STEP BY STEP OF SOIL TESTING FOR QUALITY AND QUANTITY ANALYSIS

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Swiss Agency for Development and Cooperation SDC

skat Swiss Resource Centre and Consultancies for Development

PROECCO PROmoting Employment through Climate Responsive COnstruction

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STEPS OF SOIL TESTING FOR QUALITY AND QUANTITY ANALYSIS

01.1- RECEIVING THE REQUEST FOR SOIL TESTING

VOUCHER APPLICATION FORM

1. General information on applicant

Name of Enterprise/entrepreneur	
Address: District, sector	
Telephone & E-mail	
Type of business (cooperative, family, company, government)	
Current occupation	
Main products	
Total annual production	
Infrastructure at disposal (kiln, hangar)	
Technology used (type of fuel, equipment)	
Support requested[1]	

Applicant's Name & signature: **Date:**

SKAT DECISION:

Name & signature: **Date:**

[1] 1. Soil testing to determine clay content &quality
2. Study tour
3. Kiln upgrading and Modification
4. Technical Assistance to design new kilns and supervisory services for the construction of those kilns
5. Facilitation for investment permit (environment protection, geo coordinates, summary business plan…)
6. Machine testing and acquisition, product development
7. Firing technology research and process optimization
8. Coaching entrepreneurs to write business plans, record keeping, and other related services

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STEPS OF SOIL TESTING FOR QUALITY AND QUANTITY ANALYSIS

01.2- FIELD WORK

FIELD OBSERVATION:

Changing of soil layers, quick soil test, type of soil, nearby basic infrastructure, landscape, collection of field coordinates and then Collection of samples to the laboratory.

SOIL DRILLING:

Soil samples are recuperated in bassins following their layers and deepness.

Each sample in labeled (with the name of site and the deepness).

CURRENT STATE OF EQUIPMENT

•The soil auger is available for two teams

The bassins for keeping the samples.

Equipment:

1. Soil Auger
2. Manpower to manipulate the auger
3. Small bassins to recuperate the samples

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STEPS OF SOIL TESTING FOR QUALITY AND QUANTITY ANALYSIS

01.2- FIELD WORK

Soil sampling and samples recuperation from the field

Soil auger: Tool for soil drilling and sampling activites

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STEPS OF SOIL TESTING FOR QUALITY AND QUANTITY ANALYSIS

01.3- SAMPLE PREPARATION FOR ANALYSIS AT BMC LABORATORY AND SHRINKAGE TEST

Mould the specimen 1, fabricate the bricks, for clay shrinkage test, measure the brick with the precision, dry the small bricks under a shelter after until they are well dryed.

Drying Shrinkage = DS
Length after shaping = Ls
Length after drying = Ld
Length after firing = Lf
Firing Shrinkage = FS
Total Shrinkage = TS

DS = (Ls-Ld)/Ld*100
FS = (Ld-Lf)/Lf*100
TS = DS + FS

Briquettes extruded through mini extruder

CURRENT STATE OF EQUIPMENT

- Equipment are available and functional

A part of specimen 1 is molded with a mini-extruder to make the briquettes which will be used for the clay shrinkage test, dry the briquettes after the measurement accurately before firing in the oven.

Measurement of briquette

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STEPS OF SOIL TESTING FOR QUALITY AND QUANTITY ANALYSIS

01.4- SEDIMENTOMETRIC SOIL ANALYSIS OR HYDROMETER TEST

A) Preparation of the solution

The deflocculant used is a 4% solution of sodium Hexameta phosphate. To have a 4% solution, take 40 gr of solid H2NaPO3, add enough water to make exactly 1000ml of solution.

B) Preparation of the sample

- Dry and grind the soil sample (specimen 2)
- Weigh exactly 50 gr of grinded soil
- In a deflocculation tank (dispersion), mix this 50gr of soil with 125 ml of sodium Hexa meta phosphate solution at 4% prepared above
- Let stand (deflocculate) for about 12 hours
- Sift under 0.008 mmm sieve
- The refusal constitutes the sandy fraction. Dry it, weigh it and note its weight in gr.
- The passat constitutes the fraction of silt + clay which will be analyzed by the hydrometric method to separate the clays from the silts.

C) Preparation of the sedimentation test tube and reading of the hydrometer.

- Carefully transfer all of the pass with all its water (see B above) to the sedimentation test tube.

- Add clean water to fill the test tube to 1000ml. Close the cylinder and shake vigorously in all directions for 1 minute.

