

TIME TABLE

TIME	Monday June 16	Tuesday June 17	Wednesday June 18	Thursday June 19	Friday June 20
9,00 - 9,45	Registration	Pijaudier-Cabot	Pijaudier-Cabot	Darve	Pastor
9,45 - 10,30	Darve	Vardoulakis	Pijaudier-Cabot	Darve	Pastor
11,00 - 11,45	Darve	Vardoulakis	Vardoulakis	Pastor	Pastor
11,45 - 12,30	Nova	Nova	Vardoulakis	Pastor	General discussion
14,30 - 15,15	Nova	Nova	Vardoulakis	Pastor	
15,15 - 16,00	Nova	Nova	Vardoulakis	Darve	
16,30 - 17,15	Nova	Pijaudier-Cabot	Vardoulakis	Darve	
17,15 - 18,00	Pijaudier-Cabot	Pijaudier-Cabot	Part. contributions	Part. contributions	

### ADMISSION AND ACCOMMODATION

The registration fee is 650,00 €, or 450,00 € for participants on the regular staff of Universities and Academies of Sciences.

The DFG offers scholarships for German students (Deutsche Forschungsgemeinschaft, Kennedyallee 40, 53175 Bonn, contact Mr. Höfeld +49 (0) 228 885 2321, <http://www.dfg.de/>).

Applicants must send the application form at least one month before the beginning of the course. Application forms can also be sent by post, or on-line through our web site: <http://www.cism.it>.

A letter of confirmation will be sent to accepted participants.

A limited number of participants from Universities and Academies who are not supported by their own Institutions can be offered board and/or lodging in a middle class hotel. **For this they should send their request to the Secretariat of CISM by April 16, 2003** and enclose a curriculum and a letter of recommendation by the Dean confirming that the Institute has no funds for financing their participation. Preference will be given to applicants from countries which have adhered to CISM and contribute to its operating resources.

A list of hotels in Udine is available at <http://www.cism.it>, or can be sent by post upon request.

For further information please contact:

CISM  
Palazzo del Torso - Piazza Garibaldi 18  
33100 Udine (Italy)  
tel. +39 0432 248511 (6 lines)  
fax +39 0432 248550  
E-mail: [cism@cism.it](mailto:cism@cism.it)  
<http://www.cism.it>



ACADEMIC YEAR 2003

The Onicescu Session

## *DEGRADATIONS AND INSTABILITIES IN GEOMATERIALS*

Advanced School  
Coordinated by

**F. Darve, INPG, Grenoble, France**  
**I. Vardoulakis, National Technical University  
of Athens, Greece**

**Udine, June 16 - 20, 2003**

**International Centre for Mechanical Sciences  
Centre International des Sciences Mécaniques**

## DEGRADATIONS AND INSTABILITIES IN GEOMATERIALS

Degradation phenomena (linked to cyclic loading, ageing, weathering, internal erosion, capillary effects, ...) in geomaterials can be treated today within the frame of constitutive theories such as anisotropic elasto-visco-plastic or damage relations, possibly extended to non-coaxiality, second gradient effects and incremental non-linearity. Besides the existing continuum chemo-mechanics framework can be utilized by assuming specific expressions for the chemical potential and by identifying the relevant chemo-stress effect on the basis of the dominant physico-chemical mechanisms for concrete and rocks.

Nowadays it is recognized that there is a large stress domain of bifurcations and instabilities of different types, leading to various modes of failure, strictly inside the "Mohr-Coulomb" plastic limit condition of granular materials. The existence of such instabilities before reaching the localization criterion and the Mohr Coulomb limit condition has been conjectured from the theory of non-associated elasto-plasticity and from the "controllability" theory. Some of these modes of rupture can be called "diffuse ruptures" and they seem to be leading mechanisms in certain types of slope failures, which can be simulated with the finite element method.

Once localized or diffuse failure has been triggered, a mass of soil may undergo a peculiar phase change and start moving in a fluid-like manner. Analytical and numerical models of flow-slides can be classified in full-3D formulations and in 1D "depth-integrated" or "shallow-water" models.

In recent years the use of scaled-down 1g laboratory experiments as well as 2D discrete element numerical models are proposed for analyzing granular flows and rockfalls. It is today possible to reproduce sliding overturning of a group of blocks, impacts (with fragmentation) on the rock slope and on the base debris, interaction with a sheltering structure.

This course is addressed to researchers in geomechanics, geoen지니어ing and civil engineering, who are interested by the recent developments in the modelling of degradations (of thermo-chemo-mechanical origin) and

of bifurcations and instabilities (leading to localised or diffuse modes of rupture) taking place in geomaterials (soils, rocks, concretes). Practical aspects will be considered in the applications (landslides, rockfalls, debris flows, concrete and rock ageing, ...).

### INVITED LECTURERS

**F. Darve** - Institut National Polytechnique de Grenoble, France  
*6 lectures on:*

Fundamentals of constitutive relations for geomaterials (constitutive functional, incremental relations, incremental piecewise linearity versus incremental non-linearity). Modes of failure (localised, diffuse) and the related instability criteria. Finite element versus discrete element modelling of failure in granular materials.

