EGF Newsletter

Official Newsletter of the European Group on Fracture — Nr. 11, Winter 1989/1990

The European Symposium on Elastic-Plastic Fracture Mechanics:

ELEMENTS OF DEFECT ASSESSMENT

A successful EGF/DVM meeting

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ASFM7 Registration form on page 19

The symposium mentioned in the headline was held on October 9-12, 1989, in Freiburg, F.R.G., and was attended by 190 participants from 26 countries. It was jointly sponsored and organised by the European Group on Fracture (EGF) and by Deutscher Verband für Materialforschung und -prüfung (DVM). The account that follows below was received from the conference chairmen, *J.G. Blauel and K.-H. Schwalbe.*

The aim of this symposium was to review those elements which are needed for assessing crack-like defects in structural components, except test methods, as these have been addressed a number of times by special symposia. In order to achieve an overview on the current state-of-the-art of defect assessment 8 keynote lectures were focussed on the topics:

- Fundamentals of Ductile Fracture, Including Numerics;
- Crack Tip Constraint;
- J and CTOD Analysis;
- Continuum Mechanics and Microstructure: Ductile to Brittle Transition, Statistical Aspects;
- Size and Geometry Effects, Transferability;
- Ductile Fracture Dynamics;
- Component Assessment;
- Assessment of Welds.

Prof. Bilby (left) and Prof. Irwin in action during the Symposium

39 original contributions and 35 posters were presented. The posters were given special attention by reviewers each of whom summarised a group of poster papers in the respective main session.

According to the topics listed above both the aspects of a driving force acting on a crack in a structure and of the material's resistance against crack extension were dealt with.

Finite element calculations were presented for the calculation of driving forces; a number of papers dealt with simplified assessment techniques aiming at the estimation of a driving force parameter rather than predicting it accurately. In this area a crack in a mis-matched weldment represents a particularly interesting problem, which deserves further elaboration.

The ductile material properties - i.e. crack initiation and stable crack growth to final instability - were discussed under several aspects. Hereby the transferability of crack

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European EPFM Symposium
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growth behaviour from specimen to structure is still a problem which among other things requires a sufficiently long valid R-curve. Lively discussions arose on this subject, with particular emphasis on how to describe a crack growth resistance curve: J, J_M or CTOD the most suitable parameter, or should the R-curve be represented in a normalised manner? It became clear that a satisfactory solution to the problem of transferability is only possible with a quantitative description of the constraint conditions near the crack tip and their effects on fracture.

The ductile-to-brittle transition was described both in terms of mechanisms and statistics. The development of a damage model integrating the limiting cases of brittle and ductile fracture still presents a major challenge to research and application in this area.

It was shown that weldments present a twofold complication: the inhomogeneity of microstructure gives rise to strong variations of fracture properties, the mechanical inhomogeneity of deformation properties leads to a variation of the driving force across the weld for different crack geometries.

A number of examples were given, describing how the performance of cracked structural components can be successfully assessed using current fracture mechanics techniques.

No matter which technique - including analyses - is used for defect assessment the treatment of input data needs special attention. This includes the reliability of input quantities, like for example information on applied loads or residual stresses, the statistical treatment of fracture properties or a possible difference between nominal and actual data, like tensile properties, structural dimensions, and so on.

The high quality of the presentations, the skill of the chairmen, the contributions of the audience to the discussion, the willingness of the Symposium Committee to carry out all the preparatory work needed for structuring the Symposium, the social programme, and the local organisation made this European Symposium a remarkable success.

The co-chairmen wish to thank all the individuals involved in these tasks for their personal engagement and enthusiasm, as well as the numerous sponsoring organisations for their valuable support.

We look forward to receiving proceedings with papers of high quality.

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EGF Membership

Balance after one year

One year ago we started with the EGF Personal Membership and with Organizational Membership/Sponsorship. It was difficult for us to foresee how many personal members and organizational members we could expect. In our opinion we need some 300 personal members to have a balanced technical forum that may vote on technical issues in the future. To make EGF's present activities financially possible we calculated that we need about 35 organizational members. It is obvious that several years are needed to reach these numbers. After one year we have registered about 110 personal members and 16 organizational members/sponsors, being over 1/3 and almost 1/2 of the target numbers, respectively.

It is also obvious that the rate of registrations will gradually drop, so that we cannot expect to reach these targets within the coming 2 years. On the other hand, this year it will become very attractive to become a personal EGF member. The reduction in fee for ECF8 in Torino, Italy (1-5 October, 1990) will be equal to the membership fee for two years. In addition EGF members will receive reductions for the fee of the 5th Int. Conference on Numerical Methods in Fracture Mechanics, Freiburg, FRG (23-27 April, 1990) and for that of the International Conference on Fracture Processes in Disordered Materials, Noordwijk, NL (19-21 June, 1991).

With regard to organizational members/sponsors we do not have much time left to reach the target number. We really need to achieve a financial stability to ensure the continuity of our operations.

So when your organization has not yet registered as a Member/Sponsor, please try to convince your superiors that EGF is worthwhile to be supported.

EGF wishes you a happy and productive 1990.

A. Bakker, EGF Secretary

European Group on Fracture

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CALL FOR INTEREST

Standardized Stress-Time Histories for Fatigue Testing

The results of fatigue tests depend on a large number of parameters. It is therefore necessary to make such tests comparable.

This is simple for constant amplitude tests, which are completely defined by two parameters. However, most components and structures in service are loaded by more or less irregular stress-time histories. Unless the corresponding variable amplitude fatigue tests are somehow standardized, the results are not comparable and therefore not generally useful. This is the reasoning behind the development of the standardized stress-time histories already available for aircraft wings, helicopter rotor blades, gas turbine disks, offshore structures, steel mill drive systems, automobile components, wind turbine blades etc. Other "Standards", for example for aircraft landing gears and railroad running stock, are being discussed, further ones, for example for bridges, trucks, earth moving machinery, ships, steel mill cranes etc. are urgently needed.

In order to co-ordinate these activities I propose the formation of a Task Group on "Standardized Stress Time Histories for Fatigue Testing".

As I have been involved in practically all the existing standards, I am willing to act as co-chairman of this Task Group, together with an expert from the LBF, another laboratory with equally long experience in this field.

Individual standards of this type will be treated by Working Parties. Anyone interested in these activities is invited to contact me. One Working Party on off-shore structures is being formed under co-chairmanship of Dr. Pook, NEL, East Kilbridge and Prof. Dover, University College London (see specific announcement below).

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CALL FOR INTEREST

Standard Fatigue Loading Histories for Off-Shore Structures

A European Working Group, now known as the Wave Action Standard History (WASH) Working Group, was formed in 1979. The basic steps needed for the construction of a set of standard 'WASH' fatigue loading histories have been agreed. We propose that the WASH Working Group be reconstituted as a Working Party on Fatigue Loading Histories for Offshore Structures. We plan to hold the first meeting of the Working Party, together with a short seminar, on 14 March 1990 at University College London.

Anyone interested specifically in this Working Party is invited to contact one of us.

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EGF Task Group on

Polymers and Composites

Report on meeting in Le Diablerets, 18-20 October 1989

Received from J.G. Williams

The Task Group met to review its activities for the past six moth period. Three materials had been circulated for use in the multiple specimen 'J' method for initiation J and R curve determination using a recently circulated draft protocol. Only a few groups reported but they highlighted the difficulties in fracture surface, crack length measurement, for some materials. This is partially due to the procedure for breaking open the specimens and also to the problem of identifying the crack growth. It was decided to explore different cooling and breaking procedures and also the use of crack penetrant dyes. A revised protocol will be circulated and all groups are expected to complete their tests on the three materials over the next six months. There was also some discussion of the single specimen method where recent experience has been encouraging. Several groups said they would try this on the same materials as an exploratory exercise. Dr. Hale and Professor Williams will attend the meeting of the ASTM group looking at J testing of plastics which will meet in Orlando on 10 November 1989.

There was a detailed review of the Mode I delamination test for composites for which the protocol now seems quite satisfactory. The main part of the discussion was in preparation for the meeting of Dr. Davies and Professor Williams with ASTM representatives again in Orlando on the 6-7 November '89. ASTM are proposing a draft Mode I standard and have expressed a wish for unity with the European version. There are substantial differences at the moment, particularly with regard to defining initiation and the use of propagation values. It is hoped to persuade ASFM to adopt a rather broader draft at this early stage.

There was also a long discussion of the Mode II tests, both ELS and ENF. There were substantial differences between the various groups and again many problems with initiation. Ther are also some problems with the consistency of the analysis. There is also a draft ASTM standard for this test and this will also be discussed in Orlando. It is proposed to proceed with a further round-robin of tests during the next six months.

