Research Journal of Forensic Sciences ______________________________ ISSN 2321–1792
Vol. **8(2),** 20-24, July **(2020)** *Res. J. Forensic Sci.*

Short Communication

Analogous studies on composition, morphology and density of natural and artificial soil in forensic application

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Available online at: www.isca.in, www.isca.me
Received 4th February 2020, revised 20th May 2020, accepted 30th June 2020

Abstract

Artificial soil (AS) was widely used today for the construction, but it requires more research activities for the identification and comparison of natural soil (NS) and artificial soil in forensic application. Present article reports the morphological information of the AS and NS sample using digital stereomicroscope. The elemental profiling of the NS and AS sample was carried out using portable XRF analyzer. Further the density of the NS and AS is compared and analyzed by density gradient method. The morphology, elemental profiling and density method was analyzed to compare and identify the NS and AS sample in sand trafficking.

Keywords: Soil, EDXRF, morphology, density gradient.

Introduction

Sand place very important role for the construction of industry and many buildings which requires massive amounts of natural sand for its projects. Sand is the compound material which having components of both organic and inorganic with different proportions[1]. In most of the states of India, the natural sand mining was prohibited due to the dredging rivers beyond a safe capacity. Due to the shortage of the natural sand, the most of the industries are utilizing artificial soil for the construction of industry. Many of the mining company transporting natural and artificial sand for completion of their project. The forensic comparison of the natural and artificial sand place very important role to confirm whether the transporting sandy soil was a natural or artificial? Soil evidence place important role in crime scene. As per the Locard exchange principle, if any two surface interact with each other, there is mutual transfer of content of surface between each other[2,3]. It is encountered material used for different offences on surface. Transportation of illegal sand used as evidence by police to avoid trafficking. Particularly this article focusing on the comparison of the natural and artificial soil based on the composition, morphological information and its density which was found in the illegal transportation for the construction of the industry.

To compare the natural and artificial soil, it is important to understand and know the characteristic features of the different soil such as its composition and how they form[2]. It is possible to compare the soil by forensic examiner due to the unique character, different type and soil variation over very short distances both horizontally and vertically[2]. Sandy soil is found in the form of granular and it consists of finely grounded rocks and many mineral particles.

It mainly composed of silicate minerals and silicate rock granular particles ranging in size from 0.06mm to 2mm. One of the dominant mineral present in the sandy soil was quartz. Some other common minerals are found to be amphiboles and micas. Some of the heavy minerals are also exist in the soil such as tourmaline, zircon. It is defined by size, being finer than gravel and coarser than silt. Soil can also refer to a textural class of soil or soil type; i.e., a soil containing more than 85 percent sand-sized particles by mass[4-9].

Materials and methods

Materials: Natural soil, artificial soil, electronic balance, density gradient tube, sieve mesh, Nitrobenzene ($C_6H_5NO_2$), Bromoform ($CHBr_3$), XRD analyser.

Sampling: Investigating natural and artificial soil samples were thoroughly mixed and collected on the top surface of the region using clean spatula. The collected natural and artificial soil samples are then packed in the labeled paper packet for further investigation. The collected samples were air dried, mixed, gently homogenized and sieved through the mesh sieve for the uniform particle distribution. Among the collected natural and artificial soil, two different set of sample were made and labeled as NS-1 (Natural soil-1), NS-2 (Natural soil-2), AS-1 (Artificial soil-1) and AS-2 (Artificial soil-2).

Results and discussion

Microscopic observation: The texture of the natural sandy soil was observed using Leica MZ16 stereomicroscope under 10X and 25X magnification.

The samples was sieved in the sieve mesh and two set of soil samples are collected for the microscopic observation marked as NS-1 (Natural soil-1), NS-2 (Natural soil-2), AS-1 (Artificial soil-1) and AS-2 (Artificial soil-2) at different magnification. Figure-1(a-d) shows the microscopic image of the NS-1 and NS-2 sample under 10X and 25X magnification. Figure-2(a-d) shows the microscopic image of the AS-1 and AS-2 sample under 10X and 25X magnification. Microscopic image of the samples reveals that the sand particles are found to be single grained, aggregated, granular, non porous and massive in nature and having particles with different colors. In particular, the NS samples having white, red, brown and black color stones and plenty colorless (quartz) stones are observed over the area. The AS samples having less color stones include black and plenty of colorless (quartz) stones. The sand particles are found to be interconnected, loosely bonded between each other, less rounded, often rugose, well separated from each other and rather compact inside[10-11].