**R. Nova** - Politecnico di Milano, Italy  
*7 lectures on:*

Fundamentals of elasto-plasticity for geomaterials (non associativeness, hardening plasticity, Cam Clay model). Notion of non-controllability in loading tests and applications to slope stability problems. Weathering of geomaterials. Discrete element methods and applications to the modelling of rockfalls.

**M. Pastor** - University of Madrid, Spain  
*6 lectures on:*

Mathematical modelling of initiation mechanisms of landslides (rain, seismic loading), discretization techniques using finite element method for the initiation. Mathematical modelling of propagation phase, rheological models for debris flows and flowslides, discretization techniques for the propagation.

**G. Pijaudier-Cabot** - Ecole Centrale de Nantes, France  
*6 lectures on:*

Fundamental aspects of continuum damage, advanced damage modelling (induced anisotropy, microplane modelling, smeared crack models). Strain localisation due to strain softening, non-local damage models (integral and gradient formats). Ageing and damage (chemical, thermal and physical effects; damage on lattices, internal length scales).

**I. Vardoulakis** - National Technical University of Athens, Greece  
*7 lectures on:*

Uniqueness theorems. Localised bifurcations (Thomas-Hill Mandel shear band model, shear band analysis in plane-strain rectilinear deformations, strain softening behaviour). Second

gradient constitutive models (averaging and meaning of second gradient, a Mindlin-type second gradient linear elasticity). A second gradient plasticity model for granular materials.

### PRELIMINARY SUGGESTED READINGS

Computational Geomechanics, O.C. Zienkiewicz, A.H.C. Chan, M. Pastor, B.A. Schrefler and T. Shiomi (eds), John Wiley and Sons publ., 2000.

Constitutive Modelling of Geomaterials, B.Cambou and C. di Prisco (eds), Hermes publ., 2000.

Numerical Modelling in Geomechanics, M. Pastor and C. Tamagnini (eds), Hermes publ., 2002.

Micro-Crack Clustering, Non Local and Gradient Damage Models, G. Pijaudier-Cabot, Statistical Aspects of Damage, D. Krajcinovic and J.G.M. van Mier eds., Springer Verlag Publ., pp. 170-216, 2000.

Chemomechanical Effects in Mortar Beams Subjected to Water Hydrolysis, C. Le Bellego, B. Gerard and G. Pijaudier-Cabot, J. Engrg. Mech. ASCE, Vol. 126, pp. 266-272, 2000.

Bifurcation Analysis in Geomechanics, I. Vardoulakis and J. Sulem, Blackie Academic and Professional (Chapman & Hall) publ., 1995.

Fondamenti di Meccanica delle Terre, R. Nova, Mc Graw Hill publ., 2002.

An investigation on the uniqueness of the incremental response of elastoplastic models for virgin sand, S. Imposimato and R. Nova, Int. J. Mech. Cohes.-Frict. Mater., vol. 3, pp. 65-87, 1998.

Geomaterials Constitutive Equations and Modelling, F. Darve ed., Taylor and Francis Books (Elsevier Applied Science publ.), 1990.

Instabilities in granular materials and application to landslides, F. Darve and F. Laouafa, Int. J. Mech. Cohes.-Frict. Mater., vol. 5, n. 8, pp 627-652, 2000.

### LECTURES

All lectures will be given in English. Lecture notes can be downloaded from CISM web site, instructions will be sent to accepted participants.

**DEGRADATIONS AND INSTABILITIES  
IN GEOMATERIALS**

**Udine, June 16 - 20, 2003**

**Application Form**

(Please print or type)

Surname \_\_\_\_\_

Name \_\_\_\_\_

Affiliation \_\_\_\_\_

Address \_\_\_\_\_

E-mail \_\_\_\_\_

Phone \_\_\_\_\_ Fax \_\_\_\_\_

**Method of payment upon receipt of confirmation**  
(Please check appropriate box)

- I shall send a check of Euro 650,00 / 450,00  
(IVA, VAT included and excluded bank charges)
- Payment will be made to CISM - Bank Account N° 210900,  
VENETO BANCA - Udine (CAB 12300 - ABI 05418 - SWIFT AMBPIT2M)  
Copy of the receipt should be sent to the secretariat
- I shall pay at the registration counter with check, cash or VISA Credit  
Card (*Mastercard/Eurocard, Visa, CartaSi*)

**IMPORTANT: CISM is obliged to present an invoice for the above sum.  
Please indicate to whom the invoice should be addressed.**

Name \_\_\_\_\_

Address \_\_\_\_\_

C.F.\* \_\_\_\_\_

IVA or VAT\* \_\_\_\_\_

(\* Only for EU residents or foreigners with permanent business activity in Italy.

According to the Italian law 675/96 in defense of privacy, your personal data will be used exclusively for CISM's activities, any other use will require your explicit authorization.

Date \_\_\_\_\_ Signature \_\_\_\_\_

**Please return to:**

CISM, Piazza Garibaldi 18 - 33100 UDINE (Italy)