INVESTIGATION OF THE USAGE OF STONE POWDER WASTE COOKED WITH BORON MINERALS AS A SUBSTITUTION AND ADDITIVE MATERIAL IN METAKAOLIN BASED GEOPOLYMER MORTARS

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ABSTRACT

Portland cement, which is used as a binding material in traditional concrete, continues to have a market advantage in the construction industry in the past and still thanks to its cheap and easily available raw materials (limestone and clay). Although Portland cement continues to be the most used binder material in the concrete industry today, due to the high energy requirement during the production of cement and the harmful effect of the CO_2 gas released on the atmosphere, some studies have been carried out for the production of alternative binder building materials to cement in recent years. In this study, while producing geopolymer mortars, metakaolin as a binder, baked stone dust waste at 15%, 30%, 45% replacement ratios as substitute material, colemanite mineral at 10%, 20%, 30% replacement ratios as substitute material, borax penta hydrate mineral at 10%, 20%, 30% replacement ratios as substitute material, borax deca hydrate mineral is used at 10%, 20%, 30% replacement rates. At the same time, metakaolin as a binder, colemanite mineral as an additive at 10%, 15%, 20% additive rates, borax penta hydrate mineral at 10%, 15%, 20% additive rates, and borax deca hydrate mineral was used in 10%, 15%, 20% additive ratios. In mortar production, 50% of 10M sodium hydroxide (NaOH) and 50% of 2 Module sodium silicate Na_2SiO_3 were used as alkali activators. Geopolymer mortars produced using a liquid/binder ratio of 1, a water/binder ratio of 0.60, and a sand/binder ratio of 2.25 were cured for 24 hours at room temperature and 60 ℃ curing conditions. When the dispersion values of the produced geopolymer mortars were examined, it was observed that the dispersion value increased with the increase of the replacement rate of the baked stone dust waste substituted for the metakaolin as a binder, and the dispersion values increased with the increase of the substitution rate of colemanite, borax penta hydrate and borax deca hydrate substituted for the metakaolin.When the mechanical properties of geopolymer mortars were examined at different curing temperatures, it was observed that the 7 and 28-days flexural and compressive strengths of the samples containing only metakaolin as a binder at room temperature and 60 ℃ curing temperature did not differ. It was observed that the best results were obtained at 30% substitution rate in 7-days flexural and compressive strengths at room temperature and 60 ℃ curing temperature in the samples using baked stone dust waste as a substitute material, while the samples using only metakaolin gave the best results in the 28-days compressive strength. In the samples using colemanite mineral as a substitute material for metakaolin, it was observed that the best values in flexural and compressive strength of 7 and 28 days at room temperature curing were found only in the samples using metakaolin. In the samples cured at 60 ℃, it was observed that the best strength value in 7-days flexural and compressive strength was obtained in 10% colemanite mineral substitution. Likewise, considering the 28-days compressive strength of the samples cured at 60 ℃, the best values were obtained in the samples using only metakaolin as a binder. On the other hand, in the samples where borax penta hydrate and borax deca hydrate mineral were used as substitute materials instead of metakaolin as binder, it was observed that the best strength values were obtained in the samples produced using only metakaolin at both room temperature and 60 ℃ curing temperature. When colemanite mineral was used as an additive to metakaolin binder geopolymer mortars, it was observed that the best results at room temperature curing were obtained only in samples using metakaolin. At 60 ℃ curing temperature, it was observed that the best value in 7-days flexural and compressive strength was observed in the samples using 20% colemanite mineral, while in the 28-days compressive strength, only metakaolin was used as a binder.When borax penta hydrate mineral is used as an additive to metakaolin binder geopolymer mortars in mortar production, it has been observed that the best value in 7-days flexural and compressive strength at 60 ℃ curing temperature is obtained with 10% additive, while 28-days compressive strength is obtained in samples produced using only metakaolin. Likewise, in the samples using the mineral borax deca hydrate as additive material, it was observed that the best values in the flexural and compressive strength of 7 and 28 days at room temperature curing and 60 ℃ curing temperature were found only in the samples using metakaolin. As a result, it has been seen that metakaolin should be used as the main binder in the production of geopolymer mortar and that metakaolin gains strength at room temperature.It has been observed that up to 30% baked stone dust waste can be used as a metakaolin replacement material in geopolymer mortars, especially in early strength conditions. It has been observed that boron minerals cannot be used as a substitute material in geopolymer mortars in any way, and it has been observed that colemanite and borax penta hydrate minerals can be used up to 10% to 20%, especially in early strength conditions, in terms of additive material.

KEYWORDS - geopolymer mortar, alkali activator, compressive strength, flexural strength,cooked stone powder waste