011-ENGR

A novel clean biopolymer-based additive to improve mechanical and microstructural properties of fine-grained construction and demolition waste

The construction and demolition (C&D) industry generates a massive amount of waste, with fine-grained materials often being the hardest to reuse due to their mixed and inconsistent nature. Traditional stabilization methods, such as alkali activation or high-temperature curing, may improve performance but come with high environmental costs. This study explored the use of xanthan gum-based gels as a sustainable method to stabilize fine-grained construction and demolition waste (CDW), particularly materials with high fines content sourced from a recycling facility in Tennessee. To evaluate this approach, the CDW materials were first characterized by examining particle size distribution and analyzing their microstructure using scanning electron microscopy (SEM). Xanthan gum gel solutions were prepared at varying concentrations (0.5%,1%,1.5%,2%,2.5% and 3%) and mixed with CDW, with the optimal moisture content determined through Modified Proctor tests. The samples were compacted into cylindrical molds, cured under controlled conditions, and subjected to unconfined compressive strength (UCS) testing for 7,14,28,56,90 and 146 days. The results showed that a 1.5% xanthan gum gel concentration consistently provided the highest performance across all curing times. By 146 days, the samples achieved a peak strength of 3,205 kPa. SEM analysis revealed that the gel formed cohesive networks, binding the particles together and enhancing stability. Energy-dispersive spectroscopy (EDS) identified key chemical interactions that contributed to the improved strength and durability of the stabilized material. This study demonstrated that xanthan gum gels are a viable and eco-friendly solution for stabilizing fine-grained CDW. The use of xanthan gum gels not only improved the mechanical performance of the material but also offered a sustainable alternative to traditional methods. These findings provide a pathway for advancing waste management practices in the construction industry, promoting greener and more efficient use of resources to meet both environmental and engineering goals.