

## Interlaminar Mode-I Fracture Characterization Underwater of Reinforced Bituminous Specimens

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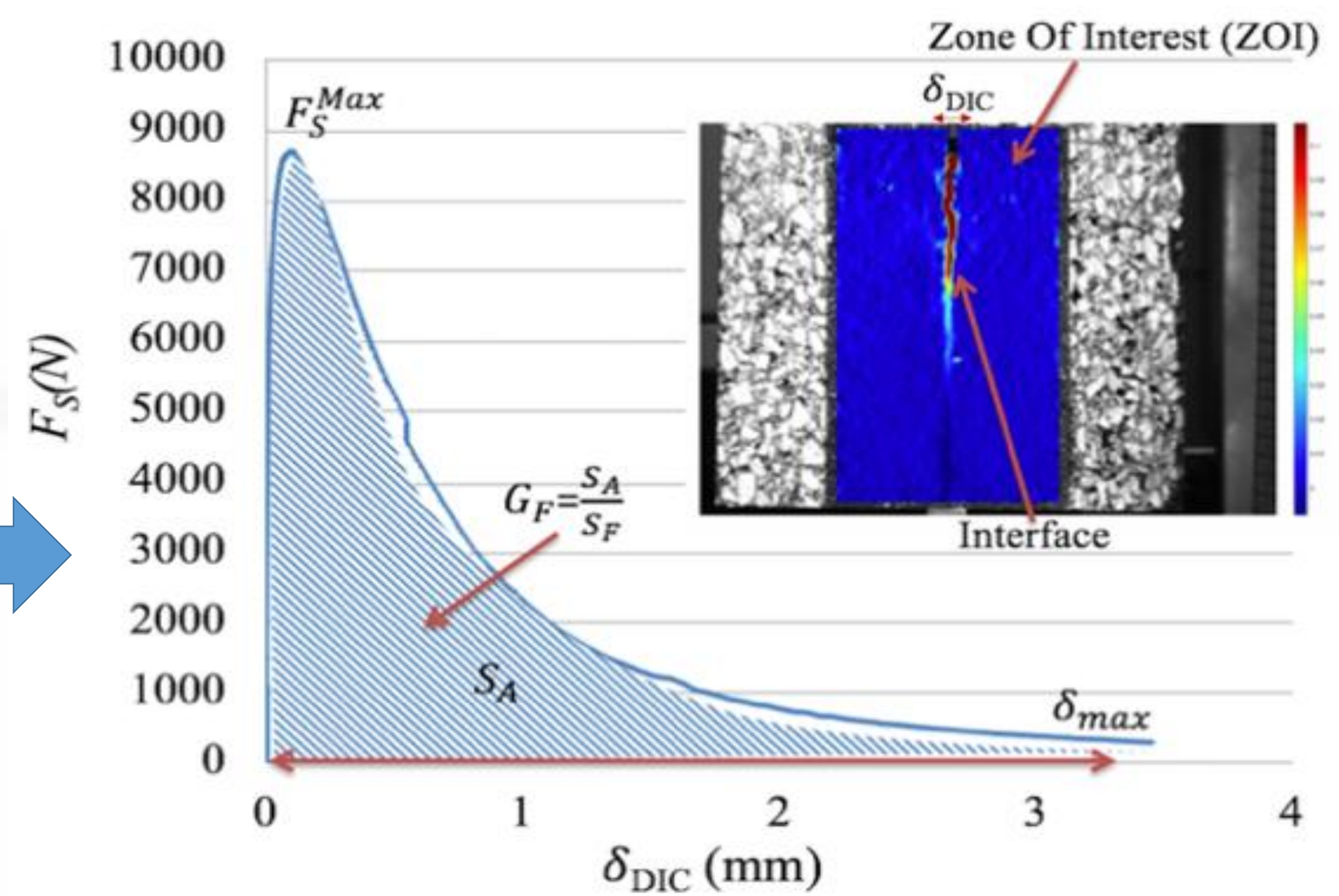


Fig. 1b  $F_S - \delta_{DIC}$  curve

### Objective:

Using an adapted wedge splitting test (WST) for specimens extracted from real test track [2-3], experimental characterization underwater of their interlaminar mode I fracture behavior.

