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FRP Alignment Measurement using Digital Image Analsysis

By

Dr. Norbert H. Maerz

University Transportation Center Program at

The University of Missouri-Rolla

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16. Abstract

We propose to develop a prototype image analysis system to measure alignment errors in install FRP materials. We will make modifications to the FRP sheet so that alignment can easily be seen in digital images. We will develop methods for fixing a camera in the appropriate orientation. We will develop computer algorithms for capturing images and measuring the angular alignment error.

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Norbert H. Maerz

Introduction

The use of fiber reinforced polymers (FRP) for reinforcement of concrete members has emerged as one of the most promising technologies in materials and structural engineering to repair and strengthen infrastructure. FRP sheets are ideally suited for repair and strengthening of concrete structures in aggressive environments due to their non-corrosive, non-magnetic characteristics. They have high tensile strength to weight ratio and high elastic limit. Externally applied FRP sheets or laminates are bonded directly to a concrete surface with an epoxy providing additional flexural or shear strength capacity depending on the application and fiber alignment. This significantly increases the load carrying ability of a structural component and/or structural system.

Correct fiber alignment of FRP sheets is crucial to the performance of the repair system. Yang et al. (2001) indicate that a misalignment of 5 degrees or more can significantly affect the performance of the repair.

Project Objective

The objectives of the project was to develop a technique to image (take pictures of) installed FRP sheets and measure their alignment error, using digital image analysis.

The method must be quick, simple and unobtrusive, and field based.

Work

Material

For the experimental work, constructrex cloth with tracers of yellow Kevlar 29, 1500 deciteks in size was obtained from Sigmatec. The material was imaged without epoxy coverage (Figure 1)

A white wire was used as a reference line, manualy strung at the simulated “correct” orientation (Figure 1).

