EDITORIAL BY THE ESIS PRESIDENT

The next meeting of the ESIS Executive Committee (ExCo) will take place on March 6, 2015 in Rome. Recall that the Committee consists of myself as President, Francesco Iacoviello and Aleksandar Sedmak, the two Vice Presidents, Bamber Blackman, Secretary, Giuseppe Ferro, Treasurer, Valery Shlyannikov, Publications Manager, Zhiliang Zhang, Liaison to other organizations, and Per Ståhle, Blogger.

At this meeting, we will consider having Elsevier’s Procedia as the platform for future ECF meetings, as well as National and Technical
Committee meetings. A poll of the committee chairs has indicated some interest. We will also consider video recording TC meetings to be put on U-tube. I would be happy to hear opinions on these subjects from our membership.

Special issues resulting from ECF and TC meetings from 2013 until 2015 are listed below:

We can see from these many volumes the excellent activity of our members. I would like to thank them, as well as all of the authors, for their important contribution to ESIS and our knowledge of structural integrity.


Finally, I would like to remind you that ECF21 will take place in Catania, Sicily, June 20 to June 24, 2016. The co-chairs are Francesco Iacoviello, Giuseppe Ferro, Donato Firrao and Luca Susmel. And for those who want to really plan ahead, ECF22 will take place in Belgrade, Serbia, in the summer of 2018, chaired by Aleksandar Sedmak.

Leslie Banks-Sills

WELCOME

This issue of the Newsletter has traditional content.

We thoroughly inform our readers about the activities of National and Technical Committees.

It is gratifying to note the increased activity of these committees in 2014.

You’ll also find information on upcoming international conferences and special issues of journals associated with ESIS.

A great number of international conferences the subject of which are the problems of Structural Integrity reflects the continuing interest of scientists and specialists to various aspects of investigations and researches in this interdisciplinary field of knowledge.

It is a tradition that ESIS awardees are invited to present a scientific paper. Professor Gordon Williams was awarded the Griffith Medal at ECF 20 in Trondheim, Norway. You will find his paper in the present Newsletter.

Special Issues devoted to ECF19 have been published:

Valery Shlyannikov
**ESIS COUNCIL MEETING**

**Trondheim, Norway**

**2nd July 2014, 18:00**

**MINUTES**

**Attendees:** The meeting was attended by 41 representatives. A full list is given at the end of the minutes.

1. **Welcome, Leslie Banks-Sills**
   a. The president, Leslie Banks-Sills (LBS), chaired the meeting and thanked all the council members for coming, and the ECF organisers for providing the meeting room.
   b. The voting members of Council were established by the secretary, (based on unique memberships for 2013/2014). Proxy representation had been identified earlier by communication with the secretary.
      i. Austria: R. Pippan
      ii. Bulgaria: D. Angelova
      iii. Czech Republic: J. Pokluda
      iv. France: J. Besson
      v. Germany: D. Klingbeil
      vi. Italy: F. Iacoviello
      vii. Israel: D. Sherman
      viii. Norway: Z. Zhang
      ix. Poland: A. Niemitz
      x. Portugal: P. Moirera
      xi. Russia: R. Goldstein
      xii. Serbia: A. Sedmak
      xiii. Slovenia: N. Gubeljak
      xiv. Spain: A. Martin-Meizoso
      xv. Sweden: S. Melin (for J. Larsson)
      xvi. Switzerland: A. Brunner
      xvii. Ukraine: H. Nykyforchin (for V. Panasyuk)
      xviii. United Kingdom: G. Williams
      xix. TC1: U. Zerbst
      xx. TC2: J. Pokluda
      xxi. TC3: A. Spagnoli (for A. Carpinieri)
      xxii. TC4: G. Williams
      xxiii. TC5: Y. Petrov
      xxiv. TC8: H. Yuan
      xxv. TC9: G. Ferro
      xxvi. TC10: J. Toribio
      xxvii. TC11: U. Zerbst (for H. Klingelhöffer)
      xxviii. TC24: M Carboni (for S. Beretta)
      xxix. Vice-President: J. Pokluda
      xxx. Vice-President: S. Beretta
      xxxi. Secretary: J. Marrow

2. **Minutes of last meeting:** L. Banks-Sills
   a. The minutes of the last council meeting (Kazan, ECF19) were available on the ESIS website. They were accepted as correct.

3. **President’s Report: L. Banks-Sills**
   a. The president thanked the ECF20 organisers and congratulated them on the conference, which was attended by 536 participants from 40 countries.
   b. She reported that four ESIS fellows had been elected at ECF20; Bamber Blackman, James Marrow, Jesús Toribio and Huang Yuan.
   c. The ECF20 awards committee was Deitmar Klingbeil, Francesco Iacoviello, Andrzej Neimitz, Aleksander Sedmak, Antonio Martin-Meizoso, Hrihory Nykyforchin, Otmar Kolednik, Vlad Ulmanu and Andreas Brunner. The Griffith medal had been awarded to Gordon Williams, and the Wöhler medal to Reinhard Pippan. The award of merit had been presented to Wolfgang Dietzel; John Hutchinson had been elected an Honorary Member of ESIS. These awards would be presented at the ECF20 Conference dinner.
   d. ESIS had provided the registration fees for 20 scientists to support their participation in ECF20, following a selection process. Four scientists from Ukraine had also been given support, due to problems caused by the political unrest there.
   e. The ESIS affiliated journals (Engineering Failure Analysis, Engineering Fracture Mechanics, International Journal of Fatigue) had published a number of special issues, as part of the ESIS/Elsevier contract.
      i. The issues for 2013 were:
• Micromechanisms of Deformation and Fracture (Eds. J. Pokluda, T.J. Marrow): EFM 110, Sept. 2013


ii. There also 3 special issues so far in 2014
• Multiaxial Fracture 2013 (Eds. A. Fatemi, L. Pook, A. Spagnoli, S-T Tu): EFM 123 (June 2014)

iii. Four special issues were published in 2011 and two in 2012.

f. The chair of TC1 commented that TC1 had attempted to produce a special issue about 18 months ago, but had experienced problems and had not progressed further. The president said there had been a workflow problem between the journal editors and the guest editors. She had discussed this with Elsevier. The editorial website had since been changed. She recommended TC chairs to contact the ESIS president if problems were experienced. She thanked all the guest editors for their support.

g. The Young Scientist Award had been reinstated by the ExCo with support of Elsevier. The prizes would be given at the ECF20 conference dinner.

h. All ECF proceedings have been digitised and are on the ESIS website.

i. The president reported on the recent e-vote on the proposed statute change to alter the voting procedures of the ESIS Council to one vote per member. There were 17 votes for, 6 against and 4 abstentions. The necessary 2/3 majority was not reached so the statute change was not passed. The ExCo would discuss this further in preparation for a debate and vote at ECF21 in Catania, Italy. The straw-vote on associate-member status for non-European countries had been in favour and would also be considered for ECF21

j. The president also thanked the ExCo and ECF chairs for their continued efforts.

4. Report on ECF20, Z. Zhang

a. The ECF20 chair reported that the meeting had received 702 abstracts and was attended by 600 participants from 43 nations. There were 536 presentations, including 13 plenary lectures, 2 medal lectures, 40 keynote lectures and 10 parallel sessions. A total of 365 papers had been published as Open Access on Procedia a few days before the meeting.

b. The summer school had been attended by 60 participants from 20 countries, with excellent responses from the participants to the lectures. A special session on "how to teach fracture mechanics" had been included. An e-poster session had been included for first time and the organisers would be evaluating its success; 5 minutes presentation from each speaker with no questions.

5. Report on ECF21, F. Iacoviello

a. The ECF21 chair reported that the ECF21 website was open (www.ecf21.eu). A Facebook page had also been created and a Twitter account, which might be used during the event for changes and announcements. The IGF had successfully organized an event at same location (FRAMCOS) to test the venue, and will be holding a meeting in Sept 2014 in collaboration with Spain and Portugal.

b. The proceeding will be published in "Frattura ed Integrita Strutturale", and will be available to read online during the meeting, for instance accessed using QR codes posted outside the sessions.

c. The conference fee will €550 (early bird). This will not include lunch, as there is a wide range of facilities available and this will allow flexibility for participants. There will be a summer school (18-19 June 2016) with a fees of €250 (early bird).

d. The social events will include the Greek theatre in Siracusa and some other surprises.

