

Dataset to track concrete cracking using DIC with a fixed and moving camera

Today, Digital Image Correlation (DIC) has become a standardized method to track displacements and crack-propagation of civil engineering structures in a laboratory environment. The benefit of using DIC over other standard methods is that it is contact-free and only requires a standard DSLR camera. Moreover, the displacement can be tracked over the entire image, which is a great advantage compared to the limitations of standard sensors that only measure the deformation at a specific point. In standard DIC, the displacements are directly extracted from the images. Hence, the position of the camera must be fixed during the entire test. Therefore, DIC is commonly used in a laboratory environment to measure displacement during short-term testing, e.g. testing of the structural capacity of a reinforced concrete beam. The data presented in this paper was used to verify a newly developed and innovative photogrammetric algorithm, Deformation from Motion (DfM). This algorithm overcomes the standard limitation of traditional DIC and enables high-accuracy measurements to be performed using a camera with no fixed position. As a reference, the crack propagation was on one side monitored with a LVDT and on the other side with a camera with a fixed position. During testing, a moving camera also captured imagery on both sides.

Laboratory preparation of the specimens

We cast a post-tensioned concrete beam in the laboratory with dimensions 800 x 150 x 100 mm (length x width x height). During the beam preparation, we placed two plastic tubes with an approximated diameter of 4 mm close to the bottom of the mould to allow for the post-tension reinforcement to be placed. After casting, we stored the beam underwater for 28 days. Then, we placed the beam in the laboratory to dry for one day before testing. Before testing, we placed two steel bars with a diameter of 6.8 mm in the plastic tubes, and we post-tensioned them to approximately 18 kN, i.e. 500 MPa. Before the post-tension force was applied, we applied an external load of 1.5 kN at the centre of the beam to prevent crack formation at the top of the beam during the post-tension process. No internal structural connection existed between the steel and the plastic or the plastic and the concrete. Hence, the purpose of the post-tensioning was to impose a compressive force on the concrete to increase until cracking. This set-up typically yields in the development of a controlled propagation of one single and centric-placed crack. The beam was tested in three-point bending in the laboratory. An overview of the test is shown in Figure 1.

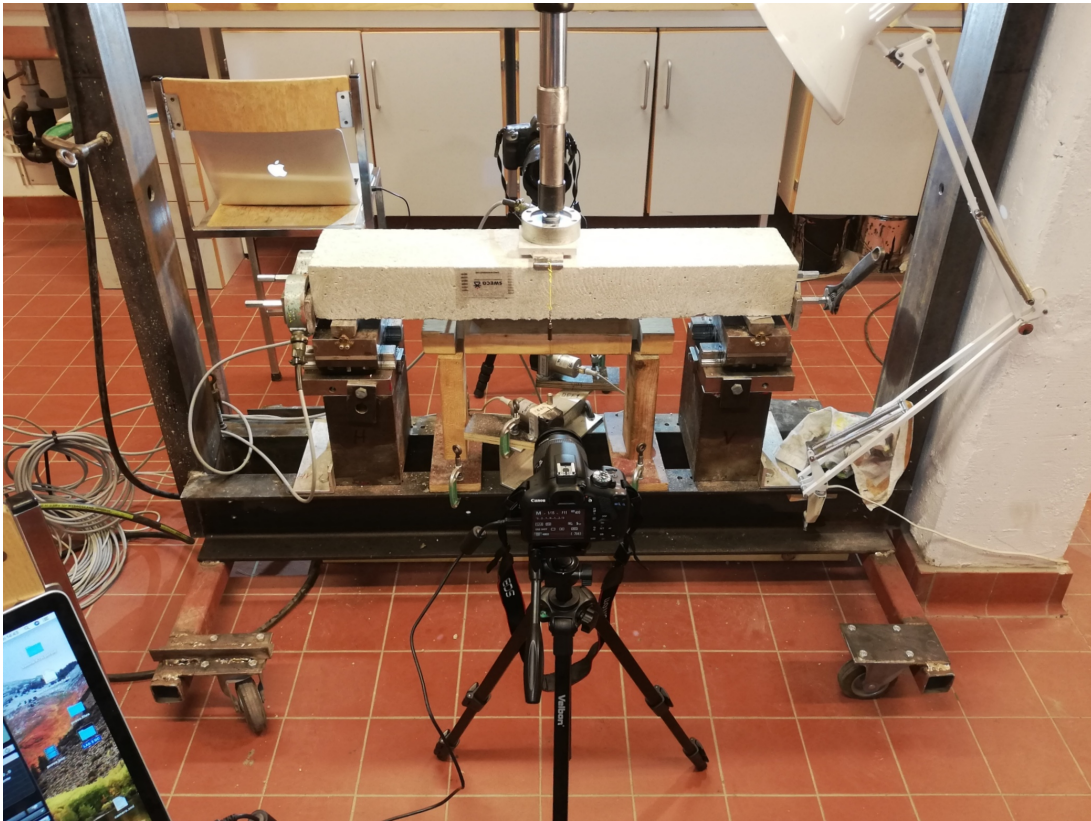


Figure 1. Overview of the test set-up in the laboratory.