The K_c-G_c protocol was reviewed and it was decided to run a new set of tests to provide data in support of the final version. This time it must be done rigorously to the protocol. There was also reported some slow, but sure, progress with CEN and ISO. The same protocol is now being processed through the ASTM adoption procedure.

It was also decided to start some new activities in a preliminary way. Some K_c tests would be run on short fibre composites with a view to adding an appendix for covering such materials. It was also thought useful to try doing K_c measurements at higher speed in instrumented impact machines. A set of tests are planned as a preliminary skirmish. It was also thought worthwhile to do some tests on a mixed-mode test using one arm of the ELS test. The idea is to report on these efforts at the next meeting and then decide on the next steps.

Professor Kausch reported on his appointment as Chairman of the newly formed Task Group on Terminology (We felt rather proud that ours is the first Task Group to have an offspring!) He received our congratulations and assurance of continued support for this work. Professor Kausch said that he felt this was an appropriate moment to step down as co-chairman. All of us thanked him for his efforts over the last five years. Professor Pavan indicated that he was willing to replace Professor Kausch as co-chairman and this was approved by those present. Professor Pavan will act in this role until his appointment is confirmed at the next EGF Council meeting.

Overall it was felt that this was a successful meeting and the next gathering was fixed as 16-18 May 1990, again in Les Diablerets . Any general enquiries should be directed to either Professor Williams or Professor Pavan and for specific topics as follows;

1 **Composite Laminates**
(Including Mixed Mode)
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2 **K_c-G_c Protocol**
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3 **K_c-G_c Tests on Short Fibre Composites**
Professor J.G. Williams, *see page 2.*

4 **Impact K_c Tests**
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5 **'J'-Testing**
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News about the

Round Robin on Local Criteria

received from F. Mudry

For the numerical part, we have received 10 contributions to now. Some other contributions are expected soon.

For the experimental part, the contract with th EEC has just been received. However, the homogeneity tests had already been started. We hope to send the specimens by the end of 1989/early 1990. This is almost one year later than originally scheduled. We had a lot of financial troubles because of the large amount of participants.

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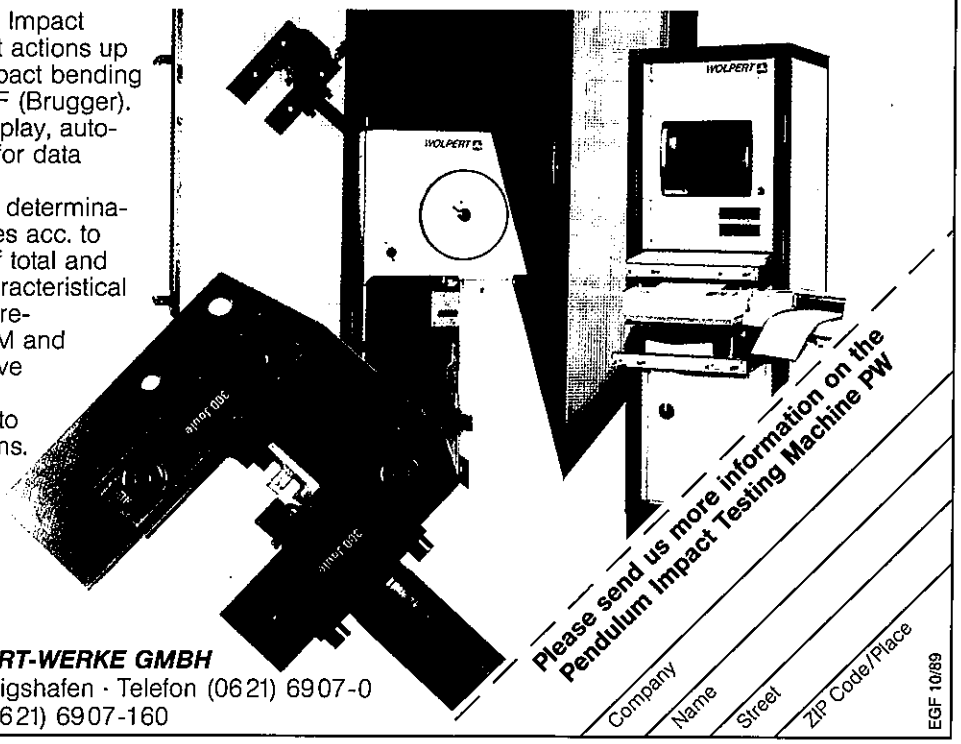

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Task Group on

CERAMIC MATERIALS

Minutes of the First Meeting

The first meeting of the new Task Group "Ceramic Materials" took place in Karlsruhe (FRG) on September 11, 1989.

Prof. D. Munz welcomes 16 participants from 7 countries (A, CH, D, DK, GB, NL, S). According to the agenda the participants gave short introductions on their activities and interests.

After that, there were three presentations:

R.W. Steinbrech (KFA Jülich)

R curve behaviour of long and short cracks in monolithic ceramics.

He concluded (on Al_2O_3 and Mg-PSZ):

1. Different R curves were determined from short natural surface flaws and long cracks in standard fracture mechanics specimens.
2. The short cracks have
   i) lower starting (threshold?) values,
   ii) a steeper slope of the R curve, and
   iii) the point of instability determines the strength of the specimen
3. The long cracks
   i) do not have unique R curves,
   ii) exhibit plateau values which overestimate the toughness of the specimen, and
   iii) are thus not suitable for determination of component related strength and toughness parameters.

He posed the following questions concerning the behaviour of short cracks:

- Is continuum mechanics applicable?
- Do unique R curves exist?
- What are the mechanisms that govern the R-curve behaviour?
- How does environment influence R curves?
- Which dependence on loading situation exists (monotonic/dynamic, cyclic)?

P. Bach (ECN, Petten)

Fracture toughness determination of Zirkonia.

He presented result of K_{Ic} determination for ZrO_2 + 3 % Y_2O_3 according to different methods:

1. Direct Crack Measurement (DCM) - Different equations yield different K_{Ic} values (4 - 6 MPa $\sqrt{m}$)
2. Indentation Strength by Bending (ISB) - rather constant K_{Ic} values (~ 4,5 MPa $\sqrt{m}$)
3. Straight Notch - K_{Ic} depends slightly on a/W and significantly on notch width (6 - 10 MPa $\sqrt{m}$)
4. Single Edge Precracked Beam (SEPB, bridge method) - rather constant K_{Ic} values (~ 4 MPa $\sqrt{m}$)
5. Chevron Notch (CN) - stable crack growth depends on notch width and stored elastic energy (50 mm notch width gives a K_{Ic} = 4,7 MPa $\sqrt{m}$)

He conclude that

i) K_{Ic} depends on test method and test conditions (a/W, notch width)
ii) there is a need for standardisation
iii) this material did not show R curve behaviour.

T. Fett (KFK, Karlsruhe)

Modelling of R-curve behaviour.

He presented the modelling of R curves by weight functions. The formula derived

$$K_R = K_{Ic} + \int_{a_0}^{a} h\left(\frac{x}{a}, \frac{a}{t}\right) \sigma_{br}\left[\left(\frac{x}{a}, \frac{a}{t}, \delta_{appl}\right)\right] dx$$

(h: weight function, σ_{br}: bridging stresses in the crack tip area) shows that the R curve depends:
i) on initial notch depth a_o and

ii) on the loading case (δ_{appl}) and is therefore not a pure material curve.

Finally, the goals and activities of the new Task Group were discussed. Several areas of interest for further discussion and possible co-operation were identified:

1. Measurement of fracture toughness K_{Ic};
2. Effect of small and large defects on crack growth;
3. Lifetime prediction of components (Weibull statistics, volume effect, tension vs. bending);
4. Clarification of fracture processes;
5. Application of testing methods;
6. Significance of material parameters;
7. Exchange of information and discussion among the participants within the Task Group, but also with other groups like the VAMAS Group on Ceramics and the ASTM Research Sub-committee C28.92. D. Munz, who participates in both groups will hold the contact to both of these groups.

Since all participants of the first Task Group Meeting are interested in future activities, the 2nd meeting of the new Task group "Ceramic Materials" was scheduled for Petten, NL, on 13th/14th February, 1990. "Subcritical Crack Growth" including small cracks, high temperatures and cyclic loading was selected main topic of the meeting.

Prospective participants are asked to submit possible contributions preferably related to the main topic to one of the chairmen ***(see addresses listed on page 2).***

Report from Task Group EPFM Working Party on

Ductile Tearing Instability

by I. Milne

A draft of the guide-lines for selection and use of methods for assessment of the integrity of structures and components containing defects has been drawn up by the drafting panel. Before they finalise it, they would like comments from a wider selection of people, especially from users who are less familiar with the methods than the drafting panel. The draft guide-lines have therefore been reproduced in full (excluding Figs) on pages 11-15 of this Newsletter and comments are invited on all aspects, but particularly on the following:

(1) Is the form and scope of the document useful?
(2) Are the methods included useful, and so do you want more (e.g. ASME XI code)? If so, which?
(3) Are the description in Section 4 adequate and appropriately balanced between the methods?
(4) What other information would be valuable (e.g. figures and diagrams)?
(5) Would you like to see a short section linking the different methods together to show their commonality?