6. Treasury Report, G. Ferro

a. The ESIS deposit continues to rise and was currently just less than €220000. There was a need to reduce this.

b. The president commented that the ExCo had supported ECF20 (including attendance of Young Scientists, scientists from Ukraine due to current circumstances and also the summer school). DK urgently need some
7. Budget, L. Banks-Sills
   a. The president presented a 2 year budget, with income from special issues, ECF20 and membership fees, balanced by expenditure to support the meetings of the TC’s, ExCo and its working groups, the ESIS website, support for scientists at ESIS meetings and a contingency budget for actions such as the recent support of Ukranian scientists.

8. Elsevier special issues and Publications, W. Brocks
   a. In addition to the special issues reported by the president, the publications manager noted that there were still 5 special issues planned from ECF19 that are under preparation. He said that it was important that the publications manager was informed about the progress on special issues by the guest editors.

   a. The secretary reported that ESIS had 546 members in 2013, with similar numbers for 2014. Credentials for access to the ESIS website can be obtained from the secretary or Francesco Iacoviello.
   b. The president asked the TC chairs to encourage people to join ESIS.

10. ESIS Awards: L. Banks-Sills
    a. The president reported that the awards committee for ECF21 will be nominated by the ESIS ExCo, following ECF20, and Council will be informed.
    b. The chair of the ECF21 awards committee is Francesco Iacoviello. The chair of the Fellows’ Committee is the ESIS President.
    c. The council was reminded that recommendations and nominations for ESIS Fellows awards for ECF21 were needed by the deadline of Dec 20th 2015.

11. ECF22: A Sedmak
    a. The proposed date for ECF22 is 26-31 August 2018 in Belgrade, with the title “Loading and Environmental Effects on Structural Integrity”. The conference will be supported by Minister of Education and Science of Republic of Serbia, the Mayor of Belgrade. The registration fee will be €630 (€550 for ESIS members) with €50 discount for early registration. €150 for students and accompanying persons.
    b. The meeting structure and dissemination will be similar to ECF20.
    c. The social programme will include: welcome reception, a boat cruise on Danube, dinner in Kalemegdan Fortress amongst other events and an accompanying person programme. A large number of hotels are available. The buffet lunches will be included in the conference fee.
    d. Further sponsorship is expected from local organisations, and the registration fee will be reduced if possible. There will be a summer school and young scientist award competition.
    e. The proposal was accepted by the council by acclamation.

12. ECF23: P. Moreira
    a. An indicative proposal for ECF23 in 2018 was presented from Portugal. A firm proposal will be presented in Catania at ECF21. The proposed dates are 28 June-3 July in Funchal, Madeira, Portugal. The proposal has the support of the Portuguese Society of Materials.
    b. The programme and structure will be consistent with previous ECF meetings; up to 12 parallel sessions can be accommodated at the venue.
    c. The social programme includes a Welcome cocktail reception (Quinta Magnolia), Madeira’s gastronomical adventure (Sao Tiago Fortress, 17th century) and Madeira Sight Seeing tour and also a conference banquet (Pestana Casino Park Hotel).
    d. The venue will be the Hotel Pestana Casino Park (5*, with 340 rooms). Other hotels nearby are 5-10 minutes from the conference centre (4* and 3*). Travel links are good.
    e. The preliminary registration fee is €680 maximum (early bird). ESIS member €620 (early bird), student €450 (early bird). However, expected sponsorships from local government and industry have not yet been included.
    f. There were some concerns from members of the Council that the registration fees were high and flights to Madeira were long and expensive. This could discourage the typical ECF attendees. Portugal responded that it was expected to reduce the registration fee with sponsorship.
13. Election of Officers: J. Marrow
   a. There were two candidates; Leslie Banks-Sills was nominated by Sweden and seconded by Spain, Stefano Beretta was nominated by the Czech Republic and seconded by France.
   b. Each gave a brief speech outlining their views and plans for ESIS, and responded to questions from Council. Following the vote, Leslie Banks-Sills was elected as president of ESIS for the next 4 years until ECF22 (17 votes to 13 votes).
   c. For Vice-President; Aleksander Sedmak was nominated by the President and seconded by Sweden, Francesco Iacoviello was also nominated by the President and the TC10 chair. These nominations were accepted by acclamation.


Attendance:

T.J. Marrow
### Special Issues 2013-14

<table>
<thead>
<tr>
<th>Journal</th>
<th>Title</th>
<th>Source</th>
<th>Editor</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Int J Fatigue</td>
<td>Recent Progress in the Understanding of Fatigue Crack Propagation</td>
<td>ECF 18</td>
<td>H.J. Christ, D. Klingbeil</td>
<td>IJF 50, May 2013</td>
</tr>
<tr>
<td>Eng Fract Mech</td>
<td>Cohesive Zone Models</td>
<td>TC 8</td>
<td>H. Yuan, J. Besson</td>
<td>EFM 109, 2013</td>
</tr>
<tr>
<td>Eng Fract Mech</td>
<td>Special Issue on Multiaxial Fracture 2013</td>
<td>ECF 19</td>
<td>A. Spagnoli</td>
<td>EFM 123, 2014</td>
</tr>
<tr>
<td>Eng Fract Mech</td>
<td>Microstructural effects on macroscopic fracture properties</td>
<td>ECF 19</td>
<td>R. Goldstein, V. Shlyannikov</td>
<td>EFM 130, Nov. 2014</td>
</tr>
<tr>
<td>Int J Fatigue</td>
<td>Fatigue Mechanism and Structural Integrity: Advances and Applications</td>
<td>ECF 19</td>
<td>Y. Murakami, V. Shlyannikov</td>
<td>in preparation</td>
</tr>
<tr>
<td>Eng Failure Anal</td>
<td>Failure analysis of structure components undergone stress corrosion, fatigue and neutron irradiation</td>
<td>ECF 19</td>
<td>R. Goldstein, V. Shlyannikov</td>
<td>EFA 47B, Jan. 2015</td>
</tr>
</tbody>
</table>
National Committees

Hungary

ESIS Conference, Miskolc, Hungary, November 7, 2014

The European Structural Integrity Society (ESIS) is actively working for decades; today ESIS has some 500 members. The Hungarian National Committee (HNC) was established by a group of specialists expressed their interest for ESIS in 1980; Dr. Ernő Czoboly became the leader of the Committee. Dr. Czoboly was replaced by Prof. László Tóth in 1994. Under the leadership of Prof. Tóth the HNC provided a remarkable activity first of all within the Technical Committee on Education and Training (ESIS TC 13).

Due to personal and other reasons in the past couple of years the TC 13 activity showed serious erosion, and the number of HNC members decreased fewer than 10. The latter has meant that Hungary has had no voting right in the ESIS Council. A small group of the related people has recognized the indefensibility of this situation, and decided to revitalize the ESIS HNC and, in general, to reinvigorate the structural integrity assessment related activities in Hungary and, if the need exists, to coordinate it in the future. The idea was supported by the fact that in the recent years, in three different places of the country, in three different poles of the scientific and technical life “entities” were established with special focus on structural integrity. These were: (1) the Structural Integrity Section at the Bay Zoltán Institute for Logistics and Production Engineering, (2) the Structural Integrity Department at the Miskolc University and (3) the Structural Integrity Subcommittee within the Materials Science and Engineering Scientific Committee of the Hungarian Academy of Science.

To move forward this direction an „ESIS Conference“ was jointly organized by the Structural Integrity Sub-committee of the Materials Science and Engineering Scientific Committee of the Hungarian Academy of Science and the Bay Zoltán Institute for Logistics and Production Engineering. The conference was sponsored by the project TÁMOP-4.2.3.-12/1/ konv-2012-058. Over 40 specialists from industry, academia and state administration attended. The following presentations were presented followed by living discussions:

- Prof. L. Tóth: Past, present and future of the ESIS Hungarian National Committee
- Prof. P. Trampus: Short and long term visions and plans of the ESIS HNC
- Prof. L. Tóth: What should we understand when saying „structural integrity“?
- Prof. P. Trampus: Structural integrity assessment vs. Structural health monitoring
- Dr. S. Szávai: Role of BAY-LOGI in EU sponsored projects in the field of structural integrity
- Prof. J. Lukács: Status of the Hungarian high education relating to „structural integrity“
- B. Fekete: Low cycle fatigue of reactor pressure vessel steels
- Dr. G. Králics, P. Rózsahegyi: Cyclic crack propagation in stainless steel structures
- Round table discussion: Goals of ESIS HNC.
In the round table discussion the participants unanimously expressed the opinion that there was a need for the HNC activity and supported Prof. L. Tóth’s efforts. Prof. Tóth backed out of the HNC leadership and passed over this function to Prof. Trampus who received a strong support from the participants. Prof. Trampus declared that he would reorganize the HNC activity however he required the support of all interested people. The work may be positively influenced and strengthened by the current Hungarian economic situation (e.g. building new nuclear units, other important investments, development in high education).

