8th RILEM International Conference on Mechanisms of Cracking and Debonding in Pavements

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Recent progress in Digital Image Correlation: towards integrated identification?

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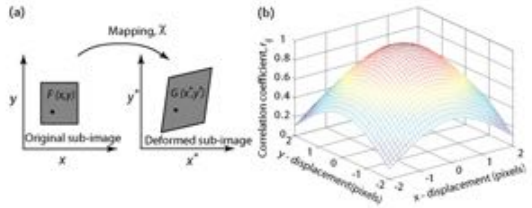
Digital Image Correlation



DIC is predicated on the maximization of a correlation coefficient that is determined by examining pixel intensity array subsets on two or more corresponding images and extracting the deformation mapping function that relates the images (Figure 1). An iterative approach is used to minimize the 2D correlation coefficient by using nonlinear optimization techniques. The cross correlation coefficient rij is defined as

$$r_{ij}(u,v,\frac{\partial u}{\partial x},\frac{\partial u}{\partial y},\frac{\partial v}{\partial x},\frac{\partial v}{\partial y}) = 1-\frac{\sum_i\sum_j[F(x_i,y_j)-\bar{F}][G(x_i^\star,y_j^\star)-\bar{G}]}{\sqrt{\sum_i\sum_j[F(x_i,y_j)-\bar{F}]^2\sum_i\sum_j[G(x_i^\star,y_j^\star)-\bar{G}]^2}}$$

Here F(xi ,yj) is the pixel intensity or the gray scale value at a point (xi ,yj) in the undeformed image. G(xi* ,yj*) is the gray scale value at a point (xi* ,yj*) in the deformed image. and are mean values of the intensity matrices F and G, respectively. The coordinates or grid points (xi ,yj) and (xi* ,yj*) are related by the deformation that occurs between the two images. If the motion is perpendicular to the optical axis of the camera, then the relation between (xi ,yj) and (xi* ,yj*) can be approximated by a 2D affine transformation such as:

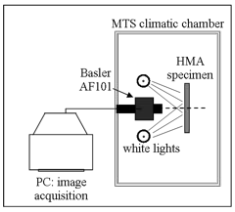
$$x^\star = x + u + \frac{\partial u}{\partial x}\Delta x + \frac{\partial u}{\partial y}\Delta y \qquad y^\star = y + v + \frac{\partial v}{\partial x}\Delta x + \frac{\partial v}{\partial y}\Delta y$$

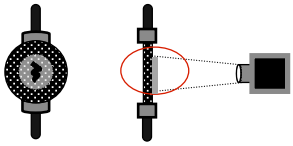
Here u and v are translations of the center of the sub-image in the X and Y directions, respectively. The distances from the center of the sub-image to the point (x, y) are denoted by Δx and Δy. Thus, the correlation coefficient rij is a function of displacement components (u, v) and displacement gradients

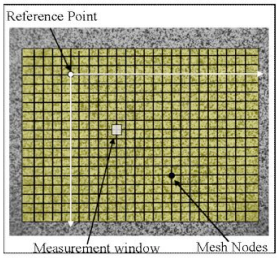
$$\frac{\partial u}{\partial x},\frac{\partial u}{\partial y},\frac{\partial v}{\partial x},\frac{\partial v}{\partial y}$$

