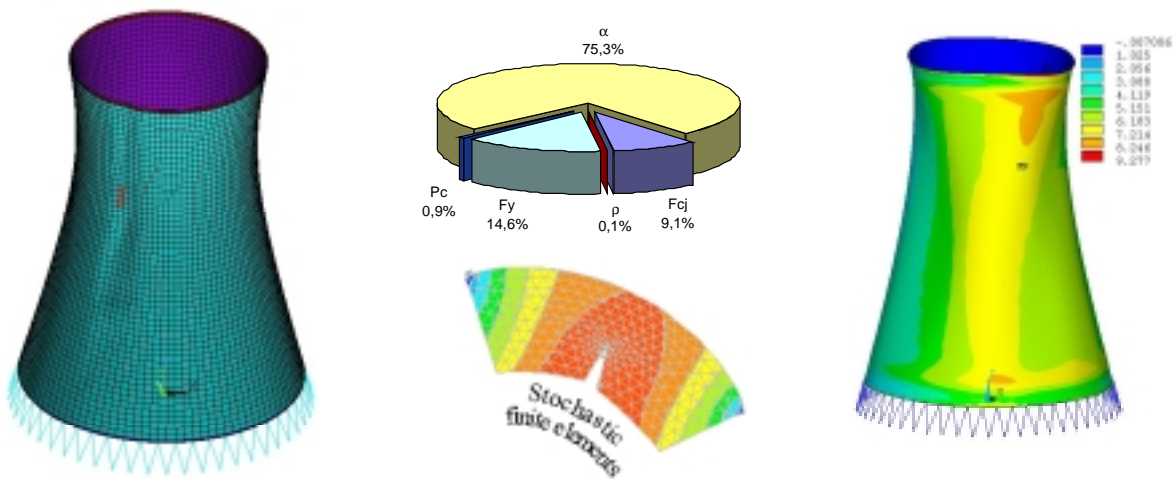


<b>Short description of the laboratory</b>		
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Main topics	Examples of activities	Number of scientists
<b>Structural and Materials Mechanics and Reliability</b>	<ul style="list-style-type: none"> <li>– Reliability-based design and optimization</li> <li>– Mechanical-Reliability coupling methods</li> <li>– Safety factor calibration for Reinforced concrete structures</li> <li>– Crack propagation analysis</li> <li>– Stability of thin shells</li> <li>– Composite material characterization and control</li> </ul>	8
<b>Dynamics of Mechanisms, Robots and Real-life Structures</b>	<ul style="list-style-type: none"> <li>– Identification of the parameters controlling the real working conditions</li> <li>– Analysis of vibrations, chocks and noise effects</li> <li>– Contact and friction in high speed manufacturing</li> <li>– Integrated design by using expert systems</li> </ul>	11
<b>Main equipment:</b> Reliability-based design software, Testing machines for composite materials, Manufacturing machines, Workstations		

<b><u>Activities related to the field of COST Action E24</u></b>
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**Probabilistic Mechanics of Structures** (M. Lemaire, A. Mohamed, A. Beakou, J.C. Mitteau, M. Pendola)

In mechanical modeling, the deterministic approach is shown to be insufficient to predict structural failure. The uncertainty effects are decisive information for high technologies, such as nuclear power plants, gas pipelines, submarines and aerospace systems. The objective is to develop mechanical-reliability methods taking account for geometrical and material nonlinearities, damage and crack propagation, fatigue cracking and time-dependent deterioration phenomena. In this scope, the research group has developed methods and numerical tools for coupling mechanical models with reliability procedures. The reliability methods have been applied to cracking of pressure vessels, to buckling of submarine and aerospace thin shells and to the design of composite materials. The problem of lack of statistical information has been studied and numerical solutions are proposed for practical reliability-based design. The calibration of safety factors is proposed for the design of reinforced concrete structures and for the maintenance of gas pipelines. Ongoing studies are carried out to take into account the time effects; these studies are applied to maintenance of nuclear power plants and aerospace industry.

