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ADVANCED CHARACTERIZATIONS OF SRI LANKAN ROOF TILE CLAYS FOR MORE OVER INDUSTRIAL USES

Abstract. *Roof tile industry is an abundant industry in different areas of Sri Lanka because of the availability of different clay verities at large number of specific locations in Sri Lanka. In the comparison of the modern uses of such clays, it is highly limited the advanced applications of such clays for advanced science and technological uses other than the primary uses such as the pottery industry, brick industry or roof tile industry. The advanced chemical analysis and identifications of the important chemical characters of a selected roof tile clay type were the aims and objectives of the existing research. The representative clay samples were collected from Dankotuwa area which is recognized as an abundant area of finer grained clays that much suitable for roof tile industry. The collected clay samples were chemically analysed using X-ray diffraction (XRD) spectrometer, X-ray fluorescence (XRF) spectrometer and Fourier transform infrared (FT-IR) spectrometer. The obtained results showed the presence of Fe, Zr, Ba, Ti and K as the major elements, kaolinite, quartz, glauconite, muscovite and marcasite as the minerals. In the considerations of advanced characteristics of such minerals, kaolinite, glauconite and marcasite have been identified as strong adsorbents for some specific compounds such as some heavy metals, radioactive elements and pathogens and some of ferrous minerals may have the supporting capacities in the catalytic activities for some chemical reactions that combining with some specific solid compounds such as activated carbon. Therefore, as the suggestions, it is possible to* *recommend the developments and enhancements for such clays for the uses in the waste water treatment applications and catalytic activities as a supporting material in various forms such as the bulks, composite materials or nano-materials.*

Keywords: *Roof tile clay, X-ray diffraction (XRD) characterization, X-ray fluorescence (XRF) characterization, Fourier transform infrared (FT-IR) characterization, Advanced industrial uses*

1. Introduction

Clays have been identified as multi-purpose materials because of the specific characteristics of most of clays including the variations in chemical compositions, physical properties and mechanical behaviors. According to the chemical compositions of mainly found clays, there were investigated the presence of kaolinite and montmorillonite as the common minerals in such clays [1, 2, 3, 4, 5].

In addition that there were observed the presence of Si, Fe, Ca, Mg, K, Ti (in the form of their oxides) and some of heavy metals (trace elements) as the common elements in most of well known clay varieties [1-10]. In the existing research, there were expected to investigate the chemical composition and mineralogy of a selected industrially using clay variety and disclose the advanced uses of such clay type.

2. Materials and Methodology

The representative clay samples were collected from Dankotuwa area in Sri Lanka which is a well-known area for clay deposits and roof tile manufacturing.