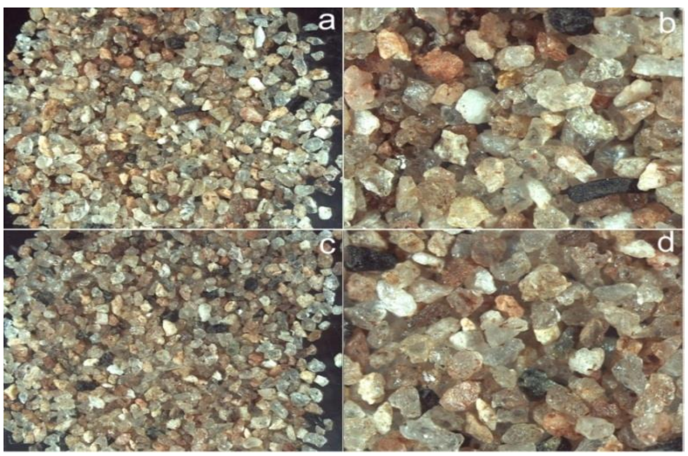

Figure-1: Microscopic images of Natural soil.

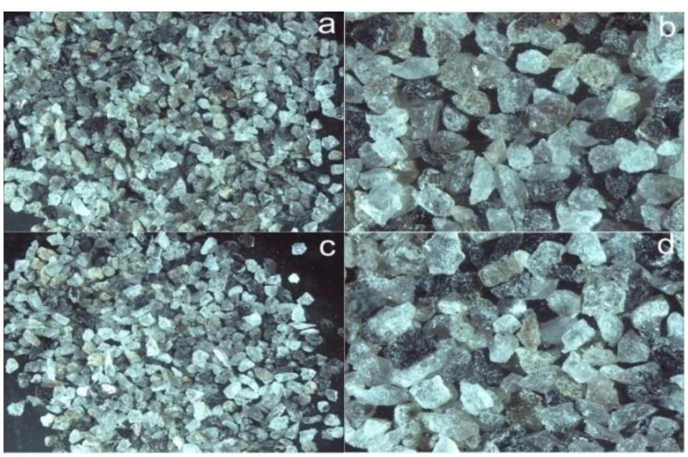

Figure-2: Microscopic images of artificial soil.

Elemental analysis: The non-destructive multielemental analysis of sandy soil samples are analyzed using thermo scientific portable Niton XL2 XRF analyzer. The NS and AS samples are sieved in the sieve mesh and two set of soil samples are collected for elemental composition analysis. Figure-3 and 4 shows the elemental composition of the NS and AS samples. Among the total concentration of the elements, major six trace elements have been determined in the NS sample namely Mn, Fe, Zr, Mo, Pb and Bi in different percentage which was shown plot-3. Similarly major six trace elements have been determined in the AS sample namely Ti, Fe, Co, Zn, Zr and Mo in different percentage which was shown in Figure-4. In NS profiling, the Fe and Ti was found to be bit higher concentration compared to the other elements determined in the sample. In AS profiling, the Fe and Zr was found to be bit higher concentration compared to the other elements determined in the sample. The Co and Zn was found to be unique in NS samples and Zr and Mo unique in AS samples[12-14].