L. Tóth, P. Trampus

**Israel**

The Fourth Israel Structural Integrity Group (ISIG) Symposium is a one day event that will take place on Monday, January 26, 2015, at Tel Aviv University, Israel. This Symposium, for which there is no fee, will gather scientists and engineers from different universities, as well as various industries from all over Israel to present their latest research results in the fields of fracture mechanics and fatigue. More than 50 fracture mechanics and fatigue experts are planning to participate in this event. In the morning session of the Symposium, a student competition will be held in order to encourage students to work in this field; there will be a cash prize awarded for the best oral presentation. The aim of this meeting is to provide an opportunity to learn and discuss recent advances in this field. Moreover, the symposium serves as a forum for networking and collaboration.

https://sites.google.com/site/israelstructuralintegrity

Dana Ashkenazi
Leslie Banks-Sills

**Italy**

In 2014 IGF, Italian Group of Fracture (www.gruppofrattura.it), in cooperation with Grupo Español de Fractura and Portuguese Society of Materials/Fracture Division, organized in Catania (Italy) a Multilateral workshop on “Fracture and Structural Integrity related Issues”, with more than 80 participants. In addition, IGF published 4 issues of the IGF “International Journal Fracture and Structural Integrity” (Frattura ed Integrità Strutturale), ISSN 1971-8993.

In 2015 IGF will organize:
- April 20–22, 2015: Third IJFatigue & FFEMS Joint Workshop Characterization of Crack Tip Fields, Urbino, Italy.
- April 22–24, 2015: First International Workshop on Challenges in Multiaxial Fatigue, Urbino, Italy.

Francesco Iacoviello

**Latvia**

The Latvian Delegate to ESIS is now Andrejs Krasnikovs.

The previous representative Prof. Vitauts Tamuzs recently has retired after 20 years of chairmanship.

**Portugal**


**Serbia**


The conference NT2F14 under the title “Fatigue and fracture at all scales” was held in Belgrade from 15 to 18 September. This year’s conference was attended by 99 participants from 14 countries (Serbia, France, Croatia, India,
Libya, Hungary, Portugal, Romania, Slovakia, Slovenia, Turkey, Algeria, Bosnia and Herzegovina).

Two opening lectures were presented by Prof. Guy Pluvinage (University of Metz, France) and Prof. Laszlo Toth (Universities of Mislolic and Debrecen, Hungary).

Four plenary lectures were given by: Prof. Mohamed Hadj Meliani (Hassiba Ben Bouali University of Chief, Algeria), Prof. Ljubica Milović (University of Belgrade, Faculty of Technology and Metallurgy, Serbia), Prof. Željko Božić (University of Zagreb, Faculty of Mech. Engineering and Naval Architecture, Croatia), and Prof. Aleksandar Sedmak (University of Belgrade, Faculty of Mechanical Engineering, Serbia).

Two lectures were dedicated to the memory of eminent scientists Mladen Berković and Michael Wnuk.

A total of 33 oral lectures and 7 posters were presented.

A special award for exceptional contribution to developments and applications of Fracture Mechanics in Yugoslavia was presented to the Honourable President of NT2F14 and first President of DIVK, Prof. Stojan Sedmak. The founder of the New Trends in Fatigue and Fracture conference Prof. Guy Pluvinage was also awarded (the Appreciation Award - Gratitude) for contributions in organizing all fourteen conferences held to date.

The NT2F group has held a meeting that voted on the next NT2F15 conference to be held in Algeria, in November 2015. Prof. Mohamed Hadj-Meliani has been elected as President of the Organising Committee.

All reviewed papers presented at NT2F14 shall be published in Structural Integrity and Life, Vol. 14 (No. 2, 3), and Vol. 15 (No. 1), which is open access journal (www.divk.org.rs).

Obituary

Prof. Stojan Sedmak, Professor of the University of Belgrade, Serbia, internationally recognized scientist, has died on 2.11.2014, at the age of 85. Ever since his post graduate Magister diploma work in 1968 he has been active in the field of Fracture Mechanics and Structural Integrity, introducing these disciplines in ex-Yugoslavia and Southeast Europe. His doctoral thesis, defended in 1977, was one of the first in the region to be completely devoted to fracture mechanics, leading to the establishment of a sound basis for its further development.

Based on that, Stojan has established International Fracture Mechanics Summer Schools, starting from 1980 (10 of them held in the meantime), and became the principle investigator of the USA-Yu project on "Weldment Fracture Mechanics", 1982-1990. These two activities were the pillars of strong development of Fracture Mechanics in the whole region, including all six ex-Yu republics. This was also the decade in which Stojan started his fruitful activities in the scope of EGF and European Conferences on Fracture, which culminated in 1992, with ECF9 in Varna, which he organized successfully as the "mission impossible".
Unfortunately, a tragic chain of events in ex-Yugoslavia significantly slowed down all activities afterwards. Anyhow, after 2001 a new era emerged, starting with the establishment of the Society for Structural Integrity and Life (DIVK) in Serbia, which has gathered more than 200 members, including 50 members of ESIS. Stojan served as the first president and the first editor-in-chief of the Journal “Structural Integrity and Life”, also established in 2001. Renewed activities culminated with a successful bid for ECF22 to be held in Serbia in 2018, as decided in Trondheim in July 2014. Stojan has also witnessed another great recognition for Serbia - the president of DIVK becoming an ESIS Vice-President. Surely, to his greatest satisfaction, it was his own son, and if I may say, his loyal co-worker for the last 32 years. Let me be clear - there is no doubt it is he who should be honored for these two significant achievements and recognitions for Serbia and the region.

Now, when I look back at my father’s career, I can see a great man with a vision, building the pyramid of knowledge, seeing everything from the top of it, and leading us all. I can see the raising pyramid touching the sky, taking him to well-deserved peace in heaven.

Alek Sandar Sedmak

Sweden

- In October the 20-21, 2014, the UTMIS autumn course was held. 84 participants representing Sweden, Finland, Norway and Switzerland took part in the course “Fatigue analysis of notches, defects and cracks” given by Professor Gunnar Härkegård from NTNU, Trondheim, Norway. The course was hosted by the Royal Institute of Technology (KTH) in Stockholm, Sweden.

- The annual UTMIS meeting will be held January 27-28 hosted by ABB High Voltage Cables in Karlskrona, Sweden. Except from taking part of the host company’s matters on fatigue the audience also will hear several presentations given by PhD students within the fields of VHCF, endurance modelling, fatigue of cast iron and in large welded structures.

- The spring meeting will be held May 19-20 hosted by Atlas Copco Rock Drills in Örebro, Sweden. Presentations from the academy and industry will be given on the theme weld joints. The master thesis work of 2014 also will be presented.

- The autumn course 2015 is in the planning phase. It will take place in October at Sandvik Materials Technology in Sandviken, Sweden. The subject probably will be related to VHCF and the influence of microstructurally short cracks.

The meetings are held in Swedish, but the autumn courses are in many cases held in English and could be of interest for an international audience.

Jörgen Larsson

Ukraine

The preparation of 5th International Conference “Fracture Mechanics of Materials and Structural Integrity” was the main achievement of Ukrainian National Group of ESIS for year of 2014. The conference was successfully held from June 24 to June 27 in Lviv (Ukraine) under the auspices of the National Academy of Sciences of Ukraine and ESIS. The information about this event was published in the last issue of the ESIS Newsletter # 54 (please, see pages 15-17).

Now Ukrainian National Group of ESIS takes part in the preparation of 14th Polish-Ukrainian-German Summer School “Fracture Mechanics of Materials and Structural Integrity”, which will be held from 22 to 25 September 2015 in Ternopil (Ukraine). In time we will certainly prepare the short paper about this school for next issues of the ESIS Newsletter.

V.V. Panasyuk

TECHNICAL COMMITTEES

TC 2: Micromechanisms

Let me tell you some words about the 10th TC2-ESIS meeting on Micromechanisms in Leoben, Austria, in April 2015:

We received in total 38 abstracts submitted by authors from 12 countries, one of them was not accepted. The meeting is planned for two full days and the program will consist of 36 oral presentation and 1 keynote given by Prof. Stan Veprek from the Technical University Munich, Germany, on ”Mechanism of Hardness Enhancement and of Plastic Deformation in Super-and Ultrahard nc-TiN/Si3N4 and Related Nanocomposites”.

Mainly because of an extended production of special issues of journals related to ESIS, the TC2 can provide support for those participants who made a relevant application for financial assistance. To facilitate the attendance in Leoben, two young participants from Russia and Sweden will receive partial assistance (conference fee) and one participant from Ukraine will gain full support (fee, travel expenses and accommodation).