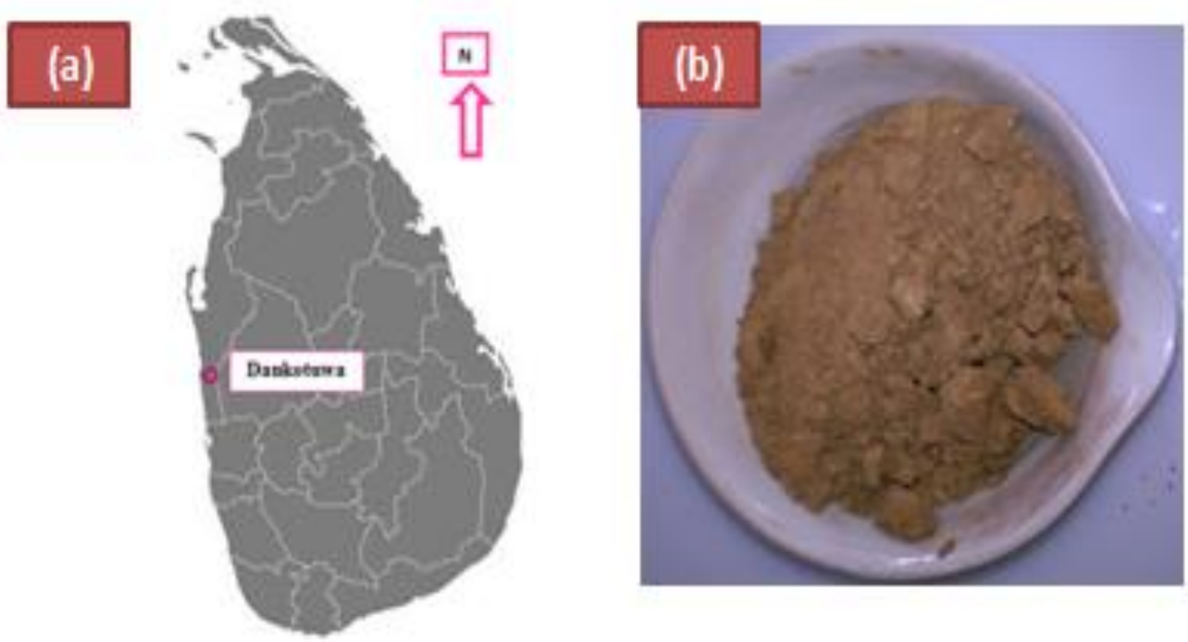

Fig. 1. **(a) Sample collected area and (b) a representative clay sample**

The collected clay samples were well handled using non-contaminated tools and stored in cleaned polythene bags.

A few of sub-portions were separated from the initial clay mass and those sub-portions were oven dried for 24 hours at 110C and crushed using ceramic crucible and ball mills as necessary while obtaining powdered samples.

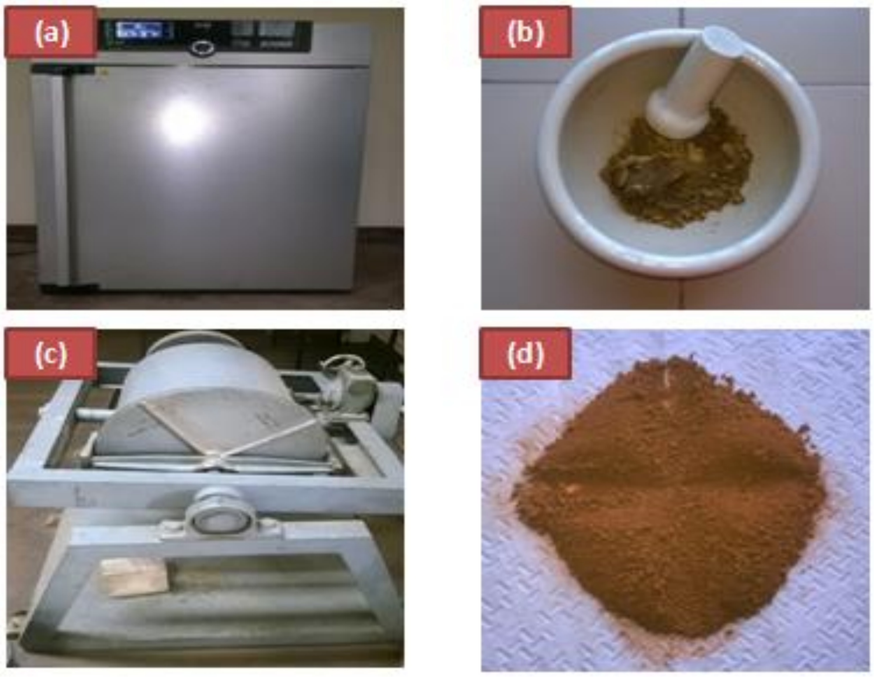

Fig. 2. **(a) Oven, (b) ceramic crucible, (c) ball mill and (d) powdered clay**

Three representative clay samples were chosen from the prepared clay powder using the coning and quartering method which is most suitable sample selection method for solid powdered materials.

