

Design, Development and Testing of Split Hopkinson Tension and Compression Bar Setup for High Strain Rate Material Testing

Abstract

The recent advancements in the potential development of composite materials have found numerous applications in the area of ballistic protection. The composite materials intended to be used for ballistic protection are strain rate dependent, i.e. they respond differently under quasi static and dynamic loading. During development stage, the performance of ballistic protection materials and their properties at high strain rate are of paramount importance in order to assess safety and structural integrity. Conformance to the specified standard levels of ballistic protection requires mechanical characterization of developed materials at high strain rates. Over the years, Split Hopkinson Pressure Bar (SHPB) in various modes, i.e. tension, compression, torsion has been utilized for mechanical characterization of different materials at high strain rate. In this study, an innovative approach of SHPB for tensile and compressive high strain rate testing on a single setup is designed based on elasticity of materials and then developed and tested for variety of candidate materials. The dynamic effect of strain rate on stress strain curve is reported and analysed for different categories of materials. The mutual assessment of experimental observations and numerical predictions of SHPB setup along with their comparison is also presented. In addition to this, the numerous design modifications of SHPB are discussed in this study which primarily includes mechanisms for generation of stress waves, improvement in mounting of specimen, rationale for eliminating noise signals and adequate alignment of bars. In addition to this, the behavioural analysis of different metals, composites, ballistic protective materials when subjected to SHPB testing is discussed in detail.

Keywords: Split Hopkinson Pressure Bar, High Strain Rate Testing, High Strength Low Alloy Steels, Ballistic Protective Composite Material.