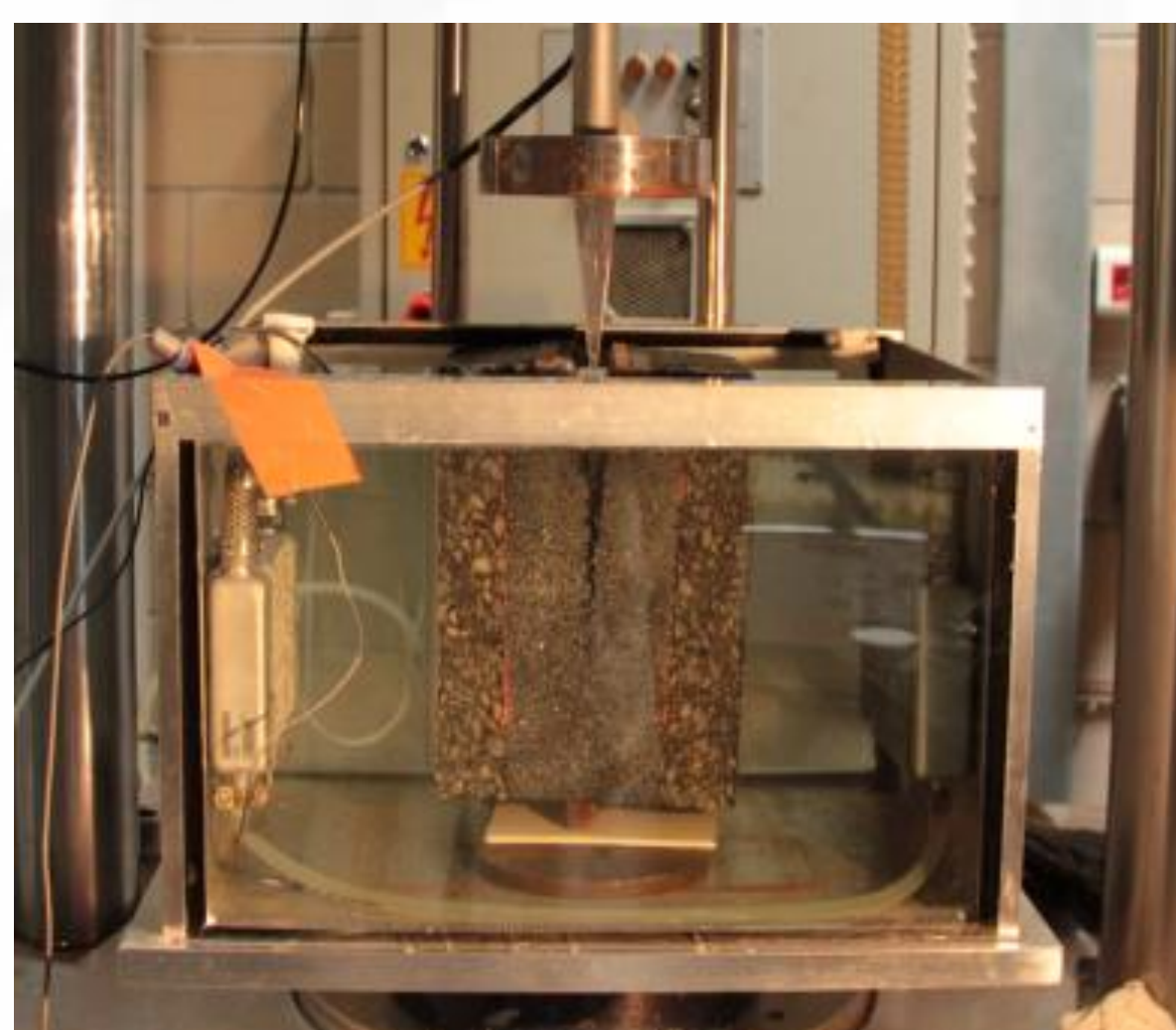


Fig. 1a The aquarium designed, built and used for testing specimens under water similarly to Hun's PHD works (2012) [1]

