DYMAT NEWS

N°27 September 1998 *Editor Thibault de Resseguier*

EDITORIAL

Here is the Dymat Newsletter again, in this beginning of school year, an appropriate time for starting new dynamics. In this issue, some words from our President, the titles of some thesis defended recently, and some announcements for the coming events related to our activities. Then some novelties, like Dymat on the Web and a few words on the AFM Association by Michel Stelly. Finally, a description of the Arcueil Technical Centre by Cyrille Kammerer.

C'est la rentrée de la Dymat Newsletter, en ce début d'année universitaire propice au lancement de nouveaux projets. Au sommaire, un mot du Président, les titres de quelques thèses soutenues récemment, et les annonces de conférences en rapport avec nos activités. Ensuite, le point sur quelques nouveautés, comme la Dymat sur le Web et quelques mots de Michel Stelly sur l'Association AFM. Enfin, une présentation du Centre Technique d'Arcueil par Cyrille Kammerer.

SOME WORDS FROM THE PRESIDENT

After this holiday period that I hope was very pleasant for all of you, here is the new issue of Dymat News. Since the last issue much work has been completed.

Firstly, the Dijon technical meeting has been organised by Richard Dormeval and his team. We hope that this meeting will be a success. It seems that it will be from the number of registrations.

Secondly, the web, Bradley Dodd and Michel Epinette (our web team) have completed a lot of work in order to make it as professional and as interesting as it can be. We hope that all of you will find on it all that you wish. Please feel free to make any comments or suggestions for modifications that you think could lead to our association becoming more well-known. Concerning the web, I would like to invite you to send by mail, fax, or preferably e-mail to Brad (**meldymat@etca.fr**) or to myself (**tthomas@etca.fr**) data related to your laboratory (expertise, equipment,..), theses and books written in your lab. All this data will permit us to show what Dymat is : a wonderful network of specialists that work in dynamic property fields!

Thirdly, some movements have been made in the field of standardisation : groups have been set up (you will find the list of groups and contacts in this pages) and some contacts have been made with a French organisation : BNS, Bureau de normalisation de la sydérurgie ; this organisation is dealing with standardisation. I think that with such actions it will be possible for Dymat to be a driving force in the field of standardisation of dynamic tests and simulations. We all know that some standards are very important for our industries to be able to specify tests on materials or structures and for us to make differences at other laboratories.

Lastly, the DYMAT 2000 meeting project is now on the road. You will receive more information soon.

Prof. Thierry Thomas
Centre technique d'Arcueil.

Standardisation

The experiments of members allows DYMAT to establish recommendations for dynamic test procedures.

These recommendations should allow you to specify more closely the test conditions which are required to evaluate the behaviour of your material at high rates of deformation or to better specify these material properties to your supplier.

A number of groups of members have been reassessing together these recommendations and supplementing them. The list of the groups and the name of the person in charge in each case is given below. Soon, you will be able to read the summary of this recommendation on our web.

If you wish to buy the recommendation in full contact us (you may use the web). If you want to participate to the work of one of these groups, or need to create one, do not hesitate to contact us.

Test	**Group leader**
Compression tests	André Lichtenberger
Tension tests	Klaus Hoog
Torsion tests	*To be defined*
Plate impact tests	Stephan Walley
Taylor tests	Hervé Couque
Dynamic toughness determination	Carlos Navarro
Bending tests	Carlos Navarro
Expending ring tests	*To be defined*

DYMAT and AFM

Association Française de Mécanique
(French Mechanical association)

Many DYMAT Members are interested by the links between DYMAT and the newly created French Association of Mechanics (AFM) and ask questions. Let us make the point and open possible discussions on this point.