- Place the sedimentation test tube next to the reference test tube and start the stopwatch immediately. This is the cumulative time t = 0. Insert the hydrometer into the sedimentation cylinder and start reading L.

- Read the hydrometer at cumulative time t = 0.5 min; 1 min; 2 min; 4min; 8min. Always read the upper level of the meniscus. The hydrometer remains in the sedimentation cylinder for all the readings that are taken during the first 8 minutes. At the end of these 8 minutes, it is removed after each reading and placed in the control cylinder.

- Continue reading the hydrometer in the sedimentation test tube and the temperatures in the reference test tube at approximately t = 8, 15, 30, 60 min. and 2 hours. For each reading, leave the hydrometer in the sedimentation cylinder for about 30 seconds and then place it in the reference (control) cylinder.

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STEPS OF SOIL TESTING FOR QUALITY AND QUANTITY ANALYSIS

01.4- SEDIMENTOMETRIC SOIL ANALYSIS OR HYDROMETER TEST

D) The readings will be written down in the form, (see the example of the sheet in annexes) where the formulas are set considering the elapsed time, and where the temperature will be recorded (the calculations are based on the Stock Law). The results will be calculated as % sand, % silt, % clay.

CURRENT STATE OF EQUIPMENT

The solution of sodium Hexameta phosphate is not available (the requisition was submitted), Graduated cylinders (1000 ml) are very old need to be replace (10 pieces).

Equipment:

1. Plastic hummer, 0.008 sieve mm
2. Precision balance 0.01 gr
3. Hydrometer
4. Stopwatch
5. Thermometer
6. Clean water if possible demineralized
7. Deflocculating chemical Sodium Hexametaphoshate
8. Graduated cylinder (1000 ml)
9.1000 ml graduated cylinder called control or reference.
10. Prepared sheet, a pen

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STEPS OF SOIL TESTING FOR QUALITY AND QUANTITY ANALYSIS

01.4- SEDIMENTOMETRIC SOIL ANALYSIS OR HYDROMETER TEST

dryed soil samples and grinded ones for hydrometer analysis (specimen 2)

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STEPS OF SOIL TESTING FOR QUALITY AND QUANTITY ANALYSIS

01.4- SEDIMENTOMETRIC SOIL ANALYSIS OR HYDROMETER TEST

Sedimentometric test or Hydrometer analysis

Granulometric tests of sand

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STEPS OF SOIL TESTING FOR QUALITY AND QUANTITY ANALYSIS

01.5- SIEVE ANALYSIS

To determine the distribution of the coarser, larger-sized particle:

(1) Write down the weight of each sieve as well as the bottom pan to be used in the analysis.

(2) Record the weight of the given dry soil sample.

(3) Make sure that all the sieves are clean, and assemble them in the ascending order of sieve numbers Place the pan below #100 sieve. Carefully pour the soil sample into the top sieve and place the cap over it.

(4) Place the sieve stack in the mechanical shaker and shake for 10 minutes.

(5) Remove the stack from the shaker and carefully weigh and record the weight of each sieve with its retained soil.

In addition, remember to weigh and record the weight of the bottom pan with its retained fine soil.

(6) Obtain the mass of soil retained on each sieve by subtracting the weight of the empty sieve from the mass of the sieve + retained soil, and record this mass as the weight retained on the data sheet. The sum of these retained masses should be approximately equals the initial mass of the soil sample. A loss of more than two percent is unsatisfactory.

(7) Calculate the percent retained on each sieve by dividing the weight retained on each sieve by the original sample mass.

(8) Calculate the percent passing (or percent finer) by starting with 100 percent and subtracting the percent retained on each sieve as a cumulative procedure.

<u>POINTS TO BE CONSIDERED:</u>

1. Organization of the collection, classification and description of samples for analysis.
A sample reception register available at BMC.