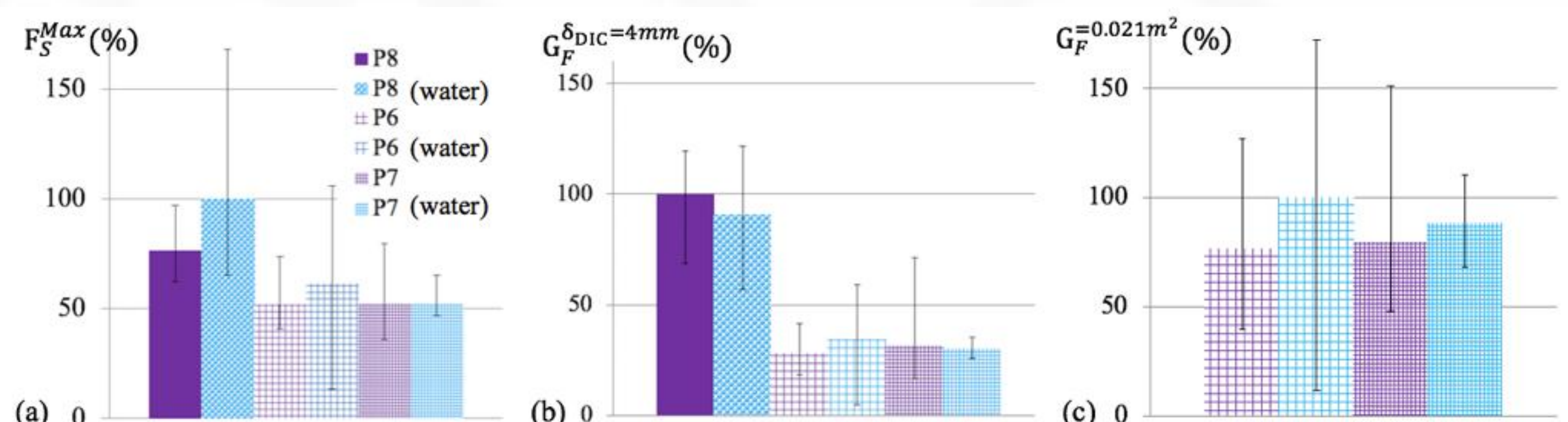


Fig. 2. Comparison of results (normalized values) for unreinforced P8 specimens and reinforced specimens P6 (with a Ref 100kN G3 glass grid) and P7 (with a new 100kN G4 glass grid) :

a)  $F_S^{Max}$ , b)  $G_F^{\delta_{DIC}=4mm}$ , c)  $G_F^{0.021m^2}$

Table 1. Moisture characteristics of specimens tested under water

Specimen name	Test T (°C)	$S_r$	Immersion time (h)
P8	~20°C	~48 (31 to 71)	~45 (26 to 74)
P6 (G3)	~20°C	~52 (37 to 66)	~26 (21 to 28)
P7 (G4)	~20°C	~43 (34 to 61)	~41 (7 to 96)
P7 (G4)	~7°C	~42 (28 to 83)	~36 (18 to 98)