Please make your suggestions positive and objective. Where you can see the need for improvement, please provide the text yourself, don't just say that some paragraph or sentence can be improved. Send your comments, by 26 January 1990, to:

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CALL FOR PAPERS
International Conference on

FRACTURE PROCESSES IN BRITTLE DISORDERED MATERIALS (CONCRETE, ROCK, CERAMICS)

Noordwijk (The Netherlands), June 19-21, 1991

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J.G. Rots

Theme

Fracture processes in brittle disordered materials are extensively studied world-wide, and rapid advances are made in the field. The predictive power of fracture models that were developed in the past is however not yet sufficient to warrant a fool proof application of fracture mechanics principles in practice. A salient feature in the fracture of brittle disordered materials is the size effect. Furthermore, different loadings (e.g. fatigue, long term loading, dynamic loading) may have a pronounced influence on the fracture process. The experimental validation of the models is under development, and gradually the geometry dependency of the outcome is better understood.

Localization of deformations seems to be the final stage in a fracture process. Similar phenomena are observed in tensile and compressive fracture. Yet the two fields are separated: tensile fracture is studied in the field of fracture mechanics, compressive fracture is of much interest to continuum mechanics specialists.

Since recently, fracture processes are studied in the physics community as well. Fracture is regarded as a growth process, and the aim of the physicists is to arrive at a universal fracture law for disordered materials.

The aim of this conference is to bring together specialists from fracture mechanics, continuum mechanics, material scientists specialised in rock, concrete and ceramics, and physicists to discuss the salient problems of fracture processes in brittle disordered materials. Progress in either of these fields is rapid, much on the advent of the introduction of numerical techniques. Researchers working in different areas are sometimes not aware of parallel research in other fields. Therefore it is felt that the conference may serve as a discussion forum for researchers from the above mentioned specialisms.

Specific topics:

- Fracture mechanics modelling of failure processes
- Continuum mechanics based approaches
- Damage and Micromechanical modelling
- Structure and non-linear behaviour of heterogeneous materials
- Rate effects, fatigue and sustained loading
- Numerical modelling of failure processes
- Fracture mechanics test-methods for concrete, rock and ceramics (destructive, non-destructive)
- Applications of fracture mechanics

Call for Papers

Abstracts (500 words) on the above topics are invited by July 1st, 1990. Notification of acceptance will be given by October 1st, 1990, at which stage recommendations concerning the format of the papers will be sent to the authors. Completed manuscripts are required January 1st, 1991 in order to ensure production of the Proceedings before the Conference. Abstracts should be sent to the Conference Secretary:

Mrs. R. Komen-Zimmerman
Congress Office ASD
P.O. Box 54
2640 AB Pijnacker
The Netherlands

EGF Guide-Lines for the

Selection and Use of Methods for Assessment of the Integrity of Structures and Components Containing Defects

Draft published by EGF Task Group EPFM, Working Party on:
"DUCTILE TEARING INSTABILITY"
April 1989

Drafting Panel

I. Milne	CEGB, UK	K.N. Akhurst	CEGB, UK
K.H. Schwalbe	GKSS, FRG	A. Cornec	GKSS, FRG
S.J. Garwood	TWI, UK	S. Bhandari	Framatome, France
L. Hodulak	IWM Freiburg, FRG	G. Angelino	CISE, Italy
S. Reale	Firenze, Italy		

1. Background

Within the European Group on Fracture, a Working Party under Task Group 1 has been evaluating the effectiveness of methods of analysis for ductile tearing instabilities against known structural tests. The results of these have been reported elsewhere (Milne 1986, Milne and Knee 1986, Knee and Milne 1985, Knee 1986).

The methods used by the working group participants had not been specified in advance, the choice being left to them. The success of the 'predictions' therefore depended upon the participant making an appropriate choice of method, and using it in the correct way. Since some of the methods are tightly defined and others are loosely defined, this meant that the status of the result could not be judged in advance. While such an uncertainty is not unexpected in a developing discipline but when the discipline is advanced enough to be applied to critical items of industrial plant by practitioners who may not be familiar with the background of the different procedures, it is unacceptable.

It was therefore decided to produce an EGF document giving guide-lines for the selection and use of methods.

2. The Document

The objective is to provide the user with information to guide him to the method or methods appropriate to his problem. The document is not a scientific treatise, not is it a critique. It contains only information to identify the objectives of the methods, the status of each component of the methods, their ease of use the level and amount of information needed, and the controls imposed and advice given to establish the method's objectives. It is emphasised that the document does not contain all known methods of analysis, only those which in the experience of the compilers are in most frequent and general use. Methods which are not contained in this document should not be regarded as being inferior to those included.

3. Methods Included

Screening Methods

- J-T Diagrams
- Battelle Pipe Screening Method
- KWU Screening Method

Methods for calculating J applied, CTOD applied, etc.

- GE - EPRI Scheme
- GKSS - ETM Scheme
- First Order Plastic (FOP)

Comprehensive Methods

- CEGB R6 Method
- BSI Document PD6493 Revision (proposed 1989)

4. Procedures Requirements/Safeguards

4.1 Screening Methods

Although not explicitly defined as such the methods listed under this heading employ a minimum amount of data and analysis and are intended for quick and easy use.

(a) J-T Diagrams (Paris 1982)

These have their origin in the J-integral. Their objective is to define the J applied at which ductile tearing instability will occur. From this the critical loading conditions can be computed.

The method requires the calculation of J and T applied to the structure as a function of applied load, and compares this with the J-T relationship for the material on a J-T diagram. Simplified methods can be used to calculate J and T applied using first order plasticity corrections (see Section 4.2(c) and it is claimed that a linear extrapolation to large scale plasticity is valid. The materials J-T properties have also to be obtained. However for some nuclear pressure vessel steels a correlation has been proposed which permits this step to be by-passed.

The procedures were developed for evaluating for ductile instability in nuclear pressure vessels where the flaw is contained in material with a low ductile tearing resistance (upper shelf). It is claimed to cater for both pressure and thermal loading. No check is imposed to safeguard against failure by plastic collapse. No guidance is given about the accuracy of the result, the use of factors or evaluation of uncertainties. No comment is made about the treatment of a potential brittle fracture event.

(b) Battelle Pipe screening Method (Wilkowski et al. 1987)

This method uses net section stress criteria for evaluating the bending loads permitted on a pipe containing a circumferential crack, with or without pressure.

Knowledge of the material's flow stress and fracture toughness, expressed as J_{IC} is required. Semi-empirical curves are then used to calculate the permitted loading as a function of crack depth, crack length and pipe diameter and thickness.

The empirical basis of the method makes it reasonably accurate for the range of geometries used for its derivation. No guidance is available on the treatment of factors, and the method should be assumed to provide a "best estimate" result. No guidance is given for the treatment of thermal and residual stresses.

(c) KWU Screening Method (Golembewski and Vasoukis 1985)

Intended to be more generally applicable than the Battelle method, this procedure is similarly based upon net section stresses.

Knowledge is required of the tensile properties of the material and the Charpy energy, in joules. Recourse is then made to a diagram on which is plotted a bounding line to about 250 experimental tests. The tests include component and fracture mechanics specimens of a variety of designs made of austenitic and ferritic materials.

Although no guidance is given on the treatment of factors, the method is clearly intended to underestimate defect tolerance and may do so by a very large margin. No information is available on the treatment of stress concentration factors, or thermal or residual stresses.

4.2 Methods for calculating applied parameters

These methods are suitable for calculating the loading applied to the crack tips, in terms of J, CTOD or the K equivalent. They may be used directly, by comparing them with the appropriate materials property parameter, or indirectly in an analysis using J-T diagrams (Section 4.1 (a)). They may also be used to construct failure assessment diagrams independent of those recommended in the procedures in Section 4.3.

(a) GE-EPRI Scheme (Kumar, German and Shih 1981 onwards)
This scheme permits the calculation of the J or CTOD applied as a function of crack depth to a set of standard structures. The method separates the elastic calculation from the plastic one, the elastic calculation using simple elasticity theory and the plastic one, the deformation theory of plasticity. Elastic-plastic interpolation is done using first order plasticity corrections.

In order to make the calculations tractable, a set of tables are given which permit calculation of J or CTOD for any loading regime under both load and displacement control, the latter as a function of gauge length. However, only simplified geometries may be treated, of pipes, pressure vessels and plates, with only 1-dimensional (i.e. extended) cracks. Apart from geometric input data, the materials tensile stress-strain data is needed in the form of a Ramberg-Osgood power law.

