

ABSTRACT OF DOCTORAL THESIS

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- II. Major:** Transport Construction Engineering
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- IV. Co-Supervisors:** 1. Assoc.Prof. Dr. Nguyen Lan
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- V. Thesis' title:** Investigation of the electrical resistance behavior of self-sensing concrete under elastic compressive loading.
- VI. Training institution:** University of Science and Technology - The University of Da Nang.
- VII. Summary of thesis content**

1. Rationale of thesis

In the context of modern infrastructure development, self-sensing concrete (SSC) has emerged as a promising solution for large-scale sensing applications. The sensing mechanism of SSC is based on the incorporation of electrically conductive fillers into the concrete matrix, resulting in changes in electrical resistance under the influence of mechanical loading and environmental conditions. These changes enable the indirect determination of stress and strain states without the need for externally attached sensors.

Previous studies have primarily focused on the sensing performance of SSC during damage initiation and propagation, whereas investigations into its sensing capability under non-destructive conditions remain limited. Therefore, this dissertation aims to clarify and formulate the electrical resistance behavior of SSC within the low-stress elastic range, thereby facilitating its long-term sensing applications and improving its economic efficiency.

In addition, most existing studies have considered SSC as an individual sensing element. This research extends the investigation to systems comprising multiple SSC units operating simultaneously, providing a basis for the development of large-scale weighing systems. Such systems have potential applications in load monitoring, traffic management, and intelligent logistics, offering a cost-effective alternative to conventional sensing technologies.

These considerations highlight the urgency, scientific significance, and practical value of the selected research topic.

2. Research Objectives

The primary objective of this study is to elucidate the electrical resistance behavior of self-sensing concrete (SSC) when functioning as bearing elements in structural components subjected to loads within the elastic compressive range, where the material remains in a non-destructive state. The research outcomes are intended to support the development of a new generation of sensing systems constructed from the concrete material itself, capable of performing continuous real-time load measurement.

The specific objectives of the study are as follows:

- i. To fabricate SSC and investigate the fundamental mechanisms governing its electrical resistance behavior under loading within the elastic compressive range.
- ii. To identify the factors affecting the electrical resistance behavior of SSC, including the type and content of conductive fillers, specimen dimensions, measurement conditions, and environmental factors.
- iii. To investigate the electrical resistance behavior of systems comprising multiple SSC specimens subjected to static loads within the elastic compressive range under both concentric and eccentric compression conditions, thereby providing a basis for the development of large-scale load-weighing systems.

3. Research Objects and Scope

3.1. Research Objects

SSC using conductive fillers, including carbon black or carbon fibers.

3.2. Research Scope

SSC incorporating conductive fillers in the form of carbon black or carbon fibers was employed in this study. The research focuses on investigating the electrical resistance behavior of SSC subjected to static loading within the elastic compressive range of the material, while the effects of dynamic and impact loading are beyond the scope of the present work. Furthermore, the study examines the influence of temperature and moisture on the electrical properties of SSC under controlled laboratory conditions, without extending the investigation to field environments involving combined cyclic temperature–moisture exposure.

4. Research Methods.

The study employs theoretical analysis, experimental methods, and statistical analysis.

5. Scientific and Practical Significance of the Dissertation

The novelty and scientific significance of this dissertation can be summarized as follows:

