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INTERNATIONAL COLLOQUIUM

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**DURABILITY OF POLYMER BASED COMPOSITE
SYSTEMS FOR STRUCTURAL APPLICATIONS**

(ANALYSIS and PREDICTION)

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Free University Brussels (V.U.B.)
August 27-31, 1990

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DURABILITY OF POLYMER BASED COMPOSITE SYSTEMS FOR STRUCTURAL APPLICATIONS

(ANALYSIS and PREDICTION)

DAJA 89-A1-0213

Tentative Program

(May - June 1990)

This colloquium is sponsored by :

- . the Free University Brussels (V.U.B.)*
- . the Belgian National Science Foundation (NFWO-FNRS)*
- . the European Association for Composite Materials (EACM)*
- . the British Society for Composites*
- . the Association Française pour les Matériaux Composites (AMAC)*
- . the US Army RDS-Group - U.K.*
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- . the Belgian "Nationale Loterij - Loterie Nationale"*

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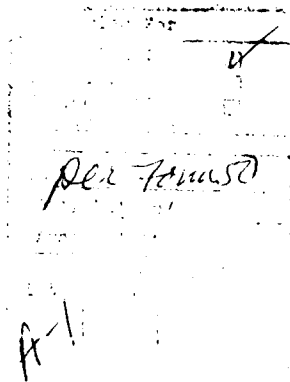
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Conference Secretariate :

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AIMS AND SCOPE :

Most of the new composite systems, based on polymers (materials, structures and adhesive joints) exhibit time effects and their behaviour is strongly influenced by temperature, moisture absorption and other environmental factors.

The use of these materials for structural applications, mechanical loads, (of static, dynamical and impact type), in a surrounding with varying environmental conditions, needs design procedures, which take into account this general loading history interacting with the thermomechanical characteristics, in order to obtain a reliable prediction of the long term behaviour.

A valid methodology for life time prediction and/or durability analysis is probably the key element for a larger development of the use of polymer based composite systems in structures in the future.

Such a durability analysis has to be based on a specific number of tests which are to be performed during a short time period. The use of these results in order to construct valuable long term predictions must be based on the knowledge of the variation of the thermomechanical properties of these materials under a general, mechanical and environmental, loading history.

A complete analysis also needs valid criteria for the limit behaviour in order to predict life-time with stated safe structural conditions.

A global analytical limit criterium can be chosen or a fracture mechanics approach can be used. It is also possible to use a continuum mechanics damage theory including a propagation equation and criteria for damage concentrations and local failures, based on micromechanics and experimental results.

The objective of this colloquium is to bring together specialists of reliability, durability analysis, viscoelastic behaviour, damage theory, wear resistance, fatigue, fracture mechanics, structural analysis and design, in order to compare the existing methodologies and realize the "state of the art" concerning this problem.

It is also our aim to bring together researchers working on this problem, to stimulate discussions and arrive, perhaps not to an unique accepted methodology, but certainly to guidelines for further research and the realisation, or start, of a large international coordination of history controlled real time tests in order to build up an accepted data basis for the comparison of different durability analysis methodologies in the future.

The invited general lectures and presentations will cover :

- theoretical, numerical and experimental aspects
- all composite systems based on polymers
- prediction theories based on thermodynamics, fracture micromechanics or combinations
- the study of the influence of *time, temperature, moisture diffusion, stress level* and type on the behaviour of polymer based composite systems separately or combined
- presentation and discussion of the design of tests and the data processing of scientific and technological tests
- viscoelasticity, creep and relaxation behaviour, including ageing effects under static and dynamic loading conditions.

