Optimized Aggregate Gradation

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Abstract

Concrete is well known and used in a variety of construction applications such as bridges and buildings. With good design, they are cheap, strong, durable and sustainable. The main components of concrete are aggregate, binding materials, and water. Aggregates are important in concrete in which they compose 60-80% of the total volume of concrete. So, they can influence the concrete behavior. Thus, optimizing the aggregates not only improve concrete fresh and hardened properties, but also, improve the concrete durability, sustainability, and cost. There are many techniques to optimize aggregate gradations. Each one has pros and cons. In this part project (GP1), a comparison between four models was done. Also, sieve analysis tests were conducted on sources of coarse, intermediate , and fine aggregates. from different regions Riyadh, Jeddah and Dammam , The results showed a diversity of gradations , especially the fine aggregate sources where it was discovered that the fine aggregates in KSA are very fine. Similarly, the coarse aggregates gradation retained much amount of materials on certain sieve sizes (i.e. ½"). Thereafter, these aggregates from different regions will be used to design concrete mixtures using the TC that will take place in GP2

Problem Statement

Mixture designs are usually selected based on the experience and total availability of local materials. Model packing theories aim to decrease the voids by optimizing the combined gradation. This reduction in the voids between aggregates particles will reflect on the amount of paste in a mixture, which will reflect on the cost, and durability of concrete. The main objective of the grading process is to obtain an optimal aggregate grading that allows a concrete mixture to have a low cementitious content while maintaining workability, durability, and strength. Also, testing the limits of the Tarantula curve and whether it is work or not on deferent aggregates in KSA. The Tarantula curve showed great success in producing concrete mixtures that are workable, durable, and strong with the lowest quantity of cementitious materials in USA. Therefore, we will compare the gradation and performances obtained from mixtures made in KSA such as ACI mixture and contractor mixture to Tarantula curve limit.

Project Objectives

The following are the objectives for this graduation project:

- investigate gradations of local aggregates used in concrete mixtures from different region in KSA.
- Design mixtures within, at, and outside the Tarantula Curve limits.
- Making the ACI mixture, the contractor mixture, and modified mixture that made by Tarantula curve.
- Measure the performance of these mixtures.
- Comparison of mixtures based on the applicable test.

Methodology

Tarantula Curve Investigation:
We investigate gradations of local aggregates used in concrete mixtures from different region in KSA. Therefor, we used Aggregate from Jeddah which were closer to the limit of Tarantula curve. Therefore, to investigate the Tarantula curve method, the coarse aggregate upper limits were tested. Three mixtures were designed to have a targeted strength between 35 MPA and 40 MPA ,also , slump range between 150 mm and 200 mm. Mix I, the sieve size 12.5 mm limit was exceeded. In Mix II was made to be at the coarse aggregate limits of the TC. In Mix III, the sieve size 4.75 mm limit was exceeded as show in figure 1.1 .

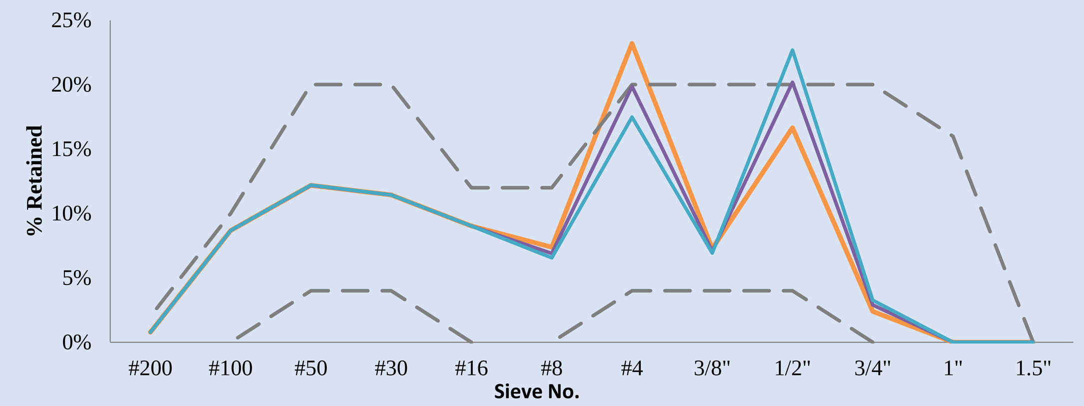

Figure 1.1: The three mixtures which at limit, sieve size 12.5 mm exceeded and sieve size 4.75 mm exceeded.

Compared Mixtures Designed:
Different and many mixtures were made by TC curve, and the best ones were concluded based on the results of the strength test, and workability test and cement amount. Also, the mixture of ACI and the contractor mixture was made. The goal of these mixtures is to obtain the required strength, which is in the range from 35 to 40.