2. The interpretation of the results have to be well visible in the results report.

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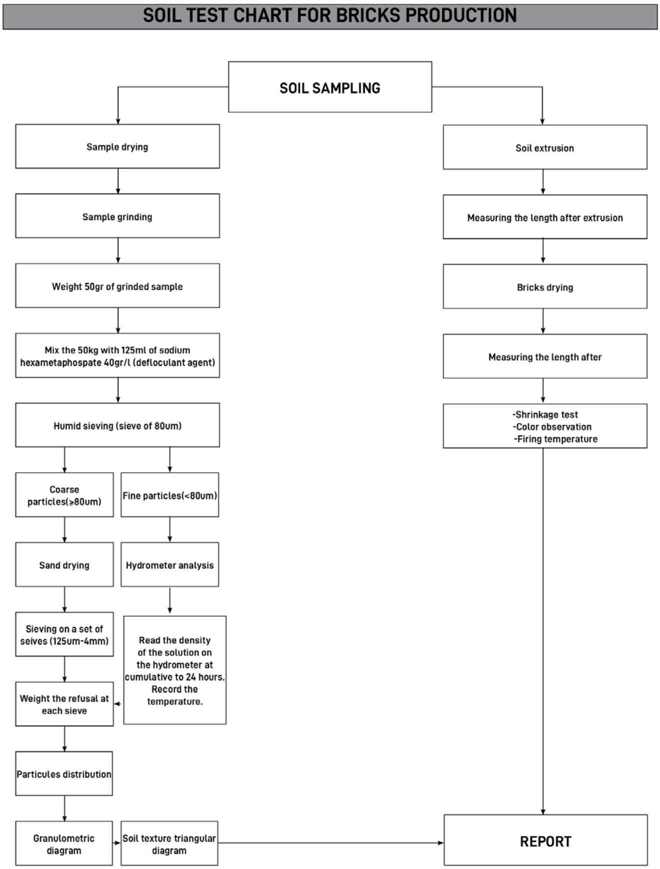
STEPS OF SOIL TESTING FOR QUALITY AND QUANTITY ANALYSIS

01.6- SOIL TESTING CHART USED FOR BRICK PRODUCTION



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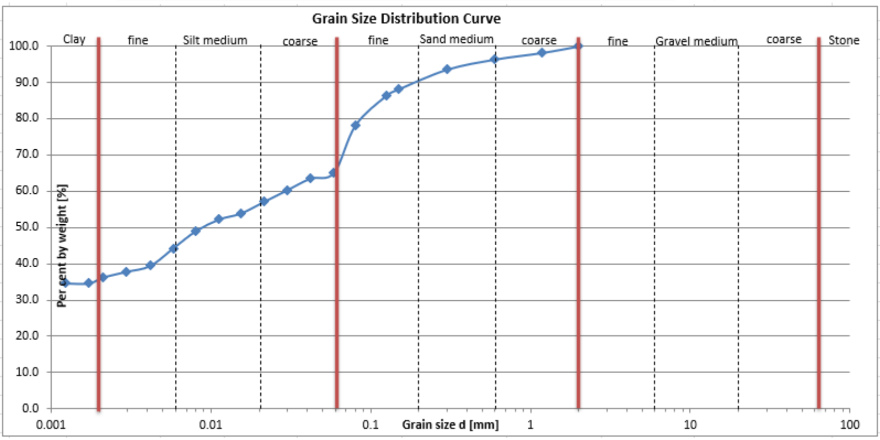
STEPS OF SOIL TESTING FOR QUALITY AND QUANTITY ANALYSIS

01.7- RESULTS FORM FOR SEDIMENTOMETRIC ANALYSIS

PROJECT : STUDY OF CLAY DEPOSIT				*Particle Size Analysis (Hydrometer Method)*			SAMPLING DATE : 23/08/2017		
SAMPLE: SOIL SAMPLE				SITE LOCATION : KAMONYI_RUGALIKA			TESTING DATE :30/08/2017		
SAMPLING NUMBER : SI				SOIL TEXTURE TRIAGEL BY USDA :			DEPTH (Cm) : 80 to 200		
				% Sand	% Silt	% Clay			
				34.9	28.9	36.2			
Initial dry mass=50gr					Meniscus correction Cm = 0.5	Particle density measured rs = 2650 Mg/m3			
mass of dry specimen m = 50 gr					Reading in dispersant 3,5				
K	TIME(sec)	Elapsed time(min)	Temp T (° C)	Hydrometer reading	D =K Ö (L / t) mm		Rd = Rh - Ro/	Percentage of particle finer that the corresponding particle diameter K(%).	Temperature correction (F$_t$)
					corrected reading	Equivalent particle diameter D (mm)			
						2		100.0	
						1.18		98.20	
						0.6		96.40	
						0.3		93.6	
						0.15		88.20	
						0.125		86.40	
0.0133						0.08		78.20	
	30	0.5	27	22	10.465	0.05874	20.28	65.15	1.28
	60	1	27	21.5	10.5975	0.04180	19.78	63.54	1.28
	120	2	27	20.5	10.8625	0.02992	18.78	60.33	1.28
	240	4	27	19.5	11.1275	0.02142	17.78	57.12	1.28
	480	8	27	18.5	11.3925	0.01532	16.78	53.90	1.28
	900	15	27	18	11.525	0.01125	16.28	52.30	1.28
	1800	30	27	17	11.79	0.00805	15.28	49.09	1.28
	3600	60	27	15.5	12.1875	0.00579	13.78	44.27	1.28
	7200	120	27	14	12.585	0.00416	12.28	39.45	1.28
	14400	240	27	13.5	12.7175	0.00296	11.78	37.84	1.28
	28800	480	27	13	12.85	0.00210	11.28	36.24	1.28
	43200	720	27	12.5	12.9825	0.00172	10.78	34.63	1.28
	86400	1440	27	12.5	12.9825	0.00122	10.78	34.63	1.28



