

Research Project: Determining the Initial and Final Setting Time of Concrete on the Construction Site

Problem Statement

When concrete is poured into a high formwork, the lateral pressure in the formwork can become too high, depending on factors such as the concrete mix used and the concrete temperature. This can lead to damage to the formwork and the structure and may create safety risks for personnel on the construction site.

To prevent this, the pressure of the concrete in the formwork is measured. Important parameters in this context are the “beginning and end of setting time.” To date, there is no practically applicable method to determine these moments quickly and accurately on the construction site.

The central problem statement is therefore: how can the moment of “beginning and end of setting” be determined easily and accurately on the construction site?

Research Objective and Research Questions

Research Objective

The objective of this study is to demonstrate that, using temperature and electrical conductivity measurements via the ConSensor, the “beginning and end of setting time” can be determined accurately and practically on the construction site.

Literature (among others¹) shows that electrical conductivity, and in particular its derivative (dG/dt), provides an accurate indication of, among other things, the times of initial and final setting. In these studies, conductivity measurements and their derivatives were compared with measurements of the stiffening of cement paste using a Vicat apparatus.

Research Questions

The following research questions will be addressed:

1. For what purpose and in what way is information about the “beginning and end of setting time” used in planning and executing concrete pouring? When is this information needed, what additional information may be required, and how should this information be communicated to the user?
2. Cement paste and concrete are not the same. Are the relationships between dG/dt and the initial and final setting times of cement paste, as found in existing studies, also valid for concrete?
3. Does the relationship between dG/dt and final setting remain valid when the water-to-binder ratio changes, or when accelerators, retarders, or other admixtures are added to the concrete mix?
4. Is this relationship also applicable to other types of binders?

¹ Monitoring the evolution of material structure in cement pastes and concretes using electrical property measurements. K.B. Sanish, Narayanan Neithalath, Manu Santhanam (Construction and Building Materials, 2013)

5. Does the temperature of the concrete influence the relationship between the initial or final setting time and the characteristic points of the conductivity derivative?
6. Does the height of the concrete column influence the measurement?

Research Approach

The outline below is a preliminary proposal that will be evaluated and adapted where necessary at the start of the study in consultation with the researchers and supervisors.

Methodological Consideration: Measuring Equipment

In an earlier study, a ConSensor measuring device was used; in the study mentioned in the footnote, a different device was used. It must be investigated whether this affects the research outcomes and to what extent the results are mutually comparable.

Phase 1: Preliminary Study

1. **Literature review.** In addition to the literature already available (approximately 10 articles), it will be investigated whether more relevant publications on this subject are available. It will be assessed whether the literature generates new research questions or has consequences for the research design.
2. **Interviews with concrete technologists and other experts.** The outcomes of these discussions will be used to ascertain that the practical usability of the research outcomes is incorporated in the research design.
3. **Determining which binders will be investigated,** in combination with which aggregates and other parameters such as the water-to-binder ratio, and under which conditions (including temperature).
4. **Determining the test specimen setup:** shape of the test specimens, the measurement methods to be used (Vicat measurement in the paste, Humm probe for the concrete, ConSensor system for temperature and electrical conductivity), and the number of sensors per specimen. It will also be determined whether conductivity and Vicat and Humm probe measurements will be carried out in the same or in separate test specimens.

Phase 2: Tests and Measurements

1. **Preparation of test specimens** with cement paste and concrete mixes based on the same cement.
2. **Measuring conductivity, temperature, and setting** using the Vicat apparatus (in the paste) and the Humm probe (in the concrete) and ConSensor in both.
3. Analysis of results and preparation of the report.

Phase 3: Reporting and Publication

The research results will be documented in a final report. Where possible, the findings will be submitted for publication in a scientific or technical journal.

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