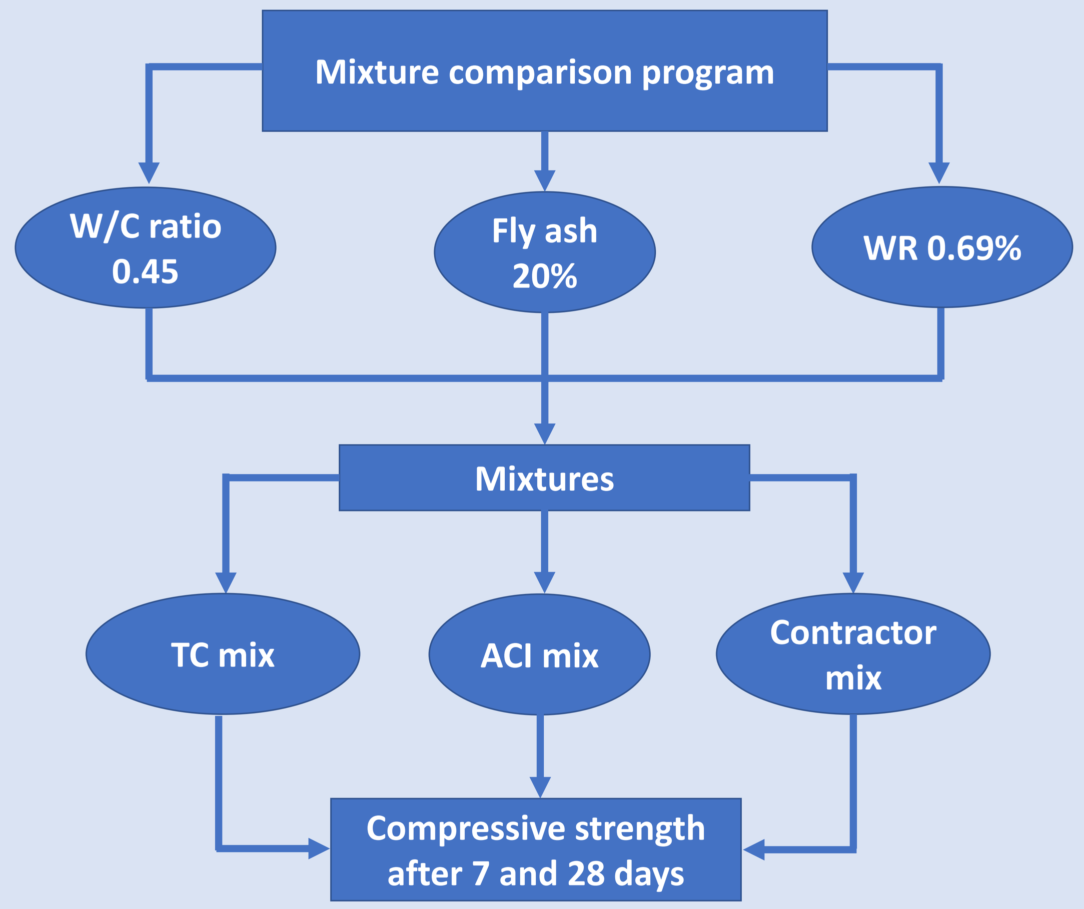

Figure 1.2: Mixture comparison program.

Experiments

ACI TC Contractor

Figure 1.3: The slump test pictures of three mixtures.

Results

Now, after making adjustments and extracting a successful mixture with a less amount of cement, we will compare the results that we obtained through our experiments with three mixtures, ACI mixture, contractor mixture, and the modified mixture that we made through TC. In table 1.1 shows the results of slump test, Compressive strength test, and amount of cement.

Mixture	ACI	TC	Contractor
Slump (mm)	250	140	190
Cement (Kg)	384	267	320
Compressive strength 7-day (MPa)	25.5	26.45	20.5
Compressive strength 28-day (MPa)	36.25	37.6	29.14

Conclusions

- An investigation was done to test the TC upper limits for coarse aggregates (sieves size 12.5 mm and 4.75 mm). The results showed that if the limits were exceeded, poor workability and lower compressive strength were obtained, which indicate that the TC gave proper limits in optimizing the gradation of aggregates for the tested sieves.
- When comparing ACI 211, TC, and a contractor design methods, the TC method showed better workability performance and higher compressive strength in comparison to the mentioned design methods.
- Using the TC method allowed the mixture to save by 35% of cement content compared of ACI 211.
- Reducing the amount of CO_2 emissions. Also, reducing the cost.

Recommendations

The time period was not enough, so we recommend to applying sieve size other than the tested (12.5 mm and 4.75 mm) to obtain the optimal aggregates gradation to be within the limit of TC and to minimize cement amount with required strength.

We faced difficulty in obtaining the required materials from different sources and where they were stored in the college.

QR Code