INTRODUCTION.

Tests performed to assess the use of MAXEh will be presented in this document. MAXEh is an additive that when mixed with clay-free dirt, cement and water produces a masonry type product that has similar results as concrete but behaves differently when tested in the laboratory. The standard by the book methods for testing concrete therefore does NOT apply to MAXEh mixtures. The reason for these differences lies both in the characteristics of the dirt used and in the strong binding action of MAXEh which is additional to the one provided by the cement. That's why MAXEh mixtures must not be considered as concrete for designing nor testing purposes.

SOIL SELECTION.

The process begins with the selection of the borrow bank. After inspection of two sites in Nelamangala area near Bangalore city, it was decided to use one sandy type material from one of these sites. It will be referred as Nelamangala soil and one cubic meter was transported to lab facility. Quick field tests for selecting adequate material were explained to Karle engineers but a protocol for these tests will be prepared as a guide. Another sandy type soil from Gadad area, 600 km from Bangalore, has been tested and it will be referred as Gadad red soil, but only a 45 to 50 liter sample was available.

PHOTO 1. Silty sand soil obtained from Nelamangala site.

Boulevard. De la conspiración #11, San Miguel Allende, Guanajuato 37747, MEXICO.
Phone: +52 415 152 2541
E-Mail: maxeh.mexico@hotmail.com Web: www.maxehterracreto.com

DENSITY TESTS.

Some materials are measured by weight while others by volume. To get the numbers of different materials as much as in weight as in volume, density tests were performed for all of them. In Nelamangala soil typical loose density test was run but the soil was tested with natural moisture. For Gadad red soil as well as for cement, water and MAXEh tests were performed in a graduated plastic test tube; at least two tests were run for each material.

PHOTO 2. Soil prepared for loose density test with natural moisture i.e water content as found in quarry.

PHOTO 3. Density tests for MAXEh as well as for the water. Similar test was used for cement.

Same procedure was utilized for fresh mixtures but with a graduated 2 liter plastic jar.

WATER NEEDED. PRELIMINARY ESTIMATION.

In order to figure out how much water needs to be added to MAXEh mixtures a first test is performed for each soil with no cement and no MAXEh. Procedure is a trial and error one and consists on adding in a mixer, measured quantities of water to a fixed volume of soil and running slump tests on the mixtures until the desired slump is obtained. Having defined quantity of water per liter of soil tests with MAXEh and cement could be performed; water to be added in definitive tests is 65% to 70% of water used in first trials.

PHOTO 4. Cement used for tests.

PHOTO 5. Adding water to trial sample.

PHOTO 6. Slump test in water needed trials.

WATER PREPARATION.

Two types of samples would be prepared: ones with no MAXEh and others with MAXEh. For the last ones, MAXEh proportion is always 1 kg per 200 liters of water. For the first tests 100 liters of water were improved by the addition of 500 grams of MAXEh and mixed by hand due to an electrical problem with the pump requested. Since MAXEh additive must be maintained in suspension in the water with the help of a pump, every time improved water was going to be added to the soil it was mixed by hand.

PHOTO 7. Water and MAXEh.

SAMPLE PRODUCTION.

In an electro-mechanical mixer soil and cement were mixed until observing a uniform mixture. Soil quantities were 100 liters loose condition in first mixtures but they were reduced to 70 and 40 liters in last mixtures. Cement quantities were 100, 150 and 200 kg per cubic meter (1 000 liter) of loose soil but they were adjusted to the volume of soil used on each sample. Then after MAXEh improved water is added to the soil-cement mixture using the quantity of water according to the volume of soil used on each case. Mixture continues and slump is checked to see if more water needs to be added, until the slump desired is reached or slightly surpassed. Slump measured was in the 11 to 14 cm range while 9 cm or 15.5 cm were obtained in some cases, although 12 cm slump was the target value.

With these results 9 to 11 cube specimens 15 x 15 x 15 cm each were prepared for each sample. In the first test with MAXEh and 100 kg of cement per cubic meter of soil 6 cylinder specimen, 6 in diameter by 12 inches height were also prepared. The objective is to correlate cube resistance with cylinder resistance since all experience with MAXEh up to today has been measured in cylindric specimens.

100 and 150 kg of cement per cubic meter of soil were also prepared with simple water, no MAXEh, to observe the effect of MAXEh in the final resistance of specimens. In some cases measurements of the fresh mixtures density were also executed.

Details and results obtained in all of these experiments are reported on an atached table.