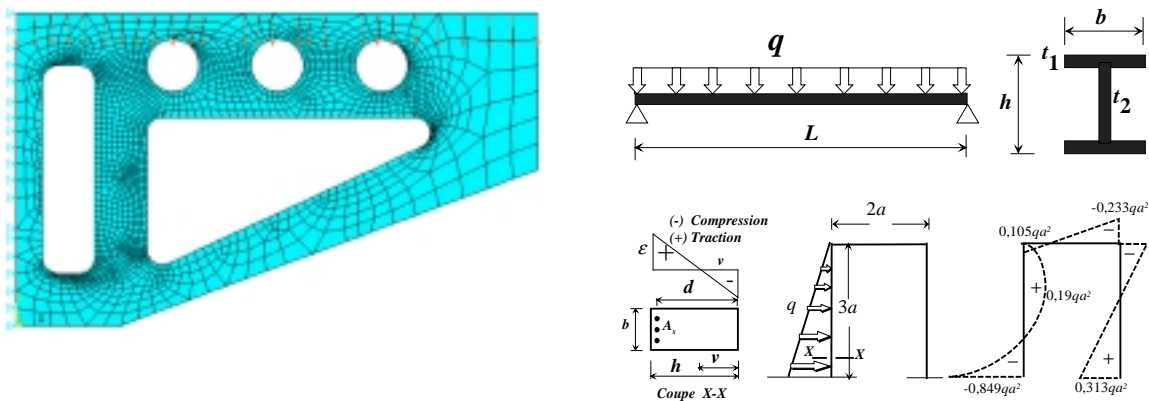


## Reliability-based Design and Optimization (A. Mohamed, M. Lemaire, G. Kharmanda)

The reliability analysis of real engineering structures requires sophisticated reliability and mechanical models. The coupling between these two models is subjected to many practical difficulties, such as computation cost, convergence stability and numerical error propagation. The sensitivity operators are integrated in the mechanical model in order to give accurate and fast schemes. A reliability-based design software (RYFES) has been developed, in order to ensure efficient coupling between reliability methods and standard finite element software. Industrial applications proved the high performance of the proposed coupling schemes, especially for nonlinear behavior.

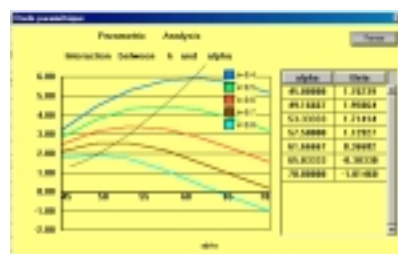
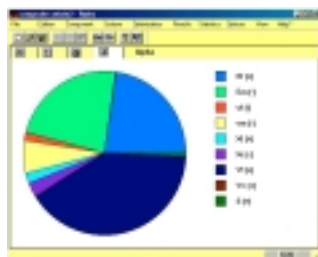
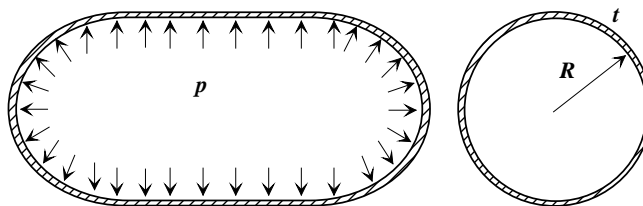
To design reinforced concrete structures, new safety factor format has been proposed in order to ensure homogeneous reliability levels, by integrating the design parameters such as material strength, cross-section dimensions, slenderness and reinforcement ratio.

Contrary to the deterministic structural optimization, the reliability-based optimization allows us to equilibrate cost and safety. But usually, this is very costly in computation time due to the coupling of mechanical analyses, reliability methods and optimization procedures. In a recent work, we have proposed a new formulation for this problem, having the advantage of very large reduction of the calculation time. For complex finite element models, the time cost reduction is more than 80%.



## Probabilistic Mechanics of Materials (A. Béakou, M. Drean, A. Mohamed, D. Marquis)

The design of composite material structures depends on many uncertainties in the mechanical properties and the material components (e.g. fiber orientations,...). The work of this research group covers two fields: the first field concerns the mechanical characterization of composite materials. The interest is given to data and response scattering, the influence of fabrication methods and the time deterioration phenomena. The second field proposes reliability-based design rules by integrating the system uncertainties. Original design recommendations have been given for the design of Cylindrical Laminated Composites (i.e. pressure vessels and pipelines), where the optimum winding angle depends on the variable scattering of the composite constituents as well as the loading path.



## Selected references

Partial safety factors for homogeneous reliability of nonlinear reinforced concrete columns

A. Mohamed, R. Soares and W. S. Venturini

Structural Safety, 2001.

Influence of variable scattering on the optimum winding angle of cylindrical laminated composites

A. Béakou and A. Mohamed

Journal of Composite Structures, 2001.

Combination of Finite Element and Reliability Methods in Nonlinear Fracture Mechanics

M. PENDOLA, A. MOHAMED and M. LEMAIRE

Reliability Engineering and System Safety, vol. 70, n° 1, pp. 15-27, 2000.

The use of sensitivity operators in the reliability analysis of structures.

A. Mohamed and M. Lemaire.

3rd Int. Conference on Computational Stochastic Mechanics, Santorini, Greece, 14-17 June, 1998.

Combination of Finite Element and Reliability: Application to Cracked Heating System

A. MOHAMED and M. LEMAIRE

Nuclear Engineering and Design, pp. 185-202, 1998.

The Use of Finite Element Codes for the Reliability of Structural Systems

M. LEMAIRE, A. MOHAMED and O. FLORES-MACIAS

Reliability and Optimization of Structural Systems, ed. Corotis R.B., Rackwitz R. and Frangopol D.M., IFIP WG7.5, Elsevier Sciences, Colorado, USA, pp. 223-230, 1997.

A New Tool for Reliability Based Design with ANSYS FEA

A. MOHAMED, F. SUAU and M. LEMAIRE

Seventh Int. ANSYS Conference and Exhibition, Huston, U.S.A., vol. 3, pp. 13-24, 20-22 may, 1996.

Linearized Mechanical Model to Evaluate Reliability of Offshore Structures

A. MOHAMED and M. LEMAIRE

Structural Safety, vol. 17, pp. 167-193, 1995.