

## Delamination evaluation on basalt FRP composite pipe by electrical potential change

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**Abstract.** Since composite structures are widely used in structural engineering, delamination in such structures is an important issue of research. Delamination is one of a principal cause of failure in composites. In This study the electrical potential (EP) technique is applied to detect and locate delamination in basalt fiber reinforced polymer (FRP) laminate composite pipe by using electrical capacitance sensor (ECS). The proposed EP method is able to identify and localize hidden delamination inside composite layers without overlapping with other method data accumulated to achieve an overall identification of the delamination location/size in a composite, with high accuracy, easy and low-cost. Twelve electrodes are mounted on the outer surface of the pipe. Afterwards, the delamination is introduced into between the three layers (0°/90°/0°)s laminates pipe, split into twelve scenarios. The dielectric properties change in basalt FRP pipe is measured before and after delamination occurred using arrays of electrical contacts and the variation in capacitance values, capacitance change and node potential distribution are analyzed. Using these changes in electrical potential due to delamination, a finite element simulation model for delamination location/size detection is generated by ANSYS and MATLAB, which are combined to simulate sensor characteristic. Response surfaces method (RSM) are adopted as a tool for solving inverse problems to estimate delamination location/size from the measured electrical potential changes of all segments between electrodes. The results show good convergence between the finite element model (FEM) and estimated results. Also the results indicate that the proposed method successfully assesses the delamination location/size for basalt FRP laminate composite pipes. The illustrated results are in excellent agreement with the experimental results available in the literature, thus validating the accuracy and reliability of the proposed technique.

**Keywords:** delamination assessing; electrical capacitance sensor (ECS); basalt FRP pipe; FEM; response surfaces method (RSM); least square error method

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### 1. Introduction

Delamination is a major failure mode in structures manufactured from polymer-matrix composite materials reinforced with fibers as a basalt FRP and has been a subject of intensive research for many years. The delamination detection in general is a difficult and expensive job to

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