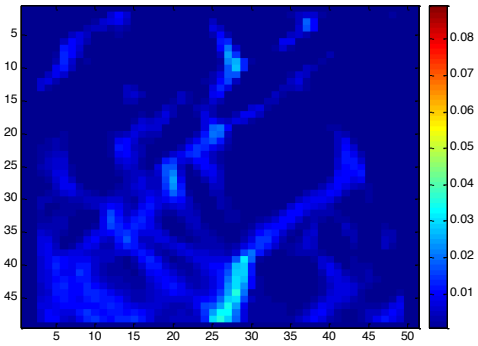
Digital Image Correlation

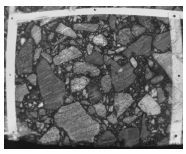
AN EXAMPLE

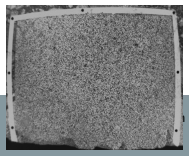


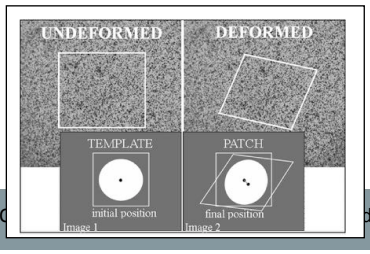












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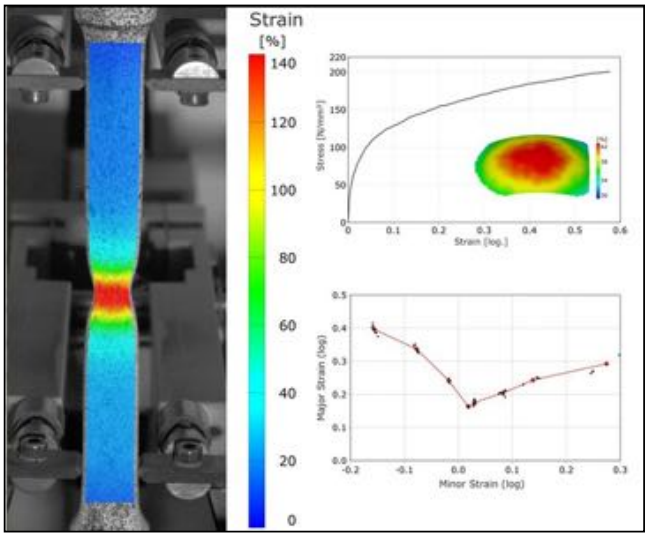
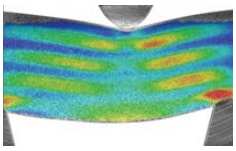
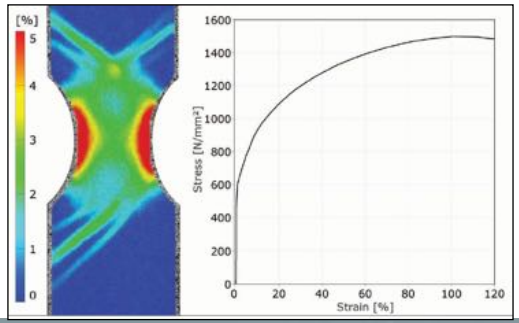
Digital Image Correlation

AN EXAMPLE

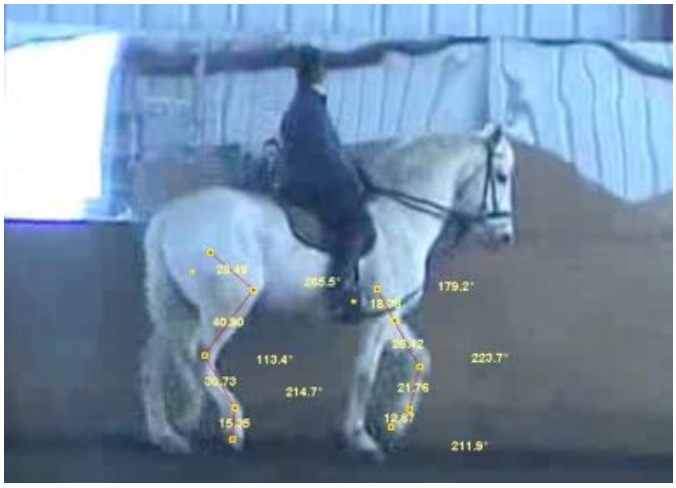






Digital Image Analysis

Image analysis is the extraction of meaningful information from images; mainly from digital images by means of digital image processing techniques