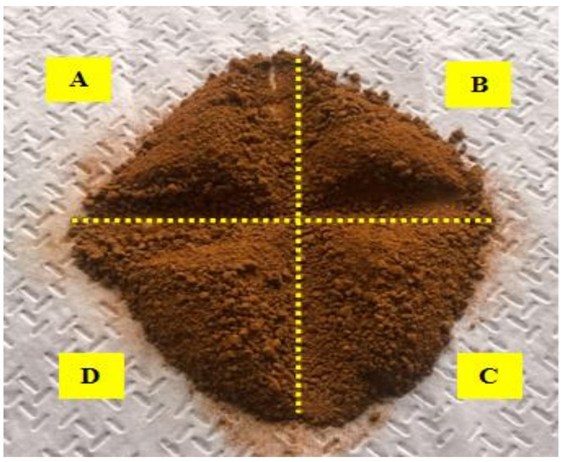

Fig. 3. **Coning and quartering method**

The selected representative clay samples were analyzed using following analytical instruments based upon the mentioned objectives.

– X-ray Diffraction (XRD) Spectrometer - Mineralogy of the clay

– X-ray Fluorescence (XRF) Spectrometer- Elemental chemical composition of the clay

– Fourier Transform Infrared (FT-IR) Spectrometer- Chemical structure of the clay

Fig. 4. **(a) X-ray diffraction (XRD) spectrometer, (b) Fourier transforms infrared (FT-IR) spectrometer and (c) X-ray fluorescence (XRF) spectrometer**

3. Results and Discussion

The elemental chemical composition of the selected roof tile clay is shown in the Figure 5.

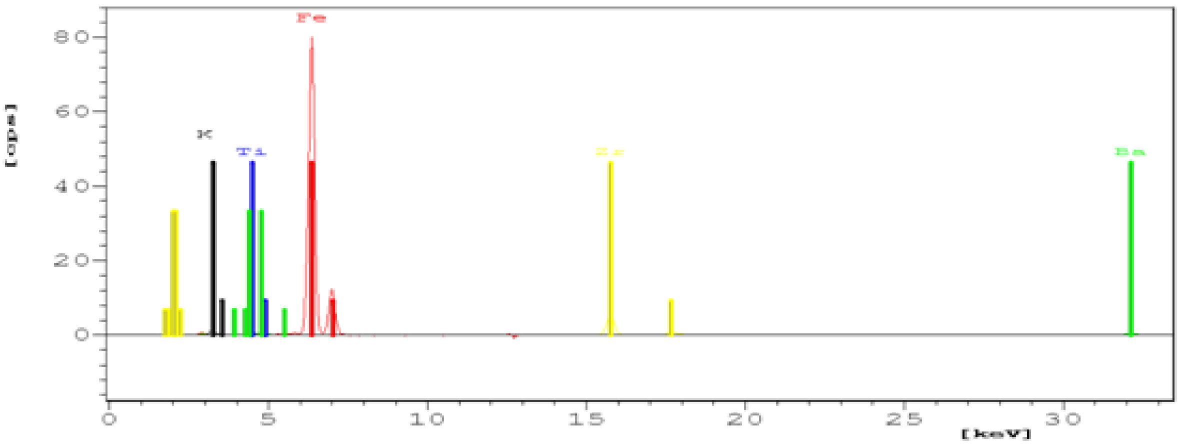

Fig. 5. **X-ray fluorescence (XRF) spectroscopy of roof tile clay**

The important observations of the above graph have been summarized in the Table 1.

Table 1

Elemental chemical composition of roof tile clay

Element	Fe	Ti	Ba	Zr	K
Content (%)	75.72	2.95	5.30	3.36	12.67

These metallic elements are usually found in clays/soils in the forms of their oxides because of the reaction with the moisture. There was not found any hazardous element such as the heavy metals even though the Ba^{2+} is toxic in aqueous solutions [5, 8, 9, 10].

