Case study

Using DIC to determine modulus of elasticity of concrete

A study comparing a non-contact measurement technique, Digital Image Correlation (DIC), with a conventional contact-based method, Linear Variable Displacement Transducer (LVDT), for determining the modulus of elasticity of concrete.

Published August 2023

Introduction

A team of researchers from Newcastle University of Singapore and National University of Singapore, has developed a novel and practical method of assessing the mechanical properties of structures, with potential application to structural health monitoring of large structures such as bridges and viaducts in Singapore.

The team has presented their findings exploring whether DIC is a comparable technique to conventional contactable methods for indicating the stiffness of a material.[1] A uniaxial compression test was setup to measure the displacement of a concrete sample under load. The study presents whether DIC can be used to obtain the static modulus of elasticity of concrete accurately.

Research methods

A cylindrical concrete sample with a height of 300 mm and a diameter of 100 mm was loaded by a universal testing machine. Two methods, one contact based (DIC) and one non-contact based (LVDT), were used to measure the displacement of the object's surface.

DIC system

The non-contact based method used in the experimental setup was Imetrum's Flexi (DIC) System. The hardware consists of a computer processing unit connected to a monochrome camera and 25 mm lens. Imetrum's Video Gauge™ software tool was used to capture, process, and analyse the non-contact measurements. The camera was positioned at a distance of 1M from the targets set at the surface of the sample (fig 1).

[1] Loh TB, Wu Y, Goh SH, Kong KH, Goh KL and Chong JJ. *Determination of Static Modulus of Elasticity of Concrete in Compression using Digital Image Correlation (DIC) Method.* 2022

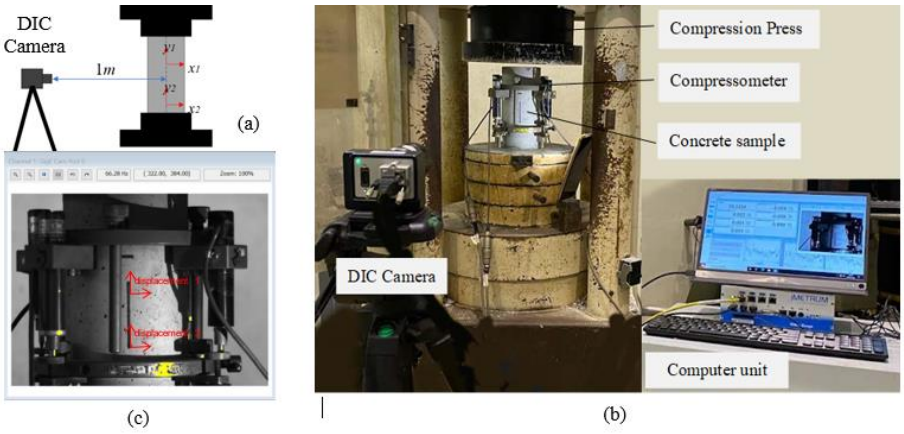

Fig. 1. (a) Schematic and (b) photo of equipment setup showing the position of the DIC camera, (c) field of view of natural targets captured by Video Gauge™ software

Results

The sample was preloaded to a compressive stress of 36 MPa and held for 50 seconds before unloading. Figure 2 shows the strain values measured by both methods.

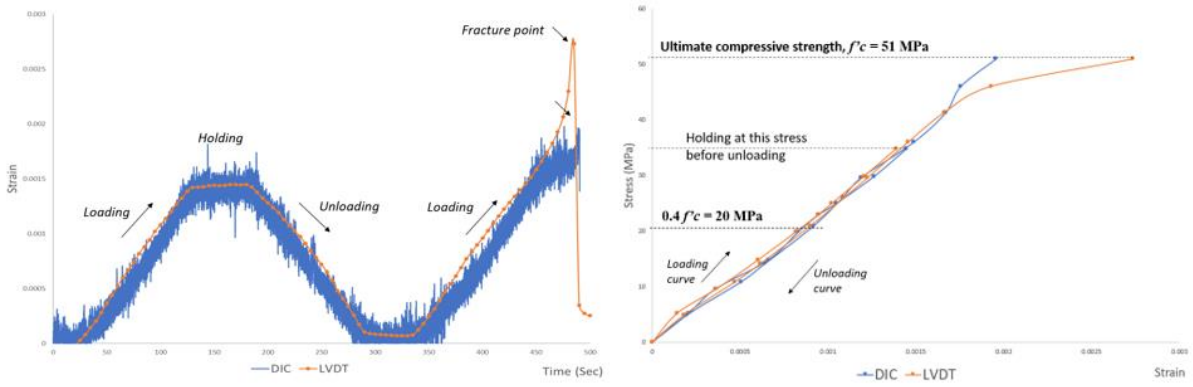

Fig 2. (a) Comparison of deformation measurement using DIC and LVDT (b) Comparison of the stress-strain curve using DIC and LVDT

The DIC results from both the strain measurement and comparison of modulus of elasticity show a comparable correlation to the LVDT.

Strain (ε) at 0.4 f'_c ($1x10^{-3}$)		Deviation
DIC	LVDT	
0.83	0.81	2.4%

Table 1. Comparison of strain measurement using DIC and LVDT

Modulus of elasticity *Ec* (GPa)		Deviation
DIC	LVDT	
24.1	24.8	2.8%

Table 2. Comparison of modulus of elasticity calculated from DIC and LVDT measurement.

Conclusion

This study has shown that the DIC method can be used to obtain the static modulus of elasticity of concrete accurately. DIC also has the advantage over contacting methods like LVDTs that you are able to directly measure the deformation on the surface of the concrete sample.

Visit the website page: https://www.imetrum.com/case-studies/using-dic-to-determine-modulus-elasticity-of-concrete/