Sustainable innovation in self-compacted concrete: Integrating by-products and waste rubber for green construction practices

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Abstract

Due to increasing concern about global climate change and its negative influence on societies, there is a specific focus on the construction sector as the greatest contributor to greenhouse gas emissions. About 8–10% of global CO2 emissions come from cement production, which releases almost a ton of CO2 for every ton of cement. Growing demand for cement and concrete is attributed to rapid urbanization, industrialization, and economic growth, which also substantially impacts the depletion of natural resources. To address these challenges, a feasible approach is to utilize by-product materials and waste rubber as alternatives to cement and natural fine aggregates in producing self-compacted concrete (SCC). The utilization of various percentages of fly ash (FA), ground granulate blast furnace slag (GGBFS) as cement replacement, and crumb rubber (CR) from waste tires as a partial substitution of fine aggregate offers a suitable choice for the development of sustainable SCC. In addition, compressive strength (CS) is a vital property when considering other characteristics of concrete. Therefore, it is vital to develop reliable models for predicting the CS of SCC to achieve cost, time, and energy savings. Therefore, this research examines the impact of various contents of FA and GGBFS as cement (C) alternatives and CR as a sand replacement on the CS of SCC. To predict the CS of rubberized SCC mixtures, four different models were employed: linear regression (LR), multi-linear regression (MLR), full quadratic (FQ), and M5P-tree. To accomplish this, a comprehensive set of data comprising approximately 436 samples was analyzed to develop the models; as input variables, various mixture proportions, and curing ages were considered. To ensure the accuracy and reliability of the predictive models, several statistical assessments were performed. Based on the statistical assessment tools conducted in this study, the FQ model is considered the most effective model for forecasting the CS of SCC. Based on the statistical assessment tools, the FQ model was also implemented to forecast the splitting tensile and flexural strengths of SCC. The sensitivity analysis indicates that CR and GGBFS content are the best criteria for forecasting the CS of SCC utilizing this data set.

پوختە

بەهۆی زیادبوونی نیگەرانییەکان لە گۆڕانی کەشوهەوای جیهانی و کاریگەرییە نەرێنییەکانی لەسەر کۆمەڵگاکان، گرنگییەکی تایبەت بە کەرتی بیناسازی وەک گەورەترین بەشداربوو لە دەردانی گازی گەرمخانەییدا هەیە. نزیکەی 8-10%ی دەردانی CO2 لە جیهاندا لە بەرهەمهێنانی چیمەنتۆوە دێت، کە نزیکەی تۆنێک CO2 بۆ هەر تۆنێک چیمەنتۆ ئازاد دەکات. گەشەسەندنی خواست لەسەر چیمەنتۆ و کۆنکرێت دەگەڕێتەوە بۆ شارنشینی خێرا و پیشەسازی و گەشەی ئابووری، کە هەروەها کاریگەرییەکی بەرچاوی لەسەر کەمبوونەوەی سەرچاوە سروشتییەکان هەیە. بۆ چارەسەرکردنی ئەم تەحەدایانە، ڕێگەیەکی جێبەجێکراو بریتییە لە بەکارهێنانی کەرەستەی بەرهەمی لاوەکی و لاستیکیی پاشەڕۆ وەک بەدیل بۆ چیمەنتۆ و کۆکراوە وردە سروشتییەکان لە بەرهەمهێنانی کۆنکرێتی خۆپاڵچەککراو (SCC).

الملخص

بسبب القلق المتزايد بشأن تغير المناخ العالمي وتأثيره السلبي على المجتمعات، هناك تركيز خاص على قطاع البناء باعتباره المساهم الأكبر في انبعاثات الغازات الدفيئة. حوالي 8-10% من انبعاثات ثاني أكسيد الكربون العالمية تأتي من إنتاج الأسمنت، والذي يطلق ما يقرب من طن من ثاني أكسيد الكربون لكل طن من الأسمنت. ويعزى الطلب المتزايد على الأسمنت والخرسانة إلى التوسع الحضري السريع والتصنيع والنمو الاقتصادي، مما يؤثر أيضًا بشكل كبير على استنزاف الموارد الطبيعية. ولمواجهة هذه التحديات، يتمثل النهج المجدي في استخدام المواد الثانوية ونفايات المطاط كبدائل للأسمنت والركام الناعم الطبيعي في إنتاج الخرسانة ذاتية الضغط(SCC) .

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About Soran University

Soran University (SUN) is located in the city of Soran, which is about a two-hour drive north-east of Erbil (Arbil, Hewlér), the capital of the Kurdistan Region of Iraq (KRIQ). The city is flanked by the famous Korek, Zozik, Henderén, and Biradost mountains. The medieval mountain village of Rewandiz (Rawanduz, رەواندز) is a stone-cast away, and the two cities share this lovely, harmonious upland. While waiting for its green, environmentally friendly building to be erected on a hilltop overlooking the cities of Soran and Rewandiz, its existing city campus has been meticulously set out to accommodate the lovely natural landscape. The new campus will be the first of its type, being walkable, balanced, powered by renewable energy, and compliant with all international environmental regulations. There are 5 Faculties in SUN; Faculty of Arts (FAAR), Faculty of Science (FSCN), Faculty of Education (FEDU), Faculty of Law, Political Science, and Management (FLAW/PSM), and Faculty of Engineering (FENG). Also, there is SUN research centre. Moreover, at SUN, there is a Language Center. SUN signed many Memoranda of Understandings (MoU) with many International Universities.

How to get here

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