Jaroslav Pokluda
TC 3: Micromechanisms

ACTIVITIES in the years 2014-2016

(a) Professor Andrea Carpinteri (Parma, Italy), Professor Les P. Pook (Sevenoaks, UK), Professor Luca Susmel (Sheffield, UK), and Dr Sabrina Vantadori (Parma, Italy): Guest Editors of a Special Issue on “Fatigue Crack Paths 2012” of the “International Journal of Fatigue”, Vol. 58, 1-224, 2014, with papers selected from those presented at the 4th International Conference on Crack Paths (CP 2012), held in Gaeta, Italy, 19th to 21th September, 2012.

(b) Professor Andrea Carpinteri (Parma, Italy), Professor Takamoto Itoh (Ritsumeikan, Japan), Professor Thierry Palin-Luc (Talence, France), Professor Masao Sakane (Ritsumeikan, Japan), and Professor Luca Susmel (Sheffield, UK): Guest Editors of a Special Issue on “Multiaxial Fatigue 2013” of the “International Journal of Fatigue”, Vol. 67, 1-228, 2014, with papers selected from those presented at the 10th International Conference on Multiaxial Fatigue and Fracture – ICMFF10, held in Kyoto, Japan, 3rd to 6th June, 2013.

(c) Professor Ali Fatemi (Toledo, USA), Professor Les P. Pook (Sevenoaks, UK), Professor Andrea Spagnoli (Parma, Italy), and Professor Shan-Tung Tu (Shanghai, China): Guest Editors of a Special Issue on “Multiaxial Fracture 2013” of the “International Journal of Engineering Fracture Mechanics”, Vol. 123, 1-222, 2014, with papers selected from those presented at the 10th International Conference on Multiaxial Fatigue and Fracture – ICMFF10, held in Kyoto, Japan, 3rd to 6th June, 2013.

(d) Professor Andrea Carpinteri (Parma, Italy), Professor Les Pook (Sevenoaks, UK), Professor Luca Susmel (Sheffield, UK) and Professor Roberto Tovo (Ferrara, Italy): Chairmen of the 5th International Conference on Crack Paths (CP 2015), to be held in Ferrara, Italy, 16th to 18th September, 2015.

(e) Professor Andrea Carpinteri (Parma, Italy), Professor Ali Fatemi (Toledo, USA) and Professor Carlos Navarro (Seville, Spain): Chairmen of the 11th International Conference on Multiaxial Fatigue and Fracture (ICMFF11), to be held in Seville, Spain, 1st to 3rd June, 2016.

Andrea Carpinteri
Les P. Pook

TC 4: Polymers And Polymer Composites

Report on 2014:

The committee hosted the 7th International Conference on the Fracture of Polymers, Composites and Adhesives in Les Diablerets in September 2014. The conference was organised by Elsevier. There were 101 delegates and a single oral session of 38 papers and a poster session with 40 posters, over three days. An excellent conference was enjoyed by all, with the conference dinner on the final night being held in the mountains overlooking the village. Delegates were taken by cable car to and from the dinner location.

The best poster prize was awarded before dinner by the ESIS president, Professor Leslie Banks-Sills. The prize winners were Nadia Perillo (Politecnico di Milano) and Marc Kanters (TU/e). The poster chairman was Professor Ian Horsfall and the poster prize was sponsored by Permali.

A special issue of Engineering Fracture Mechanics will be published with selected papers from the conference.

ESIS TC4 met twice in 2014, in May and September to make progress in the current work areas. These include elastic and elastic-plastic test methods for polymers, fracture of polymers at high test rates, mode II and mixed-mode fracture in composites, fatigue of composites, short fibre composites, structural adhesives testing and the peel testing of flexible laminates.

Committee chairman, Professor Gordon Williams, was awarded the Griffith Medal at ECF 20 in Trondheim, and technical secretary Dr Bamber Blackman was awarded an ESIS Fellowship.

Plans for 2015


Bamber Blackman
TC 10: Environmentally Assisted Cracking

ESIS TC 10 Workshop on Environmentally Assisted Cracking & Hydrogen Embrittlement
Venice, Italy, 3-4 November 2014

EUROPEAN STRUCTURAL INTEGRITY SOCIETY (ESIS)
UNIVERSITY OF SALAMANCA (USAL)
VENEZIA TECNOLOGIE (VT)

VENIZIAD B SALAMANCA

ESIS TC-10 Workshop
ENVIRONMENTALLY ASSISTED CRACKING & HYDROGEN EMBRITTLEMENT
Venecia, Italy, 3-4 November 2014

CHAIRS
Prof. Dr. Jesús Toribio (University of Salamanca, Spain, E-mail: toribio@usal.es)
Dr. Giovanna Gabetta (Eniricherche, Italy, E-mail: Giovanna.Gabetta@eni.com)

INTERNATIONAL ADVISORY COMMITTEE
Prof. Dr. Hrihoriy Nykyforchyn (Karpenko Institute, Ukraine, E-mail: nykyfor@ipm.lviv.ua)
Dr. Wolfgang Dietzel (Helmholtz-Zentrum Geesthacht, Germany, E-mail: wolfgang.dietzel@hzg.de)

LOCAL ORGANIZING COMMITTEE
Dr. Marino Tolomio (Venezia Tecnologie, Italy, E-mail: mtolomio@veneziatecnologie.it)
Dr. Marco Scapin (Venezia Tecnologie, Italy E-mail: mscapin@veneziatecnologie.it)
Dr. Letizia Meregalli (Venezia Tecnologie, Italy E-mail: imeregalli@veneziatecnologie.it)

VENUE
Venezia Tecnologie S.p.A.
Via Delle Industrie, 39 Porto Marghera
Venecia, ITALY

1. History of ESIS TC 10 Committee
The ESIS TC 10 Committee on Environmentally Assisted Cracking (EAC) was established by ESIS (European Structural Integrity Society) in 1991. In 1995, following an initiative by the members of the Karpenko Physico-Mechanical Institute (KPMI) of the National Academy of Sciences of Ukraine (NASU), a new Sub-committee on the topic of Hydrogen Degradation was also established. The main objective of ESIS TC10 was – and continues to be – a merger of research experience in the areas of fracture mechanics and structural integrity as a method of failure assessment, and of practice in the environmental degradation/corrosion of materials. From the very beginning, the work has been strongly devoted to the development of fracture mechanics test and evaluation techniques and procedures and to their application to problems of environmentally assisted cracking.

TC 10 workshops are usually held during ESIS conferences, but sometimes they are hosted by a participating organization, such as is the case of VeTec. Venezia Tecnologie hosted the meeting the first time in 2004, and again in 2006. The location is quite good for the
workshop purpose since it offers the opportunity of establishing a good relationship based on work but also on friendship and networking. In fact, the need to implement the activities of scientific working parties with the aim at a better use of modern tools such as social networks is nowadays growing. However, implementation of tools is not effective if it is not coupled with a cultural exchange that should be promoted by the activities of associations and/or working parties, such as ESIS TC 10 Committee.

Dr. Wolfgang Dietzel, who was the Chairman of the Committee since its inception, and Dr. Giovanna Gabetta who became co-chairperson since 1996 were both present; Prof. Hryhoriy Nikyforchyn, Chairman of the Sub-Committee on Hydrogen Degradation presented a paper via Skype. Starting at the ESIS Council Meeting during the ECF 18 in Dresden in August/September 2010, the ESIS TC 10 Committee Chairmanship was handed to Prof. Jesús Toribio from the University of Salamanca in Spain. In recent years, TC 10 started to take up new EAC related tasks for which the open and versatile structure of the group appears ideally suited. Knowledge Management and the solution of complex technical problems are new challenges that need to be addressed, and the formation of new networks will play an important role in future. To this aim, TC 10 and its Chairman Jesús Toribio actively took part in the organization, by the Italian, Portuguese and Spanish Group on Fracture, of the 1st MULTILATERAL WORKSHOP ON “FRACTURE AND STRUCTURAL INTEGRITY RELATED ISSUES”, held in Catania, Italy, on September 15-17 2014.

2. Papers presented in the Workshop

Researchers from Austria, Germany, Italy, Japan, Spain and Ukraine participated in the Workshop. Here is the list of papers, presented after the opening address by Prof. Jesús Toribio and Dr. Giovanna Gabetta:

**Giovanna Gabetta:**
35 years in EAC – What is left?

**Wolfgang Dietzel:**
SCC of high strength Aluminum alloys.

**Jesús Toribio and Viktor Kharin:**
Revisiting continuum modeling of hydrogen diffusion and trapping in metals.

**Hryhoriy Nykyforchyn and Giovanna Gabetta:** Experimental modeling of in-bulk material degradation of main gas pipelines.