No guidance is given on the representation of cracks of limited length by fully extended ones, nor on the means of fitting the Ramberg-Osgood equation to the stress-strain data. In both cases gross inaccuracies may result if these are inappropriate, yet appropriate representations can yield very accurate results. For this reason the method is at its best for analysing 2-dimensional problems, especially specimen geometries. Treatments are also given for thermal stresses, but the lack of solutions for cracks in stress gradients limits the scope of this, and also restricts calculations in regions of stress concentrations, or extensions to geometries not contained within the tables. No guidance is given to safeguard against plastic collapse.

(b) GKSS-ETM Scheme (Schwalbe 1988)
Providing estimates of J and CTOD applied, this method is simpler and more flexible than the GE-EPRI scheme. The basis of this method is K, but correction factors are added to this, in contained yielding a first order plastic zone correction (see Section 4.2 (c)) and in uncontained yielding a plane stress correction based upon a lower law stress-strain curve.

Apart from K, the only input required are the stress strain data for the material. Recommendations are given on how to derive the power law representation. Geometric effects are incorporated via K, and via the plastic yield load, Fy. This has to be evaluated independently.

The method is quick to apply, and can cope with all geometries. It is aimed at providing a best estimate of the applied J or CTOD. The closed form solutions are particularly suitable for parameter studies. No recommendations are given for the treatment of thermal or residual stresses and no guidance is given to safeguard against plastic collapse.

(c) First Order Plastic Zone Size Correction (Originally Irwin 1960)
Initially, this was aimed at providing a small scale yielding correction suitable for application in situations just outside of the LEFM range. It is still used for this, being quick, easy and relatively unambiguous, but is also used as an input to other methods (see Sections 4.1(a), 4.2(a) and (b)).

In its simplest form, only a knowledge of K and the yield stress, s_y is needed, together with a judgement on what factor to use to characterise the plastic zone size. This depends upon the state of strain in the structure. In more sophisticated applications, especially those identified in Sections 4.2(a) and (b), the work hardening index used for the stress-strain power law is also needed.

4.3 Comprehensive Methods

The methods under this heading are intended to provide enough instruction and guidance to produce a complete analysis. They are written in the form of a manual, are as far as possible self-contained, and refer only to related compendia or national standards for additional necessary information.

(a) CEGB R6 Method (Milne et al. 1988)
This method, based upon the J-integral, uses the concept of a failure assessment diagram to define the boundary between the safe and unsafe operating conditions of a structure. The diagram simplifies the

calculational requirements, permits rapid assessment of margins and sensitivity of the results to the input data, and provides an informative pictorial representation of the susceptibility of a structure to failure by brittle or ductile mechanisms, with an automatic safeguard against plastic collapse.

The analysis can be performed at a variety of levels of sophistication, depending upon the detail of the input data available, the mode of cracking (ductile or brittle) and the complexity of the problem. Thus 3 options are given for the failure assessment diagram and 3 categories of analysis may be performed for each option.

The choice of failure assessment diagram is governed primarily by the available tensile data. A complete stress-strain curve is needed for options 2 and 3 failure assessment diagrams, and it need not be smoothed or constrained by a mathematical fit. Where this detail is absent, the yield and ultimate tensile strength are needed for the option 1 failure assessment diagram.

Having defined the failure assessment diagram, the analysis then requires calculation of 2 parameters, K_r and L_r. K_r requires evaluation of the applied LEFM stress intensity factor, K_I and a knowledge of the materials fracture toughness in terms of K, called K_{mat} in R6. Since this governs the choice of analysis category, and its validity may have important implications on the results, detailed guidance is given in the use of K_{mat}. L_r requires the evaluation of the plastic yield load of the cracked structure. This is dependent upon the material's yield stress as well as the crack size of the structure's geometry. Representative solutions for this are given in R6 for common geometries and a comprehensive compendium of solutions for more complex geometries has been published (Miller 1988).

Rather than a best estimate, R6 aims to provide an estimate of the limiting loading or crack size condition below which failure will not occur. To ensure this, a number of safeguards are incorporated and detailed instruction is given where this is needed to ensure consistency. Safety or reserve factors are not incorporated explicitly, being required to be judged by the analyst following a sensitivity analysis, and guidance is given on this. The procedure is set out in a series of steps, and the status of each of these steps is clearly defined in a separate section. A check-list is also provided to help the analyst define the status of his results.

R6 has no limitations on its application being flexible and adaptable. It treats thermal and residual stresses as well as mechanically induced ones, and 2 and 3 dimensional geometries. For displacement controlled problems and problems associated with local geometric discontinuities (e.g. weld profiles) the accuracy of the result depends upon details of the stress analyses. No specific guidance is given for these. Guidance is given for the treatment of shear modes of failure, and sub-critical cracking mechanisms such as fatigue and environmental assisted cracking.

(b) Proposed PD6493 Revision (BSI 1989)

Produced by a committee under the auspices of BSI, this document aims to combine the R6 procedure and the CTOD procedures formalised in the 1980 version of BS PD6493. It permits 3 levels of analysis, intended to be used hierarchically, viz

Level 1: Similar to BS PD6493 (1980) but rewritten in terms of stress rather than strain, with safeguards against plastic collapse.
Level 2: Similar to R6 Rev 2, (Harrison et al. 1982) but permitting only simplified forms of analysis.
Level 3: Similar to R6 Rev 3.

Levels 2 and 3 may be analysed in terms of K (or the J equivalent) or CTOD, while Level 1 may be analysed only in terms of CTOD.

For calculational purposes, CTOD is obtained from K_I using the expressions given in the document. The other main calculational input is the net section stress, as this is used for the plastic collapse calculation. This input is applicable to all levels of analysis, whether CTOD or K based.

The material's property requirements vary with the analysis level and type. In terms of tensile data Levels 1 and 2 require yield and ultimate tensile strengths, and Young's modulus while the full Level 3 requires the full stress strain curve. A Level 3 option does exist however for use when only yield and

ultimate tensile stresses are available. For fracture toughness data CTOD or K (derived from J) data are needed as appropriate and as defined by appropriate standards or guide-line documents. Levels 1 and 2 require only single value estimates of the fracture toughness, while Level 3, if used for a ductile tearing analysis, requires a resistance curve.

The methods are intended to define safe loading regimes rather than best estimates of failure conditions. Controls are incorporated to ensure this. Safety factors are implicit in these controls and more specifically in the Level 1 acceptance criteria. In the Level 2 and 3 analyses, guidance is given on the use of partial safety factors which can be derived from a statistical analyses of the materials toughness data.

Procedures are incorporated for the treatment of thermal and residual stresses, and for analysis under ductile and brittle failure conditions. Extensive guidance is given for the treatment of defects at welded joints, including the joint type, the relative match of the weld and parent yield stress, and typical residual stress profiles. Recommendations are also given for the treatment of non-planar defects, and a large section is included for analysing for crack growth by fatigue.

References

BSI (1980), Guidance on some methods for the derivation of acceptance levels for defects in fusion welded joints, British Standards Institution, PD6493 1980, London, UK.

BSI (1989), Draft Published Document for Guidance on some methods for the derivation of acceptance levels for flaws in fusion welded joints (Revision of PD6493), British Standards Ins., London, UK.

Golembewski H.J. and Vasoukis G. (1985), Nuclear Engineering and Design **87**, pp 67-71.

Harrison R.P, Milne I, Loosemore K. and Dowling A.R. (1982), Assessment of the Integrity of Structures Containing Defects, CEGB Report R/H/R6.

Irwin G.R. (1960), Plastic Zone near a crack and fracture toughness, proc. 7th Sagamore Conf. pp (iv) 63-78.

Knee N. (1987), Report on Phase IV of EGF round-robin exercise on the prediction of ductile instability in the fracture mechanics of welds, EGF publication 2, ed. J.G. Blauel and K.H. Schwalbe, pp 209-223.

Knee N. and Milne I. (1985), Stable crack extension from semi-elliptic defects in the presence of residual welding stresses, in proc. Conf. on Effects of Fabrication Related Stresses, Cambridge 20-25 September, paper 41.

Kumar V., German M.D. and Shih C.F. (1981), Elastic-Plastic Fracture Handbook, EPRI report NP 1931 (plus associated reports to EPRI NP 5596).

Miller A.G. (1988), Review of Limit Loads of Structures containing defects, In. J of Press Vess and Piping **32** (1-4) 197.

Milne I. (1986), An EGF Exercise in predicting ductile instability : Phase 1, Compact Tension Specimen, Fatigue Fract. Engng. Mater. Struct. **9** (4) pp 79-94.

Milne I. Ainsworth R.A. Dowling A.R. and Stewart A.T. (1988), Assessment of the integrity of structures containing defects, Int. J. Press. Vess. and Piping **32** pp 2-104.