The mineralogy of the selected roof tile clay is shown in the Figure 6.

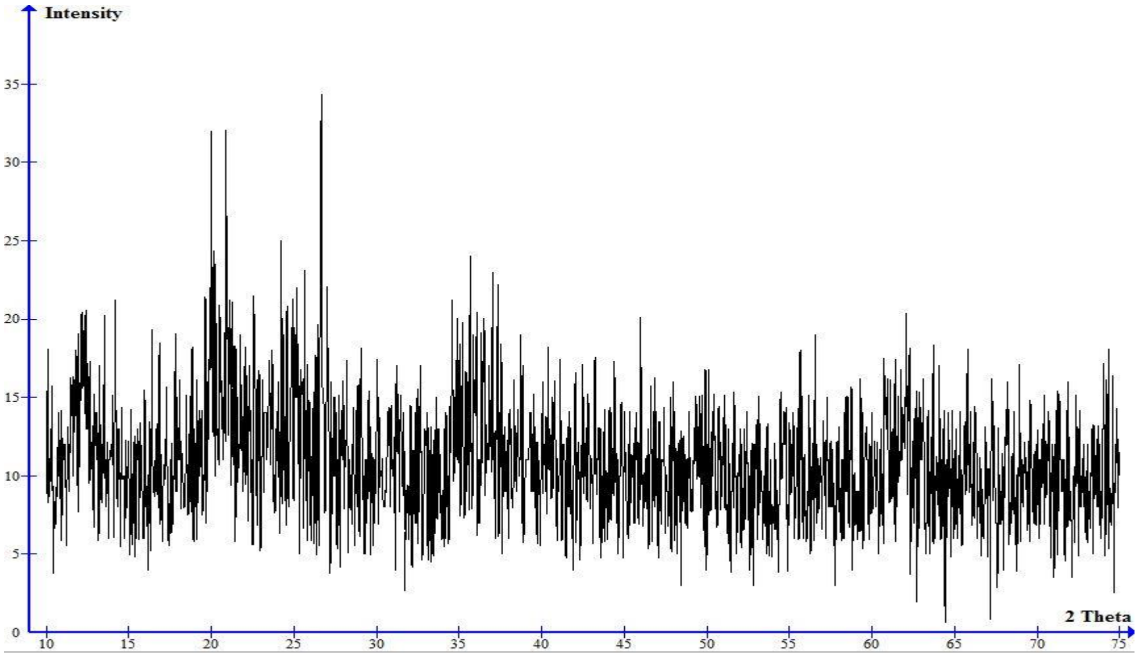

Fig. 6. **X-ray diffraction (XRD) spectroscopy of roof tile clay**

According to the highlighted peaks of 2ϴ at 14^0, 20^0, 26^0, 45^0 and 65^0, it was indicated the presence of kaolinite as a mineral in a lower amount because of the low intensity of the major peaks [1, 2, 5, 7].

In the consideration of the chemical formula of kaolinite $Al_2 (Si_2O_5) (OH)_4$, the Al would be a major element even though it was not detected in the elemental chemical composition experiment [5,7].

The chemical structural analysis results of roof tile clay are shown in the Figure 7.