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STEPS OF SOIL TESTING FOR QUALITY AND QUANTITY ANALYSIS

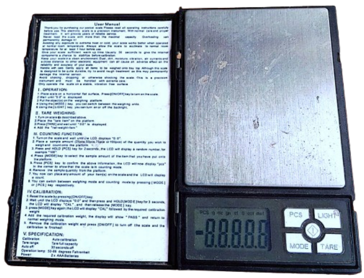
01.8- EQUIPMENT

<u>Equipment Required:</u>

1. Set of sieves
2. Shaker machine
3. Precision balance (0.01gr)

1. Set of sieves

2. Shaker machine



3. Precision balance

02

QUALITATIVE TEST OF BRICKS MADE FROM CLAY

02.1- TEST OF COMPRESSIVE STRENGTH

PROCEDURES:

The “compressive strength” parameter of a brick or block determines the load that a brick can withstand on a given surface.

- Polish the surfaces of the material that will support the load.

- Take the dimensions of the material (length and width) to determine the surface that supports the load.

- Using a compression machine, compress the brick until it breaks and record the breaking force (F).

The compressive strength (CS) is then determined by the following relation:

CS (in Mpa)= [Breaking Force (F) (in KN) / Surface (S) of brick (in sqm)] x10.

S= L (in cm) x l (in cm)
L: Length
l: Width
F is read on the machine

Taking into account the standards of the “East African Community" and the values obtained for the compressive strength.

The bricks are classified as follows:

• CS $\geq$ 28Mpa: Special bricks;
• 10.5Mpa <CS <28Mp: Bricks of category A (Good quality);
• 7 Mpa <CS $\leq$ 10.5 Mpa: Bricks of category B (medium quality);
• 3.5 Mpa <CS $\leq$ 7 Mpa: Category C bricks (poor quality);
• CS $\leq$3.5 Mpa: Unclassified bricks (poor quality)

NB: it is recommended to test at least 10 bricks for each firing cycle.

Responsible: Expert

02

QUALITATIVE TEST OF BRICKS MADE FROM CLAY

02.2- WATER ABSORPTION TEST

PROCEDURES:

Water absorption test helps to determine the ability of material of absorbing water. It is conditioned by its porosity and its permeability.
Water absorption is determined as follows:

- Using a precision scale, determine the weight of the brick after firing

- Immerse the brick in water for 24 hours and measure the weight of the brick again after immersion.

The water absorption coefficient is determined by the following relationship:

Water absorption (%):
[(Weight of the brick after 24 hours of immersion - weight of the brick after firing) x 100] / Weight of the brick after firing.

The bricks are then classified as follows:

• Absorption <7%: Special bricks (refractories);
• 7% ≤Absorption ≤12%: Bricks of good quality;
• 12% <Absorption <20%: Bricks of average quality;
• Water absorption ≥20%: Poor quality bricks.

NB: it is recommended to test at least 10 bricks for each firing cycle.

Responsible: Expert/Technician /Brickmaker

02

QUALITATIVE TEST OF BRICKS MADE FROM CLAY

02.03- DIMENSIONS TEST

<u>PROCEDURES:</u>

The dimensions of the bricks make it possible to know whether the bricks produced meet the required dimensions or the dimensions of the order offered.

This parameter is evaluated according to the length, The width and the height of the bricks.

To assess the dimensions of the bricks, we proceed as follows:

- Place 10 bricks side by side along their length.
- Measure the total length using a decameter.

Do the same for the width and height.

According to the norms of the "East African Community" standards, the deviation required for the length of 10 bricks is ± 4cm while for the total width and height, the deviation is ± 2cm.

Responsible: Expert/Technician Brickmaker

03

DETERMINATION OF SOIL ORGANIC MATTER BY LOI METHOD

03.01- DESCRIPTION

Soil is composed of living organisms, water, carbonates, carbon containing material, mineral matter, decomposing matter and much more.

To determine how much one of these soil components make up the entire soil mass, the Loss On Ignition (LOI) procedure is implemented.