Milne I. and Knee N. (1986), An EGF Exercise in predicting ductile instability : Phase 2, cracked pressure vessel, Fatigue Fract. Engng. Mater. Struct. **9** (4) pp 231-257.

Paris P.C. (1982), A Method of application of elastic-plastic fracture mechanics to nuclear vessel analysis, published as App B of NUREG 0744, Vol I, Rev I, USNRC.

Schwalbe K.H. (1988), The Engineering Treatment Model, GKSS tech. note, GKSS WW 88/5.

Wilkowski G.M. et al. (1987), Degrade Piping Programme - phase II progress. Nuclear Engng. and Design **96**, pp 195-217.

EIGHTH EUROPEAN CONFERENCE ON FRACTURE

(IGF) GRUPPO ITALIANO FRATTURA

European Group on Fracture

ECF8

POLITECTICO DI TORINO
Torino Italy 1-5 October 1990

The Theme

The Conference will comprise Invited Plenary Lectures, presentation and discussion of Contributed Papers, as well as Poster Sessions about various themes centred on:

Fracture Behaviour and Design of Materials and Structures

The Venue

The ECF8 Conference will be held in the Politecnico di Torino, one of the two leading Italian Technical Universities. The City of Torino, the ancient Capital of Italy in the core of Piemonte, one of the European industrial heartlands, will welcome the delegates with its magnificent royal architecture and beautiful surroundings. Furthermore, the *Mont Blanc*, the Matterhorn, as well as the *Riviera* are only a *couple of hours away*. Direct flight connections to the Torino Caselle airport from many European airports, as well as bus transportation from the intercontinental Milano Malpensa airport allow for easy travel to ECF8. Frequent Intercity trains to the Torino Porta Nuova main railroad station are also available from many European cities.

Technical Visits

Technical visits in the Torino area are being arranged. Full details in the next circular.

Pre- and Post-Conference Tours

Riviera and Alpine tours are being organized. Please signal your preference.

Social Programme

A full social programme for delegates and accompanying persons will be organized, including a banquet and tours to places of cultural and historical interest. More details and a booking form will be sent together with the next circular.

Exhibition

An exhibition of testing machines and technical publications is being organized. Inquiries to the Conference Secretariat.

Proceedings

EMAS will publish the proceedings with an ad-hoc selected format for camara-ready originals. As an experiment ASCII characters documents c an be submitted on diskette alongside the originals to aim for more uniformity and a more stylish effect. A list of preferred symbols as suggested within EGF will be sent to authors upon acceptance.

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ECF8 *TORINO, ITALY* *1-5 October 1990*

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☐ I WISH TO PARTICIPATE
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Task Group

Elastic-Plastic Fracture Mechanics

18th plenary meeting in Apeldoorn (NL), December 13 and 14, 1989

The 18th plenary meeting of the EPFM-Task Group was hosted by the Metals Institute of TNO in Apeldoorn, The Netherlands. The meeting was scheduled later in the year than usual because of possible interference with the EPFM Symposium at Freiburg in October. Most probably this still caused a lower attendance than usual (16 from 4 countries). However, the program was very interesting and the small number of attendants allowed for lively discussions on very interesting subjects.

After a general introduction to the TNO Metals Institute by its director, B. Dane, the application of fitness for purpose methods for assessing material problems in the Eastern Scheldt Storm Surge Barrier and for the determination of inspection intervals were presented by F.J. ter Avest and H.J.M. van Rongen of the Metals Institute. The Eastern Scheldt Storm Surge Barrier forms the closing part of the huge Delta Works which must protect the parts of The Netherlands that lie below sea level against flooding. These works were a direct result of the last major flooding in February 1953.

The program contained furthermore five interesting lectures on various EPFM subjects and reports of the Working Parties of the Task Group. The reports of the Working Parties on ***R-Curves and Tearing Instability*** and on ***Local Approach*** are printed elsewhere in this Newsletter. The reports of the Working Parties on ***High Temperature Crack Growth*** and ***Fracture Mechanics Testing Standards*** will be presented at ECF8 at Torino (1-5 October, 1990). W. Schmitt, the co-ordinator of the Working party on ***Numerical Round Robins***, gave an overview of the past and present activities. Numerical methods play an important role in almost all disciplines within EGF's scope, not only in EPFM. Because of that it has been decided to form a new Task Group on Numerical Methods. This new Task Group will aim at strong links with the other EGF Task Groups in the form of joint Working Parties and joint meetings. Because of the strong present link with the EPFM Task Group it was suggested to have a joint meeting between the EPFM and Numerical Task Groups every year.

Another example of a strong link between Task Groups is the subject of Local Approach to Fracture, which subject is treated in both the EPFM and Micromechanics Task Groups. It was therefore decided organize the next meeting as a joint meeting between these Task Groups. The local organization will be in the hands of CEGB Berkeley, UK. The dates are May 16-18, 1990. ***Persons interested in attending this joint meeting on "Ductile Fracture: Mechanics & Mechanisms", and who are not on the mailing list of the EPFM Task Group are asked to contact dr. Angelino (address see page 2).***

Possible New EGF Activity on

RESIDUAL STRESS EFFECTS

CALL FOR INTEREST

Many excellent tasks are currently being performed all over the world to establish the influence of residual stress on the service behaviour of components and structures subjected to hydrogen embrittlement, corrosion and fatigue environments. In many cases, when the cause of failure is not known the presence of residual stresses is often considered to be a contributing factor. Certainly when analyzing the moment of failure initiation and progression, including stress relaxation, residual stress effects should be quantified. In both cases the evaluation of residual stresses may be performed either in experiments or in theoretical models.

The european scientific community is invited to voice their opinions and interests in the creation of a scientific group within the European Group on Fracture dealing with the various problems related to residual stresses and their influence on failure of metallic materials.

Persons interested to join this activity should contact the EGF Secretariat (prof. Bakker), address see p.2. In case of sufficient interest we may assist with creating an organizational structure.

European Group on Fracture

ADVANCED SEMINAR ON FRACTURE MECHANICS

ASFM7

Numerical Methods in Fracture Mechanics

Kielce, Poland

28th May – 1st June 1990

After years of intensive development Fracture Mechanics has become a field of science that cannot be ignored in the design of structures in cases when structural failure would entail economic losses or endanger the safety of persons. Moreover, it provides tools to estimate the life-time of structures in service when cracks have been detected by means of non-destructive tests.

Owing to the complex, three-dimensional structure of the analysed objects, the non-linear nature of the physical phenomena and the time-dependent character of the failure processes, in many cases the analytical approach to solve both basic and practical problems is either inadequate or too complex. On the other hand, the rapid development of the computer technology means that almost every engineer these days has unlimited access to fast, high-class computers. Numerical methods have therefore become easily accessible to researchers and engineers wishing to solve complex problems.

Fracture Mechanics, like other fields in science, has its own specific features resulting from the nature of the failure processes. Thus the application of standard numerical methods used in Structural Mechanics to Fracture Mechanics must be supplemented by specific techniques, definitions of notions unknown in other disciplines and finally a proper interpretation of the results obtained. These problems will be the subjects discussed in a series of lectures to be presented by distinguished lecturers during the Seventh Advanced Seminar on Fracture Mechanics (ASFM7) of the European Group on Fracture (EGF).

Programme

- Introductory lectures on basic principles of Fracture Mechanics and the Finite Element Method;
- Numerical techniques to determine basic Fracture Mechanics parameters (K, J, and others);
- Application of stress intensity (K) and J-integral methods;
- Numerical treatment of thermal problems;
- Numerical treatment of creep crack growth;
- Numerical treatment of dynamic crack growth;
- Numerical methods in damage mechanics;
- Workshops and demonstrations.

General Information

Venue

The Seminar will be held in the "Swietokrzyski" Hotel in Cedzyna, 8 km west of Kielce, a city over 900 years old in the central part of Poland (165 km south of Warsaw)

Hotel accommodation

In order to allow discussions during the evening and to facilitate transport, participants will be accommodated in the 1st class "Swietokrzyski" Hotel which has all the facilities necessary to host ASFM7. The hotel is in a beautiful lake-side location in the forest area, with a good bus connection to the city of Kielce.

Fee

The participation fee includes:

- lecture notes;
- accommodation in single or double bedrooms;
- breakfast, lunch and dinner each day;
- coffee and refreshments during the Seminar;
- banquet;
- cocktail party
- special event;
- bus service from/to the airport in Warsaw for those arriving on May 27th and leaving June 2nd.

The total fee is Dfl 1250 (Dutch guilders) for persons choosing accommodation in a double bedroom and Dfl1450 for those who wish to have a single room.

Enrolment

The deadline for acceptance of enrolment is 1st April 1990.

Lecture Notes

A folder of lecture notes will be available to the participants at the beginning of the Seminar.