**Giovanni Meneghetti:**
Engineering estimations of notch-stress intensity factors using the peak stress method.

**Gabriella Bolzon:**
The diagnostic capabilities of indentation tests.

**Donato Firrao and Paolo Matteis:**
Is 13 years too a long time for an EAC gas bottle burst?

**Raúl Bermejo, Clemens Krautgasser, Peter Supancic and Robert Danzer:**
Environmentally strength degradation of glass-ceramic composites: experiments and modeling.

**Takashi Matsuo, Masahiro Endo and Hisao Matsunaga:**
Effects of internal hydrogen on the ductility of ductile cast iron.

**Jesús Toribio, Miguel Lorenzo, Diego Vergara and Viktor Karin:**
FE numerical analysis of hydrogen-assisted rolling-contact fatigue degradation in bearings for wind turbines

**Manuela Gentile:**
Pipeline sour service material selection: where are we?

**Laura Vergani, Giorgia Gobbi and Chiara Colombo:** A cohesive model to simulate hydrogen-assisted cracking

**Filippo Berto and Pasquale Gallo:**
High temperature fatigue of notches components made of structural steel.

**Alberto Pontarollo:**
Experimental devices for EAC tests at ultra high pressure.

3. Round Tables and Discussions

In the final part of the meeting, two subjects were discussed: Round Table n°1 discussed the NATO Program Science for Peace: Implications in Environmentally Assisted Cracking. A project will be proposed by Karpenko at the beginning of 2015, with the cooperation of Politecnico di Milano (Gabriella Bolzon). The cooperation of Salamanca University and of eni SpA is foreseen.

Round Table N°2 was devoted to the discussion of Future Activities of ESIS TC10. Jesús Toribio illustrated the next event: Salamanca 2015: ESIS TC10 Conference on Environmentally Assisted Cracking & Hydrogen Embrittlement and Degradation.

4. Photos of the Event
Wolfgang Dietzel was awarded at the ESIS ECF20 Conference for his service as Chairman.

The new Chairman Jesús Toribio receiving the ESIS Fellow Award at ECF20 Conference.

Jesús Toribio
Giovanna Gabetta

TC 24: Integrity of Railway Structures

1. Scientific Report

A TC24 meeting was held on 1-2 October 2014, at Politecnico di Milano. The meeting had been organized by S. Beretta and M. Carboni at the Department of Mechanical Engineering.

The opportunity of the meeting has been offered by results obtained within EU projects (EURAXLES, SUSTRAIL) and other projects about new concepts for fatigue design and durability, that can represent a significant advance and challenge to current practices.

Moreover, new interesting outcomes about maintenance and inspections have been presented. The meeting was organized in two sessions attended by more than 80 experts from Europe, US, Japan and China (see Fig. 1).

The presentations were organized in two sessions, the first devoted to fatigue design and the second to maintenance and inspections. An interesting technical discussion was held at the end of Session 1, where a way was devised to report some of the important results presented in the meeting to CEN, for incorporation into future revision of standards EN13103/13104 and 13261.

Fig. 1 - TC24 meeting held in Milan: a) overview of the meeting room; b) presentation by S. Cervello.
Session 1 - Fatigue Design, Life and reliability calculations

<table>
<thead>
<tr>
<th>AUTHOR(S)</th>
<th>TITLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Landaberea (CAF, Spain)</td>
<td>EURAXLES - Analysis of local stress concentration at transitions</td>
</tr>
<tr>
<td>M. L. Nguyen-Tajan (SNCF, France)</td>
<td>EURAXLES - Advances in reliability assessments of axles</td>
</tr>
<tr>
<td>M. Filippini &amp; M. Luke (PoliMi, Italy, &amp; IWM, Germany)</td>
<td>EURAXLES - Fatigue properties of railway axles: small scale tests and damage calculations</td>
</tr>
<tr>
<td>S. Cervello (Lucchini RS, Italy)</td>
<td>EURAXLES - Fatigue properties of railway axles: new results of full-scale specimens</td>
</tr>
<tr>
<td>S. Beretta (PoliMi, Italy)</td>
<td>EURAXLES - Summary of strength distributions and probabilistic damage calculations</td>
</tr>
<tr>
<td>M. Luke (IWM, Germany)</td>
<td>EURAXLES - Initiation of fretting fatigue in press fits</td>
</tr>
<tr>
<td>S. Friedrich &amp; M. Traupe (DB Systemtechnik GmbH, Germany)</td>
<td>Dynamic Torsional Loads on Wheelsets -</td>
</tr>
</tbody>
</table>

Session 2 - Maintenance, service and inspections

<table>
<thead>
<tr>
<th>AUTHOR(S)</th>
<th>TITLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. Foletti (PoliMi, Italy)</td>
<td>EURAXLES - Acceptance of defects at press-fits</td>
</tr>
<tr>
<td>K. Maedler (DB Systemtechnik GmbH, Germany)</td>
<td>An experimental approach to determining the residual lifetimes of wheelset axles on a full-scale wheel-rail roller test rig</td>
</tr>
<tr>
<td>T. Gerlach (GHH Radsatz GmbH, Germany)</td>
<td>EURAXLES - New axle coatings and axle preparation</td>
</tr>
<tr>
<td>W. Kappes (IZFP, Germany)</td>
<td>EURAXLES - Potential improvements of the presently applied in-service inspection of wheel-set axles</td>
</tr>
</tbody>
</table>

The speakers have accepted making public their presentation, which are available at: http://esistc24.mecc.polimi.it/milano_14.html.

All the participants appreciated that a Special Issue of Int. J. Fatigue has been approved by ESIS Exco, Elsevier and Journal Editors.

The workflow of the special issue (whose Guest Editors will be S. Beretta and M. Carboni) will be: i) submission deadline 28th February 2015; ii) acceptance deadline 30th July 2015; iii) expected online publication October 2015.

The successful meeting has surely confirmed the role of ESIS TC24 as the leading forum for the structural integrity of railway components. The next TC24 meeting is going to be held in Fall 2015.

S. Beretta
ESIS TC24 Chairman
# Calendar of TC Meetings & Activities

<table>
<thead>
<tr>
<th>TC 11</th>
<th>September 10, 2014</th>
<th>HTMTC Committee Meeting</th>
<th>EMPA Dübendorf (Switzerland)</th>
<th><a href="http://www.htmtc.com">www.htmtc.com</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>TC 11</td>
<td>September 11-12, 2014</td>
<td>Creep-Fatigue Crack Initiation &amp; Growth</td>
<td>Swansea, UK</td>
<td><a href="http://www.htmtc.com">www.htmtc.com</a></td>
</tr>
<tr>
<td>TC 4</td>
<td>September 14-18, 2014</td>
<td>7th Int. ESIS TC4 conference</td>
<td>Les Diablerets, Switzerland</td>
<td><a href="http://www.esistc4conference.com">www.esistc4conference.com</a></td>
</tr>
<tr>
<td>TC 24</td>
<td>October 1-2, 2014</td>
<td>Committee Meeting: new concepts for fatigue design and durability</td>
<td>Politecnico di Milano, Italy</td>
<td><a href="http://esistc24.mecc.polimi.it">http://esistc24.mecc.polimi.it</a></td>
</tr>
<tr>
<td>TC 2</td>
<td>April 13-14, 2015</td>
<td>10th Meeting of ESIS-TC2 on Micromechanisms</td>
<td>Leoben, Austria</td>
<td><a href="http://www.esisweb.org/">http://www.esisweb.org/</a></td>
</tr>
<tr>
<td>TC 4</td>
<td>May 27-29, 2015</td>
<td>TC4 meeting</td>
<td>Les Diablerets, Switzerland</td>
<td><a href="mailto:b.blackman@imperial.ac.uk">b.blackman@imperial.ac.uk</a></td>
</tr>
<tr>
<td>TC 4</td>
<td>September 30-October 2, 2015</td>
<td>TC4 meeting</td>
<td>Les Diablerets, Switzerland</td>
<td><a href="mailto:b.blackman@imperial.ac.uk">b.blackman@imperial.ac.uk</a></td>
</tr>
</tbody>
</table>