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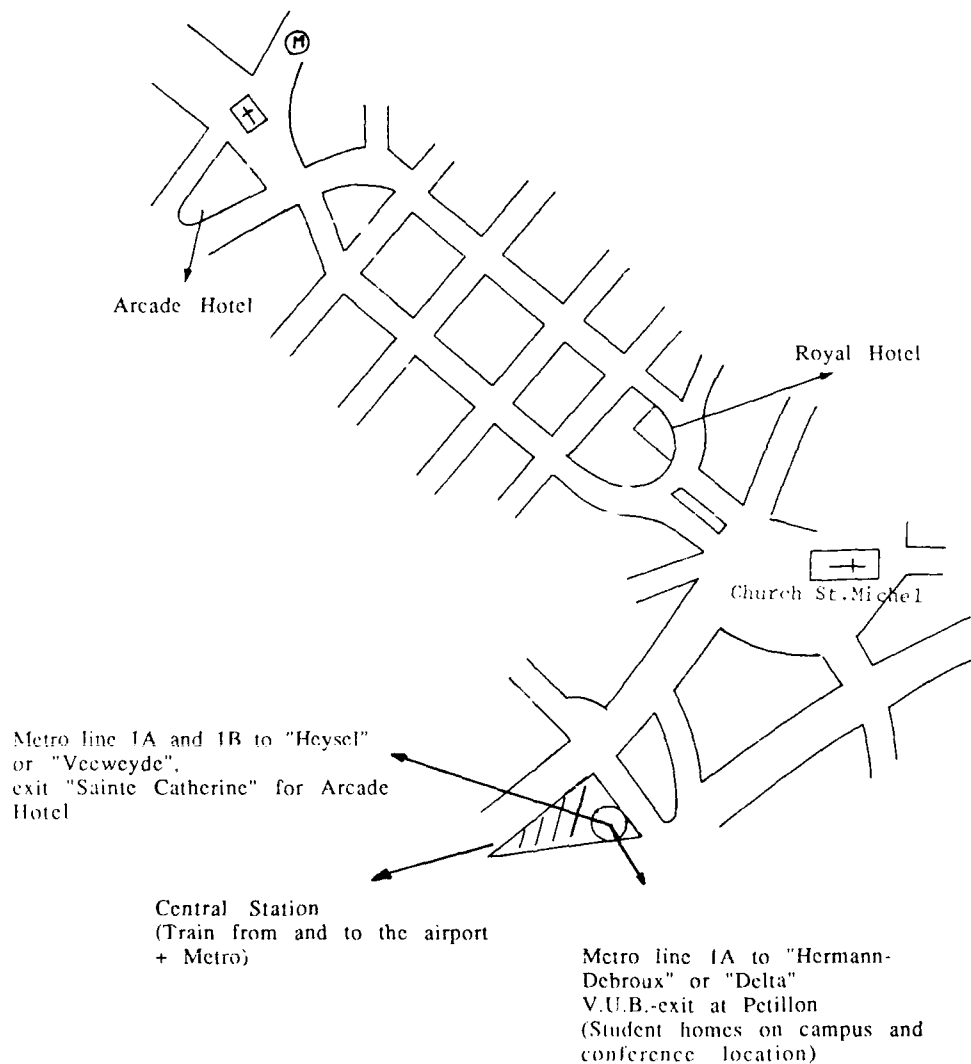
The format of the conference, limited to 120 participants, will ensure all conditions for a maximum of free informal discussion in and out the sessions. Two general discussion sessions are provided and we expect all participants to arrive on Monday 27 August afternoon and to stay till Friday for active participation.

MONDAY AUGUST 27, 1990

15.00 - 19.00 : Registration

19.00 - 21.00 : Welcome Reception

at the SAS - Royal Hotel
Wolvengracht - Rue Fossé-au-Loups, 47
B-1000 Brussels
Tel : 32/2/219.28.28 Fax : 32/2/219.62.62



TUESDAY AUGUST 28, 1990

8.30 Opening Ceremony - Introductory remarks

9.00 Session 1a

Invited Lecture 1

K. Reifsnider (Virginia Tech - VA - USA)

"Performance simulation of polymer based composite systems"

9.50 R.J. Morgan, K. Battges, E. English, P. Hogg, C. Dunn, S. Turner
(Midland - USA ; London - U.K)

"Durability of polymer matrix fibrous composites"

