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**A STUDY ON GEOPOLYMERIZATION OF IRON ORE TAILINGS**

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## **A STUDY ON GEOPOLYMERIZATION OF IRON ORE TAILINGS**

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# ESTUDO DA GEOPOLIMERIZAÇÃO DE REJEITO DE BARRAGEM DE MINÉRIO DE FERRO

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*“All we have to decide is what to do with the  
time that is given us”*

***John Ronald Reuel Tolkien***

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## ABSTRACT

Geopolymers are a relatively new technology, which is pointed as a potential alternative to the ordinary Portland cement for some applications. The need for an alternative to this binder comes from the environmental problems related to its production process and the tremendous volume of non-replaceable resources extracted to its production. Considering the importance of ordinary Portland cement, to find a suitable alternative binder is a hard task. At the same time, the re-application of industrial by-products from several productive sectors is an effective management way to save non-replaceable resources as well as a correct destination. In this sense, the main objective of this study is evaluating the feasibility of the iron ore tailings as a raw material to the production of geopolymeric composites. Additionally, two blend materials and fine aggregate were applied and verified the influence and effects on the geopolymer final properties. Were applied a solution of sodium hydroxide at three different molar concentrations (8, 10, and 12 mol/l) and curing temperature of 100 °C. A depth characterization procedure was applied in all raw materials and blend used in this work. The performance of the obtained geopolymer was observed over mechanical strength, physical properties, dimensional stability, and microstructural analysis. The experimental procedure enabled a closely understand of the geopolymeric synthesis and kinetics, influence of specific aspects on the geopolymerization and final properties, and the role of iron in this process. The experimental results showed that the geopolymer based on iron ore tailings is an efficient binder with interesting properties to construction industry. Finally, the geopolymers derived from iron ore tailings rise as an interesting construction material.

**Keywords:** Geopolymer; Iron ore tailings; Binder; X-ray diffraction; Microstructure.

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## RESUMO

Os geopolímeros são uma tecnologia relativamente nova, apontado como uma alternativa em potencial ao cimento Portland convencional, para algumas aplicações. A necessidade de um aglomerante alternativo advém dos problemas ambientais relacionados a produção do cimento Portland e, ainda, do enorme volume de matéria prima não renovável extraída para sua produção. Considerando a importância do Cimento Portland convencional, encontrar um aglomerante alternativo adequado se torna uma tarefa árdua. Ao mesmo tempo, a reaplicação de resíduos industriais, provenientes de diversos setores produtivos, é uma maneira eficaz de gerenciamento e ao mesmo tempo, de reduzir o consumo de recursos não renováveis, e ainda prover uma destinação adequada. Nesse sentido, o principal objetivo deste estudo é avaliar a viabilidade da aplicação de rejeito de minério de ferro como matéria prima na produção de compósitos geopoliméricos. Além disso, dois materiais suplementares e agregado miúdo foram empregados, sendo avaliado sua influência nas propriedades finais dos geopolímeros. Foi utilizada uma solução simples de hidróxido de sódio em três concentrações molares (8, 10, e 12 mol/l) e temperatura de cura de 100 °C. Um extenso procedimento de caracterização foi aplicado em todas as matérias primas e materiais suplementares empregados neste trabalho. O desempenho dos geopolímeros obtidos foi observado acerca de sua resistência mecânica, propriedades físicas, estabilidade dimensional e parâmetros microestruturais. O procedimento experimental possibilitou um entendimento da síntese e cinética de geopolimerização, a influência de aspectos específicos na geopolimerização e nas propriedades finais, assim como o efeito do ferro neste processo. Os resultados experimentais apresentados mostraram que o geopolímero baseado em rejeito de barragem de minério de ferro é um aglomerante eficiente com propriedades interessantes para a indústria da construção civil. Finalmente, os geopolímeros baseados em rejeito de barragem de minério de ferro surgem como um material de construção interessante.

**Palavras-chave:** Geopolímero; Rejeito de barragem de minério de ferro; Aglomerante; Difração de raios-X; Microestrutura;

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## LIST OF ABBREVIATIONS

C-S-H – Calcium silicate hydrate

DTA – Differential thermal analysis

GIOT – Geopolymer derived from iron ore tailings

GIOT GWR – Geopolymer derived from iron ore tailings blended with glass wool residue

GIOT MK – Geopolymer derived from iron ore tailings blended with metakaolin

GIOT SD – Geopolymer mortars derived from iron ore tailings

GWR – Glass wool residue

IOT – Iron ore tailings

IOT-1 – Iron ore tailings milled for one hour

IOT-2 – Iron ore tailings milled for two hours

IOT-3 – Iron ore tailings milled for three hours

MK – Metakaolin

QXRD – Quantitative X-ray diffraction

SCMs – Supplementary cementitious materials

SEM – Scanning electron microscope

STA – Simultaneous thermal analysis

TG – Thermogravimetric

XRD – X-ray diffraction

XRF – X-ray fluorescence

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## **CHAPTER 1 - General Introduction**

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### **ABSTRACT**

All environmental problems related to the production of ordinary Portland cement, the eco-efficiency of the construction industry, and the tremendous volume of diverse types of industrial by-products encourage several scientific studies on the scope of eco-efficiency and environmentally friendly technologies. Geopolymer technology emerges as a potential alternative to the binder mentioned above and presented superior properties and characteristics. However, since there is a relatively new scientific field, exists a lack of data and information about several important aspects necessary to the spread and broad application of this new technology. This fact is a huge opportunity to explore new technologies. In this Chapter, is presented a brief discussion on the beginnings of geopolymer technologies, general aspects, usual terms, as well as the thesis' partition and configuration.

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