Discussion about dynamic behaviour of materials and structures

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Abstract

To model the behavior of materials using constitutive relation, experimental tests are necessary. Generally, the tests consist of doing some tests for different loading paths (tension, compression, shear…), strain rates and temperatures. This kind of approach seems easy and many results are published in the international literature. However, depending on the authors the results may be different for the same material considered. For example, considering dynamic compression, it is observed that the material behavior change due to the specimen geometry used. The main reasons are related to the local inertia and the friction effect between the bars and the specimen. Not considering these effects induced an overstress state as it was discussed in details in [1]. The same aspects are also discussed in [2] for biaxial compression. In tension, the material behavior may be also disturbed, for example using short specimen under dynamic tension to increase the maximum strain rate, which can be reached with fast hydraulic machine [3]. In this precise case, not only the stress level is changed but also the hardening increase during plastic deformation. Thus, the material behavior defined, based on experiments is not only reporting the intrinsic material behavior of the material but also the geometric effect of the specimens, local inertia and fiction. Coming back to dynamic compression and tests at high temperatures, the specimen sandwiched between the Hopkinson Pressure Bars may be heated using different methods as induction [4], hot spot [5] or oven. Each technique has some advantages and disadvantages. Therefore, it is necessary to validate that the specimen temperature is corresponding to the assumed temperature without a large gradient of temperature along the specimen. The heterogeneous temperature in the specimen is mainly related to the heat transfer to the interface between the specimen and the bars but also by radiation in the air. For certain conditions, the process of elastic waves propagation may be disturbed as the elastic waves measured using stain gauges [6].

Concerning the structures, influence of projectile nose shape on the perforation of a thin steel sheet. Experimental, analytical and numerical investigations have been carried out to analyze in details the perforation process. The projectiles have conical, blunt and hemispherical tipped noses, additional test results are also obtained for six different included angles of the conical strikers. A wide range of impact velocities from 35 to 180 m/s has been covered during the tests. As discussed before, the measurements must be precise mainly when the force history is measured using for example piezoelectric sensor [7]. This point will be discussed and the boundary conditions used analyzed in details. Moreover using an inverse method, it is

observed that the sensors are not reporting exactly the force history during the process of perforation.

In conclusion, even if many experimental results are published in international journals, a careful attention must be paid when experiments are used to propose a model. A good understanding of the measure is necessary to avoid modeling not only the material or structure behavior but also the behavior with some artifacts.

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