Density gradient method: In the density gradient method, a glass cylinder tubes (gradient tubes) of diameter 1cm and 35cm long were filled with the bromoform ($CHBr_3$, Density: 2.89g/cm³, Molar mass: 252.73g/mol) and nitrobenzene ($C_6H_5NO_2$, Density: 1.2g/cm³, Molar mass: 123.11g/mol). These high density and low density solution were added in step wise to the gradient tubes such that the high density solution Bromoform was filled at the bottom of the cylinder and low density solution nitrobenzene was at the top of the tubes. The one end of the tubes was sealed using rubber cock[15]. The NS and AS samples are sieved in the sieve mesh and 0.05gm of the soil sample was collected for the density distribution study. The 0.05gm of the NS and AS samples were added to the gradient tubes using glass funnel. The soil sinks through the solutions of lighter density until it reaches a place where the density of the solution matches the particle density[13]. Further the particles of the NS and AS sample producing the bands at 10.5cm and 10.cm from the bottom of the gradient tube shown in figure-5. These particular bands are representing the densities of the particles. Some of the heavy particles of the AS sample are settled at the bottom of the gradient tube. Only few particles are settled at the bottom for NS. There no any such special changes in bands are observed in the density gradient tube[15-17].

Conclusion

Morphology information of the samples reveals that the particles are found to be single grained, aggregated, granular, non porous and massive in nature and having particles with different colors. In particular, the NS samples having white, red, brown and black color stones and plenty colorless (quartz) stones are observed over the area. The AS samples having less color stones include black and plenty of colorless (quartz) stones. Major six trace elements have been found in NS sample namely Mn, Fe, Zr, Mo, Pb and Bi. Similarly major six trace elements have been found in the AS sample namely Ti, Fe, Co, Zn, Zr and Mo. The Co and Zn was found to be unique in NS samples and Zr and Mo unique in AS samples. The particles of the NS and AS sample producing the bands at 10.5cm and 10.cm from the bottom of the gradient tube. There are no any such special changes in bands are observed in the density gradient tube.

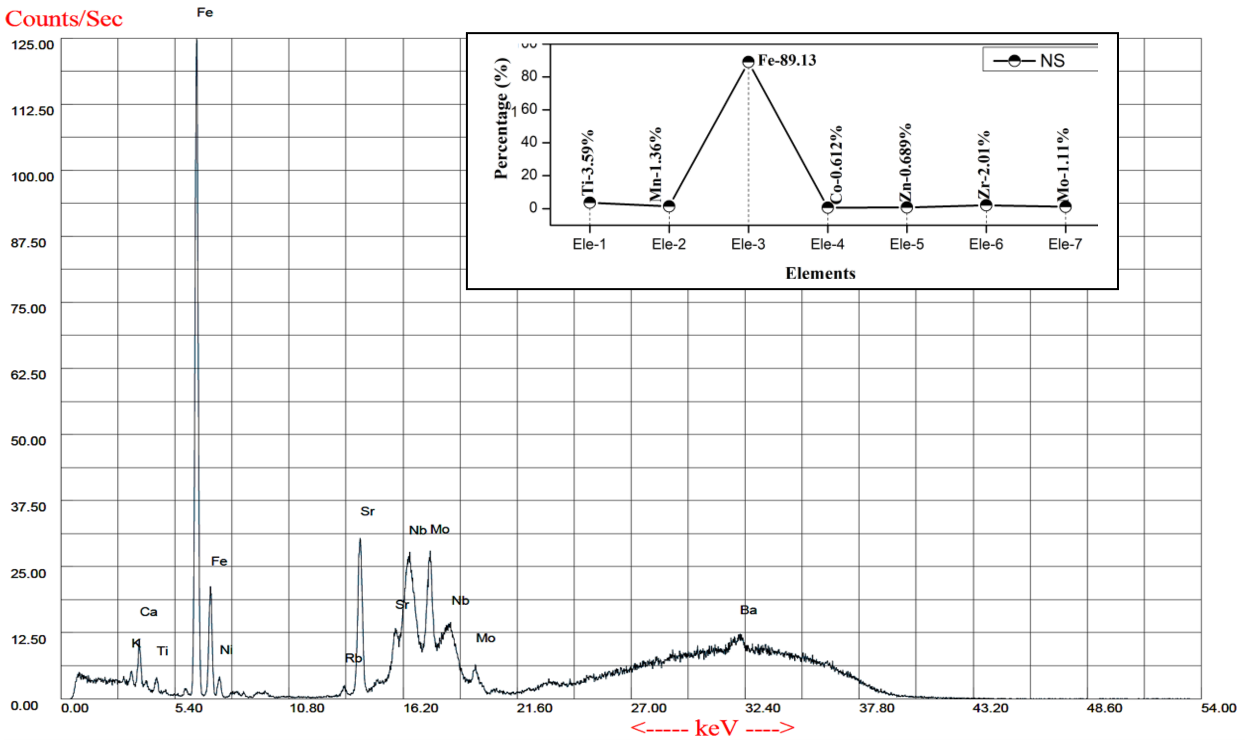

Figure-3: Elemental profiling of NS.