PHOTO 8. Pouring cement into dry soil.

PHOTO 9. Adding water with MAXEh to dry soil-cement mixture.

Boulevard. De la conspiración #11, San Miguel Allende, Guanajuato 37747, MEXICO.
Phone: +52 415 152 2541
E-Mail: maxeh.mexico@hotmail.com Web: www.maxehterracreto.com

PHOTO 10. Cube specimens for one test.

PHOTO 11. Cylinder specimens for same test.

Boulevard. De la conspiración #11, San Miguel Allende, Guanajuato 37747, MEXICO.
Phone: +52 415 152 2541
E-Mail: maxeh.mexico@hotmail.com Web: www.maxehterracreto.com

PHOTO 12. Density measurement in fresh mixture.

UNCONFINED COMPRESSION TESTS.

Both cubes and cylinders will be subjected to unconfined compression test the same way they're performed in concrete samples. Originally there was planned to test two specimens at each of the next ages: 3, 7, 14, 21 and 28 days.

First samples showed a hardening process extremely slow so it was asked not to extract specimens from the molds at 24 hours as usual but at 72 hours. Then a curing process began introducing specimens in plastic bags. All of these procedures impacted the dried process so the first samples tested in the compression machine were very low since specimens were very humid. On four cubes tested at 5 day age in unconfined compression test resistance was on the order of 0.40 MPa (4 kg/cm^2), being the target 8 MPa (80 kg/cm^2) at 28 day age.

PHOTO 10. Cube specimens for one test.

This was the reason for changing the curing process: all samples will be extracted from their molds at 24 hours and letting them to dry freely at natural environment, nor plastic bags, but in a shadowed place.

PRELIMINARY CONCLUSIONS.

1) MAXEh mixtures must not be designed, nor curing and nor tested, according to concrete standards.

2) Hardening process of MAXEh mixtures do not follow the same curves as for typical concrete mixtures.

3) Air drying is necessary for MAXEh to develop strong binding forces in the soil mass. The faster the sample or the element is exposed to direct air the faster the resistance is obtained.

4) These are the first tests with soils in India and all of the team is acquiring experience. Since drying process has been very slow it's recommended to test next specimens at 21, 28 and 56 days, and not before 21 days in any case.

5) In the table attached to this report it is clear that for the same cement proportion (say 100 or 150 kg of cement per cubic meter of loose soil) it is needed 8% to 10% more water if it contains no MAXEh compared to water-MAXEh mixtures. It could be interpreted for the MAXEh as a water reducing element.

6) For most concrete mixtures the water/cement ratio is the most important factor in the final resistance: the lower the ratio the higher the resistance, being a number of 0.45 to 0.50 the best an in general less than 1. In MAXEh mixtures this conclusion is not longer valid since higher resistances could be attained with more than 2 ratios.

7) Variations in the test results could be explained by the heterogeneity of the soil i.e. some parts has more silt content than others. Don't lose that the goal is to use soil as they're encountered in the field with no additional treatments.

8) More work and research must be done to obtain more uniform results, but MAXEh is the best option yet since it doesn't require wash sand, river sand, crushing dust nor gravel or aggregates; besides it requires less amounts of cement and could be prepared by unskilled but trained people.

9) Results obtained with soils studied up to today are not universal as in the concrete mixtures, but a well trained group of engineers and technicians can make enough tests in very short time to develop practical rules and methods on each project.

10) To get a practical idea of what to expect let's say: soil must be clay-free or low clay silty sand or very sandy silt with low plasticity; geotechnical engineers from Bangalore area informed that these soils exists in most parts of India, below a top soil layer of 1 to 2 meters depth. Cement consumption will be on the range of 180 to 250 kg per cubic meter of loose soil, to get resistances of at least 8 MPa (80 kg/cm^2). Water consumption could vary from 230 to 280 liters per cubic meter of soil, depending on the type of soil, its plasticity and the grain size distribution. MAXEh consumption will be 1 kg per 200 liters of water.