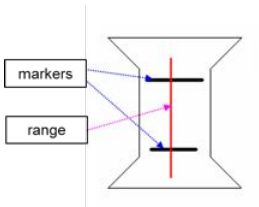


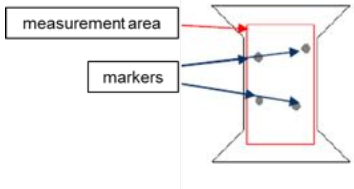
Digital Image Analysis

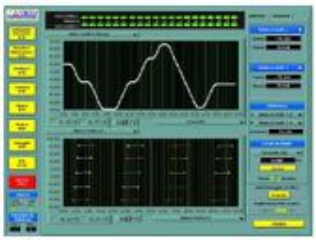
AN EXAMPLE

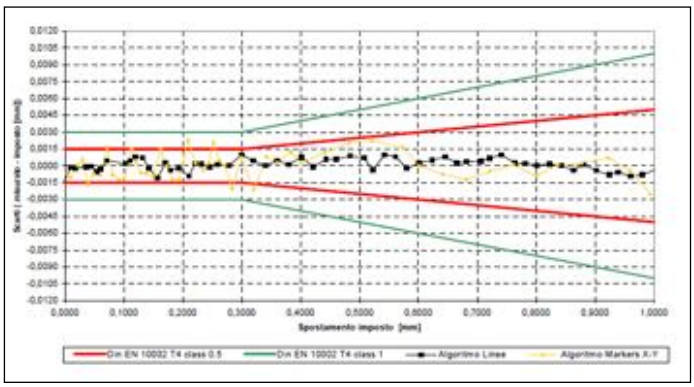
TRIO SISTEMI E MISURE

OPTICAL EXTENSOMETER









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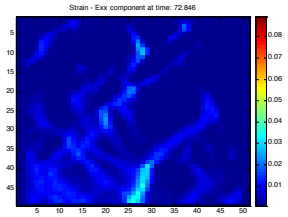
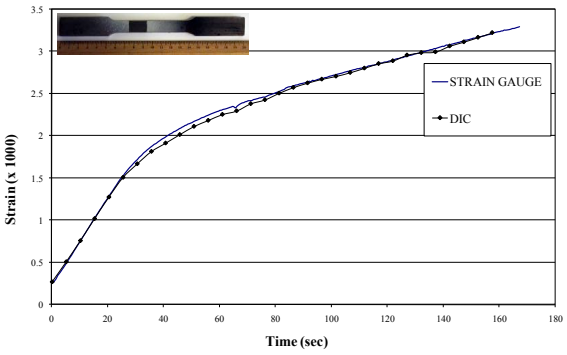
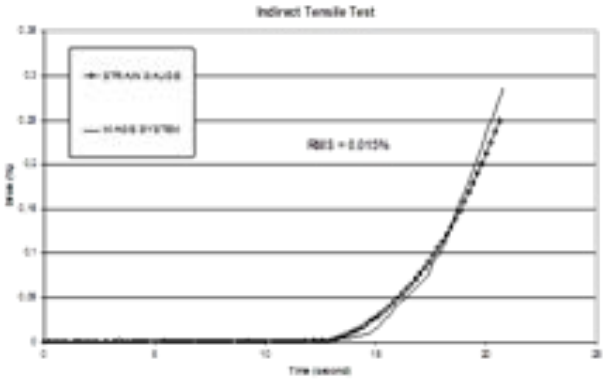
Calibration & Validation

Standard protocol?????

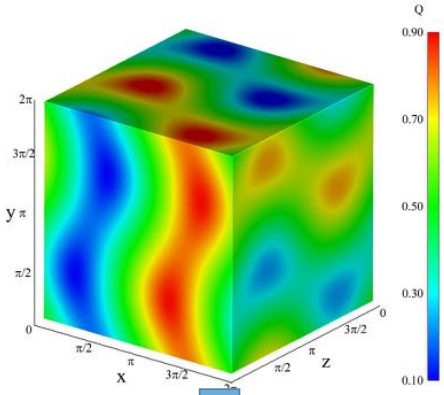


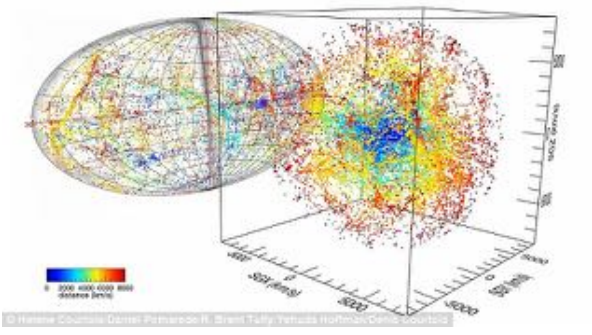


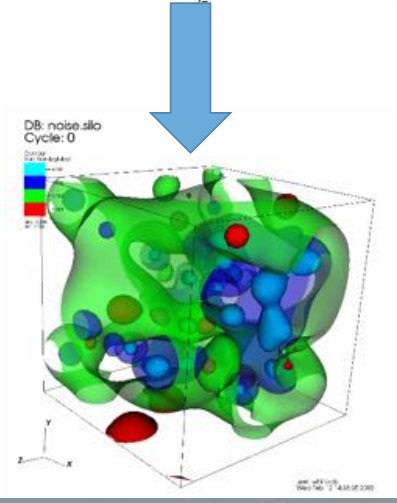


3D Measurement

How to have information not only limited at surface?