10.10 A.E. Bogdanovich (Riga - USSR)

"Prediction of deformation and failure processes in laminated composite shells and plates subjected to dynamical loads"

10.30 Break

11.00 Session 1b

H.D. Wagner (Rehovot - Israel)

"Single-fiber monolayers as a tool for the analysis of short- and long-term damage in composite materials"

11.20 D.H. Allen (College Station - USA)

"A continuum damage mechanics model for life prediction of laminated composites"

11.40 S. Murakami, Y. Kanagawa, T. Ishida (Nagoya - Japan)

"Deterioration of graphite composites under multiaxial cyclic loadings"

12.00 J. Karger-Kocsis, K. Friedrich (Hamburg - FR.Germany)

"Mechanical properties and failure behaviour of glass fiber mat-reinforced nylon RIM composites"

12.45 - 14.00 Lunch

14.10 Session 2

Invited Lecture 2

L. Nicolais (University of Naples - Italy)

"Solvent sorption synergy in PEEK"

15.00 X.R. Xiao, S.V. Hoa, K.N. Street (Montreal - Victoria - Canada)

"On the durability and the morphology relationship in crystalline thermoplastic composites"

15.20 A. Murakami, T. Toku, H. Aoki, T. Yoshiki, S. Murakami, O. Watanabe, M. Saito, H. Inoue (Hyogo - Japan)

"Fracture behaviours of epoxy resin containing thermoplastics and their composites"

15.40 - 16.00 Break

16.00 Poster Presentations

(see the list of posters - poster exhibition starts on Tuesday August 28
afternoon till Friday August 31 at noon)

17.00 End

19.00-20.30 Informal optional dinner in the Royal Hotel

20.30-22.30 Presentation of short contributions of Work in Progress and general
discussion at the Royal Hotel.

WEDNESDAY AUGUST 29, 1990

9.00 **Session 3.a**

Invited Lecture 3

H.F. BRINSON (University of Texas at San Antonio - USA)

"A nonlinear viscoelastic approach to durability predictions for polymer based composite structures"

9.50 R. Pyrz (Aalborg - Denmark)

"Inelastic constitutive modelling of composites - Rate and damage effect"

10.10 Y. Chevalier, Y. Neuamani (Saint Ouen - France)

"Effective viscoelastic behavior of woven composites"

10.30 Break

11.00 **Session 3.b**

R.D. Maksimov, V.A. Kochetkov (Riga - USSR)

"Thermorheologically complex deformation prediction of hybrid polymer composites"

11.20 S. Kyu Ha, Q. Wang, Fu-Kuo Chang (Stanford - USA)

"Mechanical response of thermoplastic matrix composites at elevated temperatures"

11.40 H. Fukuda (Tokyo - Japan)

"Five years outdoor exposure on advanced composite materials"

12.00 P.S. Theocaris (Athens - Greece)

"The elliptic paraboloid yield locus for anisotropic materials"

12.30 14.00 Lunch

14.00 Afternoon free

or

Optional excursion to Brugge, Damme and Ghent with dinner in Ghent and return to the hotels and campus between 22.45 and 23.15.

THURSDAY AUGUST 30, 1990

9.00 **Session 4.a**

Invited Lecture 4

Z. HASHIN (Tel Aviv University - Israel)

"Micromechanics aspects of damage in composite materials"

9.50 V. Alstädt, R.W. Lang, A. Neu (Ludwigshafen, FR.Germany)

"The influence of fiber, resin and interphase on the delamination fatigue crack growth of composites"

10.10 D. Gamby, J. Martins (Poitiers - France ; San Paulo - Brazil)

"Numerical simulation of the constraining effect on a transverse crack propagation in a cross ply laminate"

10.30 Break

11.00 **Session 4.b**

K. Schulte (Köln - FR.Germany)

"The continuous monitoring of fatigue damage in composite materials"