Historical background

Since 1985, 17 French scientific societies (including DYMAT) dealing with the mechanics are associated in the « Groupe de Concertation de Mécanique » (concert group on mechanics).The main activity of this group was to have twice a year a meeting of the representatives of the different societies to exchange ideas and informations on the activities of their societies. After 12 years of this functioning it has been decided to strengthen the links and to create an Association merging some of the French scientific societies and offering to the other societies and to industrial companies a place for sharing some common activities. The « Association Française de Mécanique - AFM » (French Association of Mechanics) was born in December 1997. Three levels of membership are offered : personal membership for the scientists, academics or engineers involved in general mechanics who where already grouped in some French societies which have agreed to merge together (AUM, SFM, STF and others) ; membership for industrial companies (like RENAULT, DASSAULT, CEA, FRAMATOME, SOLLAC and others) which have decided to strongly support this Association because they are deeply involved in the field of mechanics (industrial membership); membership for scientific societies which are only partly involved in mechanics and consequently do not or cannot merge in the AFM (sectorial membership).

AFM goals and organisation

AFM intends to be the representative of the French Mechanics to the different French authorities and users and to the other foreign similar associations. AFM wants to be useful for the whole potential users and is ready to respond to their needs. AFM is organised in order to be the link between teaching organisms, research laboratories and industrial companies concerned by mechanics and has already created working groups dealing with scientific and technical subjects. AFM is publishing an internal journal and organises or supports technical meetings and conferences.

The position of DYMAT

Our Association presents two particularities : first our members are specialised in a particular field linking many different competencies in mechanics, metallurgy, ceramics, thermal, optics, electronics, modelling, experimentation and so on ; second we are an international Associations with only half of our members who are French. Consequently it was not possible and not justified to propose a merging of DYMAT in the nucleus of AFM and after many discussions we have decided to apply for a membership as sectorial member. We were accepted by the AFM board and at the subsequent election our representative, Michel STELLY, was elected as a Board Member. We are now about 10 sectorial members which have decided for similar reasons to keep our own identity but to be active members of AFM.

Our (DYMAT) objectives

We want to maintain our own activities and to keep our freedom and personality but we agree to work with other associations in order to improve our efficiency. In the statutes of AFM it is clearly indicated that the sectorial members are recognised as responsible of the domain relevant to their speciality and are in charge of the animation of this domain. They are invited to co-operate with at least the other members when possible. Consequently we think that there are no limitations concerning our normal activities but that we can improve our efficiency by working with other societies and using the strong incentive of the AFM. Being an international society is a plus for DYMAT which can be useful for AFM since we can be a guide for international co-operation knowing that AFM has relationships with other big national societies.

Here are some informations on this new AFM and on our links with it. If you want to comment please write, fax, e-mail or call us. In the next DYMAT News we will give you more news about the AFM activities and on our involvement in AFM.

Michel Stelly

EXPERTISE AND RESEARCH ACTIVITIES ON DYNAMIC PROPERTIESOF MATERIALS IN ARCUEIL TECHNICAL CENTRE

by Dr. Cyrille Kammerer
CTA, 16bis avenue Prieur de la Côte d'Or, 94114, Arcueil cedex, FRANCE

Arcueil Technical Centre is the main expertise centre of the "Délégation Générale pour l'Armement" (DGA) in the field of materials and structures. Its functions are to study the behaviour of materials under severe loading adapted to weapon systems, and to provide the expertise required for armament programs with the weapon systems architects. CTA also performs studies and expertise investigations for industries and manufacturers.

In order to carry out constitutive behaviour identifications and damage studies, CTA owns quasi-static test apparatus, high speed hydraulic test apparatus, and split-Hopkinson bars (these kinds of machine allow a good scan of strain rates: from quasi-static strain rates to ~ 5000 s^{-1}); in order to perform validations of armour concepts, it owns two gas guns (the first launcher : 5 g at 400 $m.s^{-1}$; the second : 300 g at 1200 $m.s^{-1}$ and 100 g at 2000 $m.s^{-1}$). Two FE codes can be used : Abaqus and PamShock.

In this way, the "dynamic behaviour and attenuating materials" group have four split-Hopkinson pressure bars technique apparatus. These allowed to create compression, tensile and torsion dynamic loading. Tests can be performed in order to know the constitutive compression, tensile or shear behaviour of materials, to identify fracture characteristics (I and III mode), or to study localisation phenomena with a punching test device. 700 to 5000 s^{-1} strain rate range, and -50 to 300 °C temperature range can be reached. The tests configuration are conventional : the specimen is placed between two bars, the input and output bars.

