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Advanced constitutive relations for modeling thermo-viscoplastic behaviour of metallic alloys subjected to impact loading

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In this doctoral Thesis the thermo-viscoplastic behaviour of metallic alloys used for structural protection purposes has been analyzed. The study includes the proposition of advanced constitutive relations and their integration into numerical models. These numerical models are validated for impact problems within the low-intermediate range of impact velocities *(until 85 m/s)*.

The advanced constitutive relations derived are based on the **Rusinek-Klepaczko** model whose validity is extended to metallic alloys showing dependence on plastic strain on the volume thermally activated. In addition the constitutive relations developed allow describing macroscopically viscous drag effects at high strain rates, negative strain rate sensitivity and *martensitic* transformation phenomena.

Implementation of previous constitutive relations has been conducted into the **FE** code **ABAQUS/Explicit**. Thus, development of numerical models for the simulation of ring expansion test and conventional dynamic tension test has allowed analyzing the formation of plastic instabilities. In this analysis the effects of strain rate sensitivity, strain hardening and plastic wave propagation have been considered.

Finally, it has been examined the impact behaviour of metallic alloys widely used for structural protection purposes: the mild steel **ES**, the aluminium alloy **2024-T3**, the steel **AISI 304** and the steel **TRIP 1000**. For that goal conventional characterization tests as well as impact tests have been conducted. Numerical models based on the constitutive relations derived have been developed in order to simulate the impact tests. These numerical models offered a suitable description of the perforation process in terms of ballistic limit and the associated failure mode of the target.