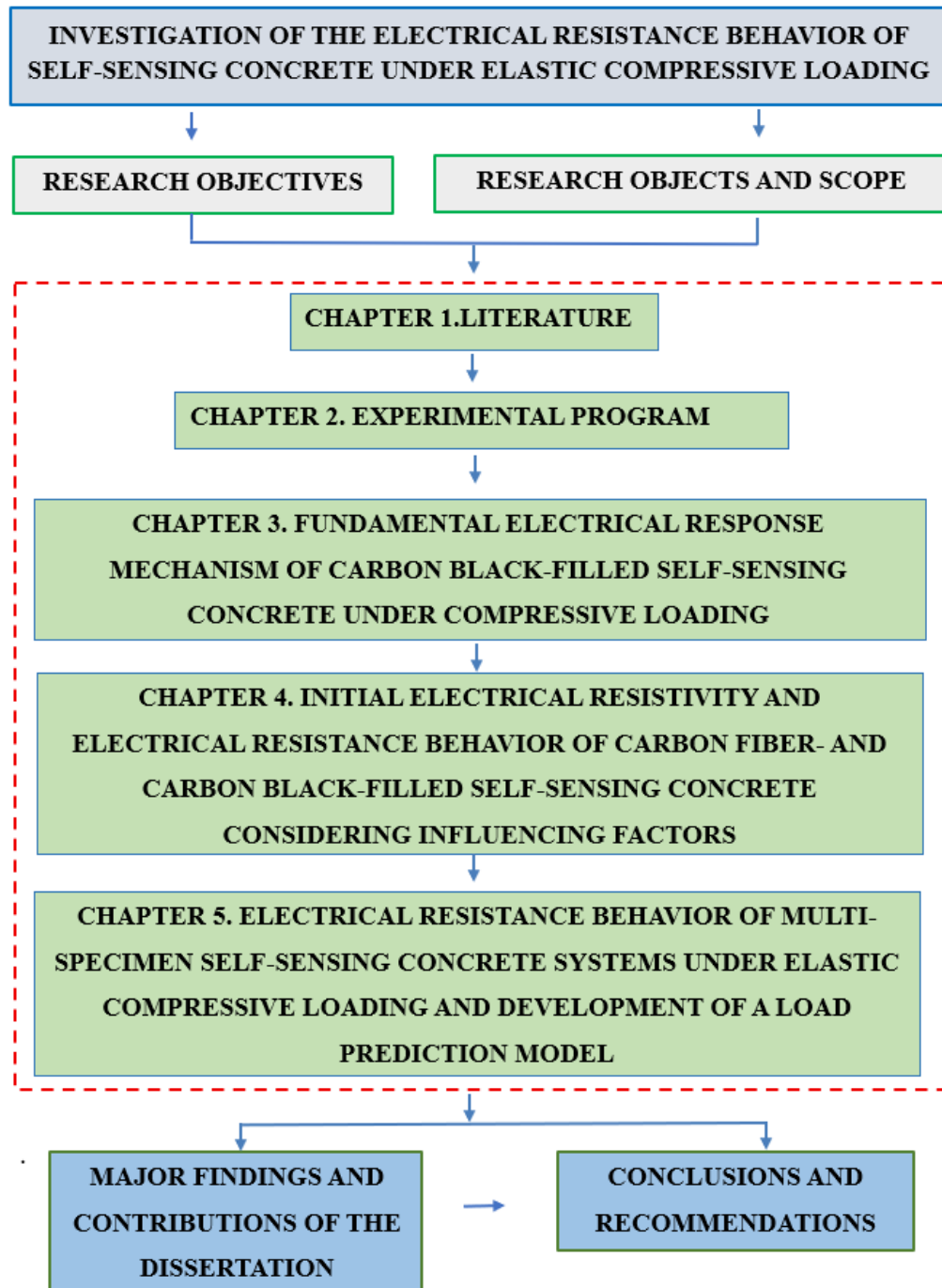
- First, the study clarifies the linear electrical resistivity response range of self-sensing concrete within the elastic compressive stress domain.
- Second, an electrical resistivity model is developed by simultaneously considering the effects of multiple influencing factors, rather than examining them individually as commonly reported in previous studies.
- Third, the electrical resistance behavior is investigated not only at the individual specimen level but also in systems comprising multiple SSC units, representing a novel research approach that has not been previously explored.

The practical contributions of the dissertation are summarized as follows:

- (1) Demonstrating the feasibility of using SSC as a compressive load-sensing device.
- (2) Providing an important scientific basis for the development of next-generation weighing systems utilizing SSC materials at a reasonable cost, thereby diversifying sensing technologies and enhancing their application potential in intelligent transportation infrastructure.

6. Structure of the Dissertation

The structure of the dissertation is summarized in the following diagram



PhD student

Vo Minh Chi