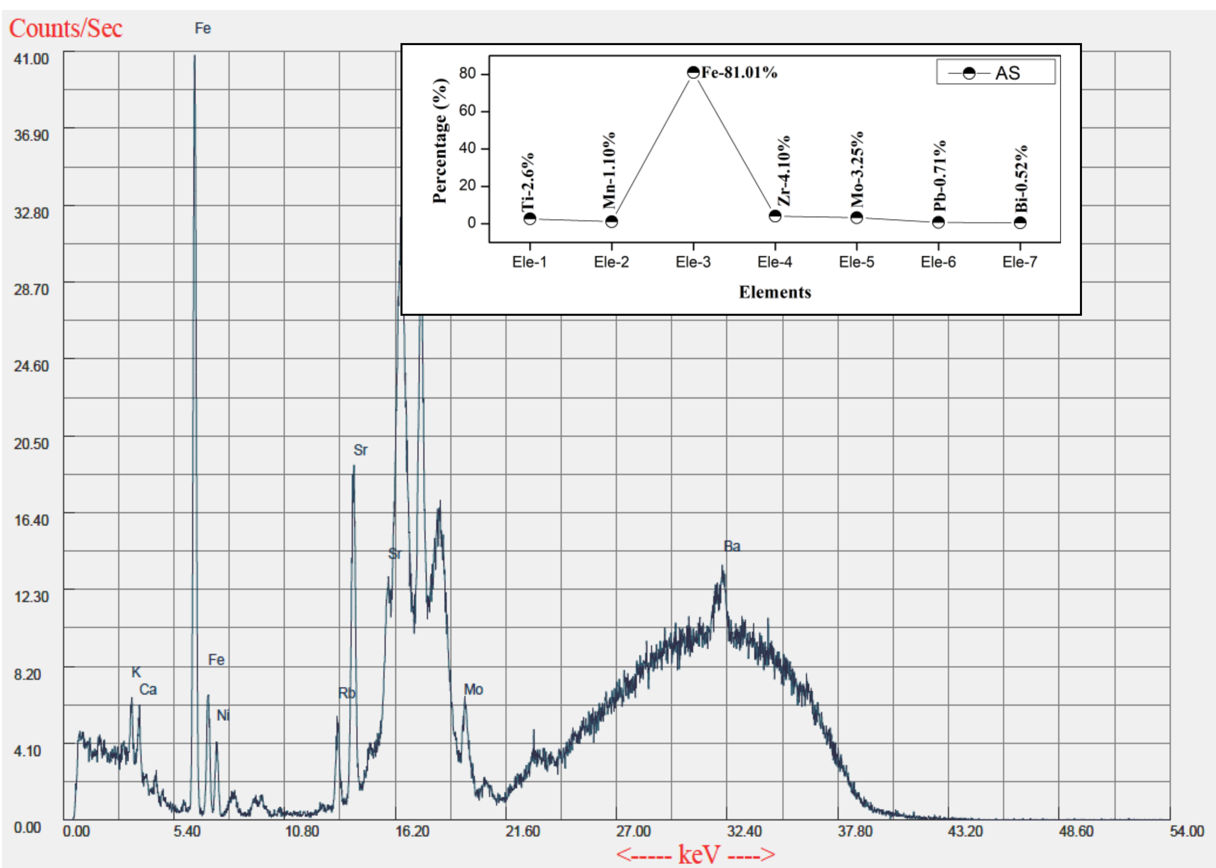

Figure-4: Elemental profiling of AS.

Figure-5: Density gradient tube.

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