MAXEh MR

Maxeh Suelo Cemento Fluido

PREVIOUS LABORATORY TESTS FOR MAXEh TERRA-CRETE

<u>Quality of soil materials</u>. The soil to be used for walls made of soil-cement shall comply with **ALL** specifications listed in the chart below:

CHART 1

CHARACTERISTICS	VALUE
PARTICLE SIZE	
MAXIMUM SIZE (INCHES)	2
% PARTICLES BIGGER THAN MAXIMUM SIZE	0
% GRAVEL (BIGGER THAN 4.76 MM)	MAXIMUM 15
% OF DUST(INFERIOR TO # 200 MESH)	MAXIMUM 35
PLASTICITY	
LIQUID LIMIT (%)	MAXIMUM 35
PLASTICITY INDEX (%)	MAXIMUM 12
LINEAR CONTRACTION (%)	MAXIMUM 2.5
CARRING CAPACITY	
VRS STANDARD (%)	MINIMUM 20
EXPANSION IN VRS TEST (%)	MAXIMUM 1.5

VRS STANDARD WILL BE SATURATED

SPECIMENS FOR VRS TEST WILL BE COMPACTED BY IMPACT ACCORDING TO ASTM, CODE, UNLESS THE DUSTS ARE INFERIOR TO 12% IN SOIL CONTENT OR THE PLASTICITY INDEX IS INFERIOR TO 6% IN WICH CASE WILL BE COMPACTED THROUGH STATIC PRESSURE

Boulevard. De la conspiración #11, San Miguel Allende, Guanajuato 37747, MEXICO.
Phone: +52 415 152 2541
E-Mail: maxeh.mexico@hotmail.com Web: www.maxehterracreto.com

As much as possible light materials should be avoided with porous particles or featherlike materials such as featherweight volcanic rock, pumice stone and pumice soil or similar.
An excess in porous material might increase the liquid limit beyond the indicated values in the chart above. In such cases a liquid limit might be acceptable if linear contraction and plasticity indexes are within the specified range.

The use of *pozzolanic ash* cement should also be avoided unless specified. Pozzolanic ash delays the resistance of the soil-cement mixture and on poured walls which are expected to harden as soon as possible. In case that a project needs Pozzolanic ash cement, the proportion of Portland cement should be increased to obtain short term reasonable resistance.

In order to proceed with the test the following codes should be used:

- ✓ ASTM D6913-04e2 Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

- ✓ ASTM D4318-05 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

- ✓ ASTM D1883-07e1 Standard Test Method for CBR (California Bearing Ratio) of Laboratory-Compacted Soils

Dry loose volumetric weight. A soil sample will be sun dried for a minimum period of 8 (eight) hours and three tests of dry loose volumetric weight will be practiced. If the average difference in the three values has a minimum or maximum variation of less than 7% the average value should be considered as valid. If such differences are larger a new test should be run.

Maximum volumetric dry weight and optimal humidity. The values should be considered for the soil material without cement.
After drying the material for a minimum of 8 (eight) hours the material should be sieved through a 3/4 inch mesh and a sample of around 50 kg. of dry soil should be obtained. The material then will be homogenized and divided into 5 (five) equal parts. 600 (six hundred) ml.

of water should be added to each of the samples of approximately 10 (ten) kg. The mix should then be mixed well and homogenized to distribute humidity. Each sample will then be kept in a plastic bag for a minimum of 12 (twelve) hours.

Five tests will be run to obtain the maximum volumetric dry weight and humidity for each sample, looking for two of them to be on the dry side of the compaction curve. Two on the humid curve and one more near the maximum limit. The method to establish the amount of water needed for sampling should be left to the lab technician's experience.

The first bag should be opened and additional water should be applied according to the lab technician's experience considering that the soil was cured during 12 (twelve) hours with limited humidity. After further homogenization-compaction of the material should be done.

The methodology to be used for compaction is ASTM standard D698-91 (1998), with a 2.49 kg (5.5 Pounds) static weight piston at a falling height of 30.5 cm (12 Inches). Each sample will be contained in a 15.24 cm (6 Inches) diameter metallic container, with three layers. Each sample will receive 56 (Fifty-Six) strokes with the described piston.

Once each specimen is compacted, humid weight will be measured and a sample of the interior will be extracted for humidity measurement. The sample then should be disposed off.
The same procedure of humidification will be followed for the remaining four samples, applying more humidity related to the former specimen.

The resulting curve will be drawn (volumetric dry weight vs humidity) and the maximum dry volumetric weight and optimum humidity will then be estimated.

An additional test should be performed for **Alkali–silica reaction (ASR)**.
Concrete microbar test should be then performed to discover cement alkali–silica reaction (ASR) for aggregates.

All the described tests (Particle size, plasticity, carrying capacity and volumetric weights) as well as Alkali- silica reaction will be then passed to the Geotecnichian consultant for analysis and approval.