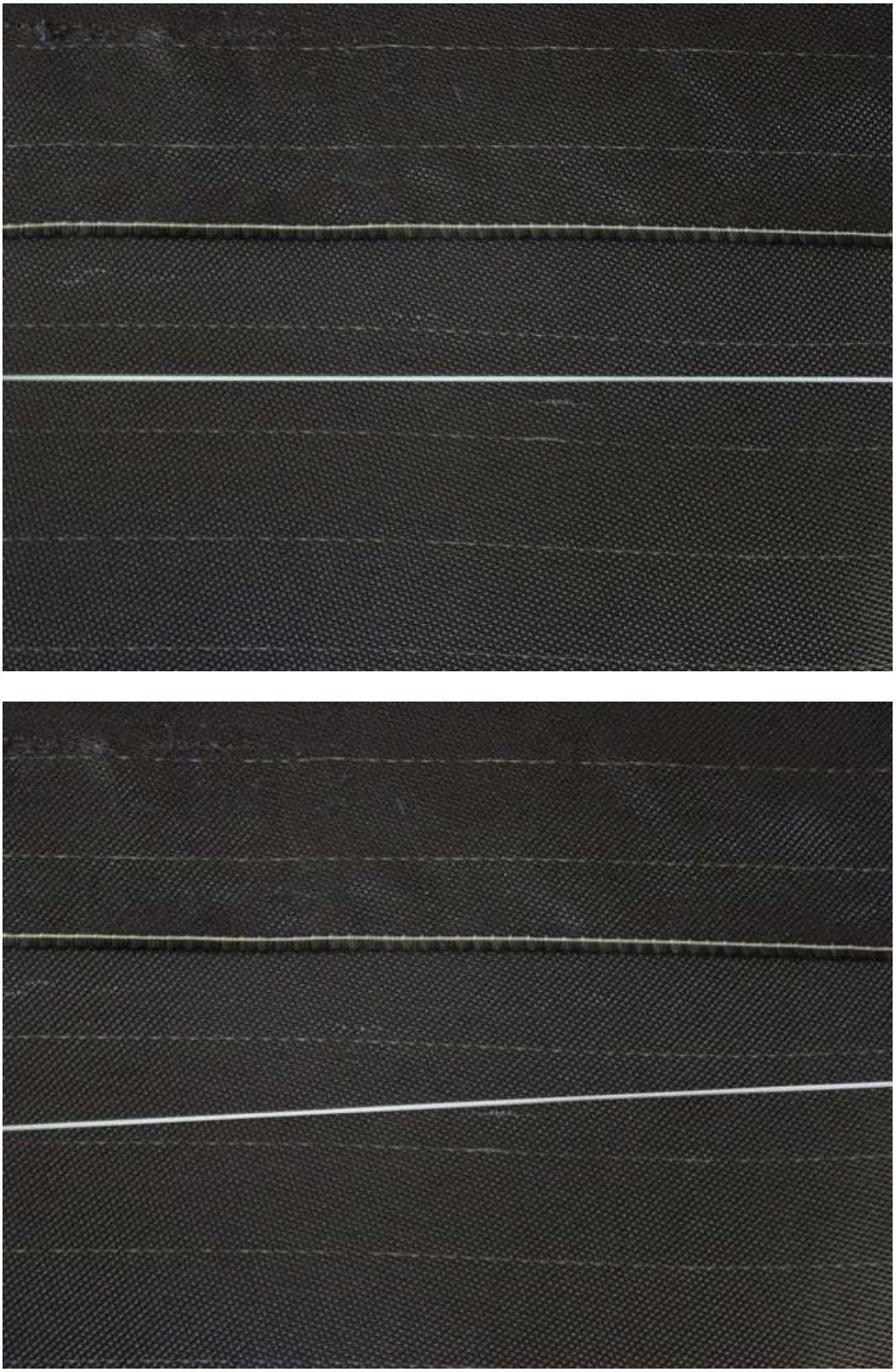

Figure 1. Top: Image of “well aligned” fabric. Bottom: Image of “poorly aligned” fabric.

Software

The alignment measurement software, developed for this application has both a manual mode and an automatic mode.

In the manual mode, endpoints of the tracer and the reference line are identified by clicking with a mouse (Figure 2). In the automated mode, the yellow tracer and the white reference lines are identified by their colors.

In both cases a straight line is fitted to the tracer and reference line, and the angle between the two is measured.

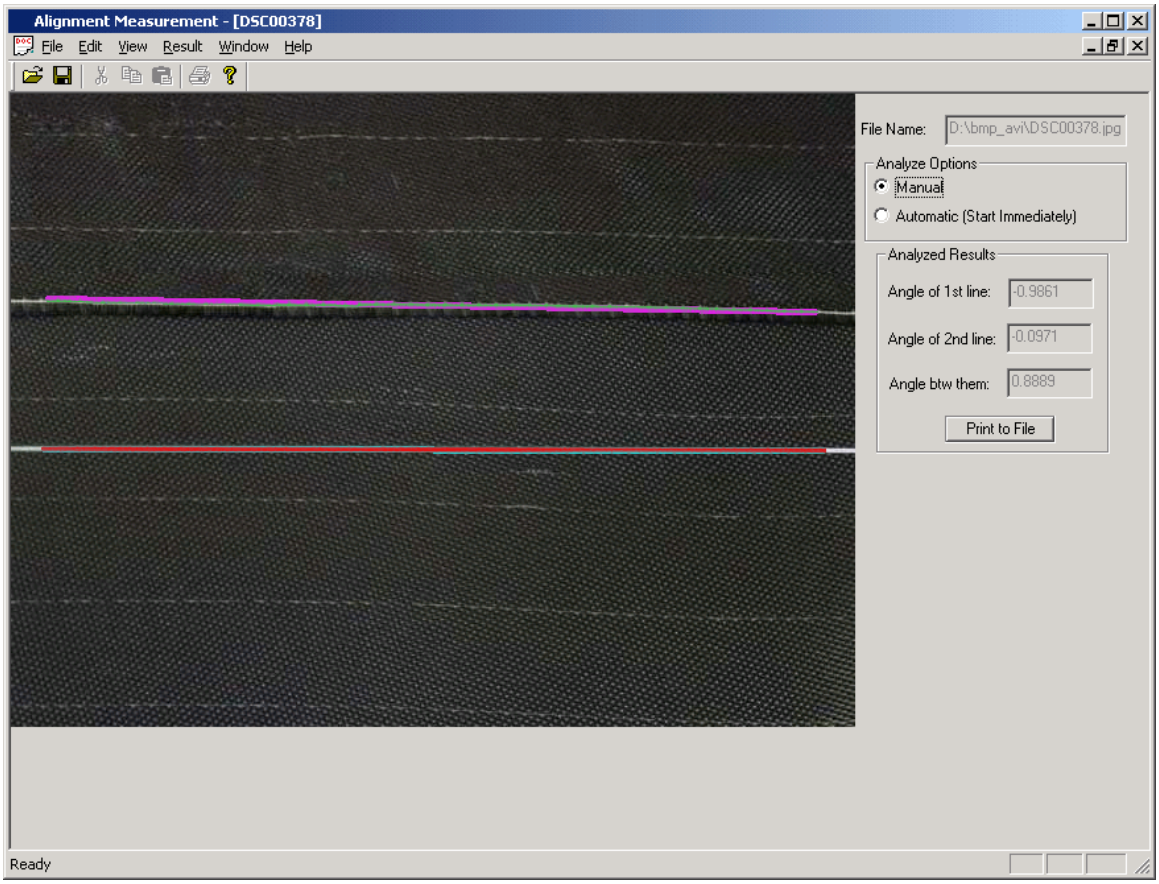

Figure 2. Manual analysis, endpoints of tracer and reference line selected by mouse, 0.9 degree angle between the lines.