11.20 G. Marom (Jerusalem - Israel)

"Strain rate effects on the durability of hybrid composites under flexural fatigue conditions"

11.40 P. Cirese, C. Folchitto, M. Marchetti, M. Porzi (Roma - Firenze - Italy)

"Damage propagation in notched CFRP laminates"

12.00 V. Tamuzs (Riga - USSR)

"Fatigue of polymer composite materials (Experiments, calculation, prediction)"

12.45 - 14.00 Lunch

14.10 **Session 5.a**

Invited Lecture 5

R. TALREJA (Technical University Copenhagen - Denmark)

"Damage mechanics of composite materials based on thermodynamics with internal variables"

15.00 C.C. Hiel, M. Sumich (NASA - Ames - USA)

"A curved beam test specimen for determining the interlaminar tensile strength of laminated composites"

15.20 C. Roy, A. Maslouhi, J. Allard, Z. Piasta (Sherbrooke - Quebec - Canada ; Kielce - Poland)

"Pattern recognition characterizations of microfailures in composites via analytical quantitative acoustic emission"

15.40 Break

16.00 Session 5.b

M.A. French, G. Pritchard (Kingston - UK)

"Strength retention of glass/carbon hybrid laminates in aqueous media"

16.20 D.A. Dillard, J.Z. Wang, F.A. Kamke, T.C. Ward, G. Wilkes, N.P. Wolcott
(Blacksburg - Morgantown - USA)

"The effects of transient moisture conditions on the viscoelastic behaviour of fibers and composites"

16.40 R. Adams, M. Singh (Bristol - U.K.)

"The effect of exposure to hot-wet conditions on the dynamic properties of fibre reinforced plastics"

17.00 R. Gopalan, G. Prathap, B. Dattaghuru (Bangalore - India)

"Hygrothermal effects on stresses and strength of single lap adhesively bonded composite joints"

17.20 End

19.30 Apertif followed by the Conference Dinner at the Royal Hotel.

FRIDAY AUGUST 31, 1990

9.00 Session 6.a

Invited Lecture 6

M. DARLINGTON (Cranfield Institute of Technology - UK)

Short fibre reinforced thermoplastics : properties and design"

9.50 T. Morii, T. Tanimoto, Z. Mackawa, H. Hamada, K. Kiyosumi (Kyoto, Kanagawa - Japan)

"Effect of surface treatment on degradation behaviour of GFRP in hot water"

10.10 J.C. SEFERIS (Seattle - USA)

"Dynamic mechanical measurements of polymers in liquid environments"

10.30 Break

11.00 Session 6.b

V. Zilvar, Z. Korinek, J. Steidl (Prague - Czechoslovakia)

"Microstructure and impact behaviour of injection moulded glass fibre reinforced polypropylene and polyamide 6"

11.20 General Discussion

Conclusions

12.00 Closure

12.30-14.00 Farewell Lunch

POSTERS

P.1 R.A. Bares, J. Hristova, Z. Fiala (Prague - Czechoslovakia)

"Forecast of PC long-time behaviour using Findley theory"

P.2 I. Gherbel, D. Valentin, M.C. Yriex, J. Gratin (Evry - Moret sur Loing - France)

"Damage propagation law in glass fibre reinforced polyester tubes under hygrothermal loading conditions"

P.3 H. Hamada, Z. Mackawa, T. Morii, A. Gotoh, T. Tanimoto (Kyoto - Kanagawa - Japan)

"Durability of adhesive bonded FRP joints immersed in hot water"

P.4 A. Lagrange (Brest - France)

"Study of the influence of various stress states on the moisture diffusion in a composite immersed in distilled water and in natural sea water"

P.5 C.A.M. Van den Ende, A. Van der Dolder (Arnhem - The Netherlands)

"Comparison of environmental stress corrosion cracking in different glass fibre reinforced thermoset composites"

