NUMERICAL HOPKINSON BAR ANALYSIS: VALIDITY OF ONE-DIMENSIONAL ASSUMPTIONS

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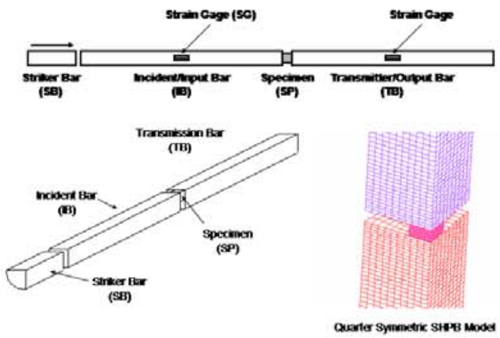
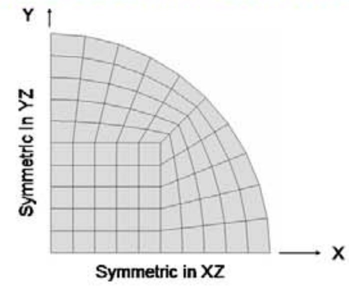
OBJECTIVES

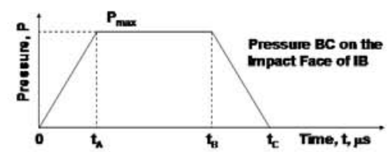
- Develop Numerical Hopkinson Bar Model
- Validate the Model
- Investigate the Validity of One-Dimensional (1D) Split Hopkinson Pressure Bar (SHPB) Assumptions



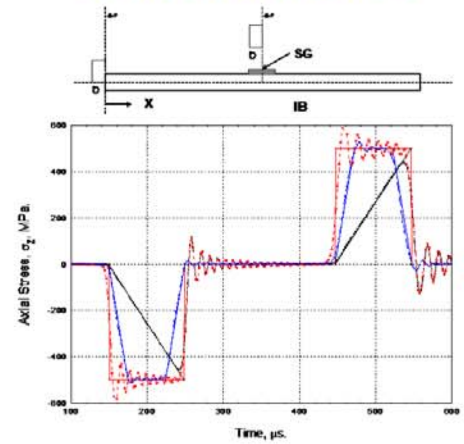
Finite Element Model of Compression Split Hopkinson Pressure Bar

INITIAL AND BOUNDARY CONDITIONS



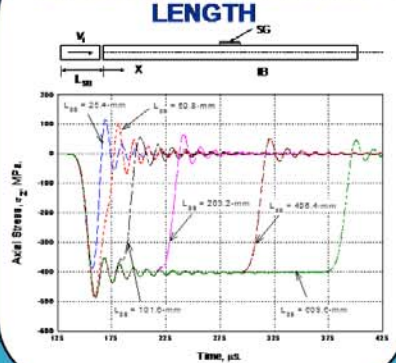


EFFECT OF PULSE SHAPE

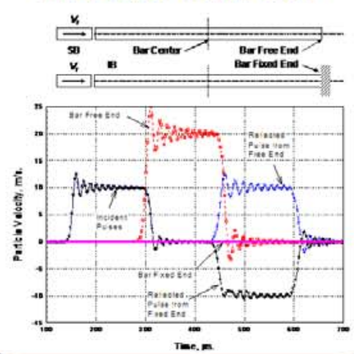


Shaped Pulse Reduces the Pochammar Modes

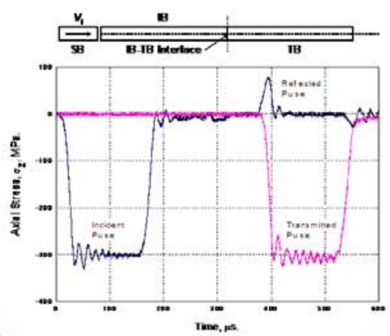
EFFECT OF STRIKER BAR LENGTH



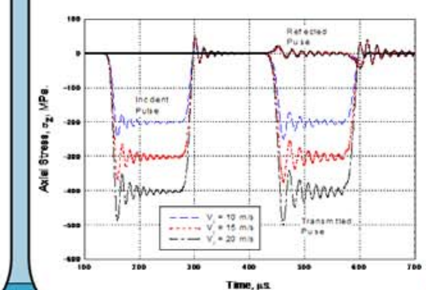
PARTICLE VELOCITY AT A FREE AND FIXED END