Certificate of Attendance

On request participants will receive a certificate of attendance at the end of the Seminar.

European Group on Fracture

ADVANCED SEMINAR ON FRACTURE MECHANICS

ASFM7

Numerical Methods in Fracture Mechanics

Kielce, Poland

28th May – 1st June 1990

Lecturing staff

J. Brochard	C.E.A. Dept. Mechanics & Heat Transfer , Saclay, France
W. Brocks	B.A.M., Berlin, Fed. Republic of Germany
Th. Charras	C.E.A. Dept. Mechanics & Heat Transfer , Saclay, France
R. Kienzler	Fraunhofer Inst. f. Werkstoffmechanik, Freiburg, Fed. Rep. of Germany
H. Kordisch	Fraunhofer Inst. f. Werkstoffmechanik, Freiburg, Fed. Rep. of Germany
M. Kuna	GDR Academy of Science, Halle, German Democratic Republic
A.R. Luxmoore	University College of Swansea, United Kingdom
H. Maschke	GDR Academy of Science, Halle, German Democratic Republic
Z. Mroz	Inst. of Fundamental Technological Research, Warsaw, Poland
F. Nilsson	Royal Institute of Technology, Stockholm, Sweden
D.R.J. Owen	University College of Swansea, United Kingdom
R. Roche	France
W. Schmitt	Fraunhofer Inst. f. Werkstoffmechanik, Freiburg, Fed. Rep. of Germany

Seminar Co-ordinators

L. Golaski and A. Neimitz, KIELCE UNIVERSITY OF TECHNOLOGY

Advisory Board

The European Group on Fracture has collaborated in the organization of this Seminar. It has nominated the following Advisory Board which has been instrumental in drafting and optimizing the programme:

A. Bakker	Delft University of Technology, Delft, The Netherlands (EGF Secretary)
Ph. Jamet	C.E.A. Dept. Mechanics & Heat Transfer , Saclay, France
M. Kuna	GDR Academy of Science, Halle, German Democratic Republic
A.R. Luxmoore	University College of Swansea, United Kingdom
W. Schmitt	Fraunhofer Inst. f. Werkstoffmechanik, Freiburg, Fed. Rep. of Germany

Bus service

Participants traveling by air or by train are advised to arrive in Warsaw on the afternoon of 27th May 1990. They can then use a special bus which leaves from Warsaw in front of the Air Terminal for the "Swietokrzyski" Hotel, Kielce. Details of the departure time from Warsaw will be announced later, along with information for those arriving on another day.

ASFM7 REGISTRATION FORM

Surname _____
Name _____
Profession _____
Title _____
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Correspondence should be mailed to:
☐ my home address
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I apply for attendance of the
7th Advanced Seminar on Fracture Mechanics (ASFM7)
"Numerical Methods in Fracture Mechanics"
28 May – 1 June 1990, Kielce, Poland.
I will pay ☐ Dfl 1250,– (includes accomodation in a double bedroom)
☐ Dfl 1450,– (includes accomodation in a single bedroom)
after confirmation that I have been registered for the Seminar.
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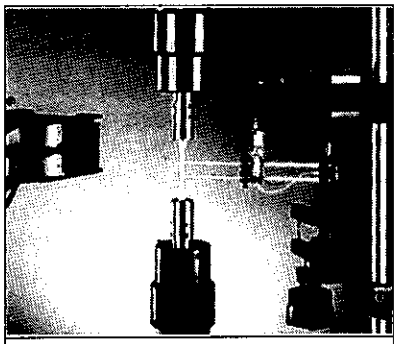
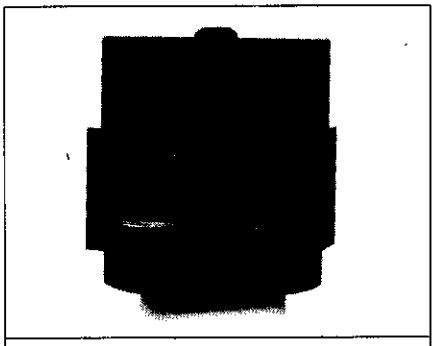
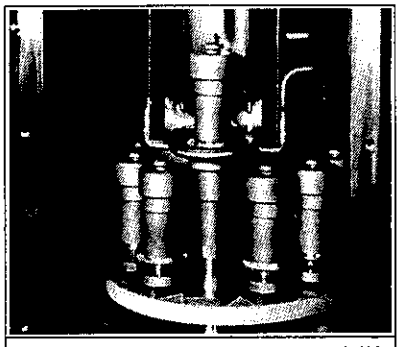
Total package capability for advanced ceramics testing



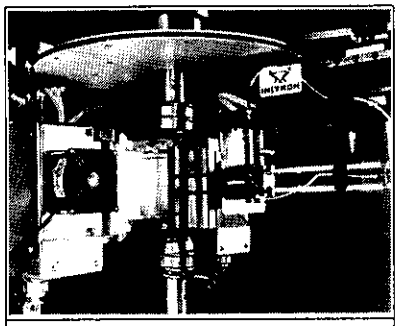
'Supergrip' tensile grips



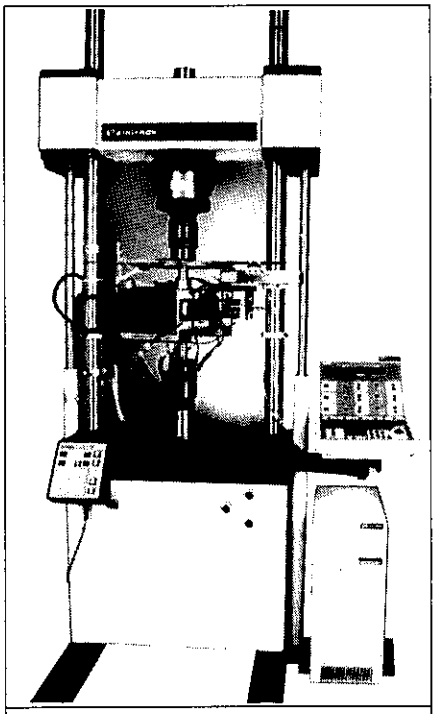
1500°C flexure testing



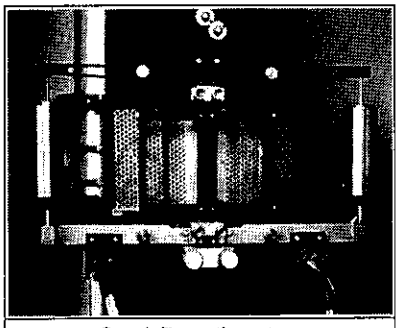
Automated 12-station multiple bend testing at 1650°C



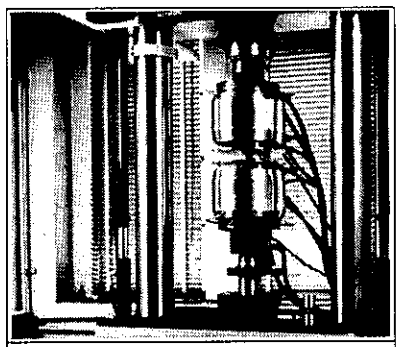
1600°C Short furnace and extensometry



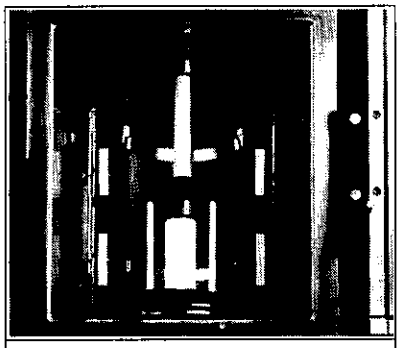
Digital tensile testing system for ceramic composites



Ceramic fibre-testing system



Tension/torsion testing of ceramic tubes



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Digitally-controlled 8500 and 4500 Series load frames offer the ideal blend of control fidelity and accuracy demanded of modern ceramics testing.

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Instron two-zone furnaces and low contact-force extensometry offer high temperature tensile and reverse stress testing up to 1600°C. Or we can incorporate cryostats for tests on superconductors.

And our 3- and 4-point bend systems provide the ultimate in bending test performance.

The choice is as diverse as it is impressive. Thankfully, we offer more than just hardware.

With over 40 years' experience in materials testing we can offer a good deal of guidance too, and Instron ceramics testing systems are being used in over 150 of the world's foremost centres of research. Contact us today, and see what Instron ceramics testing systems could do for you.

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Instron Limited, Coronation Road,
High Wycombe, Bucks HP12 3SY.
Tel: (0494) 464646 Fax: (0494) 456123.
Telex: 83222

The best test for any idea

AGENDA of Fatigue and Fracture Events

Agenda items are placed free of charge. Inform the editor about any fatigue and/or fracture related meeting of interest for the readers of this Newsletter.

