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Top and seat angle connections subjected to elevated temperatures: Finite element and mechanical modeling

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The finite element (FE) simulations and the experimental results are used to develop a mechanical model to predict the beam axial force-temperature and rotation of top and seat angle connections with and without web angles when exposed to elevated temperatures. First, FE models were developed and validated against experimental results available in the literature at elevated temperature. Second, FE models were developed to conduct an extensive parametric study to investigate some major geometric parameters such as load ratio, beam length, angle thickness, gap distance, that impact the behavior of these connections when exposed to fire. Third, a mechanical model, that considers the major geometric and material properties, was developed to predict the thermal axial force and rotation response. The mechanical model consists of multi-linear and nonlinear springs that predict each component stiffness, strength and rotation. The beam stiffness was included in the proposed model to predict beam-column connection assembly rotation and thermal axial forces and their effect on the connection response. The proposed model provides important insights into fire-induced thermal forces and deformations and their implications on the design of steel bolted top and seat angle connections with and without web angles under fire.

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Hazardous bauxite residue and ferrous ore slag application as principal components for environmentally friendly red ceramics production

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This paper reports on ceramic material based on red mud of bauxite primary treatment, ground granulated blast furnace slag, foundry (molding) sand with addition of wood waste ash and fine waste of automobile glass polishing. The purposes of this research were to replace completely the traditional raw materials (natural clay and sand mixes) for red ceramics fabrication and to decrease fusion temperature of firing process. To achieve these purposes the study of the raw materials and obtained ceramics was performed by the following methods: XRF, XRD, AAS, SEM with EDS, LAMMA, particles distribution size, flexural resistance strength, linear shrinkage, water absorption and density. The sintering process was realized by electric furnace at the temperatures 800°C, 900°C, 1000°C, 1050°C, 1100°C, 1150°C, 1200°C and 1225°C. The red mud content in the initial mixtures ranged from 50 to 100 wt.%, blast furnace slag from 10 to 50%, foundry sand from 10 to 50%, 20% wood waste ash and 20% waste glass. Depending on the raw materials compositions and sintering temperatures, the values of flexural resistance strength and others mechanical properties of the developed ceramics varied between 6.95 MPa and 12.27 MPa, significantly exceeding the values of traditional clay-sand pattern sample of ceramics at the same interval of temperatures. Analysis of physical and chemical processes of the ceramics structure formation with XRD method demonstrated almost complete change of initial minerals to new sintered minerals. Glass-like surface development was determined with SEM method, which led to decrease of amount of pores and their size. Studying of these glass-like new formations by chemical EDS and isotopes LAMMA (laser microprobe mass analyzer) methods confirms their very high chemical heterogeneity at micro level, typical for glasses. All these results prove the decrease of the materials melting point due to high content of heavy metals (Zn, Cu, Pb, etc.) and alkaline metals (Na, K, Ca, etc.) with very low melting points. Low values of leaching and solubility test of the metals also confirmed strong chemical binding of the metals, typical for glass structures. These values are hundreds and thousand times less than permitted by Brazilian sanitary standards. All these results experimentally proved the possibility to completely replace traditional natural raw materials with the mixes of industrial wastes with high technical and environmental efficiency and to decrease irreversible processes of nature destruction by quarries of mining materials and the environment contamination by polluting industrial wastes.

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