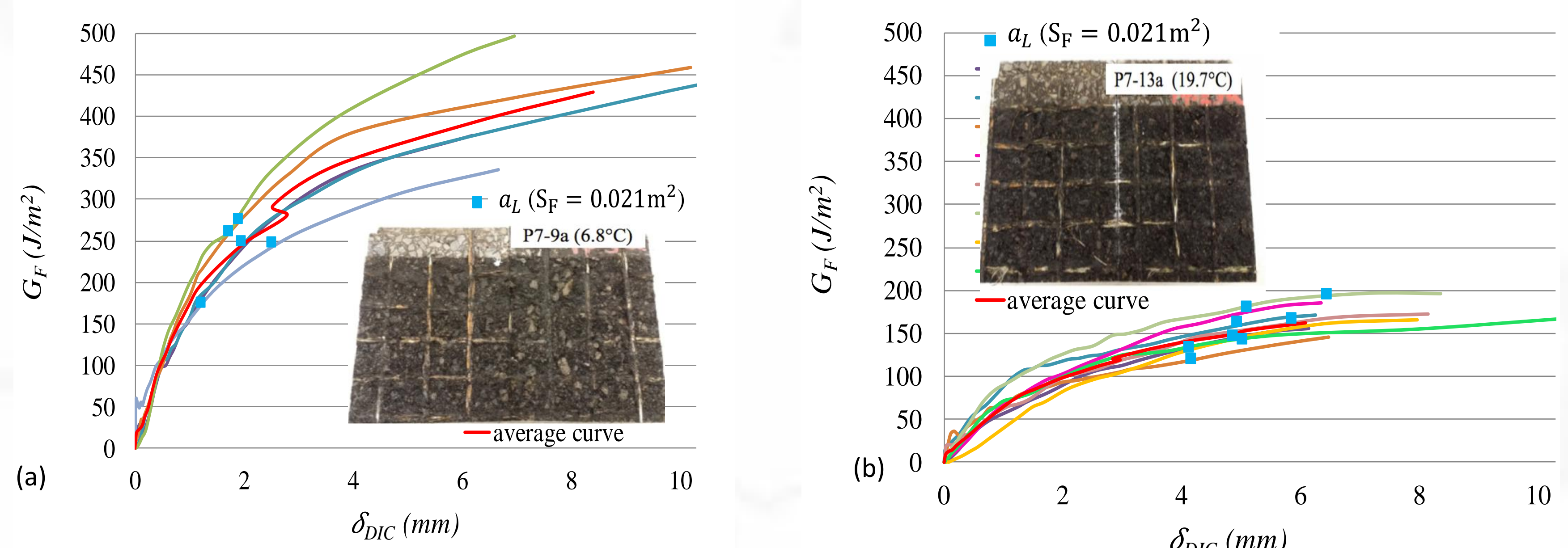


Fig. 4.  $G_F$  results and corresponding fracture surface view for reinforced P7 specimens tested under water: (a) ~ 20°C, (b) ~ 7°C

### Conclusion/Perspectives:

- Compared to unreinforced P8 specimens, the bond between bituminous layers of reinforced specimens (either with G3 and G4 grids) is reduced for both by roughly 1/3 relative to crack initiation and by 2/3 relative to propagation resistance. It yields greater understanding of some of the poor interface bond results obtained recently in the field during the APT campaign [4]
- At 20°C, the presence of water in the materials exerts an influence on the dispersion of all results, except for specimens reinforced with the G4 grid.
- WST results under water at 7°C and 20°C illustrate the thermal effect on bonding behavior. The fracture mechanisms are localized inside the G4 grid itself and on the bond between aggregates and tack coat bitumen emulsion. According to the RILEM TC241-MCD recommendation [5], no less than 10 tested specimens per configuration are needed to access to the fracture energy values.

→ These WST results provides interface parameters that may be used in a 3D pavement modelling.

### References

- Chabot, A., Hammoum, F., Hun, M.: A 4pt bending bond test approach to evaluate water effect in a composite beam. EJCE 21 (sup1), 54-69 (2017).
- Gharbi, M. : Caractérisation du collage des interfaces de chaussées par essais de rupture en mode I. ECN PhD thesis, ED SPI (<http://www.theses.fr/2018ECDN0037/document>) (2018).
- Gharbi, M., Nguyen, M.L., Trichet, S., Chabot, A.: Characterization of the bond between asphalt layers and glass fiber grid with help of a Wedge Splitting Test. BCRRRA 2017, pp. 1517-1524. (2017). <https://www.taylorfrancis.com/books/e/9781315100333/chapters/10.1201/9781315100333-201>
- Nguyen ML, Chazallon C., Sahli M., Koval G., Hornych P., Doligez D., Chabot A., Le Gal Y., Brissaud L., Godard E. Design of reinforced pavements with glass fiber grids: from laboratory evaluation of the fatigue life and its FEM/DEM modelling to accelerated full-scale test. LNCE, vol. 96: 329-338, Springer, Cham, (2020). [https://doi.org/10.1007/978-3-030-55236-7\\_34](https://doi.org/10.1007/978-3-030-55236-7_34)
- Petit, C., Chabot, A., Destrée, A., Raab, C.: Recommendation of RILEM TC 241-MCD on Interface Debonding Testing in Pavements. Materials and Structures 51 (4), article 96 (2018)