11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20 - 25, 2014, Barcelona, Spain

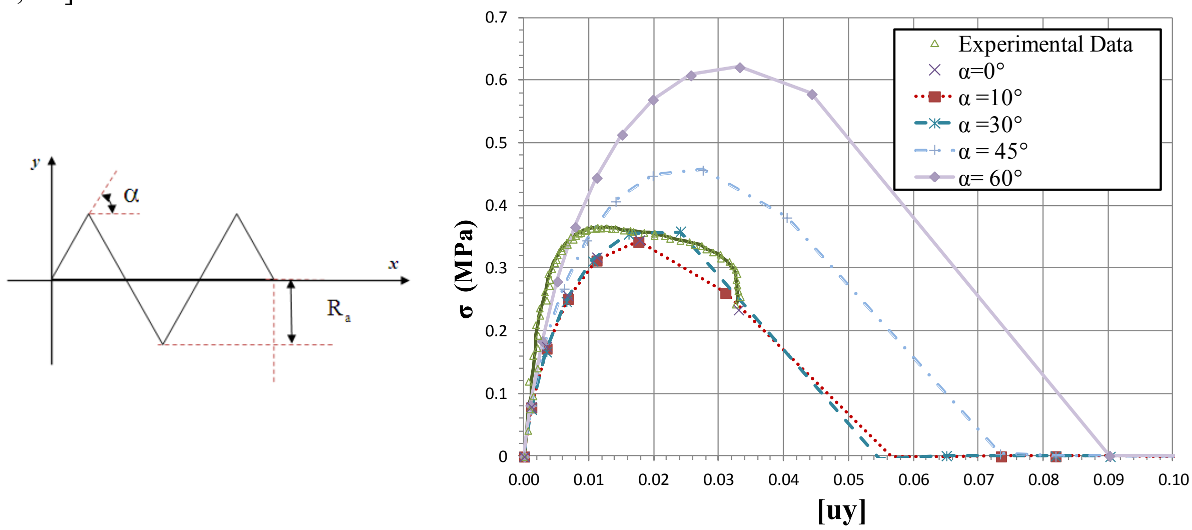
ROUGHNESS MODELING IN THE PAVEMENT LAYERS INTERFACES

R. Ktari[1], C. Khelifi[2], F. Fouchal[1], A. Millien[1], F. Lebon[2], C. Petit[1]

[1] GEMH, Civil Engineering and Durability, Université de Limoges, Boulevard Jacques Derche, 19300 Egletons, France, christophe.petit@unilim.fr
[2] LMA, Mechanics and Acoustics, Université Aix Marseille CNRS Centrale Marseille 31 Chemin Joseph Aiguier, 13402 Marseille Cedex 20, France

Key Words: *Interface, image analysis, field measurements, roughness, damage model, pavement structures, Cast3M.*

The interfaces between the bituminous pavement layers represent a very important parameter for the computational and design of these structures. However, the bonding quality depends on binder properties, adhesion state and surface cleanliness [1]. Some research [2] [3] shows the influence of the surface roughness between the different layers on the mechanical behavior of the interfaces in these structures. In fact, roughness and adhesion state is related to the specific surface and the contact surface at the interface between layers.
For providing reliability and efficiency of the pavement design methods a modeling study is required. Especially in this area the modeling interface is considered in most cases perfectly bonded with a local behavior based on empirical fatigue laws or fracture mechanics such as elastoplastic Mohr-Coulomb laws [4][5] without taking into account roughness geometrical parameters. However, in composite materials field, cohesive zone models [6, 7, 8] as well as asymptotic methods and theoretical studies [9] have been developed to simulate interlaminar degradation and delamination. Materials and interface behaviors can be elastoplastic, viscoelastic, with coupling damage [6, 7]. Few models focus on cyclic and fatigue loadings [8, 10].



a) b)

Fig.1. a) Roughness profile b) Stress-Relative normal displacement of the interface.

This paper is based on damage cohesive zone models [7, 9] applied to study debonding and degradation of a pavement interface. In a first part, monotonic tensile and double shear tests are performed, in order to obtain interphase and interface mechanical parameters. Digital image correlation (DIC) methods allow identification of uncoupled interface stiffness (k_n and k_s), damage evolutions, critical energy release rate. Experimental global and R_a mean depth roughness measurements are inputs parameters for the geometrical modeling, at interface macroscale.

The second part, consist in studying the influence of theses interface parameters and coupling effect through a numerical analysis. The interface damage model proposed by [7] implemented in the industrial computing code Cast3M is used. For this study, several cases of inclination angle α *(Fig.1.)* are tested, with mean depth roughness R_a, in order to determine the influence of the roughness on the mechanical behaviour of interface and adhesion between different layers.

REFERENCES

[1] F. Canestrari , G. Ferrotti, X. Lu, A. Millien , M.N. Partl, C. Petit, A. Phelipot-Mardelé, H.Piber and C. Raab, Mechanical testing of interlayer bonding in asphalt pavements advances in inter-laboratory testing and evaluation of bituminous materials. *State-of-the-Art Reports of RILEM Technical committee 206-ATB*, chap 6, pp. 303-360, 2013.

[2] F.A. Santagata, MN. Partl, G. Ferrotti, F. Canestrari and A Flisch, Layer characteristics affecting interlayer shear resistance in flexible pavements. *J Assoc Asphalt Paving*, Vol 77, pp.221-256, 2008.

[3] C. Raab, A.O. Abd El Halim A.O. and Partl M.N., Interlayer bond testing using a model material. *Construction and Building Materials*. Vol 26, pp. 190-199, 2012.

[4] C. Petit, M. Diakhaté, A Millien, A. Phelipot-Mardele and B. Pouteau, Pavement design for curved road sections: Fatigue performance of interfaces and longitudinal top-down cracking in multilayered pavements. *Road Materials and Pavement Design*, Vol 10-3, pp. 609-624, 2009.

[5] H. Ozer, I.L. Al-Qadi and Z. Leng, Fracture based friction model for pavement interface characterization. *Transportation Research Record* , 2057, (1), pp. 54-63. 2008

[6] O. Allix and P. Ladevèze, Interlaminar interface modelling for the prediction of delamination. *Compos Struct*, 22 (4), pp. 235–242, 1992.

[7] P. Ladevèze, O. Allix, L. Gornet, D. Lévêque and L. Perret, A computational damage mechanics approach for laminates: identification and comparison with experimental result. In: Voyiadjis GZ, Ju J-WW, Chaboche JL, editors. *Damage mechanics in engineering materials, studies in applied mechanics*, vol. 46. Elsevier, pp. 481-500, 1998.

[8] Y. Monerie and M. Raous, A model coupling adhesion to friction for the interaction between a crack and a fiber/matrix interface. *Z.A.M.M.*, pp 205-209, 2000.

[9] A. Ould Khaoua, F. Lebon, C. Licht and G. Michaille, Thin layers in elasticity: A theoretical and numerical study. In ASME, editor, Processing of the 1996, *Engineering Systems Design and Analysis Conference*, Vol 4,pp. 171-178, 1996.

[10] L. Gornet and H. Ijaz, A high-cyclicelastic fatigue damage model for carbon fibre epoxy matrix laminates with different mode mixtures. *Composites*: Part B 42, pp. 1173-1180, 2011.