# Calendar of Conferences & Workshops

<table>
<thead>
<tr>
<th>Event Date</th>
<th>Event Name</th>
<th>Location</th>
<th>Website</th>
<th>Additional Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 26, 2015</td>
<td>Fourth Israel Structural Integrity Group (ISIG) Symposium</td>
<td>Tel Aviv University, Israel</td>
<td><a href="https://sites.google.com/site/israelsstructuralintegrity">https://sites.google.com/site/israelsstructuralintegrity</a></td>
<td></td>
</tr>
<tr>
<td>March 23rd-26th, 2015</td>
<td>3rd Int. Conf. on Material and Component Performance under Variable Amplitude Loading (VAL2015)</td>
<td>Prague (Czech Republic)</td>
<td><a href="http://www.val-conf.org">www.val-conf.org</a></td>
<td></td>
</tr>
<tr>
<td>April 14-16, 2015</td>
<td>Spring Int. Conf. on Material Sciences and Technology (MST-S)</td>
<td>Beijing (China)</td>
<td><a href="http://www.engii.org/scet2015">www.engii.org/scet2015</a></td>
<td></td>
</tr>
<tr>
<td>April 20-22, 2015</td>
<td>IGF Workshop &quot;Characterization of Crack Tip Fields&quot;</td>
<td>Urbino (Italy)</td>
<td><a href="http://www.gruppofrattura.it/sito/it/background-urbino2015">http://www.gruppofrattura.it/sito/it/background-urbino2015</a></td>
<td></td>
</tr>
<tr>
<td>April 22-24, 2015</td>
<td>IGF Workshop &quot;Challenges in Multiaxial Fatigue&quot;</td>
<td>Urbino (Italy)</td>
<td><a href="http://www.gruppofrattura.it/sito/it/background-urbino2015-2">http://www.gruppofrattura.it/sito/it/background-urbino2015-2</a></td>
<td></td>
</tr>
<tr>
<td>April 27-29, 2015</td>
<td>The 32th Spanish Conference on Fracture and Structural Integrity</td>
<td>Salamanca (Spain)</td>
<td>e-mail: <a href="mailto:gef2015@usal.es">gef2015@usal.es</a></td>
<td></td>
</tr>
<tr>
<td>July 8th-10th, 2015</td>
<td>2nd Int. Conf. on Damage Mechanics (ICDM2)</td>
<td>University of Technology of Troyes (France)</td>
<td><a href="http://icdm2.utt.fr/">http://icdm2.utt.fr/</a></td>
<td>e-mail: <a href="mailto:icdm2@utt.fr">icdm2@utt.fr</a></td>
</tr>
</tbody>
</table>
### ESIS Website

**www.structuralintegrity.eu**

- become a member of ESIS and take advantage of all the "Members Only" resources on this Web site
- register automatically as a Member and pay the fee by PayPal system
- obtain your username and password for accessing the private area for downloading EGF-ESIS books and Procedures
- exchange new ideas, advancements and documents with other ESIS Members

### Advantages of being an ESIS member

- participation in TC activities and access to TC documents;
- full on-line access to ESIS procedures;
- full on-line access to former EGF-ESIS books;
- support for ESIS activity.

**how to renew?**

see page 22 or [www.structuralintegrity.eu](http://www.structuralintegrity.eu)
The Griffith Medal Lecture

The Fracture Mechanics of Soft Solids

Gordon Williams

Mechanical Engineering Department, Imperial College London, UK
Aerospace, Mechanical and Mechatronic Engineering Dept. University of Sydney, Australia

1. Introduction

I was honoured to be awarded the Griffith Medal by ESIS and to give the Medal Lecture at ECF20 in Trondheim. I chose to talk about applying energy based fracture mechanics as pioneered by Griffith, to the study of fracture in soft solids. This is a relatively new field but is becoming increasingly important in the characterisation of biological materials and foods.

I believe the energy based approach to such problems to be profound and the two papers written by Griffith [1,2] provide the basis on which an understanding can be based. On a personal note I have always felt an affinity with Alan Griffith since we share a common birthdate, 13th June, were both brought up in Liverpool and our first job was at the Royal Aircraft Establishment in Farnborough. Both of his only two fracture papers were written while he was at Farnborough and he introduced the concept of Energy Release Rate, \( G \), in honour of Griffith as the crack driving force which will be used throughout here. He also addressed the necessity of achieving a sufficient cohesive stress at the crack tip to cause fracture in addition to the necessary energy release via \( G \). He observed that for sharp cracks the stress concentration was generally sufficient to achieve this and that \( G \geq G_c \), some critical property value, was a sufficient single fracture criterion and can be used for brittle fracture where cracks remain sharp. The issue for soft solids is that the second criterion is not necessarily achieved because of crack blunting and we need more than a single criterion.

This issue has been recognised in the study of the fracture of rubber in the 1960s. Work at the Natural Rubber Research Association by a very talented group including Rivlin, Thomas, Gent, Lake and Lindley [e.g.3,4] extended the G concept to finite strains and recognised that crack blunting was an important factor. Indeed they defined a Tearing Energy when the material failed with the crack blunted by the large strains and measured values of 20 kJm\(^{-2}\) for natural rubber. They devised tests in which razor cutting was used and \( G \) calculated from the cutting force and observed a value of 0.5 kJm\(^{-2}\). It was noted that this was the true toughness and was the controlling factor in, for example, the failure of tyres. The work is notable for skilful experimental work and the pursuit of sound physics. What is described here is done in, what I hope, is the same spirit.

Also in the 1960s George Irwin [5] addressed the issue of blunt cracks in the context of crack sharpness in fracture toughness testing. He considered the stress at the tip of a crack of finite radius \( \rho \) and noted that the stress intensity factor \( K^2 = EG \) to achieve a critical stress is given by

\[
\frac{K}{K_c} = \sqrt{\frac{\rho}{\rho_c}}, \quad \rho \geq \rho_c
\]  

(1)

where \( \rho_c \) is a critical radius below which \( K = K_c \) the sharp crack values and;

\[
\frac{K}{K_c} = 1, \quad \rho \leq \rho_c
\]  

(2)

Or, in terms of \( G \),

\[
\frac{G}{G_c} = \frac{\rho}{\rho_c} \quad \text{and} \quad \frac{G}{G_c} = 1
\]  

(3)

In this case \( \rho \) is the initial radius of the crack tip and does not arise from self-blunting. The notion of \( \rho_c \) is important in all fracture mechanics testing standards.

2. Fracture in Soft Solids

A "Soft" solid is defined here as a material which has a low elastic modules, \( E \), and, in some cases, a low yield stress. The top end of the scale are soft polymer with \( E= 1 \)GP and \( \sigma_Y \) 10MPa i.e a yield strain \( \varepsilon_Y = 0.10 \), down to starch gels and cheese with \( E=0.1 \)Mpa, \( \sigma_Y = 0.05 \)
MPa and $\varepsilon_Y = 0.15$. Many very soft materials have no real yield stress and are elastic, often with some visco-elasticity. An example of what occurs when stretching a soft polymer (PE) is shown in fig. 1 in which a sharp crack self-blunts because of the large strains. Of course, initially blunt notches continue to blunt further on loading.

Figure 1. Self blunting in a stretched PE sheet (Photograph by kind permission of Hongjian (Andy) Wang, University of Sydney)

A useful model of these effects is the elastic analysis of a blunt crack of length, $a$, and a tip radius $\rho$ subjected to a stress $\sigma$. The stress at a distance $r$ from the crack tip is given by Inglis [6],

$$
\sigma_r = \sigma \frac{a}{2r} \frac{1 + \rho}{\sqrt{2\pi r} \sqrt{1 + \frac{\rho}{2r}}}^{3/2}
$$

(4)

As $\rho \to 0$, $\sigma_r \to \sigma \frac{a}{2r} \frac{\sqrt{\pi a}}{\sqrt{2\pi r}} = \frac{K}{\sqrt{2\pi r}}$ the stress at a sharp crack. For a finite $\rho$ as $r \to 0$ we have,

$$
\sigma_r = 2\sigma \frac{a}{\sqrt{\rho}} \frac{2K}{\sqrt{\pi \rho}}
$$

and if $\sigma_r \to \sigma_c$ at fracture and $K = K_c$ at $\rho = \rho_c$ we have,

$$
\frac{K}{K_c} = \frac{\sqrt{\rho}}{\sqrt{\rho_c}}
$$

the Irwin result in equation 1.