- P.6 C. Henaff-Gardin, M.L. Lafarie-Frenot (Poitiers - France)
"Analysis of fatigue transverse ply cracking in different stacking sequences of CFRP cross-ply laminates"
- P.7 A. Murakami, H. Ae, H. Ueda, M. Murakami, T. Yoshiki, Y. Fujii (Hyogo - Japan)
"The effect of matrix toughness on fracture behaviour of GFRP"
- P.8 N. Chevalier (Saint Ouen, France)
"Testing of anisotropic viscoelastic composite media by ultrasonic waves"
- P.9 D. Genin, C. Doan, P. Hamelin (Lyon - France)
"Impact behaviour and its relation to durability of composite SMC plates"
- P.10 J.J. Gerharz, H. Idelberger (Darmstadt - FR.Germany)
"A method to predict residual strength and fatigue life of impact damaged carbon epoxy laminates"
- P.11 Q. Guo, K. Friedrich, J. Karger-Kocsis (Shanghai - China ; Hamburg - FR.Germany)
"Influence of testing conditions on the sliding friction and wear behaviour of the PEEK-based composite"
- P.12 L. Czarnecki, W. Glodkowska (Warsaw, Koszalin - Poland)
"Model for compatibility of polymer composite-cement concrete system"
- P.13 M. Verheyden, Q. Yang, R. Willems (Brussels - Belgium)
"Influence of moisture absorption on the mechanical characteristics of graphite-epoxy composites"
- P.14 T. Blaszczyński (Poznan - Poland)
"Durability of cement based composite systems influenced by physico-chemical agents"
- P.15 D. Van Hemelrijck, L. Schillemans, I. Daerden, F. De Roey, F. Boulpaep (Brussels - Belgium)
"Use of thermoelastic emission techniques (SPATE) for damage analysis of graphite epoxy composites"
- P.16 H. Sol, J. De Visscher (Brussels - Belgium)
"Mixed numerical-experimental techniques for the characterisation of polymer matrix composite laminates"

GENERAL INFORMATION

Registration fee (including extended abstracts, coffee breaks, lunches, welcome reception, conference dinner and a special reduced price for the proceedings if ordered before the end of the colloquium) :

before June 30, 1990 : 25.000 BF
after June 30, 1990 (if available) : 30.000 BF.

The registration fee is reduced to 18.000 BF (or 23.000 BF after June 30, 1990) for members of EACM, the AMAC, the British Society for Composites and staff members of Belgian universities and Belgian Public Research Centra.

Optional dinner on August 28, 1990 : 1.200 BF
Optional excursion on August 29, 1990 : 2.500 BF

Companions fee (welcome reception and conference dinner) : 3.500 BF
Lunch and excursion for companions on August 29, 1990 : 2.000 BF

LODGING

A certain number of rooms are booked in two hotels and in student residences. All participants are expected to arrive on Monday August 27, or before, and to stay till Friday August 31.

We can offer lodging packages (breakfast and all taxes included) :

Royal Hotel SAS (1 st class)	4 nights	5 nights
single	BF 12.000	BF 15.000
double	BF 14.000	BF 17.500
Hotel Arcade-Stc Cathérine		
single	BF 8.000	BF 10.000
double	BF 10.000	BF 12.500
Student Homes on the Campus	BF 2.400	BF 3.000

Nights before August 2nd or extension after August 31 are possible at the same conditions, if booked with the registration.

The reservations will be confirmed if an amount of 20 % of the hotel cost is paid with the registration fee.
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The sessions of the colloquium will take place in the auditorium 1 of building K on the Campus of the V.U.B. (Triomflaan, Entry 8, building K, level 2).

The Conference Secretariate will be located in building KB, on the left hand side of building K, level 1, room KB.102.

The posters will be on display in the laboratory room of building KB, level 1, close to the rooms for the coffee breaks.

The registration desk will be open on Monday August 27 from 15.00 till 19.00 in the Royal Hotel before the welcome reception.