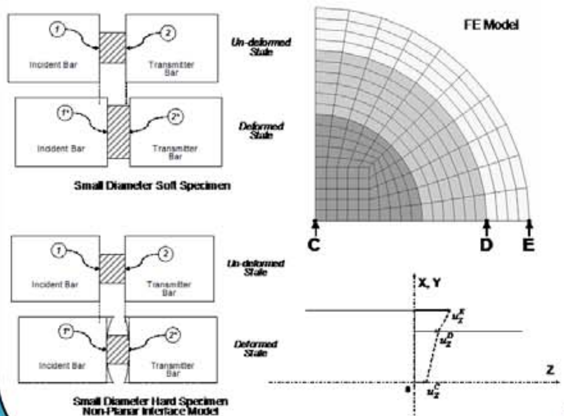
BARS APART CALIBRATION EXPERIMENT



BARS APART NUMERICAL SIMULATION

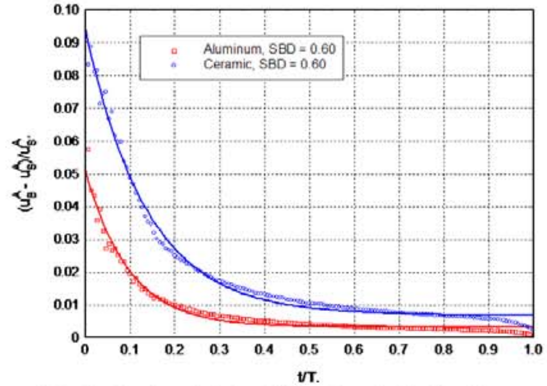


VALIDITY OF 1D ASSUMPTIONS: PLANAR BAR SPECIMEN INTERFACE



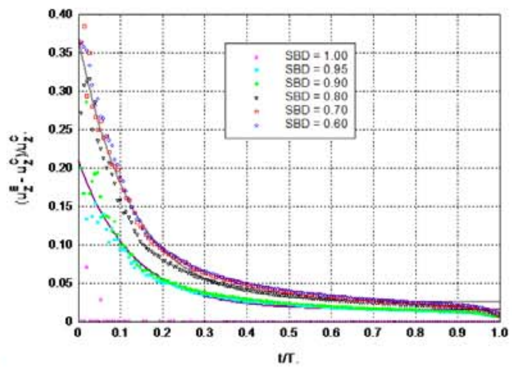
Definition of Bar-Specimen Interface Displacements

DIMENSIONLESS NON-PLANAR INTERFACE PARAMETER



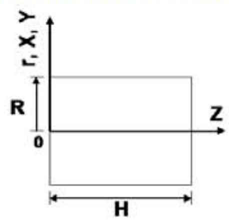
The Bar-Specimen Interface is Non-Planar in the Time Range 0 < t/T < 0.2 ~ 0.5, and is a Function of the Elastic Modulus of the Specimen

NON-PLANAR INTERFACE PARAMETER: EFFECT OF SPECIMEN DIAMETER



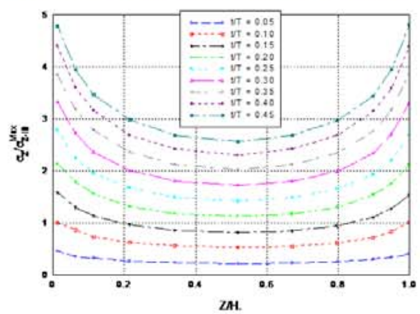
For Small-Diameter Specimens, the Interface is Non-Planar Interface is Planar for Equal-Diameter Specimens

VALIDITY OF 1D ASSUMPTIONS: UNIAXIAL STRESS IN THE SPECIMEN



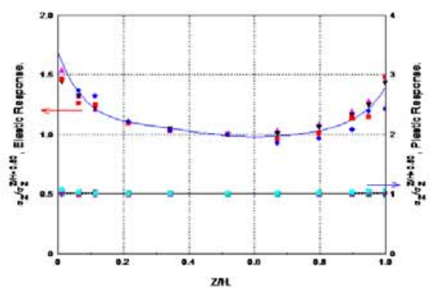
Analyses of Axial Stress, σ_Z, along the Surface of the Specimen at r/R = 1.0

ELASTIC ALUMINUM SPECIMEN



Elastic Stress Distribution is not Uniaxial

ELASTIC-PLASTIC ALUMINUM SPECIMEN



Stress Distribution is not Uniaxial in Elastic Phase; however, it is Uniaxial in the Plastic Phase of Deformation

SUMMARY

1. A quarter-symmetric finite element model of the compression split Hopkinson pressure bar is developed
2. The model is validated and verified, and is used in the study of the validity of 1D Hopkinson bar assumptions
3. The bar specimen interfaces are non-planar for small diameter specimens, in which case the elastic strain prediction from the experiment is higher
4. The specimen is not under a uniaxial state of stress in the elastic phase but is uniaxial in the plastic phase of deformation

ACKNOWLEDGEMENTS

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