Sand Dune Concrete

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Abstract

Many research studies have used industrial materials like Fly ash, Steel Slag, and Silica Fume (SF) as fillers in the binder component of concrete. However, there is a growing global concern over sand resources as building demand continues to increase, and sand mining has a negative impact on the environment (rivers and oceans). As a result, one possibility is Dune Sand (DS) which is locally accessible in Saudi Arabia and may be used as a substitute for Ordinary Sand (OS) used in concrete and construction as a filler material. The American Concrete Institute (ACI) mix design method was used to determine the proportions for the reference mix. A total of nine concrete mixes were prepared, with varying proportions of DS and SF, and their compressive strength was tested at 7, 28 days respectively, There's a 12% decrease in compressive strength when dune sand is used due to poor grading and fineness which means we don't recommend replace ordinary sand with 100% dune sand hence the addition of pozzolanic material (Silica Fume) for compensation and improvement of the strength. Results indicate that there's an increase of strength when using SF in the mix with both OS and DS with a limit then the effect will decrease.

Problem Statement

Global warming is the most serious environmental and economic threat we face today. Global warming is caused by the emissions of greenhouse gases (GHGs). carbon dioxide (CO_2), methane (CH4), nitrous oxide (N2O), and Fluorinated Gases which are man-made gases used in a range of industrial applications Fluorinated gases are classified into four categories: hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF6), and nitrogen trifluoride (NF3) [4]. And CO_2 accounts for 79% of the gases in the Earth's atmosphere. And concrete is the third leading cause of CO_2 emissions in the atmosphere.

Project Objectives

The simplicity with which the product may be manufactured from locally accessible materials as well as the difficulty in obtaining such locally produced materials.

Investigate the impact of using DS as a replacement for OS on the compressive strength of concrete.

Determine the effect of adding SF to the mixes as SCMs in the mix to improve the strength of the concrete.

Determine the optimal mix proportions that provide a balance between cost-effectiveness and compressive strength.

Evaluate the cost-effectiveness of using DS as a replacement for OS and SF replacement of cement in concrete mixes.

Methodology

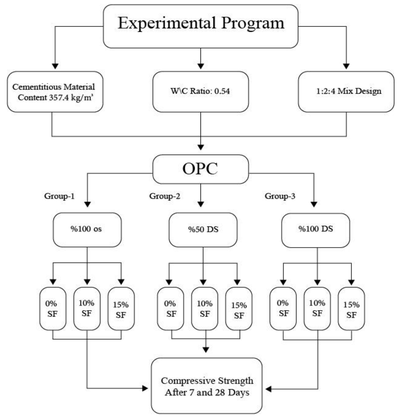


Figure 1.1 Mixing Experimental program

Experiments

Figure 1.2 Slump test

Figure 1.3 Flow Table test

Figure 1.4 Destructive test

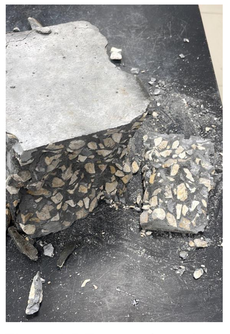
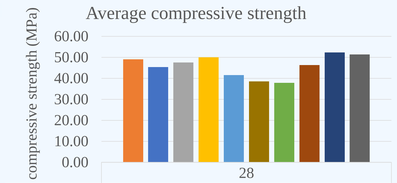


Figure 1.5 Fractured specimen

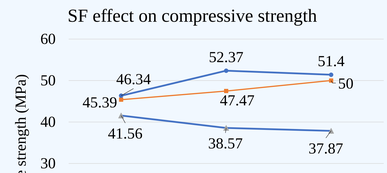
Results



Control SP	49.09
Control	45.39
OSF10	47.47
OSF15	49.99
Control DSP	41.56
DSF10	38.57
DSF15	37.87
50DS.0SF	46.34
50DS.10SF	52.37
50DS.15SF	51.40

Curing durations (days)

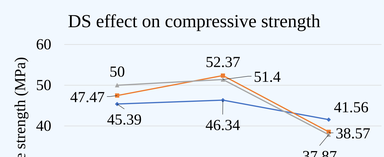
Figure 1.6 Compressive strength for concrete samples after 28days of curing from different mixing ratios of DS for concrete



	0%	10%	15%
0DS	45.39	47.47	50
100DS	41.56	38.57	37.87
50DS	46.34	52.37	51.4

SF(%)

Figure 1.7 SF behavior with different DS percent for concrete



	0DS	50DS	100DS
0SF	45.39	46.34	41.56
10SF	47.47	52.37	38.57
15SF	50	51.4	37.87

DS (%)

Figure 1.8 DS effect on compressive strength for Concrete

- The results of the 28-day compressive strength test show that the addition of SF increases the strength of the concrete mix. This effect is observed up to an SF content of 15%, even in the presence of DS. Even when DS is added by 50% or used fully, the strength of the mix continues to increase with the addition of SF. Therefore, the results suggest that the addition of SF increases the compressive strength of the mix even in the presence of DS.
- The results of strength testing on concrete mixes containing half DS and half OS show promise for use in concrete manufacturing in Saudi Arabia. However further testing is required to determine the suitability of DS for use in concrete mixes in Saudi Arabia. This is because the sieve analysis test results can vary depending on the location from which the DS was obtained, which could impact the overall results of the mix. Therefore, it is recommended that the DS is carefully tested before incorporating it into any concrete mix, to ensure that consistent and reliable results are obtained.

Cost study

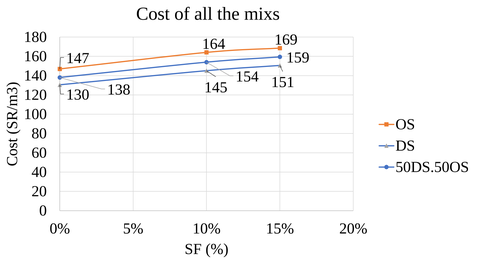


Figure 1.9 The cost of all mixes per meter cube

In order to perform the cost study analysis for this project we contacted local material and services providers in Riyadh and used the average prices per meter cube.

- The prices go higher by replacing cement with SF.
- The lowest price was achieved by using DS instead of OS with no replacement of cement with SF.

Conclusions

The objective of this project is to use dune sand as an alternative to ordinary fine sand in the manufacturing of concrete and the effectiveness of adding supplementary cementitious materials (silica fume) to concrete to improve its strength. Then mixtures were prepared and tested. We performed laboratory experiments to get physical characteristics, compressive strength tests with the same mix design, and the addition of filler in increasing sequence of proportions, and we compare them to select the best concrete based on compressive strength findings and economical cost.

- Results indicate that dune sand can be used in concrete up to 50% without much effect on strength. The negative impact of dune sand on strength was due to poor grading and fineness.
- The best strength was with a mix of ordinary sand with 15% Silica fume, but it is uneconomical.
- The best strength in dune sand was with a mix 50% ordinary sand and 50% dune sand without silica fume it is economical but won't be as much environmental impact as full DS and 15% SF and it is economical

GP1 Report

GP2 Report