Using the G form, equation 4 becomes,

$$
\sigma_r^2 = \frac{E G (1 + \frac{\rho}{2r})^2}{2\pi r(1 + \frac{\rho}{2r})^3}
$$

and using the criterion that $G \geq G_c$ for $\sigma_r = \sigma_c$ at $r = \bar{c}$ and introducing $c = \frac{E \sigma_c}{2\pi \sigma_c^2}$ we have,

$$
\frac{G}{G_c} = \frac{\bar{c}}{c} \frac{(1 + \frac{\rho}{2\bar{c}})^3}{(1 + \frac{\rho}{c})^2}
$$

(5)

A useful approximation is obtained for $\rho >> \bar{c}$, which gives the linear form,

$$
\frac{G}{G_c} = \frac{1}{2} \frac{\bar{c}}{c} + \frac{\rho}{8c}
$$

(6)

and $G/G_c = 1$ for $\frac{\rho}{c} \leq \frac{\rho_c}{c} = 8 \left(1 - \frac{1}{2\bar{c}}\right)$. This function is shown plotted in Fig 2 as $\frac{G}{G_c}$ vs $\frac{\rho}{c}$ with $\bar{c} = 0$, the Irwin solution, giving a lower bound and $\frac{\bar{c}}{c} = \frac{32}{27}$ giving the upper bound for $G = G_c$ at $\rho = 0$ in equation (5). Also $\frac{88}{27} \leq \frac{\rho_c}{c} \leq 8$ for the two bounds.

Figure 2. Dependence of $G$ on $\rho$ for a range of $\bar{c}$ values.

Self-blunting occurs from both elastic and plastic strains. The elastic radius is given by [7]
\[ \rho_v = \frac{4G}{\pi E} \]  
(7)

and the plastic contribution via the crack opening displacement \( \delta \) is

\[ \rho_p = \frac{\delta}{2} = \frac{1G}{2\sigma_y} \]  
(8)

To obtain the combined radius we must sum the displacements which are proportional to \( \sqrt{\rho} \) so that

\[ \sqrt{\rho_b} = \sqrt{\rho_e} + \sqrt{\rho_p} \]  
(9)

i.e.

\[ \rho_b = \rho_p \left( 1 + \frac{8\rho_e}{\pi} \right)^2 = k \frac{\rho_e\sigma_y}{E} \]  
(10)

Note that the effect of summing \( \sqrt{\rho} \) is highly nonlinear such that, for example, if \( \rho_e = 1\mu m, \rho_p = 10\mu m, \rho_b = 17\mu m \). Values of \( k \) for various values of \( e_y \) are shown in Table 1.

<table>
<thead>
<tr>
<th>( e_y )</th>
<th>0.01</th>
<th>0.02</th>
<th>0.05</th>
<th>0.10</th>
<th>0.50</th>
</tr>
</thead>
<tbody>
<tr>
<td>( k )</td>
<td>0.67</td>
<td>0.75</td>
<td>0.92</td>
<td>1.13</td>
<td>2.26</td>
</tr>
</tbody>
</table>

Initially blunt notches of radius \( \rho_b \) may be incorporated into the analysis as \( \sqrt{\rho_b} \) in equation (9).

Self-blunting fracture may be described by combining equation (10) with equation (6) and for the upper bound;

\[ \frac{G_b}{G_c} = 0.59 + \frac{\rho_b}{8c} = 0.59 + \left( \frac{G_b}{G_c} \right) \frac{G_c}{8c\sigma_y} \]

\[ = 0.59 + \left( \frac{\pi}{4} e_y k \right) \left( \frac{\sigma_c}{\sigma_y} \right)^2 \left( \frac{G_b}{G_c} \right) \]

i.e.

\[ \frac{G_b}{G_c} = \frac{0.59}{1 - \left( \frac{\pi}{4} e_y k \right) \left( \frac{\sigma_c}{\sigma_y} \right)^2} \]  
(11)

The following conditions pertain;

\[ \frac{\pi}{4} e_y k \left( \frac{\sigma_c}{\sigma_y} \right)^2 \leq 0.41, \quad \frac{G_b}{G_c} = 1, \quad \text{No blunting effect.} \]

\[ \frac{\pi}{4} e_y k \left( \frac{\sigma_c}{\sigma_y} \right)^2 \geq 1, \quad \frac{G_b}{G_c} \rightarrow \infty, \quad \text{No fracture} \]

\[ 0.41 < \left( \frac{\pi}{4} e_y k \right) \left( \frac{\sigma_c}{\sigma_y} \right)^2 < 1, \quad \frac{G_b}{G_c} > 1 \quad \text{from self blunting} \]

3. The effect of changing \( \sigma_y \)

A set of epoxy resins were tested in [8] and \( \sigma_y \) and \( E \) were changed by various methods including increasing the test temperature, the loading time in creep, and rubber modification. The effective \( \sigma_y \) varied from about 40MPa to 120MPa and \( e_y \) remained constant at about 0.05 thus giving the parameter \( \left( \frac{\pi}{4} e_y k \right) \left( \frac{\sigma_c}{\sigma_y} \right)^2 = 0.036 \).

Three types of behaviour were observed; for high \( \sigma_y \) the failures were brittle and stable with a sharp crack. For medium \( \sigma_y \) values the failures were brittle but unstable with \( G > G_c \) and crack blunting. For the very low \( \sigma_y \) values the failures were ductile tearing with large blunting. The results are shown in Fig 3 as \( G_b/G_c \) versus \( \sigma_y \). For \( \sigma_y \geq 110 \text{ MPa} \), \( G/G_c = 1 \) with no blunting and for \( \sigma_y \leq 70 \text{ MPa} \) there was ductile failure. In the range 70-100MPa \( G_b/G_c \) increase as \( \sigma_y \) decreased and the line shown is fitted from Equation 11 to \( G/G_c = 1 \) at \( \sigma_y = 110 \text{MPa} \) so that,

\[ 0.41 = \left( \frac{\pi}{4} e_y k \right) \left( \frac{\sigma_c}{\sigma_y} \right)^2 \quad \text{and} \quad \sigma_c = 370 \text{MPa} \]

![Figure 3. Failures in epoxy resins with varying \( \sigma_y \). (data from [9])](image)

In the original paper a similar analysis guessed a value of \( k = 1 \) which, as the analysis shows, is actually 0.92. It has taken the author 34 years to confirm the guess!

4. Cutting Methods

Since self blunting in a soft solids can give apparent toughness values much in excess of the true value an alternative test must be sought which does not involve the stretching of
the specimen. This is provided by cutting tests in which a sharp blade has a force applied to cause cutting of a sheet of thickness b. In the absence of other forms of energy dissipation such as plastic work or friction the fracture energy comes directly from the external work and is,

$$G_c = \frac{F_c}{b}$$  \hspace{1cm} (12)

This type of test was developed by Lake et al [4] for testing rubber and ways of avoiding friction were explored. In general, thin sheets do not give rise to plasticity effects.

Figure 4. Wire cutting (from [10])

Two types of cutting tests have been found to be effective for soft solids and both involve corrections for plasticity and friction. The first is wire cutting which is illustrated in fig.4. Here wire of varying diameters are pulled taut and then forced through a block of solid of thickness b, to cut the material. A very simple analysis, as illustrated if fig 4, gives (9,10)

$$\frac{F_c}{b} = G_c + \sigma_f (1 + \mu) d$$  \hspace{1cm} (13)

Steady state cutting must be achieved and Fc determined for each diameter and then $F_c/b$ plotted versus d to obtain Gc from the intercept as shown for data obtained on cheese, an obvious starting point for the method. Table 2 shows data obtained on three cheeses and three starch gels. The Gc values are small in the range of 1-10 J/m² and they are compared with results obtained on standard SENB tests.

Table 2: Wire cutting results for cheeses and starch gels. (from [10] and [11])

<table>
<thead>
<tr>
<th>Cheese</th>
<th>E</th>
<th>$\sigma_c$</th>
<th>$G_c$</th>
<th>$G_c$</th>
<th>$\rho_e$</th>
<th>$\rho_c$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kPa</td>
<td>kPa</td>
<td>Jm⁻²</td>
<td>Jm⁻²</td>
<td>(\mu)</td>
<td>(\mu)</td>
</tr>
<tr>
<td>Sharp Cheddar</td>
<td>210</td>
<td>44</td>
<td>4.5</td>
<td>5.8</td>
<td>27</td>
<td>240</td>
</tr>
<tr>
<td>Mild Cheddar</td>
<td>750</td>
<td>84</td>
<td>11.2</td>
<td>12.5</td>
<td>19</td>
<td>600</td>
</tr>
<tr>
<td>Processed cheese</td>
<td>370</td>
<td>62</td>
<td>6.8</td>
<td>5.2</td>
<td>23</td>
<td>330</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Starch Gel</th>
<th>E</th>
<th>$\sigma_c$</th>
<th>$G_c$</th>
<th>$G_c$</th>
<th>$\rho_e$</th>
<th>$\rho_c$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kPa</td>
<td>kPa</td>
<td>Jm⁻²</td>
<td>Jm⁻²</td>
<td>(\mu)</td>
<td>(\mu)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SENB Wire</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>63</td>
<td>40</td>
<td>2.2</td>
<td>2.3</td>
<td>44</td>
<td>43</td>
</tr>
<tr>
<td>2</td>
<td>150</td>
<td>80</td>
<td>3.6</td>
<td>2.3</td>
<td>25</td>
<td>35</td>
</tr>
<tr>
<td>3</td>
<td>15</td>
<td>3</td>
<td>(self weight fracture)</td>
<td>0.7</td>
<td>59</td>
<td>580</td>
</tr>
</tbody>
</table>

These are quite difficult to do and particularly for the gels where corrections for the self weight of the specimen are necessary. Indeed for one very fragile gel the specimen always failed when the beam was put on the supports. Overall, however, the agreement is good and the cutting test is far simpler. Estimates of the blunt crack radius are given together with $\rho_c$ and it can be seen that cheese does not self blunt whilst gels, in some cases, do.

