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EXPERIMENTAL STUDY ON THE GRANULOMETRY OF NATURAL AGGREGATES USED IN CONCRETE PRODUCTION

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Abstract: This study aims to evaluate the granulometry of natural aggregates used in the production of two concrete mixes. The experimental investigation involved determining the particle size distribution of fine and coarse aggregates through sieve analysis, in accordance with the requirements of the applicable standards. The results were presented as granulometric curves and compared with the permissible granulometric ranges to verify the compliance of the materials used. The analysis highlighted the influence of the granulometric composition on the workability of the concrete and other functional properties of the concrete mix. Based on the experimental results, the analyzed aggregates were considered suitable for use in the proposed concrete mixes. The study emphasizes the importance of controlling the granulometry of aggregates in concrete mix design and in ensuring the quality of the final material. The experimental study was conducted using a sieving system with 12 square-mesh sieves, with sizes ranging from 0.063 mm to 31.5 mm, in accordance with the requirements of the European standard for the geometric properties of aggregates – EN 933-1:2012
Keywords: natural aggregates; granulometric analysis; granulometric curve; concrete; concrete mix; concrete composition

1. INTRODUCTION

The granulometry of aggregates is a crucial factor in concrete mix design, as it influences the properties of both fresh and hardened concrete, including workability, porosity, density, and compaction capacity. Controlling the granulometry of natural aggregates remains a key component in concrete mix design and in ensuring the quality of construction materials. [1,2] The particle size distribution of aggregates affects the void content and the packing of particles within the concrete matrix, which has a direct impact on the strength and durability of concrete. [3,4].

Granulometric analysis according to current standards, performed using the sieve method, is an indispensable tool for quality control of the materials used and for optimizing mix designs for various structural applications. [5,6] The sieve analysis method involves separating aggregates through a set of standardized sieves and determining the particle size distribution. [6,7]

This paper presents an experimental study on the granulometric analysis of natural aggregates used in two concrete mixes, C8/10 and C12/15, evaluating the distribution of particle fractions and their compliance with normative requirements.

2. MATERIALS AND METHODS USED

The experimental study was conducted using a sieving system with 12 square-mesh sieves, with sizes ranging from 0.063 mm to 31.5 mm, in accordance with the requirements of the European standard for the geometric properties of aggregates – EN 933-1:2012. [4,5] The analysis of granulometric curves allows for the assessment of the degree of grading and the ability of the aggregates to fill voids in a concrete mix. [6,7] The sieving system used is shown in Figure 1.

According to aggregate standards for concrete, such as SR EN 12620:2003+A1:2008, these materials must comply with the specified granulometry to ensure the required performance of concrete. [5,8] The sieve analysis method is applied to both fine aggregates (sand) and coarse aggregates (gravel, crushed stone). [1,8,9]

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Figure 1. The sieving system used

3. RESULTS AND DISCUSSION

Granulometric Curve for Concrete Class C8/10 – Using Natural Aggregates

To determine the granulometry of the natural aggregates, a sieving system with 12 square-mesh sieves, with sizes ranging from 0.063 mm to 31 mm, was used. The sieve analysis of the natural aggregates used in the C8/10 concrete mix showed the following percentage distributions: 1.8% on the 0.125 mm sieve; 5.4% on the 0.25 mm sieve; 14.5% on the 0.5 mm sieve; 23.9% on the 1 mm sieve; 34% on the 2 mm sieve; 41.9% on the 4 mm sieve; 58.6% on the 8 mm sieve; and 75.9% on the 16 mm sieve. The results were graphically represented as a granulometric curve in Figure 2 and compared with the permissible grading range for 0/31 mm aggregates according to the applicable standard. [10,11]

According to the obtained granulometric curve, the natural aggregates used in the C8/10 concrete mix correspond to the 0/31 mm category, falling between the green line, which represents the usable size of the aggregates, and the purple line, which indicates the preferred size range of the natural aggregates. The distribution of the aggregates through sieving complies with the requirements of European standards for granulometric analysis. [12]

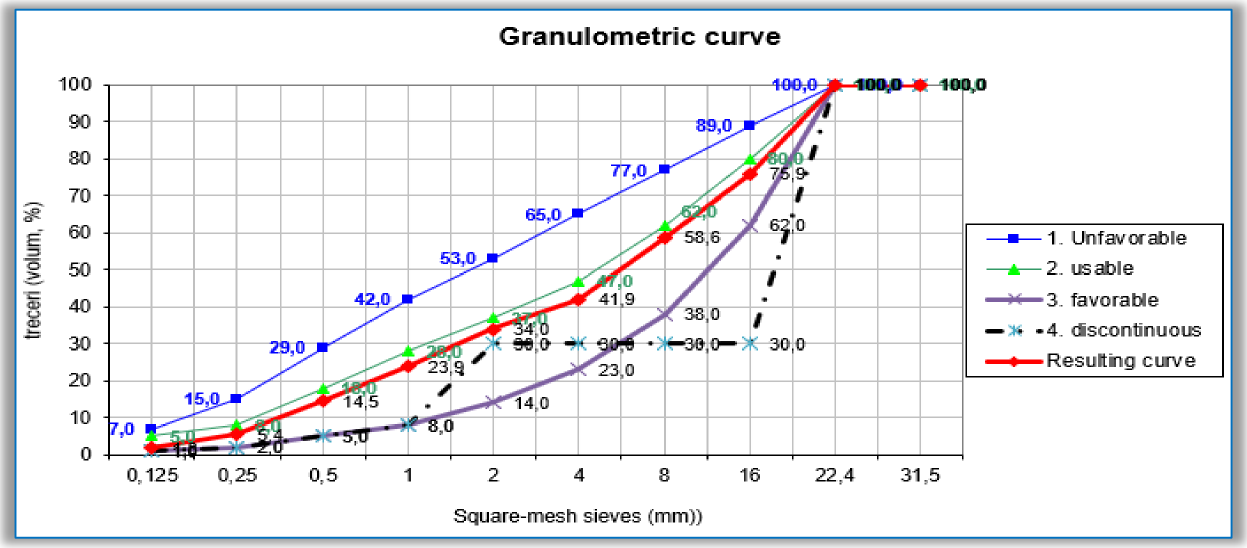

Figure 2. Granulometric curve of natural aggregates used in the C8/10 concrete mix

