



« Recent progress in Digital Image Correlation : towards integrated identification ? »

Chair: Marc François, GeM/Université de Nantes

& Co-chair: Gabriele Tebaldi, University of Parma - University of Florida



Marc FRANÇOIS is full professor at the Faculté des Sciences de Nantes (France) and researcher at the GeM (research institute for civil and mechanical engineering). Initially specialist of mechanics of materials (damage, plasticity...) and tensor decomposition (Kelvin and Boehler decompositions), he works since ten years in the field of DIC. He created the Virtual Image Correlation (VIC) method, an extension of the DIC which applies for the precise measurement of silhouettes or contours.

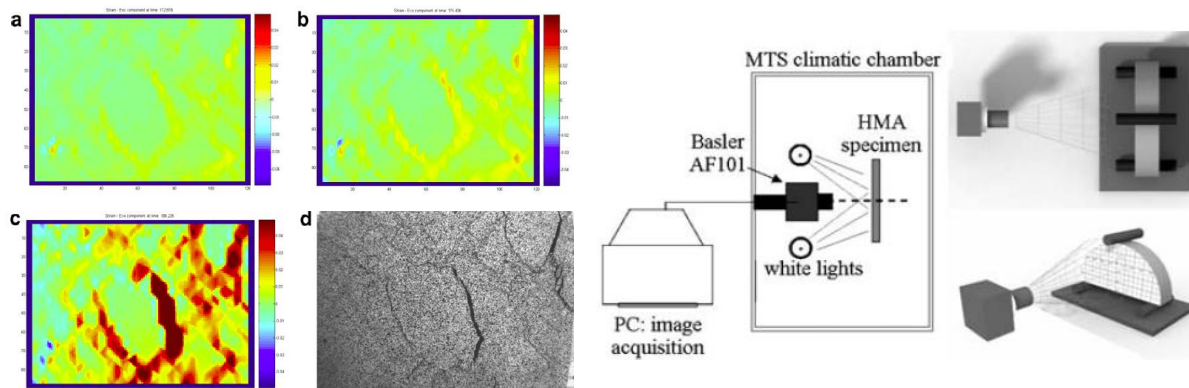


Gabriele TEBALDI is Associate Professor at University of Parma and Adjunct Professor at University of Florida. He is chairman of the Task Group on “Advanced measurement systems for crack characterization” of Rilem TC 241-MCD. He is Associated Editor of the RMPD journal and member of Editorial Advisory Committee of Material and Structures journal. He is working since 2005 on the use of DIC to analyze strain fields associated with crack initiation and crack propagation.

« Workshop Introduction »

Gabriele TEBALDI

The workshop will be focused on specific problems associated with analyses of strain fields related with cracking phenomena in pavement materials. This includes recent DIC possibilities such as direct model parameter identification, the test and specimen design evolution, the integration of DIC together with other measurement techniques, how to use DIC to validate and implement constitutive models and F.E.M., how to use DIC to investigate crack initiation and crack growth, etc...



« Practical Experiences with DIC in asphalt technology »



Moisés BUENO from EMPA (Switzerland) studied Chemical Engineering at the University of Castilla-La Mancha (Spain). Then, he moved to the Civil Engineering School to research on low-noise asphalt roads. After finishing his PhD, he joined the Road Engineering Laboratory at Empa in 2011. There, he has been involved in different research projects about mechanical, thermal and rheological properties of asphalt materials. These last years, his main interest has been focused on the artificial healing of asphalt surfaces by induction heating where the control of the damage as well as the monitoring of the (micro)crack propagation is a key factor for the efficiency of the healing process.

Abstract. Recent studies have been carried out at the Road Engineering Laboratory (Empa) involving DIC analysis. We will shortly review the last applications of this technique on triaxial tests and bridge joints temperature deformations. Finally, we will take special attention to its use for crack detection during a special fatigue test on 1.8 m long slabs damaged with the Model Mobile Load Simulator (MMLS3). The DIC system was also useful to confirm the recovery mechanical performance after the healing process.

« Meaningful civil and industrial applications of DIC measurements combined with numerical simulations »



Roberto FEDELE (born in 1973) is associate professor of Solid Mechanics at Politecnico di Milano. His main research interests concern computational and experimental mechanics with special emphasis on inverse problems and identification techniques, oriented to civil and industrial applications. He has developed several projects in a multidisciplinary context, collaborating with researchers in physics and material science. Since 2006, he has spent research stages, also invited as visiting professor, at ENS Cachan (France), working with F. Hild on Digital Image Correlation.