Data collection

During testing, the force and vertical displacement were continuously monitored. A fixed and moving camera was used on one side of the beam to monitor the crack propagation. On the other side, a Linear Variable Differential Transducer (LVDT) was used in combination with a moving camera to track the propagation of the crack. The set-up is schematically shown in Figure 2, and the specifications for the cameras and instruments are given below:

- Side A – a Canon EOS 2000D (22.3 x 14.9 mm CMOS sensor, 24 Megapixels, pixel size of 3.72 microns) fixed on a tripod during the entire test, i.e. a fixed camera, and an iPhone XS camera (12 Megapixels) manually moved between each acquisition.
- Side B - a Canon EOS 5D Mark 2 (35.8 x 23.9 mm CMOS sensor, 21.1 Megapixels, pixel size of 6.41 microns) mounted on a tripod and moved between each load step to acquire images from slightly different positions and an LVDT (range of 10 mm and a displacement measurement over a distance of 144 mm) placed at the bottom and centre part of the beam.

During testing, we applied the load according to a fixed scheme. At the beginning of each step, we increased the load by 1 kN and maintained it constant during the entire interval. For each load step, we acquired three images on Side A with the fixed camera and three images on Side B using the moving camera. On side B, we captured the

first image of each step using a fixed position. Then we translated and rotated the camera before acquiring the second and third images, respectively.

Before cracking, we acquired all the images on side A using only the fixed camera. After cracking, we used an iPhone XS on Side A to acquire one image for each load step using slightly different camera poses. The LVDT recorded the horizontal displacements during all the steps. In Figure 3, examples of cracks on both sides are shown.

Data structure

The imagery is structured in the three folders in the following way.

Fixed Camera: All images captured with the fixed camera on Side A.

Non-Fixed Camera: All images captured with the moving camera on Side B.

Non-Fixed Camera iPhone: All images captured with the moving camera on Side A.

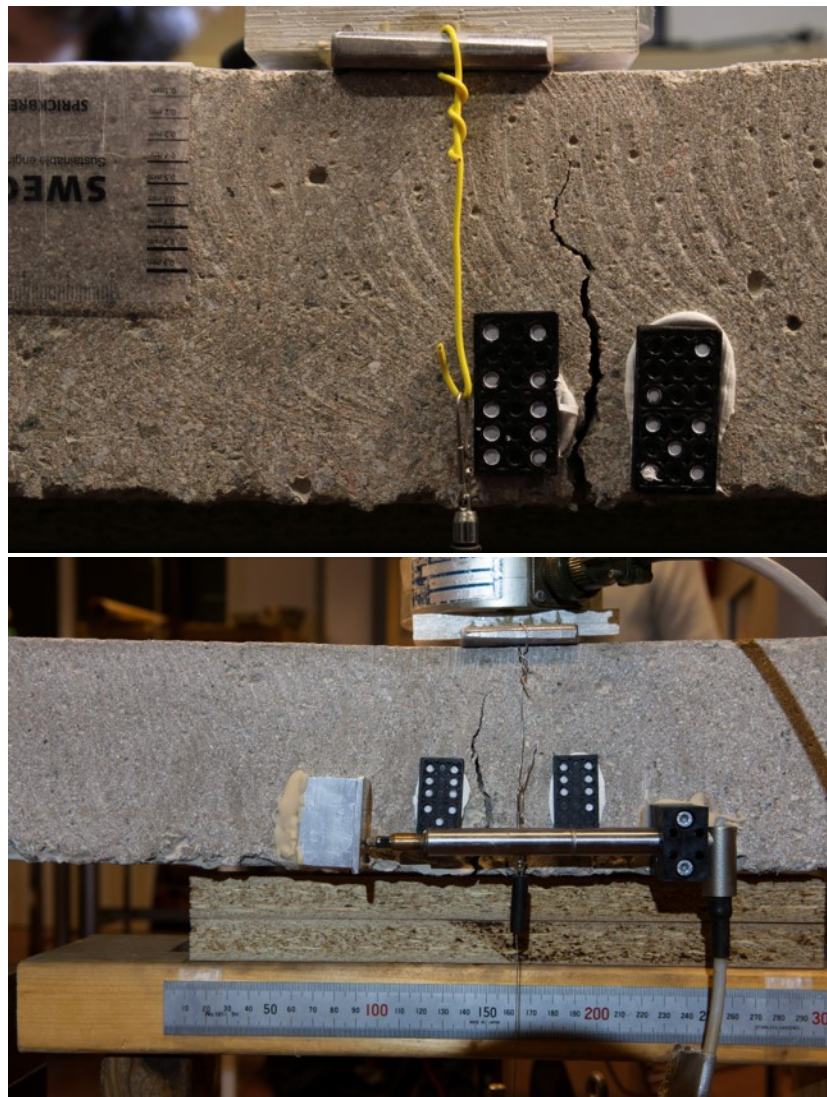


Figure 3. Example of crack on Side A (top) and Side B (bottom).

The data from the experiments are stored in Labbtest.xlsx. This includes the beam's vertical load and centric displacement measured at two sides. The horizontal displacement measured with the LVDT is also presented for each load-step, as well as the corresponding number for each image.