Initially, the researcher will take the mass of the sample prior to LOI and then place the sample into a heating device.

Depending on what the researcher is trying to determine in the soil, the temperature of the device can be set to the corresponding temperature.

The soil sample is kept at this temperature for a next ended period of time after which it is removed and allowed to cool down before re-weighing the sample.

The amount of mass lost after the LOI treatment is equal to the mass of the component the researcher is trying to determine.

03

DETERMINATION OF SOIL ORGANIC MATTER BY LOI METHOD

03.02- THE USE OF LOSS ON IGNITION

1. This method is used to determine water content levels, carbon levels, amount of organic matter levels, and amount of volatile compounds.

2. The LOI is also used in the cement industry which operates the furnace in the 950°C, combustion engineers also use LOI but at temperatures lower than 950°C.

3.The cement industry uses the LOI method by heating up a cement sample to 900-1000°C, and it is heated until the mass of the sample stabilizes. Once the mass has stabilized the mass lost due toLOI is determined. This is usually done to determine the high water content in the cement or carbonation as these reduce the quality of cement.

High losses are usually due to poor storage conditions of cement or manipulation of cement quality by suppliers.

This ensures that the cement used in a site is of the correct composition to meet safety protocols and requirements of customers.

4. In the mining industry, the use of LOI is vital in determining moisture and volatile material present in the rock. Hence, when performing whole-rock analysis to determine total volatiles the LOI method is used. In order to remove all volatiles and to oxidize all iron into iron oxides, the temperature of the LOI is set to 900-1000°C.

5. It could allow the researchers to determine the amount of water initially in the soil sample and its porosity by comparing the change in weight of the sample before and after the evaporation. This new weight of the sample is called the dry weight and its previous weight is called the weight.

03

DETERMINATION OF SOIL ORGANIC MATTER BY LOI METHOD

03.03- THE USE OF LOI TO DETERMINE THE ORGANIC MATTER CONTENT IN THE SOIL

The Loss on Ignition (LOI) analysis is used to determine the organic matter content(%OM) of a soil sample. This is a relatively simple procedure compared to others used to determine %OM.

It does not involve the use of any chemicals, only the use of a muffle furnace. LOI calculates %OM by comparing the weight of a sample before and after the soil has been ignited.

The research showed that organic matters containing the soil can be entirelyburned off from the clay body at early stages and in quite a wide range (200–600°C).

Before ignition the sample contains OM, but after ignition all that remains is the mineral portion of the soil. The difference in weight before and after ignition represents the amount of the OM that was present in the sample.

03

DETERMINATION OF SOIL ORGANIC MATTER BY LOI METHOD

03.04 -THE LOSS ON IGNITION TEST

This test may be useful for the soil used in brickmaking for the following reasons:

1. It was observed that increasing the organic matter to the clay body increases the water content required to maintain the plasticity of the clay-residue mixture, to prevent the excessive shrinkage of brick sand too much water content, the best organic matter in clayey soil is 10%.

2. It was also observed that the fibrous nature of the residues caused no dificulties during the mixing and extrusion process.

3. It was determined the organic matter in the clay body increases the water content required to maintain the plasticity of the clay–waste mixture.

4. An increase in the amount of organic residues causes a reduction in the bulk density, the main reason for such a trend is the combustion of the organic residues during the sintering period.

A. EQUIPMENT:

- Oven capable of being heated to approximately 650°C.
- Crucibles -20ml.
- Crucible racks, stainless steel, local manufacturer.
- Balance sensitive to 1mg in draft-free environment.

03

DETERMINATION OF SOIL ORGANIC MATTER BY LOI METHOD

03.04 -THE LOSS ON IGNITION TEST

B. PROCEDURE:

1. Scoop 5 to10 g of dried, grounded(10mesh) soil into tared crucibles.
2. Dry for two hours at 105°C.
3. Record weight to +0.001g.
4. Heat at 360°C for two hours (after temperature reaches 360°C).
5. Cool to 150°C.
6. Weight in a draft-free environment to 0.001g.

C. CALCULATION:

Loss of weight on ignition (LOI) is calculated by the following equation:

LOI(%)= (Weight at 105°C- Weight at 360°C x 100) / Weight at 105°C

D. ESTIMATE THE ORGANIC MATTER:

Estimation of organic matter from LOI is done by regression analysis. Select soils covering the range in organic matter expected in your state or area of testing.

Determine percent organic matter by the Walkley-Black method described above.
Regress organic matter on LOI. Use the resulting equation to convert LOI to percent organic matter.

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