Abstract. Two recent applications of DIC in a multidisciplinary context are discussed. The first problem is related to civil and structural engineering, and concerns DIC measurements of tangential slips occurring during 1-ton delamination tests on real scale masonry pillars, reinforced with external strips of FRP polymers. The second problems is related to innovative metal-ceramic joints for industrial applications. DIC measurements gathered during single lap shear experiments on small joined prototypes were used to identify an interface relationship for the innovative joints.

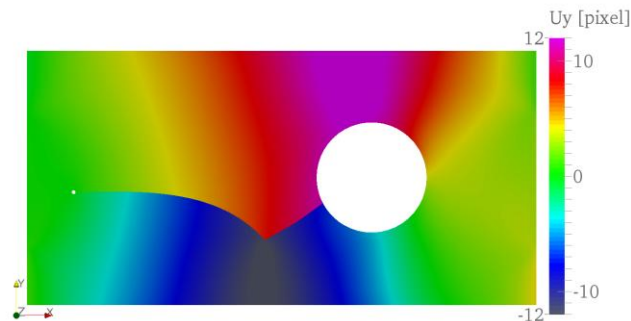


« Using DIC for crack tip detection and SIF estimation along curved cracks »



Julien RÉTHORÉ from LaMCoS (INSA de Lyon, France) did his PhD thesis under the supervision of Pr Alain Combescure at LaMCoS. The topic of his research was the dynamic propagation of cracks using X-FEM. After his PhD, he spent one year at TU Delft (The Netherlands) working with Pr René de Borst on the failure of porous media. Before he got his position at LaMCoS, he worked for one year with F. Hild and S. Roux on the development of DIC methodology dedicated to fracture. Since he entered CNRS at LaMCoS in 2007, he was continuously trying to emphasize the link between numerical simulations and full field measurements for parameters identification and model validation.

Abstract. Fracture mechanics parameters extraction from measured displacement fields has been investigated since the early development of DIC. A common strategy for estimating SIF is based on a least-squares projection of the measured displacement field onto the analytical solutions at the crack tip written as Williams' series or equivalently Westergaard solutions. These results are now well established for straight cracks but tracking the position of the tip of a curved crack and estimating SIFs during mixed mode crack propagation remains far from being a straightforward extension of this work. In this lecture, a promising strategy based on the integration within a FE framework of mechanical constraints into DIC will be proposed.



« Monitoring of debonding or cracking in bending tests by virtual image correlation »
Marc FRANÇOIS

Abstract. The VIC method is used on a simulated 4-point bending test on a two layers material with a prescribed delaminated zone. It is shown that, with only one image and a high quality picture, this method is able to identify the crack length without speckle and initial image as required for the DIC. Furthermore some applications of the classical DIC will be shown as well as the complementarity of the two methods.



« Use of Eulerian Video Magnification Technique to Study Very Low Strain Levels »



Dr. M. Emin KUTAY is an Associate Professor at the Department of Civil and Environmental Engineering at the Michigan State University (MSU, USA). His research interests include experimental characterization, modeling techniques in pavement engineering and image analysis. Dr. Kutay received his B.S. degree from the Middle East Technical University (Turkey), and M.S. and Ph.D. degrees from the Department of Civil and Environmental Engineering at the University of Maryland – College Park. Dr. Kutay’s contributions to pavement engineering have been recognized through several awards including the AAPT Walter J. Emmons Award for the best paper in 2008, 2008 ASCE Collingwood Prize, and 2009 ASCE Arthur M. Wellington Prize.

Abstract. One of the challenges associated with application of DIC techniques in asphalt mixture testing is the low strain levels required by the cyclic tests such as the dynamic modulus ($|E^*|$) and low strain level fatigue tests. Since the required strain level is quite low, use of DIC to obtain the strain distribution is often not feasible because of the resolution limitations of the cameras. In this workshop, application of a new technology called Eulerian Video Magnification technique will be illustrated. With this technique, it is possible to magnify very small displacement that happens in the sub-pixel level. This opens the door for determination of very low strain levels during asphalt mixture testing using simple cameras.

