Definition of cohesive parameters in pure modes I and II of adhesives joints

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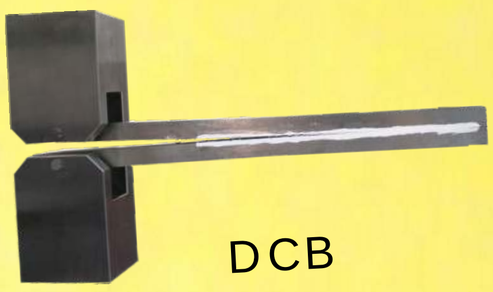
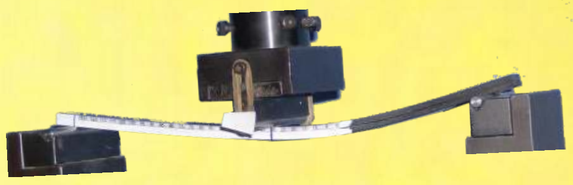
abstract

The application of bonded joints is increasing in structural components. Consequently, the definition of accurate and straightforward predictive strength methodologies is fundamental. Recently, cohesive damage models have been used to simulate the mechanical behavior of bonded joints [1, 2]. These methods allow simulating damage initiation and growth, which is essential for rigorous strength predictions. In this context, the determination of cohesive damage laws in pure modes I and II acquires special relevancy for more general mixed-mode loading cases. The objective of this study is to determine the effect of the cohesive parameters of the pure mode laws. One adhesive was considered. Triangular and trapezoidal laws were used to reproduce the adhesive behavior. The numerical load-displacement curves were fitted to the experimental ones, thus defining the respective cohesive parameters. In order to diminish the number of iterations of the fitting process, the Taguchi design technique was used to obtain a matrix relating the different parameters to be fitted. From this matrix, a sensitivity analysis was done to determine the effect of each parameter. The obtained cohesive laws can be applied to bonded joints design.

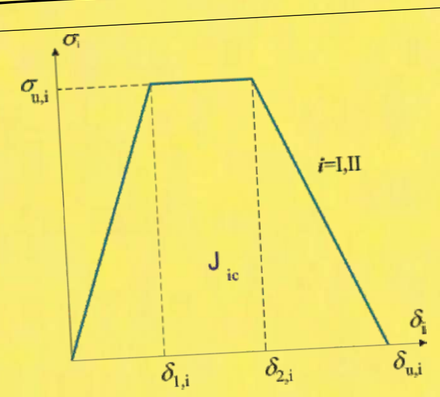
experimental and fitting



DCB



ENF



Cohesive parameters and E were introduced in a Taguchi table (table1) for posterior statistical treatment.

Triangular and trapezoidal laws (with similar areas) were used in order to define the decohesion process as input for ABAQUS mixed mode bending model.

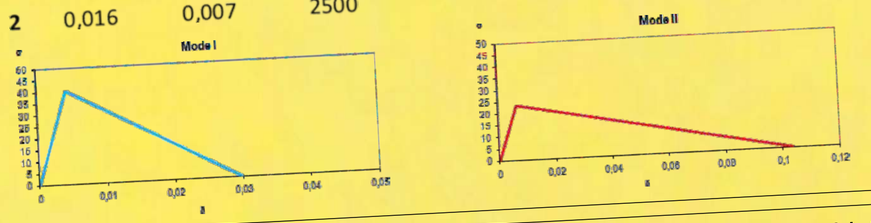
table1. cohesive parameters and E

	δ2,I	δ2,II	E
1	0,016	0,054	1850
2	0,016	0,007	2500
3	0,0045	0,054	2500
4	0,0045	0,007	1850

cohesive parameters definition

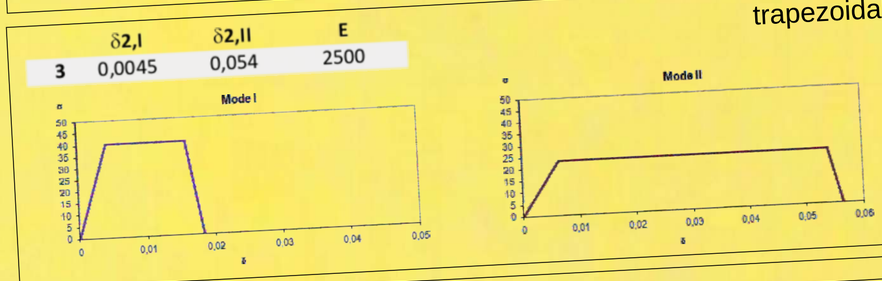
triangular

	δ2,I	δ2,II	E
2	0,016	0,007	2500

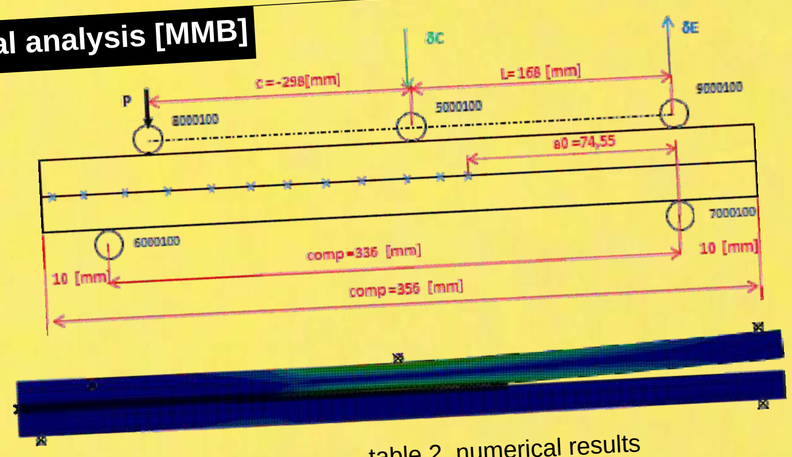


trapezoidal

	δ2,I	δ2,II	E
3	0,0045	0,054	2500



numerical analysis [MMB]



Results (GI,GII and criterion) obtained from ABAQUS, were introduced in table 2 for posterior statistical treatment.