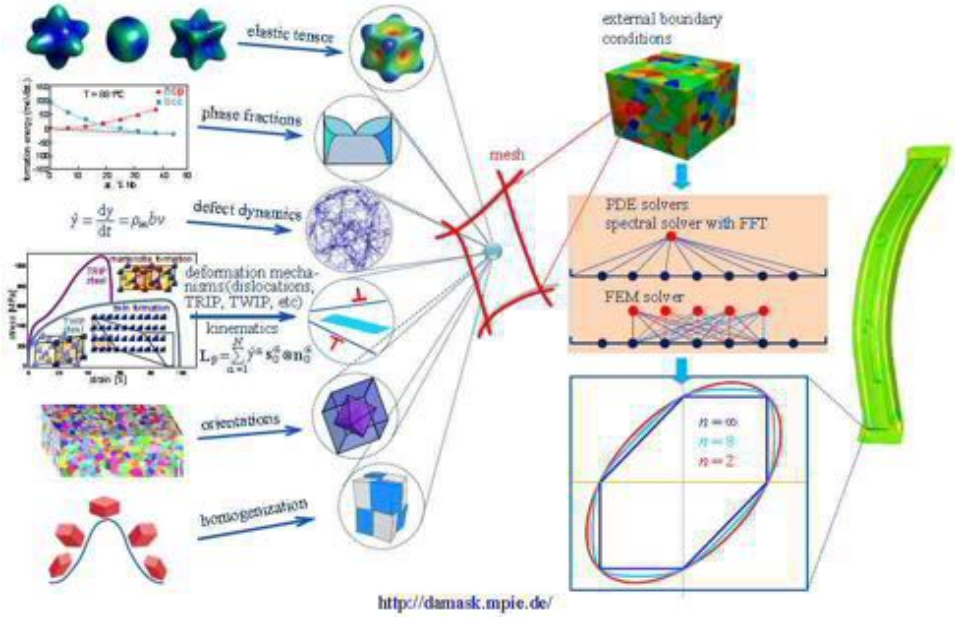




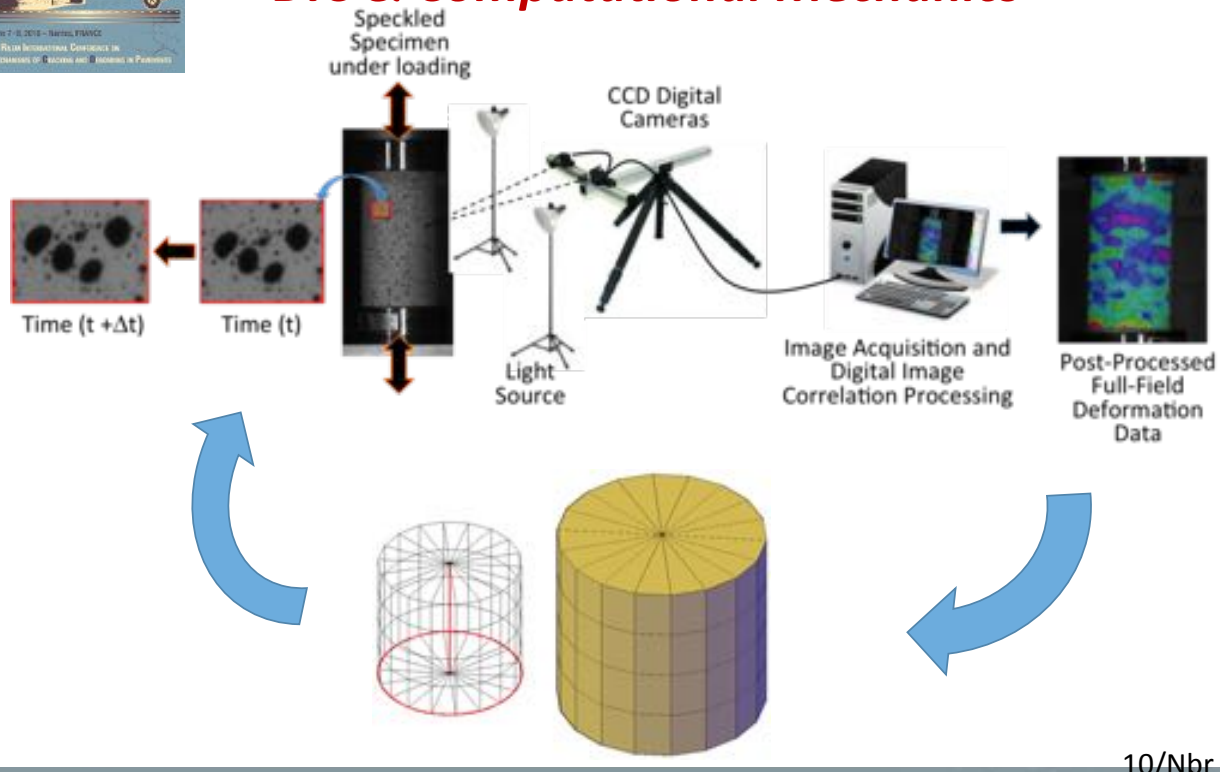


Implementation of Constitutive Models

How to use DIC to validate and implement constitutive models and F.E.M.?



DIC & Computational Mechanics



Presentation

- **Practical Experiences with DIC in asphalt technology**
  Moises Bueno

- **Meaningful civil and industrial applications of DIC measurements combined with numerical simulations**
  Roberto Fedele

- **Using DIC for crack tip detection and SIF estimation along curved cracks**
  Julien Réthoré

- ***Use of Eulerian Video Magnification Technique to Study Very Low Strain Levels***
  M. Emin Kutay