February 13-14, 1989
2nd Meeting of the EGF Task Group on Ceramic Materials
Location : Petten, The Netherlands
Main topics: Subcritical crack growth, incl. small cracks, high temperatures and cyclic loading
Inquiries : Prof. D. Munz
Inst. für Zuverlässigkeit und Schadeskunde im Maschinenbau der Universität Karlsruhe
Postfach 3640, 7500 Karlsruhe 1, FRG

March 20-22, 1990
Engineering Integrity Through Testing – EIS '90
Location : Birmingham, UK
Organizer : Eng. Integrity Society et al.
Deadlines : Feb 15, 1989 - Abstracts (200 words)
July 31, 1989 - Final manuscripts
Inquiries : Dr. H. G. Morgan, UKAEA
Northern Res. Laboratories - Springfields
Salwick, Preston PR4 0RR, UK
Tel. 0772-728262 extn. 31670

March 20-22, 1990
Int. Symposium on Structural Integrity of Aging Airplanes
Location : Atlanta, Georgia, USA
Organizer : Comp. Mechanics Center, Atlanta USA
Transp. Systems Center, Cambridge Mass, USA
Sponsor : USA Fed. Aviation Administration
Deadlines : Jan. 15, 1990 - pre-registration (preferably)
Inquiries : Prof. S.N. Atluri
Computational Mechanics Center
Georgia Institute of Tec hnology
Atlanta, Georgia 30 332-0356, USA
Tel. (404)894-2758 Fax (404)894-2299

March 21-23, 1990
ESA Symposium on Space Applications of Advanced Structural Materials
Location : ESTEC, Noordwijk, The Netherlands
Organizer : European Space Agency (ESA)
Deadlines : Abstracts - Sep. 18, 1989
Language : English and French (working language English)
Inquiries : D.C.G. Eaton
ESA/ESTEC (YME)
2200 AG Noordwijk, The Netherlands
Telex 39135-39098, Fax (31)1719-17400

March 22-23, 1990
7th Meeting of the Spanish Group on Fracture
Location : Sigüenza (guadalajara), Spain
Organizer : Univ. Politéctinca de Madrid
Deadline : Feb. 1, 1990 - Full manuscript
Language : Spanish, others ask prof. Elices
Inquiries : Prof. M. Elices
Departamento de Cienciade Materiales
E.T.S. Ingenieros de Caminos
Ciudad Universitaria s/n
28040 Madrid, Spain

April 1-6, 1990
Fourth International Conference on Creep and Fracture of Engineering Materials and Structures
Location : Swansea, UK
Organizer : University College, Swansea, UK
Deadlines : May 1, 1989 - Abstacts (200 words)
Nov. 1, 1989 - Full manuscripts
Inquiries : Prof. B. Wilshire
Department of Materials Engineering
University College
Singleton Park
Swansea, SA2 8PP, UK
Tel. (0792) 295243, Telex 48358

April 3, 1990
14. Sitzung der SVMT-Fachgruppe Bruchmechanik und Ermüdung. Themes: Numerical Methods in Fracture Mechanics; Composite Materials and Metals
Location : Alusuisse S.A., Neuhausen am Rheinfall
Organizer : SVMT
Language : German and French, others ask Dr. Prodan
Deadlines : March 1, 1990 - announcements of contributions and registration
Inquiries : Dr. M. Prodan
Gebr. Sulzer AG, Abt. 1502
8401 Winterthur, Switzerland

April 18-20, 1990
Int. Conference on Mechanics of Jointed and Faulted Rocks
Location : TU Vienna, Vienna, Austria
Organizer : Institute of Mechanics, TU Vienna, Austria
Deadlines : July 30, 1989 - Abstracts (300 words)
Jan. 31, 1990 - Full papers
Inquiries : Doz.Dr. H.P. Rossmanith
Institute of Mechanics, Technical Univ.Vienna
Wiedner Hauptstraße 8-10/325
A-1040 Vienna, Austria
Tel. (0222) 58801-5514,5519
Ttx (61) 3222467 = TUW

April 23-27, 1990
Fifth International Conference on NUMERICAL METHODS in FRACTURE MECHANICS
Location : Freiburg, FRG
Organizer : IWM Freiburg, FRG
Sponsor : EGF
Deadlines : Sep. 1, 1989 - Abstracts (500 words)
Jan. 31, 1990 - Full papers
Inquiries : W. Schmitt
Fraunhofer Inst. für Werkstoffmechanik
Wöhlerstraße 11
D-7800 Freiburg, FRG
Tel. (0761)5142-104,Fax (0761)5142-147

April 23, 1990
Symposium on Rapid Load Fracture Testing
Location : San Francisco CA, USA
Sponsor : ASTM Committee E-24
Deadlines : Abstrac ts (300-500 w) - Sep 15, 1989
Inquiries : W.R. Corwin, Symp. Co-chairman
Oak Ridge Nat. Laboratory
PO Box 2009
Oak Ridge, TN 37831-8056, Tel. 615/574-4648

AGENDA cont'd

April 1990 (one day in week April 22-27)
1st Symp. on Advances in Fatigue Life Predictive Techniques
Location : San Francisco CA, USA
Sponsor : ASTM Committee E-9
Deadlines : June 15, 1989 - Abstracts (300-500 w.)
Feb. 15, 1989 - Final Manuscripts
Inquiries : Dr. M.R. Mitchel, Symposium Chairman
Rockwell International Science Center
1049 Camino dos Rios
Thousand Oaks, CA 91360, Tel. 805/373-4450

May 23-25, 1990
MiCon 90 - Advances in Video Technology: Materials Science Applications
Location : San Francisco CA, USA
Sponsor : ASTM, Committee E-4
Deadline : Abstracts (300-500 w.) - June 15, 1989
Final manuscripts - Dec. 1, 1989
Inquiries : George F, Vander Voort, Symp. Chairman
R&D Center, Carpenter Technology Corp.
PO Box 14662, Reading PA 19612, USA
Tel. 215/371-2766

June 15-20, 1990
2nd Int. Conference on Aluminum Alloys (ICAA2)
Location : Beijing, China
Organizer : Beijing Univ. of Aeronautics&Astronautics
Deadlines : June 30,1989 - Abstracts (250 words)
Dec. 31, 1989 - Full papers
Inquiries : Prof. C.Q. Chen – Co-chairman ICAA2
Dept. of Materials Science & Engineering
Beijing Univ. of Aeronautics&Astronautics
Beijing 100083, Peoples Republic of China

June 25-27, 1990
Int. Conference on Surface Engineering: Current Trends and Future Prospects
Location : Toronto, Canada
Organizer : Univ. of Toronto, Canada
Deadlines : Abstracts (300w) - July 14, 1989
Full papers - Feb. 2, 1990
Inquiries : Prof. Shaker A. Meguid
Univ. of Toronto, Dept. Mech. Engineering
5 King's College Road
Toronto, Ontario M5S 1A4, Canada
Tel. (416) 978-5741, Telex 06218915 ut eng tor
Fax (416) 978-7753

June 26-28, 1990
1st International Conference on Computer Aided Assessment and Control of Localized Damage
Location : University of Southampton
Organizer : Wessex Inst.of Technology, Southampton UK
Sponsors : ISCME, EGF
Deadlines : Abstracts (300 w.) - Oct. 9, 1989
Full papers - March 1, 1990
Inquiries : Julia Futers, Conference Secretary
Computaional Mechanics Institute
Ashurst Lodge, Ashurst
Southampton, s04 2AA, UK
Tel. (042129) 3223, Fax (042129) 2853
Telex 47388 Attn. COMPMECH

June 26-28, 1990
22nd National Symposium on Fracture Mechanics
Location : Atlanta, Georgia, USA
Sponsor : ASTM, Committee E-24
Deadlines : Sep. 15, 1989 - Abstracts (300-500 w.)
May 1, 1990 - Final manuscripts
Inquiries : Prof. Hugo A. Ernst, Symposium Chairman
G.W. Woodruff School of Mech.Engineering
Georgia Institute of Technology
Atlanta GA 30332-0405
Tel. 404/894-3074

July 15-20, 1990
Fourth International Conference on Fatigue and Fatigue Thresholds (Fatigue 90)
Location : Honolulu, Hawaii
Organizer : Soc. of Material Science, Japan
Deadlines : June 15, 1989 - Abstracts (500 words)
Dec. 15, 1989 - Full papers
Inquiries : Secretary of Fatigue 90
The Society of Material Science, Japan
1-101, Yoshida Izumidono-cho, Sakyo-ku
Kyoto 606, Japan
Tel. Kyoto (075) 761-5321
Fax (075) 761-5325

