The benefit of TLS in the calibration of FEM models for health assessment of concrete structures

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Motivation

Terrestrial laser scanning (TLS) has become one of the most important technologies for acquisition of three-dimensional (3D) information of objects. It is a promising method to monitor the deformations and cracks of constructions. Here, the health monitoring of a concrete structure based on TLS is investigated and a Finite Element Method (FEM) model is constructed. The goal focuses on the benefits of TLS in the calibration of FEM models, in order to build an efficient and intelligent model which can be widely used for assessment of structures.

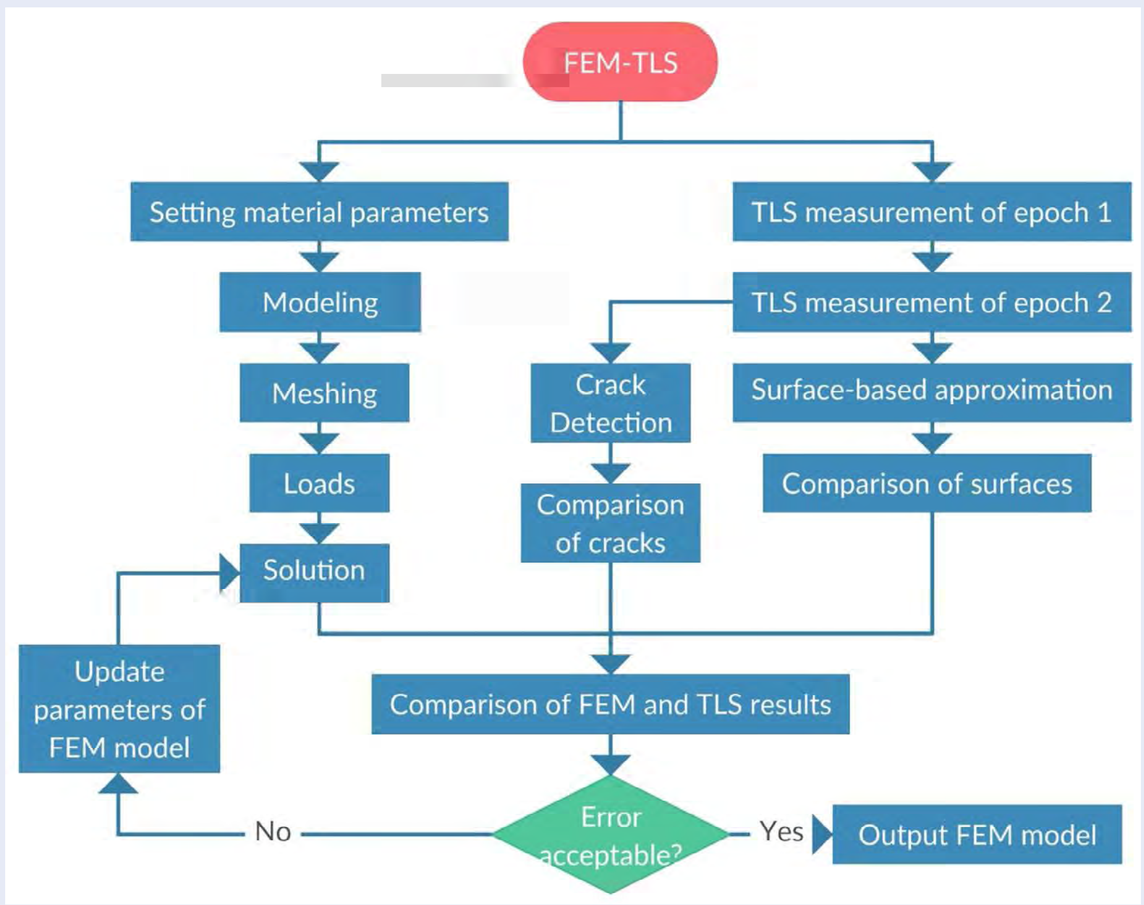

Figure 1: Work flow of this study

Method

We study the benefit of TLS in the field of FEM calibration, mostly from two aspects: deformation measurement and crack detection. Dominant innovation is to find different reliable criteria based on TLS measurement in order to correct and update FEM model. The criteria are, for example, maximum of displacement, volume of the deformation, and cracks.

The work flow of this study is shown in Figure 1. Second and third-order polynomial surfaces are fitted from the point clouds by recursive calculation (see Figure 2). Crack ratio are computed mainly based on the intensity value of the TLS measurements (see Figure 2). A MATLAB program for polynomial approximation and concrete cracks detection from the TLS point clouds data are developed.