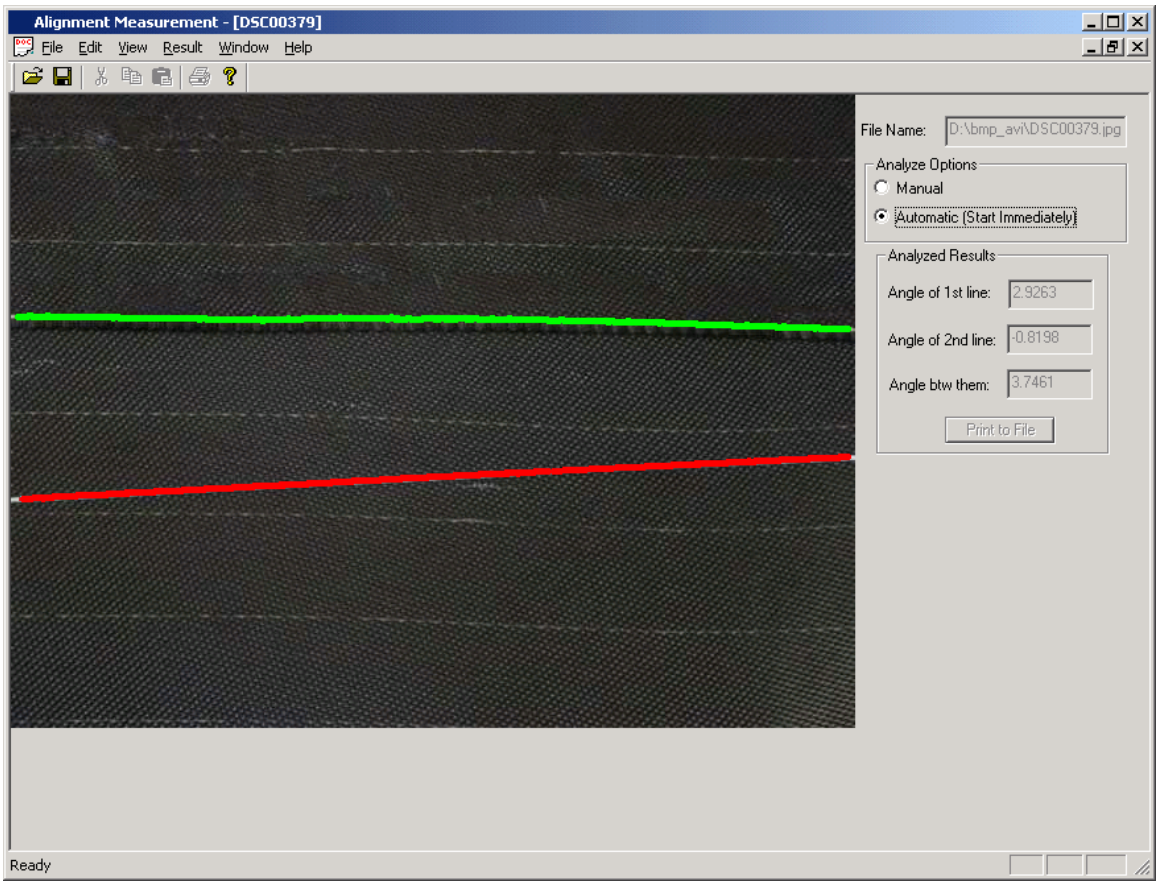

Figure 3. Automatic analysis, tracer and reference line identified by color, 3.7 degree angle between the lines.

Implementation

This technology will be implemented in the upcoming MODOT (Missouri Department of Transportation) project where various bridges will be retrofitted with FRP sheets. The procedure will be as follows:

1. The FRP sheets to be used will contain tracers of yellow Kevlar 29, 1500 deciteks in size.
2. The sheets will be installed with transparent (non-colored) epoxy.
3. White strings will be stretched along the design alignment of the tracers. Strings will be manually held in place.
4. A digital video camera will be used to take pictures of the string and tracer.
5. Image will be transferred to the computer and fiber alignment will be measured.

References

Yang, C., A. Nanni, and L. Dharani, "Effect of Fiber Misalignment on FRP Laminates and Strengthened Concrete Beams," 9th Int. Conf., Structural Faults and Repair, London, UK, July 4-6, 2001, M.C. Forde, Ed., Engineering Technics Press, CD_ROM version, 10 pp.