August 20-24, 1990
COMP '90 - Advanced Composites in Emerging Technologies
Location : Patras, Greece
Organizer : Univ. of Patras, Greece et al.
Deadlines : Dec. 1, 1989 - Abstracts (500 words)
May 1, 1990 - full papers
Inquiries : COMP'90 Symposium
Attn. Prof. S.A. Paipetis
P.O.Box 1134
261 10 Patras, Greec e

September 18-21, 1990
VGB Congress "POWER PLANTS 1990"
Location : Essen, FRG
Organizer : VGB, Essen, FRG
Deadlines : Jan. 31, 1990 - Abstracts (200 words)
Language : English/German (simult. transl. available)
Inquiries : VGB Technische Vereinigung
Großkraftwerkbetrieber e.V.
z.H. Herrn Dr. Mohrbach
Postfach 10 39 32
4300 Essen 1, FRG
Tel. 0201/8128-311 Fax 0201/8128-286
Telex 857 507

October 1-5, 1990
Eigth European Conference on Fracture (ECF8)
Location : Torino, Italy
Organizer : Italian Group on Fracture, EGF
Deadlines : Sep 15, 1989 - Abstracts (300 words)
Dec 15, 1989 - Acceptance notice
March 15, 1989 - Final manuscripts
Inquiries : IGF c/o prof. D. Firrao
Politectico di Torino
Dip.di Scienza dei Materiali e Ingegneria Chimica
C.so Duca degli Abruzzi 24
10129 Torino, Italy
Tel.(39)11-556.7777/6763, Telex 220646
Fax (39)11-556.6799/7990

AGENDA cont'd

October 15-17, 1990
Pipeline Technology
Location : Ostend, Belgium
Organizer : Royal Flemish Society of Engineers
Laboratory Soete of Gent University
Deadlines : Feb. 1, 1990 - Abstracts (200 words)
June 30, 1990 - Final texts
Inquiries : Rudi Denys
Lab. Soete, Rijksuniversiteit Gent
St. Pietersnieuwstraat 41
9000 Gent, Belgium
Fax (32) 91-237326

October 22-24, 1990
WELDING-90 - Technology, Material, Fracture
Location : Geesthacht, FRG
Organizer : Inst. for Ind. Technology Transfer
Deadlines : Dec. 15, 1989 - Abstracts (300-400 words)
Jul. 1, 1990 - Full manuscripts
Inquiries : Dr. M. Koçak
GKSS-Research Centre
Institute of Materials Research
2054 Geesthacht, FRG
Tel. (49)4152/87-2611
Fax (49)4152/87-1618

November 12, 1990
Symp. on Cyclic Deformation, Fracture and Nondestructive Evaluation of Advanced Materials
Location : San Antonio, Texas, USA
Sponsors : ASTM Committees E-9, D-30, E-24
Deadlines : Dec 15, 1989 - Abstracts (300-500 words)
Sep 15, 1990 - Full manuscripts
Inquiries : Dr. M.R. Mitchell, Symposium Chairman
Rockwell Int. Science Center
1049 Camino Dos Rios
Thousand Oaks, CA 91360, USA
Tel. 805/373-4450

November 13-14, 1990
Damage Detection and Quality Assurance in Composites
Location : San Antonio, Texas, USA
Sponsors : ASTM Committees D-30, E-9, E-24 and E-7
Deadlines : Feb 15, 1990 - Abstracts (300-500 words)
Sep 15, 1990 - Full manuscripts
Inquiries : John E. Masters, Symposium Chairman
American Cynamid Co.
1937 West Main Street
Stamford, CT 06904, USA

December 6-8, 1990
Sixth Int. Conf. on Biomedical Engineering
Location : Singapore
Organizer : Nat. University of Singapore
Deadlines : will follow this preliminary announcement
Inquiries : Secretary 6th Biomed Conference 1990
Dept. of Orthopaedic Surgery
National University Hospital
Lower Kent Ridge Road
Singapore 0511

February 4-7, 1991
Probabilistic Safety Assessment and Management (PSAM)
Location : Beverly Hills, CA, USA
Sponsor : Society for Risk Analysis
Deadlines : Apr. 6, 1990 - Abstracts (800-1200 words)
Aug. 15, 1990 - Full papers
Inquiries : Prof. G. Apostolakis
Mech., Aerospace & Nuclear Engng. Dept.
University of California
405 Hilgard Avenue
Los Angeles, CA 90024-1597 USA
Tel. (213)825-1300, fax (213)825-0761
Telex 3716012 UCLA LSA

April 21-25, 1991
Int. Conference on Computational Engineering Science - ICES '91
Location : Patras, Greece
Deadlines : May 1, 1990 - Abstracts (250 words)
Nov. 1, 1990 - Full papers
Inquiries : ICES '91 Secretariat
c/o Prof. S.N. Atluri
Computational Mechanics Center
Georgia Institute of Tec hnology
Atlanta, Georgia 30 332-0356, USA

June 19-21, 1991
Fracture Processes in Brittle Disordered Materials (Concrete, Rock, Ceramics)
Location : Noordwijk, The Netherlands
Sponsors : RILEM, EGF, Delft Univ., TNO Building Res.
Deadlines : July 1, 1990 - Abstracts (500 words)
Jan. 1, 1991 - Full manuscripts
Inquiries : Mrs. R. Komen-Zimmerman
Congress Office ASD
P.O. Box 54
2640 AB Pijnacker, The Netherlands
Tel. (31)1736-5356 Fax (31)1736-2242

July 24-26, 1991
ICRS-3, International Conference on Residual Stress
Location : Tokushima, Japan
Organizer : Soc. of Materials Science, Japan, and
Foundation for Advancement of Int. Science
Deadlines : Abstrac ts (1 page) - July 31, 1990
Full papers - June 30, 1991
Inquiries : The Society of Materials Science, Japan
Attn. Prof. K. Tanaka, Secr. General ICRS-3
Yoshida-Izumidono-cho 1-101, Sakyo-ku
606 Kyoto, Japan
Fax 075-761-5325

July 29-August 2, 1991
Sixth International Conference on Mechanical Behaviour of Materials – ICM-6
Location : Kyoto, Japan
Organizer : Society of Materials Science, Japan
Deadlines : June 1, 1990 - Abstracts (500 words)
Jan. 1, 1991 - Full papers
Inquiries : Prof. T. Inoue, Secretary General ICM-6
The Society of Materials Science, Japan
Yoshida-Izumidono-cho 1-101, Sakyo-ku
606 Kyoto, Japan
Fax 075-761-5325

Fifth International Conference on

Numerical Methods in Fracture Mechanics

Freiburg (FRG), 23-27 April 1990

The conference programme is being printed and will be mailed in January 1990. It includes more than 70 original contributions. The sessions will be divided into the following subjects:

FUNDAMENTALS ON NUMERICAL METHODS AND DAMAGE MECHANICS
APPLICATIONS ON FATIGUE, DYNAMICS, CREEP AND VISCO-PLASTICITY, LAMINATES AND CERAMICS; EPFM AND SPECIAL TOPICS ON VALIDATION, ETC....,

Including keynotes from:

S.N. ATLURI	(GIT, USA)
D. PARKS	(MIT, USA)
A. NEEDLEMAN	(BU, USA)
M. KANNINEN	(SWRI, USA)
H. RIEDEL	(FhIWM, FRG)
A. BAKKER	(TU DELFT, NL)
G. YAGAWA	(TU TOKYO, Japan)
T.K. HELLEN	(CEGB Berkeley, UK)

Accomodation

Hotel reservations can be made through the tourist office of the city of Freiburg using the form in the announcement sheet (sent to you on your request). Booking should be made before 15 March 1990.

Registration

The registration fee will include Proceedings, Refreshments and Conference dinner.
Registration by sending a cheque to: **W. Schmitt**
Fraunhofer Institut für Werkstoffmechanik (FhIWM)
Wöhlerstraße 11, D-7800 Freiburg, FRG
Tel. 0761-5142 104, Telefax 0761-5142 110

Registration fees:

before Feb. 1, 1990 DM 525,-
after Feb. 1, 1990 DM 575,-

We offer a reduction of DM 25,- to these fees to *personal members of EGF* (please indicate your membership number!!)

European Group on Fracture

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☐ **Please register me as personal EGF member.**
The Dfl. 45,- (fourty-five Dutch guilders) subscription fee for 1990 is payed by:
- **transfer to the EGF bank account, number 10.42.10.753 at the RABO Bank, Barendrecht, The Netherlands;**
- **enclosed Eurocheque in Dutch guilders (please do not forget your card number).**

Surname: **Initials:** **Title(s):**
Address :

Please return this form to : EGF Office, attn. prof. A. Bakker
c/o Laboratory for Materials Science and Engineering
P.O. Box 5025
2600 GA DELFT, The Netherlands

Organizations that wish to register 5 or more members as EGF member, with a 20 % reduction on membership fee, should write to the EGF Office at the above address.