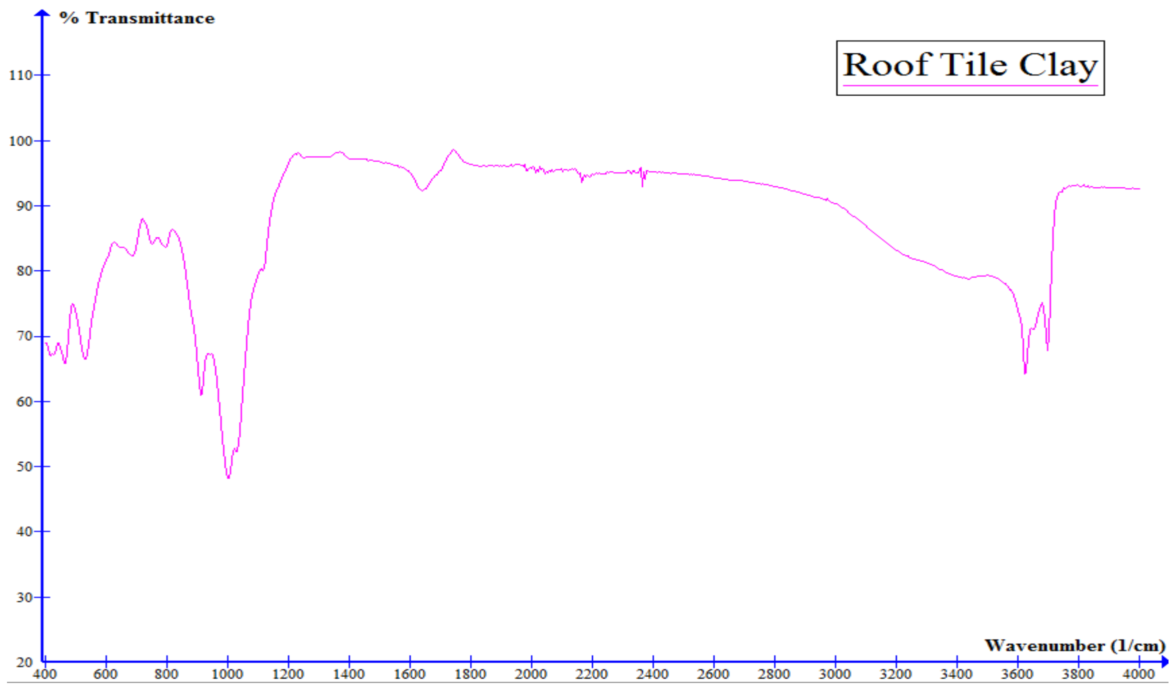

Fig. 7. **Fourier transforms infrared (FT-IR) (transmittance) spectroscopy of roof tile clay**

A discussion on the above spectrum is given in the Table 2 [1, 2, 3, 4, 5, 6, 9].

Table 2

Remarks of the structural analysis of roof tile clay

Wave number (cm^{-1}) / Obtained	Wave number (cm^{-1})/ Reference	Functional groups/ Minerals
~3700	3698	O-H stretching
~3700, ~3650, ~1100, ~900, ~700, ~550	3698, 3652,1095, 908, 689, 528	Kaolinite $Al_2(Si_2O_5)(OH)_4$
~1100, ~800, ~450	1075, 790, 452	Quartz SiO_2
~1000	1001	Muscovite $KAl_2(AlSi_3O_{10})(OH)_2$
~1000	1006	Glauconite $(K,Na)(Mg,Fe)(Fe,Al)(Si,Al)_4O_{10}(OH)_2$
~ 400	407, 396	Marcasite FeS_2

According to the analysis and remarks of Table 2, there were found a few of common clay minerals while obtaining the majority with Fe minerals. Based upon the characteristics of such Fe minerals, existing roof tile clay will be useful as a strong adsorption or sorption material for some other metallic elements and some of pathogens.

4. Conclusion and Recommendations

This roof tile was composed with Fe minerals and relatively higher amount of Fe compounds while it is free from hazardous materials. It is possible to recommend some specific industrial uses as follows.

– Sorption material in water treatment applications because of the higher sorption capacity of glauconite and marcasite for heavy metals and unnecessary compounds.

– Strong adsorber for some heavy metals and pathogens in waste water/polluted water and polluted air because of the strong adsorption capacity of kaolinite.

Also it is possible to recommend the analysis of the entire chemical composition of such roof tile clay using an advanced analytical method such as Neutron Activation Analysis (NAA) as a further research activity.

5. Acknowledgement

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