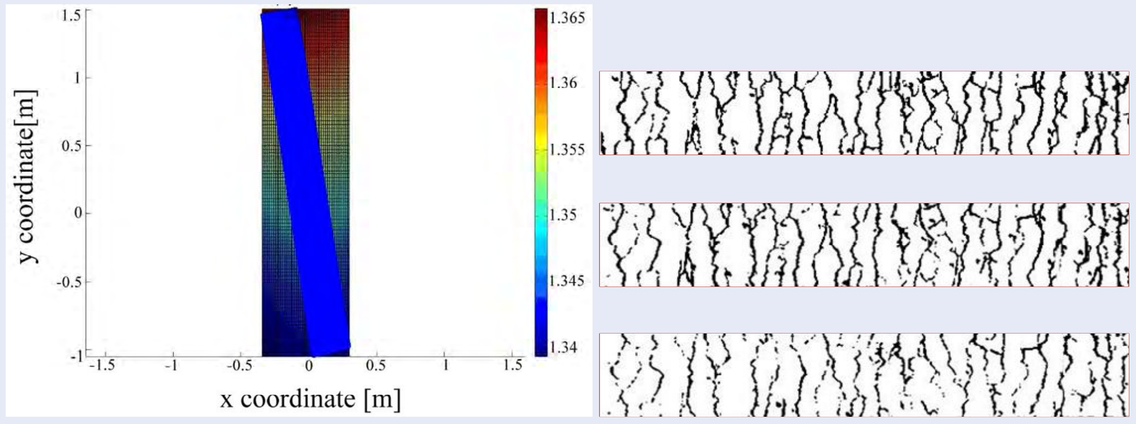

Figure 2: Surface approximation and crack detection

In this study, response surface methodology (RSM) is adopted to correct and update the FEM model (see Figure 3). The displacement-based RSM correction and volume-based RSM updating are applied and the significance of RSM models are confirmed by the determination coefficient R^2.

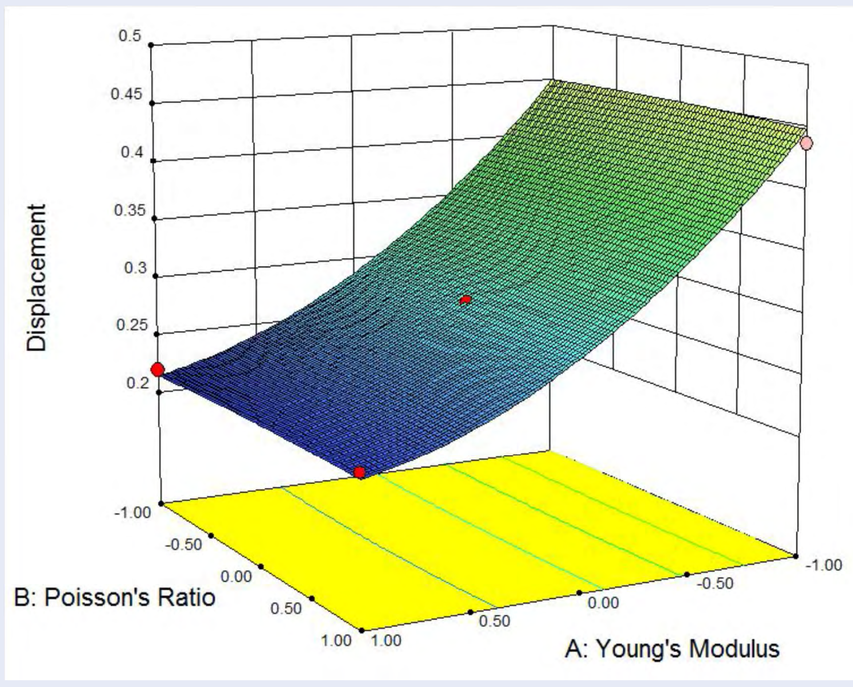

Figure 3: RSM model for FEM calibration

Result and outlook

It can be highlighted that a volume-based FEM calibration model is more suitable than the displacement-based model demonstrated by a larger determination coefficient. The precision of the calibrated FEM model is acceptable with the error 2.99‰ (Paper is in preparation).

The next aim is to apply other criteria based on TLS data for the calibration of FEM model, for example, crack ratio, which is available from TLS in our current study. Further more, the accuracy of surface approximation, crack detection and FEM calibration will be also improved.

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