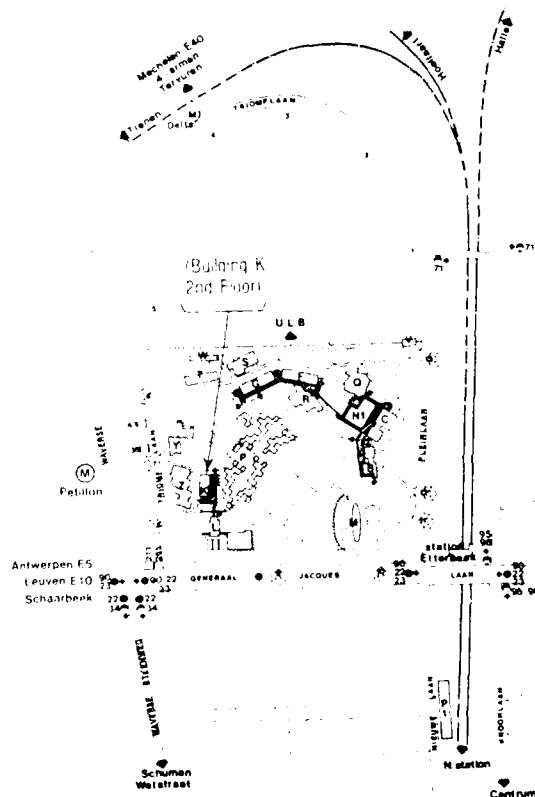
Late registration will be possible at the Conference Secretariate in building KB on the campus on Tuesday August 28 from 8.00 till 15.30.

A bus connection between the Arcade Hotel, the Royal Hotel and the campus will be available on Tuesday morning, Tuesday afternoon, Wednesday morning, Thursday morning, Thursday afternoon and Friday morning.

The Arcade Hotel (Ste Cathérine), the Royal Hotel (central station) and the campus (Petillon) are on the same underground line (1A).

The optional excursion on Wednesday August 29 will leave building K after lunch and the coaches will bring the participants back to the Arcade Hotel, the Royal Hotel and the campus between 22.45 and 23.15.

Map of campus from the Metro station "Petillon"



Related conferences in Europe end of August and September 1990

1) August 20-24, 1990

9th International Conference on Experimental Mechanics

Technical University Denmark, Lyngby, Copenhagen, Denmark

(This conference will include a special session on experimental techniques used on composite systems)

For all information : Prof. V. Askegaard

Dept. of Structural Engineering

Technical University Denmark

(Building 118)

DK-2800 LYNGBY (Denmark)

Phone : 45/42883511, Fax : 45/42882239 and 45/42883282

2) August 20-24, 1990

COMP '90

3rd International Symposium "Advanced Composites in Emerging Technologies"

University of Patras, Greece

For all information : Prof. S. PAIPEIIS

COMP '90 Symposium

P.O.Box 1134

26110 PATRAS (Greece)

Phone : 3061-992172, Fax 3061-992644

3) September 10-12, 1990

ADHESION 90 (Plastics and Rubber Institute)

4th International Conference at the University of Cambridge

For all information : Mrs. Diane VARLEY

The Plastics and Rubber Institute

11, Hobart Place

LONDON SW1 WOHL, (United Kingdom)

Phone : 01-2459555, Fax : 01-8231379

4) September 25-28, 1990

4th European Conference on Composite Materials (ECCM-4)

Stuttgart, FR-Germany

For all information : EACM

2, Place de la Bourse

F-33076 BORDEAUX CEDEX (France)

Phone : 56-529894, Fax : 56-443269

or

Dr. Füller

DFL

Pfaffenwaldring 38-40

D-7000 STUTTGART 80 (FR-Germany)

Phone : 711-6862444, Fax : 711-6862349

Also : JNC 7 (AMAC)

7th Journées Nationales sur les Matériaux Composites

6-8 November 1990, Lyon - France

For information : G3F - Secrétariat JNC 7

8, avenue Albert Einstein

F-69621 VILLEURBANNE CEDEX (France)