# Approximation and definition of state variables for a comprehensive description of damage

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Over the past decades, non-linear models describing damage and fracture of architectured materials have highly progressed taking into account varied scenrios of degradation under complex multi-axial loadings. Many of these models remain expansive to numericaly handle and difficult to understand. In parallel, full-field measurement has brought a large quantity of data similar to the output of finite element results. A challenging task for the researcher is to extract information from that quantity of data. By definition, information is comprehensive in opposition to raw data. The extraction of this information needs a langage support. In a classical framework of physics, it generaly relies on state variables and the associated energetic potentials. In this paper, the automatic definition of state variables in two situations will be presented.

The first situation corresponds to a local case where the objective is to simplify an existing constitutive relation. As an example, an anisotropic damage model developped for military applications (highly loaded) has to be simplified to be used for civil applications (not severly loaded). For that, a subset of loadings is first defined as an approximation range. On this set, the response is computed for the initial model. The result is the evolution of several 4th order tensorial variables related to different crack networks. An approximation of these damage variables is chosen as a radial decomposition as well as a norm to be minimized. This classcial Principal Component Analysis leads to the definition of a simplified damage kinematics. Several choices of approximations and errors will be discussed [1, 2].

The second situation corresponds to a structural case where the objective is to simplify fields. The developped point of view relies on local patterns extraction associated to a PUM/GFEM method. After an introduction of this method with a manually constructed handbook of local function describing the local response of a composite in elasticity [4], an automatic building method is evaluated. It is based on the local extraction of features from global fields using Principal Component Analysis. The associated difficulties are shown. This part will end with the possibility to model some fracture in composite materials at the scale of the fiber using a handbook of crack patterns [3].

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## References

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