Granulometric Curve for Concrete Class C12/15 – Using Natural Aggregates

For the C12/15 concrete mix, a total of 46.67 kg of natural aggregates was used, of which 18.47 kg corresponded to sand with a granulometry of 0–4 mm; 8.44 kg of aggregates had a granulometry of 4–8 mm, and the remaining 19.76 kg fell into the aggregate categories with granulometries of 8–16 mm and 16–31 mm. The resulting granulometric curve is shown in Figure 3.

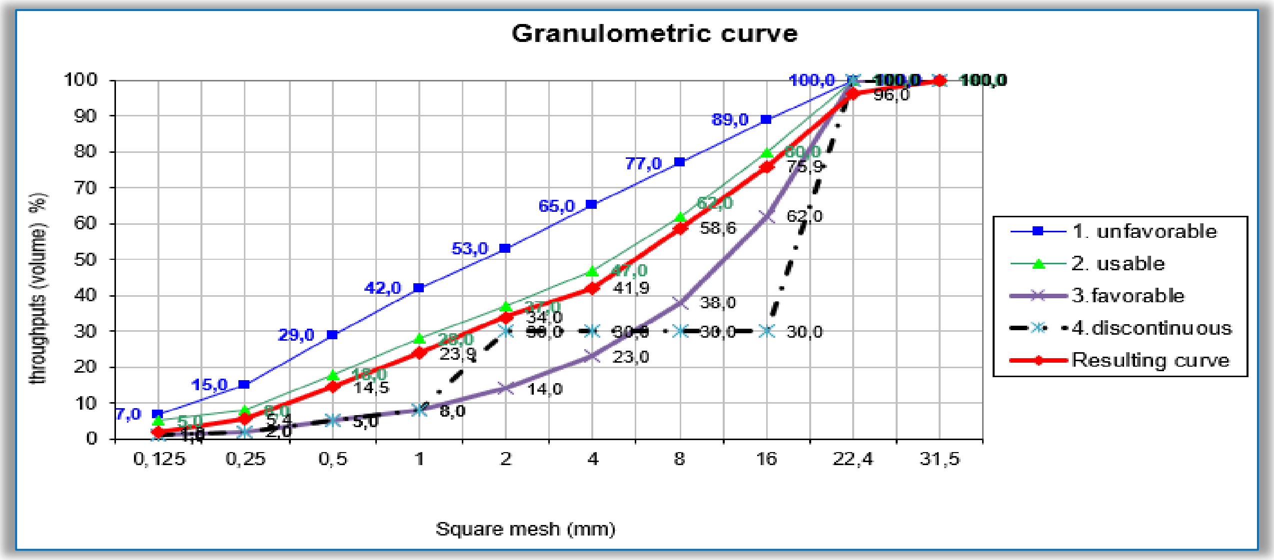

Figure 3. Granulometric curve of natural aggregates used in the C12/15 concrete mix

The obtained granulometric curve was compared with the favorable ranges specified for concrete according to the current standards. [13] The results indicate an adequate grading, which allows for a dense internal structure of the concrete, enhancing workability and mechanical properties after hardening. [14]

Aggregate granulometry is a crucial parameter in concrete mix design, directly affecting particle packing, porosity, and the mechanical properties of concrete. Optimal aggregate grading contributes to increased mix density, resulting in higher compressive strength and durability, as the reduction of internal voids limits the penetration of aggressive agents. [15,16]

An experimental study published in 2025 showed that concretes made with well-graded aggregates (open-graded and well-graded) exhibited superior mechanical performance and durability compared to those with uniform grading or voids, due to a denser internal structure and efficient particle distribution. The results also highlighted that aggregate grading influences the permeability and porosity of concrete, which are critical factors for the long-term durability of concrete structures. [15]

In practical applications, proper granulometry ensures adequate workability and an optimal balance between water demand and cement content, reducing binder consumption without compromising the final properties of the concrete. [16] Considering the favorable results obtained from the granulometric analysis of the natural aggregates, the experiment can proceed with concrete production and subsequent testing of compressive strength.

4. CONCLUSIONS

The conclusion of the study indicates that the granulometry of natural aggregates is a crucial factor in concrete mix design, directly influencing the workability, density, and strength of concrete. The experimental sieve analysis of the aggregates used in the C8/10 and C12/15 mixes demonstrated that the particle distribution complies with European standard limits, ensuring a well-graded mixture. The obtained granulometric curves highlighted a proper distribution of fine and coarse fractions, contributing to the reduction of voids and an increase in the compactness of the concrete. The results confirmed that the natural aggregates used are suitable for producing concrete with adequate mechanical properties and workability.

The study emphasized the importance of granulometric control as an integral part of quality verification for construction materials. Furthermore, it was observed that optimal aggregate grading can significantly influence concrete performance after hardening, including compressive strength and long-term durability. The overall conclusion indicates that implementing a rigorous granulometric analysis during the concrete design phase contributes to production efficiency and structural safety. Adhering to granulometry criteria is not merely a regulatory requirement but an essential element for achieving high-quality concrete.

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