After the description of our split-Hopkinson bars devices, we present our acquisition possibilities, and, in a last part, the processing of experimental data in order to obtained mechanical characteristics of tested materials.

By using the compression split-Hopkinson bar apparatus, the material and the geometry of the bars can be adapted to the tested material, in the aim of the identification of its constitutive relationship linking the strains, the stresses, and the different conditions of test (strain rate, temperature,...). Usually, five tests are performed in a same configuration. In order to know the influence of strain rate or temperature, a minimum of three configurations are carried out, and complemented by static characterisations. Also, in the case of metallic materials, it is possible to be interested by the sensitivity of materials with adiabatic shearing, then a punching test device can be used. With our two tensile split-Hopkinson bars device, we can obtained the constitutive relationship of tested materials under tensile loading. We can also reach the values of strain during constriction phases before the final rupture, in the case of ductile tested materials for example, or the values of fracture strain in the case of a brittle material. One of these two tensile split-Hopkinson bar apparatus is specially devoted to the test on orthotropic materials (such as composites) with particular design for the fixing of specimens on the ends of bars. This geometry of fixing has the advantage of being simple (with a minimum of parts, and consequently with the minimum of contacts) and it therefore enables FE numerical simulations of the set (input bar, specimen, output bar). In the case of isotropic tested materials, we use axisymmetric specimens with screwed fixing. Identifications of shear behaviour are performed on torsion split-Hopkinson bars device. Then, the link between the specimen and the bars are six-sided. It allows the transmission of torsion loading.

Conventional measurements in using split-Hopkinson bars are performed by extensometric strain gauges which are bonded on bars. We use this type of gauges to know the deformation of bars. We also use optic extensometers to measure displacement of contrasted lines (Zimmer 199, 400 kHz). The experimental data are recorded on numerical oscilloscopes (Nicolet, Lecroy, from 1 $Ms.s^{-1}$ to 2 $Gs.s^{-1}$) and on fully programmable acquisition means (Nicolet, Multipromobil 3EL ; ~ 1 $Ms.s^{-1}$). In particular case (such as tests on polymeric materials), we use stress gauges (constantan or ytterbium gauges). Moiré technology, developed at the CTA, allows to know the strains map at different fixed times on a plane surface, by using an optic apparatus and an high-speed camera (IMCO Ultranac FS 501 ; 20.106 frames per second).

In the processing of experimental data in order to obtained mechanical characteristics of tested materials, the main difficulties is to compute precisely the mechanical loading (applied strengths and applied velocities), imposed to the specimens, from the experimental data which are recorded on bars. It can be done by time-scale settings of gauge signals ; but, in the case of tensile and compression tests, we are able to take into account radial inertia dispersion phenomenon by using the Pochammer-Chree corrections.

1) In the case of the identification of high strain rates constitutive behaviours, another difficulty is the homogeneity hypothesis : is the loading homogeneous in the specimen during the tests ? If the response is yes (in most of cases : metallic specimens for example), the constitutive relationship between stress and strain is easily known. In the other hand (in the case of polymeric materials or attenuating materials), we must do an assumption about the constitutive behaviour law. Then, the different material parameters are obtained with inverse methods : a minimisation algorithm is used to reduce the gap between experimental results and numerical simulations performed with the assumed constitutive behaviour law.

2) In the case of dynamic fracture analysis, notched cylindrical specimens can be used on torsion, tensile split-Hopkinson bars apparatus, CCS specimens (Compact Compression Specimen) on compression apparatus. For brittle materials, the H invariant method, developped by LMS - Ecole Polytechnique, can be applied for example on ceramics, glasses and very high strength armour steels. Recent developments in collaboration with this laboratory allow to extend this method to ductile failures by an appropriate coupling of two invariant methods : the conventional J-integral contour and the more recent H-invariant cited above.