An alternative is orthogonal cutting illustrated in Figure 5. Here chips of varying thickness h are removed and, in steady state cutting, the cutting force $F_c$ and the transverse
Figure 5. Orthogonal cutting (from [11])

force $F_t$ are measured. $F_t$ enables the frictional contribution to be determined and is hence, [11]

$$\left(\frac{F_c}{b} - \frac{F_t}{b} \tan \phi\right) = \frac{\sigma_Y}{2} \left(\tan \phi + \frac{1}{\tan \phi}\right) h + G_c$$

(14)

$\phi$ is the shear plane angle on which the shear stress is $\sigma_Y/2$ and can be determined from the chip thickness $h_c$ from,

$$\tan \phi = \frac{\cos \alpha}{h_c - \sin \alpha}$$

(15)

where $\alpha$ is the rake angle of the tool. The general form of equation (14) is similar to that for were cutting, equation (13). $G_c$ can be found by plotting $(F_c/b-F_t/b \tan \phi) vs h/2 (\tan \phi + 1/(\tan \phi))$ and figure 6 shows such data for a range of ductile polymers.

Figure 6. Orthogonal cutting data on polymers (data from [11])

5. Conclusions

Testing soft solids for toughness presents many challenges and the idea of basing an understanding of the mechanics via energy appears to be a good way to proceed. The issue of self blunting can be rationalised and quantified in terms of $G$ and when a true toughness is needed then cutting tests seem to provide useful schemes. Such methods are essential if fracture mechanics is to be used for such materials. I hope Alan Griffith would have approved of the approach.

6. References

2. Griffith A. A.; “Proc.of 1st Int. Congress for Applied Mechanics, Delft” (1924) 55-63
4. Lake G. J., Yeoh, O.H.; Int. J. Fracture 14(5); (1978) 509-526;
6. Inglis C.E.; Trans. Inst. Naval Architects; 60 (1913); 219-230
7. Williams J.G.; Fracture Mechanics of Polymers; Ellis Harwood, Chichester; 1984
ESIS Procedures and Documents
(free available for ESIS Members at [www.structuralintegrity.eu](http://www.structuralintegrity.eu))

Two kinds of documents are produced by ESIS Technical Committees with the following designatory system: ESIS P2-92 or ESIS P4-92D, where:
1. P means "Procedure", and 2 and 4 are the current numbers, while 92 is the year of issue.
2. D following the year (eg: 92D) means "draft", i.e: not yet approved, while
3. D prior to the year (eg: D1-92) means "Document" other than test methods.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
</table>
| **P1-92** | ESIS RECOMMENDATIONS FOR DETERMINING THE FRACTURE RESISTANCE OF DUCTILE MATERIALS.  
Responsible body: TC1 Subcommittee on Fracture Mechanics Testing Standards. |
| **P2-92** | ESIS PROCEDURE FOR DETERMINING THE FRACTURE BEHAVIOUR OF MATERIALS.  
Responsible body: TC1 Subcommittee on Fracture Mechanics Testing Standards. |
| **P3-03D** | DRAFT UNIFIED PROCEDURE FOR DETERMINING THE FRACTURE BEHAVIOUR OF MATERIAL  
Responsible body: TC1 Subcommittee on Fracture Mechanics Testing Standards (UNDER PREPARATION NOT AVAILABLE). |
| **P4-92D** | ESIS RECOMMENDATIONS FOR STRESS CORROSION TESTING USING PRE-CRACKED SPECIMENS.  
Responsible body: TC10 Committee on Environmental-Assisted Cracking. |
| **P5-00/VAMAS** | PROCEDURE FOR DETERMINING THE FRACTURE TOUGHNESS OF CERAMICS USING THE SEVNB METHOD  
Responsible body: TC6 Committee on Ceramics. |
| **P6-98** | ESIS PROCEDURE TO MEASURE AND CALCULATE MATERIAL PARAMETERS FOR THE LOCAL APPROACH TO FRACTURE USING NOTCHED TENSILE SPECIMENS.  
Responsible body: TC8 Committee on Numerical Methods. |
| **P7-00** | ESIS PROCEDURE FOR DYNAMIC TENSILE TESTS  
Responsible body: TC5 Subcommittee on Dynamic Testing at Intermediate Strain rates. |
| **P8-99D** | ESIS DRAFT CODE OF PRACTICE FOR THE DETERMINATION AND INTERPRETATION OF CYCLIC STRESS-STRAIN DATA.  
Responsible body: TC11 Committee on High Temperature Mechanical Testing. |
| **P9-02D** | GUIDANCE ON LOCAL APPROACH OF RUPTURE OF METALLIC MATERIALS. (UNDER PREPARATION NOT AVAILABLE). |
| **P10-02** | A CODE OF PRACTICE FOR CONDUCTING NOTCHED BAR CREEP RUPTURE TESTS AND INTERPRETING THE DATA.  
Responsible body: TC11 High Temperature Mechanical Testing Committee. |
| **P11-02** | TECHNICAL RECOMMENDATIONS FOR THE EXTREME VALUE ANALYSIS OF DATA ON LARGE NONMETALLIC INCLUSIONS  
Responsible body: TC20 Committee on Inclusions. |
| **D1-92** | FRACTURE CONTROL GUIDELINES FOR STRESS CORROSION CRACKING OF HIGH STRENGTH ALLOYS.  
Responsible body: TC10 Committee on Environmental Assisted Cracking. |
| **D2-99** | FRACTURE TOUGHNESS OF CERAMICS USING THE SEVNB METHOD; ROUND ROBIN, TEST PROGRAMME.  
The ESIS TC6 and VAMAS TWA3 developed a test method and conducted a round robin for its validation. D2-99 presents a detailed documentation of this activity. The final form of the test method has appeared as P5-00.  
Responsible body: TC6 Committee on Ceramics. |
2015
Membership Application Form
1ST JANUARY 2015 to 31ST DECEMBER 2015

European Structural Integrity Society

All members will be registered as Individual Members and will receive the ESIS Newsletter, at least once a year, by electronic delivery to the provided e-mail address.

Membership Fees should be paid either by Cheque or by Credit Card to the value of € 30 (Euros).

Please put a cross (X) in the appropriate box(es):

☐ Register me as an ESIS member for the year 2014 and send the ESIS Newsletters to the address stated below (in BLOCK CAPITALS please).

Payment details. All cheques are to be made payable to ESIS.

Since the membership fee is exceedingly cheap, PLEASE REGARD THIS FORM AS AN OFFICIAL INVOICE, noting that on receipt of your payment you will receive an official receipt plus your ESIS 2014 membership number.

☐ Enclosed is a cheque for € 30 (Euros) payable to ESIS (please write your name, and address on the reverse side of your cheque).

OR

☐ Enclosed is a copy of bank transfer for € 30 (Euros) to ESIS account by the Unicredit Banca, Bank Code IT 22 N 02008 01160 000020016279.

OR

☐ Please charge to my (delete as appropriate) EUROCARD / MASTER CARD / VISA CARD / DINERS CARD / AMERICAN EXPRESS CARD an amount of € 30 (Euros). My card number is:

Exp Date: — —

Surname: ____________________________ Name: ____________________________ Title(s): ____________________________

Affiliation: ____________________________

Address: _____________________________________________________________

________________________________________________________

e-mail: __________________________________________ Tel No: ____________________________

Fax No: __________________________________________

Signature: ____________________________ Date: ________________

For ESIS records purposes please give the numbers of the ESIS Technical Committees in which you are most interested

Technical Committee(s): ____________________________

All ESIS Procedures and books are free for ESIS Members at www.structuralintegrity.eu

Please return this form to:
ESIS Treasurer
Professor Giuseppe Ferro,
Dept. of Structural Engineering,
Politecnico di Torino,
Corso Duca degli Abruzzi 24
10129 Torino, Italy

or complete the web membership form at www.structuralintegrity.eu