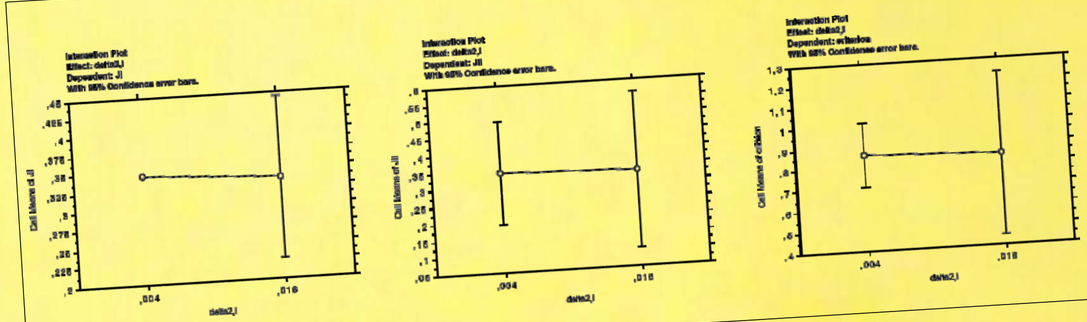
Computation time is also registered for performance measurement.

table 2. numerical results

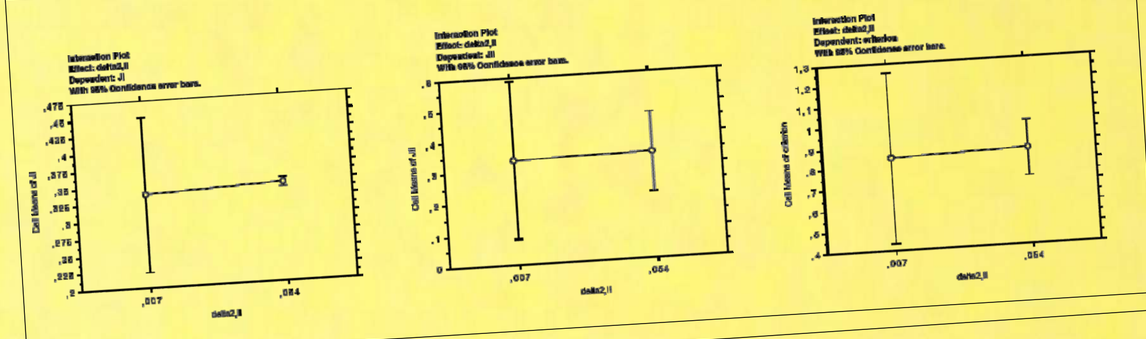
	J_I	J_{II}	criterion	comp. time
1	0,345	0,351	0,873	620 min.
2	0,328	0,315	0,811	790 min.
3	0,346	0,331	0,852	665 min.
4	0,346	0,355	0,876	895 min.

note: criterion is defined by GI/GII = 0.9

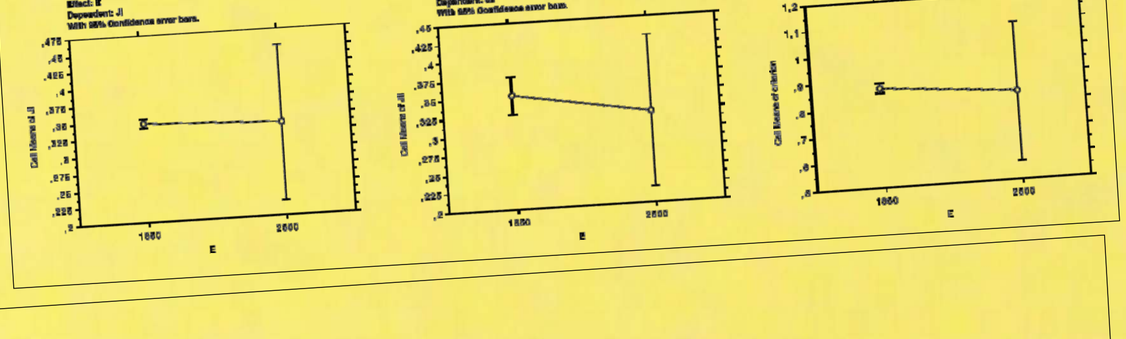
$d_{2,I}$ effect



$d_{2,II}$ effect



E effect



Conclusions

The Taguchi analysis confirms that there is no significant variance in the values of GI and GII for different cohesive parameters.

It also shows that the numerical results are better when using the trapezoidal decohesion law for this adhesive (ductile), because the criterion is closer to 0.9.

Using the trapezoidal decohesion law for this adhesive, also requires less computation time.

references

[1] MFSF de Moura, JPM Gonçalves, JAG Chousal, RDSG Campilho, Cohesive and Continuum Mixed-Mode Damage Models Applied to the Simulation of the Mechanical Behaviour of Bonded Joints, accepted for publication in International Journal of Adhesion and Adhesives.

[2] MFSF de Moura, RDSG Campilho, JPM Gonçalves, Crack Equivalent Concept Applied to the Fracture Characterization of Bonded Joints under Pure Mode I Loading, accepted for publication in Composites Science & Technology.