LOOKING BACK

♦ *Some recent thesis*

M. Graton, "Comportement d'un composite 3D carbone-carbone : méso-modélisation pour la prévision de la réponse sous choc", Janvier 1998, ENS Cachan, France.

S. Hanim, "Modélisation de l'écaillage d'un aluminium et d'un acier, effet de la température initiale", Janvier 1998, Université de Metz.

K. Tsembelis, "Elevated temperature measurements during a hypervelocity impact process", March 1998, Unit for Space Sciences and Astrophysics, University of Kent at Canterbury, UK.

J.M. Lefeuvre, "Réponse au choc thermique de plaques composites et homogènes : application aux composites Ti-6Al/SiC. Juin 98, Ecole polytechnique, France.

A Juanicotena, "Etude théorique et expérimentale du comportement viscoplastique des matériaux aux grandes déformations et grandes vitesses de déformation ; application à l'acier Mars 190 et au tantale, Juillet 1998, Université de Metz, France.

T.D. Williams, "The frontal impact crashworthiness of a spaceframe chassis vehicle", 1998, School of Mechanical Engineering, University of Leeds, Contact Dr D.C. Barton, U.K..

Y-Y. Jing, "The response of rectangular cross-section tubes under lateral impact loading", 1998, School of Mechanical Engineering, University of Leeds, Contact Dr D.C. Barton, U.K..

S.D. Galbraith, "The response of potassium chloride, ammonium nitrate solutions, and emulsion explosives to plate impact loading", 1998, Dpt. of Physics, University of Cambridge, U.K.

C.F. Kennedy, "Liquid impact of IR materials : equipment development, damage thresholds and transmission losses", Cavendish Laboratory, University of Cambridge, Contact Pr. J.E. Field, U.K.

H. Miguelez, "Dynamic characterization of advanced materials at high strain rate and high temperature", September 1998, Universidad Carlos III de Madrid, Contact Pr. C. Navarro, Spain.

N. Bonnet, Etude du comportement mécanique sous sollicitations intenses d'élastomères ; application au cas du blindage réactif, Septembre 1998, Ecole Nationale Supérieure des Arts et Métiers, France.

♦ *New Journal*

The Shock and Vibration Digest (SVD), Editor-in-Chief Daniel Inman, e-mail dinman@vt.edu

♦ *Dymat on the Web*

There is now a Dymat site on the Internet, including a catalogue of competencies which every Dymat member is invited to fill and update : **http://www.etca.fr/dymat.**

LOOKING FORWARD

♦ *Coming Conferences*

- 11èmes Journées Thématiques DYMAT, 15 et 16 Octobre 1998, Dijon, France.
- Hypervelocity Impact Symposium HVIS'98, November 16-20, 1998, Huntsville, USA.
- 11èmes Journées Nationales sur les Composites, 18-19 Novembre 1998, Arcachon, France.
- 3rd Euromech - Mecamat Conference, November 23-25, 1998, Oxford, U.K.
- Workshop on the Mechanical Reliability of Polymeric Materials & Plastic Packages of IC Devices, 29 Novembre - 3 Décembre 1998, Paris, France.
- 3rd International Symposium on Impact Engineering ISIE'98, December 7-9, 1998, Singapore.
- 7th International Symposium on Plasticity, January 5-13, 1999, Cancun, Mexico.
- 7th International Seminar Euro-Pyro'99, June 7-11, 1999, Brest, France.
- 11th APS Topical Group on SCCM, 27 June - 2 July 1999, Snowbird, USA.
- AIRAPT XVII, July 25-29, 1999, Honolulu, Hawaï.
- 14ème Congrès Français de Mécanique, 30 Août - 3 Septembre 1999, Toulouse, France.
- Eurodymat'2000, September 2000, Cracow, Poland.

DYMAT REGULAR GENERAL ASSEMBLY
OCTOBER 15th, 1998
from 4.45 to 5.45 pm
"Cellier Sainte Beguine"
Place Sainte Beguine
21000 Dijon -France

Don't forget to send us your 1998 membership fee in order to be allowed to vote.
the amount is always 200 FF.