of sedimentation or ball test on soil texture triangle. From the experiment, the soil texture class was found to be clay loam, sandy clay loam, sandy loam and loam at Kathmandu district. Table 2 represent the results obtained from sedimentation, smearing, and ball test of brick making soil of different brick kiln at Kathmandu district. Likewise, loam type soil textural class at Lalitpur district which is tabulated in table 3 and clay loam, silty loam, sandy loam, loam at Bhaktapur district which is tabulated in table 4. The soil texture class of brick making soil at Lalitpur district was found to be of uniform type that is loam texture class of soil. Among the brick making soil studied from different

**Table 2:** Results of brick making soil sample from brick kiln of Kathmandu district

S.N.	Name of Brick Industry	Soil Texture Class	Smearing Test	Ball Test
1	Umamaheshwor Chimni Bhatta, Tinthana	Clay Loam	Plastic	Plastic Clayey
2	Aadi Narayan Itta Udhyog, Thankot	Clay Loam	Plastic	Plastic Clayey
3	Chandra Binayak Itta Udhyog, Satungal	Sandy Clay Loam	Plastic	Plastic Clayey
4	B.N. Itta Udhyog, Satungal	Sandy Clay Loam	Plastic	Plastic Clayey
5	Om Shree Machindranath Itta Udhyog, Satungal	Clay Loam	Plastic	Plastic Clayey
6	Hira Itta Udhyog, Satungal	Clay Loam	Plastic	Plastic Clayey
7	Loknath Itta Udhyog, Satungal	Sandy Loam	Plastic	Plastic Clayey
8	Ganesh Chimni Itta Udhyog, Satungal	Clay Loam	Plastic	Plastic Clayey
9	Siddhiganesh Itta Udhyog	Loam	Plastic	Plastic Clayey

**Table 3:** Results of brick making soil sample from brick kiln of Lalitpur district

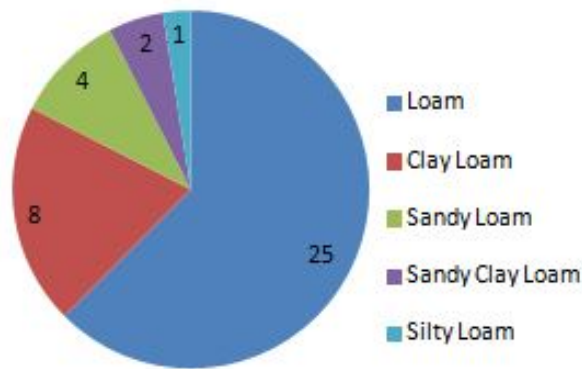
S.N.	Name of Brick Industry	Soil Texture Class	Smearing Test	Ball Test
1	R.K. Itta Chimni Bhatta, Imadol	Loam	Plastic	Plastic Clayey
2	Gautam Buddha Chimni Bhatta, Dhapakhel	Loam	Plastic	Plastic Clayey
3	Satya Narayan Chimni Bhatta, Imadol	Loam	Plastic	Plastic Clayey
4	Shiva Shakti Chimni Bhatta, Harisiddhi	Loam	Plastic	Plastic Clayey
5	Santoshi Maa Chimni Bhatta, Harisiddhi	Loam	Plastic	Plastic Clayey
6	Jaya Santoshi Maa Chimni Bhatta, Harisiddhi	Loam	Plastic	Plastic Clayey
7	Trisakti Itta Udhyog, Harisiddhi	Loam	Plastic	Plastic Clayey
8	Hosanna Chimni Bhatta, Harisiddhi	Loam	Plastic	Plastic Clayey
9	Siddhi Binayak Chimni Bhatta, Harisiddhi	Loam	Plastic	Plastic Clayey
10	Tara Chimni Bhatta, Harisiddhi	Loam	Plastic	Plastic Clayey
11	Dakshinkali Maii Chimni Bhatta, Harisiddhi	Loam	Plastic	Plastic Clayey
12	Rhiyegrib Bhairavnath Itta Udhyog, Bugmati	Loam	Plastic	Plastic Clayey
13	Bugmati Itta Udhyog, Bugmati	Loam	Plastic	Plastic Clayey
14	Om Shree Itta Udhyog, Bugmati	Loam	Plastic	Plastic Clayey
15	KC Chimni Bhatta, Imadol	Loam	Plastic	Plastic Clayey
16	Machindranath Shree Itta Udhyog, Bugmati	Loam	Plastic	Plastic Clayey

**Table 4:** Results of brick making soil sample from brick kiln of Lalitpur district

S.N.	Name of Brick Industry	Soil Texture Class	Smearing Test	Ball Test
1	Hanuman Sakti Chimni Bhatta, Nagkhel	Loam	Plastic	Plastic Clayey
2	Aajima Itta Udhyog, Chitpool	Loam	Plastic	Plastic Clayey
3	Maitri Chimni Bhatta, Chitpool	Loam	Plastic	Plastic Clayey
4	Shree Krishna Itta Udhyog, Chitpool	Loam	Plastic	Plastic Clayey
5	G.J. Chimni Itta Bhatta Udhyog, Nangkhel	Loam	Plastic	Plastic Clayey
6	G.J. Nandikeshar Fixed Itta Udhyog, Chitpool	Clay Loam	Plastic	Plastic Clayey
7	Jaya Hanuman Nangkhel Mahadev Chimni Bhatta, Nangkhel	Clay Loam	Plastic	Plastic Clayey
8	Kadambini Itta Udhyog, Chitpol	Sandy Loam	Plastic	Plastic Clayey
9	Mahasakti Itta :Udhyog, Tathali	Loam	Plastic	Plastic Clayey
10	Jaya Hanuman Brick Factory, Tathali	Sandy Loam	Plastic	Plastic Clayey
11	H.T. Brick Factory, Tathali	Sandy Loam	Plastic	Plastic Clayey
12	Chundevi Chimni Bhatta, Tathali	Loam	Plastic	Plastic Clayey
13	S.K. Itta Udhyog Chimni, Tathali	Clay Loam	Plastic	Plastic Clayey
14	Saraswati Itta Udhyog, Tathali	Loam	Plastic	Plastic Clayey
15	Majhi Bhairav Itta Udhyog, Tathali	Loam	Plastic	Plastic Clayey

brick kiln of Kathmandu valley under this research was found that the number of brick kiln that are producing brick from loam and clay loam type soil texture was maximum and brick from sandy loam, sandy clay loam and silty loam soil texture was few in numbers. The numbers of brick kiln of Kathmandu valley with respect to soil texture class is shown in the form of pie chart in figure 5.

### No. of Brick Industry



**Figure 5:** Number of Brick kiln of Kathmandu valley according to the soil texture class

### 4. Conclusion

The soil nature of brick making soil from different brick kiln of Kathmandu valley was found to be plastic clayey

type. The soil texture class found from brick kiln of Kathmandu district was of clay loam, sandy clay loam and sandy loam type, Lalitpur district was of loam type and Bhaktapur district was of loam, silty loam, clay loam and sandy loam type. It was found that the brick making soil requires plastic clayey nature of soil but the soil textural class may vary according to the location of brick kiln from the experimental observation of the fourty brick kilns of Kathmandu valley from Kathmandu, Bhaktapur and Lalitpur district.

### References

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